DST # 2

GAUGE # 111

INITIAL SHUT-IN

t_{f_1} = 14 min

Δt (min)	$\frac{t_{f_1}+\Delta t}{\Delta t}$	P_{ws} (psi)
0	—	1842.1
1	15	2022.4
2	8	2241.6
3	5.667	2275.0
4	4.500	2286.8
5	3.800	2291.1
6	3.333	2293.8
7	3.000	2297.2
8	2.750	2298.4
9	2.556	2300.2
10	2.400	2300.8
12	2.167	2302.7
14	2.000	2304.2
16	1.875	2306.6
18	1.778	2307.8
20	1.700	2308.1
22	1.636	2309.0
24	1.583	2309.0
26	1.538	2309.6
28	1.500	2309.6
30	1.467	2309.6
35	1.400	2309.6
40	1.350	2310.3
45	1.311	2310.3
50	1.280	2310.3
55	1.255	2312.1
60	1.233	2311.8

DST # 2

GAUGE # 254

INITIAL SHUT-IN

t_{f_1} = 14 min

Δt (min)	$\frac{t_{f_1} + \Delta t}{\Delta t}$	P_{ws} (psi)
0	–	1858.6
1	15	2099.0
2	8	2263.1
3	5.667	2286.0
4	4.500	2301.7
5	3.800	2306.3
6	3.333	2311.9
7	3.000	2316.0
8	2.750	2319.3
9	2.556	2320.6
10	2.400	2322.8
12	2.167	2324.9
14	2.000	2325.9
16	1.875	2327.4
18	1.778	2229.2
20	1.700	2330.7

Δt (min)	$\frac{t_{f_1} + \Delta t}{\Delta t}$	P_{ws} (psi)
22	1.636	2330.7
24	1.583	2331.2
26	1.538	2332.0
28	1.500	2332.0
30	1.467	2332.0
35	1.400	2332.0
40	1.350	2333.3
45	1.311	2333.5
50	1.280	2333.5
55	1.255	2334.3
60	1.233	2333.8

DST # 2

GAUGE # 254

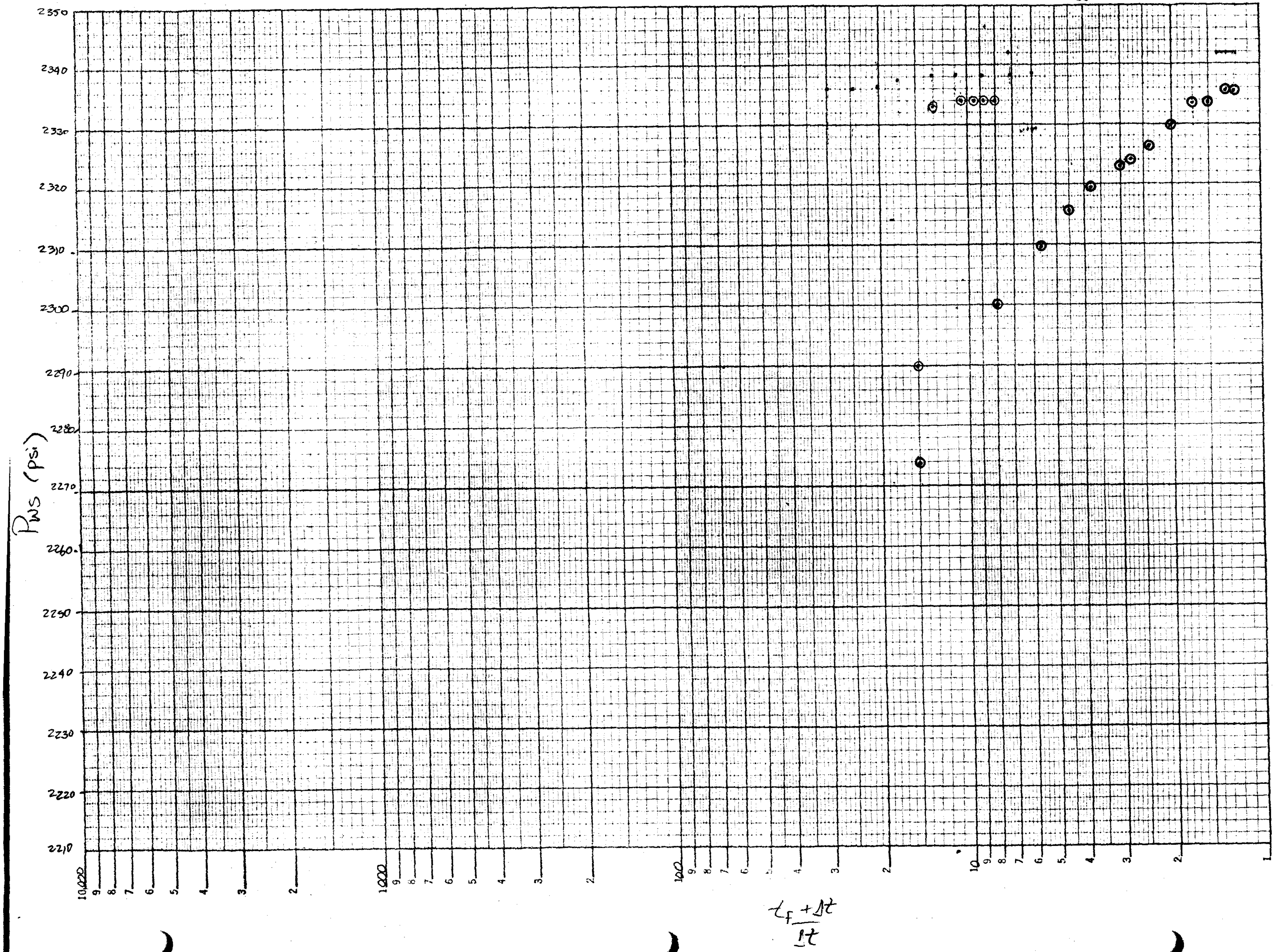
SECOND SHUT-IN

t_{f2} = 2542 min

Δt (min)	$\frac{t_{f2}+\Delta t}{\Delta t}$	P_{ws} (psi)
0		2562.5
30		2511.6
60		2282.6
90		2266.9
120		2636.5
150		2350.7
180		2220.9
210		2262.6
240		2263.1
270		2263.1
300		2263.1
330		2263.7
360		2268.2
369		2267.5

Clock RAN OUT IN THIRD FLOW

GAUGE # 207



2350
2340
2330
2320
2310
2300
2290
2280
2270
2260
2250
2240
2230
2220
2210
Pws (psi)
10,000
1000
100
10
1
$\frac{t_f + \Delta t}{\Delta t}$

DATA IS QUESTIONABLE

DST #2

GAUGE # 207

INITIAL SHUT-IN

t_{f_i} = 14 min

Δt (min)	$\frac{t_{f_i} + \Delta t}{\Delta t}$	P_{ws} (psi)
0	—	1860.6
1	15	2273.7
2	8.0	2299.9
3	5.667	2309.6
4	4.500	2315.8
5	3.800	2319.4
6	3.333	2321.1
7	3.000	2323.1
8	2.750	2324.1
9	2.556	2325.0
10	2.400	2326.5
12	2.167	2328.6
14	2.000	2329.9
16	1.875	2331.9
18	1.778	2333.1
20	1.700	2333.6

Δt (min)	$\frac{t_{f_i} + \Delta t}{\Delta t}$	P_{ws} (psi)
22	1.636	2333.6
24	1.583	2333.6
26	1.538	2333.6
28	1.500	2333.6
30	1.467	2333.8
35	1.400	2334.4
40	1.350	2335.1
45	1.311	2335.7
50	1.280	2336.1
55	1.254	2336.1
60	1.233	2335.5

DATA IS QUESTIONABLE

DST #2

GAUGE #207

SECOND SHUT-IN

$t_{f_2} = 2542$ min

Δt (min)	$\frac{t_{f_2}+\Delta t}{\Delta t}$	P_{ws} (psi)
0	—	2637.0
30	85.733	2587.6
60	43.367	2357.2
90	29.244	2346.2
120	22.183	2709.6
150	17.947	2433.2
180	15.122	2290.0
210	13.105	2333.0
240	11.592	2333.0
270	10.415	2334.2
300	9.473	2334.2
330	8.703	2334.2
360	8.061	2334.2
369	7.889	2334.2

DATA IS QUESTIONABLE

DST #2

GAUGE #207

THIRD SHUT-IN

$t_{f_3} = \sum_{i=1}^{2} t_{f_i}$

$t_{f_3} = 3174$ min

Δt (min)	$\frac{t_{f_3}+\Delta t}{\Delta t}$	P_{ws} (psi)
0	—	2189.3
1	3175	2306.1
2	1588	2312.1
3	1059	2315.7
4	794.5	2319.0
5	635.8	2320.5
6	530.0	2323.0
7	454.429	2325.0
8	397.750	2326.0
9	353.667	2328.0
10	318.400	2328.8
12	265.500	2329.3
14	227.714	2331.0
16	199.375	2331.0
18	177.333	2331.2
20	159.700	2332.0
22	145.273	2332.3
24	133.250	2332.7
26	123.077	2333.1
28	114.357	2333.1
30	106.800	2333.1
35	91.686	2334.0
40	80.350	2335.1
45	71.533	2335.1

Δt (min)	$\frac{t_{f_3}+\Delta t}{\Delta t}$	P_{ws} (psi)
50	64.480	2335.1
55	58.709	2335.5
60	53.900	2336.1
70	46.343	2336.1
80	40.675	2336.1
90	36.267	2336.1
100	32.740	2336.1
110	29.855	2336.1
120	27.450	2336.1
135	24.511	2336.3
150	22.160	2336.6
165	20.236	2336.6
180	18.633	2337.4
195	17.277	2337.4
210	16.114	2338.3
225	15.107	2338.3
240	14.225	2338.3
260	13.208	2338.3
280	12.336	2338.3
300	11.580	2338.3
320	10.919	2338.3
340	10.335	2338.3
360	9.817	2338.3
380	9.353	2338.3

→ DATA IS QUESTIONABLE

DST #2

GAUGE # 207

THIRD SHUT-IN (CON'T)

Δt (min)	$\frac{t_{f3}+\Delta t}{\Delta t}$	P_{ws} (psi)
400	8.935	2338.3
460	7.900	2338.3
520	7.100	2338.3
580	6.472	2338.3
626	6.070	2338.7

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HAMMERHEAD

RESERVOIR

STUDY

-OCS-Y 0849 #1

-J Lavrie

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DST #1 SUMMARY

Drill Stem Test (DST) #1 was carried out by Union on a sandstone interval which was perforated from 5442'-5462' and from 5470'-5490' (MD, TVD). Well logs showed a shale interval between the two sets of perforations.

D

DST #1 was conducted through a 9 5/8" liner and consisted of a series of four flow tests and four buildup tests. Only the third and fourth buildup periods were analyzed for this study.

Shut in periods one and two were not analyzed due to wellbore storage effects. Wellbore storage masks accurate information on the formation of interest. These effects can be seen on Log-Log plots 2 and 4 as lines of unit slope for these first two shut in periods.

Flow tests produced oil and water with only a trace of gas. Union reported an oil flow rate (q_o) of 31 BPH (744 STB/D) on their DST #1 summary sheet (copy enclosed) yet this value was not used in this analysis. Upon evaluating flow period #2 data it was determined that a more accurate average value of q_o was 13.5 BPH (325 STB/D). If testing continued the value of q_o would have probably stabilized at a rate close to 300-400 STB/D.

An average water rate (q_w) of 297 BWPD was calculated from flow test #2 data for use in this report.

The reservoir fluid data provided by Core Laboratories, Inc. for this well are based on a recombined sample from crude oils from both DST #1 and DST #2. The reported properties were used for both tests. It should be noted that this procedure could

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cause significant errors in a reservoir evaluation. If both zones contain fluids of differing properties an average fluid sample may not reflect these differences as well as one would like.

(5) A major problem for this analysis is one of gas. The recombined fluid sample used by Core Lab was injected with pure methane to simulate formation gas. This is appropriate for DST #2 which produced gas very similar to pure methane at a rate of approximately 202,000 SCF/D and a crude oil with a Gas-Oil-Ratio (GOR) of 220-255 SCF/STB, yet it may not be appropriate for DST #1 which only produced a trace of gas. Though using the fluid properties for DST #1 may cause erroneous conclusions we are forced to use this data since fluids from both zones were not analyzed seperately.

Horner analysis for the third and fourth shut in periods for Gauges 111 and 155 yielded a wide range of results. Calculated oil permeabilities (k_o) ranged from 1888 millidarcies (md.) to 2373 md., with an average value of 2131 md. The best estimate of k_o is 1888 md. which was obtained for the third shut in period from Gauge 111. This value seems more in line with sidewall core values (680 md average for this zone) and log calculated values than the other permeability values.

Horner analysis gave reservoir pressures (P^*) ranging from 2302 psi to 2330 psi with an average value of 2313 psi. The best estimate of P^* was 2310 psi which was calculated for the third shut in period for Gauge 111,

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3 and for the fourth shut in period for Gauge 155. Average reservoir pressures ($\bar{P}$) ranged from 2289 psi to 2318 psi with an average value of 2299.5 psi. The best estimate for $\bar{P}$ was 2295 psi calculated from Gauge 111 for shut in period three. For DST #1 all $\bar{P}$ values were less than P^* values. This is usually the case is closed, single well reservoirs. Though this phenomenon leads us to believe that this reservoir is a closed reservoir the Horner plots gave no indication of boundaries. This is not to say that boundaries do not exist, just that the shut in periods did not provide information far enough into the reservoir to detect these boundaries.

Core Lab reported a bubble point pressure (P_{BP}) of 2391 psig at a reservoir temperature of 100°F. Since all of the calculated P^* and $\bar{P}$ values are below the reported P_{BP} value one is lead to believe that the reservoir is below its bubble point. If a reservoir is at a pressure below its bubble point normally a free gas cap exists, yet for this zone no gas was produced nor was a gas cap indicated on the well logs. Possible explanations for this include; that the reservoir has lost all of its gas through upward migration, the average fluid properties from Core Labs report for this zone are in error, or that the wellbore did not intersect the gas cap. This last explanation seems like the most valid one. The gas cap, which may be very small could be updip from the well, probably to the North-North East of the Hammerhead location. The well-bore could have only intersected the oil zone which is devoid of gas since the reservoir pressure is

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below the PBP value. Further drilling and/or Fluid studies will have to be conducted to

(4) answer this question

Other calculations show that the zone tested during DST #1 is damaged. This can be seen by looking at the calculated Skin factors. Both Gauges # 111 and # 155 gave positive values for skin for shut in period three and negative values for shut in period four. A positive value for skin indicates damage while a negative value indicates enhancement. Since the third shut in period lasted for 367 minutes (Δt = 367 minutes) and the fourth shut in period lasted for 659 minutes we can conclude that the fourth shut in is looking farther into the formation than the third shut in period. Skin damage due to drilling and cementing should be localized around the wellbore. Further away from the wellbore these effects should be minimal.

The calculated Skin values for DST #1 fit the theroy explained above. For the third shut in period Gauge # 111 gave a skin value of + 31.68 (Damage) and Gauge # 155 gave a skin value of + 35.17 (Damage). For the fourth shut in period Gauge # 111 had a skin value of − 0.468 (slight enhancement) and Gauge # 155 had a skin value of − 1.61 (enhancement). This shows that the formation around the well bore is damaged while the formation further away from the wellbore is slightly enhanced. This enhancement may be due to natural fractures in the rock. If this well was to be produced the damaged zone could be removed by acidization or hydraulic fracturing, resulting in a decrease in Skin value.

The flow efficiency (F.E.) calculated for

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this zone varied from +0.18 to +1.224, with an average value of +0.66. Basically, this tells us that the production rate from this zone could increased by 34% ((1-.66) x100) by removing the damage, or possibly more than 34% with an acid or fracture treatment.

(5)

Reserve calculations for this zone resulted in the following values; Initial Oil In Place (IOIP) = 1176 STB/AC-FT OR 1291 RB/AC-FT. These calculations were based on 45 FEET OF pay, a 26% porosity, and an oil saturation value of 64%. If it is assumed that primary depletion of the reservoir allows us to recover 30% of the IOIP and if the reservoir size is taken as 5000 acres, the volume of recoverable oil is found to be 79×10^6 STB. This factor will change as more information on the size of the reservoir is obtained through further drilling. At the present time this is a ball park estimate of recoverable oil.

Based on the above information and other results of this study the author recommends that well OCS-Y 0849 #1 be determined capable of producing hydrocarbons in paying quantities as stated in OCS Order #4.

J. Levine
2/5/86

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DST #1 ANALYSIS PARAMETERS

r_w = 0.4010 Ft. (9 5/8", 47#, N-80 Buttress Liner) Union
°API = 19.6° @ 60°F (Flow Test #2 Data Sheet)
⑥ Sg_{oil} = 0.936 @ 60°F (Calculated)
γ_{gas} = 0.561 = gas Gravity (Union DST #1 Summary Sheet)
h = 45 Feet (Logs)
θ = Angle of Deviation = 0° (Vertical Well)
ϕ = 26 % (Computer Estimate)
BHT = 100°F = Reservoir Temperature (Core Report, Logs)
(*) $\bar{q}_o$ = 325 STB/D (Calculated Average Value From Data Sheet)
$\bar{q}_w$ = 297 BWPD (ST) (Calculated From Flow Test #2 Data Sheet)
$\bar{q}_g$ = 0 (Union stated Rate was To Small To Measure)
GOR ≈ 220 SCF/STB (DST #2 Data Sheet)
B_w = 1.0044 RB/STB @ 100°F, 2300 psi (Calculated)
μ_w = 0.752 cp @ 100°F, 2300 psi (Calculated)
C_w = 2.69×10^{-6} psi^{-1} @ 100°F, 2300 psi, 49,500 ppm NaCl (Calculated)
μ_o = 20 cp @ 100°F, 2350 psi (Core Lab Report, P. 11)
C_o = 4.8×10^{-6} psi^{-1} @ 2700 psig to 2391 psig (Core Lab Report, P. 2)
B_o = 1.098 $\frac{RB \text{ @ } 2391 \text{ psig}, 100°F}{STB \text{ @ } 60°F}$ (Core Lab Page 11)
C_f = 3×10^{-6} psi^{-1} @ ϕ = 26 % (Calculated)
C_t = 7.04×10^{-6} psi^{-1} (S_g = 0) (Calculated)
S_o = 64 % (Computer Estimate)
S_w = 36 % (Computer Estimate)
P_{BP} = 2391 psig @ 100°F (Core Lab Page 2)
P^* = Reservoir Pressure = 2310 - 2330 psi (Calculated)
Depth Tested = 5442' - 5462' and 5470' - 5490'

(*) This value is an average value calculated over the entire second Flow period. Unions value of 744 STB/D on the Summary Sheet seemed to high. The 325 STB/D value is close to a stabilized value

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(9)

ESTIMATION OF OIL PARAMETERS

The Reservoir Fluid Data Report prepared by Core Labs was made up of oil from both, DST #1 and DST #2. The parameters calculated from this sample can be taken as being average values from both zones. Due to this, oil properties for both tests will be the same for this analysis.

This sample was a recombined sample. Pure methane gas was added to the oil at the laboratory to simulate solution gas. It should be noted that the produced gas in DST #2 had a gas gravity of 0.576 and the gas from DST #1 a gas gravity of 0.561. The gas gravity of pure methane is 0.5539, @ 60°F, which is very close to that of the produced gas. Additionaly, the critical pressure and temperature values calculated for the gas of DST #2 are very close to that of pure methane.

TOTAL COMPRESSIBILITY CALCULATION ; C_t

$$C_t = C_o S_o + C_w S_w + C_g S_g + C_f$$

($C_g S_g \to 0$: No Free Gas)

$C_f = 3 \times 10^{-6}\ psi^{-1}$, (For $\phi = 26\%$), Monograph #5, Figure D-12, Page 229

$$\therefore\ C_t = (4.8 \times 10^{-6})(.64) + (2.69 \times 10^{-6})(.36) + 3 \times 10^{-6}$$

$$C_t = 7.04 \times 10^{-6}\ psi^{-1}$$ (Calculated, $S_g = 0$) (*)

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Calculation of Water Parameters

1) C_w; Compressibility of water

Assuming no gas in solution and 49,500 ppm NaCl;

∴ Monograph #5, Figures D-16 and D-17

C_w @ 100 °F and $P \simeq 2300$ psi

$C_w = 2.69 \times 10^{-6}$ psi^{-1} (*)

2) μ_w; Viscosity of Water

Assuming no gas in solution and 49,500 ppm NaCl (0.045 % NaCl).

∴ Monograph #5, Figure D.35

@ 100 °F and 1 atm; $\mu^*_T = 0.75$ cp

$f = 1.003$ @ 100 °F, 2300 psi

∴ $\mu_w = (\mu^*_T)(f) = (0.75\text{ cp})(1.003)$

$\mu_w = 0.7522$ cp (*)

3) B_w; Formation Volume Factor of Water

Assuming No gas in solution

$B_w = (1 + \Delta V_{wp})(1 + \Delta V_{wT})$

William D. McCain JR., "The Properties of Petroleum Fluids", Page 279, Figure 6.7

@ 100 °F; $\Delta V_{wT} = 0.007$

Page 280, Figure 6.8

@ 100 °F / 2300 psi; $\Delta V_{wp} = -0.0026$

∴ $B_w = (1 + (-0.0026))(1 + 0.007)$

$B_w = 1.0044$ RB/STB (*)

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TABLE #2

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO

GAUGE #111, SECOND SHUT IN PERIOD DATA

$t_p = 6.5 + 641 = 647.5$ minutes

$p_{wf} = 2278.5$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
0	2278.5	—	—	—
30	2278.8	0.3	22.58	1.354
60	2279.4	0.9	11.79	1.072
90	2280.6	2.1	8.19	0.914
120	2280.6	2.1	6.39	0.806
150	2282.1	3.6	5.32	0.726
180	2282.4	3.9	4.59	0.663
210	2283.3	4.8	4.083	0.611
240	2283.9	5.4	3.69	0.568
270	2283.9	5.4	3.39	0.531
300	2285.1	6.6	3.16	0.499
330	2285.1	6.6	2.96	0.472
360	2285.4	6.9	2.79	0.447
390	2286.4	7.9	2.66	0.425
420	2287.0	8.5	2.54	0.405
450	2288.2	9.7	2.44	0.387
480	2288.2	9.7	2.35	0.371
510	2288.5	10.0	2.27	0.356
540	2288.5	10.0	2.19	0.342
570	2289.7	11.2	2.14	0.330
600	2290.9	12.4	2.08	0.318
630	2290.9	12.4	2.03	0.307
660	2290.9	12.4	1.98	0.297
690	2291.5	13.0	1.94	0.287
720	2292.7	14.2	1.90	0.279
750	2292.7	14.2	1.86	0.270
763	2292.7	14.2	1.85	0.267

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TABLE #3

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO
GAUGE #111, THIRD SHUT IN PERIOD DATA

t_p = 647.5 + 172 = 819.5 minutes

p_{wf} = 1832.7 psi

Δt (min)	p_{ws} (psi)	$p_{ws}-p_{wf}$ (psi)	$\frac{t_p+\Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
0	1832.7	—	—	—
1	2238.3	405.6	820.5	2.914
2	2249.6	416.9	410.75	2.614
3	2256.2	423.5	274.17	2.438
4	2260.5	427.8	205.88	2.314
5	2264.8	432.1	164.90	2.217
6	2268.7	436.0	137.58	2.139
7	2270.5	437.8	118.07	2.072
8	2271.7	439.0	103.44	2.015
9	2274.8	442.1	92.06	1.964
10	2277.8	445.1	82.95	1.919
12	2280.9	448.2	69.29	1.841
14	2281.8	449.1	59.54	1.775
16	2283.6	450.9	52.22	1.718
18	2285.1	452.4	46.53	1.668
20	2285.4	452.7	41.975	1.623
22	2286.3	453.6	38.25	1.583
24	2287.9	455.2	35.146	1.546
26	2288.2	455.5	32.519	1.512
28	2288.8	456.1	30.268	1.481
30	2289.4	456.7	28.317	1.452
35	2290.9	458.2	24.414	1.388
40	2292.4	459.7	21.488	1.332
45	2293.6	460.9	19.211	1.284
50	2293.9	461.2	17.390	1.240
55	2294.8	462.1	15.90	1.201
60	2295.4	462.7	14.658	1.166
70	2296.1	463.4	12.707	1.104
80	2297.3	464.6	11.244	1.051
90	2298.2	465.5	10.106	1.005

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TABLE #3 CONTINUED

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Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
100	2298.5	465.8	9.195	0.964
110	2298.5	465.8	8.450	0.927
120	2299.1	466.4	7.829	0.894
135	2300.3	467.6	7.070	0.849
150	2300.3	467.6	6.463	0.811
165	2300.9	468.2	5.967	0.776
180	2300.9	468.2	5.553	0.745
195	2301.5	468.8	5.203	0.716
210	2301.5	468.8	4.902	0.690
225	2303.0	470.3	4.642	0.667
240	2303.0	470.3	4.415	0.645
260	2303.0	470.3	4.152	0.618
280	2303.3	470.6	3.927	0.594
300	2304.5	471.8	3.732	0.572
320	2304.5	471.8	3.561	0.552
340	2310.3	477.6	3.410	0.533
360	2310.3	477.6	3.276	0.515
367	2310.9	478.2	3.233	0.510

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TABLE #4

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO

GAUGE #111, FOURTH SHUT IN PERIOD DATA

$t_p = 819.5 + 969 = 1788.5$ minutes

$p_{wf} = 2239.4$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	2239.4	—	—	—
1	2260.7	21.3	1789.5	3.253
2	2266.8	27.4	895.25	2.952
3	2268.3	28.9	597.167	2.776
4	2271.4	32.0	448.125	2.651
5	2272.9	33.5	358.70	2.555
6	2274.4	35.0	299.08	2.476
7	2275.9	36.5	256.50	2.409
8	2276.2	36.8	224.563	2.351
9	2277.4	38.0	199.72	2.300
10	2278.7	39.3	179.85	2.255
12	2280.5	41.1	150.04	2.176
14	2282.0	42.6	128.75	2.109
16	2283.5	44.1	112.78	2.052
18	2285.1	45.7	100.36	2.001
20	2286.6	47.2	90.425	1.956
22	2286.6	47.2	82.296	1.915
24	2286.9	47.5	75.52	1.878
26	2288.1	48.7	69.79	1.844
28	2288.4	49.0	64.88	1.812
30	2289.3	49.9	60.62	1.783
35	2291.1	51.7	52.10	1.717
40	2292.4	53.0	45.71	1.660
45	2292.7	53.3	40.74	1.610
50	2294.2	54.8	36.77	1.566
55	2295.7	56.3	33.52	1.525
60	2296.9	57.5	30.81	1.489
70	2302.1	62.7	26.55	1.424
80	2306.6	67.2	23.36	1.368
90	2307.9	68.5	20.87	1.320

PROPRIETARY

TABLE #4 CONTINUED

(14)

Δt (min)	P_{ws} (psi)	$P_{ws} - P_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
100	2305.4	66.0	18.89	1.276
110	2310.6	71.2	17.26	1.237
120	2311.2	71.8	15.90	1.202
135	2318.2	78.8	14.25	1.154
150	2318.2	78.8	12.92	1.111
165	2316.7	77.3	11.84	1.073
180	2311.2	71.8	10.94	1.039
195	2315.7	76.3	10.17	1.007
210	2315.7	76.3	9.52	0.979
225	2312.1	72.7	8.95	0.952
240	2316.7	77.3	8.45	0.927
260	2318.2	78.8	7.88	0.897
280	2318.2	78.8	7.39	0.869
300	2314.8	75.4	6.96	0.843
320	2315.7	76.3	6.59	0.819
340	2317.6	78.2	6.26	0.797
360	2317.6	78.2	5.97	0.776
380	2318.5	79.1	5.71	0.756
400	2320.0	80.6	5.47	0.738
420	2320.6	81.2	5.26	0.721
440	2322.1	82.7	5.07	0.705
460	2322.1	82.7	4.89	0.689
480	2322.7	83.3	4.73	0.675
500	2322.7	83.3	4.58	0.661
520	2322.7	83.3	4.44	0.647
540	2322.7	83.3	4.31	0.635
560	2323.0	83.6	4.19	0.623
580	2324.2	84.8	4.08	0.611
600	2324.2	84.8	3.98	0.600
620	2324.2	84.8	3.89	0.589
640	2324.2	84.8	3.80	0.579
659	2323.6	84.2	3.71	0.570

(16)

TABLE #6 PROPRIETARY

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO,

GAUGE #155, SECOND SHUT IN PERIOD DATA

$t_p = 6.5 + 641 = 647.5$ minutes

$p_{wf} = 2281.1$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	2281.1	—	—	—
30	2283.4	2.3	22.58	1.354
60	2283.4	2.3	11.79	1.072
90	2283.7	2.6	8.19	0.914
120	2284.7	3.6	6.40	0.806
150	2285.4	4.3	5.32	0.726
180	2286.7	5.6	4.60	0.663
210	2286.7	5.6	4.08	0.611
240	2286.4	5.3	3.70	0.568
270	2286.4	5.3	3.40	0.531
300	2286.4	5.3	3.16	0.499
330	2286.7	5.6	2.96	0.472
360	2286.7	5.6	2.80	0.447
390	2287.0	5.9	2.66	0.425
420	2287.0	5.9	2.54	0.405
450	2287.0	5.9	2.44	0.387
480	2287.4	6.3	2.35	0.371
510	2287.4	6.3	2.27	0.356
540	2287.4	6.3	2.20	0.342
570	2287.4	6.3	2.14	0.330
600	2288.0	6.9	2.08	0.318
630	2288.4	7.3	2.03	0.307
660	2288.4	7.3	1.98	0.297
690	2288.7	7.6	1.94	0.287
720	2288.7	7.6	1.90	0.279
750	2288.7	7.6	1.86	0.270
763	2289.4	8.3	1.85	0.267

TABLE #7

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO, GAUGE #155, THIRD SHUT IN PERIOD DATA

(17)

$t_p = 647.5 + 172 = 819.5$ minutes

$p_{wf} = 1854.1$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	1854.1	—	—	—
1	2185.2	331.1	820.5	2.91
2	2221.7	367.6	410.75	2.61
3	2241.9	387.8	274.17	2.44
4	2251.5	397.4	205.88	2.31
5	2255.2	401.1	164.9	2.22
6	2258.8	404.7	137.58	2.14
7	2261.5	407.4	118.07	2.07
8	2262.2	408.1	103.44	2.02
9	2264.2	410.1	92.06	1.96
10	2269.8	415.7	82.95	1.92
12	2269.8	415.7	69.29	1.84
14	2271.5	417.4	59.54	1.78
16	2272.8	418.7	52.22	1.718
18	2275.1	421	46.53	1.67
20	2277.1	423	41.98	1.62
22	2278.1	424	38.25	1.58
24	2279.8	425.7	35.15	1.55
26	2280.7	426.6	32.52	1.51
28	2280.7	426.6	30.27	1.48
30	2282.1	428	28.32	1.45
35	2283.4	429.3	24.41	1.39
40	2284.7	430.6	21.49	1.33
45	2285.4	431.3	19.21	1.28
50	2285.4	431.3	17.39	1.24
55	2287.1	433	15.90	1.20
60	2288.0	433.9	14.66	1.17
70	2289.4	435.3	12.71	1.10
80	2290.0	435.9	11.24	1.055
90	2291.4	437.3	10.11	1.005

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TABLE #7 CONTINUED

(18)

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log \left(\frac{t_p + \Delta t}{\Delta t} \right)$
100	2291.7	437.6	9.195	0.964
110	2291.7	437.6	8.45	0.927
120	2293.4	439.3	7.83	0.894
135	2293.4	439.3	7.07	0.849
150	2293.4	439.3	6.46	0.811
165	2293.7	439.6	5.97	0.776
180	2293.7	439.6	5.55	0.745
195	2293.7	439.6	5.20	0.716
210	2294.7	440.6	4.90	0.690
225	2294.7	440.6	4.64	0.667
240	2294.7	440.6	4.42	0.645
260	2294.7	440.6	4.15	0.618
280	2294.7	440.6	3.93	0.594
300	2295.0	440.9	3.73	0.572
320	2295.0	440.9	3.56	0.552
340	2295.3	441.2	3.41	0.533
360	2295.3	441.2	3.28	0.515
367	2295.0	440.9	3.23	0.510

(19)

TABLE #8

PROPRIETARY

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO, GAUGE #155, FOURTH SHUT IN PERIOD DATA

$t_p = 819.5 + 969 = 1788.5$ minutes

$P_{wf} = 2228.6$ psi

Δt (min)	P_{ws} (psi)	$P_{ws} - P_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	2228.6	—	—	—
1	2246.2	17.6	1789.5	3.25
2	2249.5	20.9	895.25	2.95
3	2251.5	22.9	597.17	2.78
4	2253.2	24.6	448.125	2.65
5	2254.9	26.3	358.7	2.56
6	2256.2	27.6	299.08	2.48
7	2257.8	29.2	256.5	2.41
8	2258.5	29.9	224.56	2.35
9	2260.2	31.6	199.72	2.30
10	2261.5	32.9	179.85	2.26
12	2262.8	34.2	150.04	2.18
14	2263.5	34.9	128.75	2.11
16	2266.5	37.9	112.78	2.05
18	2267.1	38.5	100.36	2.00
20	2268.5	39.9	90.43	1.96
22	2269.8	41.2	82.30	1.92
24	2271.1	42.5	75.52	1.88
26	2272.1	43.5	69.79	1.84
28	2273.8	45.2	64.88	1.81
30	2274.8	46.2	60.62	1.78
35	2275.1	46.5	52.10	1.72
40	2275.4	46.8	45.71	1.66
45	2277.1	48.5	40.74	1.61
50	2278.8	50.2	36.77	1.57
55	2280.1	51.5	33.52	1.53
60	2282.7	54.1	30.81	1.49
70	2285.4	56.8	26.55	1.42
80	2286.7	58.1	23.36	1.37
90	2289.7	61.1	20.87	1.32

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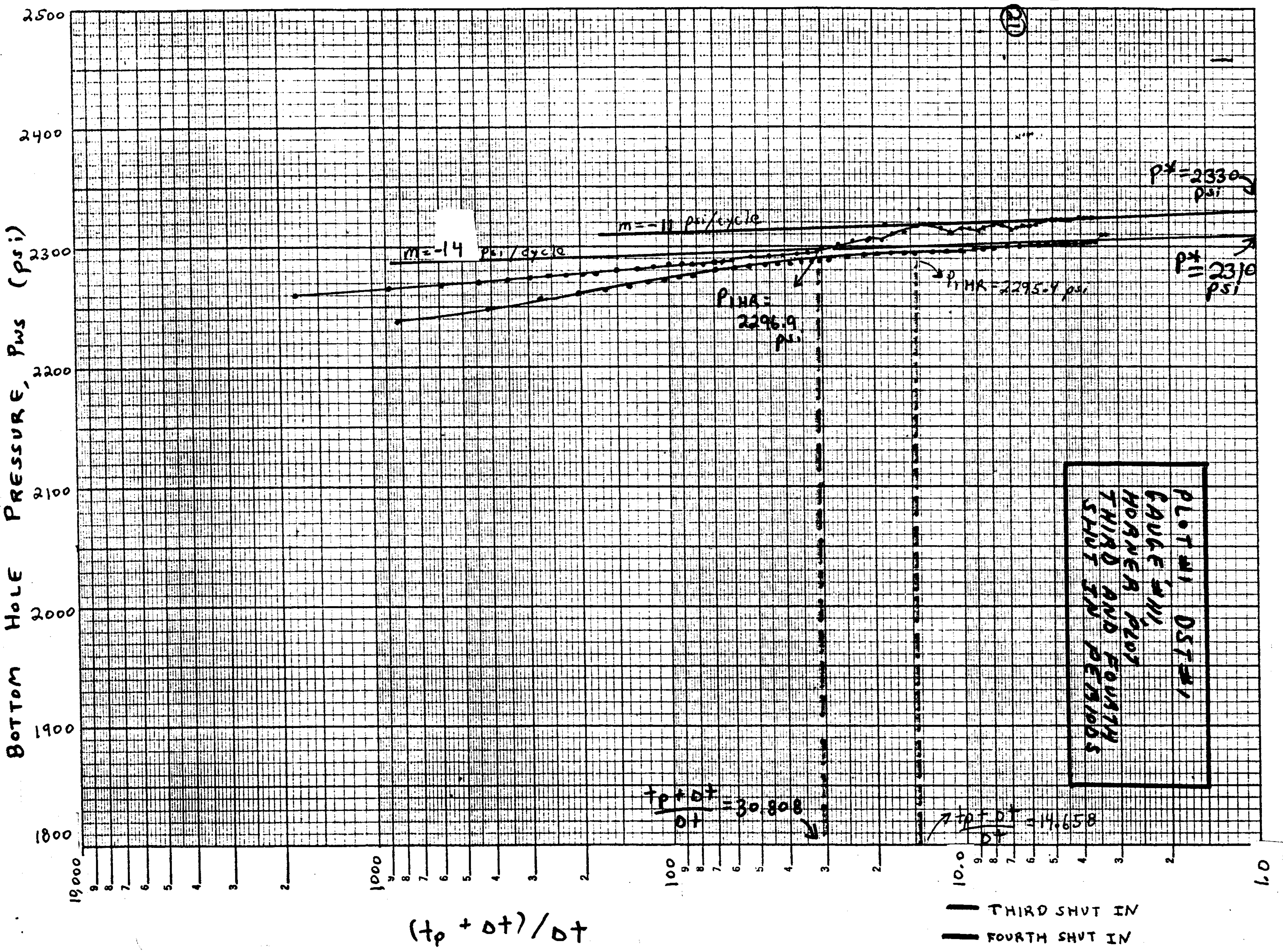
PROPRIETARY

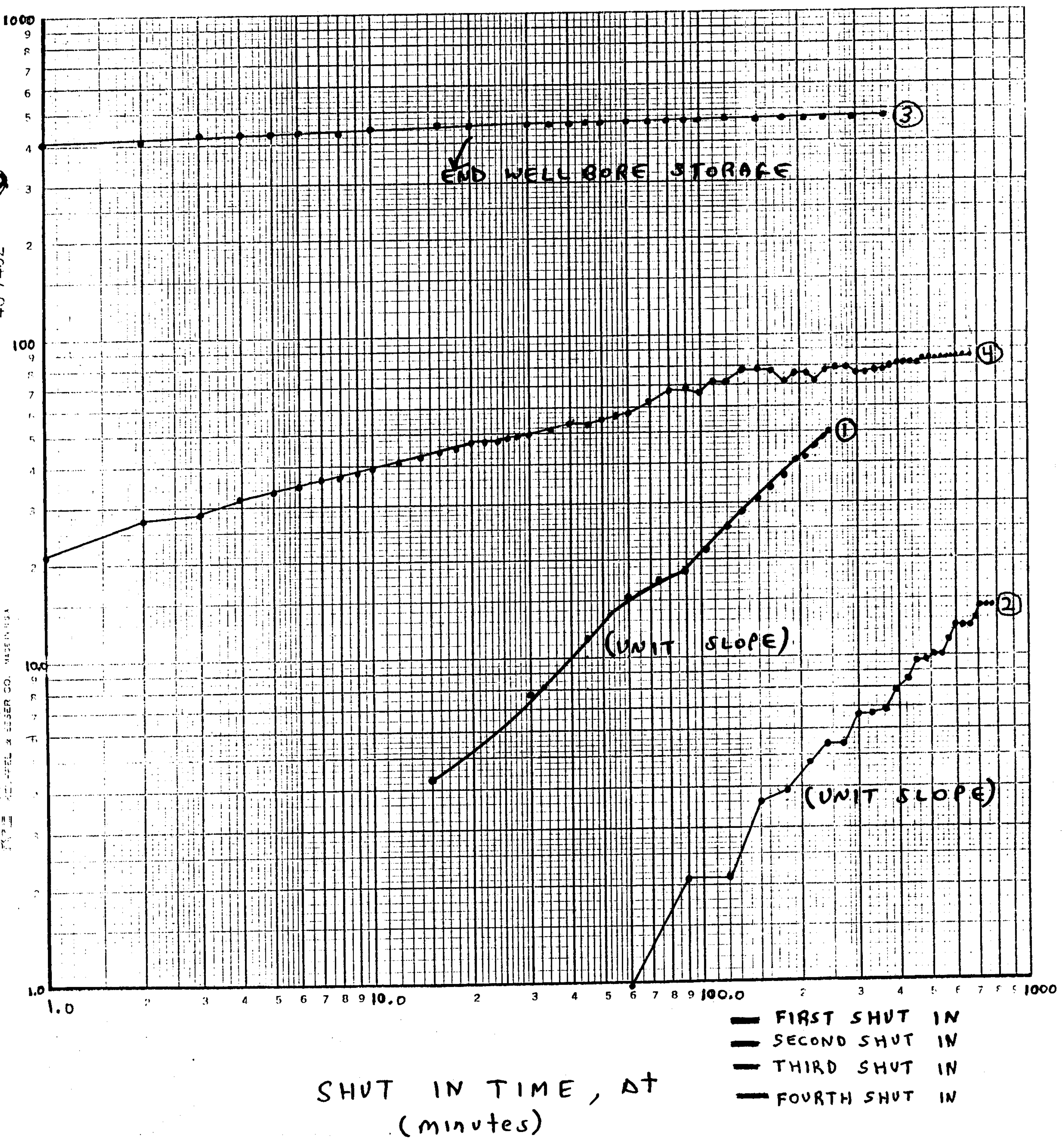
TABLE #8 CONTINUED

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
100	2292	63.4	18.89	1.28
110	2293.4	64.8	17.26	1.24
120	2294.7	66.1	15.90	1.20
135	2295	66.4	14.25	1.15
150	2299.3	70.7	12.92	1.11
165	2299.7	71.1	11.84	1.07
180	2299.7	71.1	10.94	1.04
195	2300	71.4	10.17	1.01
210	2297	68.4	9.52	0.979
225	2300	71.4	8.95	0.952
240	2301	72.4	8.45	0.927
260	2301.3	72.7	7.88	0.897
280	2301.3	72.7	7.39	0.869
300	2301.3	72.7	6.96	0.843
320	2301.3	72.7	6.59	0.819
340	2301.6	73	6.26	0.797
360	2302	73.4	5.97	0.776
380	2302	73.4	5.71	0.756
400	2302	73.4	5.47	0.738
420	2302	73.4	5.26	0.721
440	2302	73.4	5.07	0.705
460	2302	73.4	4.89	0.689
480	2303	74.4	4.73	0.675
500	2303	74.4	4.58	0.661
520	2303.3	74.7	4.44	0.647
540	2303.3	74.7	4.31	0.635
560	2304.3	75.7	4.19	0.623
580	2304.3	75.7	4.08	0.611
600	2305	76.4	3.98	0.600
620	2305	76.4	3.88	0.589
640	2305	76.4	3.79	0.579
659	2303.3	74.7	3.71	0.569

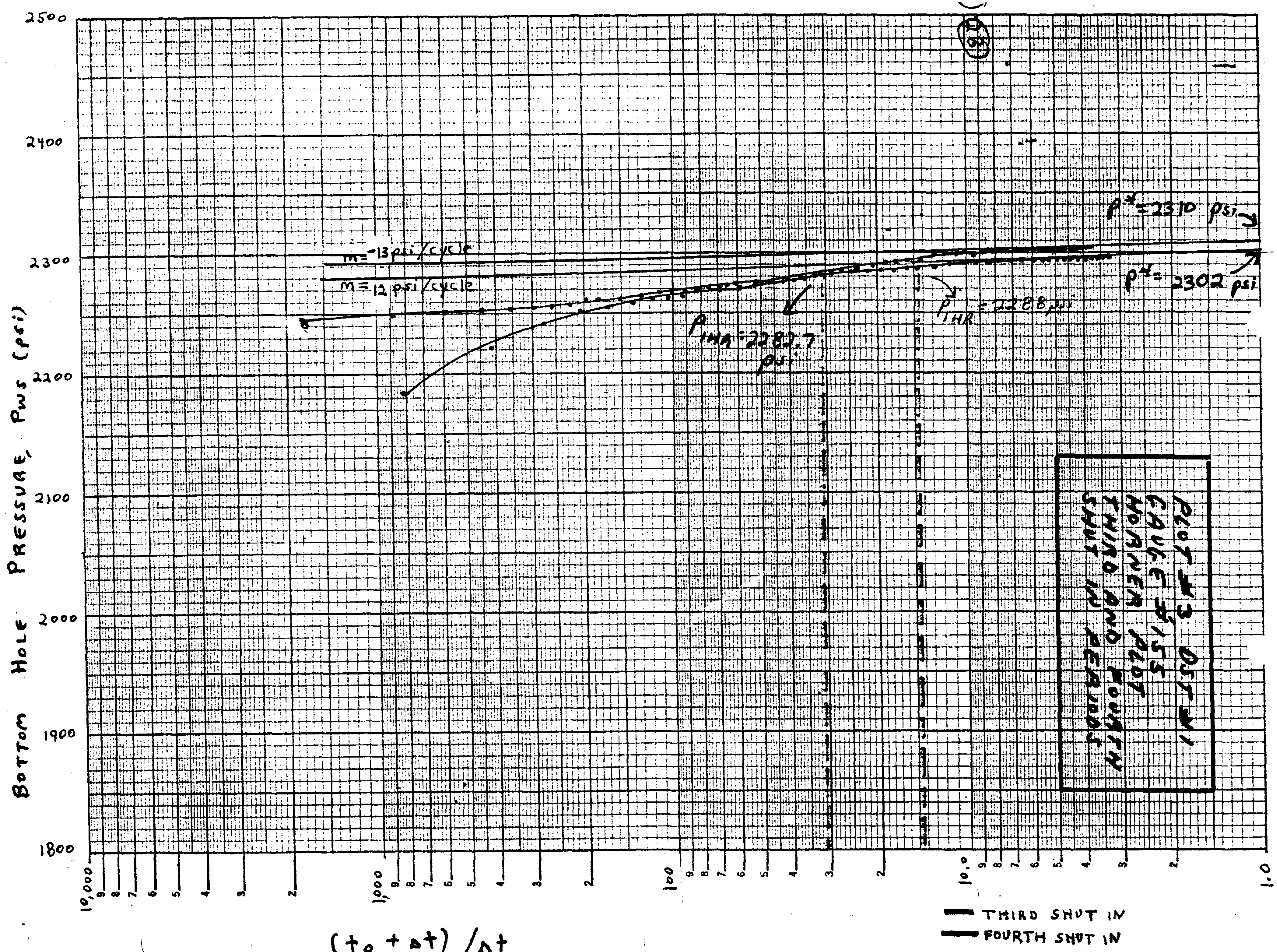


211
Bottom Hole Pressure, Pws (psi)
2500
2400
2300
2200
2100
2000
1900
1800
p* = 2330 psi
p* = 2310 psi
m = -11 psi/cycle
m = -14 psi/cycle
P1HR = 2296.9 psi
P1HR = 2295.4 psi
(tp + Δt)/Δt = 30.808
(tp + Δt)/Δt = 14.658
PLOT #1 DST #1
GAUGE #11
HORNER PLOT
THIRD AND FOURTH
SHUT IN PERIODS
10,000
1000
100
10.0
1.0
(tp + Δt)/Δt
THIRD SHUT IN
FOURTH SHUT IN

DRILL STEM TEST #1, HAMMERHEAD, OCS Y-0849#1
AMOCO, GAUGE #111, LOG-LOG PLOT
GAUGE DEPTH 5208.4' PLOT #2

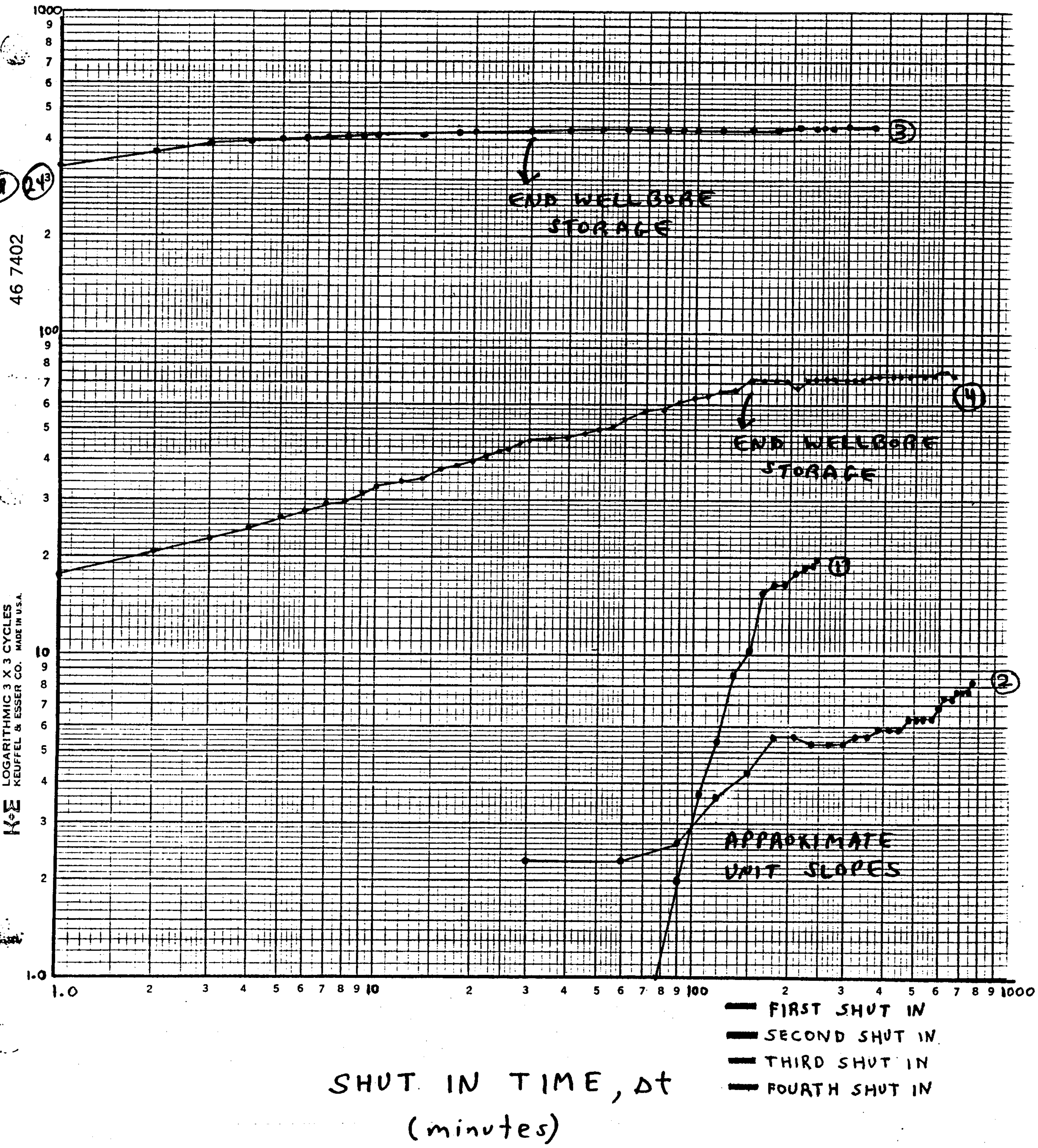


PROPRIETARY



2500
2400
2300
2200
2100
2000
1900
1800
BOTTOM HOLE PRESSURE, Pws (psi)
m=-13 psi/cycle
m=12 psi/cycle
p* = 2310 psi
p* = 2302 psi
P1HR = 2282.7 psi
P1HR = 2288 psi
PLOT #3 DST #1
GAUGE #155
HORNER PLOT
THIRD AND FOURTH
SHUT IN PERIODS
10,000
1,000
100
10.0
1.0
(tp + Δt) /Δt
THIRD SHUT IN
FOURTH SHUT IN

DRILL STEM TEST #1, HAMMERHEAD, OCS Y-0849 #1
AMOCO, GAUGE #155, <u>LOG-LOG PLOT</u>
GAUGE DEPTH 5235.8' PLOT #4



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DST #1 HORNER PLOT ANALYSIS

1) Permeability Calculation

Basic Equation; $k_n = -162.6 \frac{q_n \mu_n B_n}{m h}$

where; k_n = permeability of phase "n", md.
q_n = flowrate of phase "n", STB/D
μ_n = viscosity of phase "n", cp
B_n = formation volume factor of phase "n", RB/STB
m = slope of Horner Plot straight line, psi/cycle
h = thickness of tested interval, Feet

Since the flow periods of DST #1 produced oil and water the permeability of the formation to each phase will be calculated for each shut in period analyzed.

Gauge #111, Shut In Period #3

From Horner Plot # , m = -14 psi/cycle
P^* = 2310 psi

From Core Labs Report @ 100°F and 2310 psi, Page 8, μ_o = 20.5 cp

$\therefore k_o = -162.6 \frac{(325 \text{ STB/D})(20.5 \text{ cp})(1.098 \frac{RB}{STB})}{(-14 \text{ psi/cycle})(45 \text{ Feet})}$

k_o = 1.888 Darcies (*)

$k_w = -162.6 \frac{(297)(0.752)(1.0044)}{(-14)(45)}$

k_w = 57.9 md (*)

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Gauge # 111, Shut In Period # 4

From Horner Plot # , $m = -11$ psi/cycle

$P^* = 2330$ psi

From Core Labs Report @ 100°F and 2330 psi

Page 8, $\mu_o = 20.25$ cp

$$\therefore k_o = -162.6 \frac{(325 \frac{STB}{D})(20.25 \text{ cp})(1.098 \frac{RB}{STB})}{(-11)(45 \text{ FT.})}$$

$k_o = 2.373$ DARCIES ⊛

$$k_w = -162.6 \frac{(297)(0.752)(1.0044)}{(-11)(45)}$$

$k_w = 73.7$ md. ⊛

Gauge # 155, Shut In Period # 3

From Horner Plot # , $m = -12$ psi/cycle

$P^* = 2302$ psi

From Core Labs Report @ 100°F and 2302 psi

Page 8, $\mu_o = 20.75$ cp

$$\therefore k_o = -162.6 \frac{(325)(20.75)(1.098)}{(-12)(45)}$$

$k_o = 2.230$ DARCIES ⊛

$$k_w = -162.6 \frac{(297)(0.752)(1.0044)}{(-12)(45)}$$

$k_w = 67.5$ md. ⊛

PROPRIETARY

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Gauge #155, Fourth Shut In Period

From Horner Plot #, $m = -13$ psi/cycle

$p^* = 2310$ psi

$\mu_o = 20.5$ cp.

$$\therefore k_o = \frac{-162.6\,(325)(20.5)(1.098)}{(-13)(45)}$$

$k_o = 2.033$ Darcies (*)

$$k_w = \frac{-162.6\,(297)(0.752)(1.0044)}{(-13)(45)}$$

$k_w = 62.4$ md (*)

2) Calculation of Skin

Basic Equation;

$$S = 1.151\left[\frac{P_{1HR} - P_{WF}}{|m|} - \log\left(\frac{k}{\phi \mu C_t r_w^2}\right) + 3.23\right]$$

The above equation will be modified for multiphase flow as follows;

$$\frac{k}{\mu} = \left(\frac{k}{\mu}\right)_t = \text{Total Mobility Ratio} = \frac{k_o}{\mu_o} + \frac{k_w}{\mu_w} + \frac{k_g}{\mu_g}$$

($\frac{k_g}{\mu_g} \rightarrow 0$, No Free Gas)

Since $k = -162.6 \dfrac{q \mu B}{mh}$

$$\left(\frac{k}{\mu}\right)_t = -162.6\left(\frac{qB}{mh}\right)_t = \frac{-162.6}{mh}\left(q_o B_o + q_w B_w\right)$$

$$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-162.6}{m(45\,Ft)}\left(\left(325\,\frac{STB}{D}\right)\left(1.098\,\frac{RB}{STB}\right) + \left(297\,\frac{STB}{D}\right)\left(1.0044\,\frac{RB}{STB}\right)\right)$$

$$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-3.6133}{m}\left(655.1568\,\frac{RB}{D}\right) = -\frac{2367.2977}{m}\,\frac{md}{cp}$$

For Gauge #111, Shut In Period #3

$m = -14$ psi/cycle

(23) 28 $\therefore \left(\frac{k}{\mu}\right)_t = \frac{-2367.2977}{-14} \frac{md}{cp} = 169.0927 \frac{md}{cp}$

From Horner Plot #

P_{1Hr} @ $\Delta t = 60$ min $\therefore \frac{t_p + \Delta t}{\Delta t} = \frac{819.5 \text{ min} + 60 \text{ min}}{60 \text{ min}} = 14.658$

@ $\frac{t_p + \Delta t}{\Delta t} = 14.658$, $p_{ws} = 2295.4$ psi $= P_{1HR}$

$$\therefore S = 1.151 \left[\frac{2295.4 - 1832.7}{|-14|} - \log\left(\frac{169.0927}{(.26)(7.04 \times 10^{-6})(.4010)^2} \right) + 3.23 \right]$$

$$S = 1.151 \left[33.05 - 8.75929 + 3.23 \right]$$

$\therefore$ S = + 31.68 Severely Damaged ⊛

Gauge #111, Fourth Shut In Period

$m = -11$ psi/cycle

$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-2367.2977}{-11} \frac{md}{cp} = 215.209 \frac{md}{cp}$

From Horner Plot #

P_{1Hr} @ $\Delta t = 60$ min $\therefore \frac{t_p + \Delta t}{\Delta t} = \frac{1788.5 \text{ min} + 60 \text{ min}}{60 \text{ min}} = 30.808$

@ $\frac{t_p + \Delta t}{\Delta t} = 30.808$, $p_{ws} = 2296.9$ psi $= P_{1HR}$

$$\therefore S = 1.151 \left[\frac{2296.9 - 2239.4}{|-11|} - \log\left(\frac{215.209}{(.26)(7.04 \times 10^{-6})(.4010)^2} \right) + 3.23 \right]$$

$$S = 1.151 \left[5.227 - 8.864 + 3.23 \right]$$

$\therefore$ S = − 0.468 Slightly Enhanced ⊛

(Questionable Answer)

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Gauge # 155, Shut In Period #3

$m = -12$ psi/cycle

$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-2367.2977}{-12} \frac{md}{cp} = 197.2748 \frac{md}{cp}$

From Horner Plot #

P_{1Hr} @ $\Delta t = 60$ min $\therefore \frac{t_p + \Delta t}{\Delta t} = \frac{819.5 \text{ min} + 60 \text{ min}}{60 \text{ min}} = 14.658$

@ $\frac{t_p+\Delta t}{\Delta t} = 14.658$, $p_{ws} = 2288$ psi $= P_{1HR}$

$$\therefore S = 1.151\left[\frac{2288 - 1854.1}{|-12|} - \log\left(\frac{197.2748}{(.26)(7.04\times10^{-6})(.4010)^2}\right) + 3.23\right]$$

$S = 1.151\,(36.158 - 8.826 + 3.23)$

$S = +35.17$ Severely Damaged (*)

Gauge #155, Shut In Period #4

$m = -13$ psi/cycle

$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-2367.2977}{-13} \frac{md}{cp} = 182.099 \frac{md}{cp}$

From Horner Plot #

P_{1Hr} @ $\Delta t = 60$ min $\therefore \frac{t_p + \Delta t}{\Delta t} = \frac{1788.5 \text{ min} + 60 \text{ min}}{60 \text{ min}} = 30.808$

@ $\frac{t_p+\Delta t}{\Delta t} = 30.808$, $p_{ws} = P_{1Hr} = 2282.7$ psi

$$\therefore S = 1.151\left[\frac{2282.7 - 2228.6}{|-13|} - \log\left(\frac{182.099}{(.26)(7.04\times10^{-6})(.4010)^2}\right) + 3.23\right]$$

$S = 1.151\,(4.1615 - 8.79147 + 3.23)$

$S = -1.61$ Enhanced (*)

(Questionable Answer)

PROPRIETARY

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3) Pressure Drop Across Skin, ΔP_s;
Basic Equation; $\Delta P_s = .87\ S(m)$

Gauge #111, 3d Shut In Period
$\Delta P_s = 0.87(+31.68)(14) = +385.86$ psi (*)

Gauge #111, 4th Shut In Period
$\Delta P_s = 0.87(-.468)(11) = -4.48$ psi (*)

Gauge # 155, 3d Shut In Period
$\Delta P_s = 0.87(35.17)(12) = +367.17$ psi (*)

Gauge # 155, 4th Shut In Period
$\Delta P_s = 0.87(-1.61)(13) = -18.2$ psi (*)

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4) Flow Efficiency, F.E.
Basic Equation; $F.E. = \dfrac{P^* - P_{WF} - \Delta P_s}{P^* - P_{WF}}$

Gauge #111, 3d Shut In Period
$F.E. = \dfrac{2310 - 1832.7 - 385.86}{2310 - 1832.7} = +0.192$ (*)

Gauge #111, 4th Shut In Period
$F.E. = \dfrac{2330 - 2239.4 - (-4.48)}{2330 - 2239.4} = +1.049$ (*)

Gauge # 155, Shut In Period #3
$F.E. = \dfrac{2302 - 1854.1 - 367.17}{2302 - 1854.1} = +0.180$ (*)

Gauge # 155, Shut In Period #4
$F.E. = \dfrac{2310 - 2228.6 - (-18.2)}{2310 - 2228.6} = +1.224$ (*)

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5) Radius of Investigation, r_i

Basic Equation; $r_i = \left[\frac{kT}{40\,\phi\,\mu c}\right]^{1/2}$; T = Flow Time in days

Modify For Multiphase Flow

$$\frac{k}{\mu} = \left.\frac{k}{\mu}\right)_t = \frac{k_o}{\mu_o} + \frac{k_w}{\mu_w} \quad ; \quad C = C_t = C_oS_o + C_wS_w + C_f$$

$$\therefore \quad r_i = \left[\frac{\left(\frac{k}{\mu}\right)_t T}{40\,\phi\,C_t}\right]^{1/2}$$

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Gauge #111, 3d Shut In Period

$$T = \frac{819.5\text{ min}}{1440\ \frac{\text{min}}{\text{day}}} = .56909$$

$$r_i = \left[\frac{(169.0927)(.56909)}{40(.26)(7.04\times10^{-6})}\right]^{1/2} = \underline{\underline{1,146\text{ Ft.}}} \ (*)$$

Gauge #111 4th Shut In Period

$$T = \frac{1788.5}{1440} = 1.242$$

$$r_i = \left[\frac{(215.209)(1.242)}{40(.26)(7.04\times10^{-6})}\right]^{1/2} = \underline{\underline{1,911\text{ Ft.}}} \ (*)$$

Gauge #155, 3d Shut In Period

$$T = \frac{819.5}{1440} = .56909$$

$$r_i = \left[\frac{(197.2748)(.56909)}{40(.26)(7.04\times10^{-6})}\right]^{1/2} = \underline{\underline{1,238\text{ Ft.}}} \ (*)$$

Gauge #155, 4th Shut In Period

$$T = \frac{1788.5}{1440} = 1.242$$

$$r_i = \left[\frac{(182.099)(1.242)}{40(.26)(7.04\times10^{-6})}\right]^{1/2} = \underline{\underline{1,757\text{ Ft}}} \ (*)$$

The r_i distance is the radial distance from the wellbore influenced by the DST. Information obtained about the formation during the DST was obtained in the area of r_i.

