

23 July 1991

Manitoba Energy and Mines
#555, 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3



Attention: Mr. John Fox,
Chief Petroleum Engineer

Dear Mr. Fox:

Re: **Waskada Unit No. 16**
1991 Annual Pressure Survey

FILE: UNIT No 16
Pressure
Survey.

Enron Oil Canada Ltd. conducted pressure fall-off tests on all nine water injection wells within Waskada Unit No. 16. The semilog MDH (Miller-Dyes-Hutchinson) method was used to determine formation permeability and skin factor from the pressure fall-off test data. The average pressure within the drainage area was then estimated using SPE's Monograph No. 5 (Figure 6.6, Pg 66) for the case of constant pressure at the drainage boundary. Pressure fall-off test results for all nine wells are attached and summarized in Table 1. All nine wells continue to have average drainage region pressures exceeding the 5 000 kPa minimum requirement at a datum depth of 440 m subsea.

Should you have any questions concerning the latest pressure survey results, please feel free to contact the undersigned at your convenience.

Yours very truly,

ENRON OIL CANADA LTD.

H. Dale Logie, P.Eng.
Chief Reservoir Engineer

HDL:pdc
attach

PRESSURE FALLOFF DATA

TABLE 1

WELL	INJECTION	CORRECTED	SHUT-IN	NET	WATER	SKIN	LAST	CHART	CHART	AVERAGE
LOCATION	RATE	TIME	TIME	PAY	PERM.	FACTOR	PRESSURE	TIME	PRESSURE	PRESSURE
	Q - m ³ /D	Tp - hrs	Is - hrs	H - m	Kw - mD	S	Pws - kPa	Tda	Pmdh	Pe - kPa
05-04-02-25WPH	32.0	7250	480	8.52	1.32	-5.72	9749	0.0823	0.270	8740
11-04-02-25WPH	3.5	4100	2160	11.29	0.13	-4.96	9474	0.0332	0.700	7210
15-04-02-25WPH	8.0	8300	1392	12.66	0.30	-6.16	13670	0.0508	0.495	12300
16-05-02-25WPH	25.0	7950	480	7.17	1.83	-5.18	10670	0.1143	0.150	10300
01-09-02-25WPH	5.0	2360	506	14.09	0.21	-5.04	13500	0.0142	1.105	11070
06-09-02-25WPH	22.0	11440	481	6.49	1.30	-6.25	12130	0.0788	0.290	11140
10-09-02-25WPH	2.5	23680	481	3.40	0.29	-4.82	9899	0.0173	1.005	6510
16-09-02-25WPH	12.0	11640	481	5.20	1.13	-5.84	12570	0.0666	0.345	11650
05-10-02-25WPH	10.0	7070	506	15.22	0.23	-5.67	12350	0.0153	1.080	8240

$$T_p = 24 \cdot V_p / q$$

$$T_{da} = 0.000003557 \cdot K_w \cdot T_s / \phi^{0.7} \mu^* C_t^* A$$

$$P_{mdh} = 1.1513 (P_e - P_{ws}) / m$$

ENRON OIL CANADA LTD.

5-4-02-25WPM

Semi-log Analysis

$m = 4.282E+03$

$Tf = 1.607E+01 \text{ mD-m/cp}$

$s = -5.720E+00$

Delta Pressure, kPa

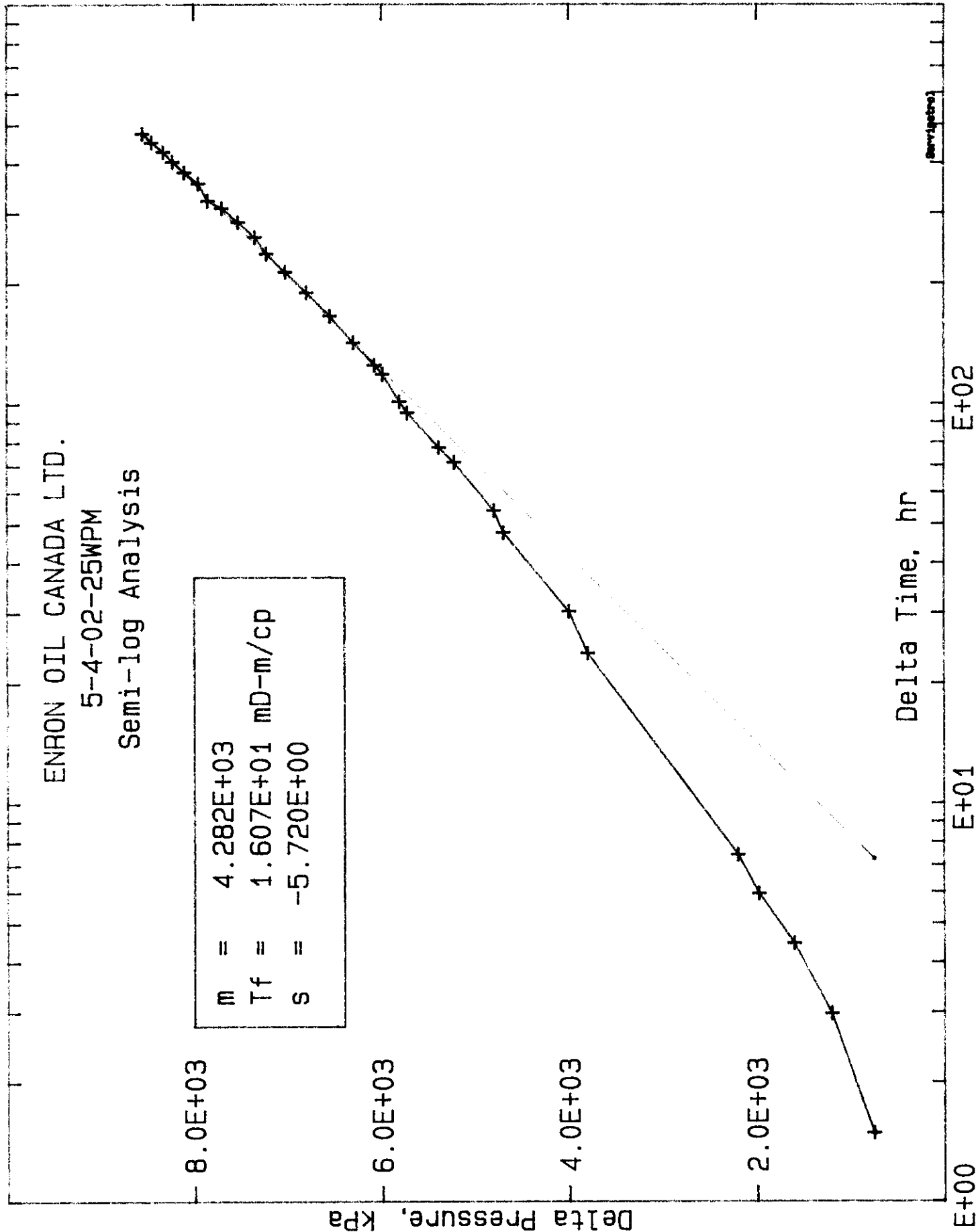
Delta Time, hr

(Derivative)

E+00

E+01

E+02



ENRON OIL CANADA LTD.
5-4-02-25WPM
FALL-OFF TEST
MARCH 1991

Buildup Data
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No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	1.500E+00	1.500E+00	1.755E+04	-7.500E+02
2	3.000E+00	2.999E+00	1.710E+04	-1.200E+03
3	4.500E+00	4.497E+00	1.670E+04	-1.600E+03
4	6.000E+00	5.995E+00	1.632E+04	-1.975E+03
5	7.500E+00	7.492E+00	1.610E+04	-2.200E+03
6	2.400E+01	2.392E+01	1.450E+04	-3.800E+03
7	3.050E+01	3.037E+01	1.430E+04	-4.000E+03
8	4.800E+01	4.768E+01	1.360E+04	-4.700E+03
9	5.450E+01	5.409E+01	1.350E+04	-4.800E+03
10	7.200E+01	7.129E+01	1.307E+04	-5.225E+03
11	7.850E+01	7.766E+01	1.291E+04	-5.390E+03
12	9.600E+01	9.475E+01	1.257E+04	-5.725E+03
13	1.025E+02	1.011E+02	1.249E+04	-5.810E+03
14	1.200E+02	1.180E+02	1.231E+04	-5.990E+03
15	1.265E+02	1.243E+02	1.222E+04	-6.075E+03
16	1.440E+02	1.412E+02	1.200E+04	-6.300E+03
17	1.680E+02	1.642E+02	1.175E+04	-6.550E+03
18	1.920E+02	1.870E+02	1.150E+04	-6.800E+03
19	2.160E+02	2.098E+02	1.127E+04	-7.025E+03
20	2.400E+02	2.323E+02	1.107E+04	-7.225E+03
21	2.640E+02	2.547E+02	1.095E+04	-7.350E+03
22	2.880E+02	2.770E+02	1.077E+04	-7.525E+03
23	3.120E+02	2.991E+02	1.060E+04	-7.700E+03
24	3.260E+02	3.120E+02	1.045E+04	-7.850E+03
25	3.600E+02	3.430E+02	1.035E+04	-7.950E+03
26	3.840E+02	3.647E+02	1.020E+04	-8.100E+03
27	4.080E+02	3.863E+02	1.007E+04	-8.225E+03
28	4.320E+02	4.077E+02	9.974E+03	-8.325E+03
29	4.560E+02	4.290E+02	9.849E+03	-8.450E+03
30	4.800E+02	4.502E+02	9.749E+03	-8.550E+03

Semi-log Analysis
=====

Input Data

Pressure Run Depth..... = 0.000E-01 m
Pressure Reference Depth..... = 9.172E+02 m
Pressure Gradient..... = 9.810E+00 kPa/m
Pressure Correction Term..... = 8.998E+03 kPa
All measured pressure data are corrected to the reference depth
Production Time..... = 7.250E+03 hr
Water Flow Rate..... = 3.200E+01 m³/D
Bottomhole Flowing Pressure..... = 1.830E+04 kPa
Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
Water Viscosity..... = 7.000E-01 cp
Reservoir Temperature..... = 4.300E+01 Degree C
Pay Thickness..... = 8.520E+00 m
Porosity..... = 1.600E-01
Total Compressibility..... = 1.510E-06 1/kPa
Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 4.282E+03
Water Transmissibility..... = 1.607E+01 mD-m/cp
Water Reservoir Capacity..... = 1.125E+01 mD-m
Water Mobility..... = 1.886E+00 mD/cp
Effective Permeability to Water... = 1.320E+00 mD
Skin Factor..... = -5.720E+00
Pressure Drop due to skin..... = -2.131E+04 kPa
Total Ideal Productivity Index... = 1.459E-03 Res m³/D/kPa
Total Actual Productivity Index... = 5.069E-02 Res m³/D/kPa
Total Flow Efficiency..... = 3.475E+01
Radius of Investigation..... = 8.949E+02 m

ENRON OIL CANADA LTD.

11-4-02-25WPM

Semi-log Analysis

$m = 3.716E+03$

$Tf = 2.025E+00 \text{ mD-m/cp}$

$s = -4.961E+00$

Delta Pressure, KPa

Delta Time, hr

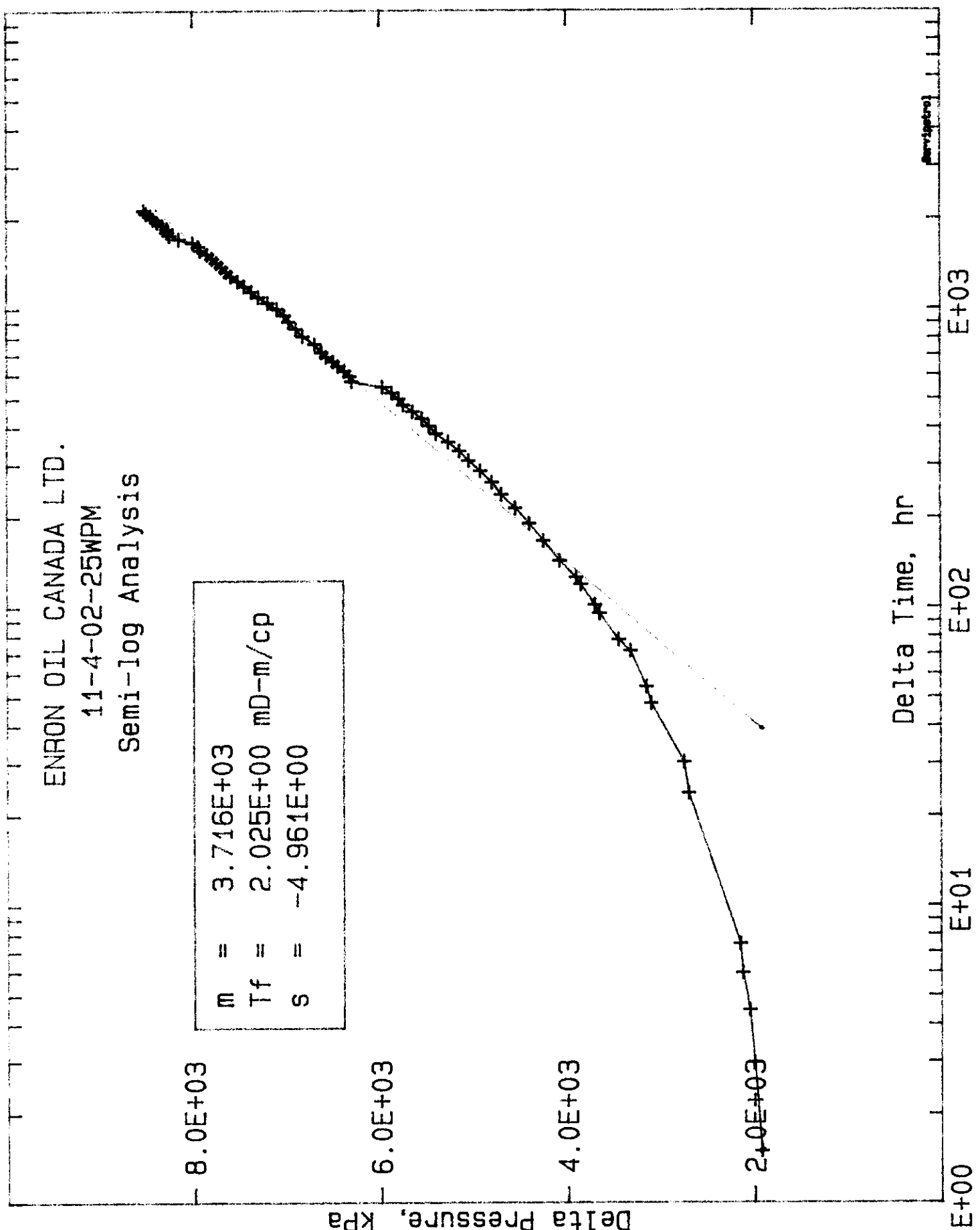
E+00

E+01

E+02

E+03

Pressure



ENROW OIL CANADA LTD.
11-4-02-2500H
FALL-OFF TEST
MARCH 1991

Buildup Data =====

No.	Shutin hr	time Effective hr	Pressure kPa	Delta P kPa
1	1.500E+00	1.499E+00	1.607E+04	-1.925E+03
2	2.000E+00	2.000E+00	1.607E+04	-1.925E+03
3	3.000E+00	3.000E+00	1.607E+04	-1.925E+03
4	4.000E+00	4.000E+00	1.607E+04	-1.925E+03
5	5.000E+00	5.000E+00	1.607E+04	-1.925E+03
6	6.000E+00	6.000E+00	1.607E+04	-1.925E+03
7	7.000E+00	7.000E+00	1.607E+04	-1.925E+03
8	8.000E+00	8.000E+00	1.607E+04	-1.925E+03
9	9.000E+00	9.000E+00	1.607E+04	-1.925E+03
10	1.000E+01	1.000E+01	1.607E+04	-1.925E+03
11	1.100E+01	1.100E+01	1.607E+04	-1.925E+03
12	1.200E+01	1.200E+01	1.607E+04	-1.925E+03
13	1.300E+01	1.300E+01	1.607E+04	-1.925E+03
14	1.400E+01	1.400E+01	1.607E+04	-1.925E+03
15	1.500E+01	1.500E+01	1.607E+04	-1.925E+03
16	1.600E+01	1.600E+01	1.607E+04	-1.925E+03
17	1.700E+01	1.700E+01	1.607E+04	-1.925E+03
18	1.800E+01	1.800E+01	1.607E+04	-1.925E+03
19	1.900E+01	1.900E+01	1.607E+04	-1.925E+03
20	2.000E+01	2.000E+01	1.607E+04	-1.925E+03
21	2.100E+01	2.100E+01	1.607E+04	-1.925E+03
22	2.200E+01	2.200E+01	1.607E+04	-1.925E+03
23	2.300E+01	2.300E+01	1.607E+04	-1.925E+03
24	2.400E+01	2.400E+01	1.607E+04	-1.925E+03
25	2.500E+01	2.500E+01	1.607E+04	-1.925E+03
26	2.600E+01	2.600E+01	1.607E+04	-1.925E+03
27	2.700E+01	2.700E+01	1.607E+04	-1.925E+03
28	2.800E+01	2.800E+01	1.607E+04	-1.925E+03
29	2.900E+01	2.900E+01	1.607E+04	-1.925E+03
30	3.000E+01	3.000E+01	1.607E+04	-1.925E+03
31	3.100E+01	3.100E+01	1.607E+04	-1.925E+03
32	3.200E+01	3.200E+01	1.607E+04	-1.925E+03
33	3.300E+01	3.300E+01	1.607E+04	-1.925E+03
34	3.400E+01	3.400E+01	1.607E+04	-1.925E+03
35	3.500E+01	3.500E+01	1.607E+04	-1.925E+03
36	3.600E+01	3.600E+01	1.607E+04	-1.925E+03
37	3.700E+01	3.700E+01	1.607E+04	-1.925E+03
38	3.800E+01	3.800E+01	1.607E+04	-1.925E+03
39	3.900E+01	3.900E+01	1.607E+04	-1.925E+03
40	4.000E+01	4.000E+01	1.607E+04	-1.925E+03
41	4.100E+01	4.100E+01	1.607E+04	-1.925E+03
42	4.200E+01	4.200E+01	1.607E+04	-1.925E+03
43	4.300E+01	4.300E+01	1.607E+04	-1.925E+03
44	4.400E+01	4.400E+01	1.607E+04	-1.925E+03
45	4.500E+01	4.500E+01	1.607E+04	-1.925E+03
46	4.600E+01	4.600E+01	1.607E+04	-1.925E+03
47	4.700E+01	4.700E+01	1.607E+04	-1.925E+03
48	4.800E+01	4.800E+01	1.607E+04	-1.925E+03
49	4.900E+01	4.900E+01	1.607E+04	-1.925E+03
50	5.000E+01	5.000E+01	1.607E+04	-1.925E+03
51	5.100E+01	5.100E+01	1.607E+04	-1.925E+03
52	5.200E+01	5.200E+01	1.607E+04	-1.925E+03
53	5.300E+01	5.300E+01	1.607E+04	-1.925E+03
54	5.400E+01	5.400E+01	1.607E+04	-1.925E+03
55	5.500E+01	5.500E+01	1.607E+04	-1.925E+03
56	5.600E+01	5.600E+01	1.607E+04	-1.925E+03
57	5.700E+01	5.700E+01	1.607E+04	-1.925E+03
58	5.800E+01	5.800E+01	1.607E+04	-1.925E+03
59	5.900E+01	5.900E+01	1.607E+04	-1.925E+03
60	6.000E+01	6.000E+01	1.607E+04	-1.925E+03
61	6.100E+01	6.100E+01	1.607E+04	-1.925E+03
62	6.200E+01	6.200E+01	1.607E+04	-1.925E+03
63	6.300E+01	6.300E+01	1.607E+04	-1.925E+03
64	6.400E+01	6.400E+01	1.607E+04	-1.925E+03
65	6.500E+01	6.500E+01	1.607E+04	-1.925E+03
66	6.600E+01	6.600E+01	1.607E+04	-1.925E+03
67	6.700E+01	6.700E+01	1.607E+04	-1.925E+03
68	6.800E+01	6.800E+01	1.607E+04	-1.925E+03
69	6.900E+01	6.900E+01	1.607E+04	-1.925E+03
70	7.000E+01	7.000E+01	1.607E+04	-1.925E+03

Semi-Log Analysis =====

Input Data -----

Pressure Run Depth..... = 0.000E-01 m
 Pressure Reference Depth..... = 0.172E+02 m
 Pressure Gradient..... = 0.810E+00 kPa/m
 Pressure Correction term..... = 8.998E+03 kPa
 All measured pressure data are corrected to the reference depth
 Production time..... = 4.100E+03 hr
 Water Flow Rate..... = 3.500E+00 m³/D
 Bottomhole Flowing Pressure..... = 1.800E+04 kPa
 Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
 Water Viscosity..... = 7.000E-01 cp
 Reservoir Temperature..... = 4.300E+01 Degree C
 Pay Thickness..... = 1.120E+01 m
 Porosity..... = 1.700E-01
 Total Compressibility..... = 1.510E-06 1/kPa
 Wellbore Radius..... = 5.700E-02 m

Output -----

Slope..... = 3.716E+03
 Water Transmissibility..... = 2.023E+00 mD-m/cp
 Water Reservoir Capacity..... = 1.428E+00 mD-m
 Water Mobility..... = 1.724E+01 mD/cp
 Effective Permeability to Water..... = 7.629E+00 mD
 Skin Factor..... = -7.261E+02
 Pressure Drop due to skin..... = 2.638E+02 kPa
 Total Ideal Productivity Index..... = 7.052E-02 Res m³/D/kPa
 Total Actual Productivity Index..... = 7.020E-02 Res m³/D/kPa
 Total Flow Efficiency..... = 2.013E+02 m

ENRON OIL CANADA LTD.

