DRILL STEM TEST REPORT

Well Radcliff — Test No. 1 — Date 3/16/81

Operator Enserch Exploration, Inc. — Formation Mississippi Lime

Field/Prospect North Peterson — Testing Co. Johnston

County-State Roosevelt, New Mexico — Well Elev. KB @ 4446.5 ft.

Mud Wt. 10.2 #/gal.

A. Interval Tested 8168'-8204' OH/Perf. Chokes: Top 1/8, 1/4, 1/2 Btm. 15/16

Cushion Used None

Testing In: Full Hole X " Rathole " with DP/[illegible] "

B. IHM: 4447 psi FHM: 4411 psi Calc. HM: 4350 psi BHT: 155 °F

First Flow Period: 14 min. 0.23 hrs. IFP 124 psi FFP 170 psi

First Shut-In Period: 37 min. 0.62 hrs. ISIP 170 psi Max. 2719 ?

Second Flow Period: 58 min. 0.97 hrs. IFP 152 psi FFP 258 psi

Second Shut-In Period: 121 min. 2.02 hrs. FSIP 2854 psi Max. 2854 ?

C. Surface Blow Strong gas blow Max. SP 29 psi

Fluid to Surface: NO XXX being @ rate of BPD/MCFD

Recovery From Pipe or Estimated While Reversing Out:

Description		Amount		Gravity or Salinity
5% Oil	95% mud	Top 300 ft.	Bbl.	42° @ 60°F, 110,000 ppm
60% Oil	40% mud	Mid. 200 ft.	Bbl.	42° @ 60°F, 110,000 ppm
2% Oil	98% mud	Bot. 120 ft.	Bbl.	107,000 ppm
		ft.	Bbl.	
		ft.	Bbl.	

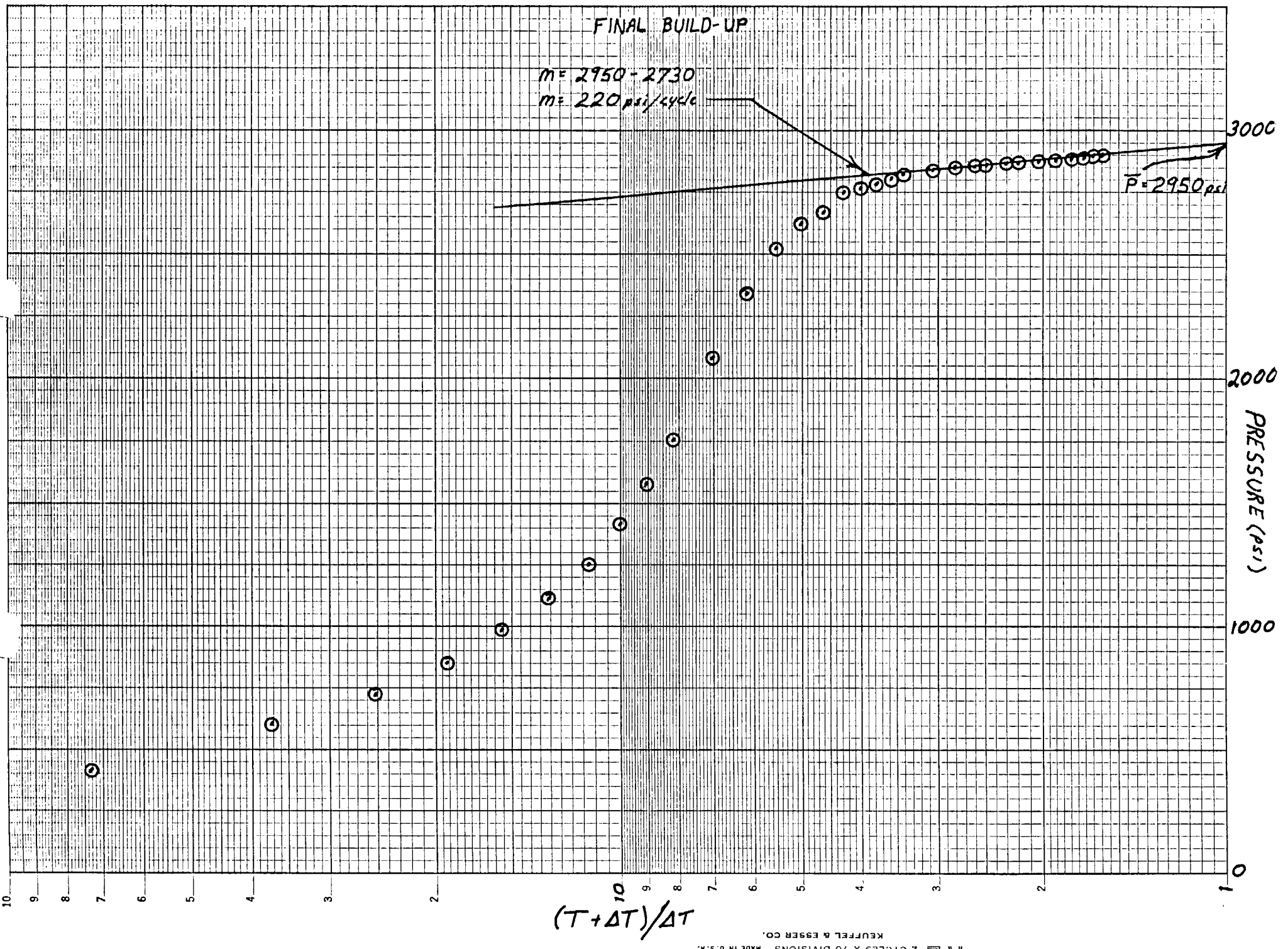
D. Indicated Flow Rate (Q) 48 BPD/MCFD Calc. Skin Effect (S) 8.5

