UGR File #034, v.1
Gruy Federal, Inc.
Jan. 25, 1979
METC/3096-WTA-3

DOE-METC GAS WELL TESTING SERVICE

CONTRACT NO. EW-78-C-21-8096

WELL TEST ANALYSIS FOR

KENTUCKY-WEST VIRGINIA GAS COMPANY

WELL NO. 1627

VOLUME I

Submitted to

U.S. Department of Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

by

Gruy Federal, Inc.
2500 Tanglewilde, Suite 150
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January 25, 1979

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Gruy Federal, Inc.
Jan. 25, 1979

GRUY FEDERAL, INC.

WELL TEST ANALYSIS
FOR
KENTUCKY - WEST VIRGINIA GAS COMPANY
WELL NO. 1627

INTRODUCTION

The Kentucky - West Virginia Gas Company Well No. 1627 is located in Perry County, Kentucky, near the town of Hazard. The well was drilled to a total depth of 2866 feet in March 1976 and completed through perforations from 2562 to 2582 feet (3 holes) and 2728 to 2790 feet (7 holes). The frac job consisted of 29,000 gallons of gelled water with a foaming agent, 37,000 pounds of 20-40 mesh sand, and 15,000 pounds of 30-100 mesh sand. A copy of the compensated formation density log for the interval of interest is enclosed in the pocket of this report.

A schematic diagram of the casing and cementing program is shown in Figure 1.

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OPERATION

Figure 1 shows that the wellhead has a swab valve and a flow line valve but no master valve. The entire assembly is supported by 2-inch tubing. In the opinion of Gruy's field personnel, the assembly could not safely support the lubricator and grease injection system. A mast was rented to stabilize the lubricator and reduce the bending moment on the pipe. Otherwise, the surface equipment was installed as shown in Figure 2.

On November 21, 1978, several sinker bars and a maximum-recording thermometer were run to a depth of 2772 feet, where the top of the frac sand was encountered. The maximum bottomhole temperature recorded was 90°F.

The Hewlett-Packard quartz gauge was run to a depth of 2700 feet with stops at every 500 feet to locate the fluid level. However, the presence of water in the well was not indicated.

The well was placed on production at 1630 hours on the same day through a 1/4-inch orifice plate; but since the well could not be flowed at the desired rate, the orifice plate was immediately replaced by a 1/2-inch plate. The flow rate remained steady for the full 96-hour flow period. The average flow rate during this period was 59 MCFD. The well was shut in at 1630 hours on November 25 and remained shut in for four days. It was again put on production at 1630 hours on November 29 through a 1/2-inch orifice plate at a flow rate of 117 MCFD, but the well could not sustain that production rate and gradually fell to 40 MCFD by the end of the 96-hour flow period. On December 3 the test was concluded at 1630 hours and the equipment was released and moved off location.

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ANALYSIS

Estimation of Fracture Length from Frac Data

The well was fraced using 52,000 pounds of sand. Assuming 10% flowback of sand, a grain density of 2.66 gm/cc, and a fracture porosity of 33%, the fracture volume was estimated to be 420.83 cubic feet. By further assuming that the frac job created two fractures with heights of 20 feet (through perforations from 2652 to 2682 feet) and 62 feet (through perforations 2728 to 2790 feet), fracture widths of 0.1 inch, and equal half-lengths for both fractures, the half-lengths are approximately 308 feet.

Estimation of Half-Fracture Length from Bottomhole Pressure Data

The two flow periods and the interim shut-in were analyzed separately to arrive at an estimate of half-fracture length. Figures 3 and 4 are plots of ΔP and $\Delta M(p)$[1,2] against linear superimposed time rate data for the first flow period. Similar plots for the shut-in period are shown in Figures 5 and 6; Figures 7 and 8 are for the second flow period. From the slope of each straight line, the following results are obtained.[3-5]

First Drawdown ΔP Plot (Figure 3)

$$K_g \bar{\lambda} x_f^2 h_f^2 = \left(\frac{4.0648 B_g}{m}\right)^2 \frac{\mu_g}{p_g C_t}$$

Assuming:*

$p_g = 0.0068$,
$B_g = 5.1516$ bbl/Mcf,
$\mu_g = 0.0112$ cp,
$C_t = 0.002043$ psi^{-1},

*The gas properties were obtained from empirical correlations based on gas sample data in Table 1. The nomenclature is explained at the end of this report.

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$$K_g \sum x_f^2 h_f^2 = 3.584 \times 10^5 \text{ md-ft}^4.$$

First Drawdown M(p) Plot (Figure 4)

$$K_g \sum x_f^2 h_f^2 = \left(\frac{40.85 T_f Z}{m}\right)^2 \frac{1}{p_g \mu_g c_t}$$

Assuming:

$Z = 0.9141$,

$T_f = 550°R$,

$$K_g \sum x_f^2 h_f^2 = 4.394 \times 10^5 \text{ md-ft}^4.$$

Buildup ΔP Plot (Figure 5)

$$K_g \sum x_f^2 h_f^2 = 3.65 \times 10^5 \text{ md-ft}^4$$

Buildup ΔM(p) Plot (Figure 6)

$$K_g \sum x_f^2 h_f^2 = 2.158 \times 10^5 \text{ md-ft}^4$$

Second Drawdown ΔP Plot (Figure 7)

$$K_g \sum x_f^2 h_f^2 = 3.340 \times 10^5 \text{ md-ft}^4$$

Second Drawdown ΔM(p) Plot (Figure 8)

$$K_g \sum x_f^2 h_f^2 = 3.305 \times 10^5 \text{ md-ft}^4$$

The average value of $K_g \sum x_f^2 h_f^2$ is 3.572×10^5 md-ft^4.