15-4-02-25WPM

Semi-log Analysis

$m = 3.184E+03$
 $Tf = 5.401E+00 \text{ mD-m/cp}$
 $s = -6.164E+00$

Delta Pressure, kPa

Delta Time, hr

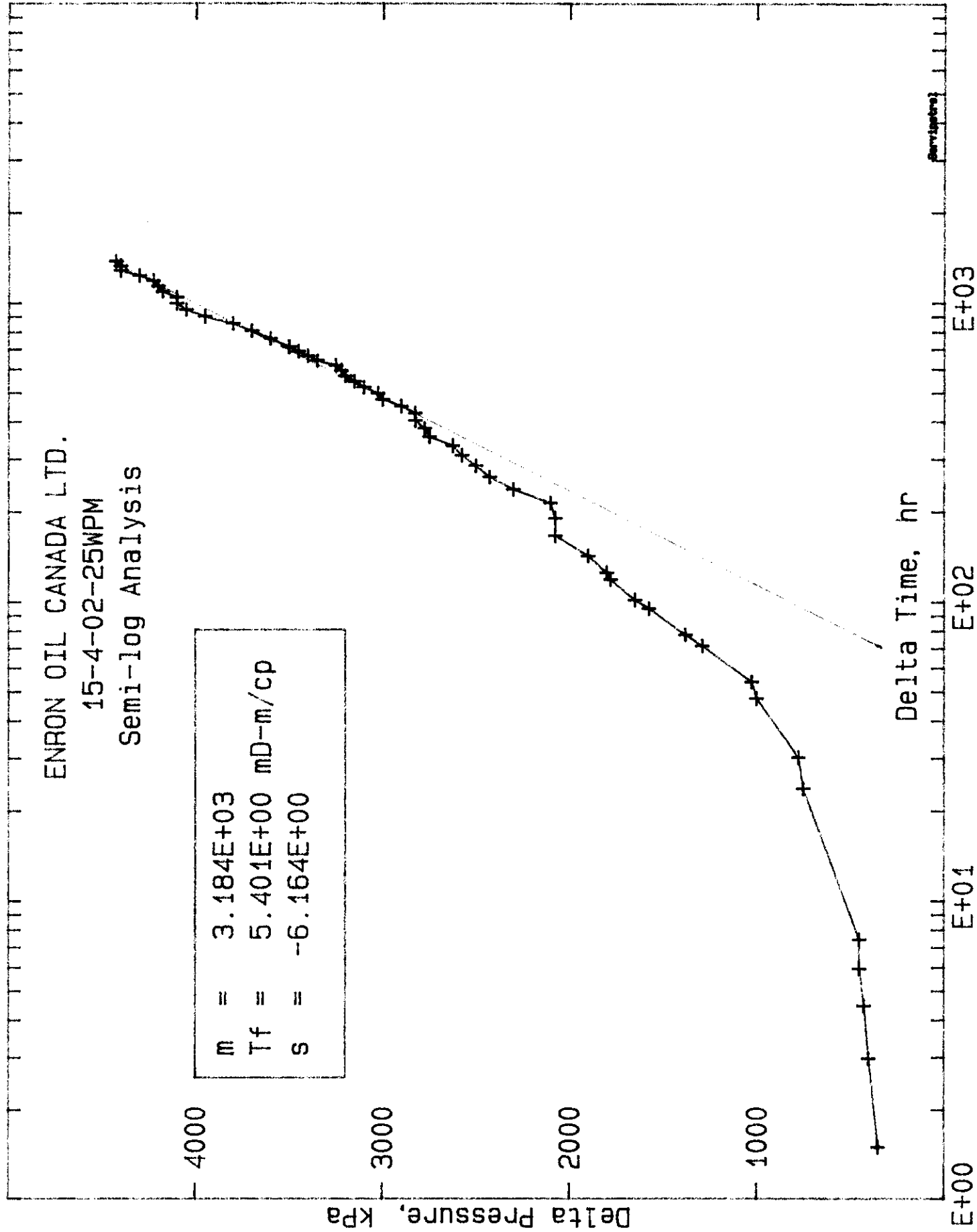
E+00

E+01

E+02

E+03

Pressure



ENRON OIL CANADA LTD.
15-4-02-25WPH
FALL-OFF TEST
MARCH 1991

Buildup Data
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No.	Shutin hr	time Effective hr	Pressure kPa	Delta P kPa
1	1.500E+00	1.500E+00	1.775E+04	-3.500E+02
2	3.000E+00	2.999E+00	1.770E+04	-4.000E+02
3	4.500E+00	4.498E+00	1.767E+04	-4.250E+02
4	6.000E+00	5.996E+00	1.765E+04	-4.500E+02
5	7.500E+00	7.493E+00	1.765E+04	-4.500E+02
6	2.400E+01	2.393E+01	1.735E+04	-7.500E+02
7	3.050E+01	3.039E+01	1.732E+04	-7.750E+02
8	4.800E+01	4.772E+01	1.710E+04	-1.000E+03
9	5.450E+01	5.414E+01	1.707E+04	-1.025E+03
10	7.200E+01	7.138E+01	1.681E+04	-1.290E+03
11	7.850E+01	7.776E+01	1.672E+04	-1.380E+03
12	9.600E+01	9.490E+01	1.652E+04	-1.575E+03
13	1.025E+02	1.012E+02	1.645E+04	-1.650E+03
14	1.200E+02	1.183E+02	1.632E+04	-1.780E+03
15	1.265E+02	1.246E+02	1.630E+04	-1.800E+03
16	1.440E+02	1.415E+02	1.620E+04	-1.900E+03
17	1.680E+02	1.647E+02	1.602E+04	-2.075E+03
18	1.920E+02	1.877E+02	1.602E+04	-2.075E+03
19	2.160E+02	2.105E+02	1.600E+04	-2.100E+03
20	2.400E+02	2.333E+02	1.580E+04	-2.300E+03
21	2.640E+02	2.559E+02	1.567E+04	-2.425E+03
22	2.880E+02	2.783E+02	1.560E+04	-2.500E+03
23	3.120E+02	3.007E+02	1.552E+04	-2.575E+03
24	3.360E+02	3.229E+02	1.547E+04	-2.625E+03
25	3.600E+02	3.450E+02	1.535E+04	-2.750E+03
26	3.840E+02	3.670E+02	1.532E+04	-2.775E+03
27	4.080E+02	3.889E+02	1.527E+04	-2.825E+03
28	4.320E+02	4.106E+02	1.527E+04	-2.825E+03
29	4.560E+02	4.323E+02	1.520E+04	-2.900E+03
30	4.800E+02	4.538E+02	1.510E+04	-3.000E+03
31	5.040E+02	4.751E+02	1.507E+04	-3.025E+03
32	5.280E+02	4.964E+02	1.500E+04	-3.100E+03
33	5.520E+02	5.176E+02	1.495E+04	-3.150E+03
34	5.760E+02	5.386E+02	1.490E+04	-3.200E+03
35	6.000E+02	5.596E+02	1.488E+04	-3.220E+03
36	6.240E+02	5.804E+02	1.485E+04	-3.250E+03
37	6.480E+02	6.011E+02	1.475E+04	-3.350E+03
38	6.720E+02	6.217E+02	1.470E+04	-3.400E+03
39	6.960E+02	6.422E+02	1.465E+04	-3.450E+03
40	7.200E+02	6.625E+02	1.460E+04	-3.500E+03
41	7.680E+02	7.030E+02	1.450E+04	-3.600E+03
42	8.160E+02	7.430E+02	1.440E+04	-3.700E+03
43	8.640E+02	7.825E+02	1.430E+04	-3.800E+03
44	9.120E+02	8.217E+02	1.415E+04	-3.950E+03
45	9.600E+02	8.605E+02	1.405E+04	-4.050E+03
46	1.008E+03	8.988E+02	1.400E+04	-4.100E+03
47	1.056E+03	9.368E+02	1.400E+04	-4.100E+03
48	1.104E+03	9.744E+02	1.392E+04	-4.175E+03
49	1.152E+03	1.012E+03	1.390E+04	-4.200E+03
50	1.200E+03	1.048E+03	1.387E+04	-4.225E+03
51	1.248E+03	1.085E+03	1.380E+04	-4.300E+03
52	1.296E+03	1.121E+03	1.370E+04	-4.400E+03
53	1.344E+03	1.157E+03	1.370E+04	-4.400E+03
54	1.392E+03	1.192E+03	1.367E+04	-4.425E+03

Semi-log Analysis
=====

Input Data

Pressure Run Depth..... = 0.000E-01 m
Pressure Reference Depth..... = 9.172E+02 m
Pressure Gradient..... = 9.810E+00 kPa/m
Pressure Correction Term..... = 8.998E+03 kPa
All measured pressure data are corrected to the reference depth
Production Time..... = 8.300E+03 hr
Water Flow Rate..... = 8.000E+00 m³/D
Bottomhole Flowing Pressure..... = 1.810E+04 kPa
Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
Water Viscosity..... = 7.000E-01 cp
Reservoir Temperature..... = 4.300E+01 Degree C
Pay Thickness..... = 1.266E+01 m
Porosity..... = 1.700E-01
Total Compressibility..... = 1.510E-06 1/kPa
Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 3.184E+03
Water Transmissibility..... = 5.401E+00 mD-m/cp
Water Reservoir Capacity..... = 3.781E+00 mD-m
Water Mobility..... = 4.266E-01 mD/cp
Effective Permeability to Water... = 2.986E-01 mD
Skin Factor..... = -6.164E+00
Pressure Drop due to skin..... = -1.708E+04 kPa
Total Ideal Productivity Index... = 4.570E-04 Res m³/D/kPa
Total Actual Productivity Index... = 1.855E-02 Res m³/D/kPa
Total Flow Efficiency..... = 4.059E+01
Radius of Investigation..... = 4.418E+02 m

ENRON OIL CANADA LTD.

16-5-02-25WPM

Semi-log Analysis

$m = 2.862E+03$
 $Tf = 1.878E+01 \text{ mD-m/cp}$
 $S = -5.178E+00$

$-8.0E+03$

$-6.0E+03$

$-4.0E+03$

$-2.0E+03$

Delta Pressure, kPa

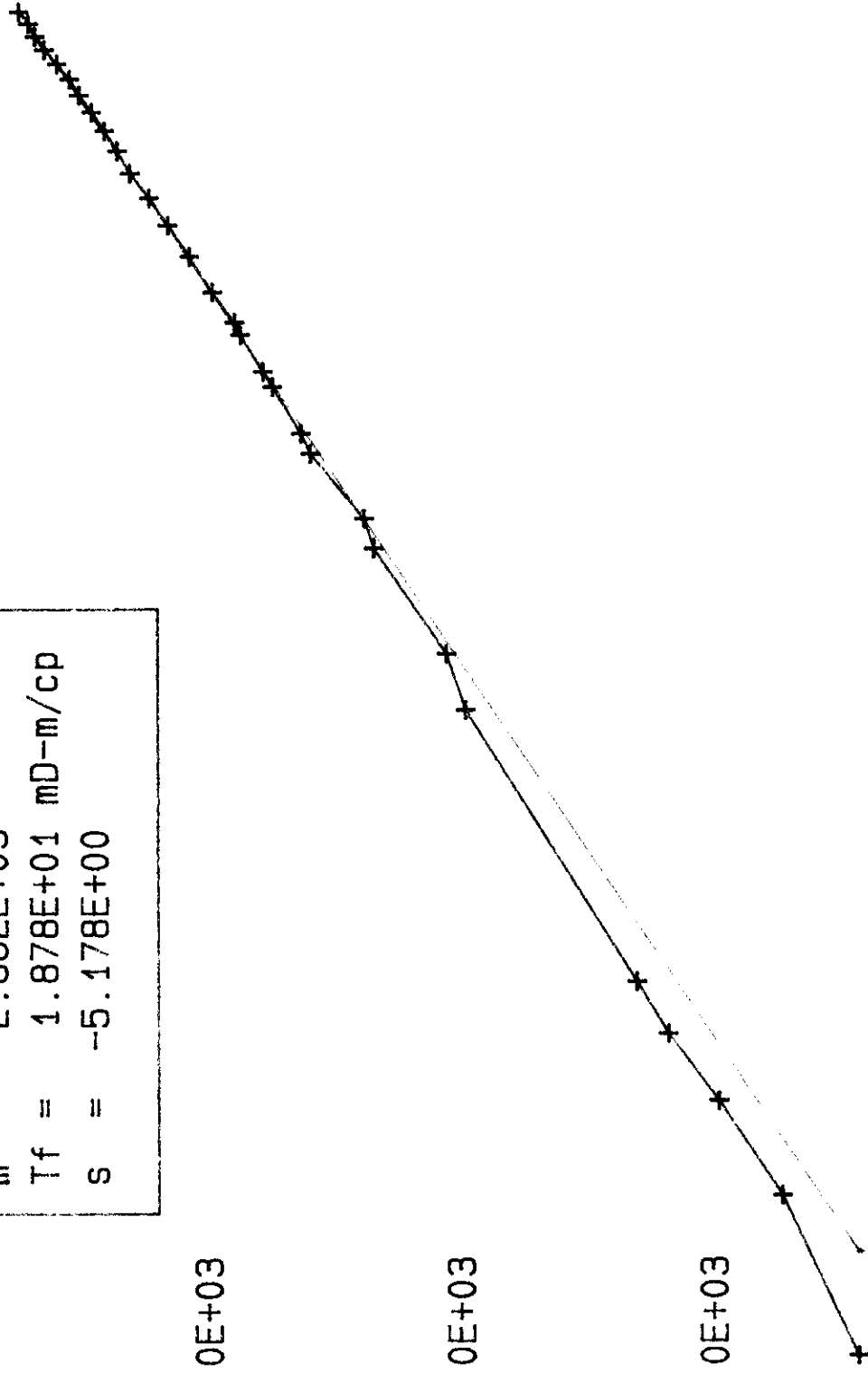
Delta Time, hr

$E+00$

$E+01$

$E+02$

Survival



ENRON OIL CANADA LTD.
16-5-02-25WPM
FALL-OFF TEST
MARCH 1991

Buildup Data
=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	1.500E+00	1.500E+00	1.730E+04	-8.500E+02
2	3.000E+00	2.999E+00	1.670E+04	-1.450E+03
3	4.500E+00	4.497E+00	1.620E+04	-1.950E+03
4	6.000E+00	5.995E+00	1.580E+04	-2.350E+03
5	7.500E+00	7.493E+00	1.555E+04	-2.600E+03
6	2.400E+01	2.393E+01	1.420E+04	-3.950E+03
7	3.050E+01	3.038E+01	1.405E+04	-4.100E+03
8	4.800E+01	4.771E+01	1.347E+04	-4.675E+03
9	5.450E+01	5.413E+01	1.340E+04	-4.750E+03
10	7.200E+01	7.135E+01	1.297E+04	-5.175E+03
11	7.850E+01	7.773E+01	1.290E+04	-5.250E+03
12	9.600E+01	9.485E+01	1.267E+04	-5.475E+03
13	1.025E+02	1.012E+02	1.260E+04	-5.550E+03
14	1.200E+02	1.182E+02	1.242E+04	-5.730E+03
15	1.265E+02	1.245E+02	1.237E+04	-5.775E+03
16	1.440E+02	1.414E+02	1.220E+04	-5.950E+03
17	1.680E+02	1.645E+02	1.202E+04	-6.130E+03
18	1.920E+02	1.875E+02	1.185E+04	-6.300E+03
19	2.160E+02	2.103E+02	1.170E+04	-6.450E+03
20	2.400E+02	2.330E+02	1.155E+04	-6.600E+03
21	2.640E+02	2.555E+02	1.145E+04	-6.700E+03
22	2.880E+02	2.779E+02	1.135E+04	-6.800E+03
23	3.120E+02	3.002E+02	1.125E+04	-6.900E+03
24	3.360E+02	3.224E+02	1.115E+04	-7.000E+03
25	3.600E+02	3.444E+02	1.107E+04	-7.075E+03
26	3.840E+02	3.663E+02	1.097E+04	-7.175E+03
27	4.080E+02	3.881E+02	1.087E+04	-7.275E+03
28	4.320E+02	4.097E+02	1.080E+04	-7.350E+03
29	4.560E+02	4.313E+02	1.075E+04	-7.400E+03
30	4.800E+02	4.527E+02	1.067E+04	-7.475E+03

Semi-log Analysis
=====

Input Data

Pressure Run Depth..... = 0.000E-01 m
Pressure Reference Depth..... = 9.172E+02 m
Pressure Gradient..... = 9.810E+00 kPa/m
Pressure Correction Term..... = 8.998E+03 kPa
All measured pressure data are corrected to the reference depth
Production Time..... = 7.950E+03 hr
Water Flow Rate..... = 2.500E+01 m³/D
Bottomhole Flowing Pressure..... = 1.815E+04 kPa
Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
Water Viscosity..... = 7.000E-01 cp
Reservoir Temperature..... = 4.300E+01 Degree C
Pay Thickness..... = 7.170E+00 m
Porosity..... = 1.600E-01
Total Compressibility..... = 1.510E-06 1/kPa
Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 2.862E+03
Water Transmissibility..... = 1.878E+01 mD-m/cp
Water Reservoir Capacity..... = 1.315E+01 mD-m
Water Mobility..... = 2.619E+00 mD/cp
Effective Permeability to Water... = 1.833E+00 mD
Skin Factor..... = -5.178E+00
Pressure Drop due to skin..... = -1.289E+04 kPa
Total Ideal Productivity Index... = 1.869E-03 Res m³/D/kPa
Total Actual Productivity Index... = 5.194E-02 Res m³/D/kPa
Total Flow Efficiency..... = 2.779E+01
Radius of Investigation..... = 1.104E+03 m

ENRON OIL CANADA LTD.

1-9-02-25WPM

Semi-log Analysis

m = 2.532E+03

Tf = 4.245E+00 mD-m/cp

s = -5.035E+00

Delta Pressure, kPa

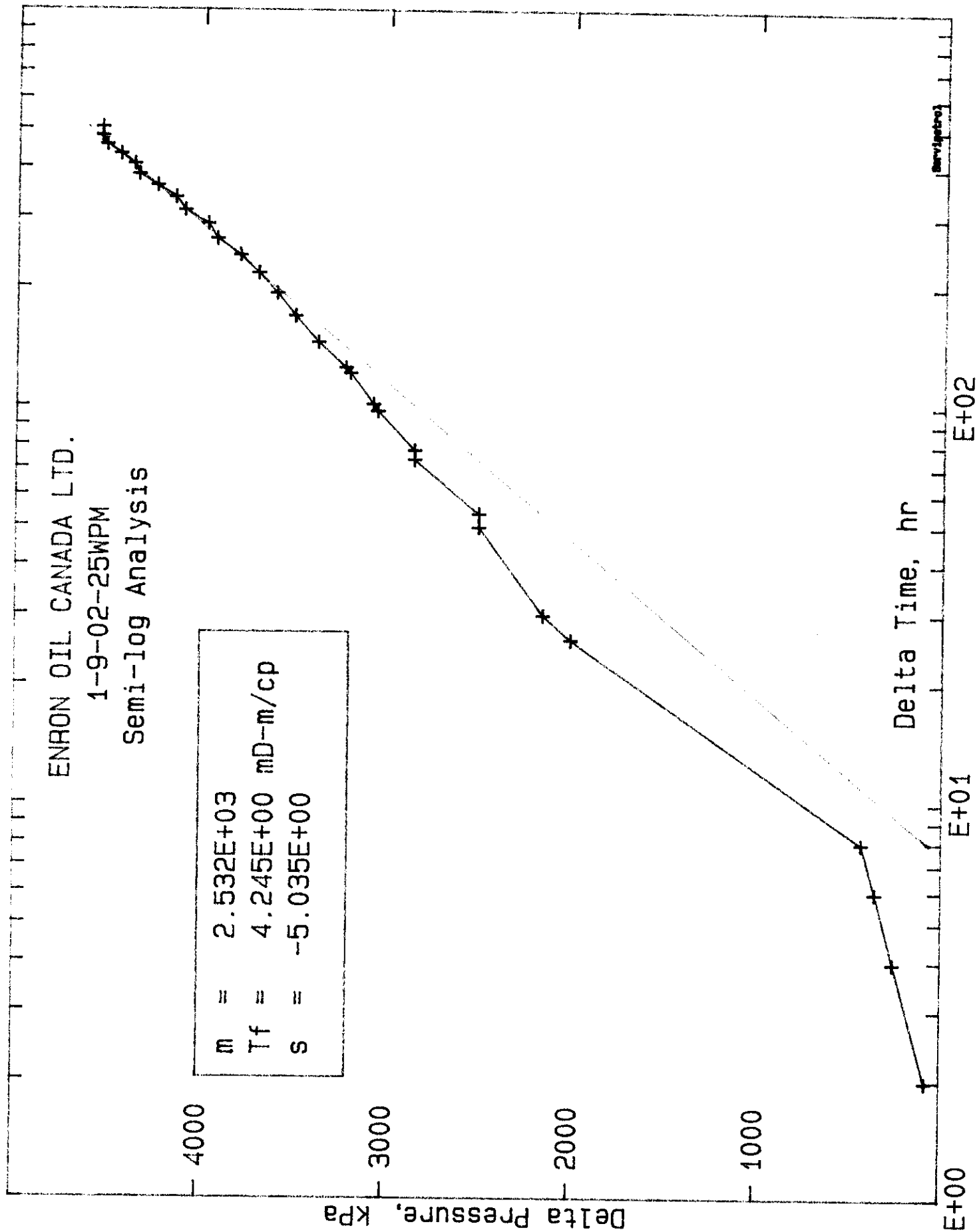
Delta Time, hr

E+00

E+01

E+02

Surv/petro3



ENRON OIL CANADA LTD.
1-9-02-25WPM
FALL-OFF TEST
MAY 1991

Buildup Data
=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	2.000E+00	1.998E+00	1.798E+04	-7.500E+01
2	4.000E+00	3.993E+00	1.780E+04	-2.500E+02
3	6.000E+00	5.985E+00	1.770E+04	-3.500E+02
4	8.000E+00	7.973E+00	1.763E+04	-4.250E+02
5	2.600E+01	2.572E+01	1.605E+04	-2.000E+03
6	3.000E+01	2.962E+01	1.590E+04	-2.150E+03
7	5.000E+01	4.896E+01	1.555E+04	-2.500E+03
8	5.400E+01	5.279E+01	1.555E+04	-2.500E+03
9	7.400E+01	7.175E+01	1.520E+04	-2.850E+03
10	7.800E+01	7.550E+01	1.520E+04	-2.850E+03
11	9.800E+01	9.409E+01	1.500E+04	-3.050E+03
12	1.020E+02	9.777E+01	1.498E+04	-3.075E+03
13	1.220E+02	1.160E+02	1.485E+04	-3.200E+03
14	1.260E+02	1.196E+02	1.483E+04	-3.225E+03
15	1.460E+02	1.375E+02	1.468E+04	-3.375E+03
16	1.700E+02	1.586E+02	1.455E+04	-3.500E+03
17	1.940E+02	1.793E+02	1.445E+04	-3.600E+03
18	2.180E+02	1.996E+02	1.435E+04	-3.700E+03
19	2.420E+02	2.195E+02	1.425E+04	-3.800E+03
20	2.660E+02	2.391E+02	1.413E+04	-3.925E+03
21	2.900E+02	2.583E+02	1.408E+04	-3.975E+03
22	3.140E+02	2.771E+02	1.395E+04	-4.100E+03
23	3.380E+02	2.957E+02	1.390E+04	-4.150E+03
24	3.620E+02	3.139E+02	1.380E+04	-4.250E+03
25	3.860E+02	3.317E+02	1.370E+04	-4.350E+03
26	4.100E+02	3.493E+02	1.368E+04	-4.375E+03
27	4.340E+02	3.666E+02	1.360E+04	-4.450E+03
28	4.580E+02	3.836E+02	1.353E+04	-4.525E+03
29	4.820E+02	4.003E+02	1.350E+04	-4.550E+03
30	5.060E+02	4.167E+02	1.350E+04	-4.550E+03

Semi-log Analysis
=====

Input Data

Pressure Run Depth..... = 0.000E-01 m
 Pressure Reference Depth..... = 9.174E+02 m
 Pressure Gradient..... = 9.810E+00 kPa/m
 Pressure Correction Term..... = 9.000E+03 kPa
 All measured pressure data are corrected to the reference depth
 Production Time..... = 2.360E+03 hr
 Water Flow Rate..... = 5.000E+00 m³/D
 Bottomhole Flowing Pressure..... = 1.805E+04 kPa
 Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
 Water Viscosity..... = 7.000E-01 cp
 Reservoir Temperature..... = 4.300E+01 Degree C
 Pay Thickness..... = 1.409E+01 m
 Porosity..... = 1.560E-01
 Total Compressibility..... = 1.510E-06 1/kPa
 Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 2.532E+03
 Water Transmissibility..... = 4.245E+00 mD-m/cp
 Water Reservoir Capacity..... = 2.971E+00 mD-m
 Water Mobility..... = 3.013E-01 mD/cp
 Effective Permeability to Water... = 2.109E-01 mD
 Skin Factor..... = -5.035E+00
 Pressure Drop due to skin..... = -1.109E+04 kPa
 Total Ideal Productivity Index... = 4.358E-04 Res m³/D/kPa
 Total Actual Productivity Index... = 1.311E-02 Res m³/D/kPa
 Total Flow Efficiency..... = 3.009E+01
 Radius of Investigation..... = 2.067E+02 m

ENRON OIL CANADA LTD.

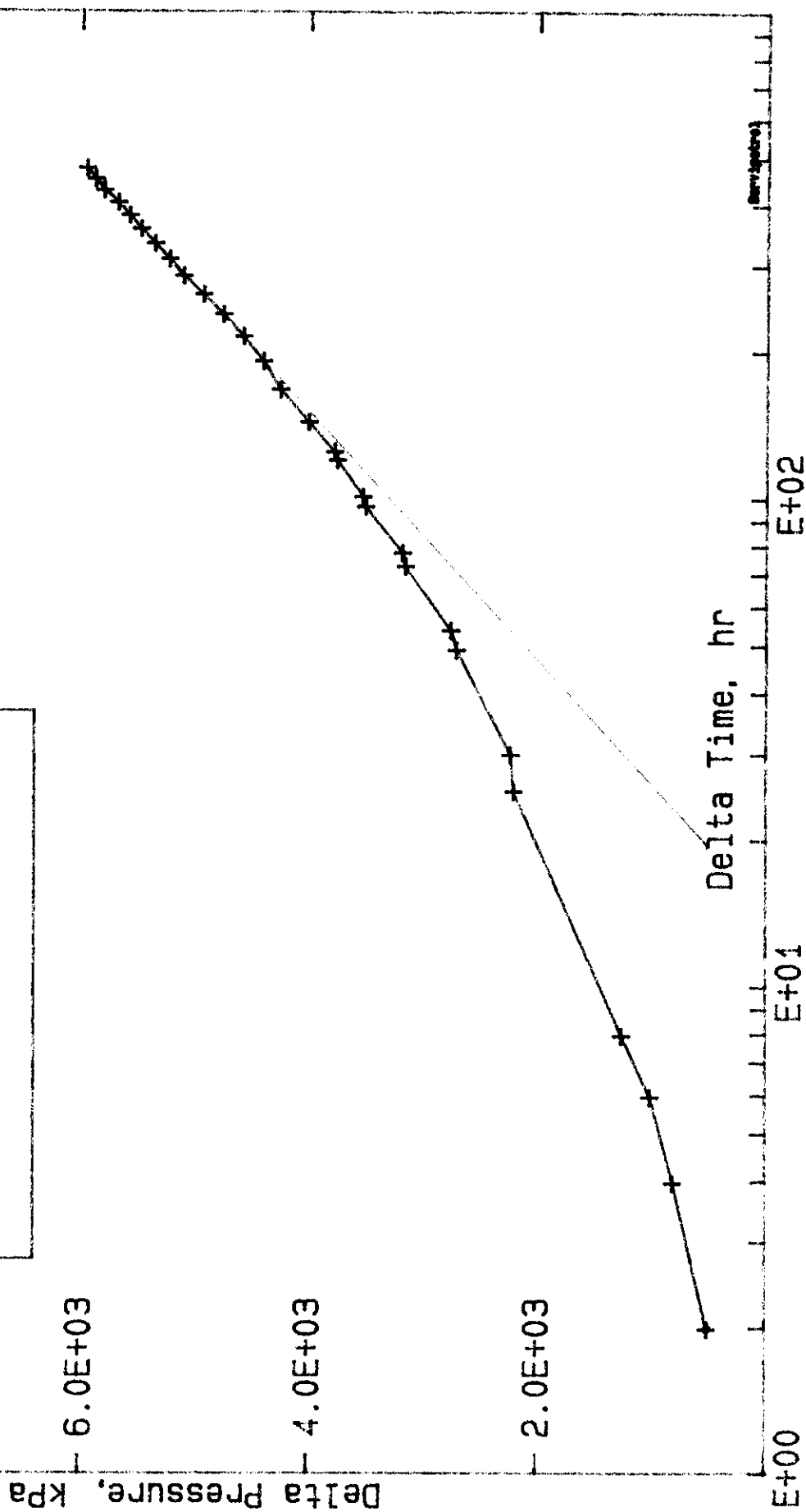
6-9-02-25WPM

Semi-log Analysis

$m = 3.928E+03$

$Tf = 1.204E+01 \text{ mD-m/cp}$

$s = -6.253E+00$



ENRON OIL CANADA LTD.
6-9-02-25WPM
FALL-OFF TEST
JUNE 1991

Buildup Data
=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	2.000E+00	2.000E+00	1.758E+04	-5.000E+02
2	4.000E+00	3.999E+00	1.728E+04	-8.000E+02
3	6.000E+00	5.997E+00	1.708E+04	-1.000E+03
4	8.000E+00	7.994E+00	1.683E+04	-1.250E+03
5	2.540E+01	2.534E+01	1.588E+04	-2.200E+03
6	3.020E+01	3.012E+01	1.585E+04	-2.225E+03
7	4.940E+01	4.919E+01	1.538E+04	-2.700E+03
8	5.420E+01	5.394E+01	1.533E+04	-2.750E+03
9	7.340E+01	7.293E+01	1.493E+04	-3.150E+03
10	7.820E+01	7.767E+01	1.490E+04	-3.175E+03
11	9.740E+01	9.658E+01	1.458E+04	-3.500E+03
12	1.022E+02	1.013E+02	1.455E+04	-3.525E+03
13	1.214E+02	1.201E+02	1.433E+04	-3.750E+03
14	1.262E+02	1.248E+02	1.430E+04	-3.775E+03
15	1.454E+02	1.436E+02	1.408E+04	-4.000E+03
16	1.694E+02	1.669E+02	1.383E+04	-4.250E+03
17	1.934E+02	1.902E+02	1.368E+04	-4.400E+03
18	2.174E+02	2.133E+02	1.350E+04	-4.575E+03
19	2.414E+02	2.364E+02	1.333E+04	-4.750E+03
20	2.654E+02	2.594E+02	1.315E+04	-4.925E+03
21	2.894E+02	2.823E+02	1.298E+04	-5.100E+03
22	3.134E+02	3.050E+02	1.285E+04	-5.225E+03
23	3.374E+02	3.277E+02	1.273E+04	-5.350E+03
24	3.614E+02	3.503E+02	1.260E+04	-5.475E+03
25	3.854E+02	3.728E+02	1.250E+04	-5.575E+03
26	4.094E+02	3.953E+02	1.240E+04	-5.675E+03
27	4.334E+02	4.176E+02	1.228E+04	-5.800E+03
28	4.574E+02	4.398E+02	1.220E+04	-5.875E+03
29	4.814E+02	4.620E+02	1.213E+04	-5.950E+03

Semi-log Analysis
=====

Input Data

Pressure Run Depth..... = 0.000E-01 m
 Pressure Reference Depth..... = 9.152E+02 m
 Pressure Gradient..... = 9.810E+00 kPa/m
 Pressure Correction Term..... = 8.978E+03 kPa
 All measured pressure data are corrected to the reference depth
 Production Time..... = 1.144E+04 hr
 Water Flow Rate..... = 2.200E+01 m³/D
 Bottomhole Flowing Pressure..... = 1.808E+04 kPa
 Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
 Water Viscosity..... = 7.000E-01 cp
 Reservoir Temperature..... = 4.300E+01 Degree C
 Pay Thickness..... = 6.490E+00 m
 Porosity..... = 1.650E-01
 Total Compressibility..... = 1.510E-06 1/kPa
 Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 3.928E+03
 Water Transmissibility..... = 1.204E+01 mD-m/cp
 Water Reservoir Capacity..... = 8.430E+00 mD-m
 Water Mobility..... = 1.856E+00 mD/cp
 Effective Permeability to Water... = 1.299E+00 mD
 Skin Factor..... = -6.253E+00
 Pressure Drop due to skin..... = -2.137E+04 kPa
 Total Ideal Productivity Index... = 1.009E-03 Res m³/D/kPa
 Total Actual Productivity Index... = 5.101E-02 Res m³/D/kPa
 Total Flow Efficiency..... = 5.054E+01
 Radius of Investigation..... = 1.098E+03 m

ENRON OIL CANADA LTD.