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6) Calculation of Average Reservoir Pressure, $\bar{p}$;

Basic Equation; $\frac{p^* - \bar{p}}{m/2.303} = 2.51$

$$\therefore \bar{p} = p^* - \frac{2.51(m)}{2.303}$$

Gauge #111, 3d Shut In Period

$$\bar{p} = 2310 - \frac{2.51(14)}{2.303} = 2295 \text{ psi}$$ (*)

Gauge #111, 4th Shut In Period

$$\bar{p} = 2330 - \frac{2.51(11)}{2.303} = 2318 \text{ psi}$$ (*)

Gauge #155, 3d Shut In Period

$$\bar{p} = 2302 - \frac{2.51(12)}{2.303} = 2289 \text{ psi}$$ (*)

Gauge #155, 4th SHUT In Period

$$\bar{p} = 2310 - \frac{2.51(13)}{2.303} = 2296 \text{ psi}$$ (*)

(28) 33

7) Reserve Calculations

The following calculations will be based on an interval thickness of 45 feet. This value has been estimated to contain oil sands by well log analysis.

a) Initial Oil In Place = IOIP

$IOIP = 7758 \frac{RB}{AC\text{-}FT} \bar{\phi} S_o / B_{oi}$ (STB)

$IOIP = 7758(0.26)(.64)/1.098$

$IOIP = 1176 \frac{STB}{AC\text{-}FT} = 1291\ RB/AC\text{-}FT$ (*)

b) According to Resource Evaluation the most probable size of this reservoir is 5000 Acres.

$IOIP$ within 5000 ACRES $= 7758\ \bar{\phi}\ S_o(\text{Acres})h/B_{oi}$

$IOIP_{5000\ Acres} = 7758(.26)(.64)(5000\ \text{Acres})(45\ \text{Feet})/(1.098)$

$IOIP_{5000\ Acres} = 264.535 \times 10^6\ STB = 290.460 \times 10^6\ RB$ (*)

c) Since the majority of the IOIP is not recovered by primary depletion techniques, the Recoverable Oil must be estimated. This will be done for three recovery factors.

n = Recovery Factor = 15%

Recoverable Oil Within 5000 Acres = $RO_{5000\ Acres}$

$RO_{5000} = IOIP \times n$

$RO_{5000} = (264.535 \times 10^6)(.15) = 39.680 \times 10^6$ STB (*)

43.569×10^6 RB (*)

$n = 30\%$

$RO_{5000} = (264.535 \times 10^6)(.30) = 79.360 \times 10^6$ STB (*)

87.137×10^6 RB (*)

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$\eta = 40\%$

$RO_{5000\ acres} = (264.535 \times 10^6)(.40) = 105.814 \times 10^6\ STB$ ⊛

$116.184 \times 10^6\ RB$ ⊛

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CALCULATION RESULTS
DST #1

Gauge #	Shut In Period	Analysis Method	P* (psi) (extrapolated pressure)	P_i (psi) (initial pressure)	$\bar{P}$ (psi) (average pressure)	Ko (md)	Kw (md)	S Skin	ΔPs (psi)	F. E. Flow Efficiency	r_i (Feet)
111	3	HORNER	2310	—	2295	1888	57.9	+31.68	+385.86	+0.192	1,146
				BEST ESTIMATE ↑							
111	4	HORNER	2330	—	2318	2373	73.7	−0.468	−4.48	+1.049	1,911
155	3	HORNER	2302	—	2289	2230	67.5	+35.17	+367.17	+0.180	1,238
155	4	HORNER	2310	—	2296	2033	62.4	−1.61	−18.2	+1.224	1,757
AVERAGE VALUES			2313	—	2299.5	2131	65.4	+16.19	+182.6	+0.66	1513

IOIP = 1176 STB/AC-FT

IOIP = 1291 RB/AC-FT

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DRILL STEM TEST

Test Date 9/7/85 Well No. OCSY 0849
Operator Union Oil
Drilling Contractor Canmar
Location (S-T-R)

Test Number DST #1
Date 9/7
Test Interval 5470'-5490' 5442-5462'
Total Depth 5560'

Hole Size 12 1/4
Drill Pipe (Size & Lgth) 5" 4571'
Drill Collars (Size&Lgth) 6 1/2" 399'
Type of Cushion Fluid N_2
Amount of Cushion 1789 psi

TEST DATA

1. Tool open at 05:26 hours.
2. Initial open period 16 minutes.
3. Initial shut-in period 368 minutes.
4. Final flow period 970 minutes.
5. Final shut-in period 612 minutes.
6. Description of blow on initial open period Blowdown of N_2 cushion at surface pressure of 1675 psi to 977 psi
7. Description of blow during test Blowdown of N_2 cushion at surface until liquid surfaced restricting flow
8. G.T.S. 25 minutes: O.T.S. 70 minutes;
   Surface choke size 3" valve Bottom hole choke size NA
9. Flow Rate: Gas *1 C.F.P.D. Oil 31 B.P.H. G.O.R. NA
10. Gravity of Gas .561 Gravity of Oil 20° API
11. Total fluid recovery: 588.5 including reverse out
12. Resistivity of H_2O NA Chlorides of H_2O 27,000 P.P.M.
13. Depth of top press bomb 5211 Bottom Bomb 5238

PRESSURE DATA

	Top Inside	Bottom Inside		Top Outside	Bottom Outside
I.H.P.	2493		I.H.P.		2474
I.S.I.P.	2288		I.S.I.P.		2300
I.F.P.	1854		I.F.P.		1833
F.F.P.	2100		F.F.P.		2226
F.S.I.P.	2311		F.S.I.P.		2313
F.H.H.	2492		F.H.H.		2501
Temp.	100°F		Temp.		100°F

SAMPLE CHAMBER DATA

1. Gas *2 C.F.
2. Oil C.C.
3. H_2O C.C.
4. Mud C.C.
5. B.O.R. B.S. & W. %

REMARKS

*1 Gas rate too small to measure

*2 Sample chamber under pressure sent to lab, found to contain only water and gas

DST #2 - TABLE OF CONTENTS

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DST #2 - SUMMARY PROPRIETARY

Union tested a sandstone interval from 5295' to 5334' (MD, TVD) by a series of flowtests and buildups.

(1) The tested interval was perforated from 5300' to 5315' and the test was conducted through a 9 5/8" liner. The tested interval was in the lower part of the Sagavanirtok formation (512' - 6410', MD, TVD) which is a tertiary formation composed of sandstone, siltstone, and shale.

Out of the four drawdown tests and four buildups tests conducted during this DST only the first shut in period could be analyzed with the hope of obtaining accurate results. This period was analyzed for two gauges, #111 and #253 by the conventional Horner method and the Miller-Dyes-Hutchinson (MDH) method. One gauge, #207 recorded pressure data for the third shut in period yet the "Formation Testing Service Report" prepared by Halliburton Services stated that all pressure data for gauge #207 was questionable. Gauge #207's third shut in data was analyzed by the Horner Method and results were found to be inaccurate. Results of this analysis are included in this report yet no significance are placed on these results and they will not be mentioned again in this summary.

The first flow period with production time (tp) of about 15 minutes was not analyzed because the initial drawdown is usually only carried out to release hydrostatic mud and cushion pressure in the drillpipe. For this test a nitrogen cushion was used with a pressure of 1725 psi.

The second flow test with a total tp of 1506 minutes was not analyzed due to sand problems. During this flow period the well killed itself due to sand production and the flow test was terminated to remove the sand. Sand was found in the test string from 4644' to 5331'. To remove sand a coiled tubing

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unit was run down the test string to wash out the sand with high pressure nitrogen. Once the sand was removed, Flow Period two was started again. These problems lead the author of this report to the conclusion that the pressure data was inaccurate and not worth analyzing.

(2) The second shut in period was analyzed for Gauges #207 and #111, yet the enclosed Horner Plot for this period shows why no further analysis was carried out for this shut in period. Pressures during this shut in decreased and were very erratic. These problems may have been caused by the sand problems in flow period two.

All other flow and buildup periods were not analyzed due to lack of pressure data. Either gauge clocks stopped, charts expired, or clocks showed stair stepping due to the pumping of nitrogen during flow test two.

Flow tests produced oil, water, and gas. After comparing Union's reported oil rate (q_o) from their summary sheet of 38 BOPH (912 STB/D) with raw field data it was decided that this value was accurate and should be used in the analysis. This rate is an average value. The q_o values reported during flow period two varied from 2600 BPD to 36 BPD. Towards the end of the flow period it appeared that q_o was starting to stabilize at the average value of 912 STB/D.

Union did not report an average water rate ($\bar{q}_w$) on their summary sheet, yet raw field data showed water production was significant and the author felt water production should be taken into consideration in the analysis. A $\bar{q}_w$ value was calculated from flow test two data as 157 STB/D to use in reservoir calculations.

Union's summary sheet reported a gas rate (q_g) of 181,559 SCF/D, yet upon reviewing raw field data a calculated rate of 202,336 SCF/D was

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found to reflect gas production more accuratley so this value was used for the analysis:

(3) Core Labs "Reservoir Fluid Study" reported a bubble point pressure (P_{BP}) of 2391 psig at a reservoir temperature of 100 °F. All Horner Plots gave extrapolated straight line pressures (P^*) in the range of 2315 psi to 2353 psi. Horner Plot calculations gave average pressures ($\bar{P}$) in the range of 2283 psi to 2336 psi. MDH analysis gave initial pressures (P_i) of 2318 psi and 2352 psi. All of the above calculated pressures were below the reported P_{BP} value of 2391 psig. Based on these numbers it is safe to say that this formation is at a pressure below its P_{BP} value.

The reported average Gas-Oil-Ratio (GOR) from the raw field data of 220 SCF/STB accounts for most of the gas produced during the flow tests. This gas is produced from the oil as solution gas when pressure is decreased. The solution gas accounts for 99% of the gas produced during the flow tests, with the remainder of the gas (≅1%) being produced from what the author believes is a tiny gas cap from the upper part of the formation. This line of reasoning makes sense when one knows that the calculated values of P^*, $\bar{P}$, and P_i are below P_{BP}. It is the authors belief that the solution gas accounts for the main mode of production for this reservoir (Solution Gas Drive). A small amount of reservoir energy is probably provided by the Free Gas Cap.

All calculated permeabilities are high. The values calculated from Gauge #207 for the third shut in period appear to be the most inaccurate. These values can be ignored as already stated in this report. The MDH permeability values are larger than the Horner values for the same gauge for the first shut in

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period. This behavoir is brought about by the MDH plots having a smaller slope value than the Horner values. According to literature, this is a normal reaction for short tp's (ie; Flow Period One tp=15 minutes).

(4)

Based on this analysis the best permeability values for the tested interval were calculated from first shut in period data for Gauges #111 and #253. Gauge #111 gave the following values for permeability to oil (ko), permeability to water (kw), and permeability to gas (kg); ko = 2951 md, kw = 15.92 md, kg = 0.49. Gauge #253 gave the following values; ko = 2693 md, kw = 14.89 md, kg = 0.46 md.

Even though the above permeability values are high they can be justified in light of Petroleum Testing Service, Inc. (PTS) Preliminary Report on Schlumberger's sidewall core samples and Schlumberger's sidewall core analysis sheet.

The PTS report gave the following air permeability values for sidewall cores;

Depth (Ft.)	Air Permeability (md.)
5302	1080
5323	1000 (** FRACTURED)
5324	749

PTS also stated that sidewall cores in SOFT formations could result in air permeability values lower than actual values. Schlumberger's sidewall analysis stated the tested interval was a soft, very unconsolidated sandstone with good k and porosity (φ) values. Based on this information and the reported fractures in the sidewall cores the permeability values calculated from the Horner analysis are believable. It appears that the interval may contain natural fractures which would enhance the formations permeability.

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(5) The calculated values of skin (S) (+11 to +12) indicate that the interval of interest is damaged. This may be due to mud or cement contamination from drilling or completion operations.

The Flow Efficiency (F.E.) values for Gauges #253 and #111 are 0.35 and 0.39. This means that the well is producing about 35% - 39% as much fluid with the given drawdown as an undamaged well. If the well was stimulated (acidization or hydraulic fracturing) and the S value was reduced and the F.E. value was closer to 1.0 this well has the potential of producing three times the amount of fluids it is currently producing from this interval. (ie - 2700 BOPD, 450 BWPD, 600,000 SCF/D).

Reserve calculations for this zone gave the following results for a 20 Foot pay zone, a 33% porosity, and a 72.3% oil saturation; IOIP = 1686 STB/AC-FT = 1851 RB/AC-FT. If a recovery factor of 30% is assumed and a reservoir size of 3690 Acres is assumed recoverable oil is estimated as 37×10^6 STB.

If both recoverable oil values for DST's #1 and #2 are combined an estimate of 116×10^6 STB is obtained for both zones in this well. Total Solution gas present in the zone tested during DST #2 is $370{,}920 \frac{SCF}{AC\text{-}FT}$ to $429{,}930 \frac{SCF}{AC\text{-}FT}$.

This well should be determined capable of producing hydrocarbons in paying quantities, yet the actual fate of this reservoir depends on economics and its remote location.

J. Levine 2/5/86

DST #2 ANALYSIS PARAMETERS

(6)

r_w = 0.4010 Ft. (9 5/8", 47#, N-80, Buttress Liner) (Union)
°API = 19.9° @ 60°F (Core Lab Report, Page 11)
Sg_{oil} = 0.935 @ 60°F (Calculated)
γ_{gas} = 0.576 = gas gravity ≃ pure CH_4 (Core Lab Report, P. 11)
h = 39 Ft. Total, 20 Ft. oil Sands (Logs)
ψ = Angle of Deviation = 0° (Vertical Well)
φ = 33% (Computer Estimate)
BHT = 100°F (Core Lab Report, Logs) Reservoir Temp.
$\bar{q}_o$ = Average Oil Rate = 38 BPH = 912 STB/D (Union)
$\bar{q}_w$ = Average Water Rate = 157 STB/D (Calculated From Flow Data #2)
$\bar{q}_g$ = Average Gas Rate (Calculated From Flow Data) = 202,336 SCF/D
GOR = 220 $\frac{SCF}{STB}$ (Flow Test Data Sheet #2 and #3)
B_g = 9.88 $\times 10^{-4}$ $\frac{RB}{SCF}$ = 5.548 $\times 10^{-3}$ $\frac{Ft^3}{SCF}$ (Calculated)
μ_g = 0.0171 @ 100°F, 2336 psi (Calculated)
C_g = 4.309 $\times 10^{-4}$ $psia^{-1}$ (Calculated)
B_w = 1.0044 RB/STB @ 100°F, 2300 psi (Calculated)
μ_w = 0.7021 cp @ 100°F, 2300 psi (Calculated)
C_w = 2.55 $\times 10^{-6}$ psi^{-1} @ 100°F, 2300 psi (Calculated)
B_o = 1.098 $\frac{RB @ 2391 \text{ psig}, 100°F}{STB @ 60°F}$ (Core Lab Report, P. 11)
μ_o = 20 cp @ 100°F, 2350 psi (Core Lab Report, P.)
C_o = 4.8 $\times 10^{-6}$ psi^{-1} @ 2700 psig To 2391 psig (Core Lab Page 2)
C_f = 3 $\times 10^{-6}$ psi^{-1} @ φ = 33% (Calculated)
C_t = 7.18 $\times 10^{-6}$ psi^{-1} (Calculated, S_g = 0)
S_o = 72.3% (Computer Estimate)
S_w = 27.7% (Computer Estimate)
S_{wirr} = 12% (Logs)
S_g ≃ 0, No Free Gas Rate

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Z_{gas} = 0.818 (Calculated)
P_{pc} = Critical Gas Pressure = 673 psia (Calculated)
T_{pc} = Critical Gas Temperature = 350°R (Calculated)
P_{pR} = Reduced Gas Pressure = 3.47 (Calculated)
T_{pR} = Reduced Gas Temperature = 1.60 (Calculated)
P_{BP} = Bubble Point = 2391 psig @ 100°F (Core Lab Page 2)
P^* = Reservoir Pressure = 2315 – 2353 psi (Calculated)
Depth Tested = 5295' – 5334'

CHRONOLOGY OF EVENTS - DST #2

1) 9/13/85; First Flow Period (PreFlow)
7 Well Opened Through Seperator @ 03:23 hrs.
Well Closed @ Tester Value @ 03:38 hrs.
Total Flow Time, Period 1 ≅ 15 min

2) 9/13/85; First Shut In Period
Well Shut In @ Tester Value @ 03:38 hrs.
Well Opened @ Tester Value @ 04:38 hrs.
Total Shut In Time ≅ 60 min.

3) 9/13/85; Second Flow Period
Well Opened @ Tester Value @ 04:38 hrs.
Shut in Well @ Surface @ 20:00 hrs., well Sanded up, Tester Value Open
20:00 hrs to 13:20 hrs 9/14/85 rigging up coiled tubing unit to remove sand
13:20 hrs. 9/14/85; Open Well @ Surface
23:04 hrs. 9/14/85 Closed @ Tester Value
Total Flow Time, Period 2 ≅

4) 9/14/85; Second Shut In
23:04 Well Shut In @ Tester Value
9/15/85 Well Opened @ Tester Value @ 05:13 hrs.
Total Shut In Time ≅ 369 min.

5) 9/15/85; Third Flow Period
05:13 Well Opened @ Tester Value
15:30 Closed Well @ Tester Value
Total Flow Time ≅ 617 min

6) 9/15/85; Third Shut In Period
15:30 Well Closed @ Tester Value
9/16/85 - 01:55 Well Opened @ Tester Value
Total Shut In Time ≅ 625 min

⑧

7) 9/16/85 ; Fourth Flow Period

01:55 - Well Opened @ Tester Valve

02:56 - Sheared Sampler Circulating Valve

Total Shut In Time ≈ 61 min

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(9)

POROSITY ϕ;

The following calculation will estimate the tested intervals' porosity from well logs.

From the 5" LDT-DNL openhole log the following values for apparent Limestone (LS) Neutron and Density porosities were obtained;

Perforations 5300' - 5315'

Depth (Feet)	Apparent DPHi (LS Units, %)	Apparent NPHi (LS Units, %)
5295	21.0	37.5
5296	20.0	36.0
5298	25.5	39.5
5300	31.5	42.0
5302	33.0	37.5
5304	33.0	37.0
5306	33.0	39.0
5308	34.0	39.0
5310	35.0	41.0
5312	35.5	42.0
5314	35.5	42.0
5316	34.5	42.5
5318	35.0	43.5
5320	34.5	42.0
5322	32.0	43.5
5324	24.5	42.0
5326	18.5	41.0
5328	19.0	41.0
5330	20.0	42.5
5332	19.0	43.0
5334	18.0	42.0

(10) From the porosity calculation for DST # 1 the following values were obtained;

$R_{mf} = .31\ \Omega$ @ 100°F

$R_m = .39\ \Omega$ @ 100°F

From the 5" Dual Induction - SFL log the following values were obtained;

SP = - 12 mV

h = 39'

If possible the SP value will be corrected to SSP for thin beds; $R_m = .39\ \Omega$

$R_i = 4.8\ \Omega$ (Medium Induction Resistivity Log, Average)

$\therefore R_i / R_m = \frac{4.8\ \Omega}{.39\ \Omega} = 12.26$

$\therefore$ No SSP Correction Needed

$\therefore R_{mf} / R_{we} = 1.45$ (For SP = -12 mV, T = 100°F)

$\therefore R_{we} = R_{mf} / (R_{mf} / R_{we}) = .31\ \Omega / 1.45 = .214\ \Omega$

Correct R_{we} to R_w

$R_w = .24\ \Omega$

$\therefore R_w \cong R_{mf}$

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To obtain true ϕ, use the neutron-density chart for Salt water muds:

Average True ϕ = 37 % (*)

Petroleum Testing Services, Inc. Preliminary Report for Union gave helium porosity values for Sidewall Core Samples of; 38.9 % @ 5302 Ft.

34.0 % @ 5324 Ft.
28.4 % @ 5321 Ft.
41.2 % @ 5323 Ft.

The calculated value from the logs is in close agreement with the PTS values, yet a value of 33 % as calculated from Resource Evaluation's Computer program will be taken as the most accurate value. A 33 % porosity value will be used in calculations.

(11)

Calculation of Gas Parameters

1) $B_g = 0.00504 \left(\frac{ZT}{P}\right)$ RB/scF

Since γ_g = Gas Gravity = 0.576;

∴ Monograph #5, Figure D-3 (Misc. Gas Curves)

P_{pc} = 673 psia

T_{pc} = 350 °R

$P_{pr} = \frac{P^*}{P_{pc}} = \frac{2336}{673} = 3.47$

$T_{pr} = T/T_{pc} = \frac{100\,°F + 460}{350\,°R} = 1.600$

NOTE; P^* for this calculation is an average value obtained from all the Horner plots

∴ Monograph #5, Figure D-7

$Z = 0.818$ ⊛

$$∴ B_g = 0.00504 \left(\frac{(.818)(100°F + 460)}{2336}\right)$$

$B_g = 9.88 \times 10^{-4}$ RB/scF ⊛ $= 5.548 \times 10^{-3}$ Ft³/scF

2) For gas viscosity, μ_g;

From William D. McCain, Jr, "The Properties of Petroleum Fluids", Fig 3-14, P. 128;

For $\gamma_g = .576$

$\mu_{g1} = 0.0114$ cp @ 100°F, 1.0 atm

Fig 3-15, P130, McCain Jr.

$\mu_g/\mu_{g1} = 1.5$ @ T_{pr}, P_{pr}

∴ $\mu_g = (\mu_{g1})(\mu_g/\mu_{g1})$

$\mu_g = (0.0114)(1.5)$ cp

$\mu_g = 0.0171$ cp @ 100°F, 2336 psi ⊛

(72)

3) Gas Compressibility, c_g;

Since; $P_{pr} = 3.47$, $P_c = 673$ psia

$T_{pr} = 1.60$ (From B_g calculation)

Monograph #1, Figure G.7A, Page 160

C_r = Pseudoreduced compressibility = 0.29

$\therefore c_g = c_r / P_c = 0.29 / 673$ psia

$c_g = 4.309 \times 10^{-4}$ psia^{-1} (*)

Total Compressibility Calculation, C_t;

$C_t = C_o S_o + C_w S_w + c_g S_g + C_f$

No Free Gas $\therefore = 0$

C_f = Effective Rock Compressibility

Monograph #1, Figure G.5, Page 159

For $\phi = 33\%$

$C_f = 3 \times 10^{-6}$ psi^{-1}

Saturation values will be used as provided from Resource Evaluation's computer program

$S_o = 72.3\%$

$S_w = 27.7\%$

$S_g = 0$

$\therefore c_t = (.723)(4.8 \times 10^{-6}) + (.277)(2.55 \times 10^{-6}) + 3 \times 10^{-6}$

$C_t = 7.18 \times 10^{-6}$ psi^{-1} (*)

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(13)

Calculation of Water Parameters

1) C_w; Compressibility of water

Assuming no gas in solution and 80,000 ppm NaCl;

Monograph #5, Figs D-16 and D-17

C_w @ 100°F and $p \cong 2300$ psi

$C_w = 2.55 \times 10^{-6}\ psi^{-1}$ (*)

2) μ_w; viscosity of water

Assuming no gas in solution and 80,000 ppm NaCl (0.08% NaCl);

Monograph #5, Figs D.35

@ 100°F and 1atm; $\mu^*_T \cong$ 0.7 cp

$f = 1.003$ @ 100°F, 2300 psi

$\therefore\ \mu_w = (\mu^*_T)(f) = (.7cp)(1.003) = .7021\ cp$ (*)

3) B_w; Formation Volume Factor of water.

Assuming no gas in solution

$B_w = (1 + \Delta V_{wp})(1 + \Delta V_{wT})$

William D. McCain, JR., "The Properties of Petroleum Fluids", Page 279 Fig 6.7

@ 100°F ; $\Delta V_{wT} = 0.007$

Page 280, Fig 6.8

@ 2300 psig 100°F ; $\Delta V_{wp} = -0.0026$

$\therefore\ B_w = (1 + (-.0026))(1 + .007)$

$B_w = 1.0044$ BB/STB (*)

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(14)

TABLE # 1

DST # 2, HAMMERHEAD, OCS Y-0849 #1, UNION

GAUGE # 253, FIRST SHUT IN PERIOD DATA

t_p = 15 minutes

p_{wf} = 1863.7 psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	1863.7	—	—	—
1	2273.4	409.7	16	1.204
2	2301.4	437.7	8.5	.929
3	2316.9	453.2	6.0	.778
4	2323.1	459.4	4.75	.677
5	2329.7	466.0	4.0	.602
6	2333.3	469.6	3.5	.544
7	2334.9	471.2	3.14	.497
8	2337.0	473.3	2.87	.459
9	2338.8	475.1	2.67	.426
10	2339.6	475.9	2.50	.398
12	2341.7	478.0	2.25	.352
14	2343.8	480.1	2.07	.316
16	2346.2	482.5	1.94	.287
18	2346.9	483.2	1.83	.263
20	2347.7	484.0	1.75	.243
22	"	"	1.68	.226
24	"	"	1.63	.211
26	"	"	1.57	.198
28	"	"	1.54	.186
30	"	"	1.50	.176
35	"	"	1.43	.155
40	2349.3	485.6	1.38	.138
45	2349.6	485.9	1.33	.125
50	"	"	1.30	.114
55	"	"	1.27	.105
59.7	2351.9	488.2	1.25	.097

(15)

TABLE #2

DST #2, HAMMERHEAD, OCS Y-0849 #1, UNION
GAUGE #111, FIRST SHUT IN PERIOD DATA

tp = production time = 15 minutes
pwf = flowing bottom hole pressure @ shut in = 1842.1 psi

Δt (min)	Pws (psi)	Pws - Pwf (psi)	$\frac{tp+\Delta t}{\Delta t}$	$\log\left(\frac{tp+\Delta t}{\Delta t}\right)$
0	1842.1	—	—	—
1	2022.4	180.3	16	1.204
2	2241.6	399.5	8.5	.929
3	2275.0	432.9	6.0	.778
4	2286.8	444.7	4.75	.677
5	2291.1	449.0	4.0	.602
6	2293.8	451.7	3.5	.544
7	2297.2	455.1	3.14	.497
8	2298.4	456.3	2.87	.459
9	2300.2	458.1	2.67	.426
10	2300.8	458.7	2.50	.398
12	2302.7	460.6	2.25	.352
14	2304.2	462.1	2.07	.316
16	2306.6	464.5	1.94	.287
18	2307.8	465.7	1.83	.263
20	2308.1	466.0	1.75	.243
22	2309.0	466.9	1.68	.226
24	2309.0	466.9	1.63	.211
26	2309.6	467.5	1.57	.198
28	"	"	1.54	.186
30	"	"	1.50	.176
35	"	"	1.43	.155
40	2310.3	468.2	1.38	.138
45	"	"	1.33	.125
50	"	"	1.30	.114
55	2312.1	470.0	1.27	.105
60	2311.8	469.7	1.25	.097

TABLE # 3

DST # 2, HAMMERHEAD, OCS Y-0849 # 1, UNION

GAUGE # 111, SECOND SHUT IN PERIOD DATA

(10)

$t_p = 15 + 1502 = 1517$ min

$p_{wf} = 2590.9$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
0	2590.9			
30	2545.3	-45.6	51.567	1.712
60	2315.6	-275.3	26.283	1.420
90	2304.0	-286.9	17.856	1.252
120	2673.0	82.1	13.642	1.135
150	2406.7	-184.2	11.113	1.046
180	2253.4	-337.5	9.428	.974
210	2290.9	-300	8.224	.915
240	2290.9	-300	7.321	.865
270	2291.5	-299.4	6.619	.821
300	2291.5	-299.4	6.057	.782
330	2291.5	-299.4	5.580	.748
360	2291.5	-299.4	5.214	.717
369	2292.4	-298.5	5.111	.709

PROPRIETARY

(17)

TABLE #4

DST #2, HAMMERHEAD, Y-0849 #1, UNION
GAUGE #207, SECOND SHUT IN PERIOD DATA

$t_p = 15 + 1502 = 1517$ min.

$p_{wf} = 2637$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
0	2637	—	—	—
30	2587.6	-49.4	51.567	1.712
60	2357.2	-279.8	26.283	1.420
90	2346.2	-290.8	17.856	1.252
120	2709.6	72.6	13.642	1.135
150	2433.2	-203.8	11.113	1.046
180	2290	-347	9.428	.974
210	2333	-304	8.224	.915
240	2333	-304	7.321	.865
270	2334.2	-302.8	6.619	.821
300	2334.2	-302.8	6.057	.782
330	2334.2	-302.8	5.580	.748
360	2334.2	-302.8	5.214	.717
369	2334.2	-302.8	5.111	.709

(15)

TABLE #5 PROPRIETARY

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO

GAUGE # 155, FIRST SHUT IN PERIOD DATA

t_p = 6.5 minutes

p_{wf} = 43.2 psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	43.2	—	—	—
15	41.9	-1.3	1.433	0.156
30	41.9	-1.3	1.217	0.085
45	42.2	-1.0	1.144	0.059
60	43.6	+.4	1.108	0.045
75	43.6	+.4	1.087	0.036
90	45.2	2.0	1.072	0.030
105	46.9	3.7	1.062	0.026
120	48.6	5.4	1.054	0.023
135	51.9	8.7	1.048	0.020
150	53.6	10.4	1.043	0.018
165	58.6	15.4	1.039	0.017
180	59.9	16.7	1.036	0.015
195	59.9	16.7	1.033	0.014
210	61.2	18.0	1.031	0.013
225	61.9	18.7	1.029	0.0124
240	62.2	19.0	1.027	0.0116
247	62.9	19.7	1.026	0.011

PROPRIETARY

(18)

TABLE # 5

DST # 2, HAMMERHEAD, OCS Y-0849 # 1, UNION

GAUGE # 207, THIRD SHUT IN PERIOD DATA

$t_p = 15 + 1502 + 618 = 2135$ min.

$p_{wf} = 2189.3$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$	$\frac{t_p + \Delta t}{\Delta t}$
0	2189.3	—	—	—
1	2306.1	116.8	3.329	2133
2	2312.1	122.8	3.029	1069
3	2315.7	126.4	2.853	712.85
4	2319	129.7	2.728	534.56
5	2320.5	131.2	2.631	427.56
6	2323	133.7	2.553	357.27
7	2325	135.7	2.486	306.20
8	2326	136.7	2.428	267.90
9	2328	138.7	2.377	238.23
10	2328.8	139.5	2.331	214.29
12	2329.3	140.0	2.253	179.06
14	2331	141.7	2.186	153.46
16	2331	141.7	2.129	134.59
18	2331.2	141.9	2.078	119.67
20	2332	142.8	2.032	107.65
22	2332.3	143.0	1.991	97.95
24	2332.7	143.4	1.954	89.95
26	2333.1	143.8	1.920	83.18
28	2333.1	143.8	1.888	77.27
30	2333.1	143.8	1.858	72.11
35	2334	144.7	1.792	61.94
40	2335.1	145.8	1.735	54.33
45	2335.1	145.8	1.685	48.42
50	2335.1	145.8	1.641	43.75
55	2335.5	146.2	1.600	39.81
60	2336.1	146.8	1.563	36.56
70	2336.1	146.8	1.498	31.48
80	2336.1	146.8	1.442	27.67

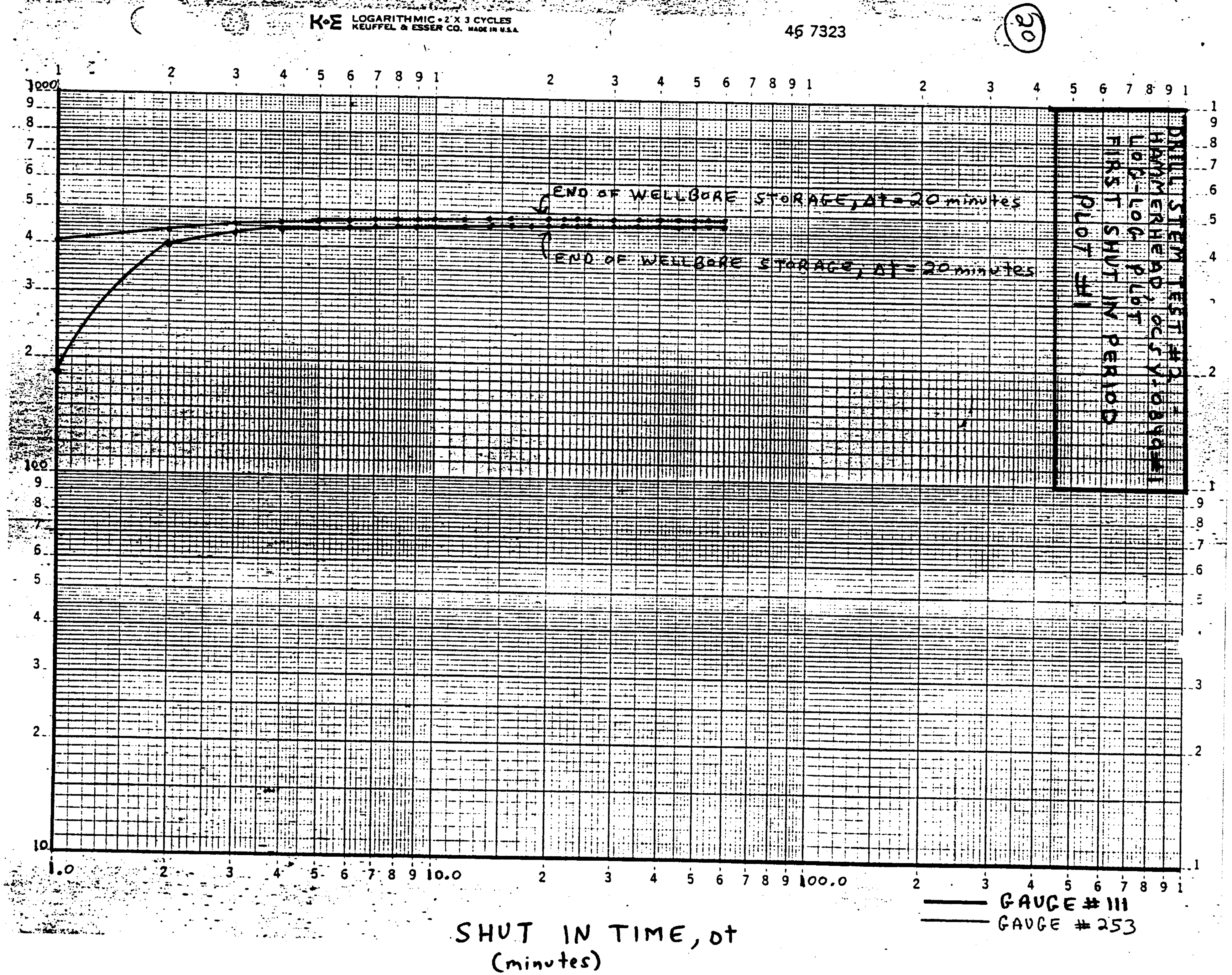
(79)

TABLE #5 (CONTINUED)

GAUGE # 207, THIRD SHOT IN PERIOD (*)

Δt (min)	P_{ws} (psi)	$P_{ws}-P_{wf}$ (psi)	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$	$\frac{t_p+\Delta t}{\Delta t}$
90	2336.1	146.8	1.393	24.72
100	2336.1	146.8	1.349	22.34
110	2336.1	146.8	1.310	20.42
120	2336.1	146.8	1.274	18.79
135	2336.3	147	1.226	16.83
150	2336.6	147.3	1.183	15.24
165	2336.6	147.3	1.144	13.93
180	2337.4	148.1	1.109	12.85
195	2337.4	148.1	1.077	11.94
210	2338.3	149	1.048	11.17
225	2338.3	149	1.021	10.50
240	2338.3	149	0.996	9.91
260	2338.3	149	0.964	9.20
280	2338.3	149	0.936	8.63
300	2338.3	149	0.909	8.11
320	2338.3	149	0.885	7.67
340	2338.3	149	0.862	7.28
360	2338.3	149	0.841	6.93
380	2338.3	149	0.821	6.62
400	2338.3	149	0.802	6.34
460	2338.3	149	0.751	5.64
520	2338.3	149	0.708	5.11
580	2338.3	149	0.670	4.68
626	2338.7	149.4	0.645	4.42

(*) All readings for Gauge #207 are questionable due to gauge possibly malfunctioning. This gauge was the only one providing data for the third shot in period.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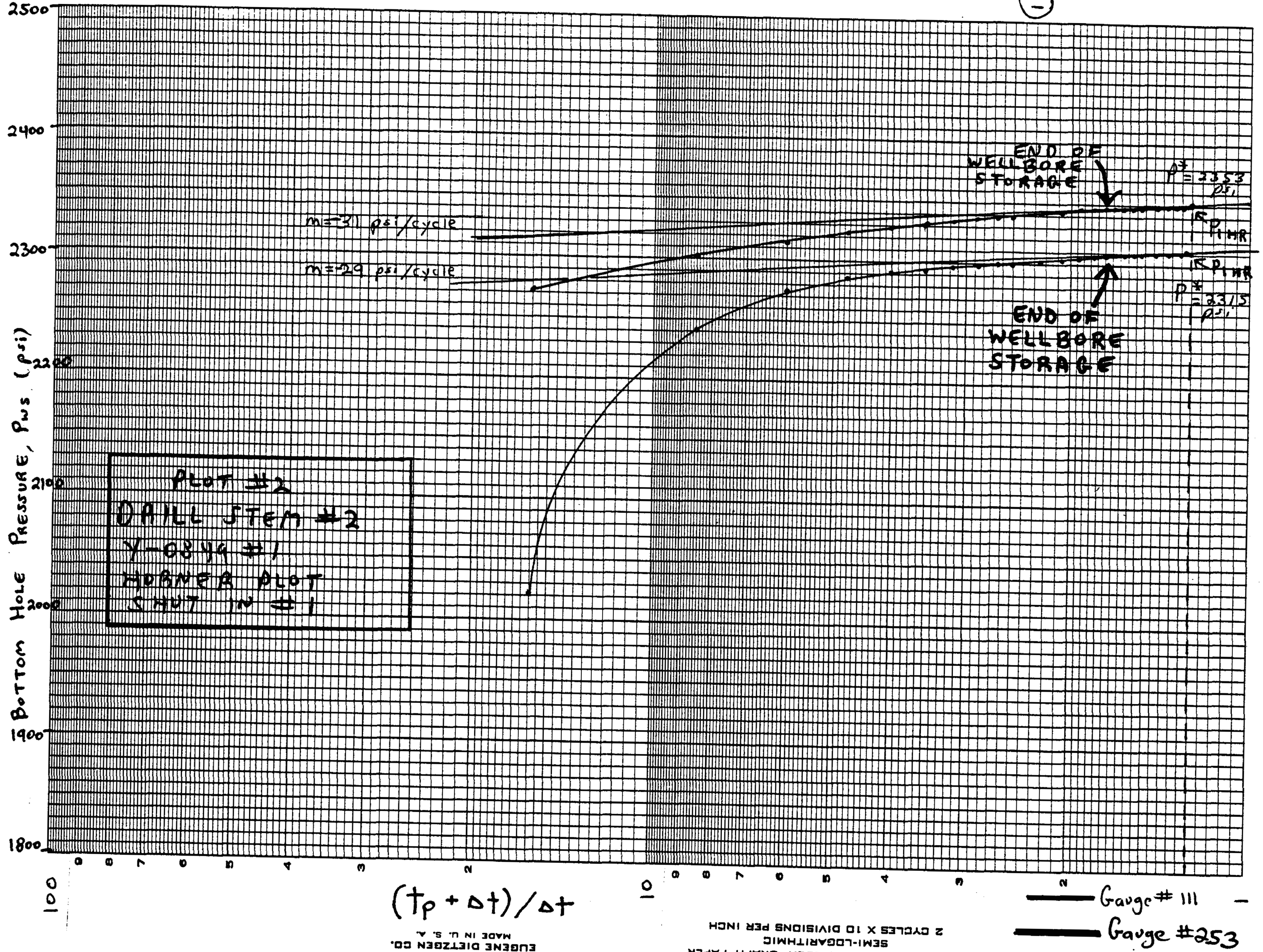
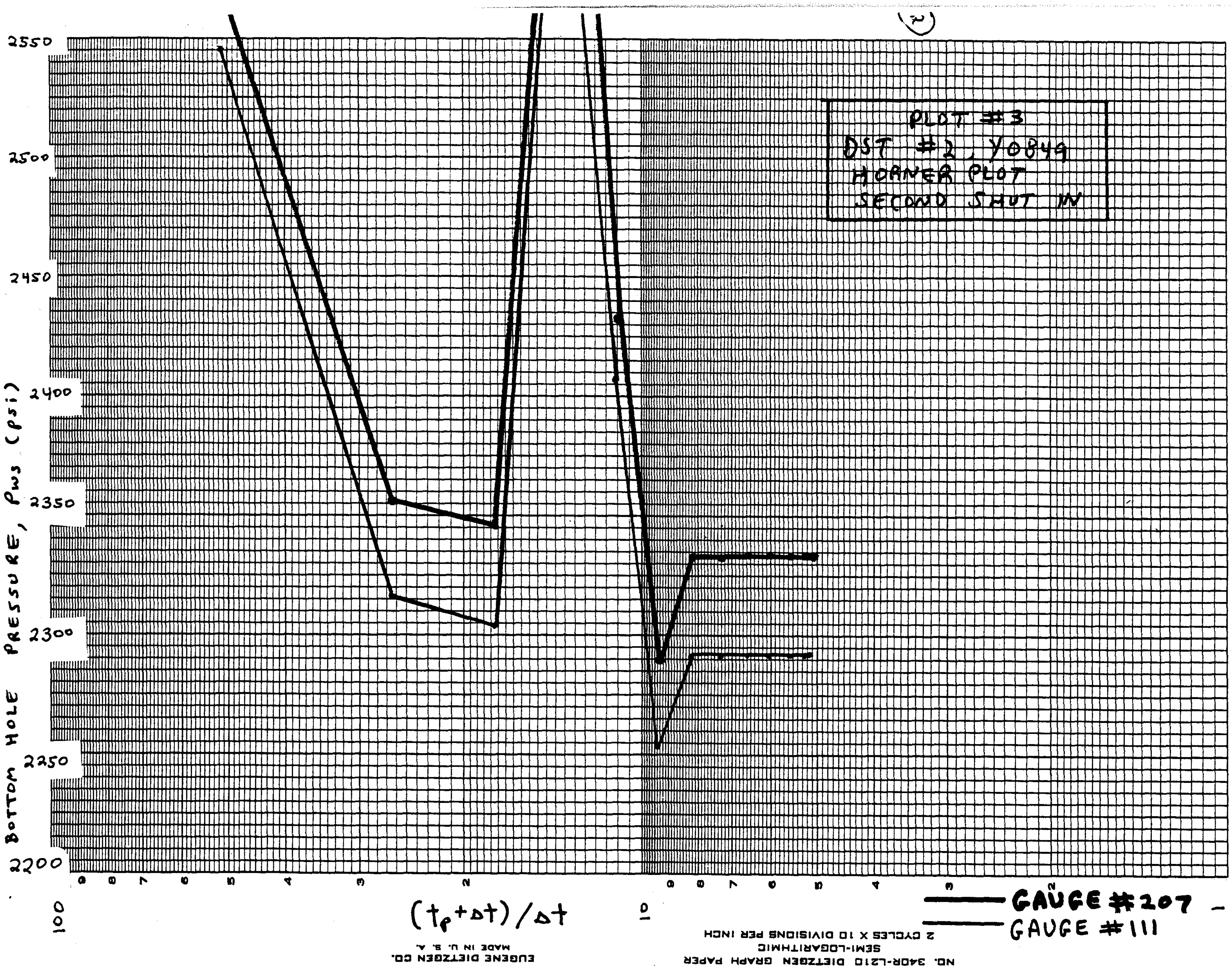
DRILL STEM TEST #3
HAMMERHEAD, OCS Y-0849 #1
LOG-LOG P PLOT
FIRST SHUT IN PERIOD
PLOT #1
END OF WELLBORE STORAGE, Δt = 20 minutes
END OF WELLBORE STORAGE, Δt = 20 minutes
PRESSURE DIFFERENCE, ΔP (psi)
1000
100
10
1.0
10.0
100.0
SHUT IN TIME, Δt
(minutes)
GAUGE #111
GAUGE #253



PLOT #2
DRILL STEM #2
Y-0844 #1
HORNER PLOT
SHUT IN #1
Bottom Hole Pressure, Pws (psi)
(tp + Δt)/Δt
m=31 psi/cycle
m=29 psi/cycle
END OF WELLBORE STORAGE
END OF WELLBORE STORAGE
P* = 2353 psi
P* = 2315 psi
P1HR
P1HR
Gauge # 111
Gauge #253



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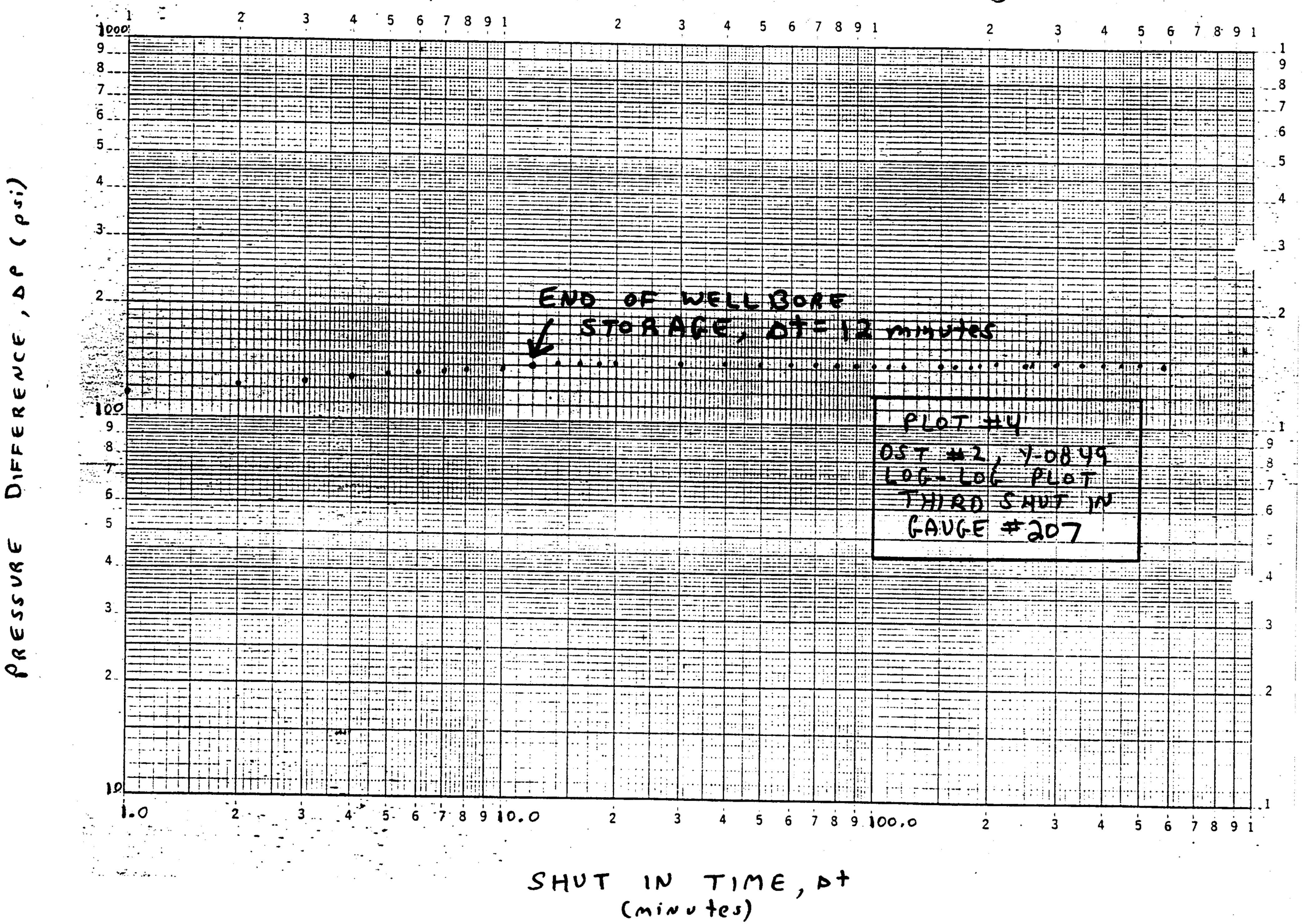

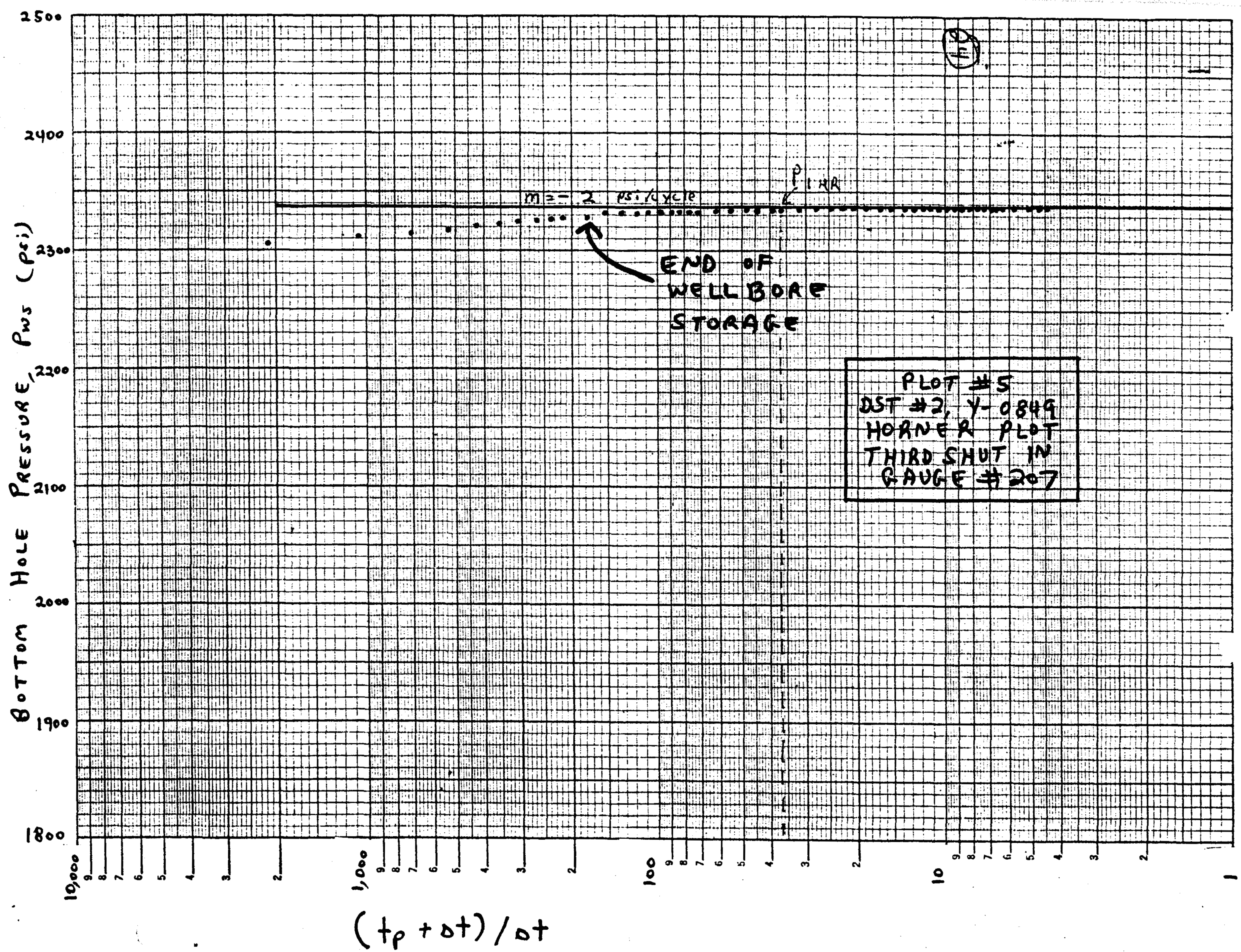

2500
2400
2300
2200
2100
2000
1900
1800
BOTTOM HOLE PRESSURE, Pws (psi)
m = - 2 psi/cycle
P 1 HR
END OF WELLBORE STORAGE
PLOT #5
DST #2, Y-0849
HORNER PLOT
THIRD SHUT IN
GAUGE #207
10,000
1,000
100
10
1
(tp + Δt) / Δt

(25)

DST #2 HORNER PLOT ANALYSIS

1) Permeability Calculation

Basic Equation; $k_n = \frac{-162.6\, q_n \mu_n B_n}{m h}$

where; k_n = permeability of phase "n", md
q_n = flowrate of phase "n", STB/D
μ_n = viscosity of phase "n", cp
B_n = formation volume factor of phase "n", RB/STB
m = slope of Horner Plot Straight Line, psi/cycle
h = thickness of interval tested, Feet

Since the flow periods of DST #2 produced oil, water, and gas the permeability of the formation to each phase will be calculated for each shut in period analyzed

Gauge #253 Shut In Period #1:

From Horner Plot #, m = -31 psi/cycle
$p^* = 2353$ psi

From Core Labs Report @ 100°F and 2353 psi, Page B

$\mu_o = 20$ cp

$$\therefore k_o = \frac{-162.6\,(912\ STBD)(20\ cp)(1.098\ RB/STB)}{(-31\ psi/cycle)(39\ Ft)}$$

k_o = 2693 md = 2.693 Darcies (*)

$$k_w = \frac{-162.6\,(157\ STB/D)(.7021\ cp)(1.0044\ RB/STB)}{(-31\ psi/cycle)(39\ Ft.)}$$

k_w = 14.89 md (*)

$$k_g = \frac{-162.6\,(202{,}336\ \tfrac{SCF}{D}/5.615\ Ft^3/BBL)(0.0171\ cp)(5.548\times10^{-3}\ Ft^3/Ft^3)}{(-31\ psi/cycle)(39\ Feet)}$$

k_g = 0.46 md. (*)

PROPRIETARY

(26)

Gauge #111, Shut In Period #1;

From Horner Plot # $m = -29$ psi/cycle

$p^* = 2315$ psi

From Core Labs Report, P. 8, @ 100°F and 2315 psi:

$\mu_o = 20.5$ cp

$$\therefore k_o = -162.6 \frac{(912)(20.5)(1.098)}{(-29)(39)} = 2{,}951 \text{ md} = 2.951 \text{ Darcies}$$ (*)

$$k_w = -162.6 \frac{(157)(.7021)(1.0044)}{(-29)(39)} = 15.92 \text{ md}$$ (*)

$$k_g = -162.6 \frac{\left(\frac{202{,}336}{5.615}\right)(0.0171)(5.548 \times 10^{-3})}{(-29)(39)} = 0.49 \text{ md}$$ (*)

Gauge #207, Third Shut In Period;

From Horner Plot # $m = -2$ psi/cycle

$p^* = 2339$ psi

From Core Labs Report, P. 8 @ 100°F and 2339 psi

$\mu_o = 20.3$ cp

$$\therefore k_o = -162.6 \frac{(912)(20.3)(1.098)}{(-2)(39)} = 42{,}376 \text{ md} = 42.376 \text{ Darcies}$$ (*)

$$k_w = -162.6 \frac{(157)(.7021)(1.0044)}{(-2)(39)} = 230.8 \text{ md}$$ (*)

$$k_g = -162.6 \frac{\left(\frac{202{,}336}{5.615}\right)(.0171)(5.548 \times 10^{-3})}{(-2)(39)} = 7.13 \text{ md}$$ (*)

(27)

2) Skin Effect Calculation

Basic Equation ; $S = 1.151\left[\frac{P_{1HR} - P_{WF}}{|m|} - \log\left(\frac{k}{\phi \mu c_t r_w^2}\right) + 3.23\right]$

The above equation will be modified for multiphase flow as follows

$$\frac{k}{\mu} = \left(\frac{k}{\mu}\right)_t = \frac{k_o}{\mu_o} + \frac{k_g}{\mu_g} + \frac{k_w}{\mu_w} = \text{TOTAL MOBILITY RATIO}$$

Free gas Rate

$$\left[\frac{k}{\mu}\right]_t = \frac{-162.6}{mh}\left[B_o q_o + B_g\left(\frac{q_{gt} - q_o R_s}{1000}\right) + B_w q_w\right]$$

where : q_{gt} = total gas flow rate
R_s = GOR,

$$\therefore \left[\frac{k}{\mu}\right]_t = \frac{-162.6}{m(39 Ft.)}\left[912(1.098) + 9.88\times10^{-1}\frac{RB}{MSCF}\left(202{,}336\frac{MSCF}{D} - \frac{912(220)}{1000}\right) + 157(1.0044)\right]$$

$$\left[\frac{k}{\mu}\right]_t = -\frac{4.169}{m}\left(1160.76\ RB/D\right) = \frac{-4839.2}{m}\ \frac{md}{cp}$$

For Gauge # 253 , Shut In Period #1

$m = -31$ psi/cycle

$\therefore \left[\frac{k}{\mu}\right]_t = \frac{-4839.2}{-31} = 156.104\ \frac{md}{cp}$ = Total Mobility

$\therefore$ From Horner Plot #

P_{1HR} @ $\Delta t = 60$ min $\therefore \frac{t_p + \Delta t}{\Delta t} = \frac{15 min + 60 min}{60 min} = 1.25$

@ $\frac{t_p + \Delta t}{\Delta t} = 1.25$, $P_{ws} = P_{1HR} = 2351.9$ psi

$$\therefore S = 1.151\left[\frac{2351.9 - 1863.7}{31} - \log\left[\frac{156.104}{(.33)(7.18\times10^{-6})(.4010)^2}\right] + 3.23\right]$$

$$S = 1.151\left[15.748 - 8.61249 + 3.23\right]$$

$\therefore$ **S = + 11.930** Severely Damaged ⊕

PROPRIETARY

(28)

For Gauge #111, Shut In Period #1

$m = -29$ psi / cycle

$\therefore [\frac{k}{\mu}]_t = -4839.2/-29 = 166.870 \frac{md}{cp}$ = TOTAL MOBILITY

$\therefore$ From Horner Plot #

P_{IHR} @ $\Delta t = 60$ min $\therefore \frac{t_p + \Delta t}{\Delta t} = \frac{15+60}{60} = 1.25$

@ $\frac{t_p + \Delta t}{\Delta t} = 1.25$, $P_{ws} = P_{IHR} = 2311$ psi

$$\therefore S = 1.151 \left[\frac{2311 - 1842.1}{+29} - \log \left[\frac{166.87}{(.33)(7.18 \times 10^{-6})(.4010)^2} \right] + 3.23 \right]$$

$S = 1.151 [16.1689 - 8.6415 + 3.23]$

S = +12.3818 Severely Damaged (*)

For Gauge #207, Shut In PERIOD 3

$m = -2$ psi / cycle

$\therefore [\frac{k}{\mu}]_t = -4839.2/-2 = 2419.6 \frac{md}{cp}$ = TOTAL MOBILITY

$\therefore$ From Horner PLOT #

P_{IHR} @ $\Delta t = 60$ min $\therefore t_p + \Delta t / \Delta t = 2135 + 60 / 60 = 36.6$

@ $t_p + \Delta t / \Delta t = 36.6$, $P_{ws} = P_{IHR} = 2337$ psi

$$\therefore S = 1.151 \left[\frac{2337 - 2189.3}{2} - \log \left(\frac{2419.6}{(.33)(7.18 \times 10^{-6})(.4010)^2} \right) + 3.23 \right]$$

$S = 1.151 (73.85 - 9.803 + 3.23)$

S = +77.44 (*)

PROPRIETARY

(30)

5) Radius of Investigation, r_i

Basic Equation: $r_i = \left(\frac{kT}{40 \phi \mu c} \right)^{1/2}$ where T = Flow Time in days

Modify for Multiphase Flow:

$$r_i = \left[\frac{\left[\frac{k}{\mu}\right]_T T}{40 \phi C_t} \right]^{1/2}$$

Gauge #253 ; T = 15 min

$$r_i = \left[\frac{156 \, (15/1440)}{40 (.33)(7.18 \times 10^{-6})} \right]^{1/2} = 131 \text{ FT.}$$ (*)

Gauge #111 ; T = 15 min

$$r_i = \left[\frac{166.8 \, (15/1440)}{40 (.33)(7.18 \times 10^{-6})} \right]^{1/2} = 135 \text{ FT.}$$ (*)

Gauge #207 ; T = 15 + 1502 + 618 = 2135 min

$$r_i = \left[\frac{2419.6 \, (2135/1440)}{40 (.33)(7.18 \times 10^{-6})} \right]^{1/2} = 6306 \text{ FT.}$$ (*)

The r_i distance is the radial distance from the wellbore influenced by the DST. Information obtained about the formation during the DST was obtained in the area of the r_i.