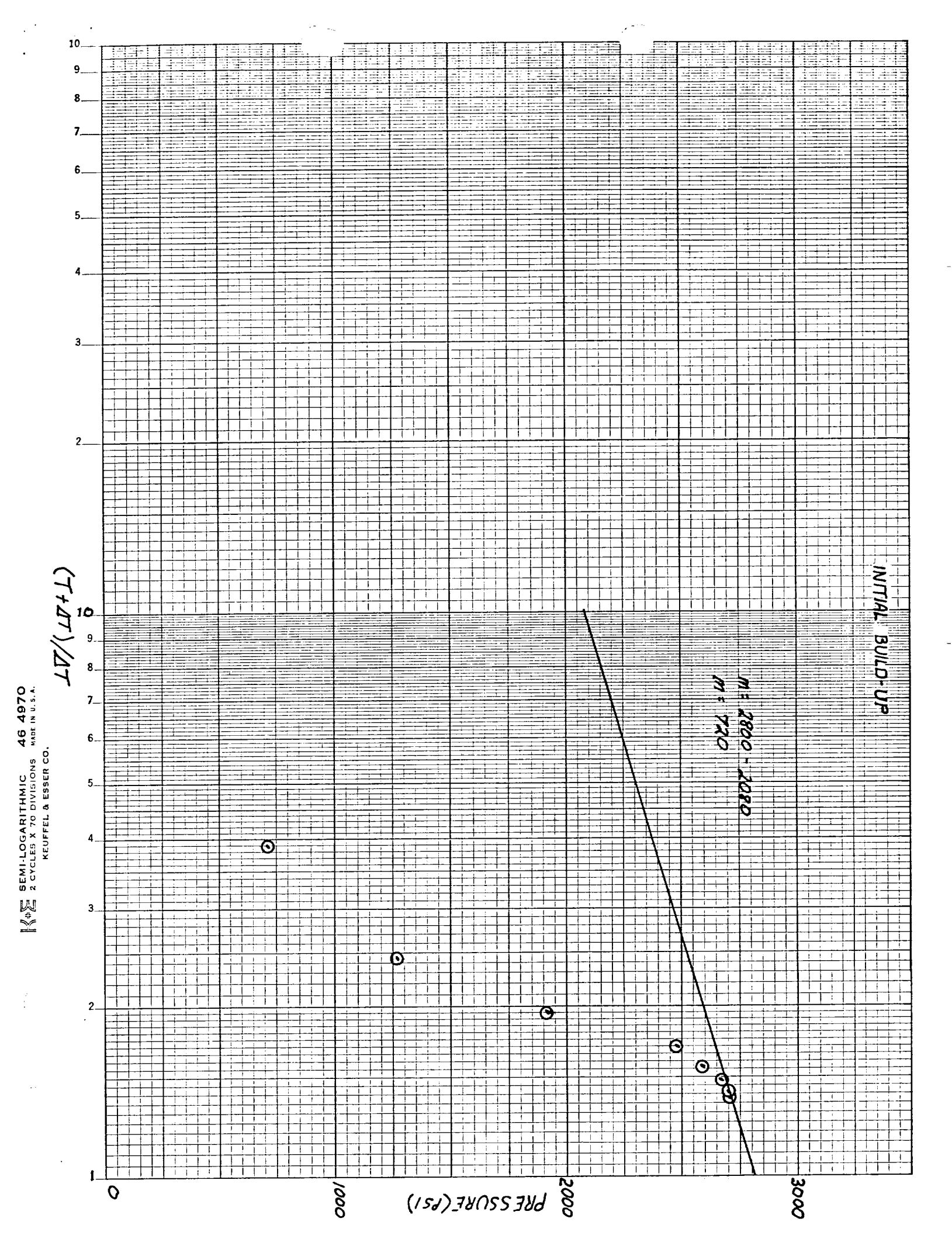
Theoretical Flow Rate (QT) BPD/MCFD Productivity Ratio (PR) 0.31