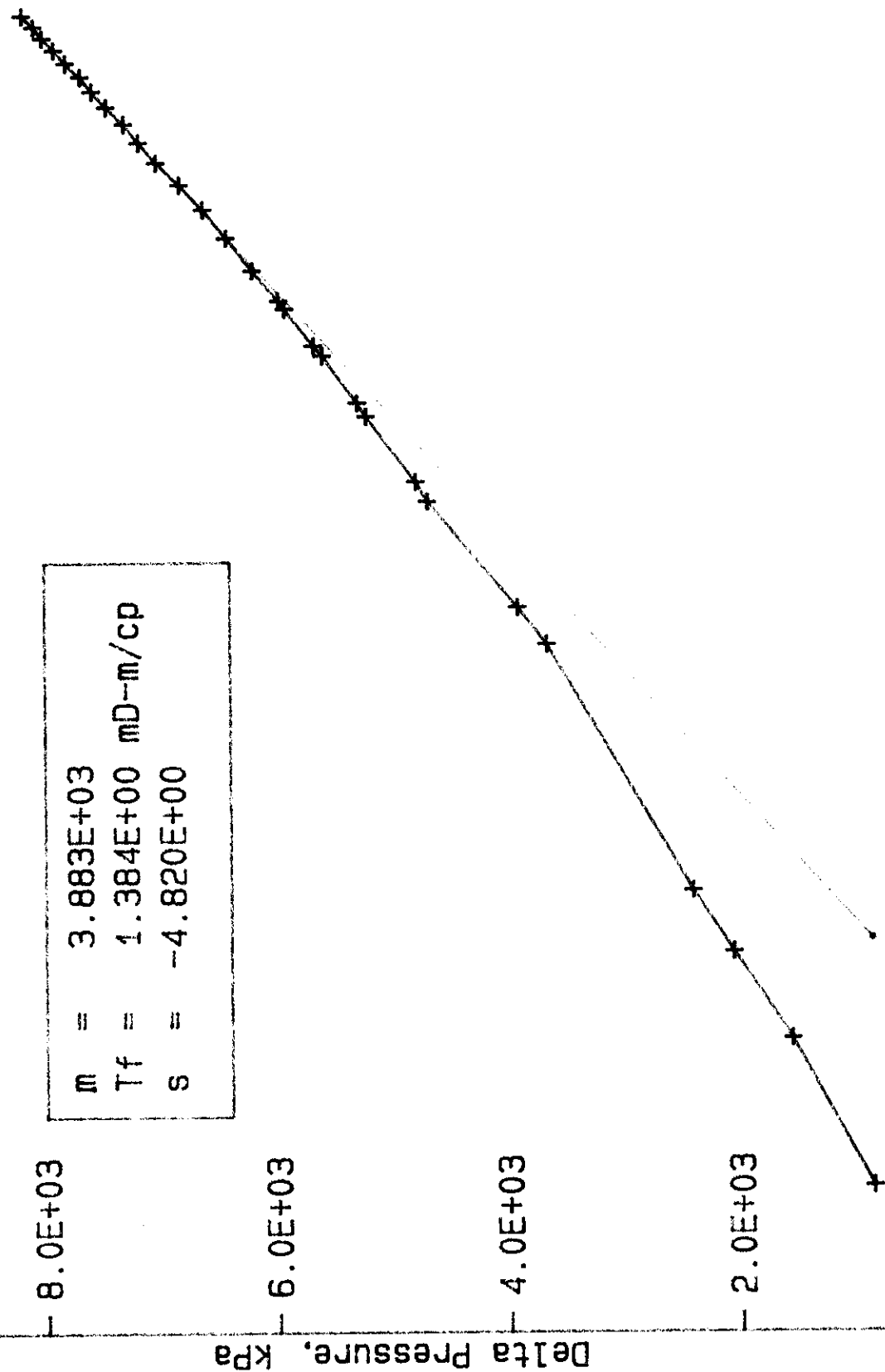
10-9-02-25WPM

Semi-log Analysis

$m = 3.883E+03$

$Tf = 1.384E+00 \text{ mD-m/cp}$

$s = -4.820E+00$



ENRON OIL CANADA LTD.
10-9-02-25WPM
FALL-OFF TEST
JUNE 1991

Buildup Data
=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	2.000E+00	2.000E+00	1.720E+04	-8.500E+02
2	4.000E+00	3.999E+00	1.650E+04	-1.550E+03
3	6.000E+00	5.998E+00	1.600E+04	-2.050E+03
4	8.000E+00	7.997E+00	1.565E+04	-2.400E+03
5	2.525E+01	2.522E+01	1.440E+04	-3.650E+03
6	3.000E+01	2.996E+01	1.415E+04	-3.900E+03
7	4.925E+01	4.915E+01	1.337E+04	-4.675E+03
8	5.400E+01	5.388E+01	1.327E+04	-4.775E+03
9	7.325E+01	7.302E+01	1.285E+04	-5.200E+03
10	7.800E+01	7.774E+01	1.277E+04	-5.275E+03
11	9.725E+01	9.685E+01	1.247E+04	-5.575E+03
12	1.020E+02	1.016E+02	1.240E+04	-5.650E+03
13	1.212E+02	1.206E+02	1.215E+04	-5.900E+03
14	1.260E+02	1.253E+02	1.210E+04	-5.950E+03
15	1.452E+02	1.444E+02	1.187E+04	-6.175E+03
16	1.692E+02	1.680E+02	1.165E+04	-6.400E+03
17	1.932E+02	1.917E+02	1.145E+04	-6.600E+03
18	2.172E+02	2.153E+02	1.125E+04	-6.800E+03
19	2.412E+02	2.388E+02	1.105E+04	-7.000E+03
20	2.652E+02	2.623E+02	1.090E+04	-7.150E+03
21	2.892E+02	2.858E+02	1.077E+04	-7.275E+03
22	3.132E+02	3.092E+02	1.062E+04	-7.425E+03
23	3.372E+02	3.325E+02	1.050E+04	-7.550E+03
24	3.612E+02	3.558E+02	1.040E+04	-7.650E+03
25	3.852E+02	3.791E+02	1.027E+04	-7.775E+03
26	4.092E+02	4.023E+02	1.017E+04	-7.875E+03
27	4.332E+02	4.255E+02	1.007E+04	-7.975E+03
28	4.572E+02	4.486E+02	9.999E+03	-8.050E+03
29	4.812E+02	4.717E+02	9.899E+03	-8.150E+03

Semi-log Analysis
=====

Input Data

Pressure Run Depth..... = 0.000E-01 m
Pressure Reference Depth..... = 9.172E+02 m
Pressure Gradient..... = 9.810E+00 kPa/m
Pressure Correction Term..... = 8.998E+03 kPa
All measured pressure data are corrected to the reference depth
Production Time..... = 2.368E+04 hr
Water Flow Rate..... = 2.500E+00 m³/D
Bottomhole Flowing Pressure..... = 1.805E+04 kPa
Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
Water Viscosity..... = 7.000E-01 cp
Reservoir Temperature..... = 4.300E+01 Degree C
Pay Thickness..... = 3.400E+00 m
Porosity..... = 1.650E-01
Total Compressibility..... = 1.510E-06 1/kPa
Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 3.883E+03
Water Transmissibility..... = 1.384E+00 mD-m/cp
Water Reservoir Capacity..... = 9.689E-01 mD-m
Water Mobility..... = 4.071E-01 mD/cp
Effective Permeability to Water... = 2.850E-01 mD
Skin Factor..... = -4.820E+00
Pressure Drop due to skin..... = -1.628E+04 kPa
Total Ideal Productivity Index... = 1.500E-04 Res m³/D/kPa
Total Actual Productivity Index... = 6.557E-03 Res m³/D/kPa
Total Flow Efficiency..... = 4.370E+01
Radius of Investigation..... = 7.399E+02 m

ENRON OIL CANADA LTD.

16-9-02-25WPM

Semi-log Analysis

m = 3.068E+03

Tf = 8.408E+00 mD-m/cp

s = -5.836E+00

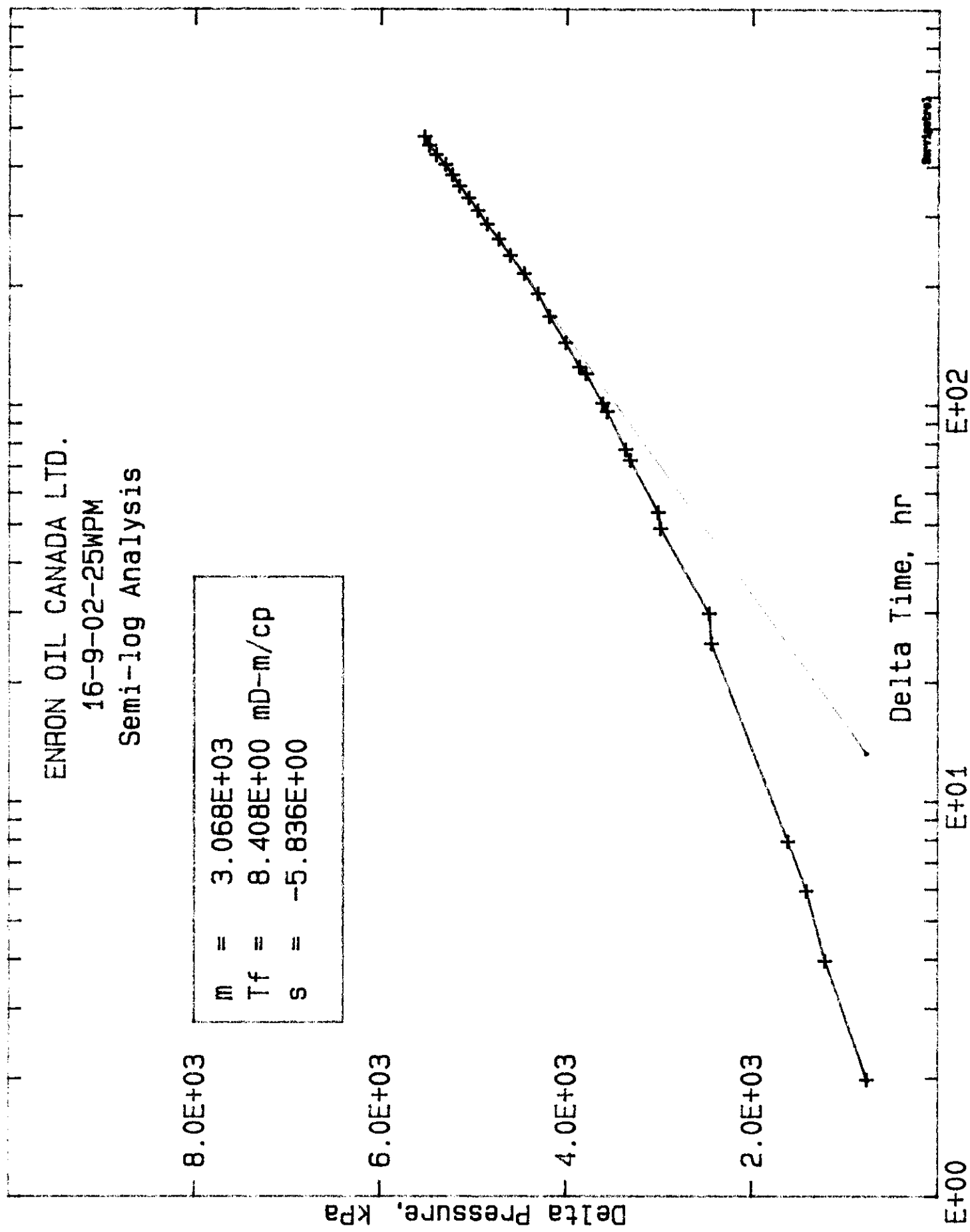
Delta Pressure, kPa

Delta Time, hr

E+00

E+01

E+02



ENRON OIL CANADA LTD.
16-9-02-25WPM
FALL-OFF TEST
JUNE 1991

Buildup Data
=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	2.000E+00	2.000E+00	1.735E+04	-7.500E+02
2	4.000E+00	3.999E+00	1.690E+04	-1.200E+03
3	6.000E+00	5.997E+00	1.670E+04	-1.400E+03
4	8.000E+00	7.995E+00	1.650E+04	-1.600E+03
5	2.530E+01	2.525E+01	1.567E+04	-2.425E+03
6	3.010E+01	3.002E+01	1.565E+04	-2.450E+03
7	4.930E+01	4.909E+01	1.512E+04	-2.975E+03
8	5.410E+01	5.385E+01	1.510E+04	-3.000E+03
9	7.330E+01	7.284E+01	1.480E+04	-3.300E+03
10	7.810E+01	7.758E+01	1.475E+04	-3.350E+03
11	9.730E+01	9.649E+01	1.455E+04	-3.550E+03
12	1.021E+02	1.012E+02	1.450E+04	-3.600E+03
13	1.213E+02	1.200E+02	1.432E+04	-3.780E+03
14	1.261E+02	1.247E+02	1.425E+04	-3.850E+03
15	1.453E+02	1.435E+02	1.410E+04	-4.000E+03
16	1.693E+02	1.669E+02	1.392E+04	-4.175E+03
17	1.933E+02	1.901E+02	1.380E+04	-4.300E+03
18	2.173E+02	2.133E+02	1.365E+04	-4.450E+03
19	2.413E+02	2.364E+02	1.350E+04	-4.600E+03
20	2.653E+02	2.594E+02	1.337E+04	-4.725E+03
21	2.893E+02	2.823E+02	1.325E+04	-4.850E+03
22	3.133E+02	3.051E+02	1.315E+04	-4.950E+03
23	3.373E+02	3.278E+02	1.305E+04	-5.050E+03
24	3.613E+02	3.504E+02	1.295E+04	-5.150E+03
25	3.853E+02	3.730E+02	1.287E+04	-5.225E+03
26	4.093E+02	3.954E+02	1.280E+04	-5.300E+03
27	4.333E+02	4.177E+02	1.270E+04	-5.400E+03
28	4.573E+02	4.400E+02	1.262E+04	-5.475E+03
29	4.813E+02	4.622E+02	1.257E+04	-5.525E+03

Semi-log Analysis
=====

Input Data

Pressure Run Depth..... = 0.000E-01 m
 Pressure Reference Depth..... = 9.172E+02 m
 Pressure Gradient..... = 9.810E+00 kPa/m
 Pressure Correction Term..... = 8.998E+03 kPa
 All measured pressure data are corrected to the reference depth
 Production Time..... = 1.164E+04 hr
 Water Flow Rate..... = 1.200E+01 m³/D
 Bottomhole Flowing Pressure..... = 1.810E+04 kPa
 Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
 Water Viscosity..... = 7.000E-01 cp
 Reservoir Temperature..... = 4.300E+01 Degree C
 Pay Thickness..... = 5.200E+00 m
 Porosity..... = 1.700E-01
 Total Compressibility..... = 1.510E-06 1/kPa
 Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 3.068E+03
 Water Transmissibility..... = 8.408E+00 mD-m/cp
 Water Reservoir Capacity..... = 5.886E+00 mD-m
 Water Mobility..... = 1.617E+00 mD/cp
 Effective Permeability to Water... = 1.132E+00 mD
 Skin Factor..... = -5.836E+00
 Pressure Drop due to skin..... = -1.558E+04 kPa
 Total Ideal Productivity Index... = 7.496E-04 Res m³/D/kPa
 Total Actual Productivity Index... = 2.782E-02 Res m³/D/kPa
 Total Flow Efficiency..... = 3.712E+01
 Radius of Investigation..... = 1.019E+03 m

ENRON OIL CANADA LTD.

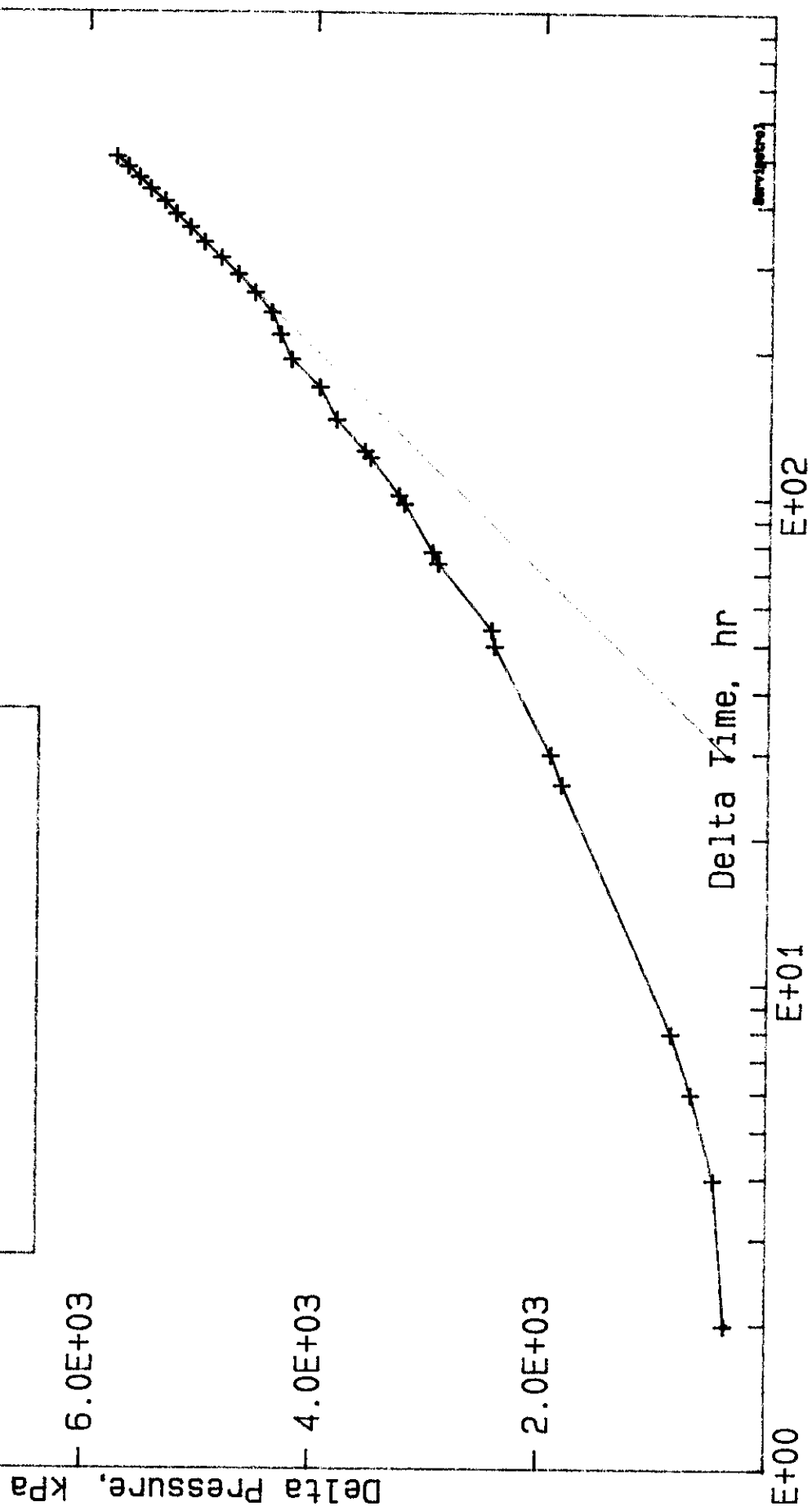
5-10-02-25WPM

Semi-log Analysis

$m = 4.379E+03$

$Tf = 4.909E+00 \text{ mD-m/cp}$

$s = -5.665E+00$



ENRON OIL CANADA LTD.
5-10-02-25WPM
FALL-OFF TEST
MAY 1991

Buildup Data
=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	2.000E+00	1.999E+00	1.775E+04	-3.500E+02
2	4.000E+00	3.998E+00	1.765E+04	-4.500E+02
3	6.000E+00	5.995E+00	1.745E+04	-6.500E+02
4	8.000E+00	7.991E+00	1.727E+04	-8.250E+02
5	2.600E+01	2.590E+01	1.630E+04	-1.800E+03
6	3.000E+01	2.987E+01	1.620E+04	-1.900E+03
7	5.000E+01	4.965E+01	1.570E+04	-2.400E+03
8	5.400E+01	5.359E+01	1.567E+04	-2.425E+03
9	7.400E+01	7.323E+01	1.520E+04	-2.900E+03
10	7.800E+01	7.715E+01	1.515E+04	-2.950E+03
11	9.800E+01	9.666E+01	1.490E+04	-3.200E+03
12	1.020E+02	1.005E+02	1.485E+04	-3.250E+03
13	1.220E+02	1.199E+02	1.460E+04	-3.500E+03
14	1.260E+02	1.238E+02	1.455E+04	-3.550E+03
15	1.460E+02	1.430E+02	1.430E+04	-3.800E+03
16	1.700E+02	1.660E+02	1.415E+04	-3.950E+03
17	1.940E+02	1.888E+02	1.390E+04	-4.200E+03
18	2.180E+02	2.115E+02	1.380E+04	-4.300E+03
19	2.420E+02	2.340E+02	1.372E+04	-4.375E+03
20	2.660E+02	2.564E+02	1.357E+04	-4.525E+03
21	2.900E+02	2.786E+02	1.342E+04	-4.675E+03
22	3.140E+02	3.006E+02	1.327E+04	-4.825E+03
23	3.380E+02	3.226E+02	1.312E+04	-4.975E+03
24	3.620E+02	3.444E+02	1.300E+04	-5.100E+03
25	3.860E+02	3.660E+02	1.287E+04	-5.225E+03
26	4.100E+02	3.875E+02	1.277E+04	-5.325E+03
27	4.340E+02	4.089E+02	1.265E+04	-5.450E+03
28	4.580E+02	4.301E+02	1.255E+04	-5.550E+03
29	4.820E+02	4.512E+02	1.245E+04	-5.650E+03
30	5.060E+02	4.722E+02	1.235E+04	-5.750E+03

Semi-log Analysis
=====

Input Data

Pressure Run Depth..... = 0.000E-01 m
 Pressure Reference Depth..... = 9.172E+02 m
 Pressure Gradient..... = 9.810E+00 kPa/m
 Pressure Correction Term..... = 8.998E+03 kPa
 All measured pressure data are corrected to the reference depth
 Production Time..... = 7.070E+03 hr
 Water Flow Rate..... = 1.000E+01 m³/D
 Bottomhole Flowing Pressure..... = 1.810E+04 kPa
 Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
 Water Viscosity..... = 7.000E-01 cp
 Reservoir Temperature..... = 4.300E+01 Degree C
 Pay Thickness..... = 1.522E+01 m
 Porosity..... = 1.550E-01
 Total Compressibility..... = 1.510E-06 1/kPa
 Wellbore Radius..... = 5.700E-02 m

Output

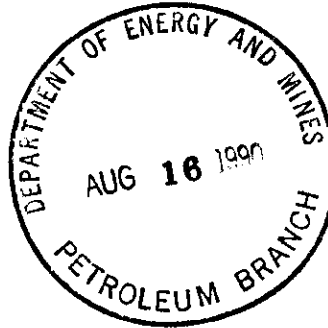
Slope..... = 4.379E+03
 Water Transmissibility..... = 4.909E+00 mD-m/cp
 Water Reservoir Capacity..... = 3.437E+00 mD-m
 Water Mobility..... = 3.226E-01 mD/cp
 Effective Permeability to Water... = 2.258E-01 mD
 Skin Factor..... = -5.665E+00
 Pressure Drop due to skin..... = -2.158E+04 kPa
 Total Ideal Productivity Index... = 4.543E-04 Res m³/D/kPa
 Total Actual Productivity Index... = 2.319E-02 Res m³/D/kPa
 Total Flow Efficiency..... = 5.104E+01
 Radius of Investigation..... = 3.713E+02 m

**ENRON
Oil Canada Ltd.**

(403) 298 2600

13 August 1990

Manitoba Energy and Mines
#555, 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3



Attention: Mr. John Fox,
Chief Petroleum Engineer

Dear Sir:

Re: Waskada Unit No. 16 Expansion Area Pressure Survey

Enron Oil Canada Ltd. conducted pressure fall-off tests on five water injection wells from June 19 to July 31, 1990. The enclosed pressure fall-off test analyses show that all five wells continue to have average drainage region pressures exceeding the 5 000 kPa minimum requirement at a datum depth of 440 m subsea.