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(31)

6) Calculation of Average Reservoir Pressure, $\bar{P}$;

Gauge #253, Shut In Period #1

$$\frac{P^* - \bar{P}}{m/2.303} = 2.51$$

m = slope from Horner Plot

$$\therefore \bar{P} = P^* - \frac{2.51(m)}{2.303}$$

$$\bar{P} = 2353 - \frac{2.51(31)}{2.303}$$

P^* = extrapolated straight line pressure from Horner Plot

$\bar{P} = 2319.2$ psi (*)

Gauge #111, Shut In Period #1

$$\bar{P} = P^* - \frac{2.51(m)}{2.303}$$

$$\bar{P} = 2315 - \frac{2.51(29)}{2.303}$$

$\bar{P} = 2283.4$ psi (*)

Gauge #207, Shut In Period #3

$$\bar{P} = 2339 - \frac{2.51(2)}{2.303}$$

$\bar{P} = 2336.8$ (*)

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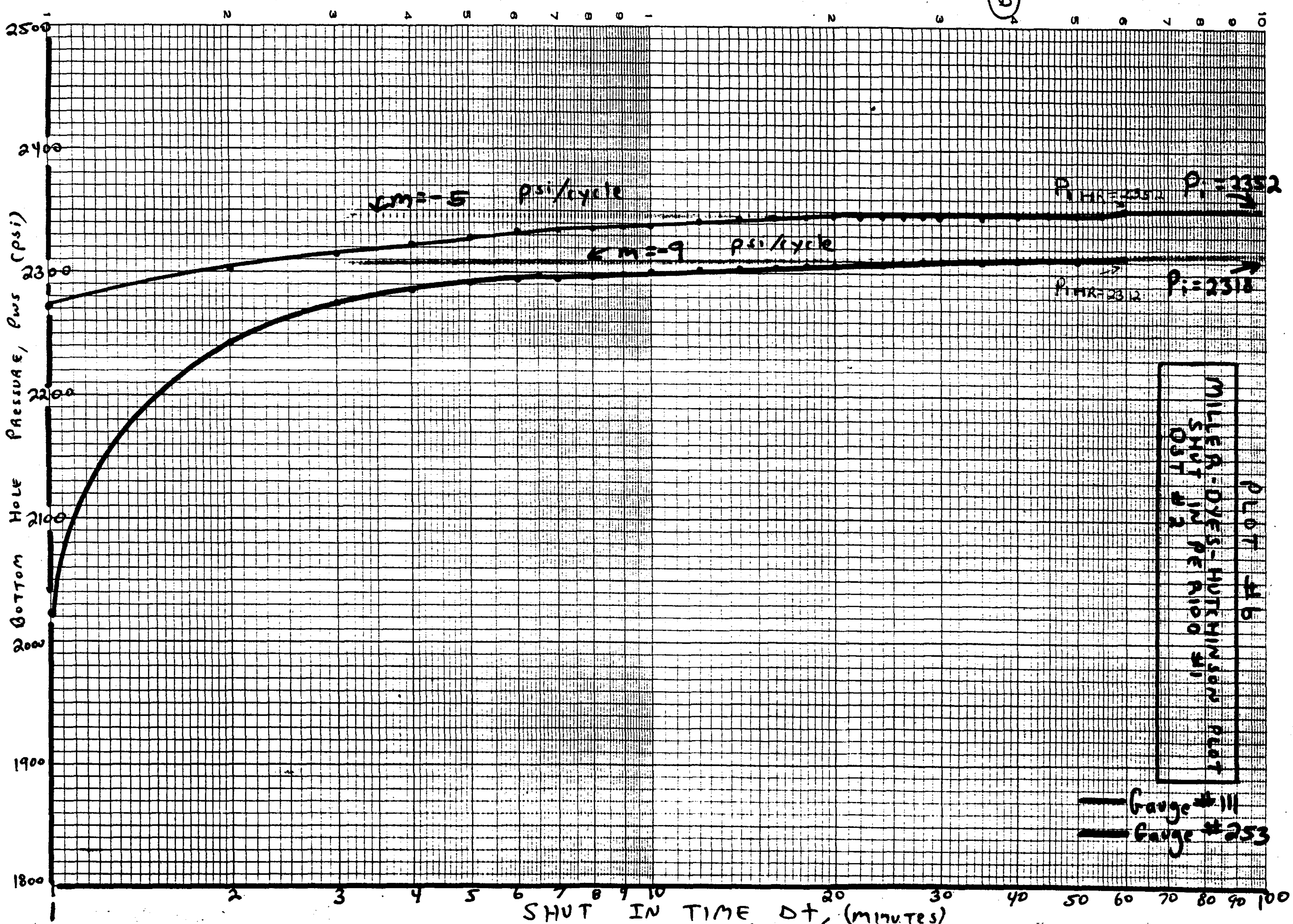

PROPRIETARY

(33)

DST #2, MILLER-DYES-HUTCHINSON PLOT ANALYSIS

Basic Equation: $k_n = -162.6 \dfrac{q_n \mu_n B_n}{mh}$

Gauge #253 First Shut In $m = -5$ psi/cycle

$k_o = -162.6 \dfrac{(912)(20)(1.098)}{(-5)(39)} = $ 16.7 Darcies (*)

$k_w = -162.6 \dfrac{(157)(.7021)(1.0044)}{(-5)(39)} = $ 92 md (*)

$k_g = -162.6 \dfrac{\left(\frac{202336}{5.615}\right)(.0171)(5.548 \times 10^{-3})}{(-5)(39)} = $ 2.85 md (*)

Gauge #111 First Shut In $m = -9$ psi/cycle

$k_o = -162.6 \dfrac{(912)(20.5)(1.098)}{(-9)(39)} = $ 9.5 Darcies (*)

$k_w = -162.6 \dfrac{(157)(.7021)(1.0044)}{(-9)(39)} = $ 51 md (*)

$k_g = -162.6 \dfrac{\left(\frac{202331}{5.615}\right)(.0171)(5.548 \times 10^{-3})}{(-9)(39)} = $ 8.9 md (*)

Estimation of Fluids in Place

(34) The following calculations will be based on an interval thickness value of h = 20 feet. According to well logs, out of the total 39 feet of sand, 20 feet contain oil sands, the remaining 19 feet contain water.

a) Initial Oil In Place = IOIP

$$IOIP = 7758 \frac{BB}{AcFT} \phi\, So / Boi \quad (STB)$$

$$IOIP = 7758\,(.33)(.723) / 1.098\ BB/STB$$

$$IOIP = 1686\ \frac{STB}{AC\text{-}FT} = 1851\ \frac{BB}{AC\text{-}FT}$$ (*)

b) According to Resource Evaluation the most probable size of this reservoir is 3690 Acres.

$$IOIP \text{ within 3690 Acres} = 7758\, \phi\, So\, (Acres)\, h / Boi$$

$$IOIP,\ 3690\ Acres = 7758\,(.33)(.723)(3690\ Acres)(20\ Ft) / 1.098$$

$$IOIP\ 3690\ Acres = 124.410 \times 10^6\ STB = 136.602 \times 10^6\ BB$$ (*)

c) Since the majority of the IOIP is not recovered by primary depletion techniques, the Recoverable Oil must be estimated. Based on historical recoveries a 30% or 40% recovery factor is a good estimate of recoverable oil by primary depletion

η = Recovery Factor = 30%

Recoverable Oil Within 3690 Acres = $RO_{3690\ Acres}$

$$RO_{3690\ Acres} = IOIP \times \eta$$

$$RO_{3690\ Acres} = 124.410 \times 10^6\ STB\ (.3) = 37.323 \times 10^6\ STB$$ (*)

$$40.980 \times 10^6\ RB$$ (*)

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η = 40%

$$RO_{3690\ Acres} = IOIP \times \eta$$

$$RO_{3690\ Acres} = 124.410 \times 10^6\ STB\ (.4) = 49.764 \times 10^6\ STB$$ (*)

$$= 54.641 \times 10^6\ RB$$ (*)

CALCULATION RESULTS
DST #2

Gauge #	SHUT IN PERIOD	ANALYSIS METHOD	p^* (psi) (extrapolated pressure)	p_i (psi) (initial pressure)	$\bar{p}$ (psi) (average pressure)	k_o (md.)	k_w (md.)	k_g (md.)	S SKIN	ΔP_s (psi)	F.E. (Flow Efficiency)	r_i (Feet)
253	1	HORNER	2353	—	2319.2	2,693	14.89	0.46	+11.9	+321	+0.35	131
					← BEST	ESTIMATES	→					
111	1	HORNER	2315	—	2283.4	2,951	15.92	0.49	+12.4	+312	+0.39	135
207	3	HORNER	2339	—	2336.8	42,376	231	7.13	+77.4	+135	−66.5	6306
253	1	MDH	—	2352	—	16,700	92	2.85	—	—	—	—
111	1	MDH	—	2318	—	9,500	51	8.9	—	—	—	—

IOIP = 1686 STB/AC-FT

IGIP (Solution) = 370,920 SCF/AC-FT → 429,930 SCF/AC-FT

IOIP = 1851 RB/AC-FT

AVERAGE VALUES			2336	2335	2313	2822 (Excluding Gauge 207, Gauge 253 MDH and Gauge 111 MDH)	81	3.96	+34	+256	+0.37 (Excluding Gauge 207)	133 (Excluding Gauge 207)

DRILL STEM TEST

Test Date 9/12/85 Well No.
Operator Union Oil
Drilling Contractor Canmar
Location (S-T-R)

Test Number DST #2
Date 9/13/85
Test Interval 5,300'-5,315'
Total Depth 5,377 plug back

Hole Size 12¼"
Drill Pipe (Size & Lgth) 5" 4,541'
Drill Collars (Size&Lgth) 6½" 399'
Type of Cushion Fluid N_2
Amount of Cushion 1,725 PSI

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TEST DATA

1. Tool open at 03:25 hours.
2. Initial open period 15 minutes.
3. Initial shut-in period 60 minutes.
4. Final flow period 625 minutes.
5. Final shut-in period minutes.
6. Description of blow on initial open period Strong blow when bleeding off N_2
7. Description of blow during test light blow, small volume of gas after liquid surfaced.
8. G.T.S. 180 minutes: O.T.S. 189 minutes;
   Surface choke size 6 10/64" Bottom hole choke size NA
9. Flow Rate: Gas 181,559 C.F.P.D. Oil 38 B.P.H. G.O.R. 201
10. Gravity of Gas .9 Gravity of Oil
11. Total fluid recovery: 289 BBL
12. Resistivity of H_2O NA Chlorides of H_2O 27,000 P.P.M.
13. Depth of top press bomb 5,181 Bottom Bomb 5,208

PRESSURE DATA

*1	Top Inside	Bottom Inside		Top Outside	Bottom Outside
I.H.P.	2,340		I.H.P.		2,461
I.S.I.P.	2,339		I.S.I.P.		2,362
I.F.P.	1,623		I.F.P.		1,883
F.F.P.	2,191		F.F.P.		NA
F.S.I.P.	2,338		F.S.I.P.		NA
F.H.H.	NA		F.H.H.		NA
Temp.	93		Temp.		

SAMPLE CHAMBER DATA No wireline samples were taken

1. Gas C.F.
2. Oil C.C.
3. H_2O C.C.
4. Mud C.C.
5. B.O.R. B.S. & W. %

REMARKS

*1 Only one gauge recorded the final flow and shut-in period, all others either failed or ran out of time.

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J. Levine

DST #1 SUMMARY

Drill Stem Test (DST) #1 was carried out by Union on a sandstone interval which was perforated
① from 5442'-5462' and from 5470'-5490' (MD, TVD). Well logs showed a shale interval between the two sets of perforations.

DST #1 was conducted through a 9 5/8" liner and consisted of a series of four flow tests and four buildup tests. Only the third and fourth buildup periods were analyzed for this study.

Shut in periods one and two were not analyzed due to wellbore storage effects. Wellbore storage masks accurate information on the formation of interest. These effects can be seen on Log-Log plots 2 and 4 as lines of unit slope for these first two shut in periods.

Flow tests produced oil and water with only a trace of gas. Union reported an oil flow rate (q_o) of 31 BPH (744 STB/D) on their DST #1 summary sheet (copy enclosed) yet this value was not used in this analysis. Upon evaluating flow period #2 data it was determined that a more accurate average value of q_o was 13.5 BPH (325 STB/D). If testing continued the value of q_o would have probably stabilized at a rate close to 300-400 STB/D.

An average water rate (q_w) of 297 BWPD was calculated from flow test #2 data for use in this report.

The reservoir fluid data provided by Core Laboratories, Inc. for this well are based on a recombined sample from crude oils from both DST #1 and DST #2. The reported properties were used for both tests. It should be noted that this procedure could →

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cause significant errors in a reservoir evaluation. If both zones contain fluids of differing properties an average fluid sample may not reflect these differences as well as one would like.

A major problem for this analysis is one of gas. The recombined fluid sample used by Core Lab was injected with pure methane to simulate formation gas. This is appropriate for DST #2 which produced gas very similar to pure methane at a rate of approximately 202,000 SCF/D and a crude oil with a Gas-Oil-Ratio (GOR) of 220-255 SCF/STB, yet it may not be appropriate for DST #1 which only produced a trace of gas. Though using the fluid properties for DST #1 may cause erroneous conclusions we are forced to use this data since fluids from both zones were not analyzed seperately.

Horner analysis for the third and fourth shut in periods for Gauges 111 and 155 yielded a wide range of results. Calculated oil permeabilities (k_o) ranged from 1888 millidarcies (md.) to 2373 md, with an average value of 2131 md. The best estimate of k_o is 1888 md. which was obtained for the third shut in period from Gauge 111. This value seems more in line with sidewall core values (680 md average for this zone) and log calculated values than the other permeability values.

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Horner analysis gave reservoir pressures (P^*) ranging from 2302 psi to 2330 psi with an average value of 2313 psi. The best estimate of P^* was 2310 psi which was calculated for the third shut in period for Gauge 111, ③ and for the fourth shut in period for Gauge 155. Average reservoir pressures ($\bar{P}$) ranged from 2289 psi to 2318 psi with an average value of 2299.5 psi. The best estimate for $\bar{P}$ was 2295 psi calculated from Gauge 111 for shut in period three. For DST #1 all $\bar{P}$ values were less than P^* values. This is usually the case is closed, single well reservoirs. Though this phenomenon leads us to believe that this reservoir is a closed reservoir the Horner plots gave no indication of boundaries. This is not to say that boundaries do not exist, just that the shut in periods did not provide information far enough into the reservoir to detect these boundaries.

Core Lab reported a bubble point pressure (P_{BP}) of 2391 psig at a reservoir temperature of 100°F. Since all of the calculated P^* and $\bar{P}$ values are below the reported P_{BP} value one is lead to believe that the reservoir is below its bubble point. If a reservoir is at a pressure below its bubble point normally a free gas cap exists, yet for this zone no gas was produced nor was a gas cap indicated on the well logs. Possible explanations for this include; that the reservoir has lost all of its gas through upward migration, the average fluid properties from Core Labs report for this zone are in error, or that the well bore did not intersect the gas cap. This last explanation seems like the most valid one. The gas cap, which may be very small could be updip from the well, probably to the North-North East of the Hammerhead location. The well-bore could have only intersected the oil zone which is devoid of gas since the reservoir pressure is

below the PBP value. Further drilling and/or Fluid studies will have to be conducted to
(4) answer this question.

Other calculations show that the zone tested during DST #1 is damaged. This can be seen by looking at the calculated Skin factors. Both Gauges # 111 and # 155 gave positive values for skin for shut in period three and negative values for shut in period four. A positive value for skin indicates damage while a negative value indicates enhancement. Since the third shut in period lasted for 367 minutes (Δt = 367 minutes) and the fourth shut in period lasted for 659 minutes we can conclude that the fourth shut in is looking farther into the formation than the third shut in period. Skin damage due to drilling and cementing should be localized around the wellbore. Further away from the wellbore these effects should be minimal.

The calculated Skin values for DST #1 fit the theroy explained above. For the third shut in period Gauge # 111 gave a skin value of + 31.68 (Damage) and Gauge # 155 gave a skin value of + 35.17 (Damage). For the fourth shut in period Gauge # 111 had a skin value of − 0.468 (slight enhancement) and Gauge # 155 had a skin value of − 1.61 (enhancement). This shows that the formation around the well bore is damaged while the formation further away from the wellbore is slightly enhanced. This enhansement may be due to natural fractures in the rock. If this well was to be produced the damaged zone could be removed by acidization or hydraulic fracturing, resulting in a decrease in Skin value.

The flow efficiency (F.E.) calculated for

this zone varied from + 0.18 to + 1.224, with an average value of + 0.66. Basically, this tells us that the production rate from this
(5) zone could be increased by 34 % ((1 - .66) x100) by removing the damage, or possibly more than 34 % with an acid or fracture treatment.

Reserve calculations for this zone resulted in the following values; Initial Oil In Place (IOIP) = 1176 STB/AC-FT OR 1291 RB/AC-FT. These calculations were based on 45 Feet of pay, a 26 % porosity, and an oil saturation value of 64 %. If it is assumed that primary depletion of the reservoir allows us to recover 30% of the IOIP and if the reservoir size is taken as 5000 acres, the volume of recoverable oil is found to be 79×10^6 STB. This factor will change as more information on the size of the reservoir is obtained through further drilling. At the present time this is a "ball park" estimate of recoverable oil.

Based on the above information and other results of this study the author recommends that well OCS-Y 0849 #1 be determined capable of producing hydrocarbons in paying quantities as stated in OCS Order #4.

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J. Levie
2/5/86

DST #1 ANALYSIS PARAMETERS

(6)

r_w = 0.4010 Ft. (9 5/8", 47#, N-80 BUTTRESS LINER) Union
°API = 19.6° @ 60°F (Flow Test #2 Data Sheet)
Sg_{oil} = 0.936 @ 60°F (Calculated)
γ_{gas} = 0.561 = gas Gravity (Union DST #1 Summary Sheet)
h = 45 Feet (Logs)
ψ = Angle of Deviation = 0° (Vertical Well)
ϕ = 26 % (Computer Estimate)
BHT = 100°F = Reservoir Temperature (Core Report, Logs)
(*) $\bar{q}_o$ = 325 STB/D (Calculated Average Value From Data Sheet)
$\bar{q}_w$ = 297 BWPD (ST) (Calculated From Flow Test #2 Data Sheet)
$\bar{q}_g$ = 0 (Union stated Rate was To Small To Measure)
GOR ≅ 220 SCF/STB (DST #2 Data Sheet)
B_w = 1.0044 RB/STB @ 100°F, 2300 psi (Calculated)
μ_w = 0.752 cp @ 100°F, 2300 psi (Calculated)
c_w = 2.69×10^{-6} psi^{-1} @ 100°F, 2300 psi, 49,500 ppm NaCl (Calculated)
μ_o = 20 cp @ 100°F, 2350 psi (Core Lab Report, P. 11)
c_o = 4.8×10^{-6} psi^{-1} @ 2700 psig to 2391 psig (Core Lab Report, P. 2)
B_o = 1.098 $\frac{RB @ 2391 psig, 100°F}{STB @ 60°F}$ (Core Lab Page 11)
c_f = 3×10^{-6} psi^{-1} @ ϕ = 26% (Calculated)
c_t = 7.04×10^{-6} psi^{-1} (S_g = 0) (Calculated)
S_o = 64 % (Computer Estimate)
S_w = 36 % (Computer Estimate)
P_{BP} = 2391 psig @ 100°F (Core Lab Page 2)
P^* = Reservoir Pressure = 2310 - 2330 psi (Calculated)
Depth Tested = 5442' - 5462' and 5470' - 5490'

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(*) This value is an average value calculated over the entire second Flow period. Unions value of 744 STB/D on the Summary Sheet seemed to high. The 325 STB/D value is close to a stabilized value

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ESTIMATION OF OIL PARAMETERS

The Reservoir Fluid Data Report prepared by Core Labs was made up of oil from both, DST #1 and DST #2. The parameters calculated from this sample can be taken as being average values from both zones. Due to this, oil properties for both tests will be the same for this analysis.

This sample was a recombined sample. Pure methane gas was added to the oil at the laboratory to simulate solution gas. It should be noted that the produced gas in DST #2 had a gas gravity of 0.576, and the gas from DST #1 a gas gravity of 0.561. The gas gravity of pure methane is 0.5539, @ 60°F, which is very close to that of the produced gas. Additionaly, the critical pressure and temperature values calculated for the gas of DST #2 are very close to that of pure methane.

TOTAL COMPRESSIBILITY CALCULATION; C_t

$$C_t = C_o S_o + C_w S_w + C_g S_g^{\nearrow 0} + C_f$$

No Free Gas

$C_f = 3 \times 10^{-6}$ psi^{-1}, (FOR $\phi = 26\%$), Monograph #5, Figure D-12, Page 229

$$\therefore\ c_t = (4.8 \times 10^{-6})(.64) + (2.69 \times 10^{-6})(.36) + 3 \times 10^{-6}$$

$$C_t = 7.04 \times 10^{-6} \text{ psi}^{-1}$$ (Calculated, $S_g = 0$) (*)

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Calculation of Water Parameters

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1) C_w; Compressibility of water

Assuming no gas in solution and 49,500 ppm NaCl;

∴ Monograph #5, Figures D-16 and D-17

C_w @ 100 °F and $P \approx 2300$ psi

$C_w = 2.69 \times 10^{-6}$ psi^{-1} (*)

2) μ_w; Viscosity of Water

Assuming no gas in solution and 49,500 ppm NaCl (0.045 % NaCl).

∴ Monograph #5, Figure D.35

@ 100 °F and 1 atm; $\mu^*_T = 0.75$ cp

$f = 1.003$ @ 100 °F, 2300 psi

∴ $\mu_w = (\mu^*_T)(f) = (0.75 \text{ cp})(1.003)$

$\mu_w = 0.7522$ cp (*)

3) B_w; Formation Volume Factor of Water

Assuming No gas in solution

$B_w = (1 + \Delta V_{wp})(1 + \Delta V_{wT})$

William D. McCain Jr., "The Properties of Petroleum Fluids", Page 279, Figure 6.7

@ 100 °F; $\Delta V_{wT} = 0.007$

Page 280, Figure 6.8

@ 100 °F / 2300 psi; $\Delta V_{wp} = -0.0026$

∴ $B_w = (1 + (-0.0026))(1 + 0.007)$

$B_w = 1.0044$ RB/STB (*)

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TABLE #1

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO
GAUGE # 111, FIRST SHUT IN PERIOD DATA

t_p = production time = 6.5 minutes

p_{wf} = flowing bottom hole pressure at shut it = 28.8 psi

Δt (minutes)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	28.8	—	—	—
15	33.1	4.3	1.433	0.156
30	36.5	7.7	1.217	0.085
45	40.4	11.6	1.140	0.059
60	44.1	15.3	1.110	0.045
75	45.9	17.1	1.087	0.036
90	47.1	18.3	1.072	0.030
105	50.5	21.7	1.062	0.026
120	53.8	25.0	1.054	0.023
135	56.9	28.1	1.048	0.020
150	59.6	30.8	1.043	0.018
165	62.4	33.6	1.039	0.017
180	65.7	36.9	1.036	0.015
195	69.4	40.6	1.033	0.014
210	70.6	41.8	1.031	0.013
225	74.3	45.5	1.029	0.012
240	77.3	48.5	1.027	0.012
247	77.9	49.1	1.026	0.011

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TABLE #2

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO
GAUGE #111, SECOND SHUT IN PERIOD DATA

$t_p = 6.5 + 641 = 647.5$ minutes

$p_{wf} = 2278.5$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
0	2278.5	—	—	—
30	2278.8	0.3	22.58	1.354
60	2279.4	0.9	11.79	1.072
90	2280.6	2.1	8.19	0.914
120	2280.6	2.1	6.39	0.806
150	2282.1	3.6	5.32	0.726
180	2282.4	3.9	4.59	0.663
210	2283.3	4.8	4.083	0.611
240	2283.9	5.4	3.69	0.568
270	2283.9	5.4	3.39	0.531
300	2285.1	6.6	3.16	0.499
330	2285.1	6.6	2.96	0.472
360	2285.4	6.9	2.79	0.447
390	2286.4	7.9	2.66	0.425
420	2287.0	8.5	2.54	0.405
450	2288.2	9.7	2.44	0.387
480	2288.2	9.7	2.35	0.371
510	2288.5	10.0	2.27	0.356
540	2288.5	10.0	2.19	0.342
570	2289.7	11.2	2.14	0.330
600	2290.9	12.4	2.08	0.318
630	2290.9	12.4	2.03	0.307
660	2290.9	12.4	1.98	0.297
690	2291.5	13.0	1.94	0.287
720	2292.7	14.2	1.90	0.279
750	2292.7	14.2	1.86	0.270
763	2292.7	14.2	1.85	0.267

TABLE #3

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO
GAUGE #111, THIRD SHUT IN PERIOD DATA

(11)

$t_p = 647.5 + 172 = 819.5$ minutes
$p_{wf} = 1832.7$ psi

Δt (min)	pws (psi)	pws-pwf (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	1832.7	–	–	–
1	2238.3	405.6	820.5	2.914
2	2249.6	416.9	410.75	2.614
3	2256.2	423.5	274.17	2.438
4	2260.5	427.8	205.88	2.314
5	2264.8	432.1	164.90	2.217
6	2268.7	436.0	137.58	2.139
7	2270.5	437.8	118.07	2.072
8	2271.7	439.0	103.44	2.015
9	2274.8	442.1	92.06	1.964
10	2277.8	445.1	82.95	1.919
12	2280.9	448.2	69.29	1.841
14	2281.8	449.1	59.54	1.775
16	2283.6	450.9	52.22	1.718
18	2285.1	452.4	46.53	1.668
20	2285.4	452.7	41.975	1.623
22	2286.3	453.6	38.25	1.583
24	2287.9	455.2	35.146	1.546
26	2288.2	455.5	32.519	1.512
28	2288.8	456.1	30.268	1.481
30	2289.4	456.7	28.317	1.452
35	2290.9	458.2	24.414	1.388
40	2292.4	459.7	21.488	1.332
45	2293.6	460.9	19.211	1.284
50	2293.9	461.2	17.390	1.240
55	2294.8	462.1	15.90	1.201
60	2295.4	462.7	14.658	1.166
70	2296.1	463.4	12.707	1.104
80	2297.3	464.6	11.244	1.051
90	2298.2	465.5	10.106	1.005

TABLE #3 CONTINUED

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
100	2298.5	465.8	9.195	0.964
110	2298.5	465.8	8.450	0.927
120	2299.1	466.4	7.829	0.894
135	2300.3	467.6	7.070	0.849
150	2300.3	467.6	6.463	0.811
165	2300.9	468.2	5.967	0.776
180	2300.9	468.2	5.553	0.745
195	2301.5	468.8	5.203	0.716
210	2301.5	468.8	4.902	0.690
225	2303.0	470.3	4.642	0.667
240	2303.0	470.3	4.415	0.645
260	2303.0	470.3	4.152	0.618
280	2303.3	470.6	3.927	0.594
300	2304.5	471.8	3.732	0.572
320	2304.5	471.8	3.561	0.552
340	2310.3	477.6	3.410	0.533
360	2310.3	477.6	3.276	0.515
367	2310.9	478.2	3.233	0.510

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TABLE #4

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO

GAUGE #111, FOURTH SHUT IN PERIOD DATA

$t_p = 819.5 + 969 = 1788.5$ minutes

$p_{wf} = 2239.4$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	2239.4	—	—	—
1	2260.7	21.3	1789.5	3.253
2	2266.8	27.4	895.25	2.952
3	2268.3	28.9	597.167	2.776
4	2271.4	32.0	448.125	2.651
5	2272.9	33.5	358.70	2.555
6	2274.4	35.0	299.08	2.476
7	2275.9	36.5	256.50	2.409
8	2276.2	36.8	224.563	2.351
9	2277.4	38.0	199.72	2.300
10	2278.7	39.3	179.85	2.255
12	2280.5	41.1	150.04	2.176
14	2282.0	42.6	128.75	2.109
16	2283.5	44.1	112.78	2.052
18	2285.1	45.7	100.36	2.001
20	2286.6	47.2	90.425	1.956
22	2286.6	47.2	82.296	1.915
24	2286.9	47.5	75.52	1.878
26	2288.1	48.7	69.79	1.844
28	2288.4	49.0	64.88	1.812
30	2289.3	49.9	60.62	1.783
35	2291.1	51.7	52.10	1.717
40	2292.4	53.0	45.71	1.660
45	2292.7	53.3	40.74	1.610
50	2294.2	54.8	36.77	1.566
55	2295.7	56.3	33.52	1.525
60	2296.9	57.5	30.81	1.489
70	2302.1	62.7	26.55	1.424
80	2306.6	67.2	23.36	1.368
90	2307.9	68.5	20.87	1.320

TABLE #4 CONTINUED

	Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
(14)	100	2305.4	66.0	18.89	1.276
	110	2310.6	71.2	17.26	1.237
	120	2311.2	71.8	15.90	1.202
	135	2318.2	78.8	14.25	1.154
	150	2318.2	78.8	12.92	1.111
	165	2316.7	77.3	11.84	1.073
	180	2311.2	71.8	10.94	1.039
	195	2315.7	76.3	10.17	1.007
	210	2315.7	76.3	9.52	0.979
	225	2312.1	72.7	8.95	0.952
	240	2316.7	77.3	8.45	0.927
	260	2318.2	78.8	7.88	0.897
	280	2318.2	78.8	7.39	0.869
	300	2314.8	75.4	6.96	0.843
	320	2315.7	76.3	6.59	0.819
	340	2317.6	78.2	6.26	0.797
	360	2317.6	78.2	5.97	0.776
	380	2318.5	79.1	5.71	0.756
	400	2320.0	80.6	5.47	0.738
	420	2320.6	81.2	5.26	0.721
	440	2322.1	82.7	5.07	0.705
	460	2322.1	82.7	4.89	0.689
	480	2322.7	83.3	4.73	0.675
	500	2322.7	83.3	4.58	0.661
	520	2322.7	83.3	4.44	0.647
	540	2322.7	83.3	4.31	0.635
	560	2323.0	83.6	4.19	0.623
	580	2324.2	84.8	4.08	0.611
	600	2324.2	84.8	3.98	0.600
	620	2324.2	84.8	3.89	0.589
	640	2324.2	84.8	3.80	0.579
	659	2323.6	84.2	3.71	0.570

(15)

TABLE #5

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO
GAUGE #155, FIRST SHUT IN PERIOD DATA

t_p = 6.5 minutes
p_{wf} = 43.2 psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	43.2	—	—	—
15	41.9	-1.3	1.433	0.156
30	41.9	-1.3	1.217	0.085
45	42.2	-1.0	1.144	0.059
60	43.6	+.4	1.108	0.045
75	43.6	+.4	1.087	0.036
90	45.2	2.0	1.072	0.030
105	46.9	3.7	1.062	0.026
120	48.6	5.4	1.054	0.023
135	51.9	8.7	1.048	0.020
150	53.6	10.4	1.043	0.018
165	58.6	15.4	1.039	0.017
180	59.9	16.7	1.036	0.015
195	59.9	16.7	1.033	0.014
210	61.2	18.0	1.031	0.013
225	61.9	18.7	1.029	0.0124
240	62.2	19.0	1.027	0.0116
247	62.9	19.7	1.026	0.011

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TABLE #6

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO, GAUGE #155, SECOND SHUT IN PERIOD DATA

$t_p = 6.5 + 641 = 647.5$ minutes

$p_{wf} = 2281.1$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	2281.1	—	—	—
30	2283.4	2.3	22.58	1.354
60	2283.4	2.3	11.79	1.072
90	2283.7	2.6	8.19	0.919
120	2284.7	3.6	6.40	0.806
150	2285.4	4.3	5.32	0.726
180	2286.7	5.6	4.60	0.663
210	2286.7	5.6	4.08	0.611
240	2286.4	5.3	3.70	0.568
270	2286.4	5.3	3.40	0.531
300	2286.4	5.3	3.16	0.499
330	2286.7	5.6	2.96	0.472
360	2286.7	5.6	2.80	0.447
390	2287.0	5.9	2.66	0.425
420	2287.0	5.9	2.54	0.405
450	2287.0	5.9	2.44	0.387
480	2287.4	6.3	2.35	0.371
510	2287.4	6.3	2.27	0.356
540	2287.4	6.3	2.20	0.342
570	2287.4	6.3	2.14	0.330
600	2288.0	6.9	2.08	0.318
630	2288.4	7.3	2.03	0.307
660	2288.4	7.3	1.98	0.297
690	2288.7	7.6	1.94	0.287
720	2288.7	7.6	1.90	0.279
750	2288.7	7.6	1.86	0.270
763	2289.4	8.3	1.85	0.267

TABLE #7

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO, GAUGE #155, THIRD SHUT IN PERIOD DATA

$t_p = 647.5 + 172 = 819.5$ minutes

$p_{wf} = 1854.1$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	1854.1	—	—	—
1	2185.2	331.1	820.5	2.91
2	2221.7	367.6	410.75	2.61
3	2241.9	387.8	274.17	2.44
4	2251.5	397.4	205.88	2.31
5	2255.2	401.1	164.9	2.22
6	2258.8	404.7	137.58	2.14
7	2261.5	407.4	118.07	2.07
8	2262.2	408.1	103.44	2.02
9	2264.2	410.1	92.06	1.96
10	2269.8	415.7	82.95	1.92
12	2269.8	415.7	69.29	1.84
14	2271.5	417.4	59.54	1.78
16	2272.8	418.7	52.22	1.718
18	2275.1	421	46.53	1.67
20	2277.1	423	41.98	1.62
22	2278.1	424	38.25	1.58
24	2279.8	425.7	35.15	1.55
26	2280.7	426.6	32.52	1.51
28	2280.7	426.6	30.27	1.48
30	2282.1	428	28.32	1.45
35	2283.4	429.3	24.41	1.39
40	2284.7	430.6	21.49	1.33
45	2285.4	431.3	19.21	1.28
50	2285.4	431.3	17.39	1.24
55	2287.1	433	15.90	1.20
60	2288.0	433.9	14.66	1.17
70	2289.4	435.3	12.71	1.10
80	2290.0	435.9	11.24	1.05
90	2291.4	437.3	10.11	1.005

TABLE #7 CONTINUED

(18)

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
100	2291.7	437.6	9.195	0.964
110	2291.7	437.6	8.45	0.927
120	2293.4	439.3	7.83	0.894
135	2293.4	439.3	7.07	0.849
150	2293.4	439.3	6.46	0.811
165	2293.7	439.6	5.97	0.776
180	2293.7	439.6	5.55	0.745
195	2293.7	439.6	5.20	0.716
210	2294.7	440.6	4.90	0.690
225	2294.7	440.6	4.64	0.687
240	2294.7	440.6	4.42	0.645
260	2294.7	440.6	4.15	0.618
280	2294.7	440.6	3.93	0.594
300	2295.0	440.9	3.73	0.572
320	2295.0	440.9	3.56	0.552
340	2295.3	441.2	3.41	0.533
360	2295.3	441.2	3.28	0.515
367	2295.0	440.9	3.23	0.510

TABLE #8

DST #1, HAMMERHEAD, OCS Y-0849 #1, AMOCO, GAUGE #155, FOURTH SHUT IN PERIOD DATA

(19)

$t_p = 819.5 + 969 = 1788.5$ minutes

$P_{wf} = 2228.6$ psi

Δt (min)	P_{ws} (psi)	$P_{ws} - P_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
0	2228.6	—	—	—
1	2246.2	17.6	1789.5	3.25
2	2249.5	20.9	895.25	2.95
3	2251.5	22.9	597.17	2.78
4	2253.2	24.6	448.125	2.65
5	2254.9	26.3	358.7	2.56
6	2256.2	27.6	299.08	2.48
7	2257.8	29.2	256.5	2.41
8	2258.5	29.9	224.56	2.35
9	2260.2	31.6	199.72	2.30
10	2261.5	32.9	179.85	2.26
12	2262.8	34.2	150.04	2.18
14	2263.5	34.9	128.75	2.11
16	2266.5	37.9	112.78	2.05
18	2267.1	38.5	100.36	2.00
20	2268.5	39.9	90.43	1.96
22	2269.8	41.2	82.30	1.92
24	2271.1	42.5	75.52	1.88
26	2272.1	43.5	69.79	1.84
28	2273.8	45.2	64.88	1.81
30	2274.8	46.2	60.62	1.78
35	2275.1	46.5	52.10	1.72
40	2275.4	46.8	45.71	1.66
45	2277.1	48.5	40.74	1.61
50	2278.8	50.2	36.77	1.57
55	2280.1	51.5	33.52	1.53
60	2282.7	54.1	30.81	1.49
70	2285.4	56.8	26.55	1.42
80	2286.7	58.1	23.36	1.37
90	2289.7	61.1	20.87	1.32

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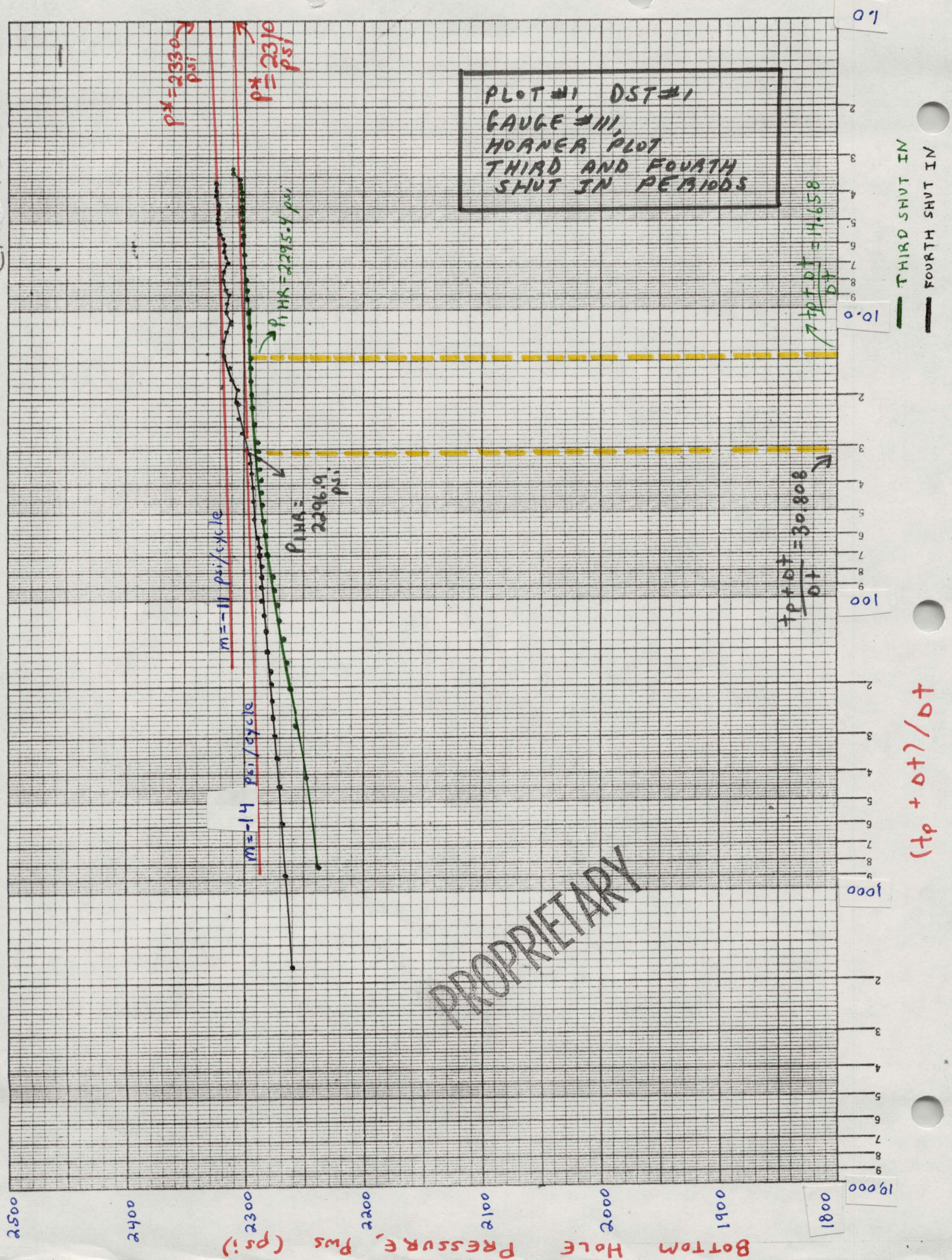
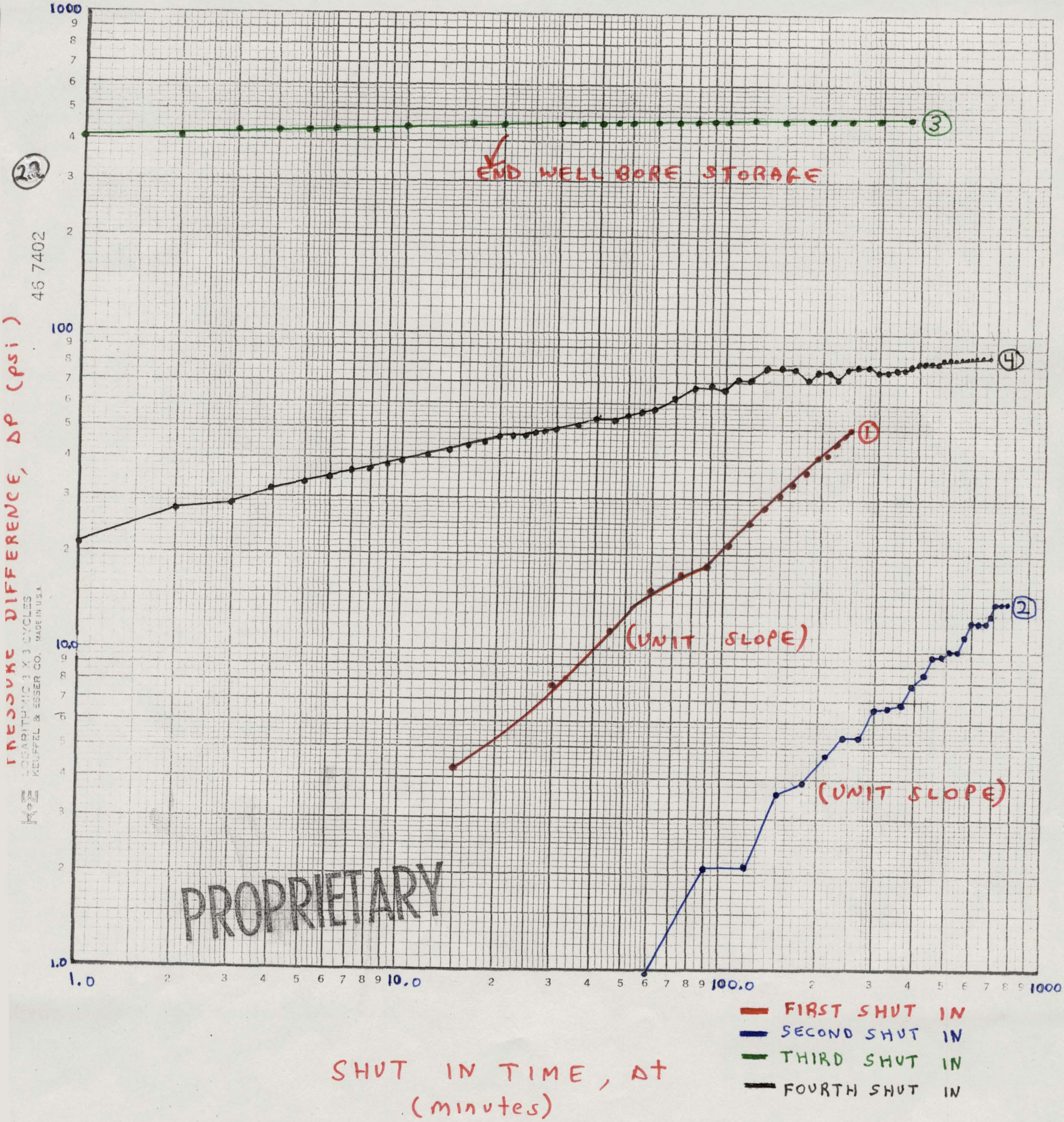
TABLE #8 CONTINUED

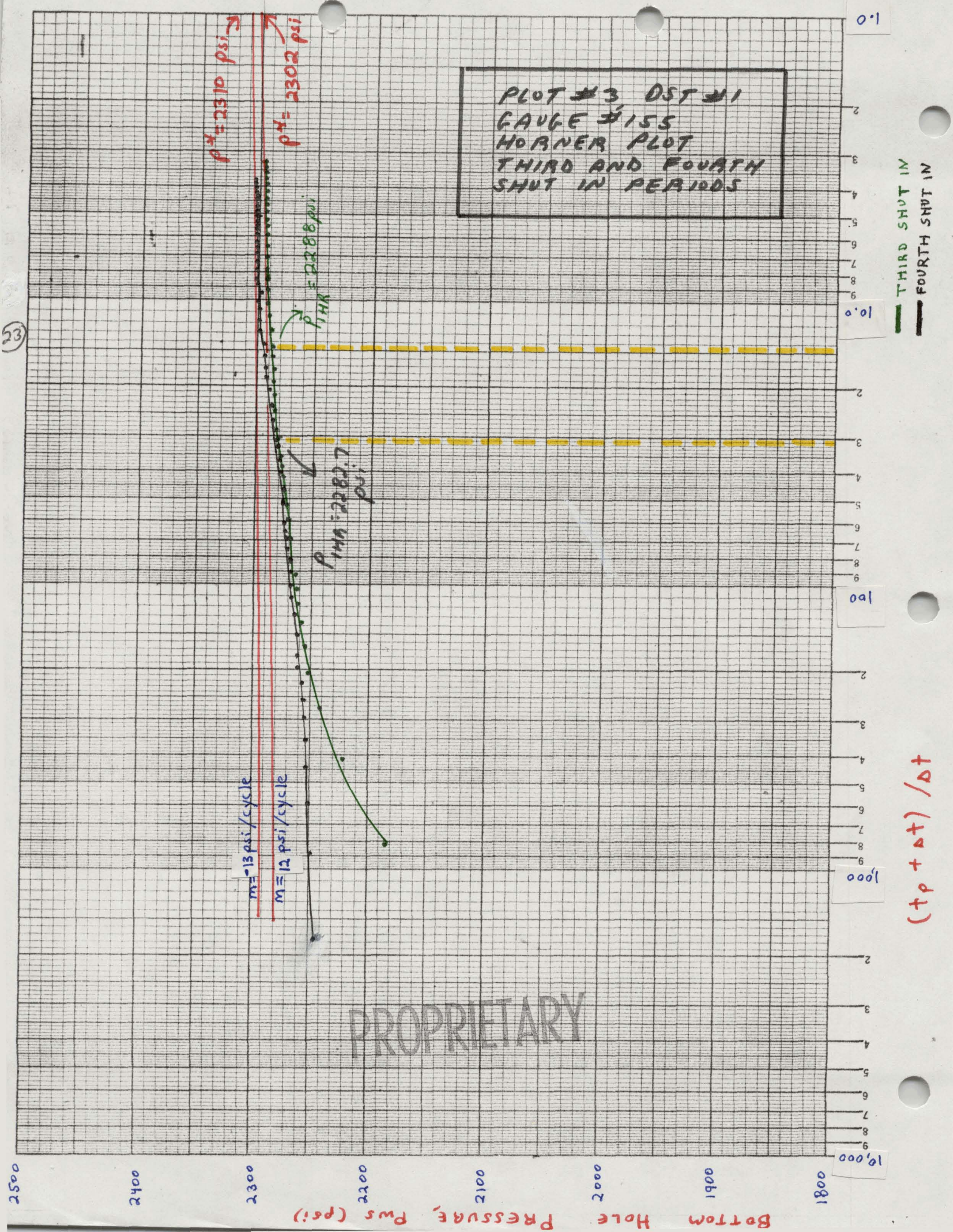
Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wF}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$
100	2292	63.4	18.89	1.28
110	2293.4	64.8	17.26	1.24
120	2294.7	66.1	15.90	1.20
135	2295	66.4	14.25	1.15
150	2299.3	70.7	12.92	1.11
165	2299.7	71.1	11.84	1.07
180	2299.7	71.1	10.94	1.04
195	2300	71.4	10.17	1.01
210	2297	68.4	9.52	0.979
225	2300	71.4	8.95	0.952
240	2301	72.4	8.45	0.927
260	2301.3	72.7	7.88	0.897
280	2301.3	72.7	7.39	0.869
300	2301.3	72.7	6.96	0.843
320	2301.3	72.7	6.59	0.819
340	2301.6	73	6.26	0.797
360	2302	73.4	5.97	0.776
380	2302	73.4	5.71	0.756
400	2302	73.4	5.47	0.738
420	2302	73.4	5.26	0.721
440	2302	73.4	5.07	0.705
460	2302	73.4	4.89	0.689
480	2303	74.4	4.73	0.675
500	2303	74.4	4.58	0.661
520	2303.3	74.7	4.44	0.647
540	2303.3	74.7	4.31	0.635
560	2304.3	75.7	4.19	0.623
580	2304.3	75.7	4.08	0.611
600	2305	76.4	3.98	0.600
620	2305	76.4	3.88	0.589
640	2305	76.4	3.79	0.579
659	2303.3	74.7	3.71	0.569



PLOT #1 DST #1
GAUGE #111,
HORNER PLOT
THIRD AND FOURTH
SHUT IN PERIODS
p* = 2330 psi
p* = 2310 psi
p_{1HR} = 2295.4 psi
p_{1HR} = 2296.9 psi
m = -11 psi/cycle
m = -14 psi/cycle
$\frac{t_p + \Delta t}{\Delta t}$ = 14.658
$\frac{t_p + \Delta t}{\Delta t}$ = 30.808
THIRD SHUT IN
FOURTH SHUT IN
$(t_p + \Delta t)/\Delta t$
1.0
10.0
100
1000
10,000
2500
2400
2300
2200
2100
2000
1900
1800
BOTTOM HOLE PRESSURE, P_{ws} (psi)
PROPRIETARY

DRILL STEM TEST #1, HAMMERHEAD, OCS Y-0849#1
AMOCO, GAUGE #111, LOG-LOG PLOT
GAUGE DEPTH 5208.4' PLOT #2

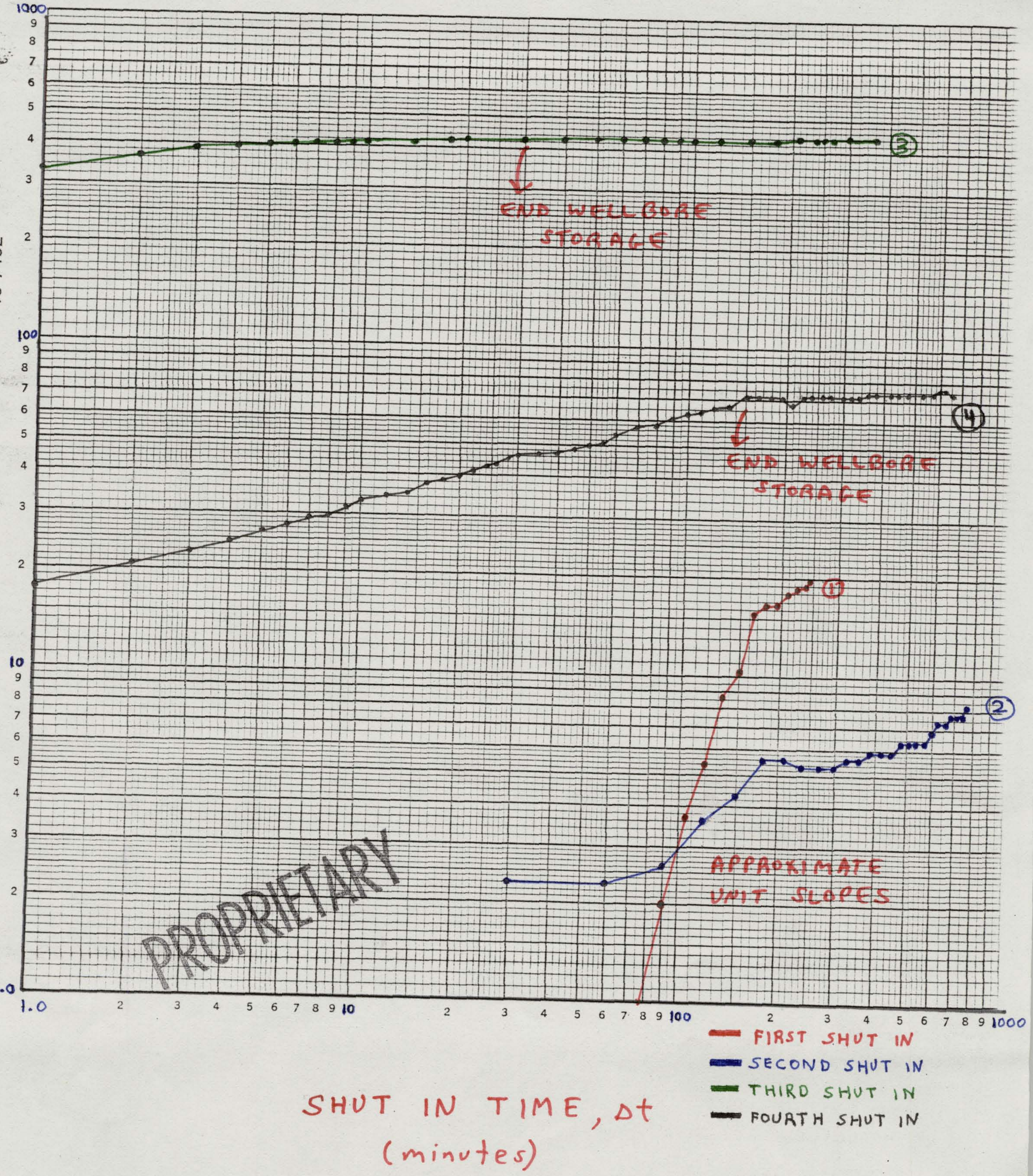




PLOT #3 DST #1
GAUGE #155
HORNER PLOT
THIRD AND FOURTH
SHUT IN PERIODS
p* = 2310 psi
p* = 2302 psi
P_{1HR} = 2288 psi
P_{1HR} = 2282.7 psi
m = -13 psi/cycle
m = 12 psi/cycle
THIRD SHUT IN
FOURTH SHUT IN
$(t_p + \Delta t)/\Delta t$
1.0
10.0
100
1000
10,000
BOTTOM HOLE PRESSURE, Pws (psi)
2500
2400
2300
2200
2100
2000
1900
1800
PROPRIETARY
(23)

DRILL STEM TEST #1, HAMMERHEAD, OCS Y-0849 #1
AMOCO, GAUGE #155, LOG-LOG PLOT
GAUGE DEPTH 5235.8' PLOT #4

(24)



(25)

DST #1 HORNER PLOT ANALYSIS

1) Permeability Calculation

Basic Equation; $k_n = \frac{-162.6\ q_n\ \mu_n\ B_n}{mh}$

where; k_n = permeability of phase "n", md.

q_n = flowrate of phase "n", STB/D

μ_n = viscosity of phase "n", cp

B_n = formation volume factor of phase "n", RB/STB

m = slope of Horner Plot straight line, psi/cycle

h = thickness of tested interval, Feet

Since the flow periods of DST #1 produced oil and water the permeability of the formation to each phase will be calculated for each shut in period analyzed.

Gauge # 111, Shut In Period #3

From Horner Plot # , $m = -14$ psi/cycle

$P^* = 2310$ psi

From Core Labs Report @ 100°F and 2310 psi,

Page 8, $\mu_o = 20.5$ cp

$$\therefore k_o = \frac{-162.6\ (325\ \text{STB/D})(20.5\ \text{cp})(1.098\ \frac{\text{RB}}{\text{STB}})}{(-14\ \text{psi/cycle})(45\ \text{Feet})}$$

k_o = 1.888 Darcies (*)

$$k_w = \frac{-162.6(297)(0.752)(1.0044)}{(-14)(45)}$$

k_w = 57.9 md (*)

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Gauge # 111, Shut In Period # 4

From Horner Plot # , $m = -11$ psi/cycle

$P^* = 2330$ psi

From Core Labs Report @ 100°F and 2330 psi

Page 8, $\mu_o = 20.25$ cp

$$\therefore k_o = \frac{-162.6\,(325\ \tfrac{STB}{D})(20.25\ cp)(1.098\ \tfrac{RB}{STB})}{(-11)(45\ FT.)}$$

$k_o = 2.373$ DARCIES ⊛

$$k_w = \frac{-162.6\,(297)(0.752)(1.0044)}{(-11)\,(45)}$$

$k_w = 73.7$ md. ⊛

Gauge # 155, Shut In Period # 3

From Horner Plot # , $m = -12$ psi/cycle

$P^* = 2302$ psi

From Core Labs Report @ 100°F and 2302 psi

Page 8, $\mu_o = 20.75$ cp

$$\therefore k_o = \frac{-162.6\,(325)(20.75)(1.098)}{(-12)(45)}$$

$k_o = 2.230$ DARCIES ⊛

$$k_w = \frac{-162.6\,(297)(0.752)(1.0044)}{(-12)(45)}$$

$k_w = 67.5$ md ⊛

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Gauge #155, Fourth Shut In Period

From Horner Plot #, $m = -13$ psi/cycle

$p^* = 2310$ psi

$\mu_o = 20.5$ cp.

$$\therefore k_o = \frac{-162.6(325)(20.5)(1.098)}{(-13)(45)}$$

$k_o = 2.033$ Darcies ⊕

$$k_w = \frac{-162.6(297)(0.752)(1.0044)}{(-13)(45)}$$

$k_w = 62.4$ md ⊕

2) Calculation of Skin

Basic Equation;

$$S = 1.151\left[\frac{P_{1HR} - P_{wf}}{|m|} - \log\left(\frac{k}{\phi \mu C_t r_w^2}\right) + 3.23\right]$$

The above equation will be modified for multiphase flow as follows;

$$\frac{k}{\mu} = \left(\frac{k}{\mu}\right)_t = \text{Total Mobility Ratio} = \frac{k_o}{\mu_o} + \frac{k_w}{\mu_w} + \frac{k_g}{\mu_g} \rightarrow 0, \text{ No Free Gas}$$

Since $k = -162.6 \dfrac{q \mu B}{mh}$

$$\left(\frac{k}{\mu}\right)_t = -162.6\left(\frac{qB}{mh}\right)_t = \frac{-162.6}{mh}\left(q_o B_o + q_w B_w\right)$$

$$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-162.6}{m(45\,Ft)}\left(\left(325\,\frac{STB}{D}\right)\left(1.098\,\frac{RB}{STB}\right) + \left(297\,\frac{STB}{D}\right)\left(1.0044\,\frac{RB}{STB}\right)\right)$$

$$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-3.6133}{m}\left(655.1568\,\frac{RB}{D}\right) = -\frac{2367.2977}{m}\ \frac{md}{cp}$$

PROPRIETARY

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For Gauge #111, Shut In Period #3

$m = -14$ psi/cycle

$$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-2367.2977}{-14} \frac{md}{cp} = 169.0927 \frac{md}{cp}$$

From Horner Plot #

P_{1hr} @ $\Delta t = 60$ min $\therefore$ $\frac{t_p + \Delta t}{\Delta t} = \frac{819.5 \text{ min} + 60 \text{ min}}{60 \text{ min}} = 14.658$

@ $\frac{t_p + \Delta t}{\Delta t} = 14.658$, $P_{ws} = 2295.4$ psi $= P_{1HR}$

$$\therefore S = 1.151\left[\frac{2295.4 - 1832.7}{|-14|} - \log\left(\frac{169.0927}{(.26)(7.04\times10^{-6})(.4010)^2}\right) + 3.23\right]$$

$$S = 1.151\left[33.05 - 8.75929 + 3.23\right]$$

$\therefore$ **S = + 31.68 Severely Damaged** ⊛

Gauge #111, Fourth Shut In Period

$m = -11$ psi/cycle

$$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-2367.2977}{-11} \frac{md}{cp} = 215.209 \frac{md}{cp}$$

From Horner Plot #

P_{1hr} @ $\Delta t = 60$ min $\therefore$ $\frac{t_p + \Delta t}{\Delta t} = \frac{1788.5 \text{ min} + 60 \text{ min}}{60 \text{ min}} = 30.808$

@ $\frac{t_p + \Delta t}{\Delta t} = 30.808$, $P_{ws} = 2296.9$ psi $= P_{1HR}$

$$\therefore S = 1.151\left[\frac{2296.9 - 2239.4}{|-11|} - \log\left(\frac{215.209}{(.26)(7.04\times10^{-6})(.4010)^2}\right) + 3.23\right]$$

$$S = 1.151\left[5.227 - 8.864 + 3.23\right]$$

$\therefore$ **S = −0.468 Slightly Enhanced** ⊛

(Questionable Answer)

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Gauge # 155, Shut In Period #3

$m = -12$ psi /cycle

$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-2367.2977}{-12} \frac{md}{cp} = 197.2748 \frac{md}{cp}$

From Horner Plot #

P_{1Hr} @ $\Delta t = 60$ min $\therefore \frac{t_p + \Delta t}{\Delta t} = \frac{819.5 \text{ min} + 60 \text{ min}}{60 \text{ min}} = 14.658$

@ $\frac{t_p+\Delta t}{\Delta t} = 14.658$, $p_{ws} = 2288$ psi $= P_{1HR}$

$$\therefore S = 1.151\left[\frac{2288 - 1854.1}{|-12|} - \log\left(\frac{197.2748}{(.26)(7.04\times10^{-6})(.4010)^2}\right) + 3.23\right]$$

$S = 1.151\,(36.158 - 8.826 + 3.23)$

$S = +35.17$ Severely Damaged (*)

Gauge #155, Shut In Period #4

$m = -13$ psi /cycle

$\therefore \left(\frac{k}{\mu}\right)_t = \frac{-2367.2977}{-13} \frac{md}{cp} = 182.099 \frac{md}{cp}$

From Horner Plot #

P_{1Hr} @ $\Delta t = 60$ min $\therefore \frac{t_p+\Delta t}{\Delta t} = \frac{1788.5 \text{ min} + 60 \text{ min}}{60 \text{ min}} = 30.808$

@ $\frac{t_p+\Delta t}{\Delta t} = 30.808$, $p_{ws} = P_{1Hr} = 2282.7$ psi

$$\therefore S = 1.151\left[\frac{2282.7 - 2228.6}{|-13|} - \log\left(\frac{182.099}{(.26)(7.04\times10^{-6})(.4010)^2}\right) + 3.23\right]$$

$S = 1.151\,(4.1615 - 8.79147 + 3.23)$

$S = -1.61$ Enhanced (*)

(Questionable Answer)

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3) Pressure Drop Across Skin, ΔP_s:
Basic Equation: $\Delta P_s = .87\ S(m)$

Gauge #111, 3d Shut In Period
$\Delta P_s = 0.87(+31.68)(14) = +385.86$ psi (*)

Gauge #111, 4th Shut In Period
$\Delta P_s = 0.87(-.468)(11) = -4.48$ psi (*)

Gauge # 155, 3d Shut In Period
$\Delta P_s = 0.87(35.17)(12) = +367.17$ psi (*)

Gauge # 155, 4th Shut In Period
$\Delta P_s = 0.87(-1.61)(13) = -18.2$ psi (*)

4) Flow Efficiency, F.E.
Basic Equation: $F.E. = \frac{P^* - P_{wF} - \Delta P_s}{P^* - P_{wF}}$

Gauge #111, 3d Shut In Period
$F.E. = \frac{2310 - 1832.7 - 385.86}{2310 - 1832.7} = +0.192$ (*)

Gauge #111, 4th Shut In Period
$F.E. = \frac{2330 - 2239.4 - (-4.48)}{2330 - 2239.4} = +1.049$ (*)

Gauge # 155, Shut In Period #3
$F.E. = \frac{2302 - 1854.1 - 367.17}{2302 - 1854.1} = +0.180$ (*)

Gauge # 155, Shut In Period #4
$F.E. = \frac{2310 - 2228.6 - (-18.2)}{2310 - 2228.6} = +1.224$ (*)

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5) Radius of Investigation, r_i

Basic Equation; $r_i = \left[\frac{kT}{40 \phi \mu c}\right]^{1/2}$ { T = Flow Time in days

Modify For Multiphase Flow

$\frac{k}{\mu} = \left(\frac{k}{\mu}\right)_t = \frac{k_o}{\mu_o} + \frac{k_w}{\mu_w}$; $C = C_t = C_o S_o + C_w S_w + C_f$

$\therefore \quad r_i = \left[\frac{\left(\frac{k}{\mu}\right)_t T}{40 \phi C_t}\right]^{1/2}$

Gauge #111, 3d Shut In Period

$T = \frac{819.5 \text{ min}}{1440 \frac{\text{min}}{\text{day}}} = .56909$

$r_i = \left[\frac{(169.0927)(.56909)}{40(.26)(7.04 \times 10^{-6})}\right]^{1/2} = \underline{\underline{1,146 \text{ Ft.}}}$ (*)

Gauge #111, 4th Shut In Period

$T = \frac{1788.5}{1440} = 1.242$

$r_i = \left[\frac{(215.209)(1.242)}{40(.26)(7.04 \times 10^{-6})}\right]^{1/2} = \underline{\underline{1,911 \text{ Ft.}}}$ (*)

Gauge #155, 3d Shut In Period

$T = \frac{819.5}{1440} = .56909$

$r_i = \left[\frac{(197.2748)(.56909)}{40(.26)(7.04 \times 10^{-6})}\right]^{1/2} = \underline{\underline{1,238 \text{ Ft.}}}$ (*)

Gauge #155, 4th Shut In Period

$T = \frac{1788.5}{1440} = 1.242$

$r_i = \left[\frac{(182.099)(1.242)}{40(.26)(7.04 \times 10^{-6})}\right]^{1/2} = \underline{\underline{1,757 \text{ Ft}}}$ (*)

The r_i distance is the radial distance from the wellbore influenced by the DST. Information obtained about the formation during the DST was obtained in the area of r_i.