Transmissibility (kh/μ) 39.9 md.ft./cps Investigation Radius (Ri) 32 ft.

Extrapolated Press: ISIP 2800 psi FSIP 2950 psi Flow Capacity (kh) 14.8 md.ft.

E. Summary & Recommendations: Reservoir pressure in subject well is 830 psi greater than in the offset Finely No. 1 well. Results indicate wellbore damage is present and stimulation is necessary.


FINAL BUILD-UP
m = 2950 - 2730
m = 220 psi/cycle
P = 2950 psi
3000
2000
1000
0
PRESSURE (psi)
10
9
8
7
6
5
4
3
2
1
(T + ΔT)/ΔT
KEUFFEL & ESSER CO.
SEMI-LOGARITHMIC 46 4970
2 CYCLES X 70 DIVISIONS MADE IN U.S.A.


INITIAL BUILD-UP
m = 2800 - 2080
m = 720
(T+ΔT)/ΔT
PRESSURE (PSI)
0
1000
2000
3000
1
2
3
4
5
6
7
8
9
10
SEMI-LOGARITHMIC 46 4970
2 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.

FINAL BUILD-UP

Page

$\bar{T}$ = 72.55 min.

Remarks: Date & Time	Accumulative Time Minutes	Hours	Days	BHP psig	$BHP^2 \times 10^6$	$\frac{T + \Delta T}{\Delta T}$
	0			258		
	1			418		73.55
	2			609		37.28
	3			739		25.18
	4			861		19.14
	5			980		15.51
	6			1114		13.09
	7			1252		11.36
	8			1413		10.07
	9			1587		9.06
	10			1766		8.26
	12			2087		7.05
	14			2344		6.18
	16			2516		5.53
	18			2616		5.03
	20			2671		4.63
	22			2705		4.30
	24			2727		4.02
	26			2742		3.79
	28			2763		3.59
	30			2781		3.42
	35			2794		3.07
	40			2803		2.81
	45			2810		2.61
	50			2816		2.45
	55			2822		2.32
	60			2827		2.21
	70			2833		2.04
	80			2838		1.91
	90			2844		1.81
	100			2848		1.73
	110			2851		1.66
	120			2853		1.60
	121.6			2854		1.60