Due to the interference affects between the 15-4 and 1-9 injection wells, these two wells will be pressure tested at the same time in the future. Enron will probably conduct a treatment on the 10-9 well in an attempt to improve water injectivity.

Should you have any questions concerning the latest pressure survey results, please feel free to contact the undersigned at your convenience.

Yours very truly,

ENRON OIL CANADA LTD.

A handwritten signature in cursive script, reading "H. Dale Logie".

H. Dale Logie,
Chief Reservoir Engineer

HDL:pd
attach

xc: Chauvco Resources Ltd.
Highridge Exploration Ltd.

dl08-01.ltr

PRESSURE FALL-OFF TEST ANALYSIS

for

ENRON ET AL WASKADA 1-9-2-25 WPM

Date of Test: June 19 - July 31, 1990

PRESSURE FALL-OFF TEST ANALYSIS

Enron et al Waskada 1-9-2-25 WPM

Due to interference affects from the offset 15-4 injector, the fall-off test on well 1-9 cannot be properly interpreted. The recorded surface wellhead pressure stabilized at approximately 8 200 kPag for a twenty (20) day period from June 25 to July 14, 1990. This would yield a formation pressure of approximately 17 200 kPag at a datum depth of 440 m subsea. The water injection rate at the 1-9 well has declined to 2.3 m³/d due to the low leak off rate and high formation pressure in the near vicinity of this injection well.

Due to the interference affects between the 15-4 and 1-9 injection wells, fall-off tests will be conducted at the same time in these wells for future pressure surveys.

ENRON OIL CANADA LTD.
1-9-02-25WPM
FALL-OFF TEST
JUNE 19-JULY 31,1990

Flowrate Data
=====

No.	Elapsed time hr	Total Res m ³ /D	Oil m ³ /D	Gas m ³ /D	Water m ³ /D
1	1.078E+04	2.300E+00	0.000E-01	0.000E-01	2.300E+00

Buildup Data
=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	1.500E+00	1.500E+00	8.651E+03	-4.556E+02
2	3.000E+00	2.999E+00	8.616E+03	-4.900E+02
3	4.500E+00	4.498E+00	8.520E+03	-5.866E+02
4	6.000E+00	5.997E+00	8.492E+03	-6.142E+02
5	7.500E+00	7.495E+00	8.471E+03	-6.348E+02
6	2.500E+01	2.494E+01	8.409E+03	-6.969E+02
7	2.900E+01	2.892E+01	8.396E+03	-7.107E+02
8	4.900E+01	4.878E+01	8.389E+03	-7.176E+02
9	5.300E+01	5.274E+01	8.389E+03	-7.176E+02
10	7.300E+01	7.251E+01	8.389E+03	-7.176E+02
11	7.700E+01	7.645E+01	8.354E+03	-7.520E+02
12	9.700E+01	9.613E+01	8.327E+03	-7.796E+02
13	1.010E+02	1.001E+02	8.327E+03	-7.796E+02
14	1.210E+02	1.197E+02	8.313E+03	-7.934E+02
15	1.250E+02	1.236E+02	8.313E+03	-7.934E+02
16	1.450E+02	1.431E+02	8.299E+03	-8.072E+02
17	1.690E+02	1.664E+02	8.292E+03	-8.141E+02
18	1.930E+02	1.896E+02	8.251E+03	-8.555E+02
19	2.170E+02	2.127E+02	8.299E+03	-8.072E+02
20	2.410E+02	2.357E+02	8.299E+03	-8.072E+02
21	2.650E+02	2.586E+02	8.278E+03	-8.279E+02
22	2.890E+02	2.815E+02	8.278E+03	-8.279E+02
23	3.130E+02	3.042E+02	8.251E+03	-8.555E+02
24	3.370E+02	3.268E+02	8.292E+03	-8.141E+02
25	3.610E+02	3.493E+02	8.313E+03	-7.934E+02
26	3.850E+02	3.717E+02	8.292E+03	-8.141E+02
27	4.090E+02	3.940E+02	8.292E+03	-8.141E+02
28	4.330E+02	4.163E+02	8.265E+03	-8.417E+02
29	4.570E+02	4.384E+02	8.272E+03	-8.348E+02
30	4.810E+02	4.605E+02	8.285E+03	-8.210E+02
31	5.050E+02	4.824E+02	8.299E+03	-8.072E+02
32	5.290E+02	5.043E+02	8.306E+03	-8.003E+02
33	5.530E+02	5.260E+02	8.306E+03	-8.003E+02
34	5.770E+02	5.477E+02	8.292E+03	-8.141E+02
35	6.010E+02	5.693E+02	8.278E+03	-8.279E+02
36	6.250E+02	5.907E+02	8.244E+03	-8.624E+02
37	6.730E+02	6.335E+02	8.182E+03	-9.244E+02
38	7.450E+02	6.968E+02	8.120E+03	-9.865E+02
39	8.410E+02	7.801E+02	8.065E+03	-1.042E+03
40	9.370E+02	8.621E+02	7.996E+03	-1.111E+03
41	1.009E+03	9.226E+02	8.003E+03	-1.104E+03

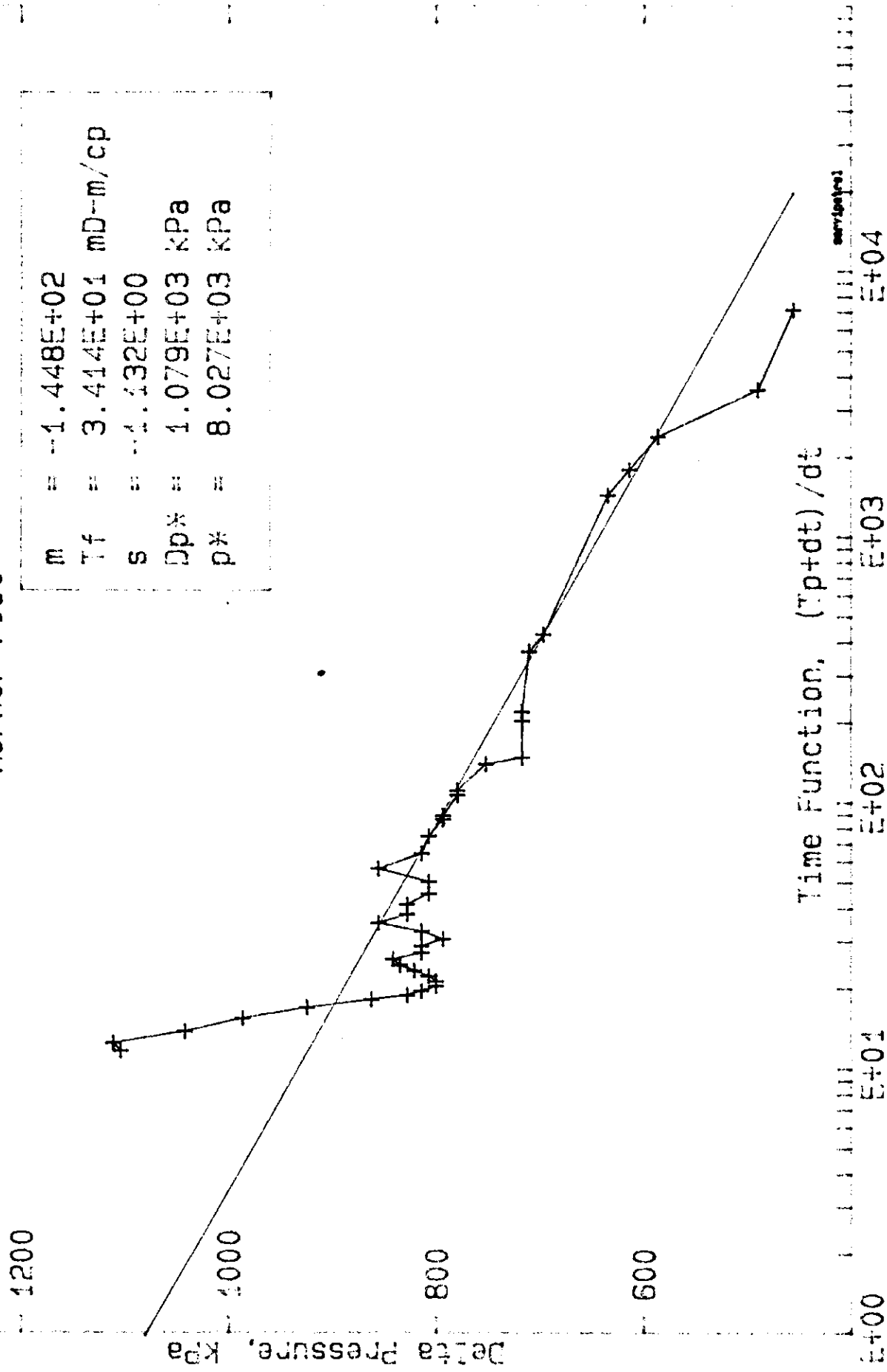
ENRON OIL CANADA LTD.

1-9-02-25WPM

FALL-OFF TEST

Horner Plot

m	=	-1.448E+02
Tf	=	3.414E+01 mD-m/cp
s	=	-1.132E+00
Dp*	=	1.079E+03 kPa
p*	=	8.027E+03 kPa



PRESSURE FALL-OFF TEST ANALYSIS

for

ENRON ET AL WASKADA 6-9-2-25 WPM

Date of Test: June 19 - July 31, 1990

PRESSURE FALL-OFF TEST ANALYSIS

Enron et al Waskada 6-9-2-25 WPM

Average Reservoir Pressure

The average reservoir pressure was calculated using the Horner build-up (fall-off) test analysis to extrapolate a static reservoir pressure. This pressure was then corrected to an average reservoir pressure by using SPE's Monograph No. 1 correlation for a five-spot waterflood injection pattern. Using this correlation the average reservoir would be 10 709 kPag, assuming normal fall-off test analysis procedure (ie. using total injection time). By using the fall-off time instead of the total injection time, a minimum average reservoir pressure was calculated to be 7 216 kPag. Based on these two analyses the actual average reservoir pressure would be somewhere between the calculated minimum and maximum reservoir pressures.

Reservoir Calculations

For reservoir parameters an effective net pay of 6.49 m was used based on log and core analysis. This resulted in a permeability thickness being 8.42 mD.m and the average permeability being 1.30 mD.

Damage Calculations

A skin of -6.76 was calculated showing that the well is stimulated and that the injectivity has been enhanced by the fracture stimulation treatment.

Average Pressure Calculations for 6-9

Using the fall-off time as the time (ie. 1009.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (1.298/0.9869) (1009.0)}{(0.165) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^{-6})} \\ \frac{(0.000264 \text{ kt})}{(\text{ØuCa})} &= 0.17 \end{aligned}$$

$$\frac{(p - p^*) kh}{70.6 i u} = (0.60) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)}$$

$$p - p^* = (0.60) (70.6) (191.3) \frac{(0.7)}{28.00}$$

$$p - p^* = 202.6$$

$$p = 202.6 + (1302 - 458)$$

$$= 1046.6 \text{ psig}$$

$$= 7216 \text{ kPag}$$

Using the injection time as the time (ie. 6952.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (1.298/0.9869) (6952.0)}{(0.165) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^{-6})} \\ \frac{(0.000264 \text{ kt})}{(\text{ØuCa})} &= 1.15 \end{aligned}$$

$$\frac{(p - p^*) kh}{70.6 i u} = (2.10) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)}$$

$$p - p^* = 2.10 * \frac{70.6 * i u}{kh} \quad \begin{array}{l} \text{where: } i = 191.3 \text{ bbl/d} \\ u = 0.7 \\ kh = 28.00 \text{ md-ft} \end{array}$$

$$p - p^* = 709.1$$

$$p = 709.1 + (1302 - 458)$$

$$= 1553.1 \text{ psig}$$

$$= 10709 \text{ kPag}$$

Estimated average reservoir pressure:

$$\frac{(7216 + 10709)}{2} = 8963 \text{ kPag}$$

NOTE: Conversion mD to md = (1/0.9869)

$$\begin{array}{ll} \text{KB} & = 475.2 \\ \text{Datum} & = 440 \text{ m SS} \end{array}$$

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ENRON OIL CANADA LTD.
6-9-02-25WPM
FALL-OFF TEST
JUNE 19-JULY 31,1990

Flowrate Data
=====

No.	Elapsed time hr	Total Res m ³ /D	Oil m ³ /D	Gas m ³ /D	Water m ³ /D
1	6.952E+03	3.040E+01	0.000E-01	0.000E-01	3.040E+01

Buildup Data
=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	1.500E+00	1.500E+00	8.816E+03	-1.586E+02
2	3.000E+00	2.999E+00	8.761E+03	-2.137E+02
3	4.500E+00	4.497E+00	8.527E+03	-4.482E+02
4	6.000E+00	5.995E+00	8.471E+03	-5.033E+02
5	7.500E+00	7.492E+00	8.368E+03	-6.067E+02
6	2.500E+01	2.491E+01	7.692E+03	-1.282E+03
7	2.900E+01	2.888E+01	7.589E+03	-1.386E+03
8	4.900E+01	4.866E+01	7.017E+03	-1.958E+03
9	5.300E+01	5.260E+01	6.941E+03	-2.034E+03
10	7.300E+01	7.224E+01	6.569E+03	-2.406E+03
11	7.700E+01	7.616E+01	6.506E+03	-2.468E+03
12	9.700E+01	9.567E+01	6.210E+03	-2.765E+03
13	1.010E+02	9.955E+01	6.162E+03	-2.813E+03
14	1.210E+02	1.189E+02	5.865E+03	-3.110E+03
15	1.250E+02	1.228E+02	5.824E+03	-3.151E+03
16	1.450E+02	1.420E+02	5.652E+03	-3.323E+03
17	1.690E+02	1.650E+02	5.348E+03	-3.627E+03
18	1.930E+02	1.878E+02	5.121E+03	-3.854E+03
19	2.170E+02	2.104E+02	4.914E+03	-4.061E+03
20	2.410E+02	2.329E+02	4.693E+03	-4.282E+03
21	2.650E+02	2.553E+02	4.493E+03	-4.482E+03
22	2.890E+02	2.775E+02	4.328E+03	-4.647E+03
23	3.130E+02	2.995E+02	4.176E+03	-4.799E+03
24	3.370E+02	3.214E+02	4.017E+03	-4.957E+03
25	3.610E+02	3.432E+02	3.907E+03	-5.068E+03
26	3.850E+02	3.648E+02	3.776E+03	-5.199E+03
27	4.090E+02	3.863E+02	3.659E+03	-5.316E+03
28	4.330E+02	4.076E+02	3.521E+03	-5.454E+03
29	4.570E+02	4.288E+02	3.425E+03	-5.550E+03
30	4.810E+02	4.499E+02	3.307E+03	-5.667E+03
31	5.050E+02	4.708E+02	3.197E+03	-5.778E+03
32	5.290E+02	4.916E+02	3.073E+03	-5.902E+03
33	5.530E+02	5.123E+02	3.052E+03	-5.923E+03
34	5.770E+02	5.328E+02	2.983E+03	-5.991E+03
35	6.010E+02	5.532E+02	2.832E+03	-6.143E+03
36	6.250E+02	5.734E+02	2.721E+03	-6.253E+03
37	6.730E+02	6.136E+02	2.556E+03	-6.419E+03
38	7.450E+02	6.729E+02	2.328E+03	-6.646E+03
39	8.410E+02	7.502E+02	2.115E+03	-6.860E+03
40	9.370E+02	8.257E+02	1.873E+03	-7.102E+03
41	1.009E+03	8.811E+02	1.722E+03	-7.253E+03

ENRON OIL CANADA LTD.

6-9-02-25WPM

FALL-OFF TEST

Horner Plot

1.6E+04

1.2E+04

8.0E+03

4.0E+03

Delta Pressure, KPa

m = -5.431E+03
Tf = 1.203E+01 mD-m/cp
s = -6.755E+00
Dp* = 1.213E+04 kPa
p* = -3.158E+03 kPa

Time Function, $(T_p + dt)/dt$

E+00

E+01

E+02

E+03

ENRON OIL CANADA LTD.

6-9-02-25WPM

FALL-OFF TEST

JUNE 19-JULY 31,1990

Input Data

Pressure Run Depth..... = 0.000E-01 m
 Fluid Analyzed..... = Multi-phase
 Production Time..... = 6.952E+03 hr
 Total Flow Rate..... = 3.040E+01 Res m³/D
 Water Flow Rate..... = 3.040E+01 m³/D
 Bottomhole Flowing Pressure..... = 8.975E+03 kPa
 Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
 Water Viscosity..... = 7.000E-01 cp
 Reservoir Temperature..... = 4.300E+01 Degree C
 Pay Thickness..... = 6.490E+00 m
 Porosity..... = 1.650E-01
 Oil Saturation..... = 6.000E-01
 Gas Saturation..... = 0.000E-01
 Water Saturation..... = 4.000E-01
 Total Compressibility..... = 1.510E-06 1/kPa
 Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 5.431E+03
 Intercept..... = 1.213E+04 kPa
 Dp or Dm(p) at 1 hour..... = -8.734E+03 kPa
 Extended Pressure..... = -3.158E+03 kPa
 Total Transmissibility..... = 1.203E+01 mD-m/cp
 Water Transmissibility..... = 1.203E+01 mD-m/cp
 Water Reservoir Capacity..... = 8.424E+00 mD-m
 Total Mobility..... = 1.854E+00 mD/cp
 Water Mobility..... = 1.854E+00 mD/cp
 Effective Permeability to Water... = 1.298E+00 mD
 Skin Factor..... = -6.756E+00
 Pressure Drop due to skin..... = -3.192E+04 kPa
 Total Ideal Productivity Index... = 6.900E-04 Res m³/D/kPa
 Total Actual Productivity Index... = 2.506E-03 Res m³/D/kPa
 Total Flow Efficiency..... = 3.631E+00
 Radius of Investigation..... = 8.556E+02 m

PRESSURE FALL-OFF TEST ANALYSIS

for

ENRON ET AL WASKADA 10-9-2-25 WPM

Date of Test: June 19 - July 31, 1990

PRESSURE FALL-OFF TEST ANALYSIS

Enron et al Waskada 10-9-2-25 WPM

Average Reservoir Pressure

The average reservoir pressure was calculated using the Horner build-up (fall-off) test analysis to extrapolate a static reservoir pressure. This pressure was then corrected to an average reservoir pressure by using SPE's Monograph No. 1 correlation for a five-spot waterflood injection pattern. Using this correlation the average reservoir would be 6 290 kPag, assuming normal fall-off test analysis procedure (ie. using total injection time). By using the fall-off time instead of the total injection time, a minimum average reservoir pressure was calculated to be 4 485 kPag. Based on these two analyses the actual average reservoir pressure would be somewhere between the calculated minimum and maximum reservoir pressures.

Reservoir Calculations

For reservoir parameters an effective net pay of 3.40 m was used based on log and core analysis. This resulted in a permeability thickness being 0.92 mD.m and the average permeability being 0.27 mD.

Damage Calculations

A skin of -5.14 was calculated showing that the well is stimulated. Water injectivity and the calculated formation permeability thickness have decreased significantly between fall-off tests. This would seem to indicate that formation damage is occurring deeper in the formation along the fracture sandface. A chemical treatment will probably be scheduled for this well in an attempt to improve injectivity.

Average Pressure Calculations for 10-9

Using the fall-off time as the time (ie. 1010.0 hrs):

$$\begin{aligned}
 \frac{TDA}{(0.000264 \text{ kt})} &= \frac{0.000264 (0.27/0.9869) (1010.0)}{(0.165) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^{-6})} \\
 (\varnothing u C_a) &= 0.04 \\
 \frac{(p - p^*) kh}{70.6 i u} &= (0.02) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \\
 p - p^* &= (0.02) (70.6) (17.00) \frac{(0.7)}{3.05} \\
 p - p^* &= 5.5 \\
 p &= 5.5 + (1305 - 660) \\
 &= 650.5 \text{ psig} \\
 &= 4485 \text{ kPag}
 \end{aligned}$$

Using the injection time as the time (ie. 8542.0 hrs):

$$\begin{aligned}
 \frac{TDA}{(0.000264 \text{ kt})} &= \frac{0.000264 (0.27/0.9869) (8542.0)}{(0.165) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^{-6})} \\
 (\varnothing u C_a) &= 0.29 \\
 &= (0.97) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \\
 p - p^* &= 0.97 * \frac{70.6 * i u}{kh} \quad \text{where: } i = 17.0 \text{ bbl/d} \\
 &\quad \quad \quad u = 0.7 \\
 &\quad \quad \quad kh = 3.05 \text{ md-ft} \\
 p - p^* &= 267.2 \\
 p &= 267.2 + (1305 - 660) \\
 &= 912.2 \text{ psig} \\
 &= 6290 \text{ kPag}
 \end{aligned}$$

Estimated average reservoir pressure:

$$\frac{(4485 + 6290)}{2} = 5388 \text{ kPag}$$

NOTE: Conversion mD to md = (1/0.9869)

$$\begin{array}{ll} \text{KB} & = 477.2 \\ \text{Datum} & = 440 \text{ m SS} \end{array}$$

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ENRON OIL CANADA LTD.
10-9-02-25WPM
FALL-OFF TEST
JUNE 19-JULY 20,1990

Flowrate Data

=====

No.	Elapsed time hr	Total Res m ³ /D	Oil m ³ /D	Gas m ³ /D	Water m ³ /D
1	8.542E+03	2.700E+00	0.000E-01	0.000E-01	2.700E+00

Buildup Data

=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	1.500E+00	1.500E+00	8.065E+03	-8.756E+02
2	3.000E+00	2.999E+00	7.754E+03	-1.186E+03
3	4.500E+00	4.498E+00	7.437E+03	-1.503E+03
4	6.000E+00	5.996E+00	7.217E+03	-1.724E+03
5	7.500E+00	7.493E+00	7.134E+03	-1.806E+03
6	2.500E+01	2.493E+01	5.920E+03	-3.020E+03
7	2.900E+01	2.890E+01	5.762E+03	-3.178E+03
8	4.900E+01	4.872E+01	5.162E+03	-3.778E+03
9	5.300E+01	5.267E+01	5.017E+03	-3.923E+03
10	7.300E+01	7.238E+01	4.693E+03	-4.247E+03
11	7.700E+01	7.631E+01	4.617E+03	-4.323E+03
12	9.700E+01	9.591E+01	4.169E+03	-4.771E+03
13	1.010E+02	9.982E+01	4.128E+03	-4.813E+03
14	1.210E+02	1.193E+02	3.824E+03	-5.116E+03
15	1.250E+02	1.232E+02	3.776E+03	-5.164E+03
16	1.450E+02	1.426E+02	3.507E+03	-5.433E+03
17	1.690E+02	1.657E+02	3.176E+03	-5.764E+03
18	1.930E+02	1.887E+02	2.983E+03	-5.957E+03
19	2.170E+02	2.116E+02	2.756E+03	-6.185E+03
20	2.410E+02	2.344E+02	2.508E+03	-6.433E+03
21	2.650E+02	2.570E+02	2.335E+03	-6.605E+03
22	2.890E+02	2.795E+02	2.156E+03	-6.784E+03
23	3.130E+02	3.019E+02	1.997E+03	-6.943E+03
24	3.370E+02	3.242E+02	1.825E+03	-7.115E+03
25	3.610E+02	3.464E+02	1.660E+03	-7.281E+03
26	3.850E+02	3.684E+02	1.529E+03	-7.412E+03
27	4.090E+02	3.903E+02	1.391E+03	-7.550E+03
28	4.330E+02	4.121E+02	1.246E+03	-7.694E+03
29	4.570E+02	4.338E+02	1.163E+03	-7.777E+03
30	4.810E+02	4.554E+02	1.060E+03	-7.881E+03
31	5.050E+02	4.768E+02	9.631E+02	-7.977E+03
32	5.290E+02	4.981E+02	8.666E+02	-8.074E+03
33	5.530E+02	5.194E+02	7.908E+02	-8.150E+03
34	5.770E+02	5.405E+02	7.149E+02	-8.225E+03
35	6.010E+02	5.615E+02	6.873E+02	-8.253E+03
36	6.250E+02	5.824E+02	5.495E+02	-8.391E+03
37	6.730E+02	6.238E+02	4.254E+02	-8.515E+03
38	7.450E+02	6.852E+02	2.599E+02	-8.680E+03
39	1.010E+03	9.032E+02	-2.357E+02	-9.176E+03

ENRON OIL CANADA LTD.