(32)

6) Calculation of Average Reservoir Pressure, $\bar{p}$;

Basic Equation; $\frac{p^* - \bar{p}}{m/2.303} = 2.51$

$$\therefore \bar{p} = p^* - \frac{2.51(m)}{2.303}$$

Gauge #111, 3d Shut In Period

$$\bar{p} = 2310 - \frac{2.51(14)}{2.303} = 2295 \text{ psi} \quad (*)$$

Gauge #111, 4th Shut In Period

$$\bar{p} = 2330 - \frac{2.51(11)}{2.303} = 2318 \text{ psi} \quad (*)$$

Gauge #155, 3d Shut In Period

$$\bar{p} = 2302 - \frac{2.51(12)}{2.303} = 2289 \text{ psi} \quad (*)$$

Gauge #155, 4th Shut In Period

$$\bar{p} = 2310 - \frac{2.51(13)}{2.303} = 2296 \text{ psi} \quad (*)$$

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7) Reserve Calculations

The following calculations will be based on an interval thickness of 45 feet. This value has been estimated to contain oil sands by well log analysis.

a) Initial Oil In Place = IOIP

$IOIP = 7758 \frac{RB}{AC\text{-}FT} \phi S_o / B_{oi}$ (STB)

$IOIP = 7758(0.26)(.64)/1.098$

$IOIP = 1176 \frac{STB}{AC\text{-}FT} = 1291\ RB/AC\text{-}FT$ (*)

b) According to Resource Evaluation the most probable size of this reservoir is 5000 Acres.

IOIP within 5000 ACRES $= 7758\ \phi\ S_o (Acres) h / B_{oi}$

$IOIP_{5000\ Acres} = 7758 (.26)(.64)(5000\ Acres)(45\ Feet)/(1.098)$

$IOIP_{5000\ Acres} = 264.535 \times 10^6\ STB = 290.460 \times 10^6\ RB$ (*)

c) Since the majority of the IOIP is not recovered by primary depletion techniques, the Recoverable Oil must be estimated. This will be done for three recovery factors.

n = Recovery Factor = 15%

Recoverable Oil Within 5000 Acres = $RO_{5000\ Acres}$

$RO_{5000} = IOIP \times n$

$RO_{5000} = (264.535 \times 10^6)(.15) = 39.680 \times 10^6$ STB (*)

43.569×10^6 RB (*)

$n = 30\%$

$RO_{5000} = (264.535 \times 10^6)(.30) = 79.360 \times 10^6$ STB (*)

87.137×10^6 RB (*)

$n = 40\%$

$RO_{5000\ Acres} = (264.535 \times 10^6)(.40) = 105.814 \times 10^6$ STB ⊛

116.184×10^6 RB ⊛

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CALCULATION RESULTS
DST #1

Gauge #	Shut In Period	Analysis Method	1 P* (psi) (extrapolated pressure)	2 P_i (psi) (initial pressure)	3 $\bar{P}$ (psi) (average pressure)	4 k_o (md)	5 k_w (md)	6 S Skin	7 ΔP_s (psi)	8 F.E. Flow Efficiency	9 r_i (Feet)	10
111	3	HORNER	2310	—	2295	1888	57.9	+31.68	+385.86	+0.192	1,146	
				BEST ESTIMATE (↑ row above)								
111	4	HORNER	2330	—	2318	2373	73.7	−0.468	−4.48	+1.049	1,911	
155	3	HORNER	2302	—	2289	2230	67.5	+35.17	+367.17	+0.180	1,238	
155	4	HORNER	2310	—	2296	2033	62.4	−1.61	−18.2	+1.224	1,757	
AVERAGE VALUES			2313	—	2299.5	2131	65.4	+16.19	+182.6	+0.66	1513	

IOIP = 1176 STB/AC-FT

IOIP = 1291 RB/AC-FT

IOIP = Initial Oil In Place

AC-FT = Acre-Feet

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DRILL STEM TEST

Test Date 9/7/85 Well No. OCSY 0849
Operator Union Oil
Drilling Contractor Canmar
Location (S-T-R)

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Test Number DST #1
Date 9/7
Test Interval 5470'-5490' 5442-5462'
Total Depth 5560'

Hole Size 12 1/4
Drill Pipe (Size & Lgth) 5" 4571'
Drill Collars (Size&Lgth) 6 1/2" 399'
Type of Cushion Fluid N_2
Amount of Cushion 1789 psi

TEST DATA

1. Tool open at 05:26 hours.
2. Initial open period 16 minutes.
3. Initial shut-in period 368 minutes.
4. Final flow period 970 minutes.
5. Final shut-in period 612 minutes.
6. Description of blow on initial open period Blowdown of N_2 cushion at surface pressure of 1675 psi to 977 psi
7. Description of blow during test Blowdown of N_2 cushion at surface until liquid surfaced restricting flow
8. G.T.S. 25 minutes: O.T.S. 70 minutes; Surface choke size 3" valve Bottom hole choke size NA
9. Flow Rate: Gas *1 C.F.P.D. Oil 31 B.P.H. G.O.R. NA
10. Gravity of Gas .561 Gravity of Oil 20° API
11. Total fluid recovery: 588.5 including reverse out
12. Resistivity of H_2O NA Chlorides of H_2O 27,000 P.P.M.
13. Depth of top press bomb 5211 Bottom Bomb 5238

PRESSURE DATA

A-111 gauge

	Top Inside	Bottom Inside	Top Outside	Bottom Outside
I.H.P.	2493			2474
I.S.I.P.	2288			2300
I.F.P.	1854			1833
F.F.P.	2100			2226
F.S.I.P.	2311			2313
F.H.H.	2492			2501
Temp.	100°F			100°F

SAMPLE CHAMBER DATA

1. Gas *2 C.F.
2. Oil C.C.
3. H_2O C.C.
4. Mud C.C.
5. B.O.R. B.S. & W. %

REMARKS

*1 Gas rate too small to measure

*2 Sample chamber under pressure sent to lab, found to contain only water and gas

DST #2 - TABLE OF CONTENTS

DST #2 - SUMMARY

Union tested a sandstone interval from 5295' to 5334' (MD, TVD) by a series of flow tests and buildups.

① The tested interval was perforated from 5300' to 5315' and the test was conducted through a 9 5/8" liner. The tested interval was in the lower part of the Sagavanirtok formation (512' - 6410', MD, TVD) which is a tertiary formation composed of sandstone, siltstone, and shale.

Out of the four drawdown tests and four buildups tests conducted during this DST only the first shut in period could be analyzed with the hope of obtaining accurate results. This period was analyzed for two gauges, #111 and #253 by the conventional Horner method and the Miller-Dyes-Hutchinson (MDH) method. One gauge, #207 recorded pressure data for the third shut in period yet the "Formation Testing Service Report" prepared by Halliburton Services stated that all pressure data for gauge #207 was questionable. Gauge #207's third shut in data was analyzed by the Horner Method and results were found to be inaccurate. Results of this analysis are included in this report yet no significance are placed on these results and they will not be mentioned again in this summary.

The first flow period with production time (tp) of about 15 minutes was not analyzed because the initial drawdown is usually only carried out to release hydrostatic mud and cushion pressure in the drillpipe. For this test a nitrogen cushion was used with a pressure of 1725 psi.

The second flow test with a total tp of 1506 minutes was not analyzed due to sand problems. During this flow period the well killed itself due to sand production and the flow test was terminated to remove the sand. Sand was found in the test string from 4644' to 5331'. To remove sand a coiled tubing

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unit was run down the test string to wash out the sand with high pressure nitrogen. Once the sand was removed, Flow Period two was started again. These problems lead the author of this report to the conclusion that the pressure data was inaccurate and not worth analyzing.

(2) The second shut in period was analyzed for Gauges #207 and #111, yet the enclosed Horner Plot for this period shows why no further analysis was carried out for this shut in period. Pressures during this shut in decreased and were very erratic. These problems may have been caused by the sand problems in flow period two.

All other flow and buildup periods were not analyzed due to lack of pressure data. Either gauge clocks stopped, charts expired, or clocks showed stair stepping due to the pumping of nitrogen during flow test two.

Flowtests produced oil, water, and gas. After comparing Union's reported oil rate (q_o) from their summary sheet of 38 BOPH (912 STB/D) with raw field data it was decided that this value was accurate and should be used in the analysis. This rate is an average value. The q_o values reported during flow period two varied from 2600 BPD to 36 BPD. Towards the end of the flow period it appeared that q_o was starting to stabilize at the average value of 912 STB/D.

Union did not report an average water rate ($\bar{q}_w$) on their summary sheet, yet raw field data showed water production was significant and the author felt water production should be taken into consideration in the analysis. A $\bar{q}_w$ value was calculated from flow test two data as 157 STB/D to use in reservoir calculations.

Union's summary sheet reported a gas rate (q_g) of 181,559 SCF/D, yet upon reviewing raw field data a calculated rate of 202,336 SCF/D was found to reflect gas production more accuratley so this value was used for the analysis.

(3)

Core Labs "Reservoir Fluid Study" reported a bubble point pressure (P_{BP}) of 2391 psig at a reservoir temperature of 100 °F. All Horner Plots gave extrapolated straight line pressures (P^*) in the range of 2315 psi to 2353 psi. Horner Plot calculations gave average pressures ($\bar{P}$) in the range of 2283 psi to 2336 psi. MDH analysis gave initial pressures (P_i) of 2318 psi and 2352 psi. All of the above calculated pressures were below the reported P_{BP} value of 2391 psig. Based on these numbers it is safe to say that this formation is at a pressure below its P_{BP} value.

The reported average Gas-Oil-Ratio (GOR) from the raw field data of 220 SCF/STB accounts for most of the gas produced during the flow tests. This gas is produced from the oil as solution gas when pressure is decreased. The solution gas accounts for 99% of the gas produced during the flow tests, with the remainder of the gas (≃1%) being produced from what the author believes is a tiny gas cap from the upper part of the formation. This line of reasoning makes sense when one knows that the calculated values of P^*, $\bar{P}$, and P_i are below P_{BP}. It is the authors belief that the solution gas accounts for the main mode of production for this reservoir (Solution Gas Drive). A small amount of reservoir energy is probably provided by the Free Gas Cap.

All calculated permeabilities are high. The values calculated from Gauge #207 for the third shut in period appear to be the most inaccurate. These values can be ignored as already stated in this report. The MDH permeability values are larger than the Horner values for the same gauge for the first shut in

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(4)

period. This behavoir is brought about by the MDH plots having a smaller slope value than the Horner values. According to literature, this is a normal reaction for short tp's (ie; Flow Period One tp=15 minutes).

Based on this analysis the best permeability values for the tested interval were calculated from first shut in period data for Gauges #111 and #253. Gauge #111 gave the following values for permeability to oil (ko), permeability to water (kw), and permeability to gas (kg); ko = 2951 md, kw = 15.92md, kg = 0.49. Gauge #253 gave the following values; ko = 2693md, kw = 14.89md kg = 0.46 md.

Even though the above permeability values are high they can be justified in light of Petroleum Testing Service, Inc. (PTS) Preliminary Report on Schlumberger's sidewall core samples and Schlumberger's sidewall core analysis sheet.

The PTS report gave the following air permeability values for sidewall cores;

Depth (Ft.)	Air Permeability (md.)
5302	1080
5323	1000 (** FRACTURED)
5324	749

PTS also stated that sidewall cores in soft formations could result in air permeability values lower than actual values. Schlumberger's sidewall analysis stated the tested interval was a soft, very unconsolidated sandstone with good k and porosity (φ) values. Based on this information and the reported fractures in the sidewall cores the permeability values calculated from the Horner analysis are believable. It appears that the interval may contain natural fractures which would enhance the formations permeability.

(+11 to +12)

(5) The calculated values of skin (S) ^ indicate that the interval of interest is damaged. This may be due to mud or cement contamination from drilling or completion operations.

The Flow Efficiency (F.E.) values for Gauges #253 and #111 are 0.35 and 0.39. This means that the well is producing about 35% – 39% as much fluid with the given drawdown as an undamaged well. If the well was stimulated (acidization or hydraulic fracturing) and the S value was reduced and the F.E. value was closer to 1.0 this well has the potential of producing three times the amount of fluids it is currently producing from this interval. (ie - 2700 BOPD, 450 BWPD, 600,000 SCF/D).

Reserve Calculations for this zone gave the following results for a 20 foot pay zone, a 33% porosity, and a 72.3% oil saturation; IOIP = 1686 STB/AC-FT = 1851 RB/AC-FT. If a recovery factor of 30% is assumed and a reservoir size of 3690 Acres is assumed recoverable oil is estimated as 37×10^6 STB.

If both recoverable oil values for DST's #1 and #2 are combined an estimate of 116×10^6 STB is obtained for both zones in this well. Total Solution gas present in the zone tested during DST #2 is 370,920 $\frac{SCF}{AC\text{-}FT}$ to 429,930 $\frac{SCF}{AC\text{-}FT}$.

This well should be determined capable of producing hydrocarbons in paying quantities, yet the actual fate of this reservoir depends on economics and its remote location.

J. Levine 2/5/86

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DST #2 ANALYSIS PARAMETERS

r_w = 0.4010 Ft. (9 5/8", 47#, N-80, Buttress Liner) (Union)

°API = 19.9 ° @ 60°F (Core Lab Report, Page 11)

Sg_{oil} = 0.935 @ 60°F (Calculated)

γ_{gas} = 0.576 = gas gravity ≅ pure CH_4 (Core Lab Report, P. 11)

h = 39 Ft. Total, 20 Ft. Oil Sands (Logs)

θ = Angle of Deviation = 0° (Vertical Well)

ϕ = 33% (Computer Estimate)

BHT = 100 °F (Core Lab Report, Logs) Reservoir Temp.

$\bar{q}_o$ = Average Oil Rate = 38 BPH = 912 STB/D (Union)

$\bar{q}_w$ = Average Water Rate = 157 STB/D (Calculated From Flow Data #2)

$\bar{q}_g$ = Average Gas Rate (Calculated From Flow Data) = 202,336 scf/D

GOR = 220 $\frac{SCF}{STB}$ (Flow Test Data Sheet # 2 and #3)

B_g = 9.88 $\times 10^{-4}$ $\frac{RB}{SCF}$ = 5.548 $\times 10^{-3}$ $\frac{Ft^3}{SCF}$ (Calculated)

μ_g = 0.0171 @ 100°F, 2336 psi (Calculated)

C_g = 4.309 $\times 10^{-4}$ $psia^{-1}$ (Calculated)

B_w = 1.0044 RB/STB @ 100°F, 2300 psi (Calculated)

μ_w = 0.7021 cp @ 100°F, 2300 psi (Calculated)

C_w = 2.55 $\times 10^{-6}$ psi^{-1} @ 100°F, 2300 psi (Calculated)

B_o = 1.098 $\frac{RB @ 2391 \text{ psig}, 100°F}{STB @ 60°F}$ (Core Lab Report, P. 11)

μ_o = 20 cp @ 100°F, 2350 psi (Core Lab Report, P.)

C_o = 4.8 $\times 10^{-6}$ psi^{-1} @ 2700 psig to 2391 psig (Core Lab Page 2)

C_f = 3 $\times 10^{-6}$ psi^{-1} @ ϕ = 33% (Calculated)

C_t = 7.18 $\times 10^{-6}$ psi^{-1} (Calculated, S_g = 0)

S_o = 72.3% (Computer Estimate)

S_w = 27.7% (Computer Estimate)

$S_{w\,irr}$ = 12% (Logs)

S_g ≅ 0, No Free Gas Rate

Z_{gas} = 0.818 (Calculated)

P_{pc} = Critical Gas Pressure = 673 psia (Calculated)

T_{pc} = Critical Gas Temperature = 350 °R (Calculated)

P_{pR} = Reduced Gas Pressure = 3.47 (Calculated)

T_{pR} = Reduced Gas Temperature = 1.60 (Calculated)

P_{BP} = Bubble Point = 2391 psig @ 100°F (Core Lab Page 2)

P^* = Reservoir Pressure = 2315 − 2353 psi (Calculated)

Depth Tested = 5295' − 5334'

(7)

CHRONOLOGY OF EVENTS - DST #2

1) 9/13/85 ; First Flow Period (PreFlow)
Well Opened Through Seperator @ 03:23 hrs.
Well Closed @ Tester Value @ 03:38 hrs.
Total Flow Time, Period 1 ≃ 15 min

2) 9/13/85 ; First Shut In Period
Well Shut In @ Tester Value @ 03:38 hrs.
Well Opened @ Tester Value @ 04:38 hrs.
Total Shut In Time ≃ 60 min.

3) 9/13/85 ; Second Flow Period
Well Opened @ Tester Value @ 04:38 hrs.
Shut in Well @ Surface @ 20:00 hrs., well Sanded up, Tester Value Open
20:00 hrs to 13:20 hrs 9/14/85 rigging up coiled tubing unit to remove sand
13:20 hrs. 9/14/85 ; Open Well @ Surface
23:04 hrs. 9/14/85 Closed @ Tester Value
Total Flow Time, Period 2 ≃

4) 9/14/85 ; Second Shut In
23:04 Well Shut In @ Tester Value
9/15/85 Well Opened @ Tester Value @ 05:13 hrs.
Total Shut In Time ≃ 369 min.

5) 9/15/85 ; Third Flow Period
05:13 Well Opened @ Tester Value
15:30 Closed Well @ Tester Value
Total Flow Time ≃ 617 min

6) 9/15/85 ; Third Shut In Period
15:30 Well Closed @ Tester Value
9/16/85 - 01:55 Well Opened @ Tester Value
Total Shut In Time ≃ 625 min

7) 9/16/85 ; Fourth Flow Period

01:55 - Well Opened @ Tester Valve

(8) 02:56 - Sheared Sampler Circulating Valve

Total Shut In Time ≅ 61 min

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POROSITY ϕ;

The following calculation will estimate the tested intervals' porosity from well logs.

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From the 5" LDT-DNL openhole log the following values for apparent Limestone (LS) Neutron and Density porosities were obtained;

PERFORATIONS 5300'-5315'

Depth (Feet)	Apparent DPHi (LS Units, %)	Apparent NPHi (LS Units, %)
5295	21.0	37.5
5296	20.0	36.0
5298	25.5	39.5
5300	31.5	42.0
5302	33.0	37.5
5304	33.0	37.0
5306	33.0	39.0
5308	34.0	39.0
5310	35.0	41.0
5312	35.5	42.0
5314	35.5	42.0
5316	34.5	42.5
5318	35.0	43.5
5320	34.5	42.0
5322	32.0	43.5
5324	24.5	42.0
5326	18.5	41.0
5328	19.0	41.0
5330	20.0	42.5
5332	19.0	43.0
5334	18.0	42.0

From the porosity calculation for DST # 1 the following values were obtained;

(10) R_{mf} = .31 Ω @ 100°F

R_m = .39 Ω @ 100°F

From the 5" Dual Induction - SFL log the following values were obtained;

SP = − 12 mV

h = 39′

If possible the SP value will be corrected to SSP for thin beds; R_m = .39 Ω

R_i = 4.8 Ω (Medium Induction Resistivity Log, Average)

∴ $R_i/R_m = \frac{4.8\ \Omega}{.39\ \Omega} = 12.26$

∴ No SSP Correction Needed

∴ R_{mf}/R_{we} = 1.45 (For SP = −12 mV, T = 100°F)

∴ $R_{we} = R_{mf}/(R_{mf}/R_{we}) = .31\ \Omega / 1.45 = .214\ \Omega$

Correct R_{we} to R_w

R_w = .24 Ω

∴ $R_w \simeq R_{mf}$

To obtain true Φ, use the neutron-density chart for Salt water muds:

<u>Average True Φ = 37 %</u> (X)

Petroleum Testing Services, Inc. Preliminary Report for Union gave helium porosity values for Sidewall Core Samples of; 38.9 % @ 5302 Ft.

34.0 % @ 5324 Ft.
28.4 % @ 5321 Ft.
41.2 % @ 5323 Ft.

The calculated value from the logs is in close agreement with the PTS values, yet a value of 33 % as calculated from Resource Evaluation's computer program will be taken as the most accurate value. A 33 % porosity value will be used in calculations.

(11)

Calculation of Gas Parameters

1) $B_g = 0.00504 \left(\frac{ZT}{P}\right)$ RB/scF

Since γ_g = Gas Gravity = 0.576 ;

∴ Monograph #5, Figure D-3 (Misc. Gas Curves)

P_{pc} = 673 psia

T_{pc} = 350 °R

$P_{pr} = \frac{P^*}{P_{pc}} = \frac{2336}{673} = 3.47$

$T_{pr} = T/T_{pc} = \frac{100\ °F + 460}{350\ °R} = 1.600$

NOTE; P* for this calculation is an average value obtained from all the Horner plots

∴ Monograph #5, Figure D-7

$Z = 0.818$ (*)

∴ $B_g = 0.00504 \left(\frac{(.818)(100°F + 460)}{2336}\right)$

$B_g = 9.88 \times 10^{-4}$ RB/scF (*) $= 5.548 \times 10^{-3}$ Ft³/scF

2) For gas viscosity, μ_g ;

From William D. McCain, JR, "The Properties of Petroleum Fluids", Fig 3-14, P. 128 ;

For γ_g = .576

μ_{g1} = 0.0114 cp @ 100°F, 1.0 atm

Fig 3-15, P 130, McCain JR.

μ_g/μ_{g1} = 1.5 @ T_{pr}, P_{pr}

∴ $\mu_g = (\mu_{g1})(\mu_g/\mu_{g1})$

$\mu_g = (0.0114)(1.5)$ cp

μ_g = 0.0171 cp @ 100°F, 2336 psi (*)

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3) Gas Compressibility, c_g;

Since; $P_{pr} = 3.47$, $P_c = 673$ psig

$T_{pr} = 1.60$ (From B_g calculation)

Monograph #1, Figure G.7A, Page 160

C_r = Pseudoreduced compressibility = 0.29

$\therefore c_g = C_r / P_c = 0.29 / 673$ psig

$c_g = 4.309 \times 10^{-4}$ psia^{-1} (*)

Total Compressibility Calculation, C_t;

$C_t = C_o S_o + C_w S_w + c_g S_g + C_f$

No Free Gas $\therefore = 0$

C_f = Effective Rock Compressibility

Monograph #1, Figure G.5, Page 159

For $\phi = 33\%$

$C_f = 3 \times 10^{-6}$ psi^{-1}

Saturation values will be used as provided from Resource Evaluation's computer program

$S_o = 72.3\%$

$S_w = 27.7\%$

$S_g = 0$

$\therefore C_t = (.723)(4.8 \times 10^{-6}) + (.277)(2.55 \times 10^{-6})$
$+ 3 \times 10^{-6}$

$C_t = 7.18 \times 10^{-6}$ psi^{-1} (*)

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Calculation of Water Parameters

1) C_w; Compressibility of water

Assuming no gas in solution and 80,000 ppm NaCl;

Monograph #5, Figs D-16 and D-17

C_w @ 100 °F and p ≈ 2300 psi

$C_w = 2.55 \times 10^{-6}$ psi^{-1} (*)

2) μ_w; viscosity of water

Assuming no gas in solution and 80,000 ppm NaCl (0.08% NaCl);

Monograph #5, Figs D.35

@ 100 °F and 1 atm; μ^*_T ≈ 0.7 cp

f = 1.003 @ 100 °F, 2300 psi

$\therefore \mu_w = (\mu^*_T)(f) = (.7cp)(1.003) = .7021$ cp (*)

3) B_w; Formation Volume Factor of water

Assuming no gas in solution

$B_w = (1 + \Delta V_{wp})(1 + \Delta V_{wT})$

William D. McCain, Jr., "The Properties of Petroleum Fluids", Page 279 Fig 6.7

@ 100 °F ; $\Delta V_{wT} = 0.007$

Page 280, Fig 6.8

@ 2300 psia 100 °F ; $\Delta V_{wp} = -0.0026$

$\therefore B_w = (1 + (-.0026))(1 + .007)$

$B_w = 1.0044$ RB/STB (*)

(14)

TABLE # 1

DST #2, HAMMERHEAD, OCS Y-0849 #1, UNION
GAUGE # 253, FIRST SHUT IN PERIOD DATA

t_p = 15 minutes

p_{wf} = 1863.7 psi

Δt (min)	p_{ws} (psi)	$p_{ws}-p_{wf}$ (psi)	$\frac{t_p+\Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
0	1863.7	—	—	—
1	2273.4	409.7	16	1.204
2	2301.4	437.7	8.5	.929
3	2316.9	453.2	6.0	.778
4	2323.1	459.4	4.75	.677
5	2329.7	466.0	4.0	.602
6	2333.3	469.6	3.5	.544
7	2334.9	471.2	3.14	.497
8	2337.0	473.3	2.87	.459
9	2338.8	475.1	2.67	.426
10	2339.6	475.9	2.50	.398
12	2341.7	478.0	2.25	.352
14	2343.8	480.1	2.07	.316
16	2346.2	482.5	1.94	.287
18	2346.9	483.2	1.83	.263
20	2347.7	484.0	1.75	.243
22	"	"	1.68	.226
24	"	"	1.63	.211
26	"	"	1.57	.198
28	"	"	1.54	.186
30	"	"	1.50	.176
35	"	"	1.43	.155
40	2349.3	485.6	1.38	.138
45	2349.6	485.9	1.33	.125
50	"	"	1.30	.114
55	"	"	1.27	.105
59.7	2351.9	488.2	1.25	.097

(15)

TABLE #2

DST #2, HAMMERHEAD, OCS Y-0849 #1, UNION

GAUGE #111, FIRST SHUT IN PERIOD DATA

t_p = production time = 15 minutes

p_{wf} = flowing bottom hole pressure @ shut in = 1842.1 psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
0	1842.1	—	—	—
1	2022.4	180.3	16	1.204
2	2241.6	399.5	8.5	.929
3	2275.0	432.9	6.0	.778
4	2286.8	444.7	4.75	.677
5	2291.1	449.0	4.0	.602
6	2293.8	451.7	3.5	.544
7	2297.2	455.1	3.14	.497
8	2298.4	456.3	2.87	.459
9	2300.2	458.1	2.67	.426
10	2300.8	458.7	2.50	.398
12	2302.7	460.6	2.25	.352
14	2304.2	462.1	2.07	.316
16	2306.6	464.5	1.94	.287
18	2307.8	465.7	1.83	.263
20	2308.1	466.0	1.75	.243
22	2309.0	466.9	1.68	.226
24	2309.0	466.9	1.63	.211
26	2309.6	467.5	1.57	.198
28	"	"	1.54	.186
30	"	"	1.50	.176
35			1.43	.155
40	2310.3	468.2	1.38	.138
45	"	"	1.33	.125
50	"	"	1.30	.114
55	2312.1	470.0	1.27	.105
60	2311.8	469.7	1.25	.097

(70)

TABLE # 3

DST #2, HAMMERHEAD, OCS Y-0849 #1, UNION
GAUGE # 111, SECOND SHUT IN PERIOD DATA

$t_p = 15 + 1502 = 1517$ min

$p_{wf} = 2590.9$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
0	2590.9	—	—	—
30	2545.3	−45.6	51.567	1.712
60	2315.6	−275.3	26.283	1.420
90	2304.0	−286.9	17.856	1.252
120	2673.0	82.1	13.642	1.135
150	2406.7	−184.2	11.113	1.046
180	2253.4	−337.5	9.428	.974
210	2290.9	−300	8.224	.915
240	2290.9	−300	7.321	.865
270	2291.5	−299.4	6.619	.821
300	2291.5	−299.4	6.057	.782
330	2291.5	−299.4	5.580	.748
360	2291.5	−299.4	5.214	.717
369	2292.4	−298.5	5.111	.709

(17)

TABLE #4

DST #2, HAMMERHEAD, Y-0849 #1, UNION
GAUGE #207, SECOND SHUT IN PERIOD DATA

$t_p = 15 + 1502 = 1517$ min.
$p_{wf} = 2637$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\frac{t_p + \Delta t}{\Delta t}$	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$
0	2637	—	—	—
30	2587.6	-49.4	51.567	1.712
60	2357.2	-279.8	26.283	1.420
90	2346.2	-290.8	17.856	1.252
120	2709.6	72.6	13.642	1.135
150	2433.2	-203.8	11.113	1.046
180	2290	-347	9.428	.974
210	2333	-304	8.224	.915
240	2333	-304	7.321	.865
270	2334.2	-302.8	6.619	.821
300	2334.2	-302.8	6.057	.782
330	2334.2	-302.8	5.580	.748
360	2334.2	-302.8	5.214	.717
369	2334.2	-302.8	5.111	.709

(18)

TABLE # 5

DST # 2, HAMMERHEAD, OCS Y-0849 # 1, UNION

GAUGE # 207, THIRD SHUT IN PERIOD DATA

$t_p = 15 + 1502 + 618 = 2135$ min.

$p_{wf} = 2189.3$ psi

Δt (min)	p_{ws} (psi)	$p_{ws} - p_{wf}$ (psi)	$\log\left(\frac{t_p + \Delta t}{\Delta t}\right)$	$\frac{t_p + \Delta t}{\Delta t}$
0	2189.3	—	—	—
1	2306.1	116.8	3.329	2133
2	2312.1	122.8	3.029	1069
3	2315.7	126.4	2.853	712.85
4	2319	129.7	2.728	534.56
5	2320.5	131.2	2.631	427.56
6	2323	133.7	2.553	357.27
7	2325	135.7	2.486	306.20
8	2326	136.7	2.428	267.90
9	2328	138.7	2.377	238.23
10	2328.8	139.5	2.331	214.29
12	2329.3	140.0	2.253	179.06
14	2331	141.7	2.186	153.46
16	2331	141.7	2.129	134.59
18	2331.2	141.9	2.078	119.67
20	2332	142.8	2.032	107.65
22	2332.3	143.0	1.991	97.95
24	2332.7	143.4	1.954	89.95
26	2333.1	143.8	1.920	83.18
28	2333.1	143.8	1.888	77.27
30	2333.1	143.8	1.858	72.11
35	2334	144.7	1.792	61.94
40	2335.1	145.8	1.735	54.33
45	2335.1	145.8	1.685	48.42
50	2335.1	145.8	1.641	43.75
55	2335.5	146.2	1.600	39.81
60	2336.1	146.8	1.563	36.56
70	2336.1	146.8	1.498	31.48
80	2336.1	146.8	1.442	27.67

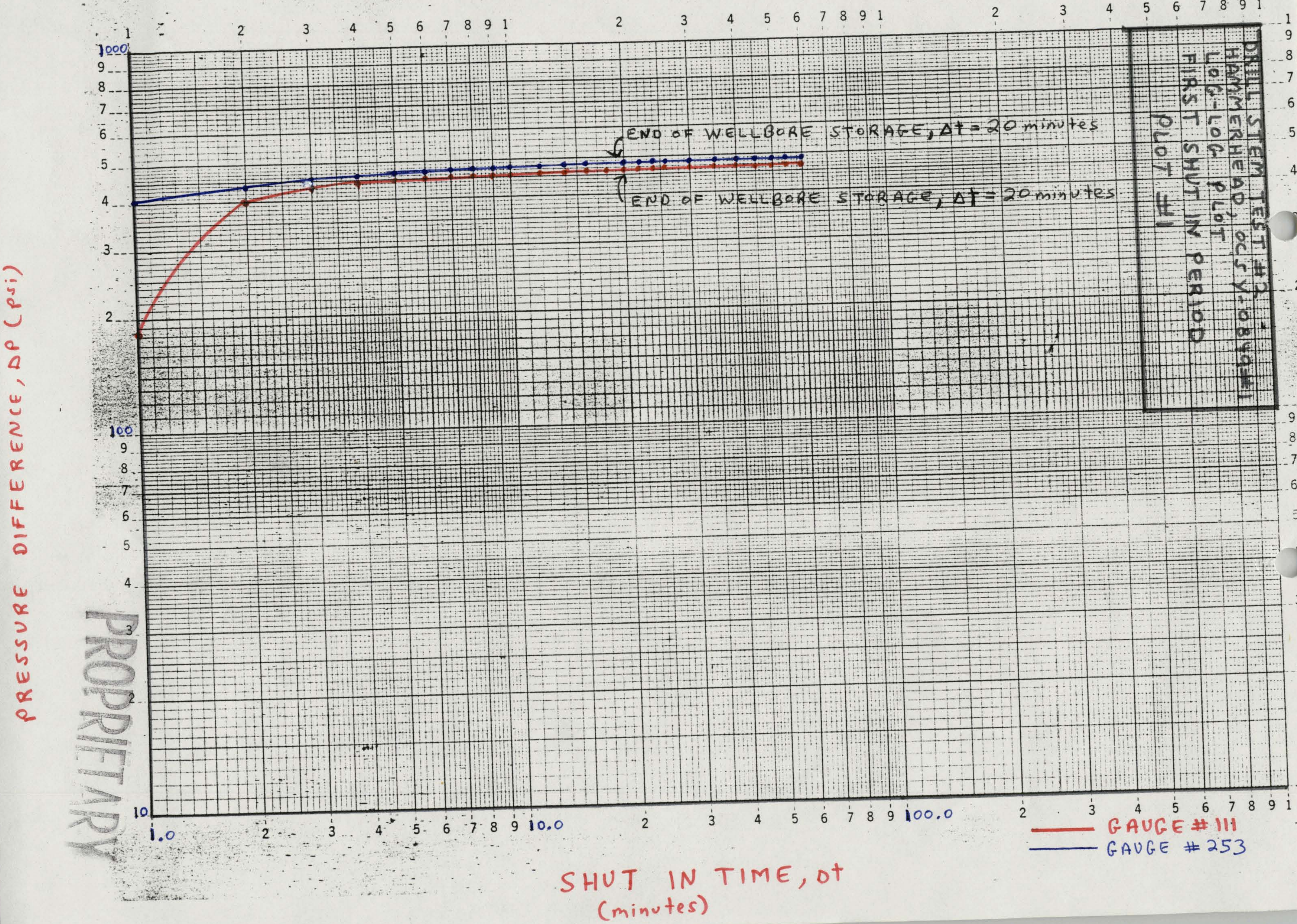
TABLE #5 (CONTINUED)

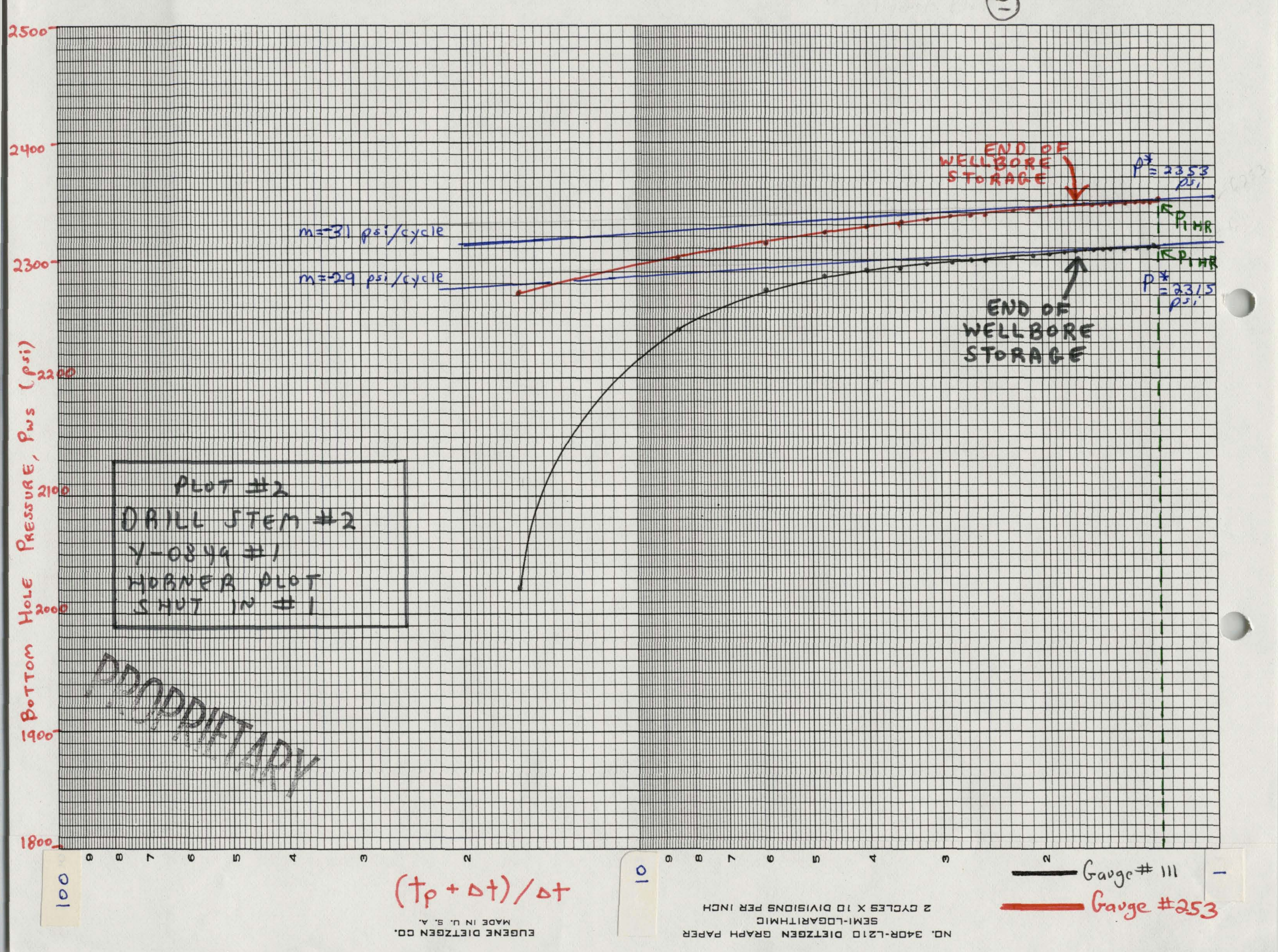
GAUGE # 207, THIRD SHOT IN PERIOD (*)

(19)

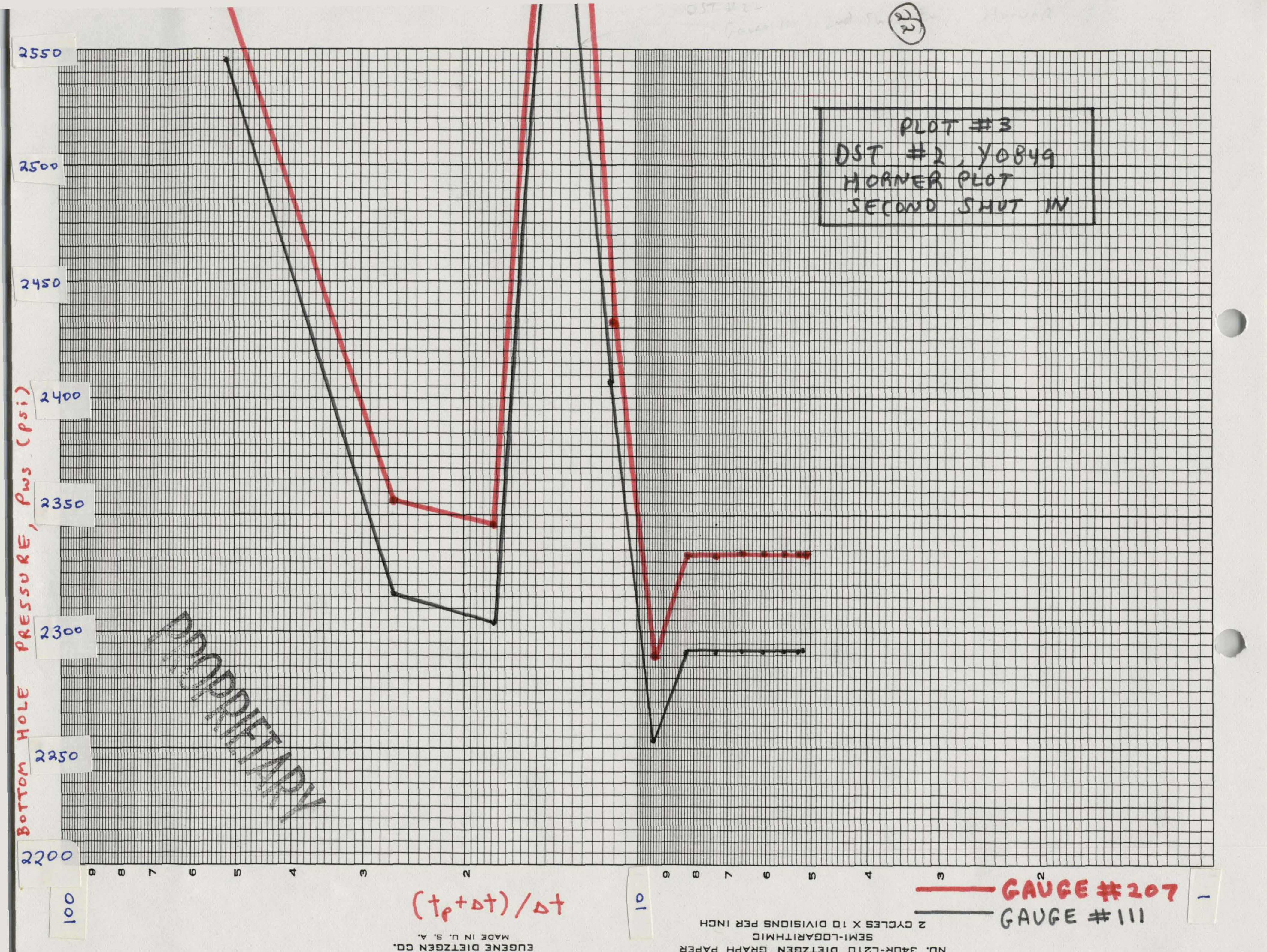
Δt (min)	p_{ws} (psi)	$p_{ws}-p_{wf}$ (psi)	$\log\left(\frac{t_p+\Delta t}{\Delta t}\right)$	$\frac{t_p+\Delta t}{\Delta t}$
90	2336.1	146.8	1.393	24.72
100	2336.1	146.8	1.349	22.34
110	2336.1	146.8	1.310	20.42
120	2336.1	146.8	1.274	18.79
135	2336.3	147	1.226	16.83
150	2336.6	147.3	1.183	15.24
165	2336.6	147.3	1.144	13.93
180	2337.4	148.1	1.109	12.85
195	2337.4	148.1	1.077	11.94
210	2338.3	149	1.048	11.17
225	2338.3	149	1.021	10.50
240	2338.3	149	0.996	9.91
260	2338.3	149	0.964	9.20
280	2338.3	149	0.936	8.63
300	2338.3	149	0.909	8.11
320	2338.3	149	0.885	7.67
340	2338.3	149	0.862	7.28
360	2338.3	149	0.841	6.93
380	2338.3	149	0.821	6.62
400	2338.3	149	0.802	6.34
460	2338.3	149	0.751	5.64
520	2338.3	149	0.708	5.11
580	2338.3	149	0.670	4.68
626	2338.7	149.4	0.645	4.42

(*) All readings for Gauge #207 are questionable due to gauge possibly malfunctioning. This gauge was the only one providing data for the third shot in period.


DRILL STEM TEST #3
HAMMERHEAD, OCS Y-0849 #1
LOG-LOG PLOT
FIRST SHUT IN PERIOD
PLOT #1
END OF WELLBORE STORAGE, Δt = 20 minutes
END OF WELLBORE STORAGE, Δt = 20 minutes
1000
100
10
1.0
10.0
100.0
PRESSURE DIFFERENCE, ΔP (psi)
SHUT IN TIME, Δt
(minutes)
GAUGE #111
GAUGE #253

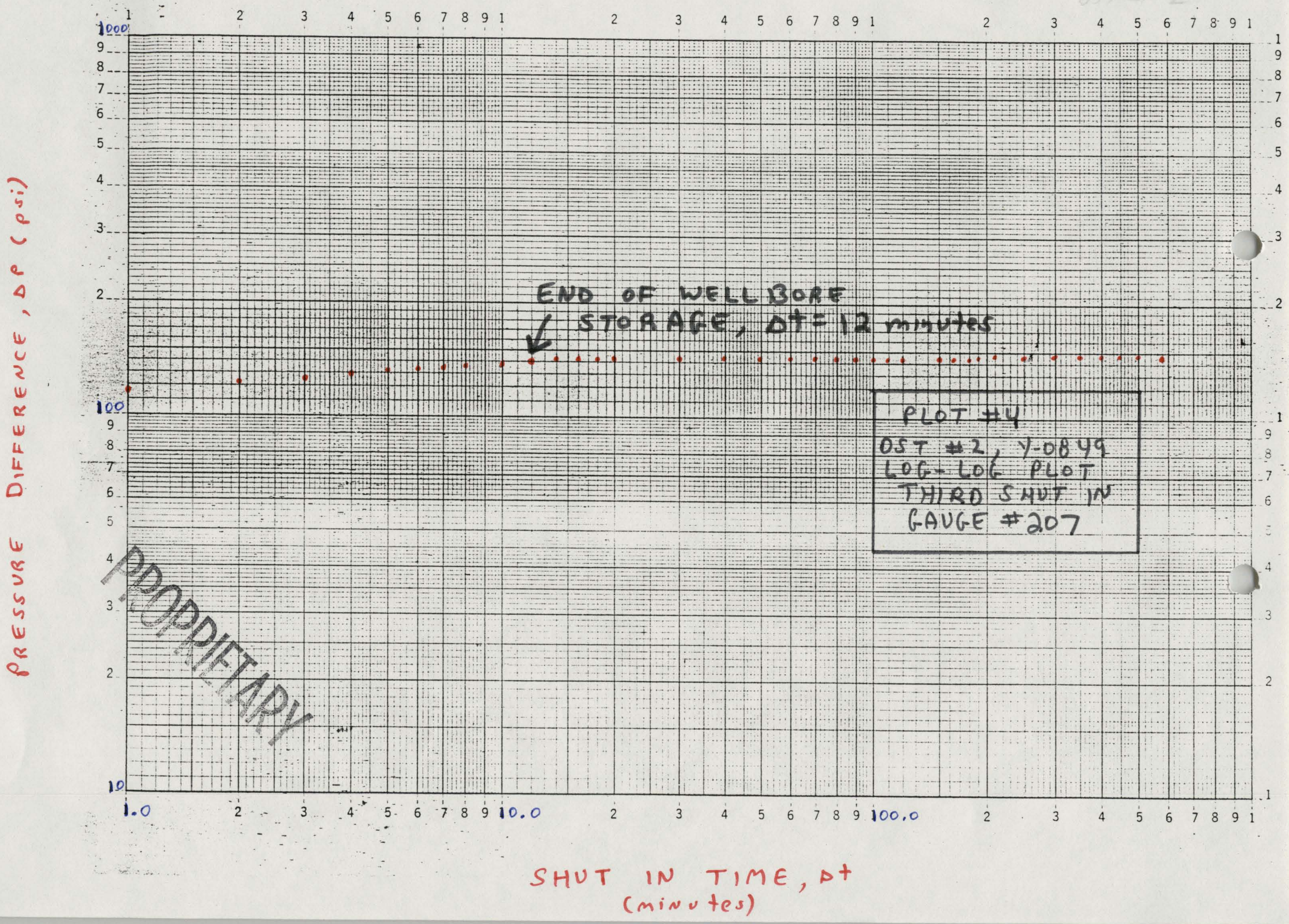


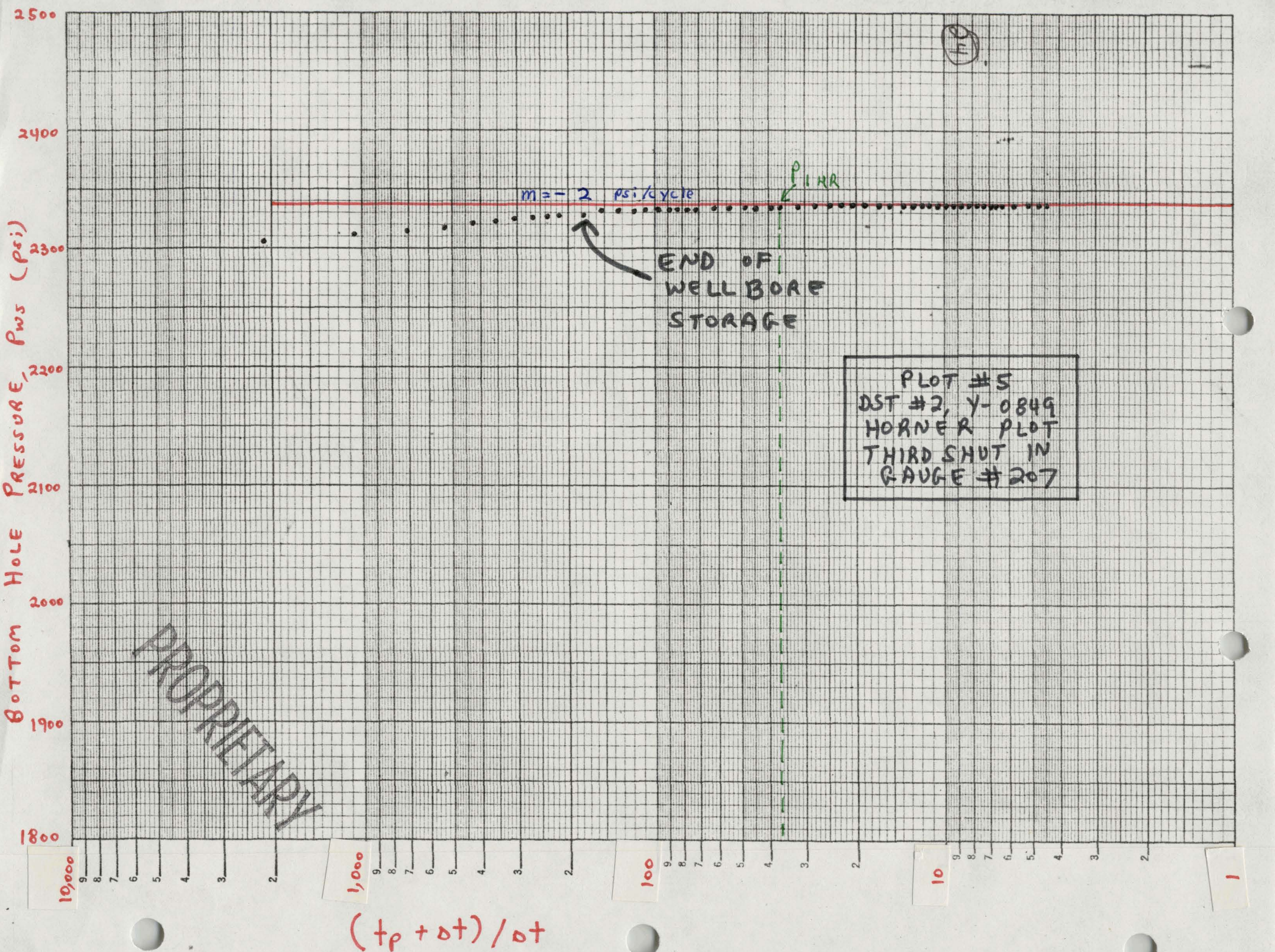
PLOT #2
DRILL STEM #2
Y-0849 #1
HORNER PLOT
SHUT IN #1
Bottom Hole Pressure, Pws (psi)
(tp + Δt)/Δt
m=-31 psi/cycle
m=-29 psi/cycle
END OF WELLBORE STORAGE
END OF WELLBORE STORAGE
P* = 2353 psi
P* = 2315 psi
P1 HR
P1 HR
Gauge # 111
Gauge #253
PROPRIETARY
NO. 340R-L210 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH
EUGENE DIETZGEN CO.
MADE IN U. S. A.


PLOT #3
DST #2, Y0849
HORNER PLOT
SECOND SHUT IN
BOTTOM HOLE PRESSURE, Pws (psi)
2550
2500
2450
2400
2350
2300
2250
2200
100
10
1
9 8 7 6 5 4 3 2
$(t_p+\Delta t)/\Delta t$
GAUGE #207
GAUGE #111
PROPRIETARY
NO. 340R-L210 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH
EUGENE DIETZGEN CO.
MADE IN U. S. A.

K&E LOGARITHMIC • 2 X 3 CYCLES KEUFFEL & ESSER CO. MADE IN U.S.A. 46 7323

(23)





2500
2400
2300
2200
2100
2000
1900
1800
Bottom Hole Pressure, Pws (psi)
m = - 2 psi/cycle
P1 HR
END OF WELLBORE STORAGE
PLOT #5
DST #2, Y-0849
HORNER PLOT
THIRD SHUT IN
GAUGE #207
PROPRIETARY
10,000
1,000
100
10
1
(tp + Δt)/Δt

25

DST #2 HORNER PLOT ANALYSIS

1) Permeability Calculation

Basic Equation; $k_n = \frac{-162.6\, q_n\, \mu_n\, B_n}{m\, h}$

where; k_n = permeability of phase "n", md
q_n = flowrate of phase "n", STB/D
μ_n = viscosity of phase "n", cp
B_n = formation volume factor of phase "n", RB/STB
m = slope of Horner Plot Straight Line, psi/cycle
h = thickness of interval tested, Feet

Since the flow periods of DST #2 produced oil, water, and gas the permeability of the formation to each phase will be calculated for each shut in period analyzed

Gauge #253, Shut In Period #1;

From Horner Plot #, $m = -31$ psi/cycle
$p^* = 2353$ psi

From Core Labs Report @ 100°F and 2353 psi, Page B
$\mu_o = 20$ cp

$$\therefore k_o = \frac{-162.6\,(912\text{ STBD})(20\text{ cp})(1.098\text{ RB/STB})}{(-31\text{ psi/cycle})(39\text{ Ft})}$$

k_o = 2693 md = 2.693 Darcies ⊛

$$k_w = \frac{-162.6\,(157\text{ STB/D})(.7021\text{ cp})(1.0044\text{ RB/STB})}{(-31\text{ psi/cycle})(39\text{ Ft.})}$$

k_w = 14.89 md ⊛

$$k_g = \frac{-162.6\,(202{,}336\ \tfrac{\text{SCF}}{\text{D}}\,/5.615\ \text{Ft}^3/\text{BBL})(0.0171\text{ cp})(5.548\times10^{-3}\ \text{Ft}^3/\text{Ft}^3)}{(-31\text{ psi/cycle})(39\text{ Feet})}$$

k_g = 0.46 md. ⊛

PROPRIETARY

(26)

Gauge #111, Shut In Period #1;

From Horner Plot # $m = -29$ psi/cycle

$p^* = 2315$ psi

From Core Labs Report, P.8, @ 100°F and 2315 psi:

$\mu_o = 20.5$ cp

$$\therefore k_o = -162.6 \frac{(912)(20.5)(1.098)}{(-29)(39)} = 2951 \text{ md} = 2.951 \text{ Darcies} \circledast$$

$$k_w = -162.6 \frac{(157)(.7021)(1.0044)}{(-29)(39)} = 15.92 \text{ md} \circledast$$

$$k_g = -162.6 \frac{\left(\frac{202,336}{5.615}\right)(0.0171)(5.548 \times 10^{-3})}{(-29)(39)} = 0.49 \text{ md} \circledast$$

Gauge #207, Third Shut In Period;

From Horner Plot # $m = -2$ psi/cycle

$p^* = 2339$ psi

From Core Labs Report, P.8 @ 100°F and 2339 psi

$\mu_o = 20.3$ cp

$$\therefore k_o = -162.6 \frac{(912)(20.3)(1.098)}{(-2)(39)} = 42,376 \text{ md} = 42.376 \text{ Darcies} \circledast$$

$$k_w = -162.6 \frac{(157)(.7021)(1.0044)}{(-2)(39)} = 230.8 \text{ md} \circledast$$

$$k_g = -162.6 \frac{\left(\frac{202,336}{5.615}\right)(.0171)(5.548 \times 10^{-3})}{(-2)(39)} = 7.13 \text{ md} \circledast$$

(27)

2) Skin Effect Calculation

Basic Equation ; $S = 1.151\left[\frac{P_{1HR} - P_{WF}}{|m|} - \log\left(\frac{k}{\phi \mu c_t r_w^2}\right) + 3.23\right]$

The above equation will be modified for multiphase flow as follows

$\frac{k}{\mu} = \left(\frac{k}{\mu}\right)_t = \frac{k_o}{\mu_o} + \frac{k_g}{\mu_g} + \frac{k_w}{\mu_w}$ = TOTAL MOBILITY RATIO

Free gas Rate

$\left[\frac{k}{\mu}\right]_t = \frac{-162.6}{mh}\left[B_o q_o + B_g\left(q_{gt} - \frac{q_o R_s}{1000}\right) + B_w q_w\right]$

where : q_{gt} = total gas flow rate

R_s = GOR,

$\therefore \left[\frac{k}{\mu}\right]_t = \frac{-162.6}{m(39Ft.)}\left[912(1.098) + 9.88\times10^{-1}\frac{RB}{MSCF}\left(202{,}336\frac{MSCF}{D} - \frac{912(220)}{1000}\right) + 157(1.0044)\right]$

$\left[\frac{k}{\mu}\right]_t = -\frac{4.169}{m}\left(1160.76 \text{ RB/D}\right) = -\frac{4839.2}{m}\frac{md}{cp}$

For Gauge # 253 , Shut In Period #1

m = -31 psi/cycle

$\therefore \left[\frac{k}{\mu}\right]_t = \frac{-4839.2}{-31} = 156.104 \frac{md}{cp}$ = TOTAL MOBILITY

$\therefore$ From Horner Plot #

P_{1HR} @ Δt = 60 min $\therefore \frac{t_p + \Delta t}{\Delta t} = \frac{15min + 60min}{60min} = 1.25$

@ $\frac{t_p+\Delta t}{\Delta t} = 1.25$, $P_{ws} = P_{1HR} = 2351.9$ psi

$\therefore S = 1.151\left[\frac{2351.9 - 1863.7}{31} - \log\left[\frac{156.104}{(.33)(7.18\times10^{-6})(.4010)^2}\right] + 3.23\right]$

$S = 1.151\left[15.748 - 8.61249 + 3.23\right]$

$\therefore S = +11.930$ Severely Damaged ⊕

PROPRIETARY

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For Gauge #111, Shut In Period #1

$m = -29$ psi/cycle

$\therefore [\frac{k}{\mu}]_t = -4839.2/-29 = 166.870 \frac{md}{cp}$ = Total Mobility

∴ From Horner Plot #

P_{1HR} @ $\Delta t = 60$ min ∴ $\frac{t_p + \Delta t}{\Delta t} = \frac{15 + 60}{60} = 1.25$

@ $\frac{t_p + \Delta t}{\Delta t} = 1.25$, $P_{ws} = P_{1hr} = 2311$ psi

$$\therefore S = 1.151 \left[\frac{2311 - 1842.1}{+29} - \log \left[\frac{166.87}{(.33)(7.18 \times 10^{-6})(.4010)^2} \right] + 3.23 \right]$$

$$S = 1.151 [16.1689 - 8.6415 + 3.23]$$

$S = +12.3818$ Severely Damaged (*)

For Gauge #207, Shut In Period 3

$m = -2$ psi/cycle

$\therefore [\frac{k}{\mu}]_t = -4839.2/-2 = 2419.6 \frac{md}{cp}$ = Total Mobility

∴ From Horner Plot #

P_{1HR} @ $\Delta t = 60$ min ∴ $t_p + \Delta t/\Delta t = 2135 + 60/60 = 36.6$

@ $t_p + \Delta t/\Delta t = 36.6$, $P_{ws} = P_{1HR} = 2337$ psi

$$\therefore S = 1.151 \left[\frac{2337 - 2189.3}{2} - \log \left(\frac{2419.6}{(.33)(7.18 \times 10^{-6})(.4010)^2} \right) + 3.23 \right]$$

$$S = 1.151 (73.85 - 9.803 + 3.23)$$

$S = +77.44$ (*)

PROPRIETARY

29

3) Pressure Drop Across Skin ΔP_s;

Basic Equation; $\Delta P_s = .87\, S(m)$

Gauge # 253

$\Delta P_s = .87(11.93)(31) = +321$ psi ⊛

Gauge # 111

$\Delta P_s = .87(12.38)(29) = +312$ psi ⊛

Gauge # 207

$\Delta P_s = .87(77.44)(2) = +135$ psi ⊛

4) Flow Efficiency, F.E.