INITIAL BUILD-UP

Page

$T = 14.38$ min

Remarks: Date & Time	Accumulative Time Minutes	Hours	Days	BHP psig	$BHP^2 \times 10^6$	$\frac{T + \Delta T}{\Delta T}$
	0			170		
	5			715		3.88
	10			1258		2.44
	15			1916		1.96
	20			2486		1.72
	25			2591		1.58
	30			2678		1.48
	35			2709		1.41
	36.9			2719		1.39

1. Oil Gravity (G_{roil})	G_{roil} 42.8	°API @60°F
2. Reservoir Temperature (T_f)	T_f 155	°F
3. Oil Saturation (S_o) Logs or Core Analysis	S_o 60.	%
4. Gas Saturation (S_g) Logs or Core Analysis	S_g 0.	%
5. Water Saturation (S_w) Logs or Core Analysis	S_w 40.	%
6. Pressure Standard Conditions (P_{sc}) Table #	P_{sc} 14.7	P
7. Reservoir Pressure (P_i) = P 2950 P_{sig} + P_{sc} 14.7	P_i 2964.7	P_{sia}
8. Final Flow Pressure (P_{wf}) = P_{wf} 258 P_{sig} + P_{sc} 14.7 PSI	P_{wf} 272.7	P_{sia}
9. Gas Oil Ratio (GOR) (a) Sample Chamber: GOR = (159,000 X Gas .9 Ft^3) ÷ Oil 775 C_c	GOR 185	$\frac{Ft^3}{Bbl}$
(b) Surface Rate: GOR = Gas Rate ____ $\frac{Scf}{day}$ ÷ Oil Rate ____ $\frac{Bbls}{day}$	GOR	$\frac{Ft^3}{Bbl}$
10. Bubble Point Pressure (B_{pp}) Chart #	*B_{pp} 2467	PSI
11. Oil Viscosity (μ_o) Charts # ____ & ____	*μ_o .37	Cps
12. Oil Formation Volume Factor (B_o) Chart #	*B_o 1.5	$\frac{Bbls}{Bbl}$
13. Oil Compressibility (C_o) Chart #	*C_o 14 X 10^{-6}	PSI^{-1}
14. Gas Compressibility (C_g) Chart # ____ $C_g = C_r$ ____ ÷ P_r ____	C_g X 10^{-}	PSI^{-1}
15. Water Compressibility (C_w)	C_w X 10^{-}	PSI^{-1}
16. Rock Compressibility (C_f)	X 10^{-}	PSI^{-1}
17. Total Compressibility (C_t) C_t = (S_o ____ dec X C_o ____ X 10^{-}) + (S_w ____ dec X C_w ____ X 10^{-}) + (S_g ____ dec X C_g ____ X 10^{-}) + C_f ____ X 10^{-1}	*C_t 14 X 10^{-6}	PSI^{-1}
18. Oil Production Rate (Q_o) (Rate Calculation Sheet 1 or 2)	Q_o 48 $\frac{Bbls}{day}$ X B_o 1.12 $\frac{Bbls}{Bbls}$ = 54	$\frac{R\,Bbls}{day}$
19. Gas Test Rate (Q_g) (Surface Measurement)	Q_g	$\frac{Mcf}{day}$
20. Water Production Rate (Q_w) (Rate Calculation Sheet 1)	Q_w	$\frac{Bbls}{day}$
21. Porosity (ϕ)	ϕ 22	%
22. Net Zone Thickness (h)	h 13	Ft
23. Wellbore Radius (r_w)	r_w 4.375 In	Ft
24. Flow Time (T)	T 72.55	Mins.
25. Shutin Time (Δt)	Δt	Mins.