10-9-02-25WPM

FALL-OFF TEST

Horner Plot

1.6E+04

1.2E+04

8.0E+03

4.0E+03

Delta Pressure, kPa

Time Function, $(T_p + dt) / dt$

E+00

E+01

E+02

E+03

m = -4.425E+03
Tf = 1.312E+00 mD-m/cp
s = -5.136E+00
Dp* = 1.349E+04 kPa
p* = -4.553E+03 kPa

ENRON OIL CANADA LTD.

10-9-02-25WPM

FALL-OFF TEST

JUNE 19-JULY 20,1990

Input Data

Pressure Run Depth..... = 0.000E-01 m
Fluid Analyzed..... = Multi-phase
Production Time..... = 8.542E+03 hr
Total Flow Rate..... = 2.700E+00 Res m³/D
Water Flow Rate..... = 2.700E+00 m³/D
Bottomhole Flowing Pressure..... = 8.940E+03 kPa
Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
Water Viscosity..... = 7.000E-01 cp
Reservoir Temperature..... = 4.300E+01 Degree C
Pay Thickness..... = 3.400E+00 m
Porosity..... = 1.650E-01
Oil Saturation..... = 6.000E-01
Gas Saturation..... = 0.000E-01
Water Saturation..... = 4.000E-01
Total Compressibility..... = 1.510E-06 1/kPa
Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 4.425E+03
Intercept..... = 1.349E+04 kPa
Dp or Dm(p) at 1 hour..... = -3.905E+03 kPa
Extended Pressure..... = -4.553E+03 kPa
Total Transmissibility..... = 1.312E+00 mD-m/cp
Water Transmissibility..... = 1.312E+00 mD-m/cp
Water Reservoir Capacity..... = 9.182E-01 mD-m
Total Mobility..... = 3.858E-01 mD/cp
Water Mobility..... = 3.858E-01 mD/cp
Effective Permeability to Water... = 2.701E-01 mD
Skin Factor..... = -5.136E+00
Pressure Drop due to skin..... = -1.977E+04 kPa
Total Ideal Productivity Index... = 8.116E-05 Res m³/D/kPa
Total Actual Productivity Index... = 2.001E-04 Res m³/D/kPa
Total Flow Efficiency..... = 2.465E+00
Radius of Investigation..... = 4.326E+02 m

PRESSURE FALL-OFF TEST ANALYSIS

for

ENRON ET AL WASKADA 16-9-2-25 WPM

Date of Test: June 19 - July 31, 1990

PRESSURE FALL-OFF TEST ANALYSIS

Enron et al Waskada 16-9-2-25 WPM

Average Reservoir Pressure

The average reservoir pressure was calculated using the Horner build-up (fall-off) test analysis to extrapolate a static reservoir pressure. This pressure was then corrected to an average reservoir pressure by using SPE's Monograph No. 1 correlation for a five-spot waterflood injection pattern. Using this correlation the average reservoir would be 10 549 kPag, assuming normal fall-off test analysis procedure (ie. using total injection time). By using the fall-off time instead of the total injection time, a minimum average reservoir pressure was calculated to be 7 271 kPag. Based on these two analyses the actual average reservoir pressure would be somewhere between the calculated minimum and maximum reservoir pressures.

Reservoir Calculations

For reservoir parameters an effective net pay of 5.20 m was used based on log and core analysis. This resulted in a permeability thickness being 4.34 mD.m and the average permeability being 0.83 mD.

Damage Calculations

A skin of -6.27 was calculated showing that the well is stimulated and that the injectivity has been enhanced by the fracture stimulation treatment.

reports\wask16-9.fo

Average Pressure Calculations for 16-9

Using the fall-off time as the time (ie. 1009.0 hrs):

$$\begin{aligned}
 \frac{TDA}{(0.000264 \text{ kt})} &= \frac{0.000264 (0.83/0.9869) (1009.0)}{(0.17) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^{-6})} \\
 (\varnothing u Ca) &= 0.10 \\
 \frac{(p - p^*) kh}{70.6 i u} &= (0.32) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \\
 p - p^* &= (0.32) (70.6) (78.0) \frac{(0.7)}{14.43} \\
 p - p^* &= 85.5 \\
 p &= 85.5 + (1305 - 336) \\
 &= 1054.5 \text{ psig} \\
 &= 7271 \text{ kPag}
 \end{aligned}$$

Using the injection time as the time (ie. 10960.0 hrs):

$$\begin{aligned}
 \frac{TDA}{(0.000264 \text{ kt})} &= \frac{0.000264 (0.83/0.9869) (10960.0)}{(0.17) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^{-6})} \\
 (\varnothing u Ca) &= 1.13 \\
 &= (2.10) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \\
 p - p^* &= 2.10 * \frac{70.6 * i u}{kh} \quad \text{where: } i = 78.0 \text{ bbl/d} \\
 &\quad \quad \quad u = 0.7 \\
 &\quad \quad \quad kh = 14.43 \text{ md-ft} \\
 p - p^* &= 561.0 \\
 p &= 561.0 + (1305 - 336) \\
 &= 1530.0 \text{ psig} \\
 &= 10549 \text{ kPag}
 \end{aligned}$$

Estimated average reservoir pressure:

$$\frac{(7271 + 10549)}{2} = 8910 \text{ kPag}$$

NOTE: Conversion mD to md = (1/0.9869)

$$\begin{array}{ll} \text{KB} & = 477.2 \\ \text{Datum} & = 440 \text{ m SS} \end{array}$$

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ENRON OIL CANADA LTD.
16-9-02-25WPM
FALL-OFF TEST
JUNE 19-JULY 31,1990

Flowrate Data
=====

No.	Elapsed time hr	Total Res m ³ /D	Oil m ³ /D	Gas m ³ /D	Water m ³ /D
1	1.096E+04	1.240E+01	0.000E-01	0.000E-01	1.240E+01

Buildup Data
=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	1.500E+00	1.500E+00	8.858E+03	-2.344E+02
2	3.000E+00	2.999E+00	8.789E+03	-3.034E+02
3	4.500E+00	4.498E+00	8.596E+03	-4.964E+02
4	6.000E+00	5.997E+00	8.416E+03	-6.757E+02
5	7.500E+00	7.495E+00	8.354E+03	-7.377E+02
6	2.500E+01	2.494E+01	7.396E+03	-1.696E+03
7	2.900E+01	2.892E+01	7.299E+03	-1.793E+03
8	4.900E+01	4.878E+01	6.782E+03	-2.310E+03
9	5.300E+01	5.274E+01	6.706E+03	-2.386E+03
10	7.300E+01	7.252E+01	6.341E+03	-2.751E+03
11	7.700E+01	7.646E+01	6.272E+03	-2.820E+03
12	9.700E+01	9.615E+01	6.031E+03	-3.061E+03
13	1.010E+02	1.001E+02	5.976E+03	-3.116E+03
14	1.210E+02	1.197E+02	5.707E+03	-3.385E+03
15	1.250E+02	1.236E+02	5.665E+03	-3.427E+03
16	1.450E+02	1.431E+02	5.479E+03	-3.613E+03
17	1.690E+02	1.664E+02	5.265E+03	-3.827E+03
18	1.930E+02	1.897E+02	5.072E+03	-4.020E+03
19	2.170E+02	2.128E+02	4.879E+03	-4.213E+03
20	2.410E+02	2.358E+02	4.714E+03	-4.378E+03
21	2.650E+02	2.587E+02	4.548E+03	-4.544E+03
22	2.890E+02	2.816E+02	4.397E+03	-4.695E+03
23	3.130E+02	3.043E+02	4.293E+03	-4.799E+03
24	3.370E+02	3.269E+02	4.169E+03	-4.923E+03
25	3.610E+02	3.495E+02	4.080E+03	-5.012E+03
26	3.850E+02	3.719E+02	3.955E+03	-5.137E+03
27	4.090E+02	3.943E+02	3.873E+03	-5.219E+03
28	4.330E+02	4.165E+02	3.762E+03	-5.330E+03
29	4.570E+02	4.387E+02	3.687E+03	-5.405E+03
30	4.810E+02	4.608E+02	3.624E+03	-5.467E+03
31	5.050E+02	4.828E+02	3.528E+03	-5.564E+03
32	5.290E+02	5.046E+02	3.425E+03	-5.667E+03
33	5.530E+02	5.264E+02	3.376E+03	-5.716E+03
34	5.770E+02	5.481E+02	3.328E+03	-5.764E+03
35	6.010E+02	5.698E+02	3.218E+03	-5.874E+03
36	6.250E+02	5.913E+02	3.135E+03	-5.957E+03
37	6.730E+02	6.341E+02	3.004E+03	-6.088E+03
38	7.450E+02	6.976E+02	2.845E+03	-6.247E+03
39	8.410E+02	7.811E+02	2.625E+03	-6.467E+03
40	9.370E+02	8.632E+02	2.404E+03	-6.688E+03
41	1.009E+03	9.239E+02	2.259E+03	-6.833E+03

ENRON OIL CANADA LTD.

16-9-02-25WPM

FALL-OFF TEST

Horner Plot

m = -4.300E+03
Tf = 6.200E+00 mD-m/cp
s = -6.265E+00
Dp* = 1.141E+04 kPa
p* = -2.319E+03 kPa

1.6E+04

1.2E+04

8.0E+03

4.0E+03

Delta Pressure, kPa

Time Function, $(T_p + dt)/dt$

E+00

E+01

E+02

E+03

ENRON OIL CANADA LTD.
16-9-02-25WPM
FALL-OFF TEST
JUNE 19-JULY 31,1990

Input Data

Pressure Run Depth..... = 0.000E-01 m
Fluid Analyzed..... = Multi-phase
Production Time..... = 1.096E+04 hr
Total Flow Rate..... = 1.240E+01 Res m³/D
Water Flow Rate..... = 1.240E+01 m³/D
Bottomhole Flowing Pressure..... = 9.092E+03 kPa
Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
Water Viscosity..... = 7.000E-01 cp
Reservoir Temperature..... = 4.300E+01 Degree C
Pay Thickness..... = 5.200E+00 m
Porosity..... = 1.700E-01
Oil Saturation..... = 6.000E-01
Gas Saturation..... = 0.000E-01
Water Saturation..... = 4.000E-01
Total Compressibility..... = 1.510E-06 1/kPa
Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 4.300E+03
Intercept..... = 1.141E+04 kPa
Dp or Dm(p) at 1 hour..... = -5.959E+03 kPa
Extended Pressure..... = -2.319E+03 kPa
Total Transmissibility..... = 6.200E+00 mD-m/cp
Water Transmissibility..... = 6.200E+00 mD-m/cp
Water Reservoir Capacity..... = 4.340E+00 mD-m
Total Mobility..... = 1.192E+00 mD/cp
Water Mobility..... = 1.192E+00 mD/cp
Effective Permeability to Water... = 8.347E-01 mD
Skin Factor..... = -6.265E+00
Pressure Drop due to skin..... = -2.343E+04 kPa
Total Ideal Productivity Index... = 3.559E-04 Res m³/D/kPa
Total Actual Productivity Index... = 1.087E-03 Res m³/D/kPa
Total Flow Efficiency..... = 3.054E+00
Radius of Investigation..... = 8.487E+02 m

PRESSURE FALL-OFF TEST ANALYSIS

for

ENRON ET AL WASKADA 5-10-2-25 WPM

Date of Test: June 19 - July 31, 1990

PRESSURE FALL-OFF TEST ANALYSIS

Enron et al Waskada 5-10-2-25 WPM

Average Reservoir Pressure

The average reservoir pressure was calculated using the Horner build-up (fall-off) test analysis to extrapolate a static reservoir pressure. This pressure was then corrected to an average reservoir pressure by using SPE's Monograph No. 1 correlation for a five-spot waterflood injection pattern. Using this correlation the average reservoir would be 7 241 kPag, assuming normal fall-off test analysis procedure (ie. using total injection time). By using the fall-off time instead of the total injection time, a minimum average reservoir pressure was calculated to be 6 626 kPag. Based on these two analyses the actual average reservoir pressure would be somewhere between the calculated minimum and maximum reservoir pressures.

Reservoir Calculations

For reservoir parameters an effective net pay of 15.22 m was used based on log and core analysis. This resulted in a permeability thickness being 1.21 mD.m and the average permeability being 0.08 mD.

Damage Calculations

A skin of -5.02 was calculated showing that the well is stimulated and that the injectivity has been enhanced by the fracture stimulation treatment.

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Average Pressure Calculations for 5-10

Using the fall-off time as the time (ie. 1009.0 hrs):

$$\begin{aligned} \frac{TDA}{(0.000264 \text{ kt})} &= \frac{0.000264 (0.08/0.9869) (1009.0)}{(0.155) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^{-6})} \\ (\phi u C_a) &= 0.01 \end{aligned}$$

$$\frac{(p - p^*)_{kh}}{70.6 i u} = (0.0) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)}$$

$$p - p^* = (0.0) (70.6) (21.4) \frac{(0.7)}{4.03}$$

$$p - p^* = 0.0$$

$$p = 0.0 + (1304 - 343)$$

$$= 961 \text{ psig}$$

$$= 6626 \text{ kPag}$$

Using the injection time as the time (ie. 9811.0 hrs):

$$\begin{aligned} \frac{TDA}{(0.000264 \text{ kt})} &= \frac{0.000264 (0.08/0.9869) (9811.0)}{(0.155) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^{-6})} \\ (\phi u C_a) &= 0.11 \end{aligned}$$

$$= (0.34) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)}$$

$$p - p^* = 0.34 * \frac{70.6 * i u}{kh} \quad \text{where: } i = 21.4 \text{ bbl/d}$$

$$u = 0.7$$

$$kh = 4.03 \text{ md-ft}$$

$$p - p^* = 89.2$$

$$p = 89.2 + (1304 - 343)$$

$$= 1050.2 \text{ psig}$$

$$= 7241 \text{ kPag}$$

Estimated average reservoir pressure:

$$\frac{(6626 + 7241)}{2} = 6934 \text{ kPag}$$

NOTE: Conversion mD to md = (1/0.9869)

$$\begin{array}{ll} \text{KB} & = 476.4 \text{ m} \\ \text{Datum} & = 440 \text{ m SS} \end{array}$$

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ENRON OIL CANADA LTD.
5-10-02-25WPM
FALL-OFF TEST
JUNE 19-JULY 31,1990

Flowrate Data
=====

No.	Elapsed time hr	Total Res m ³ /D	Oil m ³ /D	Gas m ³ /D	Water m ³ /D
1	9.811E+03	3.400E+00	0.000E-01	0.000E-01	3.400E+00

Buildup Data
=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	1.500E+00	1.500E+00	8.885E+03	-1.931E+02
2	3.000E+00	2.999E+00	8.796E+03	-2.827E+02
3	4.500E+00	4.498E+00	8.616E+03	-4.619E+02
4	6.000E+00	5.996E+00	8.458E+03	-6.205E+02
5	7.500E+00	7.494E+00	8.423E+03	-6.550E+02
6	2.500E+01	2.494E+01	7.361E+03	-1.717E+03
7	2.900E+01	2.891E+01	7.258E+03	-1.820E+03
8	4.900E+01	4.876E+01	6.686E+03	-2.392E+03
9	5.300E+01	5.272E+01	6.603E+03	-2.475E+03
10	7.300E+01	7.246E+01	6.231E+03	-2.848E+03
11	7.700E+01	7.640E+01	6.148E+03	-2.930E+03
12	9.700E+01	9.605E+01	5.851E+03	-3.227E+03
13	1.010E+02	9.997E+01	5.796E+03	-3.282E+03
14	1.210E+02	1.195E+02	5.541E+03	-3.537E+03
15	1.250E+02	1.234E+02	5.479E+03	-3.599E+03
16	1.450E+02	1.429E+02	5.293E+03	-3.785E+03
17	1.690E+02	1.661E+02	5.045E+03	-4.033E+03
18	1.930E+02	1.893E+02	4.845E+03	-4.233E+03
19	2.170E+02	2.123E+02	4.631E+03	-4.447E+03
20	2.410E+02	2.352E+02	4.452E+03	-4.626E+03
21	2.650E+02	2.580E+02	4.273E+03	-4.806E+03
22	2.890E+02	2.807E+02	4.128E+03	-4.950E+03
23	3.130E+02	3.033E+02	3.997E+03	-5.081E+03
24	3.370E+02	3.258E+02	3.880E+03	-5.199E+03
25	3.610E+02	3.482E+02	3.762E+03	-5.316E+03
26	3.850E+02	3.705E+02	3.638E+03	-5.440E+03
27	4.090E+02	3.926E+02	3.576E+03	-5.502E+03
28	4.330E+02	4.147E+02	3.493E+03	-5.585E+03
29	4.570E+02	4.367E+02	3.390E+03	-5.688E+03
30	4.810E+02	4.585E+02	3.300E+03	-5.778E+03
31	5.050E+02	4.803E+02	3.204E+03	-5.874E+03
32	5.290E+02	5.019E+02	3.094E+03	-5.985E+03
33	5.530E+02	5.235E+02	3.032E+03	-6.047E+03
34	5.770E+02	5.450E+02	2.963E+03	-6.116E+03
35	6.010E+02	5.663E+02	2.866E+03	-6.212E+03
36	6.250E+02	5.876E+02	2.832E+03	-6.247E+03
37	6.730E+02	6.298E+02	2.680E+03	-6.398E+03
38	7.450E+02	6.924E+02	2.501E+03	-6.578E+03
39	8.410E+02	7.746E+02	2.308E+03	-6.771E+03
40	9.370E+02	8.553E+02	2.101E+03	-6.977E+03
41	1.009E+03	9.149E+02	1.970E+03	-7.108E+03

ENRON OIL CANADA LTD.

5-10-02-25WPM

FALL-OFF TEST

Horner Plot

1.6E+04

1.2E+04

8.0E+03

4.0E+03

Delta Pressure, kPa

Time Function, $(T_p + dt)/dt$

E+00

E+01

E+02

E+03

$m = -4.224E+03$
 $Tf = 1.730E+00$ mD-m/cp
 $s = -5.018E+00$
 $Dp^* = 1.144E+04$ kPa
 $p^* = -2.364E+03$ kPa

ENRON OIL CANADA LTD.
5-10-02-25WPM
FALL-OFF TEST
JUNE 19-JULY 31,1990

Input Data

Pressure Run Depth..... = 0.000E-01 m
Fluid Analyzed..... = Multi-phase
Production Time..... = 9.811E+03 hr
Total Flow Rate..... = 3.400E+00 Res m³/D
Water Flow Rate..... = 3.400E+00 m³/D
Bottomhole Flowing Pressure..... = 9.078E+03 kPa
Water Formation Volume Factor..... = 1.000E+00 Res m³/m³
Water Viscosity..... = 7.000E-01 cp
Reservoir Temperature..... = 4.300E+01 Degree C
Pay Thickness..... = 1.522E+01 m
Porosity..... = 1.550E-01
Oil Saturation..... = 6.000E-01
Gas Saturation..... = 0.000E-01
Water Saturation..... = 4.000E-01
Total Compressibility..... = 1.510E-06 1/kPa
Wellbore Radius..... = 5.700E-02 m

Output

Slope..... = 4.224E+03
Intercept..... = 1.144E+04 kPa
Dp or Dm(p) at 1 hour..... = -5.420E+03 kPa
Extended Pressure..... = -2.364E+03 kPa
Total Transmissibility..... = 1.730E+00 mD-m/cp
Water Transmissibility..... = 1.730E+00 mD-m/cp
Water Reservoir Capacity..... = 1.211E+00 mD-m
Total Mobility..... = 1.137E-01 mD/cp
Water Mobility..... = 1.137E-01 mD/cp
Effective Permeability to Water... = 7.959E-02 mD
Skin Factor..... = -5.018E+00
Pressure Drop due to skin..... = -1.844E+04 kPa
Total Ideal Productivity Index... = 1.138E-04 Res m³/D/kPa
Total Actual Productivity Index... = 2.972E-04 Res m³/D/kPa
Total Flow Efficiency..... = 2.612E+00
Radius of Investigation..... = 2.597E+02 m

**ENRON
Oil Canada Ltd.**

7 June 1990

Manitoba Energy and Mines
Petroleum Department
#555, 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3

Attention: Mr. L.R. Dubreuil,
Chief Petroleum Engineer

Dear Sir:

**Re: 1990 Pressure Surveys
Waskada Unit No. 16**

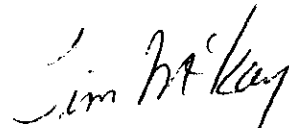
Please find attached a copy of the proposed fall-off test procedure for the expanded portion of the Waskada Unit No. 16 area.

Enron Oil Canada Ltd. hopes to start conducting the tests on the morning of June 15, 1990, while at the same time continuing to inject in the original Unit area. The continued injection into 5-4, 11-4, 15-4 and 16-5 is not expected to affect the integrity of the tests.

Enron will be forwarding completed fall-off tests as soon as the results become available.

Yours very truly,

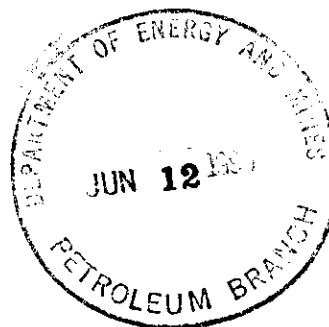
ENRON OIL CANADA LTD.


T. McKay,
Production Engineer

TM:pdc
attach
xc: C. Turnbull
tm003.ltr

CONCERNED ANALOGOUSLY
HIGH PRESSURE RESULTS
DETERMINED WITH
FALL-OFF TESTS
ESPECIALLY WHEN
COMPARED WITH
CUMULATIVE VRR = 0.7

8-2600



WASKADA UNIT NO. 16

FALL-OFF TEST PROGRAM - JUNE 1990

1. Record surface pressures of all five injectors (1-9, 6-9, 10-9, 16-9 and 5-10) on the morning of June 15, 1990.
2. Shut in injectors and record surface pressure and time of shut in.
3. Continue to record surface pressure every one to two hours for the first day of shut in (minimum of five times).
4. For the next five days record pressures twice daily.
5. During the next six to fourteen days record pressures once a day or until well goes on vacuum.
6. During these fall-off tests data sheets should be sent to the Calgary office once a week (Monday and Friday).

NOTE: It is imperative that accurate gauges be used and checked with a dead weight tester prior to and during these tests.

xc: C. Turnbull
D. Logie
D. Stoodley
L. Verstraete
L. Fenwick



Energy and Mines

Petroleum

555 — 330 Graham Avenue
Winnipeg, Manitoba, CANADA
R3C 4E3

(204) 945-6577

December 4, 1989

Enron Oil Canada Ltd.
1300, 700 — 9th Avenue S.W.
CALGARY, Alberta T2P 3V4

Attention: Mr. Tim McKay
Production Engineer

Re: 1989 Pressure Survey
Waskasda Unit No. 16

Dear Tim:

Your letter dated November 30, 1989 outlining the proposed annual pressure survey for Waskasda Unit No. 16 is acknowledged.

Your proposal to conduct 14 day pressure fall-off tests on the injection wells, 5-4-2-25 (WPM), 11-4-2-25 (WPM), 15-4-2-25 (WPM) and 16-5-2-25 (WPM) is hereby approved.

Yours sincerely,

Original Signed By
L. R. DUBREUIL

L.R. Dubreuil
Director

LRD:dah

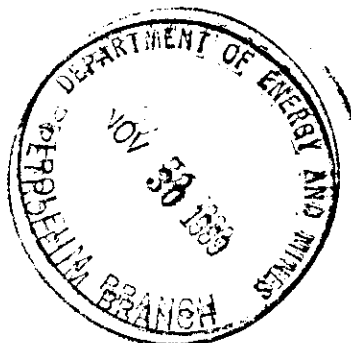
**ENRON
Oil Canada Ltd.**

(403) 298-2600

VIA PHONEFAX

30 November 1989

Manitoba Energy and Mines
Petroleum Department
#555, 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3



Attention: Mr. John N. Fox
Chief Petroleum Engineer

Dear Sir:

Re: 1989 Pressure Surveys
Waskada Unit No. 16

Please find attached a copy of the proposed fall off test procedure for the original Waskada Unit No. 16 area.

Enron Oil Canada Ltd. hopes to start conducting the test on the morning of December 5, 1989, while at the same time continuing to inject in the expanded Unit area. The continued injection into 1-9, 5-10, 6-9, 10-9 and 16-9 is not expected to affect the integrity of the tests.

Enron will be forwarding the surveys just completed on the new injectors and the fall off tests as soon as the results become available.

Yours very truly,

ENRON OIL CANADA LTD.

A handwritten signature in dark ink, appearing to read "T. McKay".

T. McKay,
Production Engineer

TM:pdc
attach

xc: C. Turnbull

WASKADA FALL-OFF TEST SHEET

WF'L LOCATION: _____

AVERAGE INJECTION RATE PRIOR TO TEST: _____

SHUT-IN DATE: _____

SHUT-IN TIME: _____

PRESSURE: _____

[illegible]

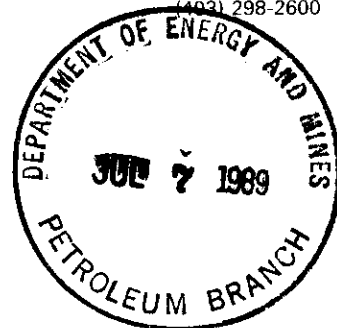
WASKADA UNIT NO. 16
FALL OFF TEST PROGRAM

1. Record surface pressures of all four injectors (5-4, 11-4, 15-4, 16-5) on the morning of December 5, 1989.
2. Shut in injectors and record surface pressure and time of shut in.
3. Continue to record surface pressure every one to two hours for the first day of shut in (minimum of five times).
4. For the next five days record pressures twice daily.
5. During the next six to fourteen days record pressures once a day or until well goes on vacuum.
6. During these fall off tests data sheets should be sent to the Calgary office twice a week (Monday and Friday).