Basic Equation; $F.E. = \dfrac{P^* - P_{wF} - \Delta P_s}{P^* - P_{wF}}$

Gauge # 253

$F.E. = \dfrac{2353 - 1863.7 - 321}{2353 - 1863.7} = +.344$ ⊛

Gauge # 111

$F.E. = \dfrac{2315 - 1842.1 - 312}{2315 - 1842.1} = +.340$ ⊛

Gauge # 207

$F.E. = \dfrac{2339 - 2337 - 135}{2339 - 2337} = -66.5$ ⊛

(30)

5) Radius of Investigation, r_i

Basic Equation; $r_i = \left(\frac{kT}{40 \phi \mu c} \right)^{1/2}$ where T = Flow Time in days

Modify for Multiphase Flow;

$$r_i = \left[\frac{\left[\frac{k}{\mu}\right]_T T}{40 \phi C_t} \right]^{1/2}$$

Gauge #253 ; T = 15 min

$$r_i = \left[\frac{156 \, (15/1440)}{40 (.33)(7.18 \times 10^{-6})} \right]^{1/2} = 131 \text{ FT.}$$ (*)

Gauge #111 ; T = 15 min

$$r_i = \left[\frac{166.8 \, (15/1440)}{40 (.33)(7.18 \times 10^{-6})} \right]^{1/2} = 135 \text{ FT.}$$ (*)

Gauge #207 ; T = 15 + 1502 + 618 = 2135 min

$$r_i = \left[\frac{2419.6 \, (2135/1440)}{40 (.33)(7.18 \times 10^{-6})} \right]^{1/2} = 6306 \text{ FT.}$$ (*)

The r_i distance is the radial distance from the wellbore influenced by the DST. Information obtained about the formation during the DST was obtained in the area of the r_i.

(31)

6) Calculation of Average Reservoir Pressure, $\bar{P}$;

Gauge #253, Shut In Period #1

$$\frac{P^* - \bar{P}}{m/2.303} = 2.51$$

m = slope from Horner Plot

$$\therefore \ \bar{P} = P^* - \frac{2.51(m)}{2.303}$$

$$\bar{P} = 2353 - \frac{2.51(31)}{2.303}$$

P^* = extrapolated straight line pressure from Horner Plot

$$\bar{P} = 2319.2 \text{ psi}$$ (*)

Gauge #111, Shut In Period #1

$$\bar{P} = P^* - \frac{2.51(m)}{2.303}$$

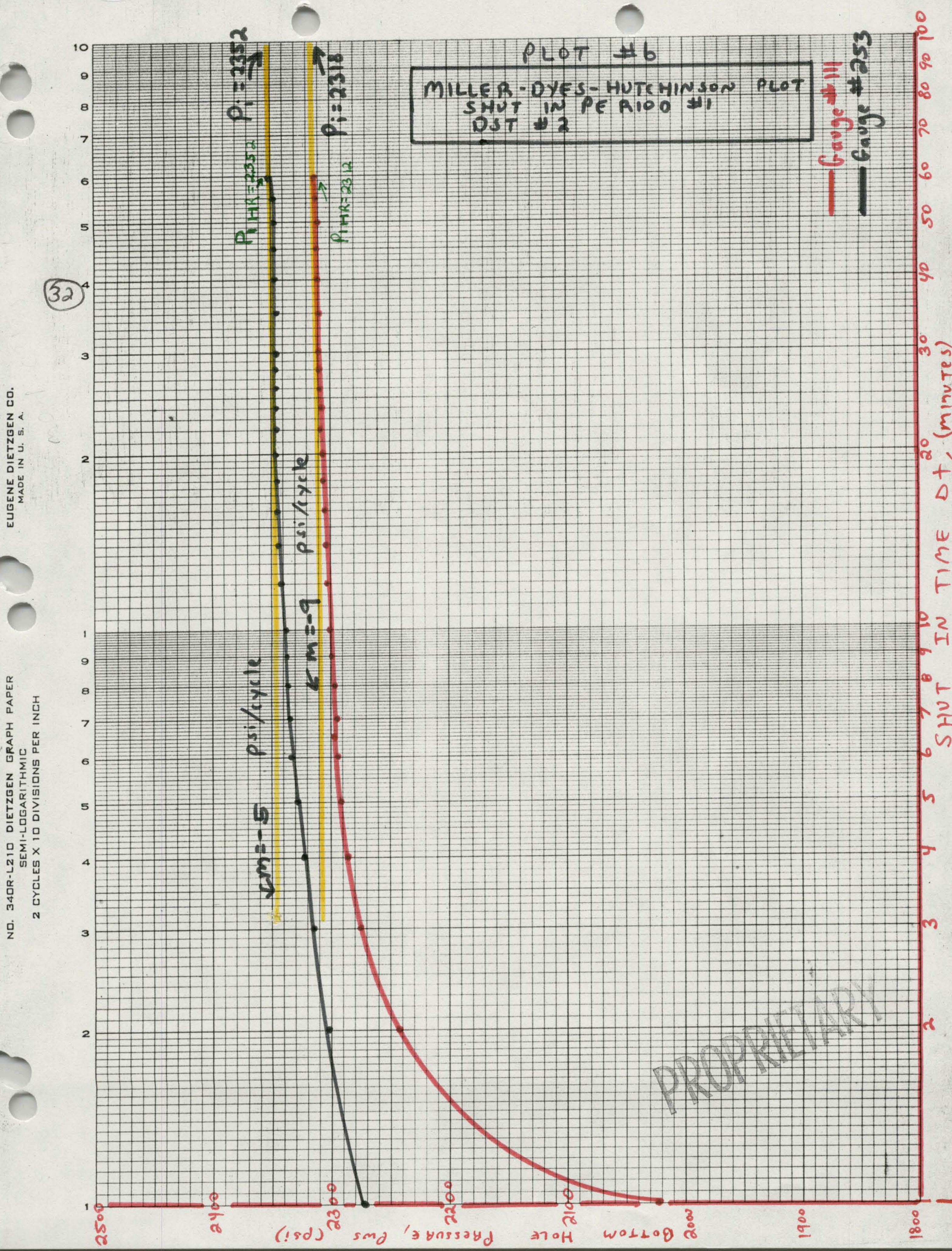
$$\bar{P} = 2315 - \frac{2.51(29)}{2.303}$$

$$\bar{P} = 2283.4 \text{ psi}$$ (*)

Gauge #207, Shut In Period #3

$$\bar{P} = 2339 - \frac{2.51(2)}{2.303}$$

$$\bar{P} = 2336.8$$ (*)


PLOT #6
MILLER-DYES-HUTCHINSON PLOT
SHUT IN PERIOD #1
DST #2
P_i = 2352
P_i = 2318
P_{1HR} = 2352
P_{1HR} = 2312
m = -5 psi/cycle
m = -9 psi/cycle
Gauge #111
Gauge #253
SHUT IN TIME, Δt, (minutes)
BOTTOM HOLE PRESSURE, Pws (psi)
2500
2400
2300
2200
2100
2000
1900
1800
PROPRIETARY
EUGENE DIETZGEN CO.
MADE IN U. S. A.
NO. 340R-L210 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH
32

(33)

DST #2, MILLER-DYES-HUTCHINSON PLOT ANALYSIS

Basic Equation: $k_n = \frac{-162.6\ q_n \mu_n B_n}{mh}$

Gauge #253, First Shut In   m = -5 psi/cycle

$k_o = \frac{-162.6\,(912)(20)(1.098)}{(-5)(39)} = \underline{16.7 \text{ Darcies}}$ (*)

$k_w = \frac{-162.6\,(157)(.7021)(1.0044)}{(-5)(39)} = \underline{92 \text{ md}}$ (*)

$k_g = \frac{-162.6\,\left(\frac{202336}{5.615}\right)(.0171)(5.548 \times 10^{-3})}{(-5)(39)} = \underline{2.85 \text{ md}}$ (*)

Gauge #111, First Shut In   m = -9 psi/cycle

$k_o = \frac{-162.6\,(912)(20.5)(1.098)}{(-9)(39)} = \underline{9.5 \text{ Darcies}}$ (*)

$k_w = \frac{-162.6\,(157)(.7021)(1.0044)}{(-9)(39)} = \underline{51 \text{ md}}$ (*)

$k_g = \frac{-162.6\,\left(\frac{202336}{5.615}\right)(.0171)(5.548 \times 10^{-3})}{(-9)(39)} = \underline{8.9 \text{ md}}$ (*)

ESTIMATION OF FLUIDS IN PLACE

(34) The following calculations will be based on an interval thickness value of h = 20 feet. According to well logs, out of the total 39 feet of sand, 20 feet contain oil sands, the remaining 19 feet contain water.

a) Initial Oil In Place = IOIP

$IOIP = 7758 \frac{BB}{AC\text{-}FT} \bar{\phi}\, S_o / B_{oi}$ (STB)

$IOIP = 7758 (.33)(.723) / 1.098$ BB/STB

$IOIP = 1686 \frac{STB}{AC\text{-}FT} = 1851 \frac{BB}{AC\text{-}FT}$ (*)

b) According to Resource Evaluation the most probable size of this reservoir is 3690 Acres.

$IOIP$ within 3690 Acres $= 7758\, \bar{\phi}\, S_o\, (Acres)\, h / B_{oi}$

$IOIP_{,\,3690\ Acres} = 7758(.33)(.723)(3690\ Acres)(20\ Ft) / 1.098$

$IOIP_{3690\ Acres} = 124.410 \times 10^6$ STB $= 136.602 \times 10^6$ RB (*)

c) Since the majority of the IOIP is not recovered by primary depletion techniques, the Recoverable Oil must be estimated. Based on historical recoveries a 30% or 40% recovery factor is a good estimate of recoverable oil by primary depletion.

n = Recovery Factor = 30%

Recoverable Oil Within 3690 Acres = $RO_{3690\ Acres}$

$RO_{3690\ Acres} = IOIP \times n$

$RO_{3690\ Acres} = 124.410 \times 10^6$ STB $(.3) = 37.323 \times 10^6$ STB (*)

40.980×10^6 RB (*)

PROPRIETARY

$n = 40\%$

$RO_{3690\ Acres} = IOIP \times n$

$RO_{3690\ Acres} = 124.410 \times 10^6$ STB $(.4) = 49.764 \times 10^6$ STB (*)

$= 54.641 \times 10^6$ RB (*)

CALCULATION RESULTS
DST #2

Gauge #	SHOT IN PERIOD	ANALYSIS METHOD	P^* (psi) (extrapolated pressure)	P_i (psi) (initial pressure)	$\bar{P}$ (psi) (average pressure)	k_o (md.)	k_w (md.)	k_g (md.)	S SKIN	ΔP_s (psi)	F.E. (Flow Efficiency)	r_i (Feet)
[redacted]												
					← BEST ESTIMATES →							
[redacted]												
207	3	HORNER	2339	—	2336.8	42,376	231	7.13	+77.4	+135	−66.5	6306
253	1	MDH	—	2352	—	16,700	92	2.85	—	—	—	—
111	1	MDH	—	2318	—	9,500	51	8.9	—	—	—	—
AVERAGE VALUES			2336	2335	2313	2822 (Excluding Gauge 207, Gauge 253 MDH and Gauge 111 MDH)	81	3.96	+34	+256	+0.37 (Excluding Gauge 207)	133 (Excluding Gauge 207)

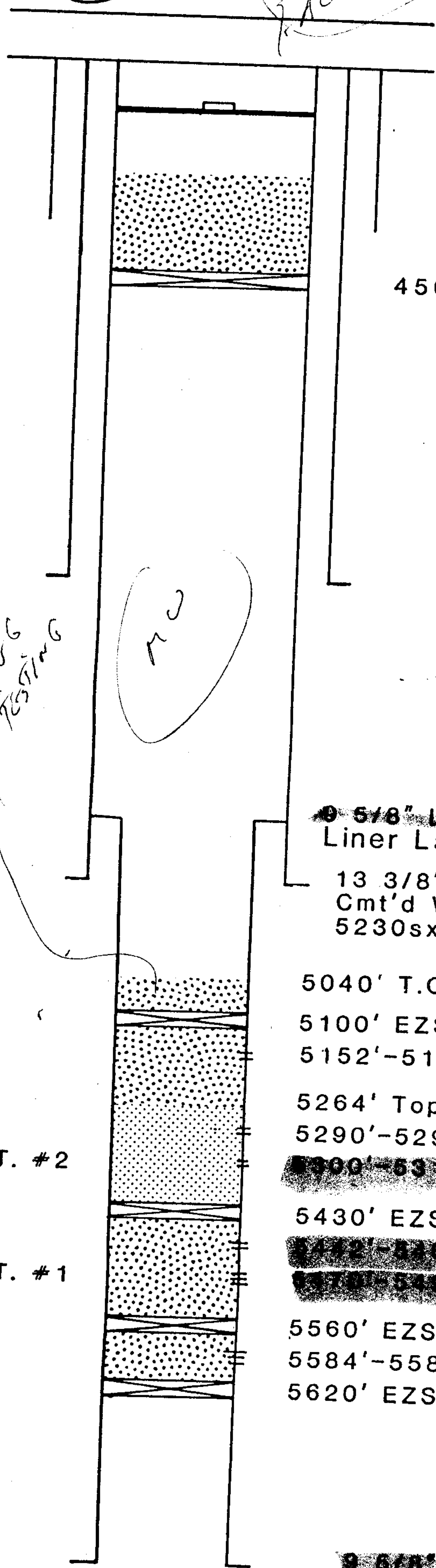
IOIP = 1686 STB/AC-FT

IOIP = 1851 RB/AC-FT

IGIP (Solution) = 370,920 SCF/AC-FT → 429,930 SCF/AC-FT

IOIP = Initial Oil In Place
IGIP = Initial Gas In Place
AC-FT = Acre-Feet
SCF = Standard Cubic Feet (60°F, 14.7 psi)

(37)



R.K.B. at 0'

Mud Line at 142.5'

Corrosion Cap Installed on VETCO 18 3/4" Housing 23' B.M.L.

Top of Cement at 250'
Cmt'd W/150sx Permafrost cement.

30", 31-#, X-42 VETCO-ST Conductor at 353'
Cmt'd W/930sx Permafrost cmt.

450' EZSV

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20", 133#, X-55 VETCO-LX Casing at 1026'
Cmt'd W/1914sx Pemafrost cmt. followed by 590sx class "G" cmt.

9 5/8" LG-20 Liner Top at 2881'
Liner Lap sqz'd W/912sxs Class "G" cmt.

13 3/8", 72#, V-150 Buttress Casing at 2882'
Cmt'd W/200sx Permafrost cmt. Followed by 5230sxs Class "G" cement.

5040' T.O.C.

5100' EZSV

5152'-5158' Injection Perfs. Sqz'd W/230sxs cmt.

5264' Top of Sand

5290'-5292' Isol. Sqz. 300sx Class "G" cmt.

D.S.T. #2 — 5300'-5315' Prod. Test Zone, Sanded Off — DST #2

5430' EZSV

5442'-5462'

D.S.T. #1 — 5478'-5490' Prod. Test Zone Sqz'd W/600sx Class "G" cmt. — DST #1

5560' EZSV

5584'-5586' Isol. sqz. 600sxs Class "G" cmt.

5620' EZSV

SAND

CEMENT

PROPRIETARY

9 5/8", 47#, N-80 Buttress Liner at 8031'
Cmt'd W/330sxs Class "G" cmt.

TD 8034'

DATE

HAMMERHEAD #1
WELL SCHEMATIC

UNION OIL COMPANY OF CALIFORNIA
ANCHORAGE, ALASKA

DRAWN	BAW
CKD.	
APP'D.	
SCALE	NONE
DATE	11/13/85

DRILL STEM TEST

Test Date 9/12/85 Well No. ______
Operator Union Oil
Drilling Contractor Canmar
Location (S-T-R) ______

Test Number DST #2
Date 9/13/85
Test Interval 5,300'-5,315'
Total Depth 5,377 plug back

Hole Size 12¼"
Drill Pipe (Size & Lgth) 5" 4,541'
Drill Collars (Size&Lgth) 6½" 399'
Type of Cushion Fluid N_2
Amount of Cushion 1,725 PSI

36

TEST DATA

1. Tool open at 03:25 hours.
2. Initial open period 15 minutes.
3. Initial shut-in period 60 minutes.
4. Final flow period 625 minutes.
5. Final shut-in period ______ minutes.
6. Description of blow on initial open period Strong blow when bleeding off N_2
7. Description of blow during test light blow, small volume of gas after liquid surfaced.
8. G.T.S. 180 minutes: O.T.S. 189 minutes; Surface choke size 6 10/64" Bottom hole choke size NA
9. Flow Rate: Gas 181,559 C.F.P.D. Oil 38 B.P.H. G.O.R. 201
10. Gravity of Gas .9 Gravity of Oil ______
11. Total fluid recovery: 289 BBL
12. Resistivity of H_2O NA Chlorides of H_2O 27,000 P.P.M.
13. Depth of top press bomb 5,181 Bottom Bomb 5,208

PRESSURE DATA

*1	Top Inside	Bottom Inside		Top Outside	Bottom Outside
I.H.P.	2,340		I.H.P.		2,461
I.S.I.P.	2,339		I.S.I.P.		2,362
I.F.P.	1,623		I.F.P.		1,883
F.F.P.	2,191		F.F.P.		NA
F.S.I.P.	2,338		F.S.I.P.		NA
F.H.H.	NA		F.H.H.		NA
Temp.	93		Temp.		

SAMPLE CHAMBER DATA No wireline samples were taken

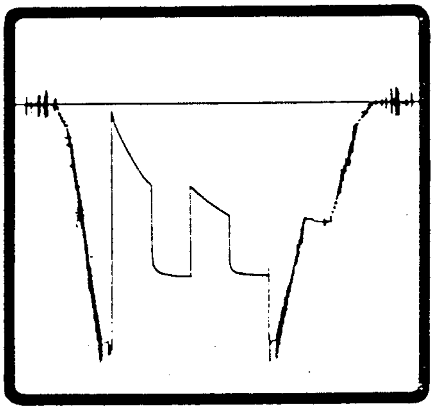
1. Gas ______ C.F. ______
2. Oil ______ C.C. ______
3. H_2O ______ C.C. ______
4. Mud ______ C.C. ______
5. B.O.R. ______ B.S. & W. ______ %

REMARKS

*1 Only one gauge recorded the final flow and shut-in period, all others either failed or ran out of time.

FOR GOVERNMENT USE ONLY

FORMATION TESTING SERVICE REPORT



Duplicate -DY

HALLIBURTON
SERVICES

Duncan, Oklahoma 73536

A Halliburton Company

5B

1296-R5 Southwestern

HALLIBURTON

SERVICES

TICKET NO. 16395800

24-SEP-85

ANCHORAGE

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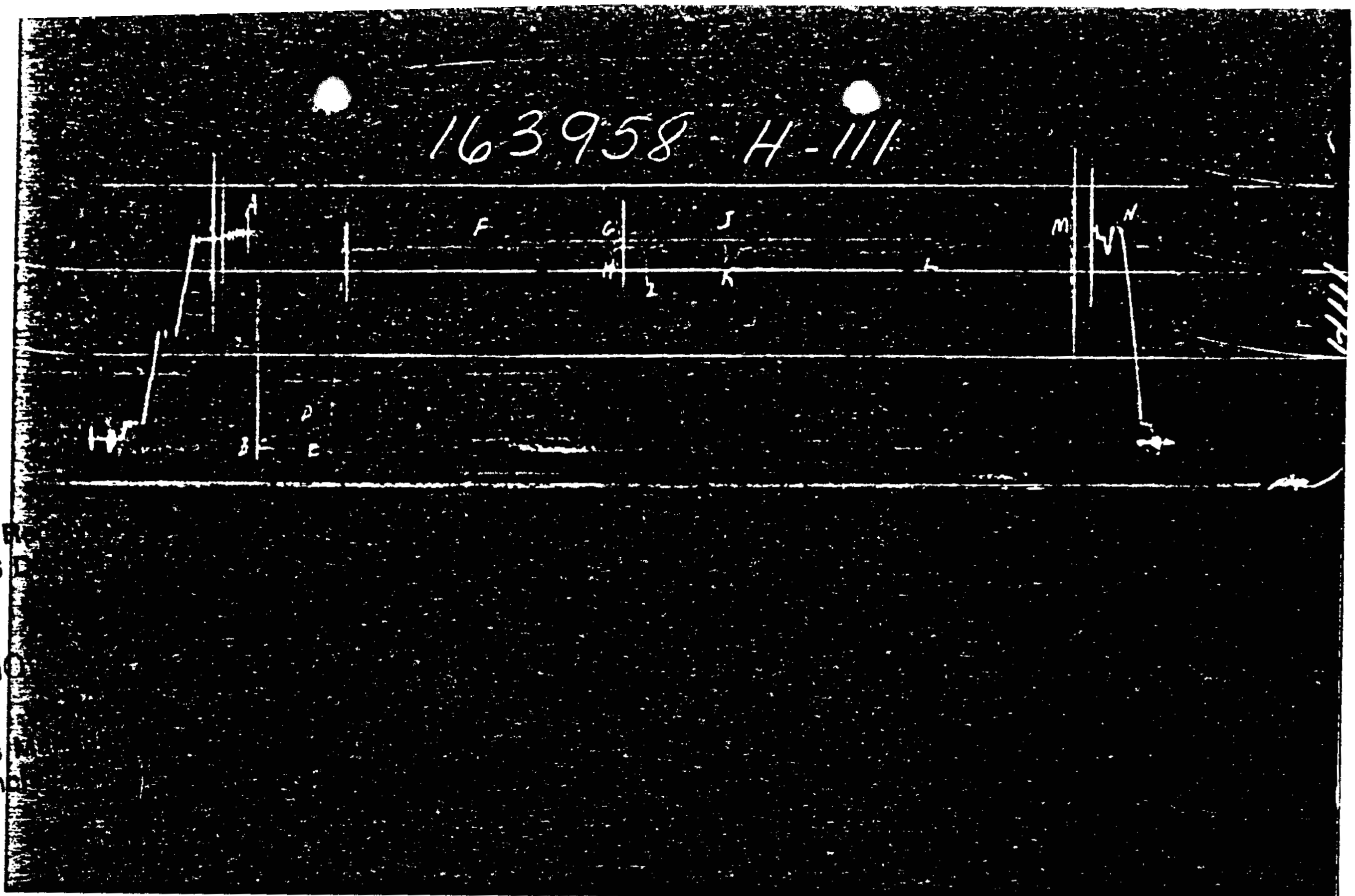
Minerals Management Service
Anchorage, Alaska

FORMATION TESTING SERVICE REPORT

LEASE NAME	HAMMERHEAD
WELL NO.	1
TEST NO.	1
TESTED INTERVAL	
LEASE OWNER/COMPANY NAME	UNION OIL COMPANY OF CALIFORNIA
LEGAL LOCATION SEC. - TWP. - RNG.	
FIELD AREA	ARCTIC OCEAN
COUNTY	NOT AVAILABLE
STATE	ALASKA SM



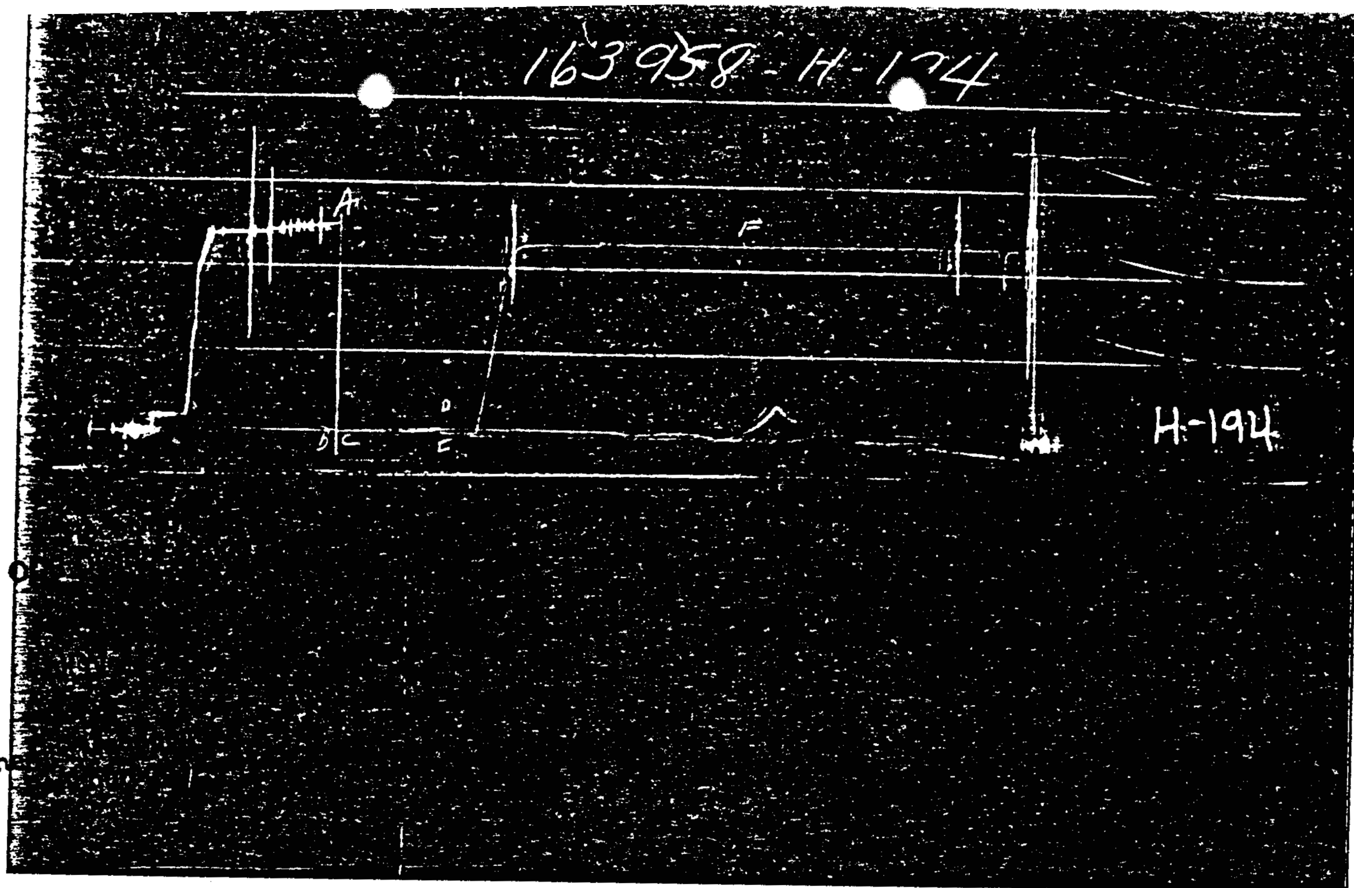
OCS

NO

Minerals
And

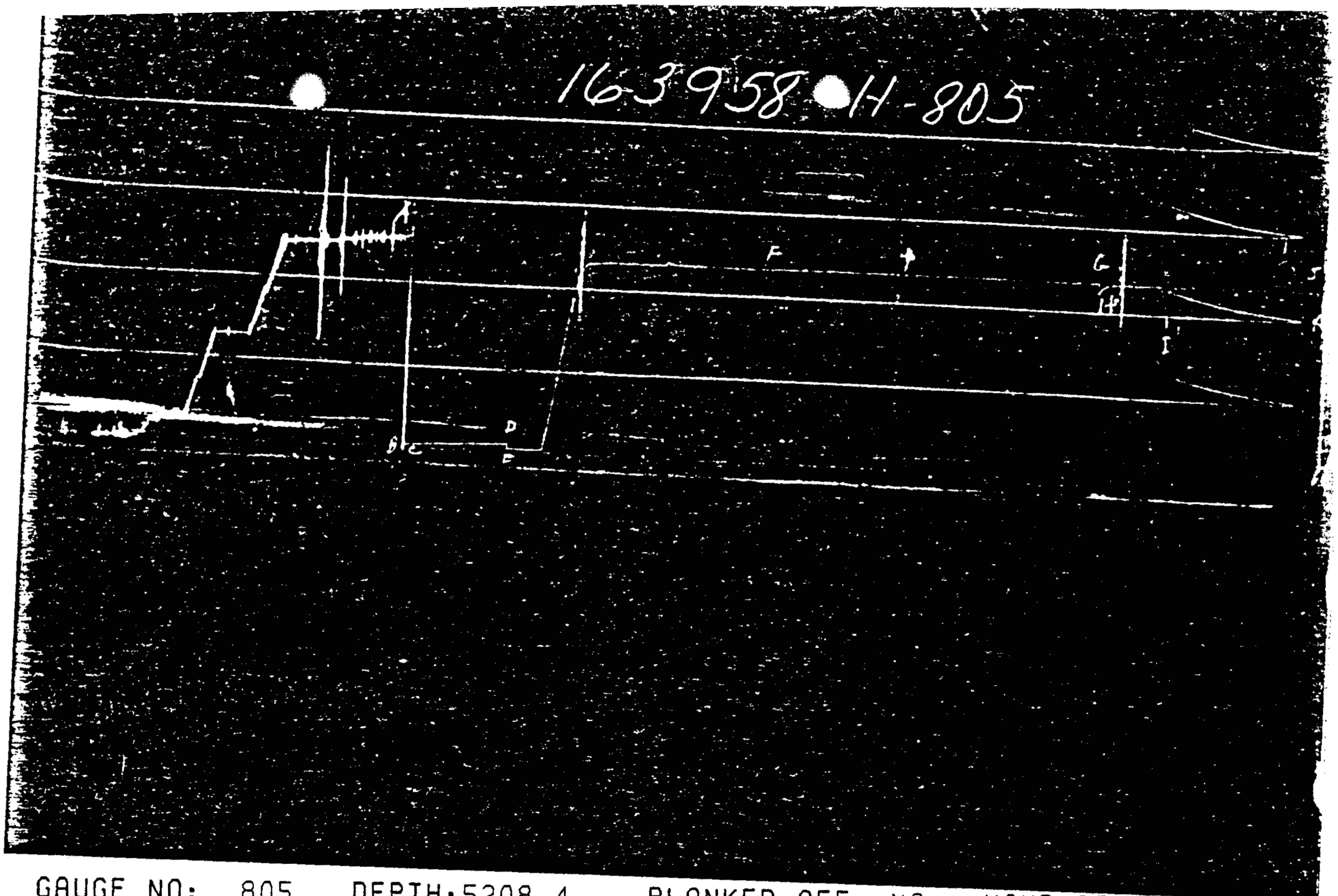
GAUGE NO: 111 DEPTH: 5208.4 BLANKED OFF: NO HOUR OF CLOCK: 96

ID	DESCRIPTION	PRESSURE REPORTED	PRESSURE CALCULATED	TIME REPORTED	TIME CALCULATED	TYPE
A	INITIAL HYDROSTATIC		2487.9			
B	INITIAL FIRST FLOW		30.1	5	7	F
C	FINAL FIRST FLOW		28.8			
C	INITIAL FIRST CLOSED-IN		28.8	247	247	C
D	FINAL FIRST CLOSED-IN		77.9			
E	INITIAL SECOND FLOW		32.5	640	641	F
F	FINAL SECOND FLOW		2278.5			
F	INITIAL SECOND CLOSED-IN		2278.5	765	763	C
G	FINAL SECOND CLOSED-IN		2292.7			
H	INITIAL THIRD FLOW		2175.6	170	172	F
I	FINAL THIRD FLOW		1832.7			
I	INITIAL THIRD CLOSED-IN		1832.7	367	367	C
J	FINAL THIRD CLOSED-IN		2310.9			
K	INITIAL FOURTH FLOW		2099.5	971	969	F
L	FINAL FOURTH FLOW		2239.4			
L	INITIAL FOURTH CLOSED-IN		2239.4	672	659	C
M	FINAL FOURTH CLOSED-IN		2323.6			
N	FINAL HYDROSTATIC		2539.1			



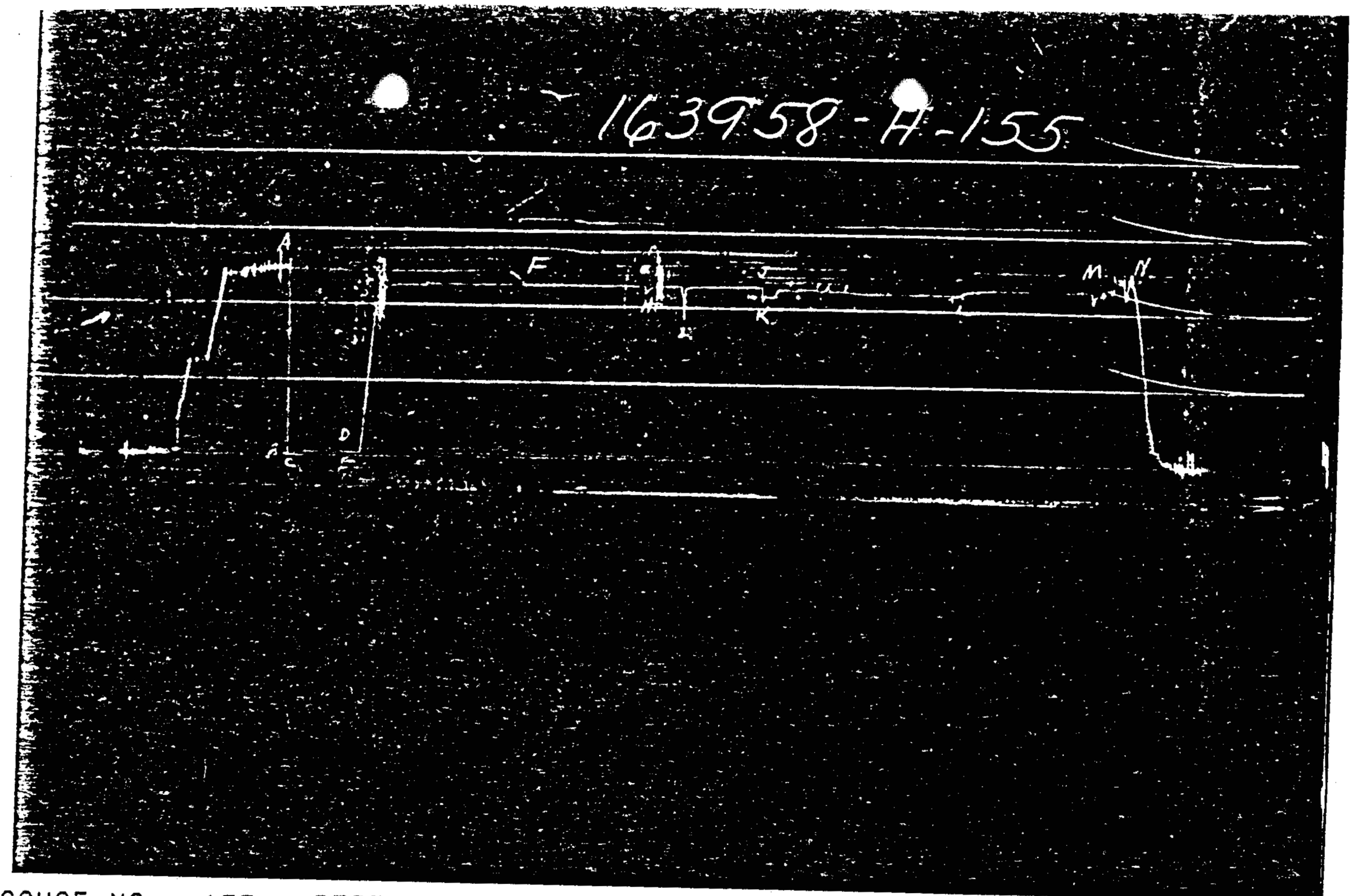
GAUGE NO: 194 DEPTH: 5208.4 BLANKED OFF: NO HOUR OF CLOCK: 48

ID	DESCRIPTION	PRESSURE REPORTED	PRESSURE CALCULATED	TIME REPORTED	TIME CALCULATED	TYPE
A	INITIAL HYDROSTATIC		2511.0			
B	INITIAL FIRST FLOW		27.5	5.0	6.5	F
C	FINAL FIRST FLOW		27.5			
C	INITIAL FIRST CLOSED-IN		27.5	247.0	246.9	C
D	FINAL FIRST CLOSED-IN		89.8			
E	INITIAL SECOND FLOW		28.1	640.0	640.8	F
F	FINAL SECOND FLOW		2306.6			
F	INITIAL SECOND CLOSED-IN		2306.6	765.0		C
G	FINAL SECOND CLOSED-IN					
H	INITIAL THIRD FLOW			170.0		F
I	FINAL THIRD FLOW					
I	INITIAL THIRD CLOSED-IN			367.0		C
J	FINAL THIRD CLOSED-IN					
K	INITIAL FOURTH FLOW			971.0		F
L	FINAL FOURTH FLOW					
L	INITIAL FOURTH CLOSED-IN			672.0		C
M	FINAL FOURTH CLOSED-IN					
N	FINAL HYDROSTATIC					



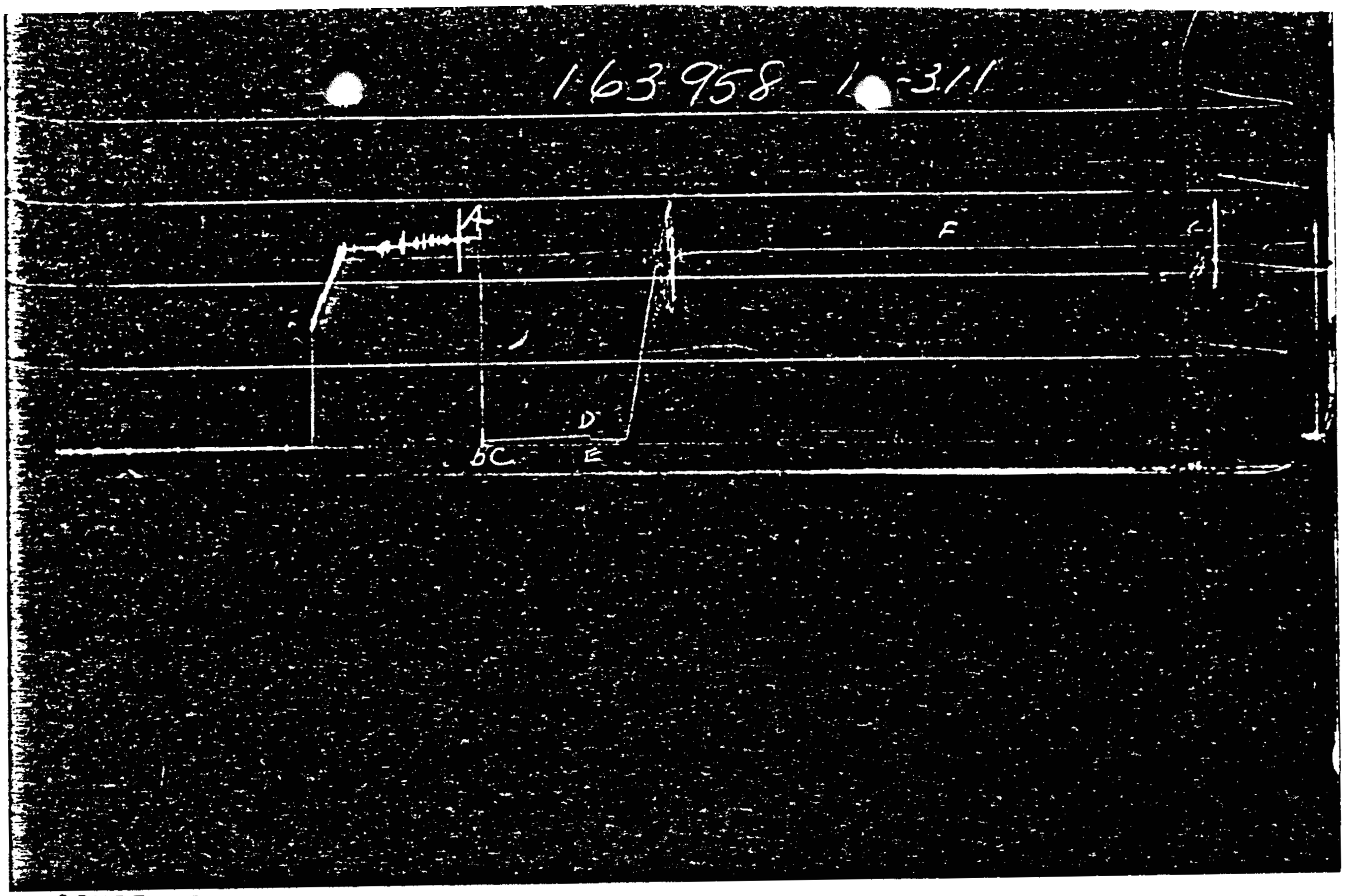
GAUGE NO: 805 DEPTH: 5208.4 BLANKED OFF: NO HOUR OF CLOCK: 4[illegible]

ID	DESCRIPTION	PRESSURE REPORTED	PRESSURE CALCULATED	TIME REPORTED	TIME CALCULATED	TYPE
A	INITIAL HYDROSTATIC		2560.9			
B	INITIAL FIRST FLOW		43.7	5.0	6.5	F
C	FINAL FIRST FLOW		43.7			
C	INITIAL FIRST CLOSED-IN		43.7	247.0	246.9	C
D	FINAL FIRST CLOSED-IN		105.2			
E	INITIAL SECOND FLOW		43.4	640.0	640.8	F
F	FINAL SECOND FLOW		2338.4			
F	INITIAL SECOND CLOSED-IN		2338.4	765.0	763.0	C
G	FINAL SECOND CLOSED-IN		2358.8			
H	INITIAL THIRD FLOW		2234.7	170.0	172.1	F
I	FINAL THIRD FLOW		1879.9			
I	INITIAL THIRD CLOSED-IN		1879.9	367.0	367.0	C
J	FINAL THIRD CLOSED-IN		2378.3			
K	INITIAL FOURTH FLOW		2162.6	971.0		F
L	FINAL FOURTH FLOW					
L	INITIAL FOURTH CLOSED-IN			672.0		C
M	FINAL FOURTH CLOSED-IN					
N	FINAL HYDROSTATIC					



GAUGE NO: 155 DEPTH: 5235.8 BLANKED OFF: NO HOUR OF CLOCK: 96

ID	DESCRIPTION	PRESSURE REPORTED	PRESSURE CALCULATED	TIME REPORTED	TIME CALCULATED	TYPE
A	INITIAL HYDROSTATIC		2509.9			
B	INITIAL FIRST FLOW		43.6	5	7	F
C	FINAL FIRST FLOW		43.2			
C	INITIAL FIRST CLOSED-IN		43.2	247	247	C
D	FINAL FIRST CLOSED-IN		62.9			
E	INITIAL SECOND FLOW		57.6	640	641	F
F	FINAL SECOND FLOW		2281.1			
F	INITIAL SECOND CLOSED-IN		2281.1	765	763	C
G	FINAL SECOND CLOSED-IN		2289.4			
H	INITIAL THIRD FLOW		2187.1	170	172	F
I	FINAL THIRD FLOW		1854.1			
I	INITIAL THIRD CLOSED-IN		1854.1	367	367	C
J	FINAL THIRD CLOSED-IN		2295.0			
K	INITIAL FOURTH FLOW		2112.8	971	969	F
L	FINAL FOURTH FLOW		2228.6			
L	INITIAL FOURTH CLOSED-IN		2228.6	672	659	C
M	FINAL FOURTH CLOSED-IN		2303.3			
N	FINAL HYDROSTATIC		2515.2			



GAUGE NO: 311 DEPTH: 5235.8 BLANKED OFF: NO HOUR OF CLOCK: 48

ID	DESCRIPTION	PRESSURE REPORTED	PRESSURE CALCULATED	TIME REPORTED	TIME CALCULATED	TYPE
A	INITIAL HYDROSTATIC		2545.3			
B	INITIAL FIRST FLOW		58.7	5.0	6.5	F
C	FINAL FIRST FLOW		58.7			
C	INITIAL FIRST CLOSED-IN		58.7	247.0	246.9	C
D	FINAL FIRST CLOSED-IN		111.2			
E	INITIAL SECOND FLOW		58.7	640.0	640.8	F
F	FINAL SECOND FLOW		2346.3			
F	INITIAL SECOND CLOSED-IN		2346.3	765.0	763.0	C
G	FINAL SECOND CLOSED-IN		2359.3			
H	INITIAL THIRD FLOW		2226.7	170.0	172.1	F
I	FINAL THIRD FLOW		1890.9			
I	INITIAL THIRD CLOSED-IN		1890.9	367.0		C
J	FINAL THIRD CLOSED-IN					
K	INITIAL FOURTH FLOW			971.0		F
L	FINAL FOURTH FLOW					
L	INITIAL FOURTH CLOSED-IN			672.0		C
M	FINAL FOURTH CLOSED-IN					
N	FINAL HYDROSTATIC					

EQUIPMENT & HOLE DATA

FORMATION TESTED: ______

NET PAY (ft): ______

GROSS TESTED FOOTAGE: TIGHT HOLE

[redacted]

CASING PERFS. (ft): TIGHT HOLE

[redacted]

ELEVATION (ft): 164.5 WEAR BUSHING TO RKB

TOTAL DEPTH (ft): TIGHT HOLE

[redacted]

FINAL SURFACE CHOKE (in): T. HOLE

[redacted]

MUD VISCOSITY (sec): ______

ESTIMATED HOLE TEMP. (°F): 100

[redacted]

TICKET NUMBER: 16395800

DATE: 9-7-85 TEST NO: 1

TYPE DST: CASED HOLE W/LPR

HALLIBURTON CAMP: ANCHORAGE

TESTER: MENKE, BURMEISTER, JIM MAC ARTHUR

WITNESS: JEFF TENZER (UNOCAL)

DRILLING CONTRACTOR: CANMAR EXPLORER II

FLUID PROPERTIES FOR RECOVERED MUD & WATER

SOURCE	RESISTIVITY	CHLORIDES
	@ °F	ppm
	@ °F	ppm
	@ °F	ppm
	@ °F	ppm
	@ °F	ppm
	@ °F	ppm

SAMPLER DATA

Psig AT SURFACE: ______

cu.ft. OF GAS: ______

cc OF OIL: ______

cc OF WATER: ______

cc OF MUD: ______

TOTAL LIQUID cc: ______

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Minerals Management Service
Anchorage, Alaska

HYDROCARBON PROPERTIES

OIL GRAVITY (°API): ______ @ ____°F

GAS/OIL RATIO (cu.ft. per bbl): ______

GAS GRAVITY: ______

CUSHION DATA

TYPE	AMOUNT	WEIGHT
[redacted]		

RECOVERED:

NOTE: THIS IS A TIGHT HOLE......ALL INFORMATION WAS NOT MADE AVAILABLE TO HALLIBURTON.

MEASURED FROM TESTER VALVE

[redacted]

SRC PRESSURE GAUGES DID NOT FUNCTION PROPERLY...CHARTS WERE NOT SENT FOR PROCESSING. CHART FROM RT-7 TEMPERATURE RECORDER (HT-315) WAS ALSO NOT SENT FOR PROCESSING.

THE SAMPLER WAS TAKEN BY UNION OIL COMPANY FOR DRAINING.

SEE TOP OF NEXT PAGE FOR ADDITIONAL REMARKS..........

TYPE & SIZE MEASURING DEVICE: ______ TICKET NO: 16395800

TIME	CHOKE SIZE	SURFACE PRESSURE PSI	GAS RATE MCF	LIQUID RATE BPD	REMARKS
					ADDITIONAL REMARKS.......
					[redacted]
					PERFORATED FIRST INTERVAL WITH
					NITROGEN CUSHION 300 PSI
					UNDERBALANCED.
					PRODUCTION TEST DATA:
[redacted]					
1000					PICKED UP AND MADE UP TOOLS AND
					GAUGES.
1005					SHUT DOWN TO MAKE DUMMY RUN WITH
					OTIS SLICK JOINT
1050					PICKED UP AND MADE UP TOOLS
1200					LOADED TOP GAUGES
1210					RIGGED UP FOR DRILL COLLARS
					RAN IN HOLE WITH NO CUSHION
1647					RUN THROUGH LINER
2120					PICKED UP TEST HEAD (Howco)
2155					HANG OFF IN WELL HEAD
2232					SET RTTS AT 5224' AND RIGGED (Safety Joint, Circ Valve)
					UP SURFACE LINES.
2300					CIRCULATE RISER
2310					CLOSED RAMS
2313					PRESSURED ANNULUS TO 1300 PSI
					WITH (24 STROKES)
2318					BLED ANNULUS TO ZERO
2345					RIGGED UP CHOKE MANIFOLD
					PRESSURE TESTED SWAB. MASTER.
					BACHRIDE C.M. VALVES TO 5000
					PSI (OKAY).
2355					BLED OFF TEST. RIGGED UP SWS
					NOWSCO
[redacted]					
0315					PRESSURE TEST SWS AND LUBRICATOR
					VALVE TO 3000 PSI WITH NITROGEN

TYPE & SIZE MEASURING DEVICE:					TICKET NO: 16395800
TIME	CHOKE SIZE	SURFACE PRESSURE PSI	GAS RATE MCF	LIQUID RATE BPD	REMARKS
					OKAY.
0325					PRESSURED ANNULUS TO 1300 PSI
					(22 STROKES) OPENED LPRN AND (Tester Valve)
					RAN IN HOLE WITH SWS. HUNG
					UP ON LUBRICATOR VALVE - NOT
					OPEN.
0445					LUBRICATOR VALVE OPEN-RAN
					IN HOLE WITH SWS TO PERFORATE-
					INJECT NITROGEN TO CHARGE
					DRILL PIPE
0520					SWS RAN THRU LPR-N
[redacted]					~~PERFORATE~~ [redacted]L
					PULLED SWS OUT OF HOLE
0700					CLOSED LUB. VALVE- RIGGED
					DOWN SUB TO CHANGE GUNS.
0921					PRESSURED UP WITH NITROGEN
					ABOVE LUBRICATOR VALVE.
0926					OPENED LUBRICATOR VALVE TO RUN
					GUNS (LUBRICATOR VALVE DID
					NOT FUNCTION)
1405					BLED OFF ANNULUS AND CLOSED
					LPR-N. PULLED SSTT AND LUB.. (Sub Sea Test Tree)
					LAID DOWN LUBRICATOR VALVE
					AND RAN IN HOLE WITH SSTT.
					WOULD NOT STAB - LATCH BACK IN.
					PULLED LANDING STRING TO
					WORK ON SSTT.
2330					LATCH IN WITH SSTT, LUB (TIW)
					VALVE AT ROTARY AND TEST
					HEAD UP IN DERRICK PER
					UNIONS INSTRUCTIONS.
2355					RIGGED UP WIRELINE (SWS).
					ATTEMPTED TO PRESSURE TEST
					TO 3000 WITH NITROGEN, RAN
					OUT OF NITROGEN, USED AIR
					FROM RISER TENSIONER.
[redacted]	9-7-85				

TYPE & SIZE MEASURING DEVICE: ______ TICKET NO: 16395800

TIME	CHOKE SIZE	SURFACE PRESSURE PSI	GAS RATE MCF	LIQUID RATE BPD	REMARKS
0155					TEST WIRELINE LUBRICATOR
0200					OPENED SSTT
0207					SSTT OPEN
0230					RAN IN HOLE WITH SWS → *PeR Forating Equip*
					[redacted]
0252					PRESSURED ANNULUS TO 1300 PSI
					[redacted] N *(Tester Valve)*
		1600			TUBING PRESSURE 1600 PSI
					NITROGEN. CONTINUED RUNNING
					IN HOLE WITH SWS
0330		1623			
0350					[redacted]
0511					WIRELINE RIGGED DOWN
[redacted]					[redacted] *(@ SurFace)*
0542					BLED OFF ANNULUS PRESSURE.
			First Flow	*16 min Flow*	[redacted] *Tester Valve*
0612					DECIDED TO RIG UP SPERRY SUN
0916					PULLED OUT OF HOLE WITH
					SPERRY SUN TO ADD SINKER BAR
1020				*Initial*	RAN IN HOLE WITH SPERRY SUN
				Shut In	PRESSURE GAUGE
1130					SPERRY GAUGES ON BOTTOM
					(1 STAND ABOVE TESTER VALVE)
1149					PRESSURED ANNULUS - O[redacted]
					L[redacted]
					OPENED CHOKE MANIFOLD AND *@ Surface*
				2nd Flow	FLOWED WELL
1910					BLED ANNULUS FROM 1500 PSI
					TO 1400 PSI
					FLOWED WELL
[redacted]					
1700					CIRCULATED RISER WITH STEAM
					AND BRINE TO KEEP FROM
					FREEZING
					[redacted]LL
1910					BLED ANNULUS 100 PSI TO
					1300 PSI

TYPE & SIZE MEASURING DEVICE:					TICKET NO: 16395800
TIME	CHOKE SIZE	SURFACE PRESSURE PSI	GAS RATE MCF	LIQUID RATE BPD	REMARKS
2153					BLED ANNULUS 75 PSI TO
					1350 PSI
2345					BLED ANNULUS 100 PSI TO
					1475 PSI
					FLOWED WELL
[redacted]	Missing				
0400	9/9/85			Must BP	~~SHUT IN AT SURFACE~~
0443				Final Shut	SPERRY SUN GAUGE PULLED OUT
				In	OF HOLE. RIGGED DOWN
0525					RAN IN HOLE WITH SWS SAMPLERS
1512					PRESSURED ANNULUS TO 2300 PSI.
					SHEARED APR M2 SAMPLER
					REVERSED OUT
					(CLOSED APR-N)
1545					WATER TO MANIFOLD
1610					FINISHED REVERSING OUT
1633					OPENED BYPASS. UNSEATED RTTS
1638					RIGGED DOWN SURFACE EQUIPMENT
					AND PULLED OUT OF HOLE
2045					SLIP JOINTS TO SURFACE
2115					PULLED OUT OF HOLE WITH
					DRILL COLLARS
2150					BROKE OUT SAMPLER
2300					TOOLS ON SURFACE

TICKET NO: 16395800

CLOCK NO: 22756 HOUR: 96

HALLIBURTON SERVICES

G[illegible]GE NO: 111

DEPTH: 5208.4

REF		MINUTES	PRESSURE	ΔP (cum.)	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
FIRST FLOW						
B	1	0	30.1			
C	2	7	28.8	-1.2		
FIRST CLOSED-IN						
C	1	0	28.8			
	2	15	33.1	4.3	4.5	0.156
	3	30	36.5	7.6	5.3	0.085
	4	45	40.4	11.6	5.7	0.058
	5	60	44.1	15.2	5.9	0.045
	6	75	45.9	17.1	6.0	0.036
	7	90	47.1	18.3	6.1	0.030
	8	105	50.5	21.6	6.1	0.026
	9	120	53.8	25.0	6.2	0.023
	10	135	56.9	28.1	6.2	0.020
	11	150	59.6	30.8	6.2	0.018
	12	165	62.4	33.5	6.2	0.017
	13	180	65.7	36.9	6.3	0.015
	14	195	69.4	40.6	6.3	0.014
	15	210	70.6	41.8	6.3	0.013
	16	225	74.3	45.4	6.3	0.012
	17	240	77.3	48.5	6.3	0.012
D	18	247	77.9	49.1	6.3	0.011
SECOND FLOW						
E	1	0	32.5			
	2	30	32.2	-0.3		
	3	60	31.0	-1.2		
[1]	4	84	30,7	-0.3		
	5	90	210.6	179.9		
	6	120	1088.1	877.6		
	7	150	2013.3	925.2		
[2]	8	160	2089.7	76.4		
	9	180	2238.2	148.5		
	10	210	2258.5	20.3		
	11	240	2261.8	3.3		
	12	270	2262.7	0.9		
	13	300	2265.1	2.4		
	14	330	2265.1	0.0		
	15	360	2265.1	0.0		
[3]	16	363	2266.4	1.2		
	17	390	2282.7	16.4		
	18	420	2279.1	-3.7		
	19	450	2277.5	-1.5		
	20	480	2276.3	-1.2		
	21	510	2276.3	0.0		
	22	540	2276.3	0.0		

ab/85

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
SECOND FLOW - CONTINUED						
	23	570	2276.3	0.0		
	24	600	2277.5	1.2		
	25	630	2277.9	0.3		
F	26	641	2278.5	0.6		
SECOND CLOSED-IN						
F	1	0	2278.5			
	2	30	2278.8	0.3	28.7	1.353
	3	60	2279.4	0.9	54.9	1.072
	4	90	2280.6	2.1	79.0	0.913
	5	120	2280.6	2.1	101.3	0.806
	6	150	2282.1	3.7	121.8	0.726
	7	180	2282.4	4.0	140.8	0.662
	8	210	2283.3	4.9	158.6	0.611
	9	240	2283.9	5.5	175.1	0.568
	10	270	2283.9	5.5	190.5	0.531
	11	300	2285.1	6.7	205.0	0.499
	12	330	2285.1	6.7	218.6	0.472
	13	360	2285.4	7.0	231.3	0.447
	14	390	2286.4	7.9	243.4	0.425
	15	420	2287.0	8.5	254.7	0.405
	16	450	2288.2	9.7	265.5	0.387
	17	480	2288.2	9.7	275.6	0.371
	18	510	2288.5	10.0	285.2	0.356
	19	540	2288.5	10.0	294.4	0.342
	20	570	2289.7	11.2	303.1	0.330
	21	600	2290.9	12.4	311.4	0.318
	22	630	2290.9	12.4	319.3	0.307
	23	660	2290.9	12.4	326.8	0.297
	24	690	2291.5	13.0	334.0	0.287
	25	720	2292.7	14.3	340.9	0.279
	26	750	2292.7	14.3	347.4	0.270
G	27	763	2292.7	14.3	350.2	0.267
THIRD FLOW						
H	1	0	2175.6			
	2	5	2215.8	40.1		
	3	10	2235.2	19.5		
	4	15	2248.3	13.1		
	5	20	2259.6	11.3		
	6	25	2265.6	6.1		
	7	30	2275.1	9.4		
	8	35	2279.3	4.3		
	9	40	2280.9	1.5		
	10	45	2283.3	2.4		
	11	50	2283.3	0.0		
	12	55	2283.3	0.0		
[2]	13	59	2283.3	0.0		

LEGEND:
[1] STARTED NITROGEN
[2] PERFORATING GUNS FIRED
[3] UNEXPLAINED PRESSURE CHANGE
[4] OPENED AT SURFACE
[5] POSSIBLE CHOKE CHANGE

REMARKS:

TICKET NO: 16395800	HALLIBURTON SERVICES	GAUGE NO: 111
CLOCK NO: 22756 HOUR: 96		DEPTH: 5208.4

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
THIRD FLOW - CONTINUED					
14	60	2288.5	5.2		
15	80	2288.5	0.0		
16	100	2288.5	0.0		
17	120	2288.8	0.3		
18	140	2290.3	1.5		
[4] 19	154	2293.0	2.7		
20	160	2164.4	-128.6		
I 21	172	1832.7	-331.7		
THIRD CLOSED-IN					
I 1	0	1832.7			
2	1	2238.3	405.6	1.0	2.931
3	2	2249.6	416.8	2.0	2.604
4	3	2256.2	423.5	3.0	2.437
5	4	2260.5	427.8	3.9	2.317
6	5	2264.8	432.0	5.0	2.213
7	6	2268.7	436.0	6.0	2.138
8	7	2270.5	437.8	6.9	2.074
9	8	2271.7	439.0	8.0	2.012
10	9	2274.8	442.1	8.9	1.963
11	10	2277.8	445.1	9.9	1.920
12	12	2280.9	448.1	11.8	1.840
13	14	2281.8	449.1	13.8	1.773
14	16	2283.6	450.9	15.7	1.718
15	18	2285.1	452.4	17.6	1.667
16	20	2285.4	452.7	19.6	1.622
17	22	2286.3	453.6	21.4	1.583
18	24	2287.9	455.1	23.3	1.545
19	26	2288.2	455.4	25.2	1.513
20	28	2288.8	456.0	27.1	1.481
21	30	2289.4	456.7	29.0	1.451
22	35	2290.9	458.2	33.5	1.388
23	40	2292.4	459.7	38.2	1.332
24	45	2293.6	460.9	42.7	1.283
25	50	2293.9	461.2	47.1	1.240
26	55	2294.8	462.1	51.6	1.201
27	60	2295.4	462.7	55.9	1.166
28	70	2296.1	463.3	64.5	1.104
29	80	2297.3	464.5	72.9	1.051
30	90	2298.2	465.5	81.1	1.004
31	100	2298.5	465.8	89.1	0.964
32	110	2298.5	465.8	97.0	0.927
33	120	2299.1	466.4	104.7	0.894
34	135	2300.3	467.6	115.9	0.849
35	150	2300.3	467.6	126.8	0.810
36	165	2300.9	468.2	137.3	0.776
37	180	2300.9	468.2	147.6	0.744
38	195	2301.5	468.8	157.5	0.716
39	210	2301.5	468.8	167.2	0.690
40	225	2303.0	470.3	176.6	0.667

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
THIRD CLOSED-IN - CONTINUED					
41	240	2303.0	470.3	185.6	0.645
42	260	2303.0	470.3	197.4	0.618
43	280	2303.3	470.6	208.7	0.594
44	300	2304.5	471.8	219.6	0.572
45	320	2304.5	471.8	230.1	0.552
46	340	2310.3	477.6	240.3	0.533
47	360	2310.3	477.6	250.1	0.515
J 48	367	2310.9	478.2	253.5	0.510
FOURTH FLOW					
K 1	0	2099.5			
2	30	2157.3	57.8		
3	60	2210.5	53.2		
4	90	2272.9	62.3		
5	120	2280.5	7.6		
[5] 6	121	2280.5	0.0		
7	150	2252.2	-28.3		
[5] 8	156	2252.2	0.0		
9	180	2273.2	21.0		
10	210	2279.6	6.4		
11	240	2280.8	1.2		
[5] 12	254	2280.8	0.0		
13	270	2248.2	-32.5		
[5] 14	295	2265.0	16.7		
15	300	2252.8	-12.2		
16	330	2248.2	-4.6		
17	360	2248.6	0.3		
[5] 18	381	2248.6	0.0		
19	390	2243.4	-5.2		
20	420	2231.5	-11.9		
21	450	2223.9	-7.6		
22	480	2218.4	-5.5		
23	510	2225.7	7.3		
24	540	2225.7	0.0		
25	570	2227.6	1.8		
26	600	2231.8	4.3		
27	630	2224.2	-7.6		
28	660	2221.2	-3.0		
29	690	2223.9	2.7		
30	720	2227.3	3.3		
31	750	2227.3	0.0		
32	780	2225.7	-1.5		
33	810	2227.9	2.1		
34	840	2229.7	1.8		
35	870	2230.3	0.6		
36	900	2231.5	1.2		
37	930	2232.7	1.2		
38	960	2234.6	1.8		
L 39	969	2239.4	4.9		

LEGEND:
[1] STARTED NITROGEN
[2] PERFORATING GUNS FIRED
[3] UNEXPLAINED PRESSURE CHANGE
[4] OPENED AT SURFACE
[5] POSSIBLE CHOKE CHANGE

REMARKS:

TICKET NO: 16395800		GAUGE NO: 111
CLOCK NO: 22756 HOUR: 96	HALLIBURTON SERVICES	DEPTH: 5208.4

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t+\Delta t}{\Delta t}$
		FOURTH CLOSED-IN			
L 1	0	2239.4			
2	1	2260.7	21.3	1.0	3.270
3	2	2266.8	27.4	2.0	2.943
4	3	2268.3	28.9	3.0	2.775
5	4	2271.4	31.9	4.0	2.655
6	5	2272.9	33.5	5.0	2.551
7	6	2274.4	35.0	6.0	2.475
8	7	2275.9	36.5	6.9	2.411
9	8	2276.2	36.8	8.0	2.348
10	9	2277.4	38.0	9.0	2.300
11	10	2278.7	39.2	9.9	2.256
12	12	2280.5	41.1	11.9	2.176
13	14	2282.0	42.6	13.9	2.108
14	16	2283.5	44.1	15.8	2.053
15	18	2285.1	45.6	17.8	2.001
16	20	2286.6	47.1	19.8	1.955
17	22	2286.6	47.1	21.7	1.915
18	24	2286.9	47.4	23.7	1.877
19	26	2288.1	48.7	25.6	1.844
20	28	2288.4	49.0	27.6	1.812
21	30	2289.3	49.9	29.5	1.782
22	35	2291.1	51.7	34.3	1.717
23	40	2292.4	52.9	39.1	1.660
24	45	2292.7	53.2	44.0	1.609
25	50	2294.2	54.7	48.6	1.566
26	55	2295.7	56.3	53.4	1.525
27	60	2296.9	57.5	58.0	1.489
28	70	2302.1	62.7	67.4	1.424
29	80	2306.6	67.2	76.6	1.368
30	90	2307.9	68.4	85.7	1.319
31	100	2305.4	66.0	94.7	1.276
32	110	2310.6	71.2	103.7	1.237
33	120	2311.2	71.8	112.5	1.201
34	135	2318.2	78.7	125.6	1.153
35	150	2318.2	78.7	138.4	1.111
36	165	2316.7	77.2	151.0	1.073
37	180	2311.2	71.7	163.5	1.039
38	195	2315.7	76.3	175.8	1.007
39	210	2315.7	76.3	188.0	0.978
40	225	2312.1	72.7	199.9	0.952
41	240	2316.7	77.2	211.6	0.927
42	260	2318.2	78.7	227.0	0.896
43	280	2318.2	78.7	242.2	0.868
44	300	2314.8	75.4	256.9	0.843
45	320	2315.7	76.3	271.4	0.819
46	340	2317.6	78.1	285.7	0.796
47	360	2317.6	78.1	299.7	0.776
48	380	2318.5	79.0	313.4	0.756
49	400	2320.0	80.6	326.9	0.738
50	420	2320.6	81.2	340.1	0.721

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t+\Delta t}{\Delta t}$
		FOURTH CLOSED-IN - CONTINUED			
51	440	2322.1	82.7	353.1	0.704
52	460	2322.1	82.7	365.9	0.689
53	480	2322.7	83.3	378.4	0.674
54	500	2322.7	83.3	390.7	0.661
55	520	2322.7	83.3	402.9	0.647
56	540	2322.7	83.3	414.7	0.635
57	560	2323.0	83.6	426.5	0.622
58	580	2324.2	84.8	438.0	0.611
59	600	2324.2	84.8	449.2	0.600
60	620	2324.2	84.8	460.4	0.589
61	640	2324.2	84.8	471.3	0.579
M 62	659	2323.6	84.2	481.3	0.570

LEGEND:
1 STARTED NITROGEN
2 PERFORATING GUNS FIRED
3 UNEXPLAINED PRESSURE CHANGE
4 OPENED AT SURFACE
5 POSSIBLE CHOKE CHANGE

REMARKS:

TICKET NO: 16395800

CLOCK NO: 16765 HOUR: 48

HALLIBURTON SERVICES

GAUGE NO: 194

DEPTH: 5208.4

FIRST FLOW

9/7/85 Ignore

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
B	1	0.0	27.5			
C	2	6.5	27.5	0.0		

FIRST CLOSED-IN

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
C	1	0.0	27.5			
	2	15.0	34.7	7.2	4.5	0.156
	3	30.0	39.1	11.6	5.3	0.085
	4	45.0	42.3	14.8	5.7	0.058
	5	60.0	47.6	20.1	5.9	0.045
	6	75.0	50.8	23.3	6.0	0.036
	7	90.0	54.5	27.0	6.1	0.030
	8	105.0	58.0	30.5	6.1	0.026
	9	120.0	61.1	33.7	6.2	0.023
	10	135.0	65.9	38.4	6.2	0.020
	11	150.0	68.4	40.9	6.2	0.018
	12	165.0	72.1	44.7	6.2	0.017
	13	180.0	76.5	49.1	6.3	0.015
	14	195.0	79.1	51.6	6.3	0.014
	15	210.0	82.5	55.0	6.3	0.013
	16	225.0	86.0	58.5	6.3	0.012
	17	240.0	88.5	61.0	6.3	0.012
D	18	246.9	89.8	62.3	6.3	0.011

SECOND FLOW

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
E	1	0.0	28.1			
	2	30.0	28.7	0.6		
	3	60.0	28.7	0.0		
[1]	4	83.6	32.8	4.1		
	5	90.0	232.2	199.4		
	6	120.0	1104.7	872.5		
	7	150.0	1955.5	850.7		
[2]	8	160.3	2121.2	165.7		
	9	180.0	2265.4	144.3		
	10	210.0	2286.0	20.6		
	11	240.0	2291.2	5.2		
	12	270.0	2292.1	0.9		
	13	300.0	2293.9	1.8		
	14	330.0	2293.9	0.0		
	15	360.0	2293.9	0.0		
[1]	16	363.2	2293.9	0.0		
	17	390.0	2313.6	19.7		
	18	420.0	2307.5	-6.1		
	19	450.0	2305.7	-1.8		
	20	480.0	2305.7	0.0		
	21	510.0	2305.7	0.0		
	22	540.0	2306.6	0.9		

SECOND FLOW - CONTINUED

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
	23	570.0	2306.6	0.0		
	24	600.0	2306.6	0.0		
	25	630.0	2306.6	0.0		
F	26	640.8	2306.6	0.0		

SECOND CLOSED-IN

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
F	1	0.0	2306.6			
	2	30.0	2307.5	0.9	28.7	1.354
	3	60.0	2307.5	0.9	54.9	1.071
	4	90.0	2309.0	2.4	79.0	0.913
	5	120.0	2309.4	2.7	101.2	0.806
	6	150.0	2310.6	4.0	121.8	0.726
	7	180.0	2312.1	5.5	140.8	0.662
	8	210.0	2312.1	5.5	158.5	0.611
	9	240.0	2312.7	6.1	175.1	0.568
	10	270.0	2313.3	6.7	190.5	0.531
	11	300.0	2313.3	6.7	205.0	0.499
	12	330.0	2314.2	7.6	218.6	0.472
	13	360.0	2315.1	8.5	231.3	0.447
	14	390.0	2315.4	8.8	243.4	0.425
	15	420.0	2316.3	9.7	254.7	0.405
	16	450.0	2317.3	10.6	265.5	0.387
	17	480.0	2318.2	11.6	275.6	0.371
	18	510.0	2318.5	11.9	285.2	0.356
[4]	19	539.6	2318.5	11.9	294.3	0.342
G	20	NO DATA FOR THIS POINT				

THIRD FLOW

REF		
H	1	NO DATA FOR THIS POINT
I	2	NO DATA FOR THIS POINT

THIRD CLOSED-IN

REF		
I	1	NO DATA FOR THIS POINT
J	2	NO DATA FOR THIS POINT

FOURTH FLOW

REF		
K	1	NO DATA FOR THIS POINT
L	2	NO DATA FOR THIS POINT

FOURTH CLOSED-IN

REF		
L	1	NO DATA FOR THIS POINT
M	2	NO DATA FOR THIS POINT

LEGEND:
[1] STARTED NITROGEN
[2] PERFORATING GUNS FIRED
[3] UNEXPLAINED PRESSURE CHANGE
[4] CLOCK STOPPED

REMARKS:
CLOCK STOPPED DURING SECOND CLOSED IN PERIOD.....STOPPED INTERMITTENTLY THROUGHOUT REST OF TEST...NO USABLE DATA AFTER SECOND CLOSED IN PERIOD.