* OBTAINED FROM AMOCO STATE NO. 1 FLUID ANALYSIS

(GAS)(LIQUID) RESERVOIR ENGINEERING
WORK_EET HORNER METHO_(P)

1. Slope Determination (M) PSI/Log Cycle

M_2 = P(0 Log Cycle) 2950 PSI
− P(1 Log Cycle) 2730 PSI
= 220 PSI/Log Cycle

M_1 = P(0 Log Cycle) _____ PSI
− P(1 Log Cycle) _____ PSI
= _____ PSI/Log Cycle

2. Pressure Gradient (PG_r)

$PG_r = P_i$ 2950 P_{sig} ÷ Recorder Depth 8204 Ft = PG_r .36 PSI/Ft

3. Transmissibility (Kh/μ) = [(162.6 X Q 54 RBPD) / (M 220 PSI/Log Cycle)] = Kh/μ 39.9 Md-Ft/Cps

4. Productive Capacity (Kh) = (Kh/μ 39.9 Md-Ft/Cps X μ .37 Cps) = Kh 14.8 Md-Ft

5. Permeability (K) = (Kh 14.8 Md-Ft) ÷ (h 13 Ft) = K 1.14 Mds

6. Damage Ratio (DR)

$$DR = \left[\frac{(P_i\ 2950\ PSI - P_{wf}\ 258\ PSI)}{M\ 220\ \frac{PSI}{Log\ Cycle} \times \left(\text{Log}\ \frac{K\ 1.14\ Mds \times T\ 72.55\ Mins}{\phi .22\ dec \times \mu .37\ Cps \times C\ 14 \times 10^{-6} \times r_w^2\ 19.1\ In}\right) - 2.85}\right] = DR\ 3.28\ Dim$$

7. Estimated Damage Ratio (EDR) = [(Pi 2950 PSI − Pwf 258 PSI) / (M 220 PSI/Log Cycle X (Log T 72.55 Min + 2.65))] = EDR 6.52 Dim

8. Pressure Drop Due To Damage (ΔP_{da})

ΔP_{da} = (Pi 2950 PSI − Pwf 258 PSI) − ((Pi 2950 PSI − Pwf 258 PSI) / DR 3.28) = ΔP_{da} 1871 PSI

9. Damage No. (S') = (ΔPda 1871 PSI / 0.87M 220 PSI/Log Cycle) = S' 8.5 Dim

10. Effective Wellbore Radius

$r_w' = r_w$ .73 Ft X e^{-s} 8.5 = r_w' .00015 ft

11. Productivity Index Actual $(PI)_a$ $(P_i)_a$ = Q 54 (Bbls/day) / (Pi 2950 PSI − Pwf 258 PSI) = $(Pi)_a$ .02 Bbls/d/PSI

12. Productivity Index Damaged Removed (Pi) (PI) = Q 54 (Bbls/day) / (Pi 2950 PSI − Pwf 258 PSI − ΔPD_a 1871 PSI) = Pi .065 Bbls/d/PSI

13. Radius of Investigation (r_i)

$$r_i = \sqrt{\frac{K\ 1.14\ Mds \times T^*\ 58.17\ Mins}{57{,}600\ \phi .22\ dec \times \mu .37\ Cps \times C\ 14 \times 10^{-6}}} = r_i\ 32\ Ft$$

*(Use flow time for R_i of flow) (Use shut-in time for R_i of shut-in)

14. Distance to an Anomaly (Intercept Method) r_a(int)

$r_a(int) = 157 \times 10^{-3}$ $\sqrt{\frac{K\ \_\_\_\ Mds \times \Delta t_i\ \_\_\_\ Mins}{\phi\ \_\_\_\ dec \times \mu\ \_\_\_\ Cps \times C\ \_\_\_ \times 10^{-}}}$ = r_a(int) Ft

15. Distance to an Anomaly (Deviation Method) r_a(dev)

$r_a(dev.) = 3.941 \times 10^{-3}$ $\sqrt{\frac{K\ \_\_\_\ Mds \times T\ \_\_\_\ Mins}{\phi\ \_\_\_ \times \mu\ \_\_\_\ Cps \times C\ \_\_\_ \times 10^{-} \times \Delta t_{dev}\ \_\_\_}}$ = r_a(dev) Ft

16. Potentiometric Surface (PS)

PS = (Pi _____ PSI X 2.309) + Elev. _____ Ft − Recorder Depth _____ Ft = PS Feet above sea level