NOTE: It is imperative that accurate gauges be used and checked with a dead weight tester prior to and during these tests.

ENRON
Oil Canada Ltd.

(403) 298-2600



4 July 1989

Manitoba Energy and Mines
Petroleum Department
#555, 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3

Attention: Mr. L.R. Dubreuil,
Chief Petroleum Engineer

Dear Sir:

Re: Waskada Unit No. 16 Expansion Area Pressure Survey

Enron Oil Canada Ltd. conducted pressure fall-off tests on the five water injection wells within Waskada Unit No. 16 starting June 5, 1989. The enclosed pressure fall-off tests analyses show that all five wells have estimated average drainage region pressures exceeding the 5 000 kPa minimum requirement at a datum depth of 440 m subsea.

Monthly Unit progress reports indicate that reservoir withdrawals have been completely replaced by injection water since injection started in December 1988 in the expanded area. It is therefore assumed that all of Waskada Unit No. 16 (Order No. PM57) has been exempted from maximum permissible rates effective July 1, 1989.

Should you wish to discuss any of the above matters, please contact the undersigned at your convenience.

Yours very truly,

ENRON OIL CANADA LTD.

A handwritten signature in cursive script that reads "T. McKay".

T. McKay,
Production Engineer

TM:pd
attach

cc: D. Logie
D. Stoodley
C. Turnbull
L. Fenwick

PRESSURE FALL-OFF TEST ANALYSIS
FOR

ENRON ET AL WASKADA 5-10
Lsd. 5-10-2-25 WPM

Date of Test: June 5-26, 1989

AVERAGE RESERVOIR PRESSURE

The average reservoir pressure was calculated using the Horner build-up (fall-off) test analysis to extrapolate a static reservoir pressure. This pressure was then corrected to an average reservoir pressure by using SPE's Monograph No. 1 correlation for a five-spot waterflood injection pattern. Using this correlation the average reservoir would be 8 282 kPag, assuming normal fall-off test analysis procedure (ie. using total injection time). By using the fall-off time instead of the total injection time, a minimum average reservoir pressure was calculated to be 7 450 kPag. Based on these two analyses the actual average reservoir pressure would be somewhere between the calculated minimum and maximum reservoir pressures.

RESERVOIR CALCULATIONS

For reservoir parameters an effective net pay of 15.22 m was used based on log and core analysis. This resulted in a permeability thickness being 3.66 mD.m and the average permeability being 0.27 mD.

DAMAGE CALCULATIONS

A skin of -5.47 was calculated showing that the well is stimulated and that the injectivity has been enhanced by the fracture stimulation treatment.

AVERAGE PRESSURE CALCULATIONS

Lsd. 5-10-2-25 WPM

Using the fall-off time as the time (ie. 506.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (0.27/0.9869) (506.0)}{(0.155) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^6)} \\ \frac{(0.000264 \text{ kt})}{(\emptyset uCa)} &= 0.02 \end{aligned}$$

$$\frac{(p - p^*) kh}{70.6 i u} = (0.02) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)}$$

$$p - p^* = (0.02) (70.6) (62.90) \frac{(0.7)}{13.66}$$

$$p - p^* = 4.6$$

$$\begin{aligned} p &= 4.6 + (1304 - 228) \\ &= 1018 \text{ psig} \\ &= 7450 \text{ kPag} \end{aligned}$$

Using the injection time as the time (ie. 4448.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (0.27/0.9869) (4448.0)}{(0.155) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^6)} \\ \frac{(0.000264 \text{ kt})}{(\emptyset uCa)} &= 0.16 \\ &= 0.55 \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \end{aligned}$$

$$p - p^* = 0.55 * \frac{70.6 * i u}{kh} \quad \text{where:} \quad \begin{aligned} i &= 62.9 \text{ bbl/d} \\ u &= 0.7 \\ kh &= 13.66 \text{ md-ft} \end{aligned}$$

$$p - p^* = 125.1$$

$$\begin{aligned} p &= 125.1 + (1304 - 228) \\ &= 1201.1 \text{ psig} \\ &= 8282 \text{ kPag} \end{aligned}$$

Estimated average reservoir pressure:

$$\frac{(7450 + 8282)}{2} = 7866 \text{ kPag}$$

NOTE: Conversion mD to md = (1/0.9869)

$$\begin{aligned} \text{KB} &= 476.4 \text{ m} \\ \text{Datum} &= 440 \text{ m SS} \end{aligned}$$

ENRON OIL CANADA LTD.
 5-10-02-25WPM
 FALL-OFF TEST
 JUNE 5-26, 1989

Flowrate Data

=====

No.	Elapsed time hr	Total Res m ³ /D	Oil m ³ /D	Gas m ³ /D	Water m ³ /D
1	4.448E+03	1.000E+01	0.000E-01	0.000E-01	1.000E+01

Buildup Data

=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	2.000E+00	1.999E+00	8.101E+03	-4.000E+02
2	4.000E+00	3.996E+00	7.851E+03	-6.500E+02
3	6.000E+00	5.992E+00	7.701E+03	-8.000E+02
4	8.000E+00	7.986E+00	7.551E+03	-9.500E+02
5	2.400E+01	2.387E+01	6.801E+03	-1.700E+03
6	3.000E+01	2.980E+01	6.501E+03	-2.000E+03
7	4.800E+01	4.749E+01	5.951E+03	-2.550E+03
8	5.400E+01	5.335E+01	5.851E+03	-2.650E+03
9	7.200E+01	7.085E+01	5.476E+03	-3.025E+03
10	7.800E+01	7.666E+01	5.401E+03	-3.100E+03
11	9.600E+01	9.397E+01	5.076E+03	-3.425E+03
12	1.020E+02	9.971E+01	5.026E+03	-3.475E+03
13	1.200E+02	1.168E+02	4.801E+03	-3.700E+03
14	1.260E+02	1.225E+02	4.751E+03	-3.750E+03
15	1.460E+02	1.414E+02	4.476E+03	-4.025E+03
16	1.700E+02	1.637E+02	4.201E+03	-4.300E+03
17	1.940E+02	1.859E+02	4.001E+03	-4.500E+03
18	2.180E+02	2.078E+02	3.801E+03	-4.700E+03
19	2.420E+02	2.295E+02	3.676E+03	-4.825E+03
20	2.660E+02	2.510E+02	3.526E+03	-4.975E+03
21	2.900E+02	2.722E+02	3.426E+03	-5.075E+03
22	3.140E+02	2.933E+02	3.251E+03	-5.250E+03
23	3.380E+02	3.141E+02	3.151E+03	-5.350E+03
24	3.620E+02	3.348E+02	3.026E+03	-5.475E+03
25	3.860E+02	3.552E+02	2.926E+03	-5.575E+03
26	4.100E+02	3.754E+02	2.826E+03	-5.675E+03
27	4.340E+02	3.954E+02	2.751E+03	-5.750E+03
28	4.580E+02	4.152E+02	2.676E+03	-5.825E+03
29	4.820E+02	4.349E+02	2.576E+03	-5.925E+03
30	5.060E+02	4.543E+02	2.501E+03	-6.000E+03

Type Curve Analysis

=====

Input Data

Pressure Run Depth.....	=	0.000E-01	m
Fluid Analyzed.....	=	Multi-phase	
Production Time.....	=	4.448E+03	hr
Total Flow Rate.....	=	1.000E+01	Res m ³ /D
Oil Flow Rate.....	=	0.000E-01	m ³ /D
Gas Flow Rate(Free Gas).....	=	0.000E-01	m ³ /D
Water Flow Rate.....	=	1.000E+01	m ³ /D
Bottomhole Flowing Pressure.....	=	8.501E+03	kPa
Specific Gravity of Gas.....	=	1.000E+00	
Gas Deviation Factor.....	=	5.399E-01	
Oil Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Gas Formation Volume Factor.....	=	1.000E-03	Res m ³ /m ³
Water Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Solution Gas-Oil Ratio.....	=	1.828E+00	m ³ /m ³
Solution Gas-Water Ratio.....	=	0.000E-01	m ³ /m ³
Oil Viscosity.....	=	1.000E+00	cp
Gas Viscosity.....	=	1.000E-03	cp
Water Viscosity.....	=	7.000E-01	cp
Reservoir Temperature.....	=	4.300E+01	Degree C
Pay Thickness.....	=	1.522E+01	m
Porosity.....	=	1.550E-01	
Oil Saturation.....	=	6.000E-01	
Gas Saturation.....	=	0.000E-01	
Water Saturation.....	=	4.000E-01	
Total Compressibility.....	=	1.510E-06	1/kPa
Wellbore Radius.....	=	5.700E-02	m

Output

Pressure Match:			
Pd = 0.198E+01	Pressure =	0.600E+04	
Time Match:			
Td = 0.256E+02	Time =	0.454E+03	
Reservoir Type: Homogeneous System			
Reservoir Parameters:			
Cd*e ^(2s)	=	8.574E-01	
Lambda*e ^(-2s)	=	0.000E-01	
Omega.....	=	1.000E+00	
Lambda.....	=	1.000E+00	
Skin factor.....	=	-5.287E+00	
Wellbore Storage.....	=	2.439E-03	m ³ /kPa
Dimensionless WBS.....	=	3.354E+04	
Total Transmissibility.....	=	6.165E+00	mD-m/cp
Water Transmissibility.....	=	6.165E+00	mD-m/cp
Water Reservoir Capacity.....	=	4.316E+00	mD-m
Total Mobility.....	=	4.051E-01	mD/cp
Water Mobility.....	=	4.051E-01	mD/cp
Effective Permeability to Water...	=	2.836E-01	mD
Radius of Investigation.....	=	3.301E+02	m

Horner Analysis

=====

No.	Elapsed time hr	(Tp+dt)/dt Dimensionless	P-Function kPa

1	2.000E+00	2.225E+03	4.000E+02
2	4.000E+00	1.113E+03	6.500E+02
3	6.000E+00	7.423E+02	8.000E+02
4	8.000E+00	5.570E+02	9.500E+02
5	2.400E+01	1.863E+02	1.700E+03
6	3.000E+01	1.493E+02	2.000E+03
7	4.800E+01	9.367E+01	2.550E+03
8	5.400E+01	8.337E+01	2.650E+03
9	7.200E+01	6.278E+01	3.025E+03
10	7.800E+01	5.803E+01	3.100E+03
11	9.600E+01	4.733E+01	3.425E+03
12	1.020E+02	4.461E+01	3.475E+03
13	1.200E+02	3.807E+01	3.700E+03
14	1.260E+02	3.630E+01	3.750E+03
15	1.460E+02	3.147E+01	4.025E+03
16	1.700E+02	2.716E+01	4.300E+03
17	1.940E+02	2.393E+01	4.500E+03
18	2.180E+02	2.140E+01	4.700E+03
19	2.420E+02	1.938E+01	4.825E+03
20	2.660E+02	1.772E+01	4.975E+03
21	2.900E+02	1.634E+01	5.075E+03
22	3.140E+02	1.517E+01	5.250E+03
23	3.380E+02	1.416E+01	5.350E+03
24	3.620E+02	1.329E+01	5.475E+03
25	3.860E+02	1.252E+01	5.575E+03
26	4.100E+02	1.185E+01	5.675E+03
27	4.340E+02	1.125E+01	5.750E+03
28	4.580E+02	1.071E+01	5.825E+03
29	4.820E+02	1.023E+01	5.925E+03
30	5.060E+02	9.791E+00	6.000E+03

Input Data

Pressure Run Depth.....	=	0.000E-01	m
Fluid Analyzed.....	=	Multi-phase	
Production Time.....	=	4.448E+03	hr
Total Flow Rate.....	=	1.000E+01	Res m ³ /D
Water Flow Rate.....	=	1.000E+01	m ³ /D
Bottomhole Flowing Pressure.....	=	8.501E+03	kPa
Water Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Water Viscosity.....	=	7.000E-01	cp
Reservoir Temperature.....	=	4.300E+01	Degree C
Pay Thickness.....	=	1.522E+01	m
Porosity.....	=	1.550E-01	
Oil Saturation.....	=	6.000E-01	
Gas Saturation.....	=	0.000E-01	
Water Saturation.....	=	4.000E-01	
Total Compressibility.....	=	1.510E-06	1/kPa
Wellbore Radius.....	=	5.700E-02	m

Output

Slope.....	=	4.114E+03	
Intercept.....	=	1.008E+04	kPa
Dp or Dm(p) at 1 hour.....	=	-4.933E+03	kPa
Extended Pressure.....	=	-1.575E+03	kPa
Total Transmissibility.....	=	5.226E+00	mD-m/cp
Water Transmissibility.....	=	5.226E+00	mD-m/cp
Water Reservoir Capacity.....	=	3.658E+00	mD-m
Total Mobility.....	=	3.433E-01	mD/cp
Water Mobility.....	=	3.433E-01	mD/cp
Effective Permeability to Water...	=	2.403E-01	mD
Skin Factor.....	=	-5.474E+00	
Pressure Drop due to skin.....	=	-1.959E+04	kPa
Total Ideal Productivity Index...	=	3.371E-04	Res m ³ /D/kPa
Total Actual Productivity Index...	=	9.924E-04	Res m ³ /D/kPa
Total Flow Efficiency.....	=	2.944E+00	
Radius of Investigation.....	=	3.039E+02	m

ENRON OIL CANADA LTD.

5-10-02-25WPM

FALL-OFF TEST

Homogeneous System

Tf = 6.2E+00
W = 1.0E+00
Lm = 1.0E+00
S = -5.3E+00
Cd = 3.4E+04

(Td/Cd) * dp/Dt and Pd

E+00

Dimensionless Time Group

servipetrol

E-01

E+00

E+01

E+02

E+03

ENRON OIL CANADA LTD.

5-10-02-25WPM

FALL-OFF TEST

Horner Plot

$m = -4.114E+03$
 $Tf = 5.226E+00$ mD-m/cp
 $s = -5.474E+00$
 $Dp^* = 1.008E+04$ kPa
 $p^* = -1.575E+03$ kPa

1.6E+04

1.2E+04

8.0E+03

4.0E+03

Delta Pressure, kPa

Time function, $(tp+dt)/dt$

E+01

E+02

E+03

E+00

PRESSURE FALL-OFF TEST ANALYSIS
FOR

ENRON ET AL WASKADA 16-9
Lsd. 16-9-2-25 WPM

Date of Test: June 5-26, 1989

AVERAGE RESERVOIR PRESSURE

The average reservoir pressure was calculated using the Horner build-up (fall-off) test analysis to extrapolate a static reservoir pressure. This pressure was then corrected to an average reservoir pressure by using SPE's Monograph No. 1 correlation for a five-spot waterflood injection pattern. Using this correlation the average reservoir would be 10 304 kPag, assuming normal fall-off test analysis procedure (ie. using total injection time). By using the fall-off time instead of the total injection time, a minimum average reservoir pressure was calculated to be 7 810 kPag. Based on these two analyses the actual average reservoir pressure would be somewhere between the calculated minimum and maximum reservoir pressures.

RESERVOIR CALCULATIONS

For reservoir parameters an effective net pay of 5.20 m was used based on log and core analysis. This resulted in a permeability thickness being 7.10 mD.m and the average permeability being 1.37 mD.

DAMAGE CALCULATIONS

A skin of -6.23 was calculated showing that the well is stimulated and that the injectivity has been enhanced by the fracture stimulation treatment.

AVERAGE PRESSURE CALCULATIONS

Lsd. 16-9-2-25 WPM

Using the fall-off time as the time (ie. 506.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (1.37/0.9869) (506.0)}{(0.17) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^6)} \\ \frac{(0.000264 \text{ kt})}{(\emptyset uCa)} &= 0.09 \\ \frac{(p - p^*) \text{ kh}}{70.6 i u} &= (0.28) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \\ p - p^* &= (0.26) (70.6) (116.3) \frac{(0.7)}{23.68} \\ p - p^* &= 63.1 \\ p &= 63.1 + (1305-235.4) \\ &= 1132.7 \text{ psig} \\ &= 7810 \text{ kPag} \end{aligned}$$

Using the injection time as the time (ie. 4448.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (1.37/0.9869) (4448.0)}{(0.17) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^6)} \\ \frac{(0.000264 \text{ kt})}{(\emptyset uCa)} &= 0.76 \\ &= 1.75 \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \\ p - p^* &= 1.75 * \frac{70.6 * i u}{kh} \quad \text{where: } \begin{aligned} i &= 116.3 \text{ bbl/d} \\ u &= 0.7 \\ kh &= 23.68 \text{ md-ft} \end{aligned} \\ p - p^* &= 424.8 \\ p &= 424.8 + (1305-235.4) \\ &= 1494.4 \text{ psig} \\ &= 10\,304 \text{ kPag} \end{aligned}$$

Estimated average reservoir pressure:

$$\frac{(7810 + 10304)}{2} = 9057 \text{ kPag}$$

NOTE: Conversion mD to md = (1/0.9869)

$$\begin{aligned} \text{KB} &= 477.2 \text{ m} \\ \text{Datum} &= 440 \text{ m SS} \end{aligned}$$

ENRON OIL CANADA LTD.
 16-9-02-25WPM
 FALL-OFF TEST
 JUNE 5-26, 1989

Flowrate Data

=====

No.	Elapsed time hr	Total Res m ³ /D	Oil m ³ /D	Gas m ³ /D	Water m ³ /D
1	4.448E+03	1.850E+01	0.000E-01	0.000E-01	1.850E+01

Buildup Data

=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	2.000E+00	1.999E+00	7.901E+03	-3.000E+02
2	4.000E+00	3.996E+00	7.851E+03	-3.500E+02
3	6.000E+00	5.992E+00	7.801E+03	-4.000E+02
4	8.000E+00	7.986E+00	7.601E+03	-6.000E+02
5	2.400E+01	2.387E+01	6.751E+03	-1.450E+03
6	3.000E+01	2.980E+01	6.351E+03	-1.850E+03
7	4.800E+01	4.749E+01	5.626E+03	-2.575E+03
8	5.400E+01	5.335E+01	5.601E+03	-2.600E+03
9	7.200E+01	7.085E+01	5.201E+03	-3.000E+03
10	7.800E+01	7.666E+01	5.101E+03	-3.100E+03
11	9.600E+01	9.397E+01	4.776E+03	-3.425E+03
12	1.020E+02	9.971E+01	4.751E+03	-3.450E+03
13	1.200E+02	1.168E+02	4.451E+03	-3.750E+03
14	1.260E+02	1.225E+02	4.401E+03	-3.800E+03
15	1.460E+02	1.414E+02	4.176E+03	-4.025E+03
16	1.700E+02	1.637E+02	3.926E+03	-4.275E+03
17	1.940E+02	1.859E+02	3.701E+03	-4.500E+03
18	2.180E+02	2.078E+02	3.526E+03	-4.675E+03
19	2.420E+02	2.295E+02	3.401E+03	-4.800E+03
20	2.660E+02	2.510E+02	3.276E+03	-4.925E+03
21	2.900E+02	2.722E+02	3.136E+03	-5.065E+03
22	3.140E+02	2.933E+02	2.976E+03	-5.225E+03
23	3.380E+02	3.141E+02	2.876E+03	-5.325E+03
24	3.620E+02	3.348E+02	2.751E+03	-5.450E+03
25	3.860E+02	3.552E+02	2.651E+03	-5.550E+03
26	4.100E+02	3.754E+02	2.551E+03	-5.650E+03
27	4.340E+02	3.954E+02	2.476E+03	-5.725E+03
28	4.580E+02	4.152E+02	2.376E+03	-5.825E+03
29	4.820E+02	4.349E+02	2.276E+03	-5.925E+03
30	5.060E+02	4.543E+02	2.201E+03	-6.000E+03

Type Curve Analysis

=====

Input Data

Pressure Run Depth.....	=	0.000E-01	m
Fluid Analyzed.....	=	Multi-phase	
Production Time.....	=	4.448E+03	hr
Total Flow Rate.....	=	1.850E+01	Res m ³ /D
Water Flow Rate.....	=	1.850E+01	m ³ /D
Bottomhole Flowing Pressure.....	=	8.201E+03	kPa
Water Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Water Viscosity.....	=	7.000E-01	cp
Reservoir Temperature.....	=	4.300E+01	Degree C
Pay Thickness.....	=	5.200E+00	m
Porosity.....	=	1.700E-01	
Oil Saturation.....	=	6.000E-01	
Gas Saturation.....	=	0.000E-01	
Water Saturation.....	=	4.000E-01	
Total Compressibility.....	=	1.510E-06	1/kPa
Wellbore Radius.....	=	5.700E-02	m

Output

Pressure Match:			
Pd = 0.207E+01	Pressure =	0.600E+04	
Time Match:			
Td = 0.293E+02	Time =	0.454E+03	
Reservoir Type: Homogeneous System			
Reservoir Parameters:			
Cd*e ^(2s)	=	6.185E-01	
Lambda*e ^(-2s)	=	0.000E-01	
Omega.....	=	1.000E+00	
Lambda.....	=	1.000E+00	
Skin factor.....	=	-6.203E+00	
Wellbore Storage.....	=	4.112E-03	m ³ /kPa
Dimensionless WBS.....	=	1.509E+05	
Total Transmissibility.....	=	1.189E+01	mD-m/cp
Water Transmissibility.....	=	1.189E+01	mD-m/cp
Water Reservoir Capacity.....	=	8.325E+00	mD-m
Total Mobility.....	=	2.287E+00	mD/cp
Water Mobility.....	=	2.287E+00	mD/cp
Effective Permeability to Water...	=	1.601E+00	mD
Radius of Investigation.....	=	7.488E+02	m

Horner Analysis

=====

No.	Elapsed time hr	(Tp+dt)/dt Dimensionless	P-Function kPa

1	2.000E+00	2.225E+03	3.000E+02
2	4.000E+00	1.113E+03	3.500E+02
3	6.000E+00	7.423E+02	4.000E+02
4	8.000E+00	5.570E+02	6.000E+02
5	2.400E+01	1.863E+02	1.450E+03
6	3.000E+01	1.493E+02	1.850E+03
7	4.800E+01	9.367E+01	2.575E+03
8	5.400E+01	8.337E+01	2.600E+03
9	7.200E+01	6.278E+01	3.000E+03
10	7.800E+01	5.803E+01	3.100E+03
11	9.600E+01	4.733E+01	3.425E+03
12	1.020E+02	4.461E+01	3.450E+03
13	1.200E+02	3.807E+01	3.750E+03
14	1.260E+02	3.630E+01	3.800E+03
15	1.460E+02	3.147E+01	4.025E+03
16	1.700E+02	2.716E+01	4.275E+03
17	1.940E+02	2.393E+01	4.500E+03
18	2.180E+02	2.140E+01	4.675E+03
19	2.420E+02	1.938E+01	4.800E+03
20	2.660E+02	1.772E+01	4.925E+03
21	2.900E+02	1.634E+01	5.065E+03
22	3.140E+02	1.517E+01	5.225E+03
23	3.380E+02	1.416E+01	5.325E+03
24	3.620E+02	1.329E+01	5.450E+03
25	3.860E+02	1.252E+01	5.550E+03
26	4.100E+02	1.185E+01	5.650E+03
27	4.340E+02	1.125E+01	5.725E+03
28	4.580E+02	1.071E+01	5.825E+03
29	4.820E+02	1.023E+01	5.925E+03
30	5.060E+02	9.791E+00	6.000E+03

Input Data

Pressure Run Depth.....	=	0.000E-01	m
Fluid Analyzed.....	=	Multi-phase	
Production Time.....	=	4.448E+03	hr
Total Flow Rate.....	=	1.850E+01	Res m ³ /D
Water Flow Rate.....	=	1.850E+01	m ³ /D
Bottomhole Flowing Pressure.....	=	8.201E+03	kPa
Water Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Water Viscosity.....	=	7.000E-01	cp
Reservoir Temperature.....	=	4.300E+01	Degree C
Pay Thickness.....	=	5.200E+00	m
Porosity.....	=	1.700E-01	
Oil Saturation.....	=	6.000E-01	
Gas Saturation.....	=	0.000E-01	
Water Saturation.....	=	4.000E-01	
Total Compressibility.....	=	1.510E-06	1/kPa
Wellbore Radius.....	=	5.700E-02	m

Output

Slope.....	=	3.922E+03	
Intercept.....	=	9.825E+03	kPa
Dp or Dm(p) at 1 hour.....	=	-4.484E+03	kPa
Extended Pressure.....	=	-1.623E+03	kPa
Total Transmissibility.....	=	1.014E+01	mD-m/cp
Water Transmissibility.....	=	1.014E+01	mD-m/cp
Water Reservoir Capacity.....	=	7.099E+00	mD-m
Total Mobility.....	=	1.950E+00	mD/cp
Water Mobility.....	=	1.950E+00	mD/cp
Effective Permeability to Water...	=	1.365E+00	mD
Skin Factor.....	=	-6.232E+00	
Pressure Drop due to skin.....	=	-2.126E+04	kPa
Total Ideal Productivity Index...	=	5.951E-04	Res m ³ /D/kPa
Total Actual Productivity Index...	=	1.883E-03	Res m ³ /D/kPa
Total Flow Efficiency.....	=	3.164E+00	
Radius of Investigation.....	=	6.915E+02	m

ENRON OIL CANADA LTD.