TICKET NO: 16395800		G[illegible]GE NO: 805
CLOCK NO: 22455 HOUR: 48	HALLIBURTON SERVICES	DEPTH: 5208.4

FIRST FLOW

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
B	1	0.0	43.7			
C	2	6.5	43.7	0.0		

FIRST CLOSED-IN

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
C	1	0.0	43.7			
	2	15.0	53.0	9.3	4.5	0.156
	3	30.0	57.6	14.0	5.3	0.085
	4	45.0	62.3	18.6	5.7	0.058
	5	60.0	65.4	21.7	5.9	0.045
	6	75.0	69.1	25.5	6.0	0.036
	7	90.0	72.5	28.9	6.1	0.030
	8	105.0	76.0	32.3	6.1	0.026
	9	120.0	79.1	35.4	6.2	0.023
	10	135.0	82.8	39.1	6.2	0.020
	11	150.0	86.8	43.2	6.2	0.018
	12	165.0	89.0	45.3	6.2	0.017
	13	180.0	91.8	48.1	6.3	0.015
	14	195.0	94.9	51.2	6.3	0.014
	15	210.0	98.3	54.7	6.3	0.013
	16	225.0	101.1	57.5	6.3	0.012
	17	240.0	104.8	61.2	6.3	0.012
D	18	246.9	105.2	61.5	6.3	0.011

SECOND FLOW

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
E	1	0.0	43.4			
	2	30.0	43.7	0.3		
	3	60.0	43.7	0.0		
[1]	4	83.6	48.0	4.3		
	5	90.0	123.2	75.2		
	6	120.0	1013.9	890.7		
	7	150.0	1878.8	864.9		
[2]	8	160.3	2160.3	281.6		
	9	180.0	2297.5	137.2		
	10	210.0	2323.5	25.9		
	11	240.0	2331.4	7.9		
	12	270.0	2335.7	4.3		
	13	300.0	2335.7	0.0		
	14	330.0	2335.7	0.0		
	15	360.0	2336.6	0.9		
[3]	16	363.2	2336.6	0.0		
	17	390.0	2348.8	12.2		
	18	420.0	2339.9	-8.9		
	19	450.0	2340.2	0.3		
	20	480.0	2340.2	0.0		
	21	510.0	2338.4	-1.8		
	22	540.0	2337.2	-1.2		

SECOND FLOW - CONTINUED

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
	23	570.0	2338.7	1.5		
	24	600.0	2338.7	0.0		
	25	630.0	2338.7	0.0		
F	26	640.8	2338.4	-0.3		

SECOND CLOSED-IN

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
F	1	0.0	2338.4			
	2	30.0	2345.4	7.0	28.7	1.354
	3	60.0	2345.4	7.0	54.9	1.071
	4	90.0	2346.6	8.3	79.0	0.913
	5	120.0	2347.5	9.2	101.2	0.806
	6	150.0	2347.9	9.5	121.8	0.726
	7	180.0	2348.8	10.4	140.8	0.662
	8	210.0	2349.4	11.0	158.6	0.611
	9	240.0	2350.3	11.9	175.1	0.568
	10	270.0	2351.2	12.8	190.5	0.531
	11	300.0	2351.2	12.8	205.0	0.499
	12	330.0	2351.2	12.8	218.6	0.472
	13	360.0	2352.4	14.1	231.3	0.447
	14	390.0	2353.3	15.0	243.4	0.425
	15	420.0	2354.0	15.6	254.7	0.405
	16	450.0	2354.0	15.6	265.5	0.387
	17	480.0	2354.0	15.6	275.6	0.371
	18	510.0	2355.2	16.8	285.3	0.356
	19	540.0	2356.1	17.7	294.4	0.342
	20	570.0	2356.1	17.7	303.1	0.330
	21	600.0	2356.1	17.7	311.4	0.318
	22	630.0	2357.3	18.9	319.3	0.307
	23	660.0	2358.2	19.8	326.8	0.297
	24	690.0	2358.2	19.8	334.0	0.287
	25	720.0	2358.2	19.8	340.9	0.279
	26	750.0	2358.8	20.5	347.4	0.270
G	27	763.0	2358.8	20.5	350.2	0.267

THIRD FLOW

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
H	1	0.0	2234.7			
	2	5.0	2281.8	47.1		
	3	10.0	2302.0	20.2		
	4	15.0	2318.2	16.2		
	5	20.0	2328.6	10.4		
	6	25.0	2335.0	6.4		
	7	30.0	2342.9	7.9		
	8	35.0	2347.5	4.6		
	9	40.0	2349.4	1.8		
	10	45.0	2349.4	0.0		
	11	50.0	2350.9	1.5		
	12	55.0	2351.5	0.6		
[2]	13	59.2	2352.1	0.6		

Received
OCS District Office
NOV 1 5 1985
[illegible] Management Servic[illegible]

LEGEND:
[1] STARTED NITROGEN
[2] PERFORATING GUNS FIRED
[3] UNEXPLAINED PRESSURE CHANGE
[4] OPENED AT SURFACE
[5] CHART TIME EXPIRED

REMARKS:

TICKET NO: 16395800

CLOCK NO: 22455 HOUR: 48

HALLIBURTON SERVICES

GAUGE NO: 805

DEPTH: 5208.4

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
THIRD FLOW - CONTINUED						
	14	60.0	2354.2	2.1		
	15	80.0	2354.2	0.0		
	16	100.0	2354.2	0.0		
	17	120.0	2354.2	0.0		
	18	140.0	2357.0	2.8		
[4]	19	154.4	2359.1	2.1		
	20	160.0	2242.4	-116.8		
I	21	172.1	1879.9	-362.5		

THIRD CLOSED-IN

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
I	1	0.0	1879.9			
	2	1.0	2269.9	390.1	1.0	2.902
	3	2.0	2297.1	417.3	2.0	2.614
	4	3.0	2313.9	434.1	3.0	2.443
	5	4.0	2322.8	442.9	4.0	2.314
	6	5.0	2329.5	449.6	5.0	2.215
	7	6.0	2334.4	454.5	5.9	2.139
	8	7.0	2337.1	457.3	6.9	2.075
	9	8.0	2340.5	460.6	8.0	2.012
	10	9.0	2341.7	461.9	8.9	1.966
	11	10.0	2343.6	463.7	9.9	1.919
	12	12.0	2347.8	468.0	11.8	1.841
	13	14.0	2350.3	470.4	13.7	1.775
	14	16.0	2352.4	472.6	15.7	1.718
	15	18.0	2353.9	474.1	17.6	1.667
	16	20.0	2354.2	474.4	19.5	1.624
	17	22.0	2355.5	475.6	21.5	1.582
	18	24.0	2355.8	475.9	23.3	1.546
	19	26.0	2357.0	477.1	25.2	1.513
	20	28.0	2358.2	478.4	27.1	1.481
	21	30.0	2358.5	478.7	28.9	1.453
	22	35.0	2360.1	480.2	33.6	1.387
	23	40.0	2361.0	481.1	38.1	1.332
	24	45.0	2362.8	482.9	42.7	1.283
	25	50.0	2363.4	483.5	47.1	1.240
	26	55.0	2364.3	484.5	51.5	1.202
	27	60.0	2364.6	484.8	55.9	1.166
	28	70.0	2365.8	486.0	64.5	1.104
	29	80.0	2367.4	487.5	72.9	1.051
	30	90.0	2367.7	487.8	81.1	1.005
	31	100.0	2368.9	489.0	89.2	0.963
	32	110.0	2369.2	489.3	97.0	0.927
	33	120.0	2369.2	489.3	104.7	0.894
	34	135.0	2369.2	489.3	115.9	0.849
	35	150.0	2370.4	490.6	126.8	0.810
	36	165.0	2370.4	490.6	137.3	0.776
	37	180.0	2370.7	490.9	147.6	0.744
	38	195.0	2371.9	492.1	157.5	0.716
	39	210.0	2372.2	492.4	167.2	0.690
	40	225.0	2373.5	493.6	176.5	0.667

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
THIRD CLOSED-IN - CONTINUED						
	41	240.0	2373.8	493.9	185.6	0.645
	42	260.0	2374.4	494.5	197.4	0.618
	43	280.0	2375.0	495.1	208.7	0.594
	44	300.0	2375.9	496.0	219.6	0.572
	45	320.0	2376.5	496.7	230.1	0.551
	46	340.0	2378.3	498.5	240.3	0.533
	47	360.0	2378.3	498.5	250.1	0.515
J	48	367.0	2378.3	498.5	253.5	0.510

FOURTH FLOW

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
K	1	0.0	2162.6			
[5]	2	12.9	2259.1	96.6		
L	3	NO DATA FOR THIS POINT				

FOURTH CLOSED-IN

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
L	1	NO DATA FOR THIS POINT				
M	2	NO DATA FOR THIS POINT				

LEGEND:
[1] STARTED NITROGEN
[2] PERFORATING GUNS FIRED
[3] UNEXPLAINED PRESSURE CHANGE
[4] OPENED AT SURFACE
[5] CHART TIME EXPIRED

REMARKS:

TICKET NO: 16395800

CLOCK NO: 24107 HOUR: 96

HALLIBURTON SERVICES

GAUGE NO: 155

DEPTH: 5235.8

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
			FIRST FLOW			
B	1	0	43.6			
C	2	7	43.2	-0.3		
			FIRST CLOSED-IN			
C	1	0	43.2			
	2	15	41.9	-1.3	4.5	0.156
	3	30	41.9	-1.3	5.3	0.085
	4	45	42.2	-1.0	5.7	0.058
	5	60	43.6	0.3	5.9	0.045
	6	75	43.6	0.3	6.0	0.036
	7	90	45.2	2.0	6.1	0.030
	8	105	46.9	3.7	6.1	0.026
	9	120	48.6	5.3	6.2	0.023
	10	135	51.9	8.7	6.2	0.020
	11	150	53.6	10.3	6.2	0.018
	12	165	58.6	15.3	6.2	0.017
	13	180	59.9	16.7	6.3	0.015
	14	195	59.9	16.7	6.3	0.014
	15	210	61.2	18.0	6.3	0.013
	16	225	61.9	18.7	6.3	0.012
	17	240	62.2	19.0	6.3	0.012
D	18	247	62.9	19.7	6.3	0.011
			SECOND FLOW			
E	1	0	57.6			
	2	30	47.6	-10.0		
	3	60	46.9	-0.7		
[1]	4	84	46.9	0.0		
	5	90	90.2	43.3		
	6	120	1067.2	976.9		
	7	150	1968.8	901.7		
[2]	8	160	2091.4	122.5		
	9	180	2161.2	69.9		
	10	210	2246.0	84.8		
	11	240	2258.9	12.9		
	12	270	2264.2	5.3		
	13	300	2266.9	2.6		
	14	330	2267.5	0.7		
	15	360	2267.5	0.0		
[3]	16	363	2267.5	0.0		
	17	390	2300.0	32.5		
	18	420	2285.4	-14.6		
	19	450	2283.7	-1.7		
	20	480	2283.4	-0.3		
	21	510	2282.1	-1.3		
	22	540	2281.7	-0.3		

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
			SECOND FLOW - CONTINUED			
	23	570	2281.4	-0.3		
	24	600	2281.4	0.0		
	25	630	2281.4	0.0		
F	26	641	2281.1	-0.3		
			SECOND CLOSED-IN			
F	1	0	2281.1			
	2	30	2283.4	2.3	28.7	1.353
	3	60	2283.4	2.3	54.9	1.071
	4	90	2283.7	2.7	79.1	0.913
	5	120	2284.7	3.7	101.2	0.806
	6	150	2285.4	4.3	121.8	0.726
	7	180	2286.7	5.6	140.8	0.663
	8	210	2286.7	5.6	158.6	0.611
	9	240	2286.4	5.3	175.1	0.568
	10	270	2286.4	5.3	190.6	0.531
	11	300	2286.4	5.3	205.0	0.499
	12	330	2286.7	5.6	218.6	0.472
	13	360	2286.7	5.6	231.3	0.447
	14	390	2287.0	6.0	243.4	0.425
	15	420	2287.0	6.0	254.7	0.405
	16	450	2287.0	6.0	265.5	0.387
	17	480	2287.4	6.3	275.6	0.371
	18	510	2287.4	6.3	285.2	0.356
	19	540	2287.4	6.3	294.4	0.342
	20	570	2287.4	6.3	303.1	0.330
	21	600	2288.0	7.0	311.4	0.318
	22	630	2288.4	7.3	319.3	0.307
	23	660	2288.4	7.3	326.8	0.297
	24	690	2288.7	7.6	334.0	0.287
	25	720	2288.7	7.6	340.9	0.279
	26	750	2288.7	7.6	347.4	0.270
G	27	763	2289.4	8.3	350.2	0.267
			THIRD FLOW			
H	1	0	2187.1			
	2	5	2197.8	10.6		
	3	10	2223.7	25.9		
	4	15	2241.6	17.9		
	5	20	2252.2	10.6		
	6	25	2261.5	9.3		
	7	30	2265.8	4.3		
	8	35	2271.8	6.0		
	9	40	2273.8	2.0		
	10	45	2274.8	1.0		
	11	50	2276.8	2.0		
	12	55	2278.4	1.7		
[2]	13	59	2278.4	0.0		

LEGEND:
[1] STARTED NITROGEN
[2] PERFORATING GUNS FIRED
[3] UNEXPLAINED PRESSURE CHANGE
[4] OPENED AT SURFACE
[5] POSSIBLE CHOKE CHANGE

REMARKS:

TICKET NO: 16395800

CLOCK NO: 24107 HOUR: 96

HALLIBURTON
SERVICES

GAUGE NO: 155

DEPTH: 5235.8

	REF	MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
	THIRD FLOW - CONTINUED					
	14	60	2286.1	7.6		
	15	80	2286.7	0.7		
	16	100	2286.7	0.0		
	17	120	2286.7	0.0		
	18	140	2287.4	0.7		
[4]	19	154	2290.0	2.7		
	20	160	2210.0	-80.0		
I	21	172	1854.1	-356.0		
	THIRD CLOSED-IN					
I	1	0	1854.1			
	2	1	2185.2	331.1	0.9	2.936
	3	2	2221.7	367.6	2.0	2.609
	4	3	2241.9	387.9	3.0	2.442
	5	4	2251.5	397.5	4.0	2.309
	6	5	2255.2	401.1	5.0	2.218
	7	6	2258.8	404.8	6.0	2.134
	8	7	2261.5	407.4	6.9	2.072
	9	8	2262.2	408.1	8.0	2.011
	10	9	2264.2	410.1	9.0	1.957
	11	10	2269.8	415.7	10.0	1.915
	12	12	2269.8	415.7	11.8	1.841
	13	14	2271.5	417.4	13.8	1.774
	14	16	2272.8	418.7	15.7	1.717
	15	18	2275.1	421.0	17.7	1.666
	16	20	2277.1	423.0	19.5	1.624
	17	22	2278.1	424.0	21.4	1.583
	18	24	2279.8	425.7	23.3	1.546
	19	26	2280.7	426.7	25.2	1.512
	20	28	2280.7	426.7	27.2	1.479
	21	30	2282.1	428.0	29.0	1.451
	22	35	2283.4	429.3	33.6	1.387
	23	40	2284.7	430.7	38.2	1.332
	24	45	2285.4	431.3	42.7	1.283
	25	50	2285.4	431.3	47.1	1.240
	26	55	2287.1	433.0	51.5	1.201
	27	60	2288.0	434.0	55.9	1.166
	28	70	2289.4	435.3	64.5	1.104
	29	80	2290.0	436.0	72.9	1.051
	30	90	2291.4	437.3	81.1	1.004
	31	100	2291.7	437.6	89.1	0.964
	32	110	2291.7	437.6	97.0	0.927
	33	120	2293.4	439.3	104.7	0.893
	34	135	2293.4	439.3	116.0	0.849
	35	150	2293.4	439.3	126.8	0.810
	36	165	2293.7	439.6	137.3	0.776
	37	180	2293.7	439.6	147.6	0.744
	38	195	2293.7	439.6	157.6	0.716
	39	210	2294.7	440.6	167.1	0.690
	40	225	2294.7	440.6	176.6	0.667

	REF	MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
	THIRD CLOSED-IN - CONTINUED					
	41	240	2294.7	440.6	185.6	0.645
	42	260	2294.7	440.6	197.4	0.618
	43	280	2294.7	440.6	208.7	0.594
	44	300	2295.0	440.9	219.7	0.572
	45	320	2295.0	440.9	230.2	0.551
	46	340	2295.3	441.3	240.3	0.533
	47	360	2295.3	441.3	250.1	0.515
J	48	367	2295.0	440.9	253.5	0.510
	FOURTH FLOW					
K	1	0	2112.8			
	2	30	2167.2	54.4		
	3	60	2185.2	17.9		
	4	90	2263.8	78.7		
	5	120	2273.4	9.6		
[5]	6	121	2273.4	0.0		
	7	150	2254.9	-18.6		
[5]	8	156	2253.5	-1.3		
	9	180	2273.1	19.6		
	10	210	2274.8	1.7		
	11	240	2274.8	0.0		
[5]	12	254	2274.8	0.0		
	13	270	2255.5	-19.3		
	14	295	2256.8	1.3		
	15	300	2261.5	4.6		
	16	330	2254.9	-6.6		
	17	360	2253.5	-1.3		
[5]	18	381	2254.2	0.7		
	19	390	2253.5	-0.7		
	20	420	2245.6	-8.0		
	21	450	2234.3	-11.3		
	22	480	2231.3	-3.0		
	23	510	2226.6	-4.6		
	24	540	2225.6	-1.0		
	25	570	2225.6	0.0		
	26	600	2225.6	0.0		
	27	630	2225.6	0.0		
	28	660	2225.6	0.0		
	29	690	2227.3	1.7		
	30	720	2227.3	0.0		
	31	750	2227.3	0.0		
	32	780	2227.3	0.0		
	33	810	2227.6	0.3		
	34	840	2228.6	1.0		
	35	870	2228.6	0.0		
	36	900	2228.6	0.0		
	37	930	2228.6	0.0		
	38	960	2228.6	0.0		
L	39	969	2228.6	0.0		

LEGEND:
[1] STARTED NITROGEN
[2] PERFORATING GUNS FIRED
[3] UNEXPLAINED PRESSURE CHANGE
[4] OPENED AT SURFACE
[5] POSSIBLE CHOKE CHANGE

REMARKS:

TICKET NO: 16395800	HALLIBURTON SERVICES	GAUGE NO: 155
CLOCK NO: 24107 HOUR: 96		DEPTH: 5235.8

FOURTH CLOSED-IN

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
L 1	0	2228.6			
2	1	2246.2	17.6	1.0	3.251
3	2	2249.5	20.9	1.9	2.978
4	3	2251.5	22.9	3.0	2.774
5	4	2253.2	24.6	4.0	2.649
6	5	2254.9	26.2	5.0	2.553
7	6	2256.2	27.5	6.0	2.474
8	7	2257.8	29.2	7.0	2.407
9	8	2258.5	29.9	8.0	2.349
10	9	2260.2	31.5	9.0	2.298
11	10	2261.5	32.9	10.0	2.253
12	12	2262.8	34.2	12.0	2.174
13	14	2263.5	34.9	14.0	2.108
14	16	2266.5	37.8	15.9	2.050
15	18	2267.1	38.5	17.8	2.002
16	20	2268.5	39.8	19.9	1.954
17	22	2269.8	41.2	21.7	1.916
18	24	2271.1	42.5	23.7	1.878
19	26	2272.1	43.5	25.6	1.844
20	28	2273.8	45.1	27.6	1.812
21	30	2274.8	46.1	29.5	1.782
22	35	2275.1	46.5	34.4	1.716
23	40	2275.4	46.8	39.3	1.658
24	45	2277.1	48.5	43.9	1.610
25	50	2278.8	50.1	48.6	1.565
26	55	2280.1	51.4	53.4	1.525
27	60	2282.7	54.1	58.1	1.488
28	70	2285.4	56.8	67.3	1.424
29	80	2286.7	58.1	76.6	1.368
30	90	2289.7	61.1	85.7	1.319
31	100	2292.0	63.4	94.8	1.276
32	110	2293.4	64.7	103.7	1.237
33	120	2294.7	66.1	112.5	1.201
34	135	2295.0	66.4	125.6	1.154
35	150	2299.3	70.7	138.4	1.111
36	165	2299.7	71.0	151.1	1.073
37	180	2299.7	71.0	163.5	1.039
38	195	2300.0	71.4	175.9	1.007
39	210	2297.0	68.4	188.0	0.978
40	225	2300.0	71.4	199.8	0.952
41	240	2301.0	72.4	211.6	0.927
42	260	2301.3	72.7	227.1	0.896
43	280	2301.3	72.7	242.1	0.868
44	300	2301.3	72.7	256.9	0.843
45	320	2301.3	72.7	271.5	0.819
46	340	2301.6	73.0	285.7	0.796
47	360	2302.0	73.3	299.7	0.776
48	380	2302.0	73.3	313.4	0.756
49	400	2302.0	73.3	326.8	0.738
50	420	2302.0	73.3	340.1	0.721

FOURTH CLOSED-IN - CONTINUED

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
51	440	2302.0	73.3	353.1	0.704
52	460	2302.0	73.3	365.9	0.689
53	480	2303.0	74.3	378.4	0.674
54	500	2303.0	74.3	390.8	0.660
55	520	2303.3	74.7	402.9	0.647
56	540	2303.3	74.7	414.8	0.635
57	560	2304.3	75.7	426.4	0.623
58	580	2304.3	75.7	437.9	0.611
59	600	2305.0	76.3	449.3	0.600
60	620	2305.0	76.3	460.4	0.589
61	640	2305.0	76.3	471.3	0.579
M 62	659	2303.3	74.7	481.3	0.570

LEGEND:
1 STARTED NITROGEN
2 PERFORATING GUNS FIRED
3 UNEXPLAINED PRESSURE CHANGE
4 OPENED AT SURFACE
5 POSSIBLE CHOKE CHANGE

REMARKS:

TICKET NO: 16395800	GAUGE NO: 311
CLOCK NO: 18552 HOUR: 48	DEPTH: 5235.8

HALLIBURTON SERVICES

FIRST FLOW

REF	MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
B 1	0.0	58.7			
C 2	6.5	58.7	0.0		

FIRST CLOSED-IN

REF	MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
C 1	0.0	58.7			
2	15.0	64.7	6.0	4.5	0.156
3	30.0	66.9	8.2	5.3	0.085
4	45.0	71.0	12.3	5.7	0.059
5	60.0	74.2	15.5	5.9	0.045
6	75.0	77.4	18.7	6.0	0.036
7	89.9	81.5	22.8	6.1	0.030
8	105.0	83.7	25.0	6.1	0.026
9	120.0	87.2	28.5	6.2	0.023
10	135.0	91.3	32.6	6.2	0.020
11	150.0	93.5	34.8	6.2	0.018
12	165.0	95.4	36.7	6.2	0.017
13	180.0	97.9	39.2	6.3	0.015
14	195.0	101.4	42.7	6.3	0.014
15	210.0	105.8	47.2	6.3	0.013
16	225.0	108.4	49.7	6.3	0.012
17	240.0	110.9	52.2	6.3	0.012
D 18	246.9	111.2	52.5	6.3	0.011

SECOND FLOW

REF	MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
E 1	0.0	58.7			
2	30.0	56.5	-2.2		
3	60.0	56.5	0.0		
[1] 4	83.6	57.4	0.9		
5	90.0	239.1	181.7		
6	120.0	1182.3	943.2		
7	150.0	2109.0	926.7		
[2] 8	160.3	2155.9	46.9		
9	180.0	2184.4	28.6		
10	210.0	2304.0	119.6		
11	240.0	2321.4	17.4		
12	270.0	2327.6	6.2		
13	300.0	2329.5	1.9		
14	330.0	2330.7	1.2		
15	360.0	2332.0	1.2		
[3] 16	363.2	2332.0	0.0		
17	390.0	2349.4	17.4		
18	420.0	2350.0	0.6		
19	450.0	2346.6	-3.4		
20	480.0	2347.5	0.9		
21	510.0	2347.5	0.0		
22	540.0	2347.5	0.0		

SECOND FLOW - CONTINUED

REF	MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
23	570.0	2345.6	-1.9		
24	600.0	2345.6	0.0		
25	630.0	2345.9	0.3		
F 26	640.8	2346.3	0.3		

SECOND CLOSED-IN

REF	MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
F 1	0.0	2346.3			
2	30.0	2347.2	0.9	28.7	1.354
3	60.0	2347.5	1.2	54.9	1.072
4	90.0	2348.1	1.9	79.0	0.914
5	120.0	2349.7	3.4	101.2	0.806
6	150.0	2349.7	3.4	121.8	0.726
7	180.0	2349.7	3.4	140.9	0.662
8	210.0	2349.7	3.4	158.6	0.611
9	240.0	2349.7	3.4	175.1	0.568
10	270.0	2351.2	5.0	190.5	0.531
11	300.0	2351.2	5.0	205.0	0.499
12	330.0	2351.2	5.0	218.6	0.472
13	360.0	2351.2	5.0	231.4	0.447
14	390.0	2352.2	5.9	243.4	0.425
15	420.0	2352.8	6.5	254.7	0.405
16	450.0	2353.1	6.8	265.5	0.387
17	480.0	2354.0	7.8	275.6	0.371
18	510.0	2354.3	8.1	285.3	0.356
19	540.0	2354.6	8.4	294.4	0.342
20	570.0	2355.6	9.3	303.1	0.330
21	600.0	2355.6	9.3	311.4	0.318
22	630.0	2355.0	8.7	319.3	0.307
23	660.0	2355.9	9.6	326.8	0.297
24	690.0	2356.8	10.6	334.0	0.287
25	720.0	2358.7	12.4	340.9	0.279
26	750.0	2359.3	13.1	347.4	0.270
G 27	763.0	2359.3	13.1	350.2	0.267

THIRD FLOW

REF	MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
H 1	0.0	2226.7			
2	5.0	2274.6	48.0		
3	10.0	2296.4	21.8		
4	15.0	2312.0	15.6		
5	20.0	2322.9	10.9		
6	25.0	2329.7	6.9		
7	30.0	2336.9	7.2		
8	35.0	2340.6	3.7		
9	40.0	2346.8	6.2		
10	45.0	2348.1	1.2		
11	50.0	2353.1	5.0		
12	55.0	2354.3	1.2		
[2] 13	59.2	2354.9	0.6		

LEGEND:
[1] STARTED NITROGEN
[2] PERFORATING GUNS FIRED
[3] UNEXPLAINED PRESSURE CHANGE
[4] OPENED AT SURFACE
[5] CHART TIME EXPIRED

REMARKS:

TICKET NO: 16395800	
CLOCK NO: 18552	HOUR: 48

HALLIBURTON
SERVICES

GAUGE NO: 311
DEPTH: 5235.8

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
THIRD FLOW - CONTINUED					
14	60.0	2354.9	0.0		
15	80.0	2355.6	0.6		
16	100.0	2355.9	0.3		
17	120.0	2356.8	0.9		
18	140.0	2357.4	0.6		
[4] 19	154.4	2363.7	6.2		
20	160.0	2231.3	-132.3		
I 21	172.1	1890.9	-340.5		

THIRD CLOSED-IN

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
I 1	0.0	1890.9			
2	1.0	2280.9	390.0	1.0	2.910
3	2.0	2303.3	412.4	2.0	2.623
4	3.0	2315.1	424.2	3.0	2.434
5	4.0	2321.6	430.8	4.0	2.316
6	5.0	2327.2	436.4	5.0	2.213
7	6.0	2331.9	441.0	6.0	2.139
8	7.0	2334.4	443.5	6.9	2.072
9	8.0	2337.5	446.6	7.9	2.017
10	9.0	2339.1	448.2	8.9	1.966
11	10.0	2341.9	451.0	9.9	1.920
12	12.0	2345.0	454.1	11.8	1.841
13	14.0	2346.8	456.0	13.8	1.775
14	16.0	2348.1	457.2	15.7	1.719
15	18.0	2349.3	458.5	17.6	1.668
16	20.0	2349.3	458.5	19.5	1.623
17	22.0	2349.3	458.5	21.4	1.583
18	24.0	2350.9	460.0	23.3	1.546
19	26.0	2351.8	461.0	25.2	1.512
20	28.0	2352.8	461.9	27.1	1.481
21	30.0	2354.3	463.4	28.9	1.452
22	35.0	2355.6	464.7	33.5	1.388
23	40.0	2357.7	466.9	38.1	1.332
24	45.0	2357.7	466.9	42.6	1.284
25	50.0	2357.7	466.9	47.2	1.240
26	55.0	2359.0	468.1	51.6	1.201
27	60.0	2360.5	469.7	55.9	1.166
28	70.0	2361.2	470.3	64.5	1.104
29	80.0	2362.4	471.5	72.9	1.051
30	90.0	2363.0	472.2	81.1	1.004
31	100.0	2364.0	473.1	89.1	0.964
32	110.0	2365.2	474.3	97.0	0.927
33	120.0	2363.6	472.8	104.6	0.894
[5] 34	123.0	2363.6	472.8	107.0	0.884
J 35	NO DATA FOR THIS POINT				

FOURTH FLOW

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
K 1	NO DATA FOR THIS POINT				
FOURTH FLOW - CONTINUED					
L 2	NO DATA FOR THIS POINT				

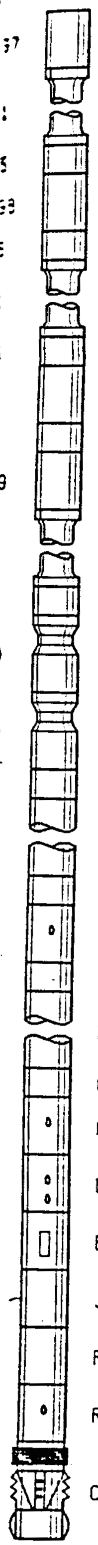
FOURTH CLOSED-IN

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
L 1	NO DATA FOR THIS POINT				
M 2	NO DATA FOR THIS POINT				

LEGEND:
[1] STARTED NITROGEN
[2] PERFORATING GUNS FIRED
[3] UNEXPLAINED PRESSURE CHANGE
[4] OPENED AT SURFACE
[5] CHART TIME EXPIRED

REMARKS:

TICKET NO. 16395800



		O.D.	I.D.	LENGTH	DEPTH
37	HOWCO TEST HEAD.................		2.680		
1	DRILL PIPE......................	5.000	2.680		
5	CROSSOVER.......................				
33	SUB SEA LUBRICATOR VALVE........				
5	CROSSOVER.......................				
1	DRILL PIPE......................	5.000	2.680		
5	CROSSOVER.......................				
5	SUB-SEA TEST TREE...............				
5	CROSSOVER.......................		4.280	1.4	
39	BOTTOM OF LANDING STRING........				165.8
1	DRILL PIPE......................	5.000	4.276	4571.4	
5	CROSSOVER.......................	5.825	2.625	1.0	
10	SLIP JOINT......................	5.000	2.250	18.2	
10	SLIP JOINT......................	5.000	2.250	13.2	
5	CROSSOVER.......................	5.750	2.750	0.7	
3	DRILL COLLARS...................	6.500	2.750	307.9	
5	CROSSOVER.......................	6.000	2.625	0.7	
51	PUMP OUT REVERSING SUB..........	5.000	2.250	0.9	5079.1
5	CROSSOVER.......................	6.000	2.625	1.0	
3	DRILL COLLARS...................	6.500	2.750	91.2	
5	CROSSOVER.......................	6.000	2.750	0.9	
55	APR-M2 SAMPLER CIRCULATING VALVE	5.000	2.250	11.3	5184.1
67	LPR-N TESTER VALVE..............	5.000	2.250	16.4	5200.5
84	BUNDLE CARRIER..................	5.325	2.250	7.9	5208.4 (Gauges -3)
15	JAR.............................	4.625	2.250	5.2	
35	RTTS SAFETY JOINT...............	4.870	2.440	3.3	
56	RTTS CIRCULATING VALVE..........	6.500	2.400	3.6	5220.4
71	CASING PACKER...................	8.250	3.750	6.5	5224.0

CONTINUED

EQUIPMENT DATA

TICKET NO. 16395800

		O.D.	I.D.	LENGTH	DEPTH
5	CROSSOVER........................	6.000	2.750	0.9	
84	BUNDLE CARRIER...................	5.325	2.250	7.9	5235.8 (Gauges -2)
5	CROSSOVER........................	5.825	3.000	1.1	
21	PERFORATED TAIL PIPE.............	2.825	2.500	21.1	

= Perfs in Casing

TOTAL DEPTH 5560

Received
OCS District Office

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Minerals Management Service
Anchorage, Alaska

EQUIPMENT DATA

EQUATIONS FOR DST LIQUID WELL ANALYSIS

Transmissibility	$\frac{kh}{\mu} = \frac{162.6\ QB}{m}$	$\frac{md\text{-}ft}{cp}$
Indicated Flow Capacity	$kh = \frac{kh}{\mu}\mu$	md-ft
Average Effective Permeability	$k = \frac{kh}{h}$	md
Skin Factor	$S = 1.151 \left[\frac{P^{*} - P_f}{m} - LOG\left(\frac{k(t/60}{\phi\ \mu\ c_t r_w^2}\right) + 3.23 \right]$	—
Damage Ratio	$DR = \frac{P^{*} - P_f}{P^{*} - P_f - 0.87\ mS}$	—
Theoretical Potential w/ Damage Removed	$Q_1 = Q\ DR$	BPD
Approx. Radius of Investigation	$r_i = 0.032 \sqrt{\frac{k(t/60)}{\phi \mu c_t}}$	ft

EQUATIONS FOR DST GAS WELL ANALYSIS

Indicated Flow Capacity	$kh = \frac{1637\ Q_g\ T}{m}$	md-ft
Average Effective Permeability	$k = \frac{kh}{h}$	md
Skin Factor	$S = 1.151 \left[\frac{m(P^{*}) - m(P_f)}{m} - LOG\left(\frac{k(t/60)}{\phi\ \mu\ c_t r_w^2}\right) + 3.23 \right]$	—
Damage Ratio	$DR = \frac{m(P^{*}) - m(P_f)}{m(P^{*}) - m(P_f) - 0.87\ mS}$	—
Indicated Flow Rate (Maximum)	$AOF_1 = \frac{Q_g\ m(P^{*})}{m(P^{*}) - m(P_f)}$	MCFD
Indicated Flow Rate (Minimum)	$AOF_2 = Q_g \sqrt{\frac{m(P^{*})}{m(P^{*}) - m(P_f)}}$	MCFD
Approx. Radius of Investigation	$r_i = 0.032 \sqrt{\frac{k(t/60)}{\phi \mu c_t}}$	ft

Perfs 5300 - 5315

FORMATION TESTING SERVICE REPORT

FOR GOVERNMENT USE ONLY

Received
OCS District Office

NOV 15 1985

Minerals Management Service
Anchorage, Alaska

Duplicate - [illegible]

HAMMERHEAD
LEASE NAME

1
WELL NO.

2-B
TEST NO.

TESTED INTERVAL

UNION OIL COMPANY OF CALIFORNIA
LEASE OWNER/COMPANY NAME

HALLIBURTON
SERVICES

Duncan, Oklahoma 73536
A Halliburton Company

5B

HALLIBURTON SERVICES

TICKET NO. 16485600
02-OCT-85
ANCHORAGE

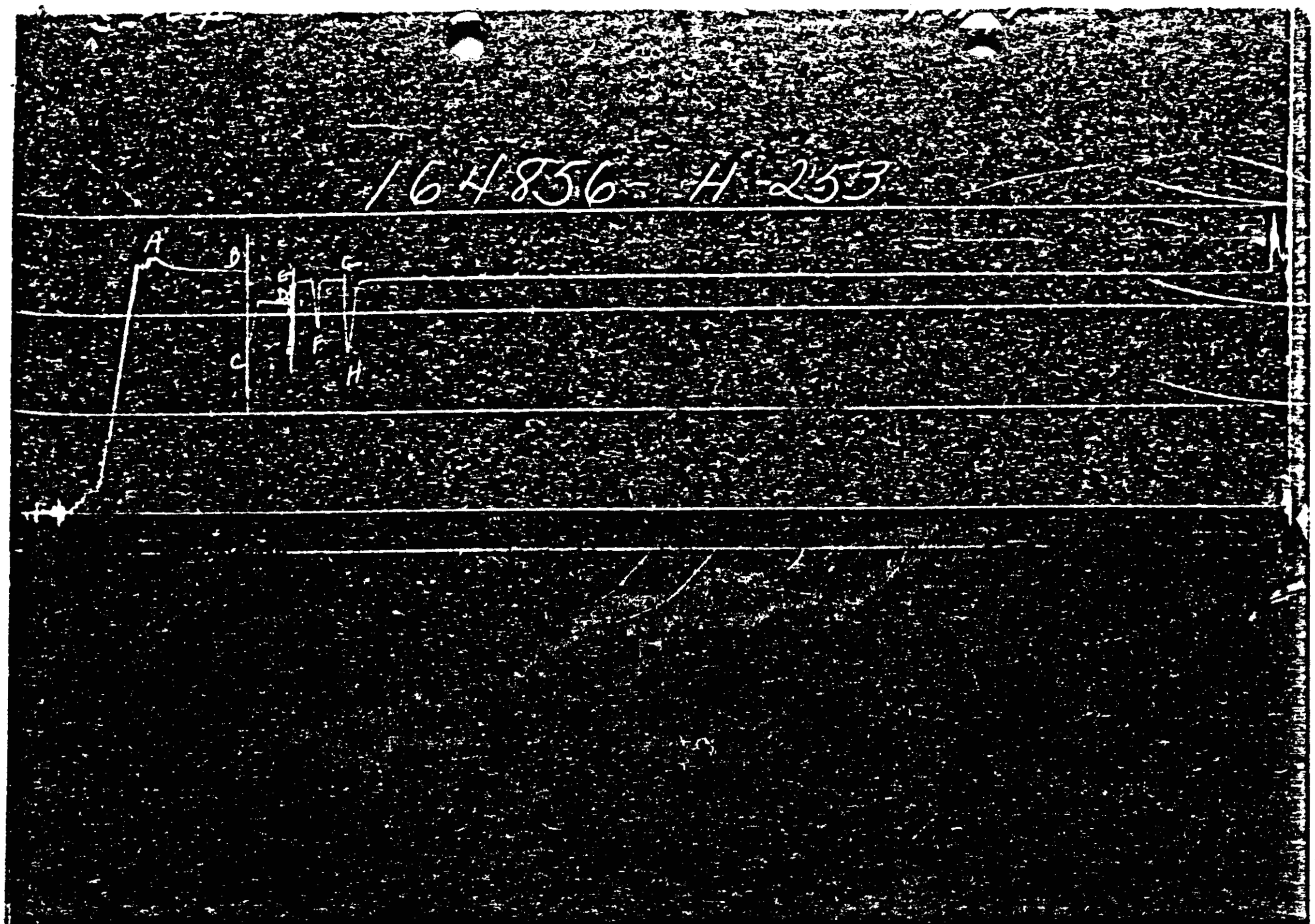
Received
OCS District Office

NOV 15 1985

Minerals Management Service
Anchorage, Alaska

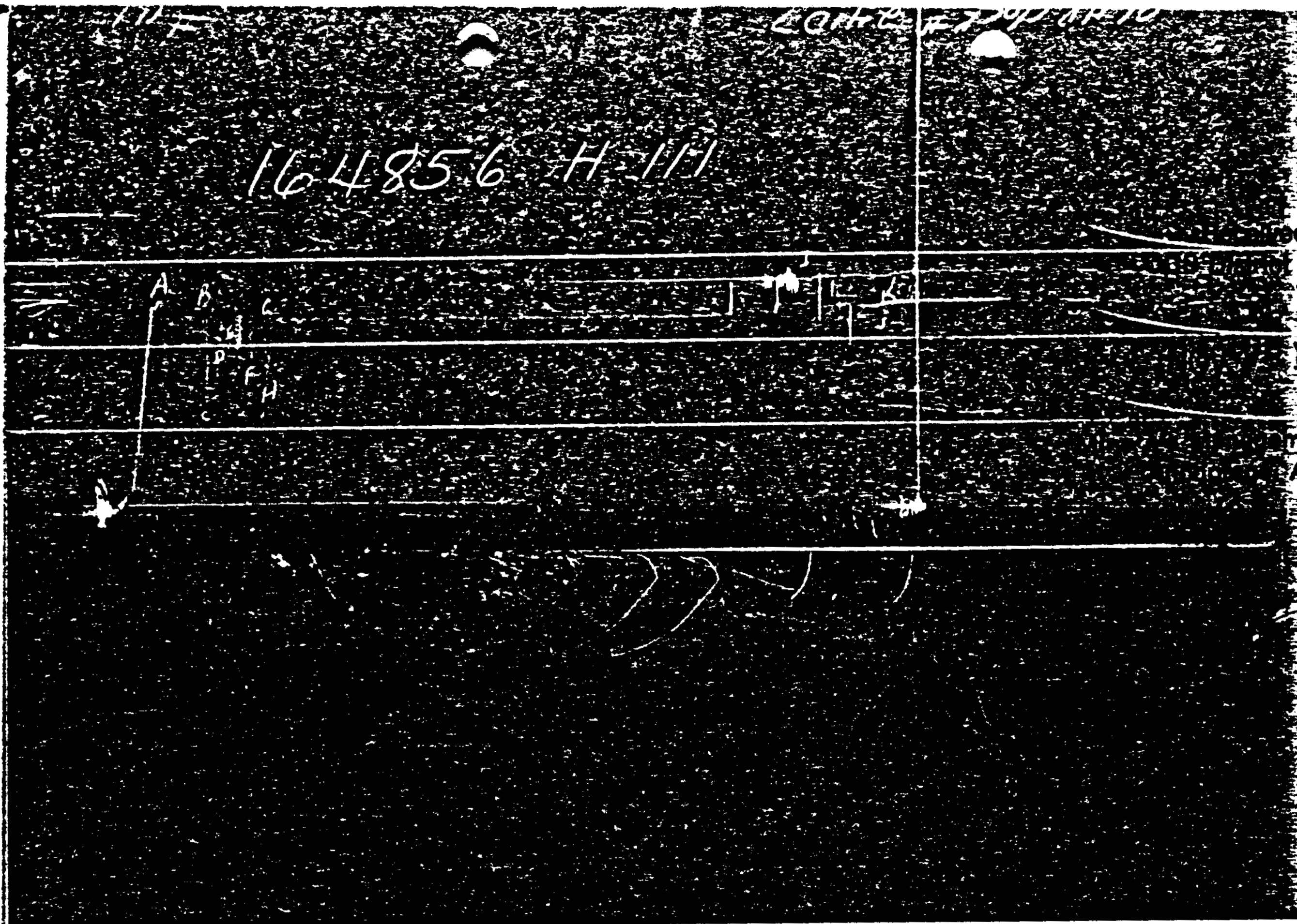
FORMATION TESTING SERVICE REPORT

LEASE NAME	HAMMERHEAD
WELL NO.	1
TEST NO.	2-B
TESTED INTERVAL	
LEASE OWNER/COMPANY NAME	UNION OIL COMPANY OF CALIFORNIA
LEGAL LOCATION SEC. - TWP. - RNG.	
FIELD AREA	ARCTIC OCEAN
COUNTY	BEAUFORT SEA
STATE	ALASKA SM



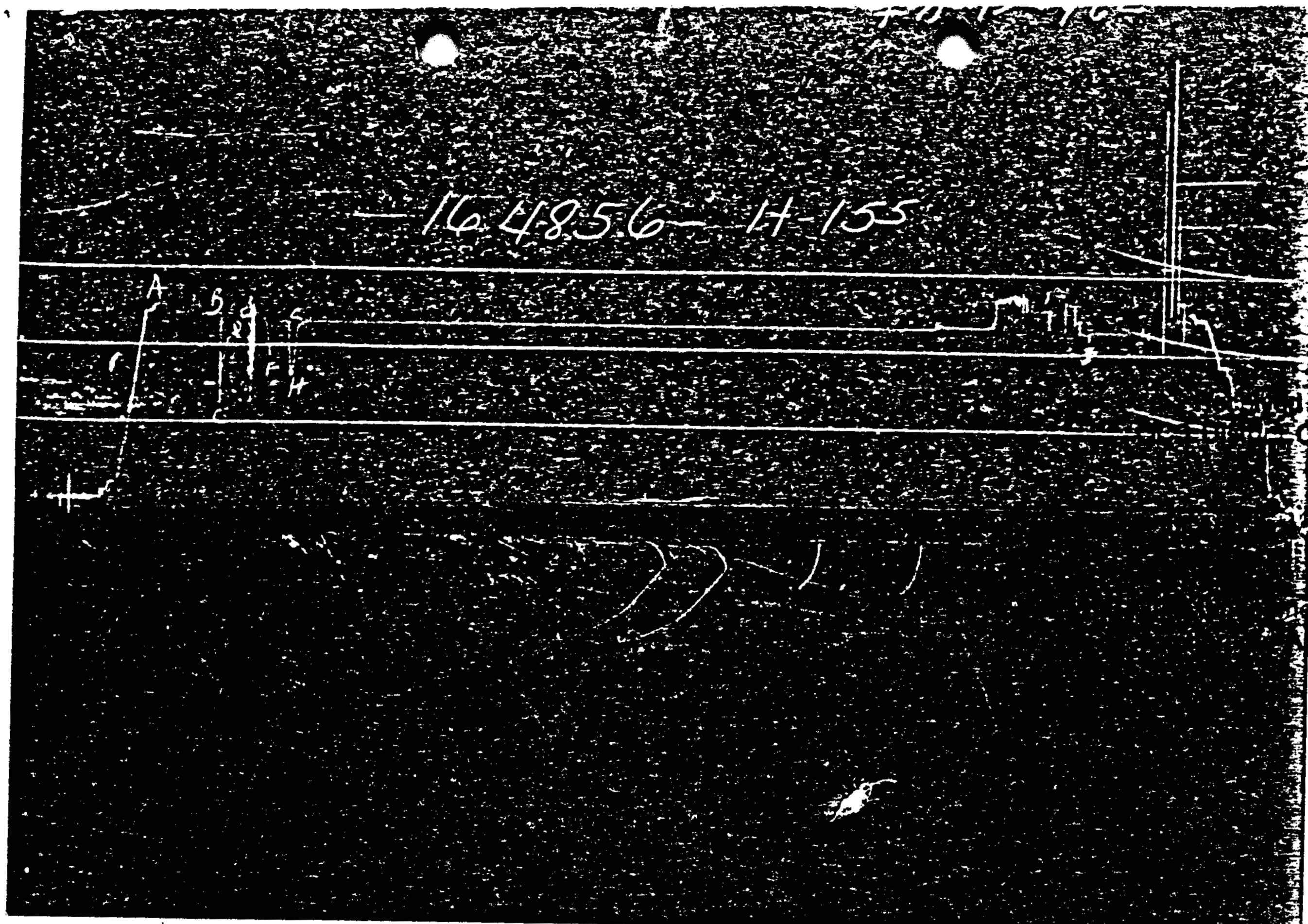
GAUGE NO: 253 DEPTH: 5177.8 BLANKED OFF: NO HOUR OF CLOCK: 48

ID	DESCRIPTION	PRESSURE REPORTED	PRESSURE CALCULATED	TIME REPORTED	TIME CALCULATED	TYPE
A	INITIAL HYDROSTATIC		2576.0			
B	END OF BLEED OFF		2450.5			
C	MINIMUM PRESSURE RELEASE		1673.3			
D	PSI BEFORE PERFORATING		2120.5			
E	INITIAL FIRST FLOW		2209.4	60.0	58.2	F
F	FINAL FIRST FLOW		1863.7			
F	INITIAL FIRST CLOSED-IN		1863.7	60.0	59.7	C
G	FINAL FIRST CLOSED-IN		2351.9			
H	INITIAL SECOND FLOW		1603.7	2546.0		F
I	FINAL SECOND FLOW					
I	INITIAL SECOND CLOSED-IN			369.0		C
J	FINAL SECOND CLOSED-IN					
K	INITIAL THIRD FLOW			617.0		F
L	FINAL THIRD FLOW					
L	INITIAL THIRD CLOSED-IN			625.0		C
M	FINAL THIRD CLOSED-IN					
N	INITIAL FOURTH FLOW			61.0		F
O	FINAL FOURTH FLOW					
O	INITIAL FOURTH CLOSED-IN			188.0		C
P	FINAL FOURTH CLOSED-IN					
Q	FINAL HYDROSTATIC					



GAUGE NO: 111 DEPTH: 5209.8 BLANKED OFF: NO HOUR OF CLOCK: 96

ID	DESCRIPTION	PRESSURE REPORTED	PRESSURE CALCULATED	TIME REPORTED	TIME CALCULATED	TYPE
A	INITIAL HYDROSTATIC		2539.7			
B	END OF BLEED OFF		2421.9			
C	MINIMUM PRESSURE RELEASE		1661.8			
D	PSI BEFORE PERFORATING		2091.1			
E	INITIAL FIRST FLOW		2211.5	60	58	F
F	FINAL FIRST FLOW		1842.1			
F	INITIAL FIRST CLOSED-IN		1842.1	60	60	C
G	FINAL FIRST CLOSED-IN		2311.8			
H	INITIAL SECOND FLOW		1576.4	2546	2542	F
I	FINAL SECOND FLOW		2590.9			
I	INITIAL SECOND CLOSED-IN		2590.9	369	369	C
J	FINAL SECOND CLOSED-IN		2292.4			
K	INITIAL THIRD FLOW		2376.4	617		F
L	FINAL THIRD FLOW					
L	INITIAL THIRD CLOSED-IN			625		C
M	FINAL THIRD CLOSED-IN					
N	INITIAL FOURTH FLOW			61		F
O	FINAL FOURTH FLOW					
O	INITIAL FOURTH CLOSED-IN			188		C
P	FINAL FOURTH CLOSED-IN					
Q	FINAL HYDROSTATIC					



GAUGE NO: 155 DEPTH: 5209.8 BLANKED OFF: NO HOUR OF CLOCK: 72

ID	DESCRIPTION	PRESSURE REPORTED	PRESSURE CALCULATED	TIME REPORTED	TIME CALCULATED	TYPE
A	INITIAL HYDROSTATIC		2514.9			
B	END OF BLEEDOFF		2416.0			
C	MINIMUM PRESSURE RELEASE		1633.2			
D	PSI BEFORE PERFORATING		2087.0			
E	INITIAL FIRST FLOW		2168.3	60	58	F
F	FINAL FIRST FLOW		1862.6			
F	INITIAL FIRST CLOSED-IN		1862.6	60	60	C
G	FINAL FIRST CLOSED-IN		2310.9			
H	INITIAL SECOND FLOW		1602.7	2546	2542	F
I	FINAL SECOND FLOW		2584.4			
I	INITIAL SECOND CLOSED-IN		2584.4	369		C
J	FINAL SECOND CLOSED-IN					
K	INITIAL THIRD FLOW			617		F
L	FINAL THIRD FLOW					
L	INITIAL THIRD CLOSED-IN			625		C
M	FINAL THIRD CLOSED-IN					
N	INITIAL FOURTH FLOW			61		F
O	FINAL FOURTH FLOW					
O	INITIAL FOURTH CLOSED-IN			188		C
P	FINAL FOURTH CLOSED-IN					
Q	FINAL HYDROSTATIC					

GAUGE NO: 206 DEPTH: 5209.8 BLANKED OFF: NO HOUR OF CLOCK: 48

ID	DESCRIPTION	PRESSURE REPORTED	PRESSURE CALCULATED	TIME REPORTED	TIME CALCULATED	TYPE
A	INITIAL HYDROSTATIC		2577.7			
B	END OF BLEEDOFF		2456.6			
C	MINIMUM PRESSURE RELEASE		1680.6			
D	PSI BEFORE PERFORATING		2126.3			
E	INITIAL FIRST FLOW		2233.3	60.0	58.2	F
F	FINAL FIRST FLOW		1871.0			
F	INITIAL FIRST CLOSED-IN		1871.0	60.0	59.7	C
G	FINAL FIRST CLOSED-IN		2347.6			
H	INITIAL SECOND FLOW		1616.2	2546.0		F
I	FINAL SECOND FLOW					
I	INITIAL SECOND CLOSED-IN			369.0		C
J	FINAL SECOND CLOSED-IN					
K	INITIAL THIRD FLOW			617.0		F
L	FINAL THIRD FLOW					
L	INITIAL THIRD CLOSED-IN			625.0		C
M	FINAL THIRD CLOSED-IN					
N	INITIAL FOURTH FLOW			61.0		F
O	FINAL FOURTH FLOW					
O	INITIAL FOURTH CLOSED-IN			188.0		C
P	FINAL FOURTH CLOSED-IN					
Q	FINAL HYDROSTATIC					

EQUIPMENT & HOLE DATA

FORMATION TESTED: ______

NET PAY (ft): ______

GROSS TESTED FOOTAGE: ______

ALL DEPTHS MEASURED FROM: [redacted]

CASING PERFS. (ft): ______

HOLE OR CASING SIZE (in): [redacted]

ELEVATION (ft): [redacted]

TOTAL DEPTH (ft): ______

PACKER DEPTH(S) (ft): [redacted]

FINAL SURFACE CHOKE (in): ______

BOTTOM HOLE CHOKE (in): ______

MUD WEIGHT (lb/gal): 9.20

MUD VISCOSITY (sec): BRINE

ESTIMATED HOLE TEMP. (°F): 100

ACTUAL HOLE TEMP. (°F): ____ @ ______ ft

TICKET NUMBER: 16485600

DATE: 9-14-85 TEST NO: 2-B

TYPE DST: [redacted]

HALLIBURTON CAMP: ANCHORAGE

TESTER: J. MENKE-BURMEISTER
J. MAC ARTHUR

WITNESS: JEFF TINSER (UNOCAL)

DRILLING CONTRACTOR: CANMAR "EXPLORER II"

FLUID PROPERTIES FOR RECOVERED MUD & WATER

SOURCE	RESISTIVITY	CHLORIDES
	@ °F	ppm
	@ °F	ppm
	@ °F	ppm
	@ °F	ppm
	@ °F	ppm
	@ °F	ppm

SAMPLER DATA

Psig AT SURFACE: ______

cu.ft. OF GAS: ______

cc OF OIL: ______

cc OF WATER: ______

cc OF MUD: ______

TOTAL LIQUID cc: ______

HYDROCARBON PROPERTIES

OIL GRAVITY (°API): ______ @ ____ °F

GAS/OIL RATIO (cu.ft. per bbl): ______

GAS GRAVITY: ______

CUSHION DATA

TYPE	AMOUNT	WEIGHT
NITROGEN (PSI)	800.0	

RECOVERED:

NOTE: THIS IS A "TIGHT HOLE", COMPLETE WELL AND TEST DATA WAS NOT MADE AVAILABLE TO HALLIBURTON.