16-9-02-25WPM

FALL-OFF TEST

Homogeneous System

Tf = 1.2E+01
W = 1.0E+00
Lm = 1.0E+00
S = -6.2E+00
Cd = 1.5E+05

(Td/Cd)*Dp/Dt and Pd

E+00

Dimensionless Time Group

E-01

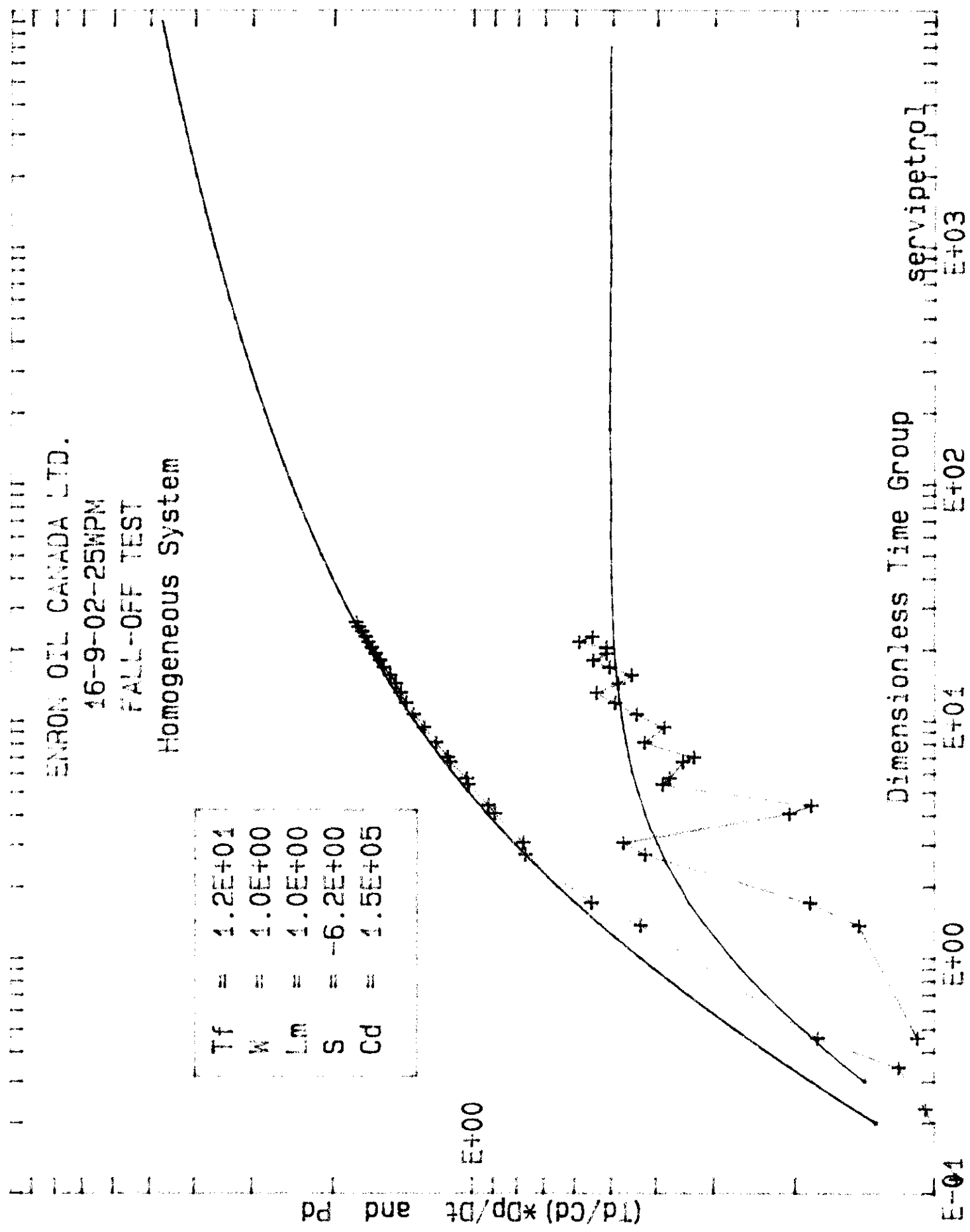
E+00

E+01

E+02

E+03

servipetrol



ENRON OIL CANADA LTD.

16-9-02-25WPM

FALL-OFF TEST

Horner Plot

$m = -3.922E+03$
 $Tf = 1.014E+01$ mD-m/cp
 $s = -6.232E+00$
 $Dp^* = 9.825E+03$ kPa
 $p^* = -1.623E+03$ kPa

Delta Pressure, kPa

8.0E+03

6.0E+03

4.0E+03

2.0E+03

Time Function, $(Tp+dt)/dt$

E+00

E+01

E+02

E+03

PRESSURE FALL-OFF TEST ANALYSIS
FOR

ENRON ET AL WASKADA 10-9
Lsd. 10-9-2-25 WPM

Date of Test: June 5-26, 1989

AVERAGE RESERVOIR PRESSURE

The average reservoir pressure was calculated using the Horner build-up (fall-off) test analysis to extrapolate a static reservoir pressure. This pressure was then corrected to an average reservoir pressure by using SPE's Monograph No. 1 correlation for a five-spot waterflood injection pattern. Using this correlation the average reservoir would be 9 176 kPag, assuming normal fall-off test analysis procedure (ie. using total injection time). By using the fall-off time instead of the total injection time, a minimum average reservoir pressure was calculated to be 7 005 kPag. Based on these two analyses the actual average reservoir pressure would be somewhere between the calculated minimum and maximum reservoir pressures.

RESERVOIR CALCULATIONS

For reservoir parameters an effective net pay of 3.40 m was used based on log and core analysis. This resulted in a permeability thickness being 4.45 mD.m and the average permeability being 1.31 mD.

DAMAGE CALCULATIONS

A skin of -5.54 was calculated showing that the well is stimulated and that the injectivity has been enhanced by the fracture stimulation treatment.

AVERAGE PRESSURE CALCULATIONS

Lsd. 10-9-2-25 WPM

Using the fall-off time as the time (ie. 506.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (1.31/0.9869) (506.0)}{(0.165) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^6)} \\ \frac{(0.000264 \text{ kt})}{(\emptyset u C a)} &= 0.08 \end{aligned}$$

$$\frac{(p - p^*) \text{ kh}}{70.6 i u} = (0.20) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)}$$

$$p - p^* = (0.20) (70.6) (62.89) \frac{(0.7)}{14.81}$$

$$p - p^* = 42.0$$

$$\begin{aligned} p &= 42.0 + (1305-331) \\ &= 1016 \text{ psig} \\ &= 7005 \text{ kPag} \end{aligned}$$

Using the injection time as the time (ie. 4448.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (1.31/0.9869) (4448.0)}{(0.165) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^6)} \\ \frac{(0.000264 \text{ kt})}{(\emptyset u C a)} &= 0.74 \\ &= 1.70 \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \end{aligned}$$

$$p - p^* = 1.70 * \frac{70.6 * i u}{kh} \quad \text{where: } \begin{aligned} i &= 62.89 \text{ bbl/d} \\ u &= 0.7 \\ kh &= 14.81 \text{ md-ft} \end{aligned}$$

$$p - p^* = 356.8$$

$$\begin{aligned} p &= 356.8 + (1305-331) \\ &= 1330.8 \text{ psig} \\ &= 9176 \text{ kPag} \end{aligned}$$

Estimated average reservoir pressure:

$$\frac{(7005 + 9175)}{2} = 8090 \text{ kPag}$$

NOTE: Conversion from mD to md = (1/0.9869)

KB 477.2 m
Datum 440 m SS

ENRON OIL CANADA LTD.
 10-9-02-25WPM
 FALL-OFF TEST
 JUNE 5-26, 1989

Flowrate Data

=====

No.	Elapsed time hr	Total Res m ³ /D	Oil m ³ /D	Gas m ³ /D	Water m ³ /D
1	4.448E+03	1.000E+01	0.000E-01	0.000E-01	1.000E+01

Buildup Data

=====

No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	2.000E+00	1.999E+00	7.201E+03	-7.000E+02
2	4.000E+00	3.996E+00	6.851E+03	-1.050E+03
3	6.000E+00	5.992E+00	6.551E+03	-1.350E+03
4	8.000E+00	7.986E+00	6.301E+03	-1.600E+03
5	2.400E+01	2.387E+01	5.201E+03	-2.700E+03
6	3.000E+01	2.980E+01	4.976E+03	-2.925E+03
7	4.800E+01	4.749E+01	4.201E+03	-3.700E+03
8	5.400E+01	5.335E+01	4.076E+03	-3.825E+03
9	7.200E+01	7.085E+01	3.676E+03	-4.225E+03
10	7.800E+01	7.666E+01	3.551E+03	-4.350E+03
11	9.600E+01	9.397E+01	3.151E+03	-4.750E+03
12	1.020E+02	9.971E+01	3.076E+03	-4.825E+03
13	1.200E+02	1.168E+02	2.801E+03	-5.100E+03
14	1.260E+02	1.225E+02	2.751E+03	-5.150E+03
15	1.460E+02	1.414E+02	2.551E+03	-5.350E+03
16	1.700E+02	1.637E+02	2.251E+03	-5.650E+03
17	1.940E+02	1.859E+02	2.051E+03	-5.850E+03
18	2.180E+02	2.078E+02	1.851E+03	-6.050E+03
19	2.420E+02	2.295E+02	1.701E+03	-6.200E+03
20	2.660E+02	2.510E+02	1.581E+03	-6.320E+03
21	2.900E+02	2.722E+02	1.476E+03	-6.425E+03
22	3.140E+02	2.933E+02	1.326E+03	-6.575E+03
23	3.380E+02	3.141E+02	1.251E+03	-6.650E+03
24	3.620E+02	3.348E+02	1.126E+03	-6.775E+03
25	3.860E+02	3.552E+02	1.051E+03	-6.850E+03
26	4.100E+02	3.754E+02	9.763E+02	-6.925E+03
27	4.340E+02	3.954E+02	9.013E+02	-7.000E+03
28	4.580E+02	4.152E+02	8.263E+02	-7.075E+03
29	4.820E+02	4.349E+02	8.263E+02	-7.075E+03
30	5.060E+02	4.543E+02	7.763E+02	-7.125E+03

Type Curve Analysis

Input Data

```

Pressure Run Depth..... = 0.000E-01 m
Fluid Analyzed..... = Multi-phase
Production Time..... = 4.448E+03 hr
Total Flow Rate..... = 1.000E+01 Res m^3/D
Oil Flow Rate..... = 0.000E-01 m^3/D
Gas Flow Rate(Free Gas)..... = 0.000E-01 m^3/D
Water Flow Rate..... = 1.000E+01 m^3/D
Bottomhole Flowing Pressure..... = 7.901E+03 kPa
Specific Gravity of Gas..... = 1.000E+00
Gas Deviation Factor..... = 5.531E-01
Oil Formation Volume Factor..... = 1.000E+00 Res m^3/m^3
Gas Formation Volume Factor..... = 1.000E-03 Res m^3/m^3
Water Formation Volume Factor..... = 1.000E+00 Res m^3/m^3
Solution Gas-Oil Ratio..... = 1.828E+00 m^3/m^3
Solution Gas-Water Ratio..... = 0.000E-01 m^3/m^3
Oil Viscosity..... = 1.000E+00 cp
Gas Viscosity..... = 1.000E-03 cp
Water Viscosity..... = 7.000E-01 cp
Reservoir Temperature..... = 4.300E+01 Degree C
Pay Thickness..... = 3.400E+00 m
Porosity..... = 1.650E-01
Oil Saturation..... = 6.000E-01
Gas Saturation..... = 0.000E-01
Water Saturation..... = 4.000E-01
Total Compressibility..... = 1.510E-06 1/kPa
Wellbore Radius..... = 5.700E-02 m

```

Output

```

Pressure Match:
Pd = 0.171E+01      Pressure = 0.712E+04
Time Match:
Td = 0.124E+03      Time = 0.454E+03
Reservoir Type: Homogeneous System
Reservoir Parameters:
Cd*e^(2s)..... = 9.500E-02
Lambda*e^(-2s)..... = 0.000E-01
Omega..... = 1.000E+00
Lambda..... = 1.000E+00
Skin factor..... = -6.157E+00
Wellbore Storage..... = 3.659E-04 m^3/kPa
Dimensionless WBS..... = 2.117E+04
Water Transmissibility..... = 4.485E+00 mD-m/cp
Water Reservoir Capacity..... = 3.140E+00 mD-m
Water Mobility..... = 1.319E+00 mD/cp
Effective Permeability to Water... = 9.234E-01 mD
Radius of Investigation..... = 5.773E+02 m

```

Horner Analysis =====

No.	Elapsed time hr	(Tp+dt)/dt Dimensionless	P-Function kPa

1	2.000E+00	2.225E+03	7.000E+02
2	4.000E+00	1.113E+03	1.050E+03
3	6.000E+00	7.423E+02	1.350E+03
4	8.000E+00	5.570E+02	1.600E+03
5	2.400E+01	1.863E+02	2.700E+03
6	3.000E+01	1.493E+02	2.925E+03
7	4.800E+01	9.367E+01	3.700E+03
8	5.400E+01	8.337E+01	3.825E+03
9	7.200E+01	6.278E+01	4.225E+03
10	7.800E+01	5.803E+01	4.350E+03
11	9.600E+01	4.733E+01	4.750E+03
12	1.020E+02	4.461E+01	4.825E+03
13	1.200E+02	3.807E+01	5.100E+03
14	1.260E+02	3.630E+01	5.150E+03
15	1.460E+02	3.147E+01	5.350E+03
16	1.700E+02	2.716E+01	5.650E+03
17	1.940E+02	2.393E+01	5.850E+03
18	2.180E+02	2.140E+01	6.050E+03
19	2.420E+02	1.938E+01	6.200E+03
20	2.660E+02	1.772E+01	6.320E+03
21	2.900E+02	1.634E+01	6.425E+03
22	3.140E+02	1.517E+01	6.575E+03
23	3.380E+02	1.416E+01	6.650E+03
24	3.620E+02	1.329E+01	6.775E+03
25	3.860E+02	1.252E+01	6.850E+03
26	4.100E+02	1.185E+01	6.925E+03
27	4.340E+02	1.125E+01	7.000E+03
28	4.580E+02	1.071E+01	7.075E+03
29	4.820E+02	1.023E+01	7.075E+03
30	5.060E+02	9.791E+00	7.125E+03

Horner Analysis

=====

Input Data

Pressure Run Depth.....	=	0.000E-01	m
Fluid Analyzed.....	=	Multi-phase	
Production Time.....	=	4.448E+03	hr
Total Flow Rate.....	=	1.000E+01	Res m ³ /D
Water Flow Rate.....	=	1.000E+01	m ³ /D
Bottomhole Flowing Pressure.....	=	7.901E+03	kPa
Water Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Water Viscosity.....	=	7.000E-01	cp
Reservoir Temperature.....	=	4.300E+01	Degree C
Pay Thickness.....	=	3.400E+00	m
Porosity.....	=	1.650E-01	
Oil Saturation.....	=	6.000E-01	
Gas Saturation.....	=	0.000E-01	
Water Saturation.....	=	4.000E-01	
Total Compressibility.....	=	1.510E-06	1/kPa
Wellbore Radius.....	=	5.700E-02	m

Output

Slope.....	=	3.383E+03	
Intercept.....	=	1.050E+04	kPa
Dp or Dm(p) at 1 hour.....	=	-1.842E+03	kPa
Extended Pressure.....	=	-2.597E+03	kPa
Water Transmissibility.....	=	6.356E+00	mD-m/cp
Water Reservoir Capacity.....	=	4.449E+00	mD-m
Water Mobility.....	=	1.869E+00	mD/cp
Effective Permeability to Water...	=	1.309E+00	mD
Skin Factor.....	=	-5.536E+00	
Pressure Drop due to skin.....	=	-1.629E+04	kPa
Total Ideal Productivity Index...	=	3.733E-04	Res m ³ /D/kPa
Total Actual Productivity Index...	=	9.525E-04	Res m ³ /D/kPa
Total Flow Efficiency.....	=	2.552E+00	
Radius of Investigation.....	=	6.872E+02	m

ENRON OIL CANADA LTD.

10-9-02-25WPM

FALL-OFF TEST

Horner Plot

$m = -3.383E+03$
 $Tf = 6.356E+00 \text{ mD-m/cp}$
 $s = -5.536E+00$
 $Dp^* = 1.050E+04 \text{ kPa}$
 $p^* = -2.597E+03 \text{ kPa}$

1.6E+04

1.2E+04

8.0E+03

4.0E+03

Delta Pressure, kPa

Time Function, $(Tp+dt)/dt$

E+00

E+01

E+02

E+03

ENRON OIL CANADA LTD.

10-9-02-25WPM

FALL-OFF TEST

Homogeneous System

Dimensionless Pressure

E+01

E+00

Dimensionless Time Group

E-01

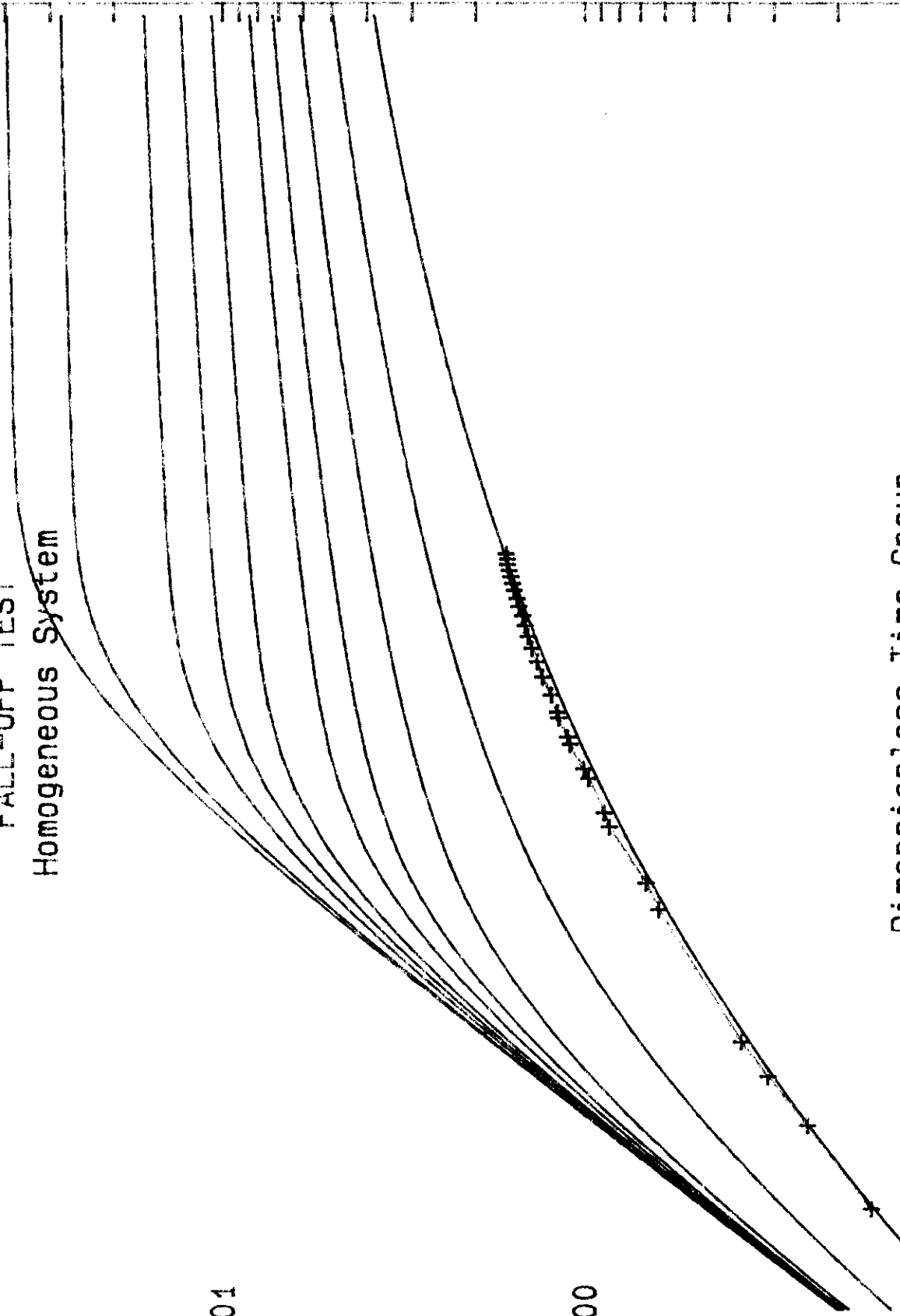
E+00

E+01

E+02

E+03

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ENRON OIL CANADA LTD.

10-9-02-25WPM

FALL-OFF TEST

Homogeneous System

Tf	=	4.3E+00
W	=	1.0E+00
Lm	=	1.0E+00
S	=	-6.2E+00
Cd	=	2.4E+04

Dimensionless Pressure

Dimensionless Time Group

servipetrol

E-01

E+00

E+01

E+02

E+03

PRESSURE FALL-OFF TEST ANALYSIS
FOR

ENRON ET AL WASKADA 6-9
Lsd. 6-9-2-25 WPM

Date of Test: June 5-26, 1989

AVERAGE RESERVOIR PRESSURE

The average reservoir pressure was calculated using the Horner build-up (fall-off) test analysis to extrapolate a static reservoir pressure. This pressure was then corrected to an average reservoir pressure by using SPE's Monograph No. 1 correlation for a five-spot waterflood injection pattern. Using this correlation the average reservoir would be 8 850 kPag, assuming normal fall-off test analysis procedure (ie. using total injection time). By using the fall-off time instead of the total injection time, a minimum average reservoir pressure was calculated to be 6 612 kPag. Based on these two analyses the actual average reservoir pressure would be somewhere between the calculated minimum and maximum reservoir pressures.

RESERVOIR CALCULATIONS

For reservoir parameters an effective net pay of 6.49 m was used based on log and core analysis. This resulted in a permeability thickness being 6.33 mD.m and the average permeability being 0.98 mD.

DAMAGE CALCULATIONS

A skin of -6.03 was calculated showing that the well is stimulated and that the injectivity has been enhanced by the fracture stimulation treatment.

AVERAGE PRESSURE CALCULATIONS

Lsd. 6-9-2-25 WPM

Using the fall-off time as the time (ie. 506.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (0.975/0.9869) (506.0)}{(0.165) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^6)} \\ \frac{(0.000264 \text{ kt})}{(\emptyset u C_a)} &= 0.06 \end{aligned}$$

$$\frac{(p - p^*) \text{ kh}}{70.6 i u} = (0.18) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)}$$

$$p - p^* = (0.18) (70.6) (108.8) \frac{(0.7)}{21.04}$$

$$p - p^* = 46.0$$

$$\begin{aligned} p &= 46.0 + (1302-389) \\ &= 959 \text{ psig} \\ &= 6612 \text{ kPag} \end{aligned}$$

Using the injection time as the time (ie. 4448.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (0.975/0.9869) (4448.0)}{(0.165) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^6)} \\ \frac{(0.000264 \text{ kt})}{(\emptyset u C_a)} &= 0.55 \\ &= 1.45 \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \end{aligned}$$

$$p - p^* = 1.45 * \frac{70.6 * i u}{kh} \quad \text{where: } \begin{aligned} i &= 108.8 \text{ bbl/d} \\ u &= 0.7 \\ kh &= 21.04 \text{ md-ft} \end{aligned}$$

$$p - p^* = 370.6$$

$$\begin{aligned} p &= 370.6 + (1302-389) \\ &= 1283.6 \text{ psig} \\ &= 8850 \text{ kPag} \end{aligned}$$

Estimated average reservoir pressure:

$$\frac{(6612 + 8850)}{2} = 7731 \text{ kPag}$$

NOTE: Conversion mD to md = (1/0.9869)

$$\begin{aligned} \text{KB} &= 475.2 \\ \text{Datum} &= 440 \text{ m SS} \end{aligned}$$

ENRON OIL CANADA LTD.
6-9-02-25WPM
FALL-OFF TEST
JUNE 5-26, 1989

Flowrate Data
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No.	Elapsed time hr	Total Res m ³ /D	Oil m ³ /D	Gas m ³ /D	Water m ³ /D
1	4.259E+03	1.730E+01	0.000E-01	0.000E-01	1.730E+01

Buildup Data
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No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	2.000E+00	1.999E+00	7.351E+03	-3.500E+02
2	4.000E+00	3.996E+00	7.276E+03	-4.250E+02
3	6.000E+00	5.992E+00	7.051E+03	-6.500E+02
4	8.000E+00	7.985E+00	6.851E+03	-8.500E+02
5	2.400E+01	2.387E+01	5.851E+03	-1.850E+03
6	3.000E+01	2.979E+01	5.601E+03	-2.100E+03
7	4.800E+01	4.747E+01	4.951E+03	-2.750E+03
8	5.400E+01	5.332E+01	4.851E+03	-2.850E+03
9	7.200E+01	7.080E+01	4.476E+03	-3.225E+03
10	7.800E+01	7.660E+01	4.351E+03	-3.350E+03
11	9.600E+01	9.388E+01	4.001E+03	-3.700E+03
12	1.020E+02	9.961E+01	3.926E+03	-3.775E+03
13	1.200E+02	1.167E+02	3.601E+03	-4.100E+03
14	1.260E+02	1.224E+02	3.501E+03	-4.200E+03
15	1.460E+02	1.412E+02	3.351E+03	-4.350E+03
16	1.700E+02	1.635E+02	3.076E+03	-4.625E+03
17	1.940E+02	1.855E+02	2.851E+03	-4.850E+03
18	2.180E+02	2.074E+02	2.651E+03	-5.050E+03
19	2.420E+02	2.290E+02	2.501E+03	-5.200E+03
20	2.660E+02	2.504E+02	2.351E+03	-5.350E+03
21	2.900E+02	2.715E+02	2.201E+03	-5.500E+03
22	3.140E+02	2.924E+02	2.076E+03	-5.625E+03
23	3.380E+02	3.131E+02	1.951E+03	-5.750E+03
24	3.620E+02	3.336E+02	1.826E+03	-5.875E+03
25	3.860E+02	3.539E+02	1.701E+03	-6.000E+03
26	4.100E+02	3.740E+02	1.601E+03	-6.100E+03
27	4.340E+02	3.939E+02	1.501E+03	-6.200E+03
28	4.580E+02	4.135E+02	1.451E+03	-6.250E+03
29	4.820E+02	4.330E+02	1.376E+03	-6.325E+03
30	5.060E+02	4.523E+02	1.301E+03	-6.400E+03