MEASURED FROM TESTER VALVE

REMARKS:

IN ADDITION TO THE EIGHT RPG-3 PRESSURE GAUGES AND ONE RT-7 TEMPERATURE GAUGE REPORTED IN THIS DOCUMENT, THERE WERE THREE GRC-EMR GAUGES RUN ON THIS TEST.

THERE WAS INSUFFICIENT DEFLECTION ON THE CHART FROM RT-7 TEMPERATURE GAUGE FOR AN ACCURATE MEASUREMENT; VALUE SHOWN WAS ESTIMATED.

SEE NEXT PAGE FOR ADDITIONAL REMARKS.....

TYPE & SIZE MEASURING DEVICE: ______ TICKET NO: 16485600

TIME	CHOKE SIZE	SURFACE PRESSURE PSI	GAS RATE MCF	LIQUID RATE BPD	REMARKS
					ADDITIONAL REMARKS:
					ALL READINGS ON H-207 SHOULD
					BE CONSIDERED QUESTIONABLE...
					GAUGE RIDING THE BRIDGE.
					PRODUCTION TEST DATA:
9-12-85					
1845					PICKED UP AND MADE UP TEST
					TOOLS
1925					MADE UP SLIP JOINTS AND RAN
					IN HOLE
2045					MADE UP OTIS SUB SEA TEST TREE
2055					LAND OUT, SPACE OUT
2058					SET RTTS AND RIGGED UP SURFACE
					EQUIPMENT
2242					STARTED PRESSURING WITH
					NITROGEN TO TEST SURFACE
					EQUIPMENT AND SWS EQUIPMENT
					PRESSURED DRILL PIPE TO 1450
					PSI WITH NITROGEN
9-13-85					
0050					PRESSURED UP ON ANNULUS TO
					1300 PSI TO OPEN LPR-N
					HAD 800 PSI NITROGEN ON DRILL
					PIPE
0106					RAN IN HOLE WITH SWS TO
					PERFORATE
0238					PERFORATE TEST INTERVAL AND
					PULLED OUT OF HOLE
0305					GUNS TO THE SURFACE, CLOSED
					SWAB VALVE
0323				First Flow	OPENED CHOKE MANIFOLD
0338					BLED OFF ANNULUS AND CLOSED
				First Shut In	LPR-N
0438				2nd Flow	OPENED LPR-N WITH 1450 PSI
0450					GAS BUBBLE TO SURFACE
0500					FLOWED WELL, NO FLUID TO

TYPE & SIZE MEASURING DEVICE:					TICKET NO: 16485600
TIME	CHOKE SIZE	SURFACE PRESSURE PSI	GAS RATE MCF	LIQUID RATE BPD	REMARKS
					SURFACE
0800					RAN IN HOLE WITH SWS AND HP
					GAUGES ON WIRELINE. COULD NOT
					REACH BOTTOM. WELL APPARENTLY
					SANDED OFF. LPR-N OPENED
					STOOD BY FOR COILED TUBING UNIT
1950					SHUT IN WELL AT SURFACE end good dill on Flow #2
					STOOD BY FOR COILED TUBING well Sanded up
					UNIT....
					UNIT ARRIVED. UNLOADED AND
					RIGGED UP. PRESSURE TESTED
					AND RAN IN HOLE
9-14-85					
2026					COILED TUBING TAGGED SAND AND
					WASH DOWN THRU SAND TO DEPTH
2228					CLOSED IN AT CHOKE MANIFOLD
2304					BLED OFF ANNULUS. CLOSED LPR-N End Second Flow
2310					TAGGED BALL (LPR-N) WITH
					COILED TUBING
					GAS LIFTED CUSHION 2nd
9-15-85					Shut In
0456					PRESSURED DRILL PIPE WITH
					NITROGEN
0513					PRESSURED ANNULUS. OPENED 3d Flow
					LPR-N
0521					OPENED AT CHOKE MANIFOLD
0828					FLUID TO THE SURFACE
0830					PUMPED NITROGEN AT 1000'
					FLOWED WELL
1530					BLED ANNULUS. CLOSED LPR-N 3d SHUT IN
9-16-85					
0155					PRESSURED ANNULUS. OPENED 4th Flow
					LPR-N. 1300 PSI.
0200					TESTED LINES. 3500 PSI
0215					OPENED FLOW HEAD. ATTEMPTED
					TO INJECT DRILL PIPE VOLUME
					INTO FORMATION

TYPE & SIZE MEASURING DEVICE: ______ TICKET NO: 16485600

TIME	CHOKE SIZE	SURFACE PRESSURE PSI	GAS RATE MCF	LIQUID RATE BPD	REMARKS
0256					SHEARED APR-M2 AT 2250 PSI
					REVERSED OUT
0604					UNSEATED RTTS AND PULLED OUT
					OF THE HOLE
					26 STANDS OUT OF HOLE
0909					SET RTTS, HANG OFF IN WELLHEAD
					PULLED LANDING STRING, RISER &
					STACK BECAUSE OF ICE FLOW.

Received
OCS District Office

NOV 15 1985

Minerals Management Service
Anchorage, Alaska

TICKET NO: 16485600	HALLIBURTON SERVICES	GAUGE NO: 253
CLOCK NO: 22457 HOUR: 48		DEPTH: 5177.8

FIRST FLOW

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
E	1	0.0	2209.4			
	2	5.0	2316.9	107.5		
	3	10.0	2334.1	17.3		
	4	15.0	2338.8	4.7		
	5	20.0	2342.2	3.4		
	6	25.0	2342.8	0.5		
	7	30.0	2344.6	1.8		
	8	35.0	2344.6	0.0		
	9	40.0	2344.6	0.0		
[1]	10	43.5	2344.6	0.0		
	11	45.0	2256.3	-88.3		
	12	50.0	2088.8	-167.5		
	13	55.0	1899.4	-189.4		
F	14	58.2	1863.7	-35.8		

FIRST CLOSED-IN

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
F	1	0.0	1863.7			
	2	1.0	2273.4	409.8	1.0	1.773
	3	2.0	2301.4	437.8	1.9	1.479
	4	3.0	2316.9	453.2	2.9	1.310
	5	4.0	2323.1	459.5	3.7	1.192
	6	5.0	2329.7	466.0	4.6	1.102
	7	6.0	2333.3	469.7	5.4	1.030
	8	7.0	2334.9	471.2	6.2	0.970
	9	8.0	2337.0	473.3	7.0	0.918
	10	9.0	2338.8	475.2	7.8	0.874
	11	10.0	2339.6	476.0	8.5	0.834
	12	12.0	2341.7	478.0	9.9	0.768
	13	14.0	2343.8	480.1	11.3	0.713
	14	16.0	2346.2	482.5	12.5	0.667
	15	18.0	2346.9	483.3	13.7	0.627
	16	20.0	2347.7	484.1	14.9	0.593
	17	22.0	2347.7	484.1	16.0	0.561
	18	24.0	2347.7	484.1	17.0	0.534
	19	26.0	2347.7	484.1	18.0	0.511
	20	28.0	2347.7	484.1	18.9	0.488
	21	30.0	2347.7	484.1	19.8	0.468
	22	35.0	2347.7	484.1	21.9	0.426
	23	40.0	2349.3	485.6	23.7	0.390
	24	45.0	2349.6	485.9	25.4	0.361
	25	50.0	2349.6	485.9	26.9	0.336
	26	55.0	2349.6	485.9	28.3	0.314
G	27	59.7	2351.9	488.3	29.5	0.296

SECOND FLOW

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
H	1	0.0	1603.7			
	2	60.0	2342.5	738.8		

SECOND FLOW - CONTINUED

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
	3	120.0	2347.0	4.4		
	4	180.0	2347.2	0.3		
	5	240.0	2347.2	0.0		
	6	300.0	2347.2	0.0		
	7	360.0	2345.7	-1.6		
	8	420.0	2345.7	0.0		
	9	480.0	2347.0	1.3		
	10	540.0	2347.0	0.0		
	11	600.0	2347.0	0.0		
	12	660.0	2346.7	-0.3		
	13	720.0	2346.5	-0.3		
	14	780.0	2346.5	0.0		
	15	840.0	2346.5	0.0		
	16	900.0	2346.5	0.0		
	17	960.0	2346.5	0.0		
	18	1020.0	2345.7	-0.8		
	19	1080.0	2345.4	-0.3		
	20	1140.0	2345.7	0.3		
	21	1200.0	2345.4	-0.3		
	22	1260.0	2344.9	-0.5		
	23	1320.0	2344.9	0.0		
	24	1380.0	2345.4	0.5		
	25	1440.0	2345.4	0.0		
	26	1500.0	2345.4	0.0		
	27	1560.0	2345.4	0.0		
	28	1620.0	2345.4	0.0		
	29	1680.0	2345.4	0.0		
	30	1740.0	2345.4	0.0		
	31	1800.0	2345.4	0.0		
	32	1860.0	2345.1	-0.3		
	33	1920.0	2345.1	0.0		
	34	1980.0	2345.1	0.0		
	35	2040.0	2345.4	0.3		
	36	2100.0	2348.0	2.6		
	37	2160.0	2353.3	5.2		
[2]	38	2174.8	2373.9	20.7		
I	39	NO DATA FOR THIS POINT				

SECOND CLOSED-IN

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
I	1	NO DATA FOR THIS POINT				
J	2	NO DATA FOR THIS POINT				

THIRD FLOW

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
K	1	NO DATA FOR THIS POINT				
L	2	NO DATA FOR THIS POINT				

LEGEND:
[1] OPENED AT SURFACE [2] BEGIN PUMPING

REMARKS:
CHART TIME EXPIRED WHILE PUMPING

TICKET NO: 16485600

CLOCK NO: 22457 HOUR: 48

HALLIBURTON
SERVICES

GAUGE NO: 253

DEPTH: 5177.8

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
		THIRD CLOSED-IN			
L	1	NO DATA FOR THIS POINT			
M	2	NO DATA FOR THIS POINT			
		FOURTH FLOW			
N	1	NO DATA FOR THIS POINT			
O	2	NO DATA FOR THIS POINT			
		FOURTH CLOSED-IN			
O	1	NO DATA FOR THIS POINT			
P	2	NO DATA FOR THIS POINT			

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$

LEGEND:
[1] OPENED AT SURFACE [2] BEGIN PUMPING

REMARKS:
CHART TIME EXPIRED WHILE PUMPING

TICKET NO: 16485600	GAUGE NO: 207
CLOCK NO: 22756 HOUR: 96	DEPTH: 5177.8

HALLIBURTON SERVICES

FIRST FLOW

Marker	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
E	1	0	2251.2			
	2	5	2309.3	58.1		
	3	10	2322.4	13.1		
	4	15	2326.3	3.9		
	5	20	2326.5	0.2		
	6	25	2327.8	1.3		
	7	30	2328.2	0.4		
	8	35	2328.4	0.2		
	9	40	2329.3	0.9		
[1]	10	44	2330.8	1.5		
	11	45	2249.2	-81.6		
	12	50	2072.2	-177.0		
	13	55	1891.5	-180.7		
F	14	58	1860.6	-30.9		

FIRST FLOW

FIRST CLOSED-IN

Marker	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
F	1	0	1860.6			
	2	1	2273.7	413.2	0.9	1.792
	3	2	2299.9	439.4	2.0	1.473
	4	3	2309.6	449.0	2.8	1.312
	5	4	2315.8	455.2	3.8	1.186
	6	5	2319.4	458.9	4.6	1.101
	7	6	2321.1	460.6	5.4	1.032
	8	7	2323.1	462.5	6.3	0.967
	9	8	2324.1	463.6	7.1	0.913
	10	9	2325.0	464.4	7.8	0.875
	11	10	2326.5	465.9	8.6	0.833
	12	12	2328.6	468.1	10.0	0.766
	13	14	2329.9	469.4	11.3	0.711
	14	16	2331.9	471.3	12.5	0.667
	15	18	2333.1	472.6	13.8	0.627
	16	20	2333.6	473.0	14.9	0.592
	17	22	2333.6	473.0	16.0	0.561
	18	24	2333.6	473.0	17.1	0.533
	19	26	2333.6	473.0	18.0	0.510
	20	28	2333.6	473.0	18.9	0.488
	21	30	2333.8	473.2	19.8	0.468
	22	35	2334.4	473.9	21.9	0.426
	23	40	2335.1	474.5	23.7	0.390
	24	45	2335.7	475.2	25.4	0.361
	25	50	2336.1	475.6	26.9	0.335
	26	55	2336.1	475.6	28.3	0.314
G	27	60	2335.5	475.0	29.5	0.296

SECOND FLOW

Marker	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
H	1	0	1599.1			
	2	60	2334.3	735.1		

SECOND FLOW - CONTINUED

Marker	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
	3	120	2334.3	0.0		
	4	180	2334.9	0.6		
	5	240	2335.3	0.4		
	6	300	2334.5	-0.9		
	7	360	2334.5	0.0		
	8	420	2334.5	0.0		
	9	480	2334.5	0.0		
	10	540	2334.5	0.0		
	11	600	2334.5	0.0		
	12	660	2334.5	0.0		
	13	720	2334.5	0.0		
	14	780	2334.5	0.0		
	15	840	2334.5	0.0		
	16	900	2334.5	0.0		
	17	960	2334.5	0.0		
	18	1020	2334.5	0.0		
	19	1080	2334.5	0.0		
	20	1140	2334.0	-0.4		
	21	1200	2334.0	0.0		
	22	1260	2334.0	0.0		
	23	1320	2334.0	0.0		
	24	1380	2334.0	0.0		
	25	1440	2334.0	0.0		
	26	1500	2334.0	0.0		
	27	1560	2334.0	0.0		
	28	1620	2334.0	0.0		
	29	1680	2334.0	0.0		
	30	1740	2334.0	0.0		
	31	1800	2334.0	0.0		
	32	1860	2334.0	0.0		
	33	1920	2334.0	0.0		
	34	1980	2333.8	-0.2		
	35	2040	2333.8	0.0		
	36	2100	2341.3	7.5		
	37	2160	2348.0	6.6		
[2]	38	2175	2370.5	22.5		
I	39	2542	2637.0	266.5		

SECOND CLOSED-IN

Marker	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
I	1	0	2637.0			
	2	30	2587.6	-49.4	29.7	1.942
	3	60	2357.2	-279.8	58.7	1.647
	4	90	2346.2	-290.8	87.0	1.476
	5	120	2709.6	72.6	114.7	1.356
	6	150	2433.2	-203.8	141.9	1.263
	7	180	2290.0	-347.0	168.3	1.189
	8	210	2333.0	-304.0	194.3	1.127
	9	240	2333.0	-304.0	219.8	1.073
	10	270	2334.2	-302.7	244.7	1.026
	11	300	2334.2	-302.7	268.9	0.985
	12	330	2334.2	-302.7	293.0	0.948

LEGEND:
[1] OPENED AT SURFACE [2] BEGIN PUMPING

REMARKS:
1) [redacted]. 2) POINTS P & Q ARE QUESTIONABLE DUE TO OVERPRESSURING BY PUMPING.

TICKET NO: 16485600	GAUGE NO: 207
CLOCK NO: 22756 HOUR: 96	DEPTH: 5177.8

HALLIBURTON SERVICES

SECOND CLOSED-IN - CONTINUED

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
	13	360	2334.2	-302.7	316.2	0.915
J	14	369	2334.2	-302.7	323.2	0.906

THIRD FLOW

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
K	1	0	2420.4			
[1]	2	7	2418.9	-1.5		
	3	30	2234.0	-184.8		
	4	60	2232.7	-1.3		
	5	90	2194.1	-38.6		
	6	120	2156.4	-37.7		
	7	150	2148.4	-7.9		
	8	180	2113.1	-35.4		
	9	210	2104.5	-8.6		
	10	240	2087.3	-17.1		
	11	270	2312.9	225.6		
	12	300	2146.4	-166.6		
	13	330	2248.3	102.0		
	14	360	2209.7	-38.6		
	15	390	2233.3	23.6		
	16	420	2224.9	-8.4		
	17	450	2154.9	-70.0		
	18	480	2159.2	4.3		
	19	510	2159.2	0.0		
	20	540	2185.6	26.4		
	21	570	2200.9	15.2		
L	22	618	2189.3	-11.6		

THIRD CLOSED-IN

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
L	1	0	2189.3			
	2	1	2306.1	116.8	1.0	3.528
	3	2	2312.1	122.8	2.0	3.201
	4	3	2315.7	126.4	3.0	3.033
	5	4	2319.0	129.7	4.1	2.900
	6	5	2320.5	131.2	5.0	2.808
	7	6	2323.0	133.7	6.0	2.733
	8	7	2325.0	135.7	7.0	2.661
	9	8	2326.0	136.7	8.0	2.606
	10	9	2328.0	138.7	9.0	2.551
	11	10	2328.8	139.5	10.0	2.508
	12	12	2329.3	140.0	12.0	2.428
	13	14	2331.0	141.7	13.9	2.364
	14	16	2331.0	141.7	15.9	2.306
	15	18	2331.2	141.9	17.9	2.254
	16	20	2332.0	142.8	19.9	2.208
	17	22	2332.3	143.0	21.8	2.169
	18	24	2332.7	143.4	23.9	2.129
	19	26	2333.1	143.8	25.8	2.096
	20	28	2333.1	143.8	27.8	2.063
	21	30	2333.1	143.8	29.8	2.033

THIRD CLOSED-IN - CONTINUED

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
	22	35	2334.0	144.7	34.6	1.969
	23	40	2335.1	145.8	39.6	1.910
	24	45	2335.1	145.8	44.4	1.860
	25	50	2335.1	145.8	49.4	1.814
	26	55	2335.5	146.2	54.1	1.774
	27	60	2336.1	146.8	58.9	1.737
	28	70	2336.1	146.8	68.5	1.672
	29	80	2336.1	146.8	78.0	1.615
	30	90	2336.1	146.8	87.5	1.565
	31	100	2336.1	146.8	97.0	1.521
	32	110	2336.1	146.8	106.4	1.481
	33	120	2336.1	146.8	115.8	1.444
	34	135	2336.3	147.1	129.7	1.395
	35	150	2336.6	147.3	143.4	1.351
	36	165	2336.6	147.3	156.9	1.312
	37	180	2337.4	148.1	170.5	1.276
	38	195	2337.4	148.1	183.9	1.243
	39	210	2338.3	149.0	197.2	1.213
	40	225	2338.3	149.0	210.3	1.185
	41	240	2338.3	149.0	223.4	1.159
	42	260	2338.3	149.0	240.5	1.126
	43	280	2338.3	149.0	257.6	1.097
	44	300	2338.3	149.0	274.4	1.069
	45	320	2338.3	149.0	291.1	1.044
	46	340	2338.3	149.0	307.6	1.020
	47	360	2338.3	149.0	323.9	0.997
	48	380	2338.3	149.0	339.9	0.976
	49	400	2338.3	149.0	355.8	0.956
	50	460	2338.3	149.0	402.5	0.903
	51	520	2338.3	149.0	447.7	0.857
	52	580	2338.3	149.0	491.5	0.816
M	53	626	2338.7	149.4	524.2	0.788

FOURTH FLOW

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
N	1	0	2237.4			
	2	5	2275.1	37.8		
	3	10	2279.2	4.1		
	4	15	2284.6	5.4		
[2]	5	19	2293.6	9.0		
O	6	61	2599.3	305.7		

FOURTH CLOSED-IN

	REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
O	1	0	2599.3			
P	2	192	2396.7	-202.5	181.3	1.257

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NOV 15 1985
Minerals Management Service

LEGEND:
[1] OPENED AT SURFACE [2] BEGIN PUMPING

REMARKS:
1) ALL READINGS QUESTIONABLE..GAUGE RIDING THE BRIDGE. 2) POINTS P & Q ARE QUESTIONABLE DUE TO OVERPRESSURING BY PUMPING.

TICKET NO: 16485600

CLOCK NO: 18522 HOUR: 72

HALLIBURTON SERVICES

GAUGE NO: 254

DEPTH: 5177.8

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
		SECOND CLOSED-IN - CONTINUED				
	13	360	2268.2	-294.3	316.2	0.915
J	14	369	2267.5	-295.0	323.2	0.906
		THIRD FLOW				
K	1	0	2345.1			
1	2	7	2344.1	-1.0		
	3	30	2160.6	-183.5		
	4	60	2161.1	0.5		
	5	90	2119.9	-41.2		
3	6	119	2079.7	-40.2		
L	7	NO DATA FOR THIS POINT				
		THIRD CLOSED-IN				
L	1	NO DATA FOR THIS POINT				
M	2	NO DATA FOR THIS POINT				
		FOURTH FLOW				
N	1	NO DATA FOR THIS POINT				
O	2	NO DATA FOR THIS POINT				
		FOURTH CLOSED-IN				
O	1	NO DATA FOR THIS POINT				
P	2	NO DATA FOR THIS POINT				

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$

LEGEND:
1 OPENED AT SURFACE 2 BEGIN PUMPING 3 CLOCK STOPPED

REMARKS:

TICKET NO: 16485600 | GAUGE NO: 111

CLOCK NO: 24107 HOUR: 96 | DEPTH: 5209.8

HALLIBURTON SERVICES

FIRST FLOW

(handwritten: Good)

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
E	1	0	2211.5			
	2	5	2290.2	78.7		
	3	10	2299.3	9.1		
	4	15	2302.7	3.3		
	5	20	2305.1	2.4		
	6	25	2305.1	0.0		
	7	30	2305.1	0.0		
	8	35	2305.1	0.0		
	9	40	2305.1	0.0		
[1]	10	44	2305.1	0.0		
	11	45	2229.0	-76.0		
	12	50	2064.8	-164.2		
	13	55	1881.5	-183.3		
F	14	58	1842.1	-39.4		

(handwritten, bracketing refs 10–14: Use This)

FIRST CLOSED-IN

(handwritten: Good)

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
F	1	0	1842.1			
	2	1	2022.4	180.3	1.0	1.755
	3	2	2241.6	399.5	1.9	1.485
	4	3	2275.0	432.9	2.9	1.308
	5	4	2286.8	444.8	3.8	1.186
	6	5	2291.1	449.0	4.6	1.103
	7	6	2293.8	451.8	5.5	1.028
	8	7	2297.2	455.1	6.2	0.972
	9	8	2298.4	456.3	7.0	0.918
	10	9	2300.2	458.1	7.8	0.872
	11	10	2300.8	458.8	8.5	0.835
	12	12	2302.7	460.6	10.0	0.766
	13	14	2304.2	462.1	11.3	0.712
	14	16	2306.6	464.5	12.5	0.667
	15	18	2307.8	465.7	13.7	0.628
	16	20	2308.1	466.1	15.0	0.590
	17	22	2309.0	467.0	16.0	0.560
	18	24	2309.0	467.0	17.0	0.535
	19	26	2309.6	467.6	18.0	0.510
	20	28	2309.6	467.6	18.9	0.488
	21	30	2309.6	467.6	19.8	0.468
	22	35	2309.6	467.6	21.9	0.425
	23	40	2310.3	468.2	23.7	0.390
	24	45	2310.3	468.2	25.4	0.361
	25	50	2310.3	468.2	26.9	0.335
	26	55	2312.1	470.0	28.3	0.313
G	27	60	2311.8	469.7	29.5	0.296

SECOND FLOW

(handwritten: Good)

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
H	1	0	1576.4			
	2	60	2306.9	730.6		

SECOND FLOW - CONTINUED

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
	3	120	2308.2	1.2		
	4	180	2308.8	0.6		
	5	240	2308.8	0.0		
	6	300	2308.8	0.0		
	7	360	2308.8	0.0		
	8	420	2308.8	0.0		
	9	480	2308.8	0.0		
	10	540	2308.8	0.0		
	11	600	2308.2	-0.6		
	12	660	2308.2	0.0		
	13	720	2308.2	0.0		
	14	780	2306.9	-1.2		
	15	840	2306.9	0.0		
	16	900	2305.4	-1.5		
	17	960	2305.4	0.0		
	18	1020	2305.1	-0.3		
	19	1080	2305.1	0.0		
	20	1140	2305.1	0.0		
	21	1200	2304.2	-0.9		
	22	1260	2303.6	-0.6		
	23	1320	2303.6	0.0		
	24	1380	2302.4	-1.2		
	25	1440	2302.4	0.0		
	26	1500	2302.4	0.0		
	27	1560	2302.4	0.0		
	28	1620	2302.1	-0.3		
	29	1680	2302.1	0.0		
	30	1740	2301.2	-0.9		
	31	1800	2301.2	0.0		
	32	1860	2299.6	-1.5		
	33	1920	2299.6	0.0		
	34	1980	2299.3	-0.3		
	35	2040	2299.3	0.0		
	36	2100	2303.6	4.3		
	37	2160	2307.6	4.0		
[2]	38	2175	2322.7	15.2		
I	39	2542	2590.9	268.2		

(handwritten, beside refs 16–17: @932 Min. Shut in due to sanding up)

(handwritten, beside refs 33–34: @1972 Min. well opened again)

(handwritten, below ref 39: Really 1502 Min Flowing Time)

SECOND CLOSED-IN

(handwritten: Good)

REF		MINUTES	PRESSURE	ΔP	$\frac{t\times\Delta t}{t+\Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
I	1	0	2590.9			
	2	30	2545.3	-45.7	29.7	1.943
	3	60	2315.6	-275.4	58.7	1.647
	4	90	2304.0	-286.9	87.1	1.475
	5	120	2673.0	82.1	114.6	1.358
	6	150	2406.7	-184.2	141.9	1.263
	7	180	2253.4	-337.5	168.4	1.189
	8	210	2290.9	-300.0	194.4	1.128
	9	240	2290.9	-300.0	219.9	1.073
	10	270	2291.5	-299.4	244.6	1.027
	11	300	2291.5	-299.4	269.0	0.985
	12	330	2291.5	-299.4	292.9	0.948

LEGEND:

[1] OPENED AT SURFACE   [2] BEGIN PUMPING   [3] CLOCK STOPPED

REMARKS:

TICKET NO: 16485600

CLOCK NO: 24107 HOUR: 96

HALLIBURTON SERVICES

GAUGE NO: 111

DEPTH: 5209.8

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$
SECOND CLOSED-IN - CONTINUED						
	13	360	2291.5	-299.4	316.2	0.915
J	14	369	2292.4	-298.5	323.2	0.906
THIRD FLOW						
K	1	0	2376.4			
[1]	2	7	2375.8	-0.6		
	3	30	2191.4	-184.3		
	4	60	2191.7	0.3		
	5	90	2143.4	-48.3		
	6	120	2110.0	-33.4		
[3]	7	144	2103.9	-6.1		
L	8	NO DATA FOR THIS POINT				
THIRD CLOSED-IN						
L	1	NO DATA FOR THIS POINT				
M	2	NO DATA FOR THIS POINT				
FOURTH FLOW						
N	1	NO DATA FOR THIS POINT				
O	2	NO DATA FOR THIS POINT				
FOURTH CLOSED-IN						
O	1	NO DATA FOR THIS POINT				
P	2	NO DATA FOR THIS POINT				

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log\frac{t+\Delta t}{\Delta t}$

LEGEND:
[1] OPENED AT SURFACE [2] BEGIN PUMPING [3] CLOCK STOPPED

REMARKS:

TICKET NO: 16485610	HALLIBURTON SERVICES	GAUGE NO: 805
CLOCK NO: 22458 HOUR: 48		DEPTH: 5209.8

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t+\Delta t}{\Delta t}$
			FIRST FLOW Good			
E	1	0.0	2159.6			
	2	5.0	2287.9	128.3		
	3	10.0	2304.7	16.8		
	4	15.0	2309.3	4.6		
	5	20.0	2310.8	1.5		
	6	25.0	2313.2	2.4		
	7	30.0	2313.2	0.0		
	8	35.0	2313.2	0.0		
	9	40.0	2313.2	0.0		
[1]	10	43.6	2313.2	0.0		
	11	45.0	2237.4	-75.8		
	12	50.0	2055.6	-181.8		
	13	55.0	1876.1	-179.5		
F	14	58.2	1842.5	-33.7		
			FIRST CLOSED-IN Good			
F	1	0.0	1842.5			
	2	1.0	2265.6	423.1	1.0	1.759
	3	2.0	2285.4	443.0	1.9	1.478
	4	3.0	2292.8	450.3	2.9	1.305
	5	4.0	2298.6	456.1	3.7	1.191
	6	5.0	2301.3	458.9	4.6	1.099
	7	6.0	2303.5	461.0	5.4	1.029
	8	7.0	2306.2	463.8	6.3	0.967
	9	8.1	2307.4	465.0	7.1	0.914
	10	9.0	2308.7	466.2	7.8	0.874
	11	10.0	2309.6	467.1	8.5	0.833
	12	12.0	2310.8	468.3	10.0	0.767
	13	14.0	2312.3	469.9	11.3	0.712
	14	16.0	2314.2	471.7	12.5	0.667
	15	18.0	2315.4	472.9	13.7	0.627
	16	20.0	2316.6	474.1	14.9	0.593
	17	22.0	2316.3	473.8	16.0	0.561
	18	24.0	2316.9	474.4	17.0	0.535
	19	26.0	2316.9	474.4	18.0	0.510
	20	28.0	2316.9	474.4	18.9	0.488
	21	30.0	2316.9	474.4	19.8	0.469
	22	35.0	2317.2	474.8	21.9	0.425
	23	40.0	2318.1	475.7	23.7	0.390
	24	45.0	2318.7	476.3	25.4	0.360
	25	50.0	2319.7	477.2	26.9	0.335
	26	55.0	2320.3	477.8	28.3	0.314
G	27	59.7	2320.3	477.8	29.5	0.296
			SECOND FLOW Good			
H	1	0.0	1580.0			
	2	60.0	2315.4	735.4		

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t+\Delta t}{\Delta t}$
		SECOND FLOW - CONTINUED				
	3	120.0	2320.0	4.6		
	4	180.0	2321.2	1.2		
	5	240.0	2321.5	0.3		
	6	300.0	2322.4	0.9		
	7	360.0	2323.0	0.6		
	8	420.0	2323.6	0.6		
	9	480.0	2324.6	0.9		
	10	540.0	2324.6	0.0		
	11	600.0	2324.9	0.3		
	12	660.0	2326.1	1.2		
	13	720.0	2327.3	1.2		
	14	780.0	2327.6	0.3		
	15	840.0	2327.9	0.3		
	16	900.0	2327.9	0.0		
	17	960.0	2329.1	1.2		
	18	1020.0	2330.4	1.2		
	19	1080.0	2331.6	1.2		
	20	1140.0	2332.2	0.6		
	21	1200.0	2332.2	0.0		
	22	1260.0	2332.2	0.0		
	23	1320.0	2332.2	0.0		
	24	1380.0	2332.2	0.0		
	25	1440.0	2332.2	0.0		
	26	1500.0	2333.1	0.9		
	27	1560.0	2333.1	0.0		
	28	1620.0	2333.4	0.3		
	29	1680.0	2333.7	0.3		
	30	1740.0	2334.0	0.3		
	31	1800.0	2334.6	0.6		
	32	1860.0	2334.6	0.0		
	33	1920.0	2334.6	0.0		
	34	1980.0	2334.6	0.0		
	35	2040.0	2336.8	2.1		
	36	2100.0	2339.8	3.1		
[2]	37	2109.6	2341.4	1.5		
I	38	NO DATA FOR THIS POINT				
			SECOND CLOSED-IN			
I	1	NO DATA FOR THIS POINT				
J	2	NO DATA FOR THIS POINT				
			THIRD FLOW			
K	1	NO DATA FOR THIS POINT				
L	2	NO DATA FOR THIS POINT				
			THIRD CLOSED-IN			
L	1	NO DATA FOR THIS POINT				

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OCS District Office
NOV 1 5 1985

LEGEND:
[1] OPENED AT SURFACE [2] CHART TIME EXPIRED

REMARKS:

TICKET NO: 16485610		GAUGE NO: 805
CLOCK NO: 22458 HOUR: 48	HALLIBURTON SERVICES	DEPTH: 5209.8

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t+\Delta t}{\Delta t}$
	THIRD CLOSED-IN - CONTINUED				
M	2	NO DATA FOR THIS POINT			
		FOURTH FLOW			
N	1	NO DATA FOR THIS POINT			
O	2	NO DATA FOR THIS POINT			
		FOURTH CLOSED-IN			
O	1	NO DATA FOR THIS POINT			
P	2	NO DATA FOR THIS POINT			

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t+\Delta t}{\Delta t}$

LEGEND:
1 OPENED AT SURFACE   2 CHART TIME EXPIRED

REMARKS:

TICKET NO: 16485610	HALLIBURTON SERVICES	GAUGE NO: 206
CLOCK NO: 18785 HOUR: 48		DEPTH: 5209.8

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t+\Delta t}{\Delta t}$
			FIRST FLOW Good			
E	1	0.0	2233.3			
	2	5.0	2312.4	79.1		
	3	10.0	2329.9	17.5		
	4	15.0	2335.3	5.4		
	5	20.0	2338.3	3.0		
	6	25.0	2340.3	1.9		
	7	30.0	2340.7	0.4		
	8	35.0	2341.3	0.6		
	9	40.0	2341.6	0.2		
[1]	10	43.6	2341.6	0.0		
	11	45.0	2260.6	-80.9		
	12	50.0	2086.1	-174.5		
	13	55.0	1904.1	-182.0		
F	14	58.2	1871.0	-33.1		
			FIRST CLOSED-IN Good			
F	1	0.0	1871.0			
	2	1.0	2290.1	419.1	1.0	1.759
	3	2.0	2309.6	438.6	1.9	1.478
	4	3.0	2317.8	446.8	2.8	1.313
	5	4.0	2324.0	453.1	3.7	1.191
	6	5.0	2328.6	457.6	4.6	1.099
	7	6.0	2330.1	459.1	5.4	1.029
	8	7.0	2332.9	461.9	6.2	0.970
	9	8.0	2336.4	465.4	7.0	0.917
	10	9.0	2336.4	465.4	7.8	0.874
	11	10.0	2337.4	466.5	8.5	0.833
	12	12.0	2340.3	469.3	10.0	0.767
	13	14.0	2342.0	471.0	11.3	0.714
	14	15.0	2342.8	471.9	12.0	0.687
	15	18.0	2344.1	473.2	13.8	0.626
	16	20.0	2344.8	473.8	14.9	0.593
	17	22.0	2344.8	473.8	15.9	0.562
	18	24.0	2344.8	473.8	17.0	0.535
	19	26.0	2344.8	473.8	18.0	0.511
	20	28.0	2344.8	473.8	18.9	0.488
	21	30.0	2344.8	473.8	19.8	0.469
	22	35.0	2346.1	475.1	21.9	0.425
	23	40.0	2346.1	475.1	23.7	0.390
	24	45.0	2346.1	475.1	25.4	0.361
	25	50.0	2346.1	475.1	26.9	0.335
	26	55.0	2347.0	476.0	28.3	0.313
G	27	59.7	2347.6	476.6	29.5	0.296
			SECOND FLOW Good			
H	1	0.0	1616.2			
	2	60.0	2337.0	720.9		

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t+\Delta t}{\Delta t}$
			SECOND FLOW - CONTINUED			
	3	120.0	2340.7	3.7		
	4	180.0	2341.6	0.9		
	5	240.0	2341.8	0.2		
	6	300.0	2341.8	0.0		
	7	360.0	2341.8	0.0		
	8	420.0	2341.8	0.0		
	9	480.0	2341.8	0.0		
	10	540.0	2341.8	0.0		
	11	600.0	2342.7	0.9		
	12	660.0	2342.4	-0.2		
	13	720.0	2343.1	0.6		
	14	780.0	2343.1	0.0		
	15	840.0	2343.7	0.6		
	16	900.0	2343.7	0.0		
	17	960.0	2344.4	0.6		
	18	1020.0	2344.4	0.0		
	19	1080.0	2344.4	0.0		
	20	1140.0	2344.4	0.0		
	21	1200.0	2344.4	0.0		
	22	1260.0	2344.4	0.0		
	23	1320.0	2344.4	0.0		
	24	1380.0	2344.4	0.0		
	25	1440.0	2344.4	0.0		
	26	1500.0	2344.4	0.0		
	27	1560.0	2345.0	0.6		
	28	1620.0	2345.9	0.9		
	29	1680.0	2345.9	0.0		
	30	1740.0	2345.9	0.0		
	31	1800.0	2345.9	0.0		
	32	1860.0	2345.9	0.0		
	33	1920.0	2346.1	0.2		
	34	1980.0	2346.1	0.0		
	35	2040.0	2346.1	0.0		
	36	2100.0	2346.1	0.0		
	37	2160.0	2346.1	0.0		
[2]	38	2174.7	2355.0	8.9		
[3]	39	2217.0	2384.2	29.2		
I	40	NO DATA FOR THIS POINT				
			SECOND CLOSED-IN			
I	1	NO DATA FOR THIS POINT				
J	2	NO DATA FOR THIS POINT				
			THIRD FLOW			
K	1	NO DATA FOR THIS POINT				
L	2	NO DATA FOR THIS POINT				

LEGEND:
[1] OPENED AT SURFACE [2] BEGIN PUMPING [3] CHART TIME EXPIRED

REMARKS:

TICKET NO: 16485610
CLOCK NO: 18785 HOUR: 48

HALLIBURTON SERVICES

GAUGE NO: 206
DEPTH: 5209.8

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
THIRD CLOSED-IN					
L 1	NO DATA FOR THIS POINT				
M 2	NO DATA FOR THIS POINT				
FOURTH FLOW					
N 1	NO DATA FOR THIS POINT				
O 2	NO DATA FOR THIS POINT				
FOURTH CLOSED-IN					
O 1	NO DATA FOR THIS POINT				
P 2	NO DATA FOR THIS POINT				

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$

LEGEND:
1 OPENED AT SURFACE 2 BEGIN PUMPING 3 CHART TIME EXPIRED

REMARKS:

TICKET NO: 16465610
CLOCK NO: 18554 HOUR: 72

HALLIBURTON SERVICES

GAUGE NO: 155
DEPTH: 5209.8

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t+\Delta t}{\Delta t}$
FIRST FLOW (Good)					
E 1	0	2168.3			
2	5	2277.4	109.1		
3	10	2290.0	12.6		
4	15	2294.6	4.6		
5	20	2297.6	3.0		
6	25	2299.0	1.3		
7	30	2300.6	1.7		
8	35	2300.6	0.0		
9	40	2300.6	0.0		
[1] 10	44	2300.6	0.0		
11	45	2210.3	-90.3		
12	50	2049.7	-160.6		
13	55	1872.9	-176.8		
F 14	58	1862.6	-10.3		
FIRST CLOSED-IN (Good)					
F 1	0	1862.6			
2	1	2234.6	371.9	1.0	1.770
3	2	2268.1	405.5	1.9	1.477
4	3	2277.7	415.1	2.9	1.308
5	4	2283.4	420.7	3.8	1.190
6	5	2289.0	426.4	4.6	1.100
7	6	2291.0	428.3	5.5	1.028
8	7	2294.3	431.7	6.3	0.967
9	8	2296.3	433.7	7.1	0.916
10	9	2297.6	435.0	7.8	0.875
11	10	2299.6	437.0	8.5	0.835
12	12	2301.3	438.6	9.9	0.768
13	14	2302.9	440.3	11.3	0.713
14	16	2304.3	441.6	12.5	0.666
15	18	2305.6	442.9	13.8	0.625
16	20	2306.9	444.3	14.9	0.592
17	22	2307.2	444.6	16.0	0.561
18	24	2307.2	444.6	17.0	0.534
19	26	2307.2	444.6	18.0	0.510
20	28	2307.6	444.9	18.9	0.489
21	30	2308.2	445.6	19.8	0.469
22	35	2309.6	446.9	21.9	0.425
23	40	2311.9	449.2	23.7	0.390
24	45	2312.2	449.6	25.4	0.361
25	50	2312.2	449.6	26.9	0.335
26	55	2312.2	449.6	28.3	0.313
G 27	60	2310.9	448.2	29.5	0.296
SECOND FLOW (Good)					
H 1	0	1602.7			
2	60	2314.2	711.5		

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t+\Delta t}{\Delta t}$
SECOND FLOW - CONTINUED					
3	120	2314.2	0.0		
4	180	2315.2	1.0		
5	240	2315.5	0.3		
6	300	2313.9	-1.7		
7	360	2313.9	0.0		
8	420	2314.2	0.3		
9	480	2314.2	0.0		
10	540	2314.2	0.0		
11	600	2314.2	0.0		
12	660	2314.2	0.0		
13	720	2314.2	0.0		
14	780	2314.2	0.0		
15	840	2314.2	0.0		
16	900	2314.2	0.0		
17	960	2314.2	0.0		
18	1020	2314.2	0.0		
19	1080	2314.2	0.0		
20	1140	2314.2	0.0		
21	1200	2314.2	0.0		
22	1260	2314.2	0.0		
23	1320	2314.2	0.0		
24	1380	2314.2	0.0		
25	1440	2314.2	0.0		
26	1500	2314.2	0.0		
27	1560	2314.2	0.0		
28	1620	2314.2	0.0		
29	1680	2314.2	0.0		
30	1740	2314.2	0.0		
31	1800	2314.2	0.0		
32	1860	2314.2	0.0		
33	1920	2313.9	-0.3		
34	1980	2313.9	0.0		
35	2040	2313.9	0.0		
36	2100	2313.9	0.0		
37	2160	2323.8	10.0		
38	2175	2332.8	9.0		
I 39	2542	2584.4	251.6		
SECOND CLOSED-IN					
I 1	0	2584.4			
2	30	2333.8	-250.6	29.6	1.943
3	60	2678.1	93.7	58.6	1.647
4	90	2437.1	-147.4	87.0	1.476
5	120	2275.4	-309.0	114.7	1.356
6	150	2307.3	-277.1	141.8	1.263
7	180	2312.0	-272.5	168.4	1.189
8	210	2312.0	-272.5	194.3	1.126
9	240	2312.0	-272.5	219.7	1.073
10	270	2313.3	-271.2	244.6	1.027
11	300	2313.3	-271.2	269.0	0.985
12	330	2275.4	-309.0	292.8	0.948

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LEGEND:
[1] OPENED AT SURFACE [2] BEGIN PUMPING [3] CLOCK STOPPED

REMARKS:
~~ALL READINGS AFTER PUMPING QUESTIONABLE DUE TO STAIR STEPPING...~~CLOCK STOPPED AND STARTED AGAIN WHILE COMING OUT OF HOLE.

TICKET NO: 16485610

CLOCK NO: 18554 HOUR: 72

HALLIBURTON SERVICES

GAUGE NO: 155

DEPTH: 5209.8

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
	SECOND CLOSED-IN - CONTINUED					
	13	360	2219.0	-365.4	316.3	0.915
I	14	367	2219.0	-365.4	321.4	0.908
J	15	NO DATA FOR THIS POINT				
	THIRD FLOW					
K	1	NO DATA FOR THIS POINT				
L	2	NO DATA FOR THIS POINT				
	THIRD CLOSED-IN					
L	1	NO DATA FOR THIS POINT				
M	2	NO DATA FOR THIS POINT				
	FOURTH FLOW					
N	1	NO DATA FOR THIS POINT				
O	2	NO DATA FOR THIS POINT				
	FOURTH CLOSED-IN					
O	1	NO DATA FOR THIS POINT				
P	2	NO DATA FOR THIS POINT				

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$

LEGEND:
1 OPENED AT SURFACE 2 BEGIN PUMPING 3 CLOCK STOPPED

REMARKS:
ALL READINGS AFTER PUMPING QUESTIONABLE DUE TO STAIR STEPPING....CLOCK STOPPED AND STARTED AGAIN WHILE COMING OUT OF HOLE.

TICKET NO: 16485610	HALLIBURTON SERVICES	GAUGE NO: 194
CLOCK NO: 22455 HOUR: 48		DEPTH: 5217.9

REF		MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$
FIRST FLOW						
E	1	0.0	2229.8			
	2	5.0	2335.4	105.7		
	3	10.0	2354.3	18.9		
	4	15.0	2359.8	5.5		
	5	19.9	2360.7	0.9		
	6	25.0	2361.3	0.6		
	7	30.0	2361.3	0.0		
	8	35.0	2361.0	-0.3		
	9	40.0	2362.2	1.2		
[1]	10	43.6	2362.2	0.0		
	11	45.0	2280.2	-82.0		
	12	50.0	2110.8	-169.4		
	13	55.0	1937.4	-173.3		
F	14	58.2	1901.1	-36.3		
FIRST CLOSED-IN						
F	1	0.0	1901.1			
	2	1.0	2298.6	397.5	1.0	1.770
	3	2.0	2326.0	424.9	1.9	1.476
	4	3.0	2336.6	435.6	2.8	1.315
	5	4.0	2344.3	443.2	3.7	1.195
	6	5.0	2348.2	447.2	4.6	1.099
	7	6.0	2351.6	450.5	5.5	1.027
	8	7.0	2353.4	452.3	6.3	0.967
	9	8.0	2355.2	454.2	7.0	0.918
	10	9.0	2355.2	454.2	7.8	0.873
	11	10.0	2356.1	455.1	8.5	0.834
	12	12.0	2357.7	456.6	10.0	0.767
	13	14.0	2360.4	459.3	11.3	0.713
	14	16.0	2361.0	459.9	12.5	0.667
	15	18.0	2362.5	461.5	13.8	0.626
	16	20.0	2362.8	461.8	14.9	0.592
	17	22.0	2363.8	462.7	16.0	0.562
	18	24.0	2363.8	462.7	17.0	0.535
	19	26.0	2363.8	462.7	18.0	0.511
	20	28.0	2363.8	462.7	18.9	0.488
	21	30.0	2363.8	462.7	19.8	0.468
	22	35.0	2364.1	463.0	21.8	0.426
	23	40.0	2365.6	464.5	23.7	0.390
	24	45.0	2365.9	464.8	25.4	0.361
	25	50.0	2365.9	464.8	26.9	0.335
	26	55.0	2366.5	465.4	28.3	0.313
G	27	59.7	2366.5	465.4	29.5	0.296
SECOND FLOW						
H	1	0.0	1635.8			
	2	60.0	2364.1	728.3		
SECOND FLOW - CONTINUED						
	3	120.0	2364.1	0.0		
	4	180.0	2365.0	0.9		
	5	240.0	2365.0	0.0		
	6	300.0	2365.0	0.0		
	7	360.0	2363.8	-1.2		
	8	420.0	2363.8	0.0		
	9	480.0	2363.8	0.0		
	10	540.0	2363.8	0.0		
	11	600.0	2363.8	0.0		
	12	660.0	2363.8	0.0		
	13	720.0	2362.6	-1.2		
	14	780.0	2362.0	-0.6		
	15	840.0	2361.0	-0.9		
	16	900.0	2361.0	0.0		
	17	960.0	2361.0	0.0		
	18	1020.0	2361.0	0.0		
	19	1080.0	2361.0	0.0		
	20	1140.0	2360.7	-0.3		
	21	1200.0	2360.7	0.0		
	22	1260.0	2360.7	0.0		
	23	1320.0	2359.8	-0.9		
	24	1380.0	2359.5	-0.3		
	25	1440.0	2359.5	0.0		
	26	1500.0	2359.5	0.0		
	27	1560.0	2358.9	-0.6		
	28	1620.0	2358.9	0.0		
	29	1680.0	2358.9	0.0		
	30	1740.0	2358.0	-0.9		
	31	1800.0	2357.7	-0.3		
	32	1860.0	2357.7	0.0		
	33	1920.0	2360.4	2.7		
	34	1980.0	2360.4	0.0		
[2]	35	1988.2	2362.0	1.5		
I	36	NO DATA FOR THIS POINT				
SECOND CLOSED-IN						
I	1	NO DATA FOR THIS POINT				
J	2	NO DATA FOR THIS POINT				
THIRD FLOW						
K	1	NO DATA FOR THIS POINT				
L	2	NO DATA FOR THIS POINT				
THIRD CLOSED-IN						
L	1	NO DATA FOR THIS POINT				
M	2	NO DATA FOR THIS POINT				

LEGEND:
[1] OPENED AT SURFACE [2] CHART TIME EXPIRED

REMARKS:
~~ALL READINGS QUESTIONABLE DUE TO CONDITION OF CHART WHERE GAUGE WENT IN HOLE.~~

TICKET NO: 16485610		HALLIBURTON SERVICES	GAUGE NO: 194
CLOCK NO: 22455	HOUR: 48		DEPTH: 5217.9

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$

FOURTH FLOW

N	1	NO DATA FOR THIS POINT
O	2	NO DATA FOR THIS POINT

FOURTH CLOSED-IN

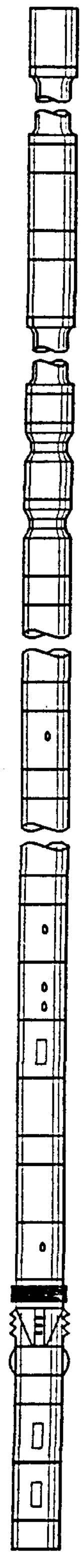
O	1	NO DATA FOR THIS POINT
P	2	NO DATA FOR THIS POINT

REF	MINUTES	PRESSURE	ΔP	$\frac{t \times \Delta t}{t + \Delta t}$	$\log \frac{t + \Delta t}{\Delta t}$

LEGEND:
1 OPENED AT SURFACE
2 CHART TIME EXPIRED

REMARKS:
ALL READINGS QUESTIONABLE DUE TO CONDITION OF CHART WHERE GAUGE WENT IN HOLE.

TICKET NO. 16485600



		O.D.	I.D.	LENGTH	DEPTH	
97	HOWCO TEST HEAD - UNITEST S-15..		2.680			
1	DRILL PIPE......................	5.000	4.276	153.0		
5	CROSSOVER.......................					
99	SUB SUR TEST TREE W/SL JT-FL HGR		4.280	13.1		
5	CROSSOVER.......................			1.4		
98	BOTTOM OF LANDING STRING........				169.7	
1	DRILL PIPE......................	5.000	4.276	4541.5		
5	CROSSOVER.......................	5.825	2.625	1.0		
10	SLIP JOINT......................	5.000	2.250	18.2		
10	SLIP JOINT......................	5.000	2.250	13.2		
5	CROSSOVER.......................	5.750	2.750	0.7		
3	DRILL COLLARS...................	6.500	2.750	307.9		
5	CROSSOVER.......................	6.000	2.625	0.9		
52	APR-TYPE "A" CIRCULATING VALVE..	5.000	2.250	3.0	5054.5	
5	CROSSOVER.......................	6.000	2.625	0.7		
3	DRILL COLLARS...................	6.500	2.750	91.2		
5	CROSSOVER.......................	6.000	2.750	0.9		
55	APR-M2 SAMPLER CIRCULATING VALVE	5.000	2.250	11.3	5150.1	
64	APR-N TESTER....................	5.000	2.250	16.4	5161.4	
84	BUNDLE CARRIER..................	5.325	2.250	7.9	5177.8	H 253 H 207 (x) H 254
15	JAR.............................	4.625	2.250	5.2		
5	CROSSOVER.......................	6.000	2.750	0.7		
35	RTTS SAFETY JOINT...............	6.120	3.870	3.5		
56	RTTS CIRCULATING VALVE..........	6.500	2.400	3.6	5195.1	
71	CASING PACKER...................	8.250	3.750	5.9	5197.4	H-805 H-206 H-155 H-111
5	CROSSOVER.......................	6.000	2.750	0.9		
84	BUNDLE CARRIER..................	5.325	2.250	7.9	5209.8	
84	BUNDLE CARRIER..................	5.325	2.250	7.9	5217.9	H 194
5	CROSSOVER.......................	5.825	3.000	1.1		

CONTINUED

EQUIPMENT DATA

TICKET NO. 16485600

	O.D.	I.D.	LENGTH	DEPTH
PERFORATED TAIL PIPE............	2.828	2.500	21.1	

TOTAL DEPTH

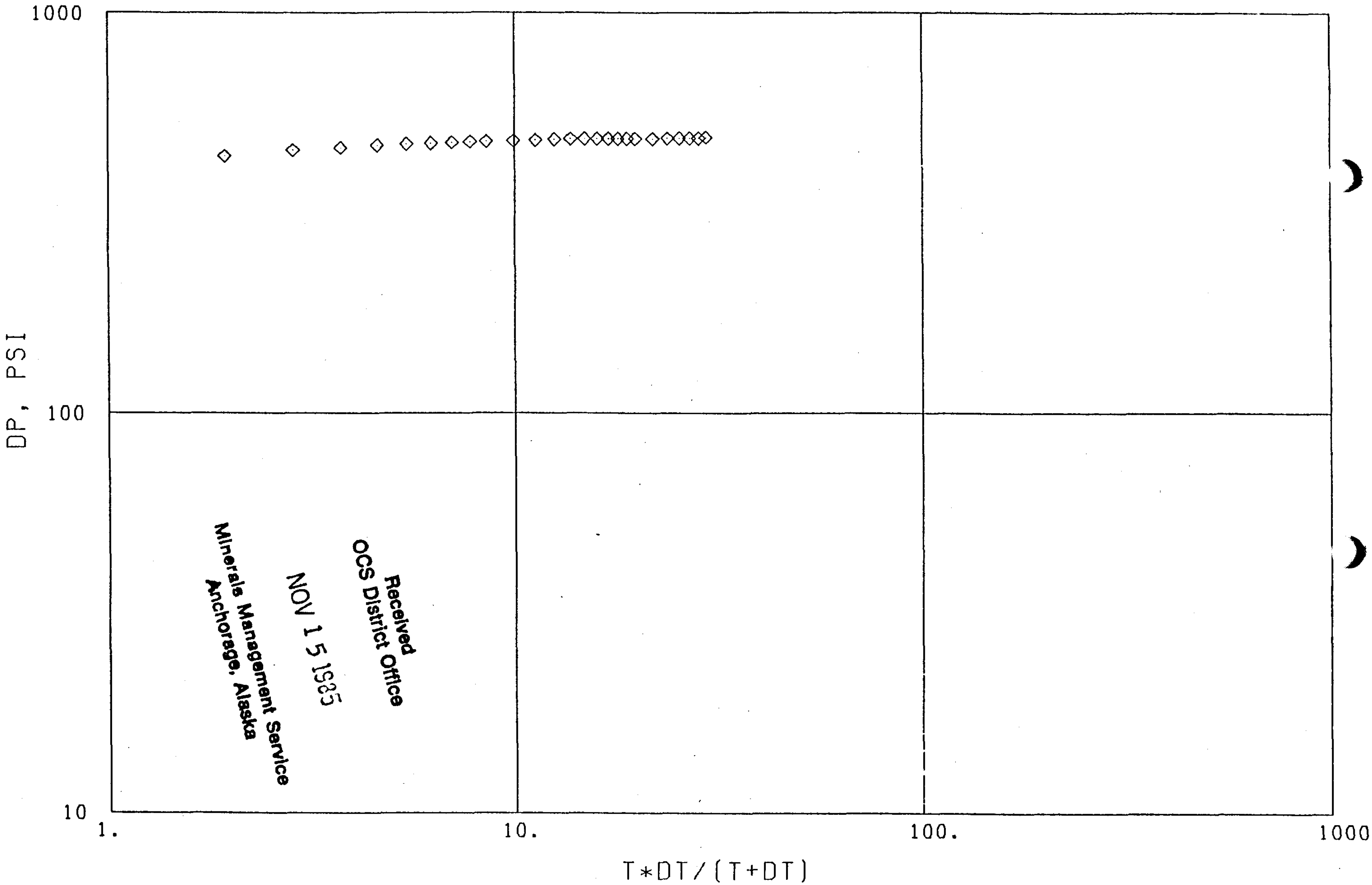
EQUIPMENT DATA

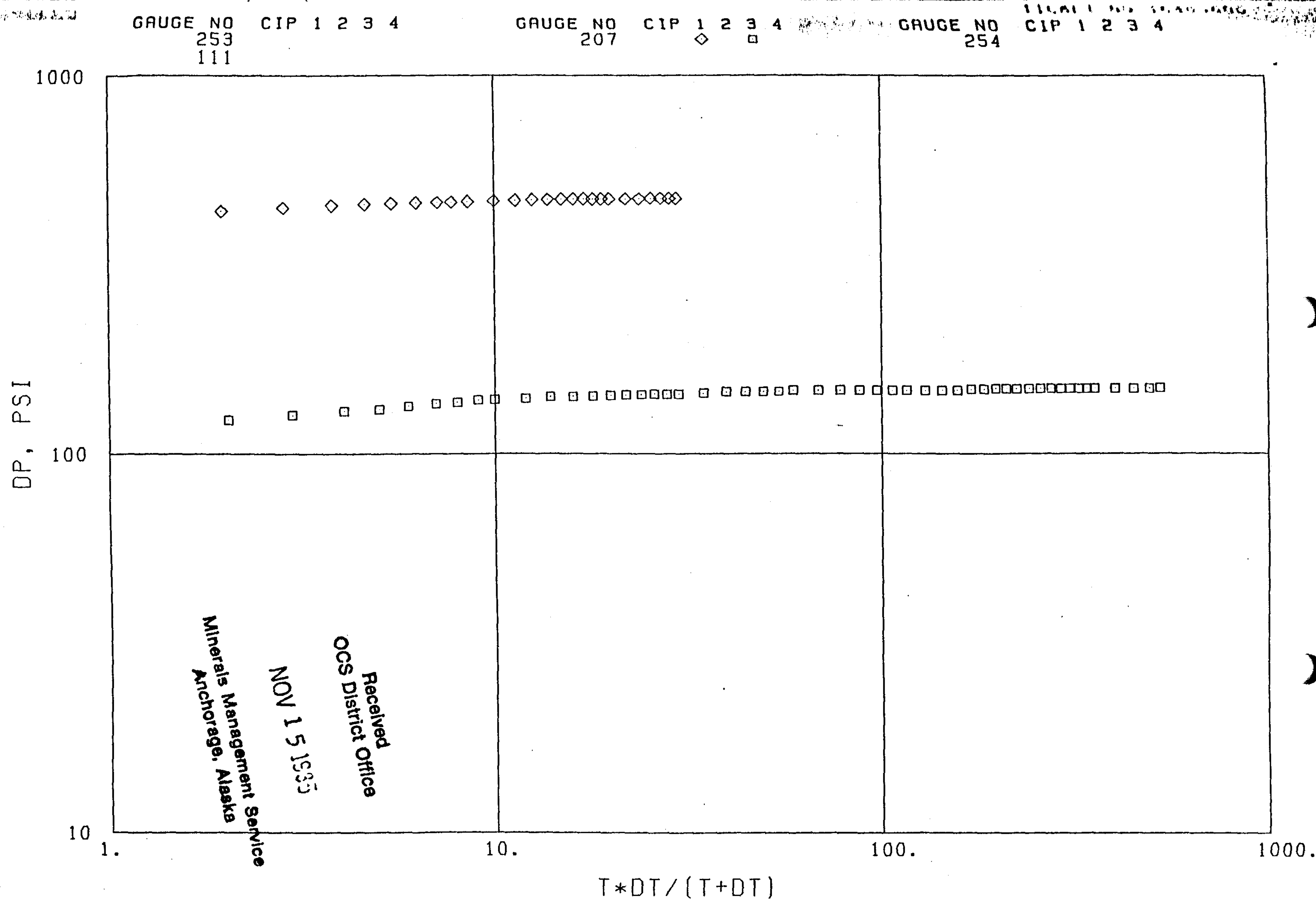
TICKET NO 16485600

GAUGE NO 253 111 CIP 1 2 3 4 ◇

GAUGE NO 207 CIP 1 2 3 4

GAUGE NO 254 CIP 1 2 3 4

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GAUGE NO 207 CIP 1 2 3 4
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DP, PSI
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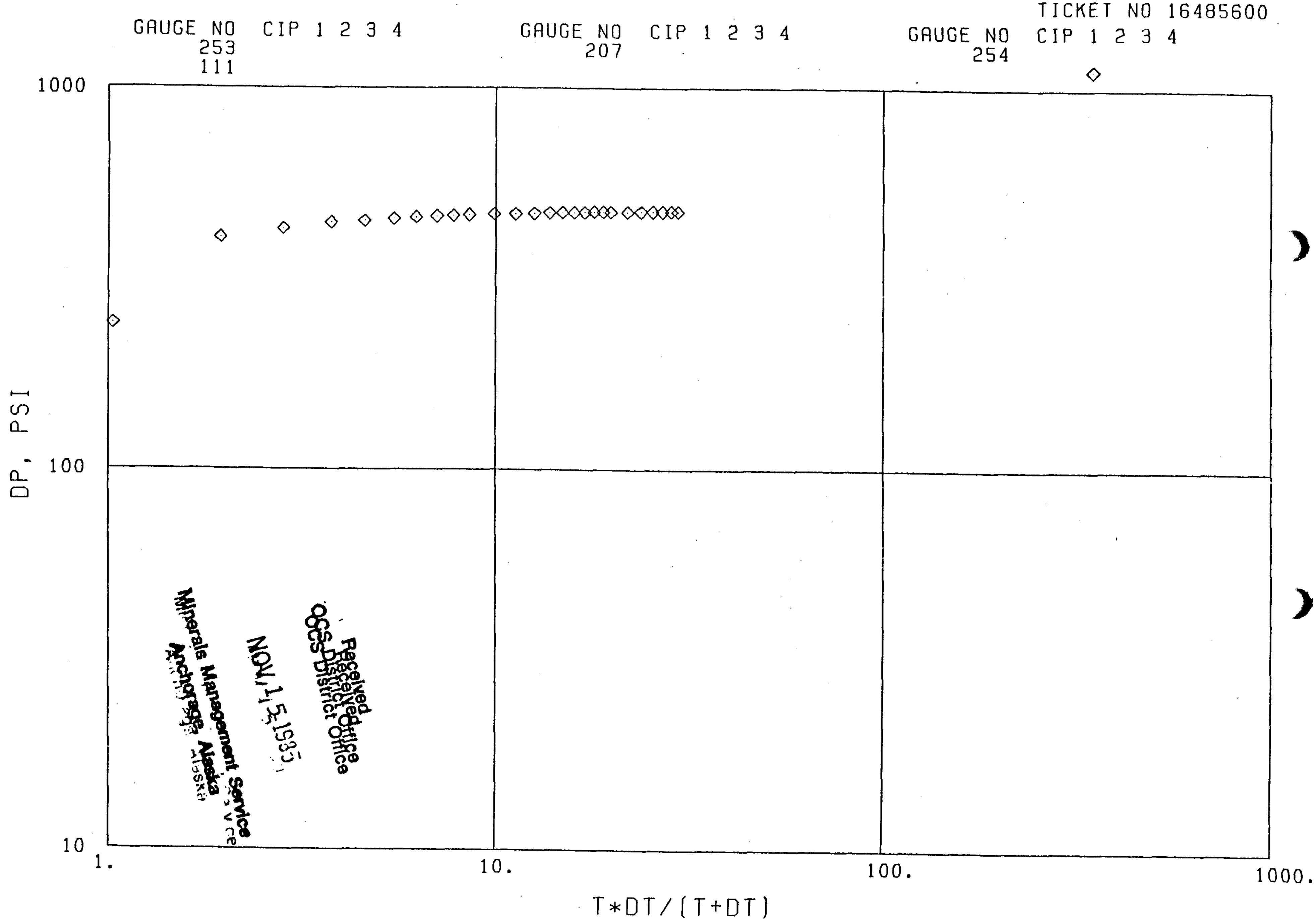

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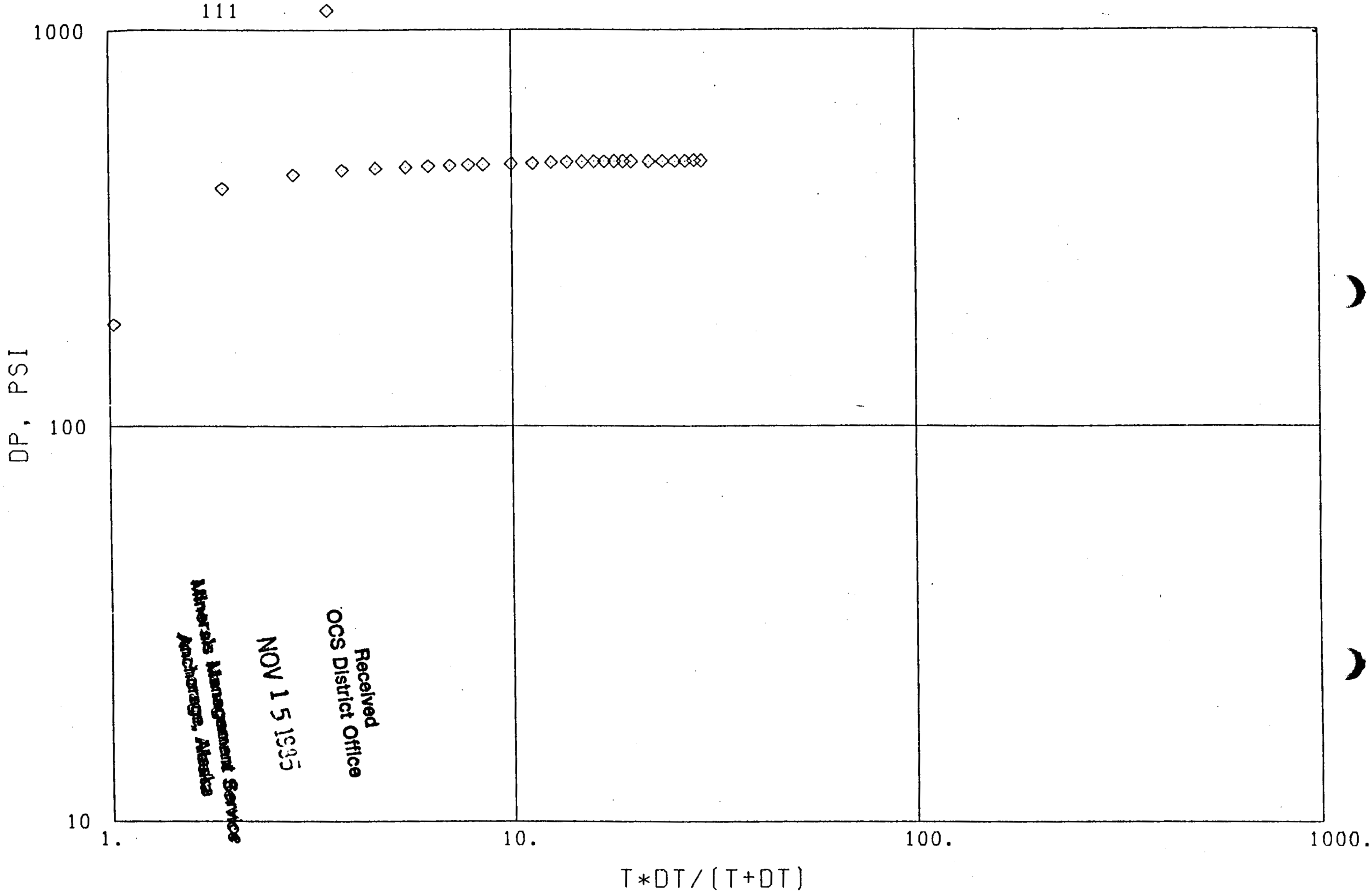

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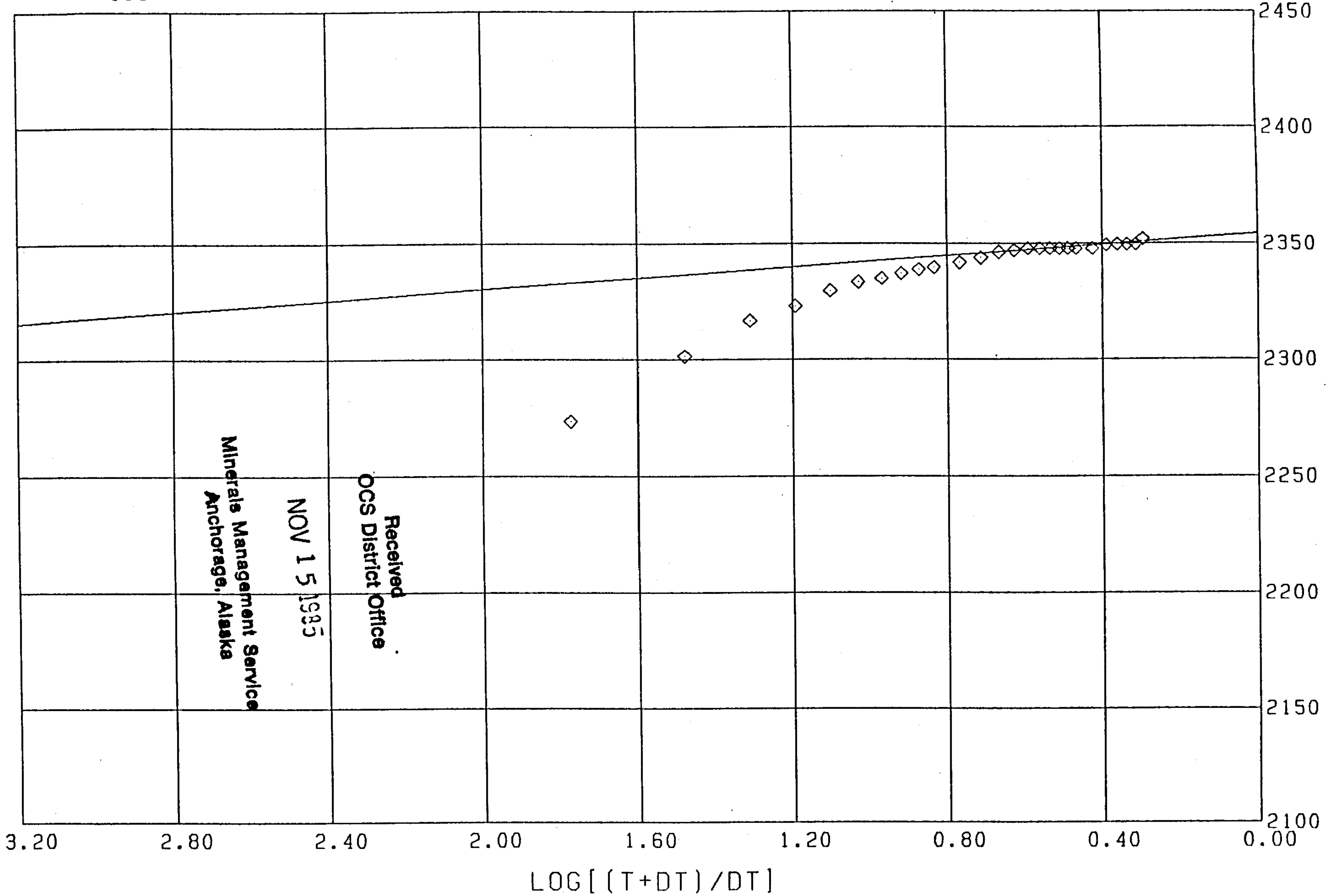

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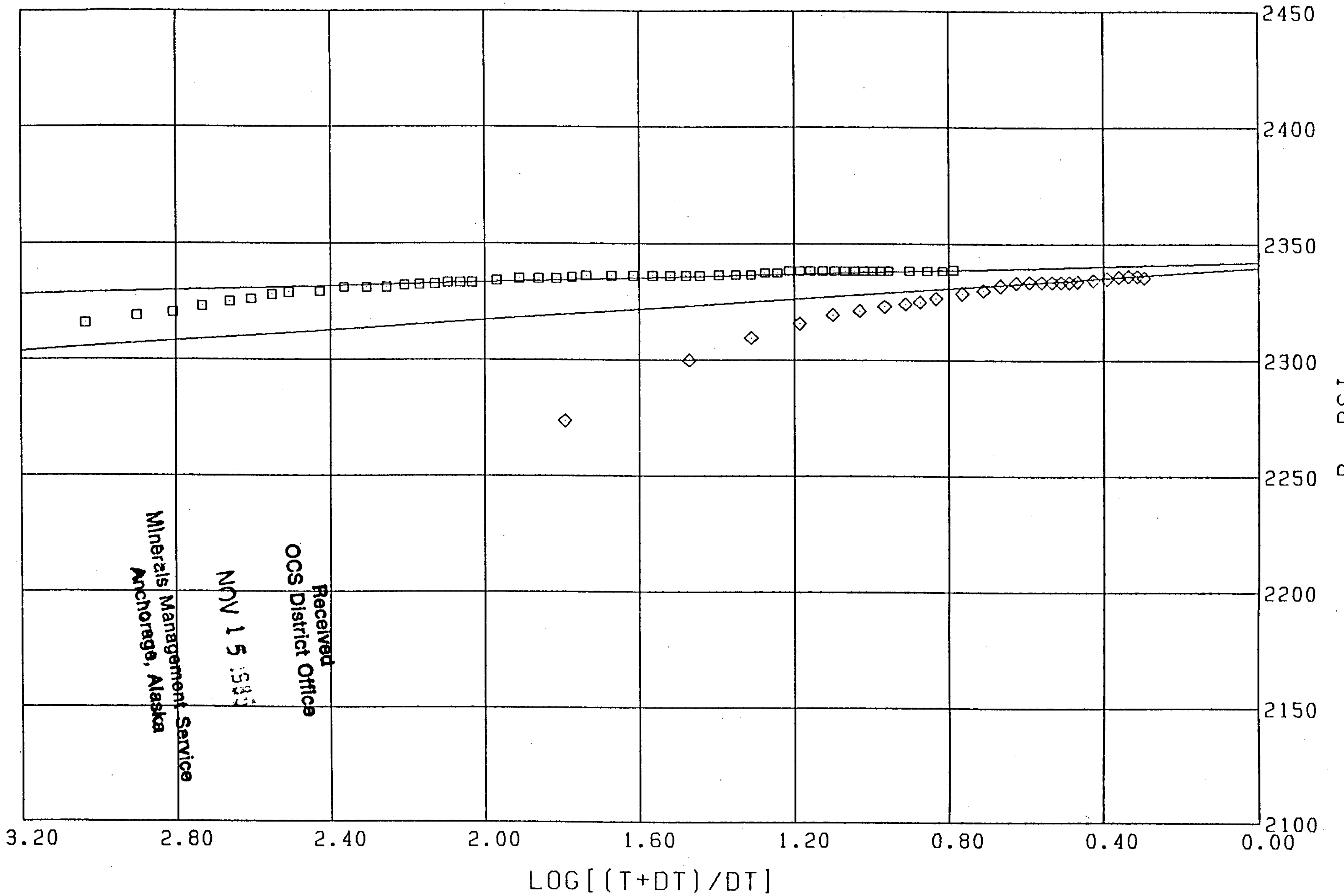
Minerals Management Service
Anchorage, Alaska

TICKET NO 16405600

GAUGE NO 253 111 CIP 1 2 3 4

GAUGE NO 207 CIP 1 2 3 4 ◇ □

GAUGE NO 254 CIP 1 2 3 4



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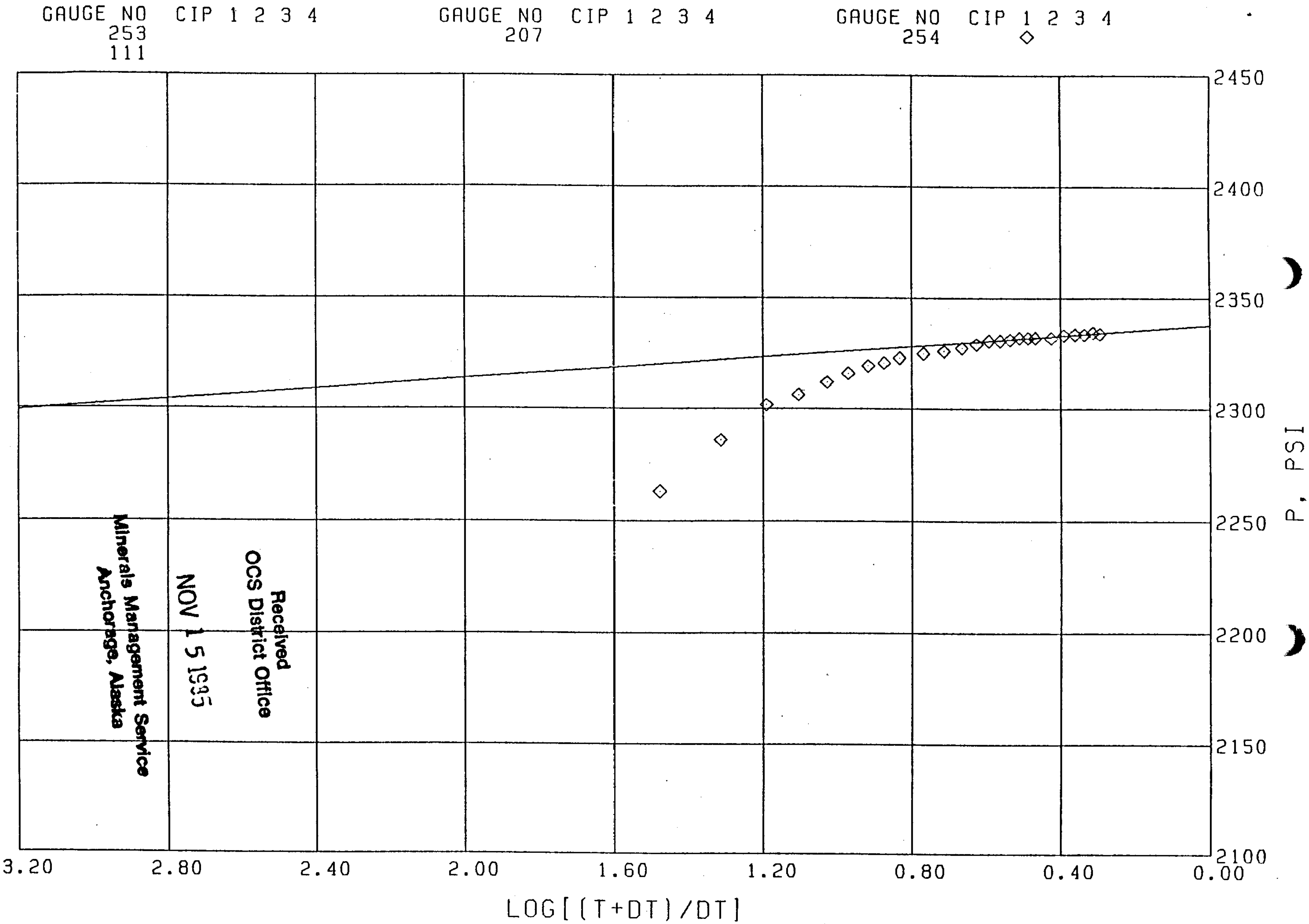

TICKET NO 18489600

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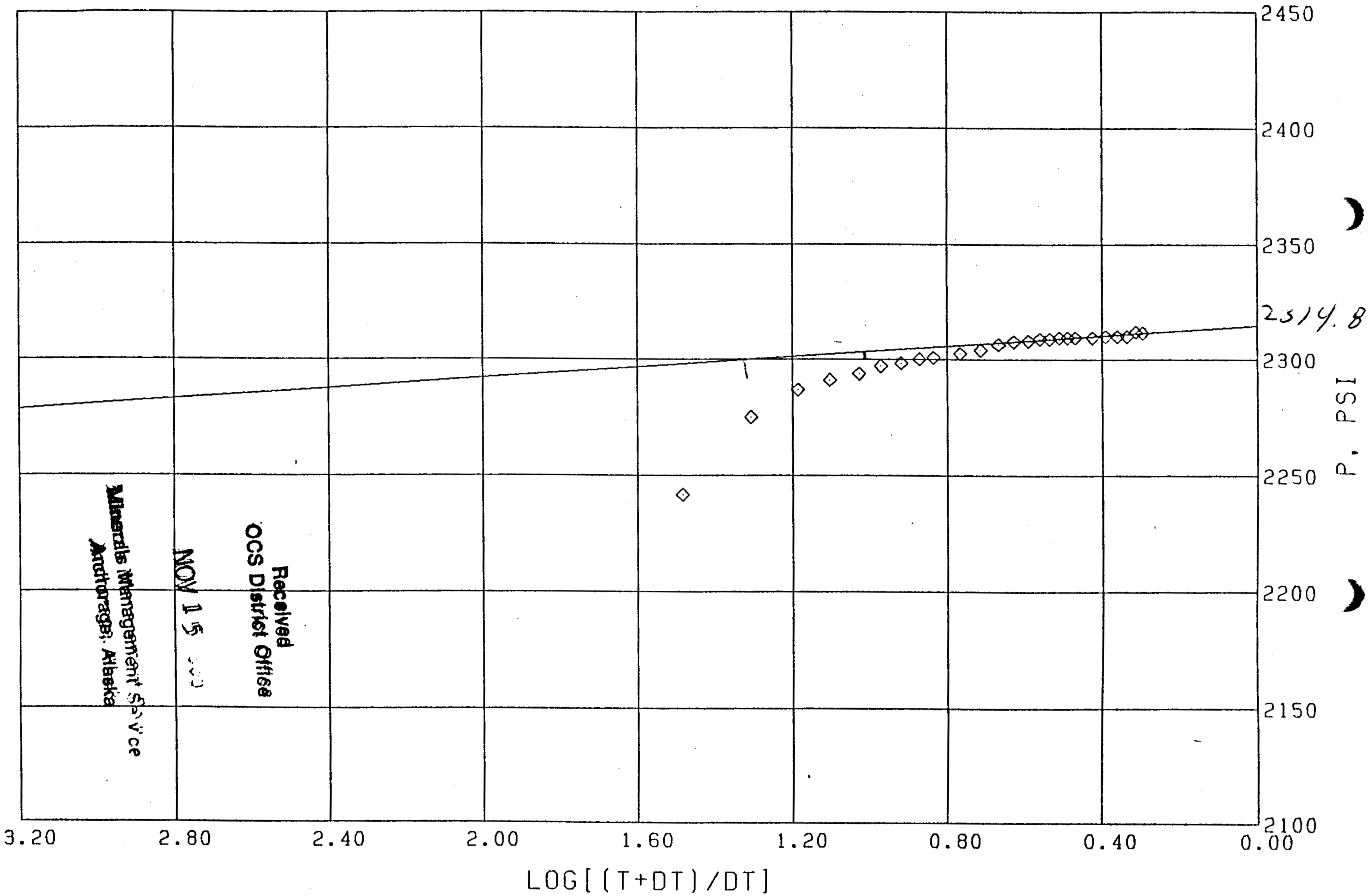

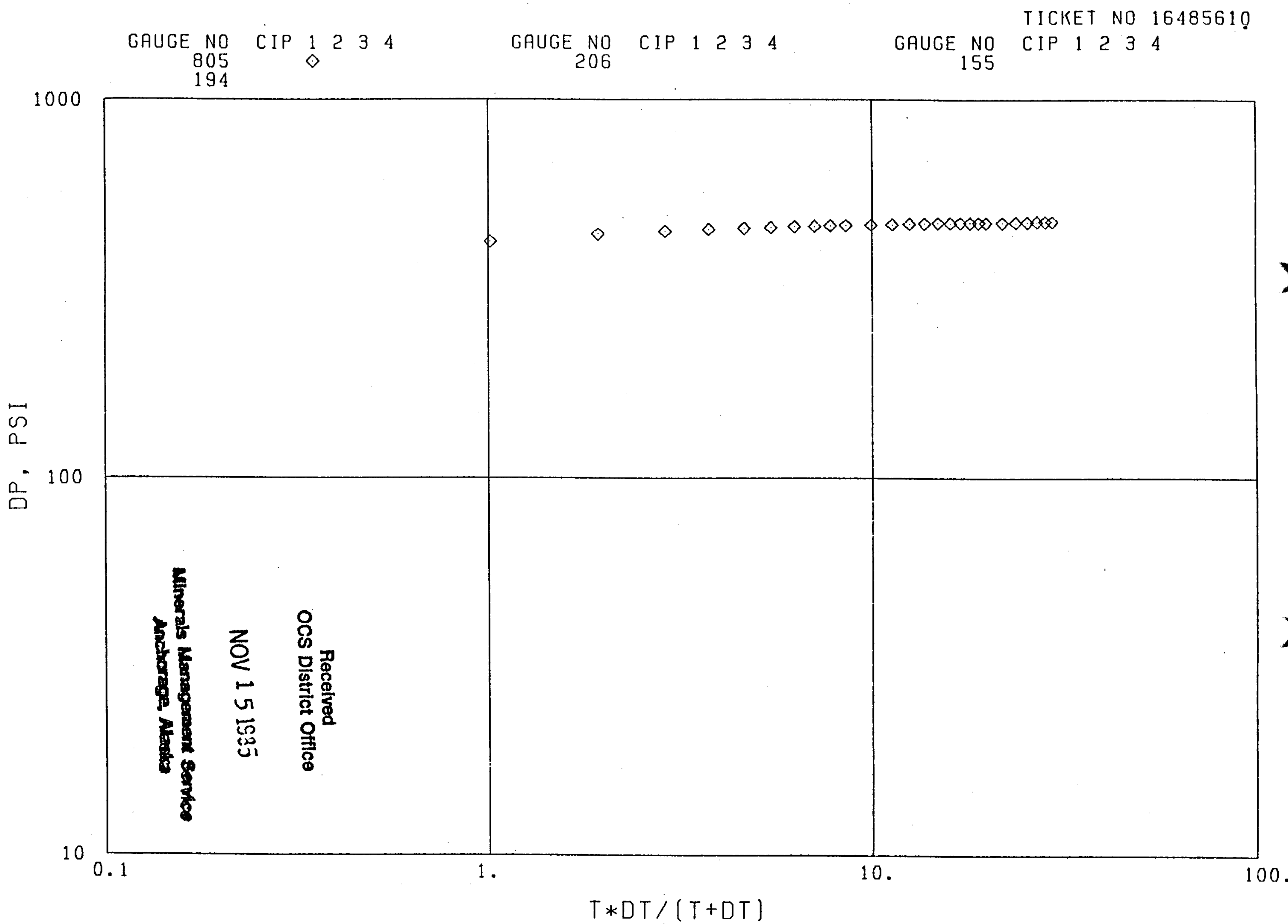
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GAUGE NO 805 194 CIP 1 2 3 4
GAUGE NO 206 CIP 1 2 3 4
GAUGE NO 155 CIP 1 2 3 4
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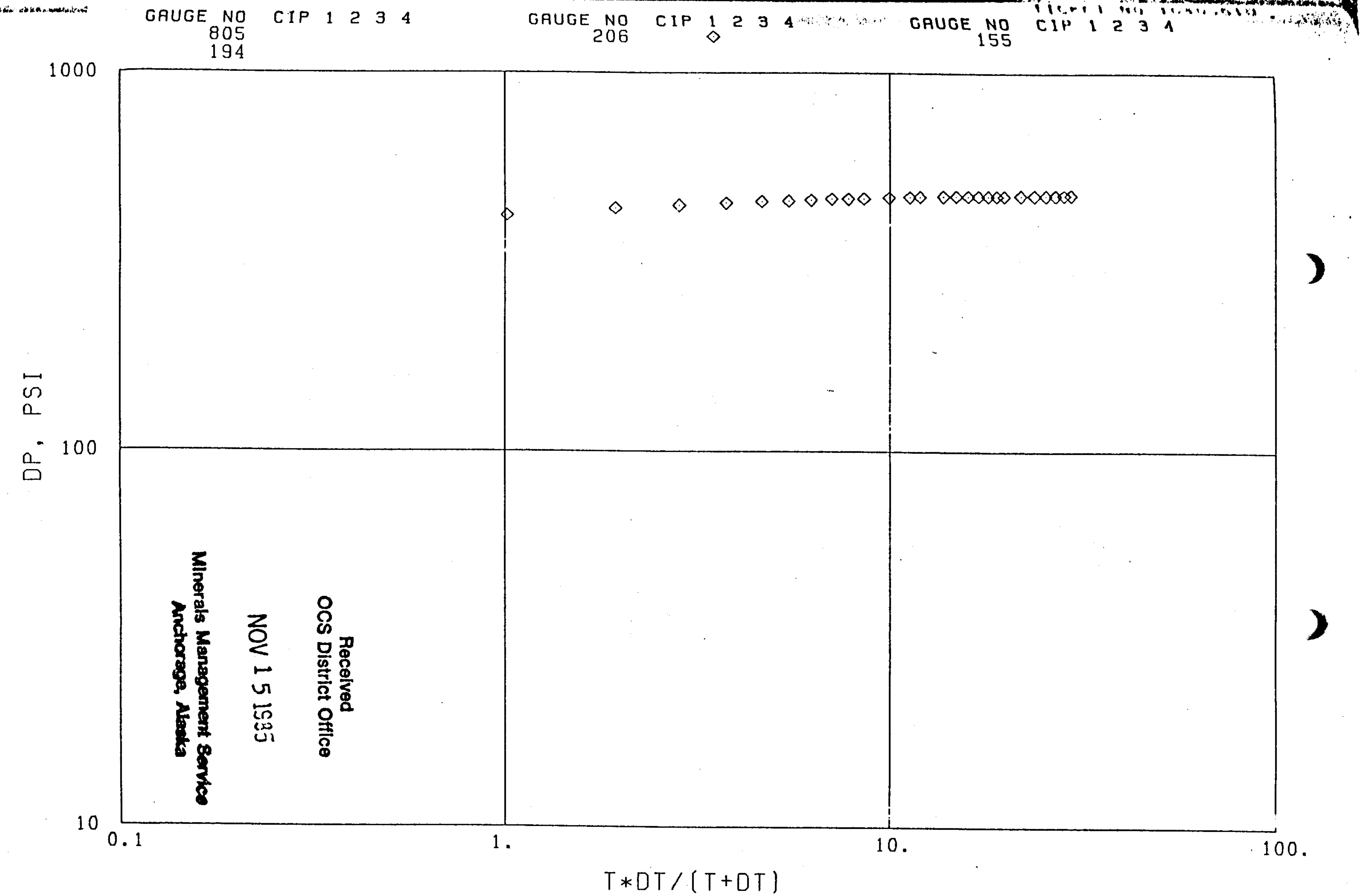
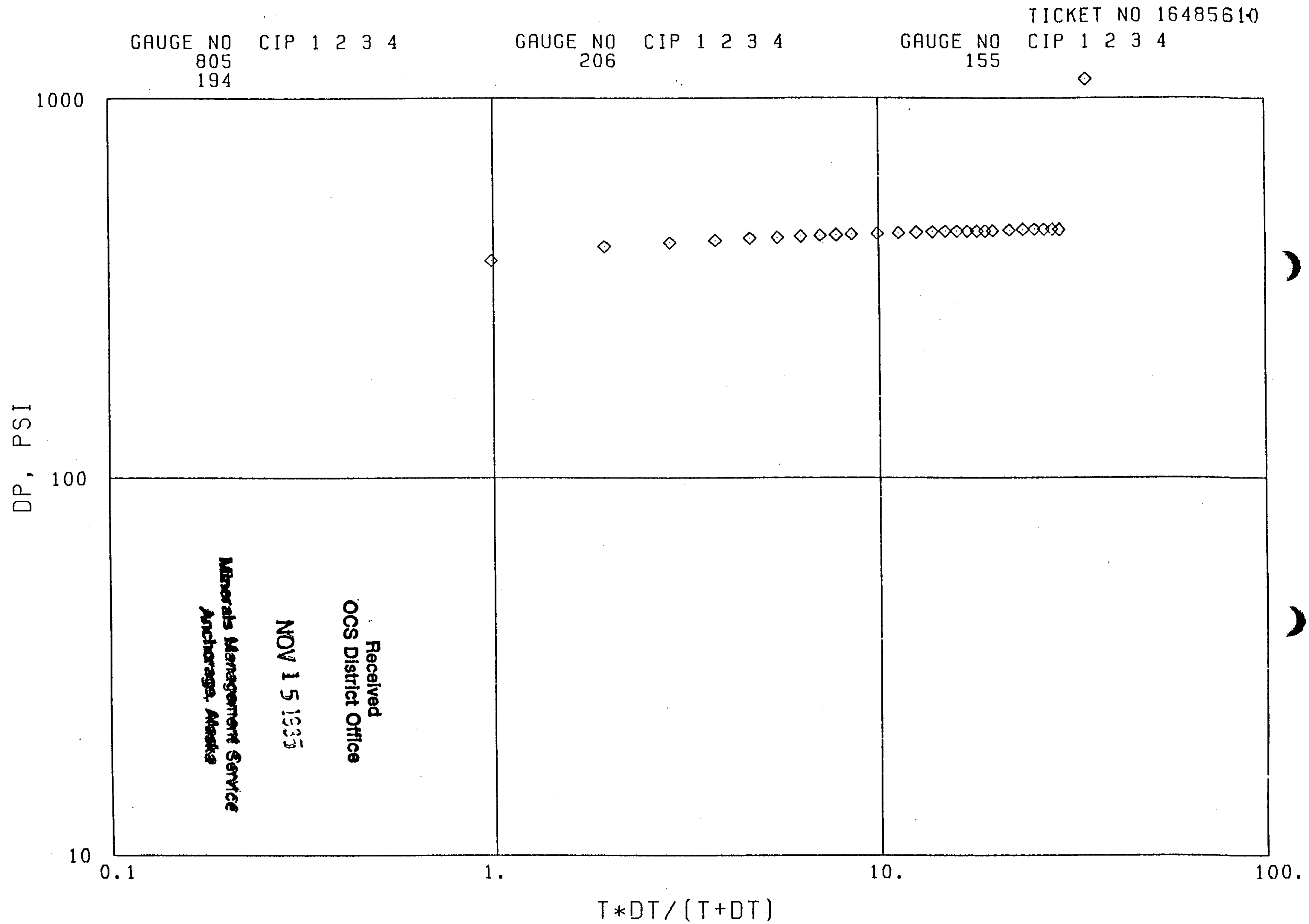
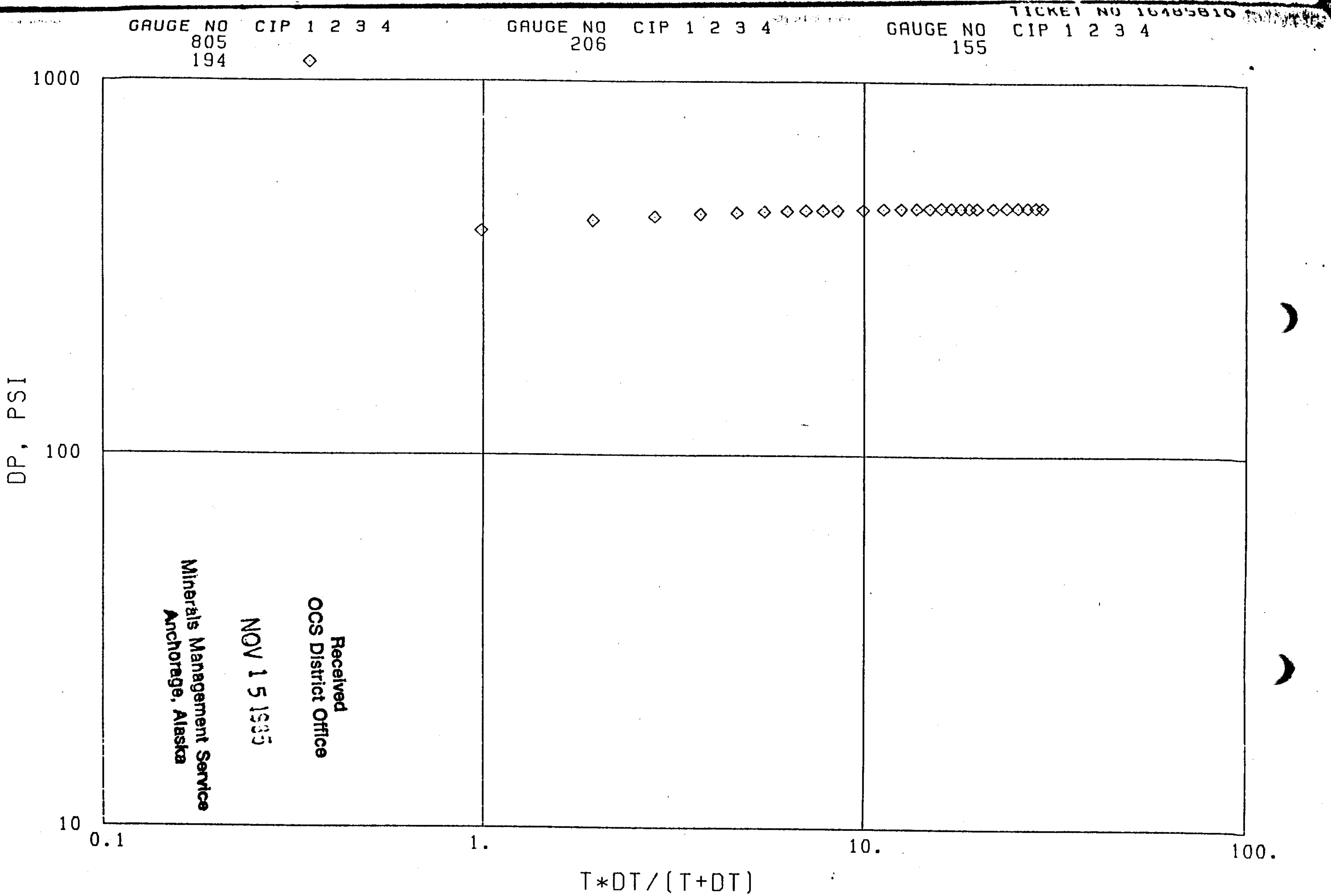
100
10
DP, PSI
0.1
1.
10.
100.
T*DT/(T+DT)
Received
OCS District Office
NOV 1 5 1985
Minerals Management Service
Anchorage, Alaska



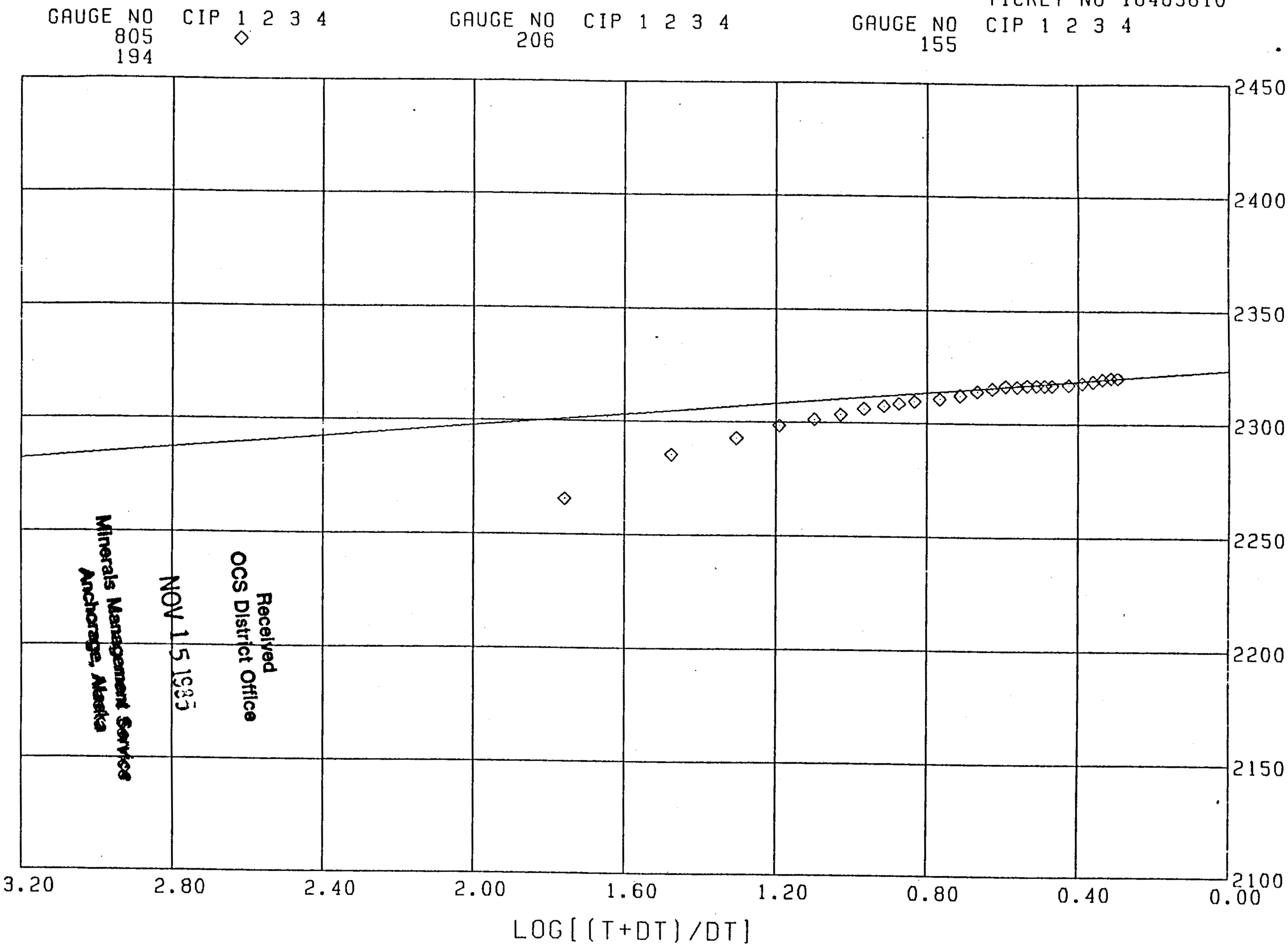
GAUGE NO 805 194 CIP 1 2 3 4
GAUGE NO 206 CIP 1 2 3 4
GAUGE NO 155 CIP 1 2 3 4
1000
100
10
DP, PSI
0.1
1.
10.
100.
T*DT/(T+DT)
Received
OCS District Office
NOV 15 1985
Minerals Management Service
Anchorage, Alaska

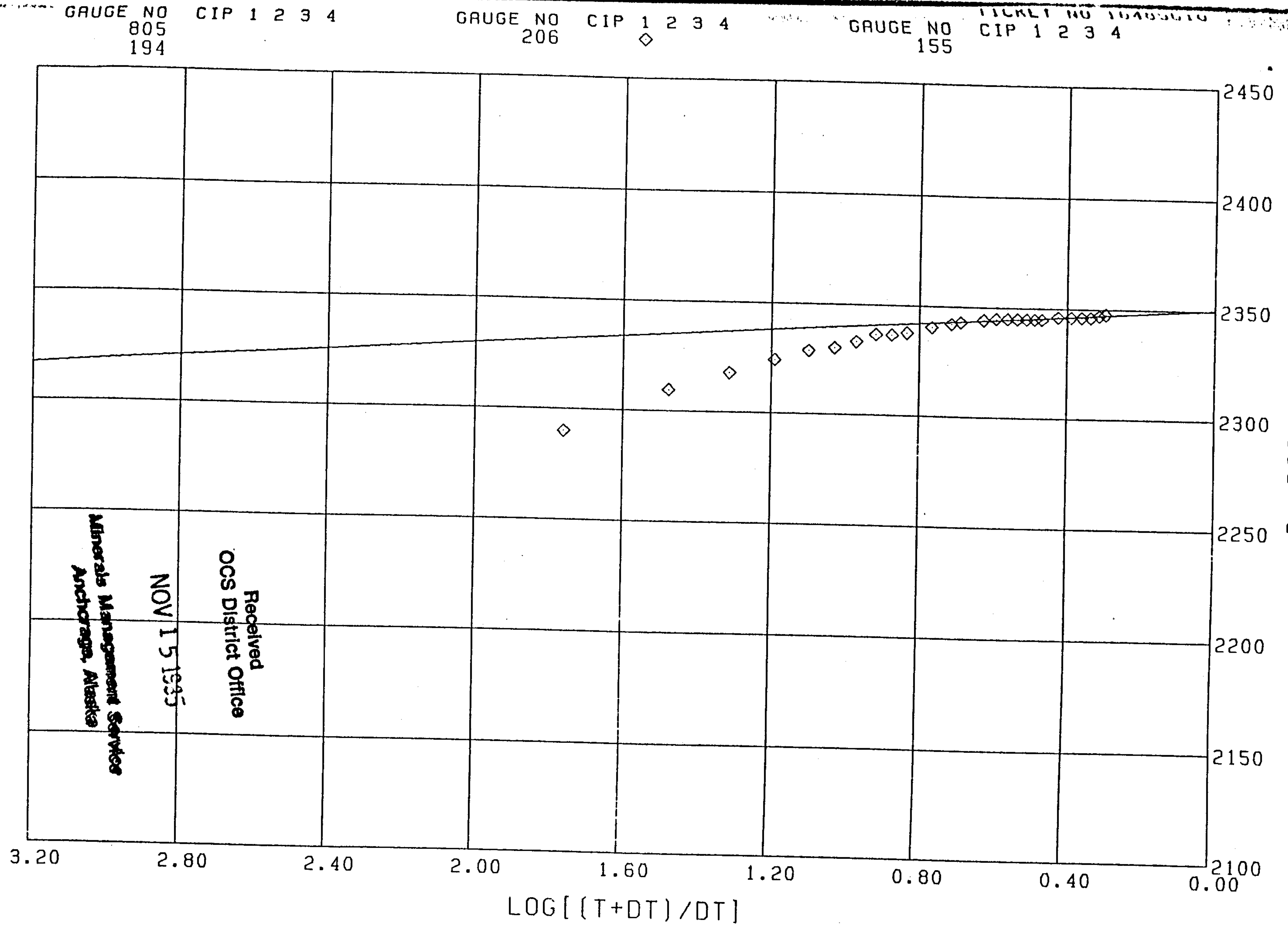

TICKET NO 16485610
GAUGE NO CIP 1 2 3 4
805
194
GAUGE NO CIP 1 2 3 4
206
GAUGE NO CIP 1 2 3 4
155
1000
100
10
DP, PSI
0.1
1.
10.
100.
T*DT/(T+DT)
Received
OCS District Office
NOV 15 1985
Minerals Management Service
Anchorage, Alaska



TICKET NO 16485810
GAUGE NO 805 194
CIP 1 2 3 4
GAUGE NO 206
CIP 1 2 3 4
GAUGE NO 155
CIP 1 2 3 4
1000
100
10
DP, PSI
0.1
1.
10.
100.
T*DT/(T+DT)

TICKET NO 16485610



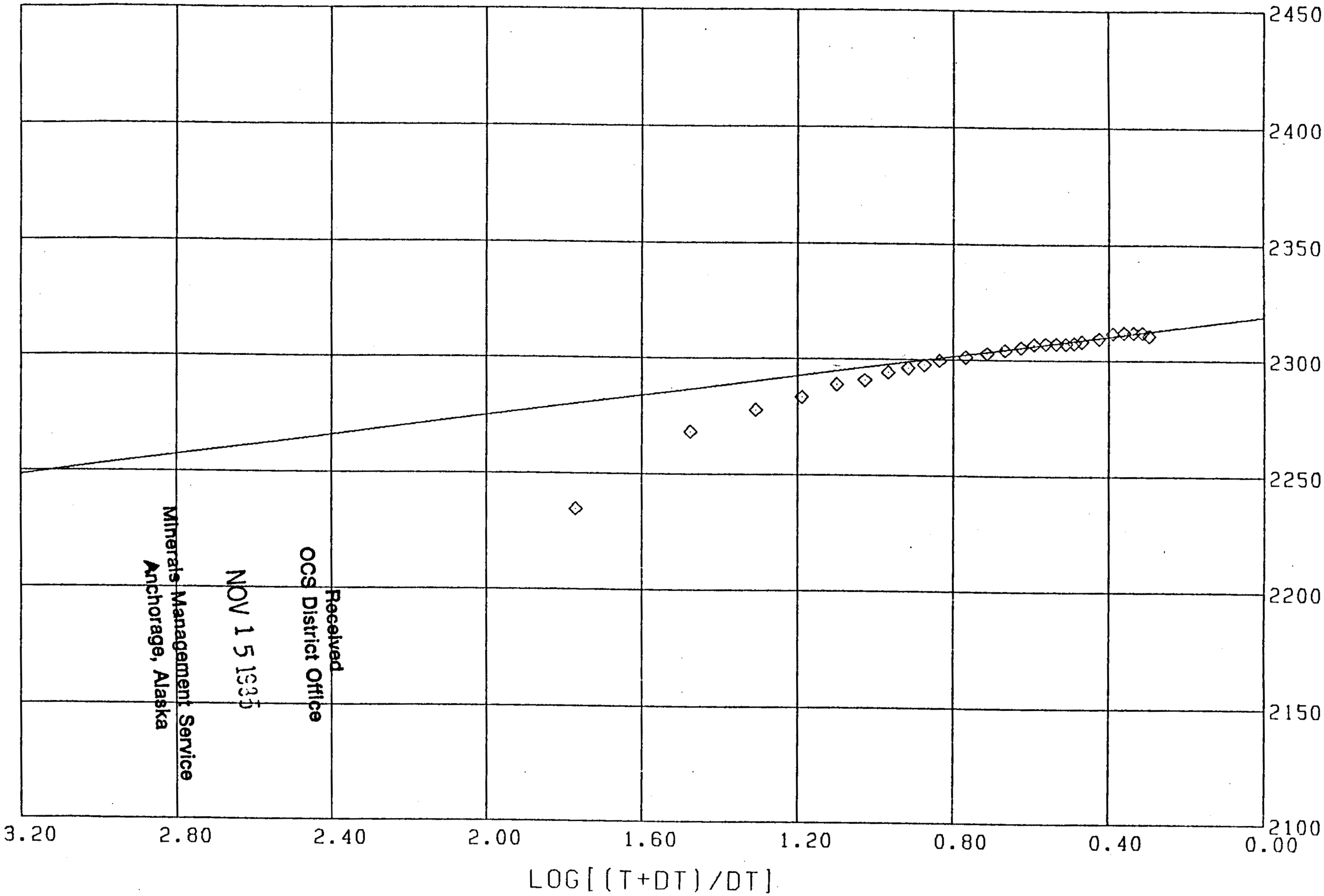

GAUGE NO 805 194 CIP 1 2 3 4
GAUGE NO 206 CIP 1 2 3 4
GAUGE NO 155 CIP 1 2 3 4
2450
2400
2350
2300
2250
2200
2150
2100
P, PSI
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
0.00
LOG[(T+DT)/DT]

TICKET NO 16485610

GAUGE NO 805 194 CIP 1 2 3 4

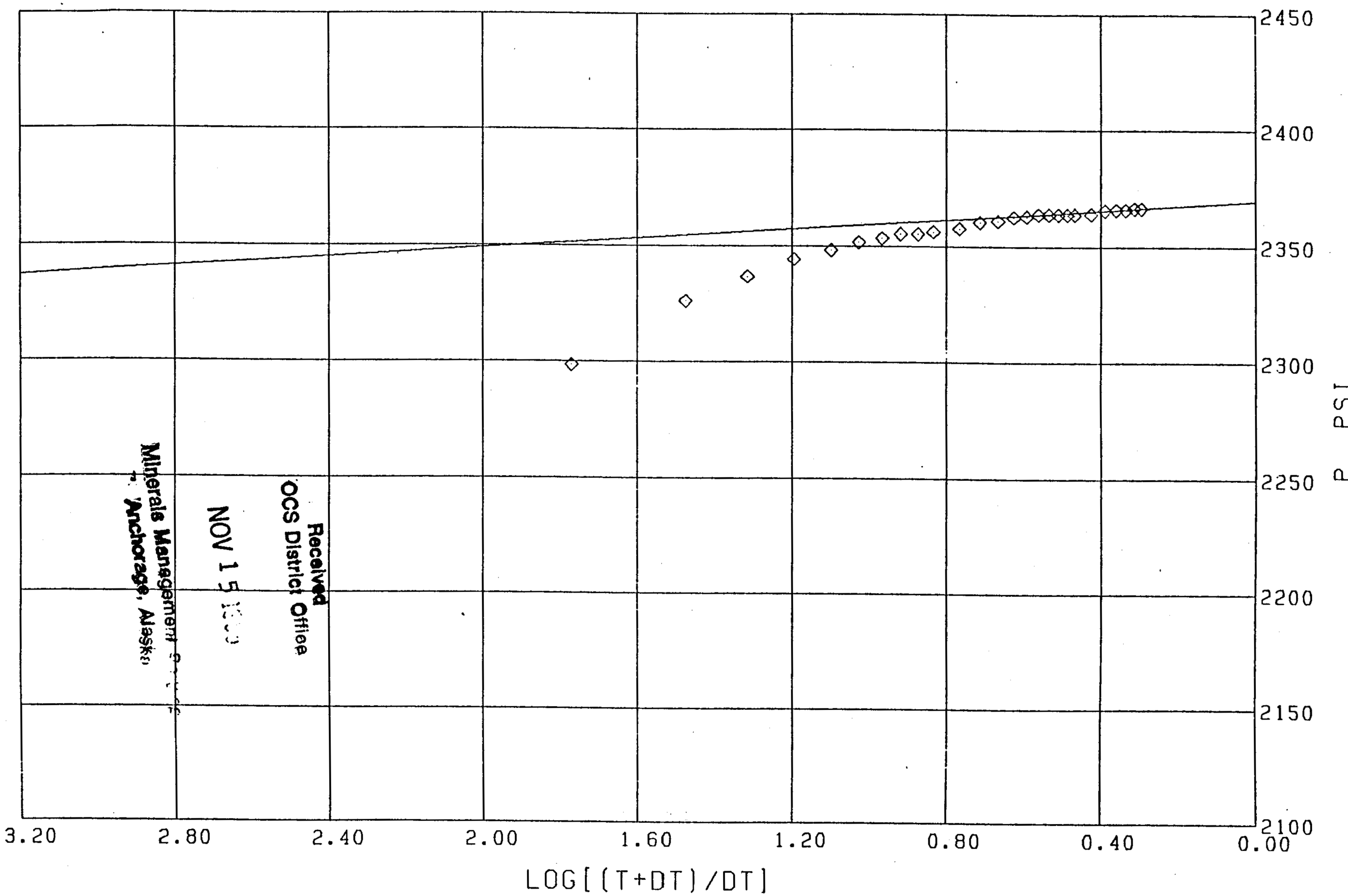
GAUGE NO 206 CIP 1 2 3 4

GAUGE NO 155 CIP 1 2 3 4 ◇



GAUGE NO CIP 1 2 3 4

GAUGE NO 805 194 CIP 1 2 3 4 ◇ GAUGE NO 206 CIP 1 2 3 4 GAUGE NO 155 CIP 1 2 3 4



TICKET NUMBER 16485600

SUMMARY OF RESERVOIR PARAMETERS

USING HORNER METHOD FOR LIQUID WELLS

OIL GRAVITY 0.0 °API@60°F
GAS GRAVITY 0.700
GAS/OIL RATIO 0.0 SCF/STB
TEMPERATURE 100.0 °F
NET PAY 0.0 ft
POROSITY 10.0 %

WATER SALINITY 0.0 % SALT
FLUID GRADIENT 0.4663 psi/ft
FLUID PROPERTIES AT 0.0 psig
VISCOSITY 0.000 cp
FMT VOL FACTOR 0.000 Rvol/Svol
SYSTEM COMPRESSIBILITY 5.47 $\times 10^{-6}$ vol/vol/psi

PIPE CAPACITY FACTORS ______ ______ ______ ______ bbl/ft

							UNITS
GAUGE NUMBER		253	207	207	254	111		
GAUGE DEPTH		5177.8	5177.8	5177.8	5177.8	5209.8		
FLOW AND CIP PERIOD		1	1	3	1	1		UNITS
FINAL FLOW PRESSURE	P_f	1863.7	1860.6	2189.3	1858.6	1842.1		psig
TOTAL FLOW TIME	t	58.2	58.2	3217.9	58.2	58.2		min
EXTRAPOLATED PRESSURE	P*	2354.3	2339.8	2342.1	2337.7	2314.8		psig
ONE CYCLE PRESSURE		2342.3	2328.4	2337.7	2325.6	2303.4		psig
PRODUCTION RATE	Q							BPD
TRANSMISSIBILITY	kh/μ							md-ft/cp
FLOW CAPACITY	kh							md-ft
PERMEABILITY	k							md
SKIN FACTOR	S							
DAMAGE RATIO	DR							
POTENTIAL RATE	Q_1							BPD
RADIUS OF INVESTIGATION	r_i							ft

REMARKS:

COMPLETE CALCULATIONS COULD NOT BE PERFORMED DUE TO LACK OF STABILIZED PRODUCTION RATE INFORMATION.

LOG-LOG PLOTS AND HORNER PLOTS OF THE AVAILABLE CLOSED-IN PERIOD DATA HAVE BEEN INCLUDED FOR YOUR INSPECTION.

THE STRAIGHT LINES PLACED THROUGH THE HORNER PLOTS YIELDED THE ABOVE VALUES OF EXTRAPOLATED AND ONE-CYCLE PRESSURE.

TICKET NUMBER 16485610

SUMMARY OF RESERVOIR PARAMETERS
USING HORNER METHOD FOR LIQUID WELLS

OIL GRAVITY 0.0 °API@60°F — WATER SALINITY 0.0 % SALT

GAS GRAVITY 0.700 — FLUID GRADIENT 0.4663 psi/ft

GAS/OIL RATIO 0.0 SCF/STB — FLUID PROPERTIES AT 0.0 psig

TEMPERATURE 150.0 °F — VISCOSITY 0.000 cp

NET PAY 0.0 ft — FMT VOL FACTOR 0.000 Rvol/Svol

POROSITY 10.0 % — SYSTEM COMPRESSIBILITY 5.47 $\times 10^{-6}$ vol/vol/psi

PIPE CAPACITY FACTORS ______ ______ ______ ______ bbl/ft

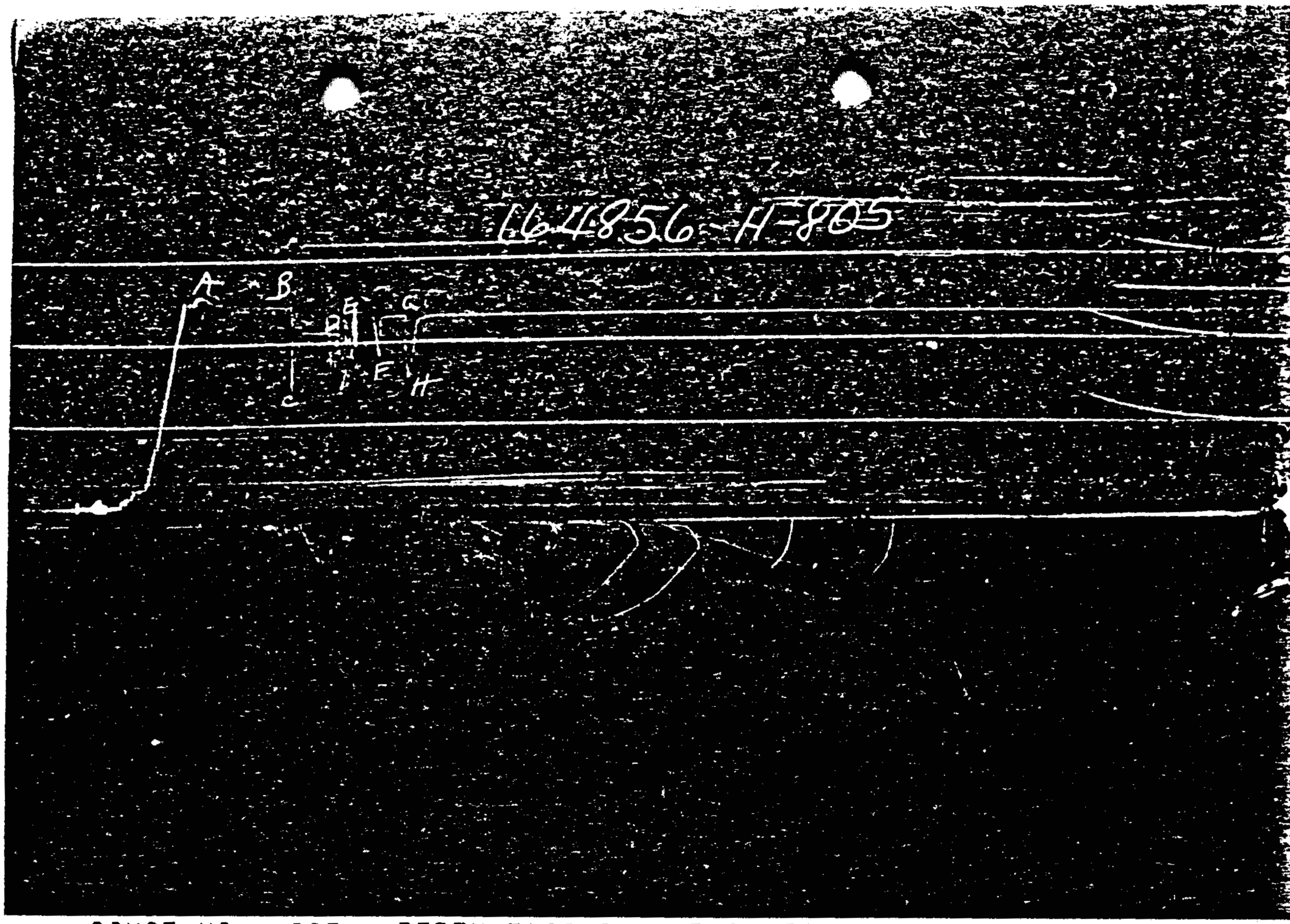
GAUGE NUMBER	805	206	155	194			
GAUGE DEPTH	5209.8	5209.8	5209.8	5217.9			
FLOW AND CIP PERIOD	1	1	1	1			UNITS
FINAL FLOW PRESSURE P_f	1842.5	1871.0	1862.6	1901.1			psig
TOTAL FLOW TIME t	58.2	58.2	58.2	58.2			min
EXTRAPOLATED PRESSURE P*	2324.0	2350.1	2319.3	2369.5			psig
ONE CYCLE PRESSURE	2310.9	2339.8	2297.1	2359.3			psig
PRODUCTION RATE Q							BPD
TRANSMISSIBILITY kh/μ							md-ft/cp
FLOW CAPACITY kh							md-ft
PERMEABILITY k							md
SKIN FACTOR S							
DAMAGE RATIO DR							
POTENTIAL RATE Q_1							BPD
RADIUS OF INVESTIGATION r_i							ft

REMARKS:

Received
OCS District Office

NOV 15 1985

Minerals Management Service
Anchorage, Alaska



GAUGE NO: 805 DEPTH: 5209.8 BLANKED OFF: NO HOUR OF CLOCK: 48

ID	DESCRIPTION	PRESSURE REPORTED	PRESSURE CALCULATED	TIME REPORTED	TIME CALCULATED	TYPE
A	INITIAL HYDROSTATIC		2562.7			
B	END OF BLEEDOFF		2440.5			
C	MINIMUM PRESSURE RELEASE		1665.2			
D	PSI BEFORE PERFORATING		2112.2			
E	INITIAL FIRST FLOW		2159.6	60.0	58.2	F
F	FINAL FIRST FLOW		1842.5			
F	INITIAL FIRST CLOSED-IN		1842.5	60.0	59.7	C
G	FINAL FIRST CLOSED-IN		2320.3			
H	INITIAL SECOND FLOW		1580.0	2546.0		F
I	FINAL SECOND FLOW					
I	INITIAL SECOND CLOSED-IN			369.0		C
J	FINAL SECOND CLOSED-IN					
K	INITIAL THIRD FLOW			617.0		F
L	FINAL THIRD FLOW					
L	INITIAL THIRD CLOSED-IN			625.0		C
M	FINAL THIRD CLOSED-IN					
N	INITIAL FOURTH FLOW			61.0		F
O	FINAL FOURTH FLOW					
O	INITIAL FOURTH CLOSED-IN			188.0		C
P	FINAL FOURTH CLOSED-IN					
Q	FINAL HYDROSTATIC					