Type Curve Analysis

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Input Data

Pressure Run Depth.....	=	0.000E-01	m
Fluid Analyzed.....	=	Multi-phase	
Production Time.....	=	4.259E+03	hr
Total Flow Rate.....	=	1.730E+01	Res m ³ /D
Water Flow Rate.....	=	1.730E+01	m ³ /D
Bottomhole Flowing Pressure.....	=	7.701E+03	kPa
Water Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Water Viscosity.....	=	7.000E-01	cp
Reservoir Temperature.....	=	4.300E+01	Degree C
Pay Thickness.....	=	6.490E+00	m
Porosity.....	=	1.650E-01	
Oil Saturation.....	=	6.000E-01	
Gas Saturation.....	=	0.000E-01	
Water Saturation.....	=	4.000E-01	
Total Compressibility.....	=	1.510E-06	1/kPa
Wellbore Radius.....	=	5.700E-02	m

Output

Pressure Match:

Pd = 0.190E+01 Pressure = 0.640E+04

Time Match:

Td = 0.220E+02 Time = 0.452E+03

Reservoir Type: Homogeneous System

Reservoir Parameters:

Cd*e ^(2s)	=	9.404E-01	
Lambda*e ^(-2s)	=	0.000E-01	
Omega.....	=	1.000E+00	
Lambda.....	=	1.000E+00	
Skin factor.....	=	-5.932E+00	
Wellbore Storage.....	=	4.405E-03	m ³ /kPa
Dimensionless WBS.....	=	1.335E+05	
Total Transmissibility.....	=	9.590E+00	mD-m/cp
Water Transmissibility.....	=	9.590E+00	mD-m/cp
Water Reservoir Capacity.....	=	6.713E+00	mD-m
Total Mobility.....	=	1.478E+00	mD/cp
Water Mobility.....	=	1.478E+00	mD/cp
Effective Permeability to Water...	=	1.034E+00	mD
Radius of Investigation.....	=	5.978E+02	m

Horner Analysis

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No.	Elapsed time hr	(Tp+dt)/dt Dimensionless	P-Function kPa

1	2.000E+00	2.130E+03	3.500E+02
2	4.000E+00	1.066E+03	4.250E+02
3	6.000E+00	7.108E+02	6.500E+02
4	8.000E+00	5.334E+02	8.500E+02
5	2.400E+01	1.785E+02	1.850E+03
6	3.000E+01	1.430E+02	2.100E+03
7	4.800E+01	8.973E+01	2.750E+03
8	5.400E+01	7.987E+01	2.850E+03
9	7.200E+01	6.015E+01	3.225E+03
10	7.800E+01	5.560E+01	3.350E+03
11	9.600E+01	4.536E+01	3.700E+03
12	1.020E+02	4.275E+01	3.775E+03
13	1.200E+02	3.649E+01	4.100E+03
14	1.260E+02	3.480E+01	4.200E+03
15	1.460E+02	3.017E+01	4.350E+03
16	1.700E+02	2.605E+01	4.625E+03
17	1.940E+02	2.295E+01	4.850E+03
18	2.180E+02	2.054E+01	5.050E+03
19	2.420E+02	1.860E+01	5.200E+03
20	2.660E+02	1.701E+01	5.350E+03
21	2.900E+02	1.569E+01	5.500E+03
22	3.140E+02	1.456E+01	5.625E+03
23	3.380E+02	1.360E+01	5.750E+03
24	3.620E+02	1.277E+01	5.875E+03
25	3.860E+02	1.203E+01	6.000E+03
26	4.100E+02	1.139E+01	6.100E+03
27	4.340E+02	1.081E+01	6.200E+03
28	4.580E+02	1.030E+01	6.250E+03
29	4.820E+02	9.836E+00	6.325E+03
30	5.060E+02	9.417E+00	6.400E+03

Input Data

Pressure Run Depth.....	=	0.000E-01	m
Fluid Analyzed.....	=	Multi-phase	
Production Time.....	=	4.259E+03	hr
Total Flow Rate.....	=	1.730E+01	Res m ³ /D
Oil Flow Rate.....	=	0.000E-01	m ³ /D
Gas Flow Rate(Free Gas).....	=	0.000E-01	m ³ /D
Water Flow Rate.....	=	1.730E+01	m ³ /D
Bottomhole Flowing Pressure.....	=	7.701E+03	kPa
Specific Gravity of Gas.....	=	1.000E+00	
Gas Deviation Factor.....	=	5.572E-01	
Oil Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Gas Formation Volume Factor.....	=	1.000E-03	Res m ³ /m ³
Water Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Solution Gas-Oil Ratio.....	=	1.828E+00	m ³ /m ³
Solution Gas-Water Ratio.....	=	0.000E-01	m ³ /m ³
Oil Viscosity.....	=	1.000E+00	cp
Gas Viscosity.....	=	1.000E-03	cp
Water Viscosity.....	=	7.000E-01	cp
Reservoir Temperature.....	=	4.300E+01	Degree C
Pay Thickness.....	=	6.490E+00	m
Porosity.....	=	1.650E-01	
Oil Saturation.....	=	6.000E-01	
Gas Saturation.....	=	0.000E-01	
Water Saturation.....	=	4.000E-01	
Total Compressibility.....	=	1.510E-06	1/kPa
Wellbore Radius.....	=	5.700E-02	m

Output

Slope.....	=	4.114E+03	
Intercept.....	=	1.038E+04	kPa
Dp or Dm(p) at 1 hour.....	=	-4.550E+03	kPa
Extended Pressure.....	=	-2.680E+03	kPa
Total Transmissibility.....	=	9.040E+00	mD-m/cp
Water Transmissibility.....	=	9.040E+00	mD-m/cp
Water Reservoir Capacity.....	=	6.328E+00	mD-m
Total Mobility.....	=	1.393E+00	mD/cp
Water Mobility.....	=	1.393E+00	mD/cp
Effective Permeability to Water...	=	9.751E-01	mD
Skin Factor.....	=	-6.035E+00	
Pressure Drop due to skin.....	=	-2.160E+04	kPa
Total Ideal Productivity Index...	=	5.409E-04	Res m ³ /D/kPa
Total Actual Productivity Index...	=	1.666E-03	Res m ³ /D/kPa
Total Flow Efficiency.....	=	3.081E+00	
Radius of Investigation.....	=	5.805E+02	m

ENRON OIL CANADA LTD.

6-9-02-25WPM

FALL-OFF TEST

Homogeneous System

Tf	=	9.6E+00
W	=	1.0E+00
Lm	=	1.0E+00
S	=	-5.9E+00
Cd	=	1.3E+05

Dimensionless Pressure

E+00

Dimensionless Time Group

E-01

E+00

E+01

E+02

servipetro

E+03

ENRON OIL CANADA LTD.

6-9-02-25WPM

FALL-OFF TEST

Horner Plot

m = -4.114E+03
Tf = 9.040E+00 mD-m/cp
s = -6.035E+00
Dp* = 1.038E+04 kPa
p* = -2.680E+03 kPa

1.6E+04

1.2E+04

8.0E+03

4.0E+03

Delta Pressure, KPa

Time Function, $(Tp+dt)/dt$

E+00

E+01

E+02

E+03

PRESSURE FALL-OFF TEST ANALYSIS
FOR

ENRON ET AL WASKADA 1-9
Lsd. 1-9-2-25 WPM

Date of Test: June 5-26, 1989

Due to lack of pressure falling off during the test, both the type curve analysis and the Horner analysis are only estimates. This lack of fall-off is due to interference from the 15-4 injector. Both methods however show the well is stimulated with the type curve analysis yielding a skin of -5.6, while the Horner shows the skin to be -5.0. Based on these two fits the average permeability would be 1.4 to 1.9 mD respectively. Based on the Horner the average reservoir pressure would be 15 862 kPag, but this is anomalously high due to interference from the 15-4 injector.

AVERAGE PRESSURE CALCULATIONS

Lsd. 1-9-2-25 WPM

Using the fall-off time as the time (ie. 506.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (1.9/0.9869) (506.0)}{(0.156) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^6)} \\ \frac{(0.000264 \text{ kt})}{(\frac{0.000264 \text{ kt}}{0.000264 \text{ kt}})} &= 0.130 \\ \frac{(p - p^*) \text{ kh}}{70.6 \text{ i u}} &= (0.43) \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \\ p - p^* &= (0.43) (70.6) (61.0) \frac{(0.7)}{89.00} \\ p - p^* &= 14.6 \\ p &= 14.6 + (1305 + 953) \\ &= 2273 \text{ psig} \\ &= 15\ 672 \text{ kPag} \end{aligned}$$

Using the injection time as the time (ie. 4448.0 hrs):

$$\begin{aligned} \text{TDA} &= \frac{0.000264 (1.9/0.9869) (4448.0)}{(0.156) (0.7) (10.41 \times 10^{-6}) (1.7424 \times 10^6)} \\ \frac{(0.000264 \text{ kt})}{(\frac{0.000264 \text{ kt}}{0.000264 \text{ kt}})} &= 1.14 \\ &= 2.10 \text{ (from Figure 8.2, pg 74; SPE MONO \#1)} \\ p - p^* &= 2.10 * \frac{70.6 * i \text{ u}}{\text{kh}} \quad \text{where: } \begin{aligned} i &= 61.0 \text{ bbl/d} \\ u &= 0.7 \\ \text{kh} &= 89.0 \text{ md-ft} \end{aligned} \\ p - p^* &= 70.0 \\ p &= 70 + (1305 + 953) \\ &= 2328 \text{ psig} \\ &= 16\ 051 \text{ kPag} \end{aligned}$$

Estimated average reservoir pressure:

$$\frac{(15\ 572 + 16\ 051)}{2} = 15\ 862 \text{ kPag}$$

NOTE: Conversion mD to md = (1/0.9869)

$$\begin{aligned} \text{KB} &= 477.4 \text{ m} \\ \text{Datum} &= 440 \text{ m SS} \end{aligned}$$

ENRON OIL CANADA LTD.
 1-9-02-25WPM
 FALL-OFF TEST
 JUNE 5-26, 1989

Flowrate Data

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No.	Elapsed time hr	Total Res m ³ /D	Oil m ³ /D	Gas m ³ /D	Water m ³ /D
1	4.448E+03	9.700E+00	0.000E-01	0.000E-01	9.700E+00

Buildup Data

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No.	Shutin time hr	Effective Time hr	Pressure kPa	Delta P kPa
1	2.000E+00	1.999E+00	8.351E+03	-2.500E+02
2	4.000E+00	3.996E+00	8.301E+03	-3.000E+02
3	6.000E+00	5.992E+00	8.101E+03	-5.000E+02
4	8.000E+00	7.986E+00	8.101E+03	-5.000E+02
5	2.400E+01	2.387E+01	7.826E+03	-7.750E+02
6	3.000E+01	2.980E+01	7.601E+03	-1.000E+03
7	4.800E+01	4.749E+01	7.351E+03	-1.250E+03
8	5.400E+01	5.335E+01	7.351E+03	-1.250E+03
9	7.200E+01	7.085E+01	7.351E+03	-1.250E+03
10	7.800E+01	7.666E+01	7.351E+03	-1.250E+03
11	9.600E+01	9.397E+01	7.351E+03	-1.250E+03
12	1.020E+02	9.971E+01	7.351E+03	-1.250E+03
13	1.200E+02	1.168E+02	7.351E+03	-1.250E+03
14	1.260E+02	1.225E+02	7.351E+03	-1.250E+03
15	1.460E+02	1.414E+02	7.351E+03	-1.250E+03
16	1.700E+02	1.637E+02	7.351E+03	-1.250E+03
17	1.940E+02	1.859E+02	7.351E+03	-1.250E+03
18	2.180E+02	2.078E+02	7.151E+03	-1.450E+03
19	2.420E+02	2.295E+02	7.151E+03	-1.450E+03
20	2.660E+02	2.510E+02	7.126E+03	-1.475E+03
21	2.900E+02	2.722E+02	7.126E+03	-1.475E+03
22	3.140E+02	2.933E+02	7.101E+03	-1.500E+03
23	3.380E+02	3.141E+02	7.101E+03	-1.500E+03
24	3.620E+02	3.348E+02	7.101E+03	-1.500E+03
25	3.860E+02	3.552E+02	7.101E+03	-1.500E+03
26	4.100E+02	3.754E+02	7.101E+03	-1.500E+03
27	4.340E+02	3.954E+02	7.101E+03	-1.500E+03
28	4.580E+02	4.152E+02	7.101E+03	-1.500E+03
29	4.820E+02	4.349E+02	7.101E+03	-1.500E+03
30	5.060E+02	4.543E+02	7.101E+03	-1.500E+03

Type Curve Analysis

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Input Data

Pressure Run Depth.....	=	0.000E-01	m
Fluid Analyzed.....	=	Multi-phase	
Production Time.....	=	4.448E+03	hr
Total Flow Rate.....	=	9.700E+00	Res m ³ /D
Water Flow Rate.....	=	9.700E+00	m ³ /D
Bottomhole Flowing Pressure.....	=	8.601E+03	kPa
Water Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Water Viscosity.....	=	7.000E-01	cp
Reservoir Temperature.....	=	4.300E+01	Degree C
Pay Thickness.....	=	1.409E+01	m
Porosity.....	=	1.560E-01	
Oil Saturation.....	=	6.000E-01	
Gas Saturation.....	=	0.000E-01	
Water Saturation.....	=	4.000E-01	
Total Compressibility.....	=	1.510E-06	1/kPa
Wellbore Radius.....	=	5.700E-02	m

Output

Pressure Match:

Pd = 0.239E+01 Pressure = 0.150E+04

Time Match:

Td = 0.627E+03 Time = 0.454E+03

Reservoir Type: Homogeneous System

Reservoir Parameters:

Cd*e ^(2s)	=	9.500E-02	
Lambda*e ^(-2s)	=	0.000E-01	
Omega.....	=	1.000E+00	
Lambda.....	=	1.000E+00	
Skin factor.....	=	-5.597E+00	
Wellbore Storage.....	=	4.675E-04	m ³ /kPa
Dimensionless WBS.....	=	6.901E+03	
Water Transmissibility.....	=	2.887E+01	mD-m/cp
Water Reservoir Capacity.....	=	2.021E+01	mD-m
Water Mobility.....	=	2.049E+00	mD/cp
Effective Permeability to Water...	=	1.435E+00	mD
Radius of Investigation.....	=	7.400E+02	m

Horner Analysis

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No.	Elapsed time hr	(Tp+dt)/dt Dimensionless	P-Function kPa

1	2.000E+00	2.225E+03	2.500E+02
2	4.000E+00	1.113E+03	3.000E+02
3	6.000E+00	7.423E+02	5.000E+02
4	8.000E+00	5.570E+02	5.000E+02
5	2.400E+01	1.863E+02	7.750E+02
6	3.000E+01	1.493E+02	1.000E+03
7	4.800E+01	9.367E+01	1.250E+03
8	5.400E+01	8.337E+01	1.250E+03
9	7.200E+01	6.278E+01	1.250E+03
10	7.800E+01	5.803E+01	1.250E+03
11	9.600E+01	4.733E+01	1.250E+03
12	1.020E+02	4.461E+01	1.250E+03
13	1.200E+02	3.807E+01	1.250E+03
14	1.260E+02	3.630E+01	1.250E+03
15	1.460E+02	3.147E+01	1.250E+03
16	1.700E+02	2.716E+01	1.250E+03
17	1.940E+02	2.393E+01	1.250E+03
18	2.180E+02	2.140E+01	1.450E+03
19	2.420E+02	1.938E+01	1.450E+03
20	2.660E+02	1.772E+01	1.475E+03
21	2.900E+02	1.634E+01	1.475E+03
22	3.140E+02	1.517E+01	1.500E+03
23	3.380E+02	1.416E+01	1.500E+03
24	3.620E+02	1.329E+01	1.500E+03
25	3.860E+02	1.252E+01	1.500E+03
26	4.100E+02	1.185E+01	1.500E+03
27	4.340E+02	1.125E+01	1.500E+03
28	4.580E+02	1.071E+01	1.500E+03
29	4.820E+02	1.023E+01	1.500E+03
30	5.060E+02	9.791E+00	1.500E+03

Input Data

Pressure Run Depth.....	=	0.000E-01	m
Fluid Analyzed.....	=	Multi-phase	
Production Time.....	=	4.448E+03	hr
Total Flow Rate.....	=	9.700E+00	Res m ³ /D
Water Flow Rate.....	=	9.700E+00	m ³ /D
Bottomhole Flowing Pressure.....	=	8.601E+03	kPa
Water Formation Volume Factor.....	=	1.000E+00	Res m ³ /m ³
Water Viscosity.....	=	7.000E-01	cp
Reservoir Temperature.....	=	4.300E+01	Degree C
Pay Thickness.....	=	1.409E+01	m
Porosity.....	=	1.560E-01	
Oil Saturation.....	=	6.000E-01	
Water Saturation.....	=	4.000E-01	
Total Compressibility.....	=	1.510E-06	1/kPa
Wellbore Radius.....	=	5.700E-02	m

Output

Slope.....	=	5.374E+02	
Intercept.....	=	2.033E+03	kPa
Dp or Dm(p) at 1 hour.....	=	7.274E+01	kPa
Extended Pressure.....	=	6.568E+03	kPa
Water Transmissibility.....	=	3.880E+01	mD-m/cp
Water Reservoir Capacity.....	=	2.716E+01	mD-m
Water Mobility.....	=	2.754E+00	mD/cp
Effective Permeability to Water...	=	1.928E+00	mD
Skin Factor.....	=	-4.975E+00	
Pressure Drop due to skin.....	=	-2.326E+03	kPa
Total Ideal Productivity Index...	=	2.225E-03	Res m ³ /D/kPa
Total Actual Productivity Index...	=	4.770E-03	Res m ³ /D/kPa
Total Flow Efficiency.....	=	2.144E+00	
Radius of Investigation.....	=	8.578E+02	m

ENRON OIL CANADA LTD.

1-9-02-25WPM

FALL-OFF TEST

Homogeneous System

Tf = 2.9E+01
W = 1.0E+00
Lm = 1.0E+00
S = -5.6E+00
Cd = 6.9E+03

Dimensionless Pressure
E+00
E-01

Dimensionless Time Group

servipetro

E-01

E+00

E+01

E+02

E+03

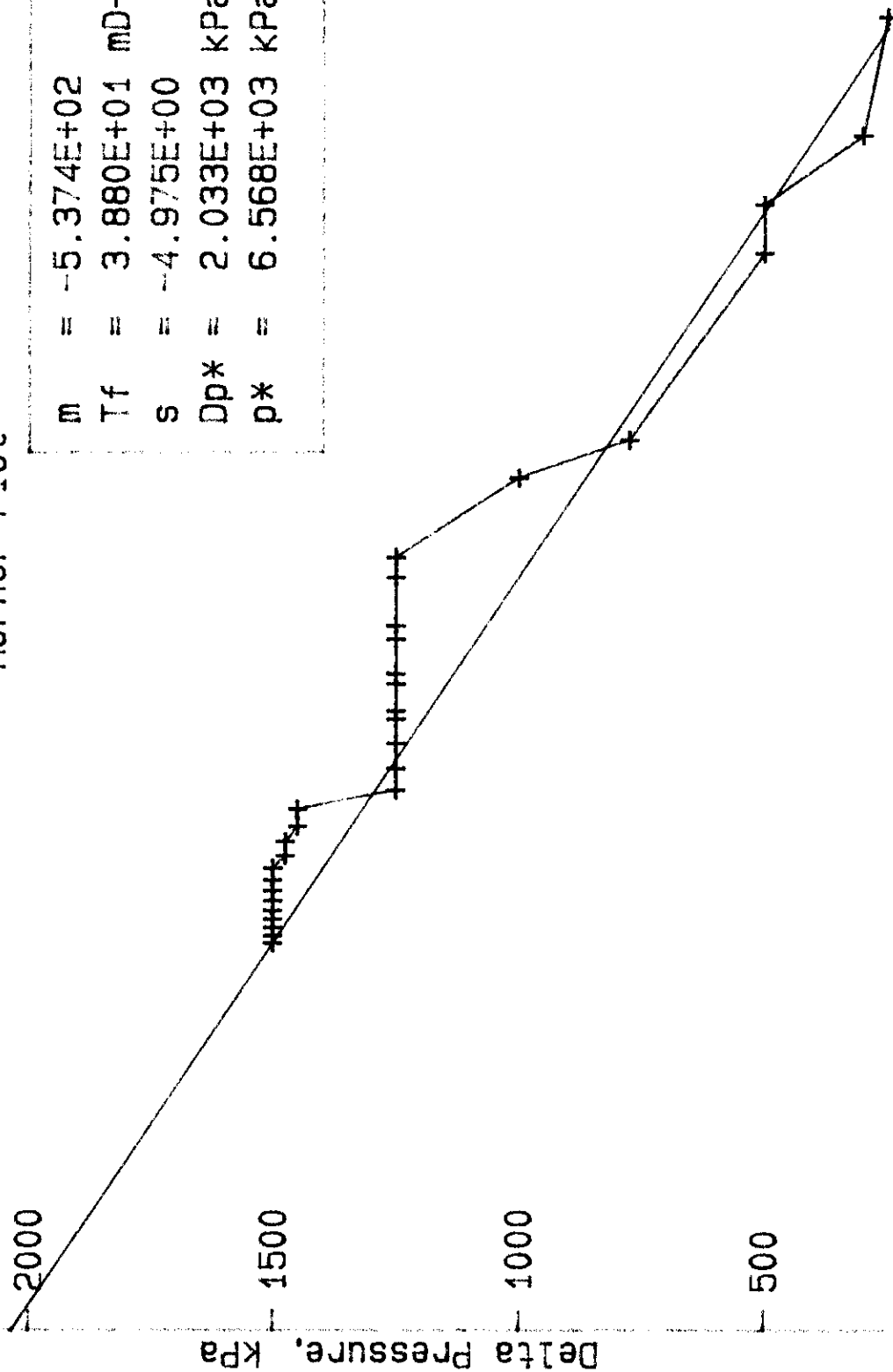
ENRON OIL CANADA LTD.

1-9-02-25WPM

FALL-OFF TEST

Horner Plot

$m = -5.374E+02$
 $Tf = 3.880E+01 \text{ mD-m/cp}$
 $s = -4.975E+00$
 $Dp^* = 2.033E+03 \text{ kPa}$
 $p^* = 6.568E+03 \text{ kPa}$



Time Function, $(Tp+dt)/dt$

$E+00$

$E+01$

$E+02$

$E+03$



Energy and Mines

Petroleum

555 — 330 Graham Avenue
Winnipeg, Manitoba, CANADA
R3C 4E3

(204) 945-6577

June 1, 1989

Enron Oil Canada Ltd.
1300, 700 — 9th Avenue S.W.
Calgary, Alberta
T2P 3V4

Attention: Mr. T. McKay

Dear Sir:

Re: Waskada Unit No. 16 — 1989 Pressure Survey

Your letter dated May 29, 1989 outlining the proposed annual pressure survey for the Waskada Unit No. 16 is acknowledged.

Your proposal to conduct 14 day, pressure fall-off tests on the wells 1-9-2-25 (WPM), 6-9-2-25 (WPM), 10-9-2-25 (WPM), 16-9-2-25 (WPM) and 5-10-2-25 (WPM) is hereby approved.

Yours sincerely,

Original Signed By
L. R. DUBREUIL

L. R. Dubreuil
Director

LRD:jtb



Energy and Mines

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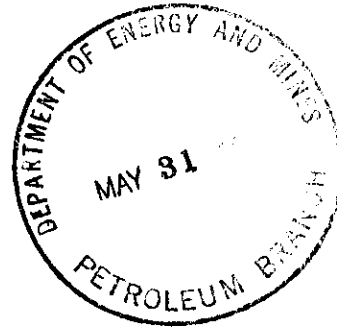

L. R. DUBREUIL

L. R. Dubreuil
Director

LRD:jtb

26 May 1989

Manitoba Energy and Mines
Petroleum Department
#555, 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3



Attention: Mr. L.R. Dubreuil,
Chief Petroleum Engineer

Dear Sir:

Re: 1988 Pressure Surveys
Waskada Unit No. 16

Please find attached a copy of the proposed fall-off test procedure for the expanded portion of the Waskada Unit No. 16 area.

Enron Oil Canada Ltd. hopes to start conducting the tests on the morning of June 5, 1989, while at the same time continuing to injection in the original Unit area. The continued injection into 5-4, 11-4, 15-4 and 16-5 is not expected to affect the integrity of the tests.

Enron will be forwarding completed fall-off tests as soon as the results become available.

Yours very truly,

ENRON OIL CANADA LTD.

A handwritten signature in cursive script that reads "T. McKay".

T. McKay,
Production Engineer

TM:pdc
attach

WASKADA UNIT NO. 16
FALL-OFF TEST PROGRAM

1. Record surface pressures of all five injectors (1-9, 6-9, 10-9, 16-9 and 5-10) on the morning of June 5, 1989.
2. Shut in injectors and record surface pressure and time of shut-in.
3. Continue to record surface pressure every one to two hours for the first day of shut-in (minimum of five times).
4. For the next five days record pressures twice daily.
5. During the next six to fourteen days record pressures once a day or until well goes on vacuum.
6. During these fall-off tests data sheets should be sent to the Calgary office twice a week (Monday and Friday).

NOTE: It is imperative that accurate gauges be used and checked with a dead weight tester prior to and during these tests.

xc: C. Turnbull
D. Logie
D. Stoodley
L. Verstraete
L. Fenwick