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Assuming:

h_1 = 20 ft (height of the first fracture),

h_2 = 62 ft (height of the second fracture),

$X_1 = X_2$ (equal half-lengths for both fractures),

K_g = 0.00175 (used in the reservoir simulator),

We get

$X_1 = X_2$ = 268 ft.

or conversely, $X_1 = X_2$ = 308 feet gives a matrix permeability of 0.0009. It must be pointed out that this method of analysis assumes that the flow capacity of the fracture is infinite, which may not be valid in this case. For vertical fractures with finite capacities, this analysis always tends to give conservative results for the estimated fracture half-length.

Estimation of Reservoir Permeability

Independent estimates of the effective reservoir permeabilities were made by analyzing the data from the first drawdown and the following buildup. The second drawdown was ignored again, for the reasons explained earlier. Figures 9 and 10 are plots of $M(p)$ and superimposed time rate data for radial flow.

It is recognized that the slopes of these curves are not necessarily indicative of the reservoir permeability, but rather a weighted average of fracture and matrix permeability. Nonetheless, these data were used initially in the simulator to arrive at an estimate for the formation permeability with the full knowledge that the estimates may be too optimistic. The results of these analyses are shown in Table 2.

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History Match Using Reservoir Simulator

Gruy Federal's program library includes a three-dimensional single-phase simulator that solves the flow equation in terms of the real gas pseudo-potential. The model also includes wellbore storage, finite capacity fractures, and turbulence.

A history match of the bottomhole pressure versus time data was achieved by maintaining a constant product of formation permeability and fracture length. The best history match of the measured data is shown in Figure 11; the reservoir parameters used to achieve this match are shown in Table 3.

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CONCLUSIONS

Analysis of the transient test data on the Kentucky-West Virginia Gas Company Well No. 1627 leads to the following conclusions:

1. The frac job created two vertical fractures with half-lengths of approximately 308 feet and heights of 20 feet and 62 feet.

2. The wellbore storage effect was never detected during the early time transient test.

3. It must be realized that the reservoir properties obtained from the history match using the reservoir simulator may not be unique, but they are consistent with the results of the other analyses. However, other combinations might give similar history matches. These properties were selected on the basis of their consistency with the other analyses.

NOMENCLATURE

B_g = gas formation volume factor (bbl/Mcf)
C_t = total system compressibility (psi^{-1})
T_f = formation temperature (°R)
Z = gas compressibility factor
h = formation thickness (ft)
K_g = effective permeability to gas (md)
m = slope
$M(p)$ = real gas pseudo-potential (psi^2/cp)
ϕ_g = gas filled porosity
μ_g = gas viscosity (cp)

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2. Al-Hussainy, R., and Ramey, H.J., Jr.: "Application of Real Gas Flow Theory to Well Testing and Deliverability Forecasting," Trans AIME (1966) 233, pp. 637-641.

3. Millheim, Keith K., and Cichowicz, Leo: "Testing and Analyzing Low-Permeability Fractured Gas Wells," Trans. AIME (1968), pp. 193-198.

4. Wattenbarger, R.A., and Ramey, H.J.,Jr.: "Well Test Interpretation of Vertically Fractured Gas Wells," Trans AIME (1969), pp. 625-632.

5. Cinco-L., H., Samaniego-V., F., and Dominquez-A., N.: "Transient Pressure Behavior for a Well with a Finite-Conductivity Vertical Fracture," Society of Petroleum Engineers Journal, (Aug. 1978), pp. 253-264.

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TABLE 1

CHROMATOGRAPHIC ANALYSES OF SEPARATOR GAS

Kentucky-West Virginia Gas Company Well No. 1627
Big Willard Field, Hazard, Kentucky

Perforations: 2675'

	RATE 1		RATE 2	
	Separator temperature 85°F		Separator temperature 85°F	
	Separator pressure 40 psig		Separator pressure 75 psig	
	Producing rate 40 MCF/day		Producing rate 59 MCF/day	
Composition	Mol. Percent	GPM @ 14.696 psia	Mol. Percent	GPM @ 14.696 psia
Carbon dioxide	trace		trace	
Nitrogen	2.03		2.08	
Methane	82.90		83.90	
Ethane	9.88	2.6350	9.85	2.6270
Propane	3.81	1.0458	3.20	0.8784
Iso-butane	0.21	0.0685	0.13	0.0424
Normal butane	0.73	0.2294	0.55	0.1729
Iso-pentane	0.09	0.0329	0.08	0.0292
Normal pentane	0.16	0.0578	0.09	0.0325
Hexanes, plus	0.19	0.0874	0.12	0.0552
TOTALS	100.00	4.1569	100.00	3.8377

BTU per cubic foot:	dry 1158.83 wet 1138.55	dry 1137.50 wet 1117.60
Specific gravity (air = 1):	0.6711	0.6571

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TABLE 2

ESTIMATION OF MATRIX PERMEABILITY
FROM DRAWDOWN AND BUILDUP ANALYSES

	Permeability (md)
First drawdown	0.00583
Buildup	0.00631
Arithmetic mean	0.00607
Log mean	0.006065

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TABLE 3

RESERVOIR PROPERTIES USED IN HISTORY MATCH

RESERVOIR	
Effective porosity	0.68%
Effective permeability	0.001175 md
Total reservoir thickness	228 feet

FRACTURE	
Half fracture length (top zone)	308 feet
Half fracture length (bottom zone)	308 feet
Fracture porosity	33%
Effective fracture permeability	500,000 md
Fracture height (top zone)	20 feet
Fracture height (bottom zone)	62 feet
Fracture width	0.1 inch

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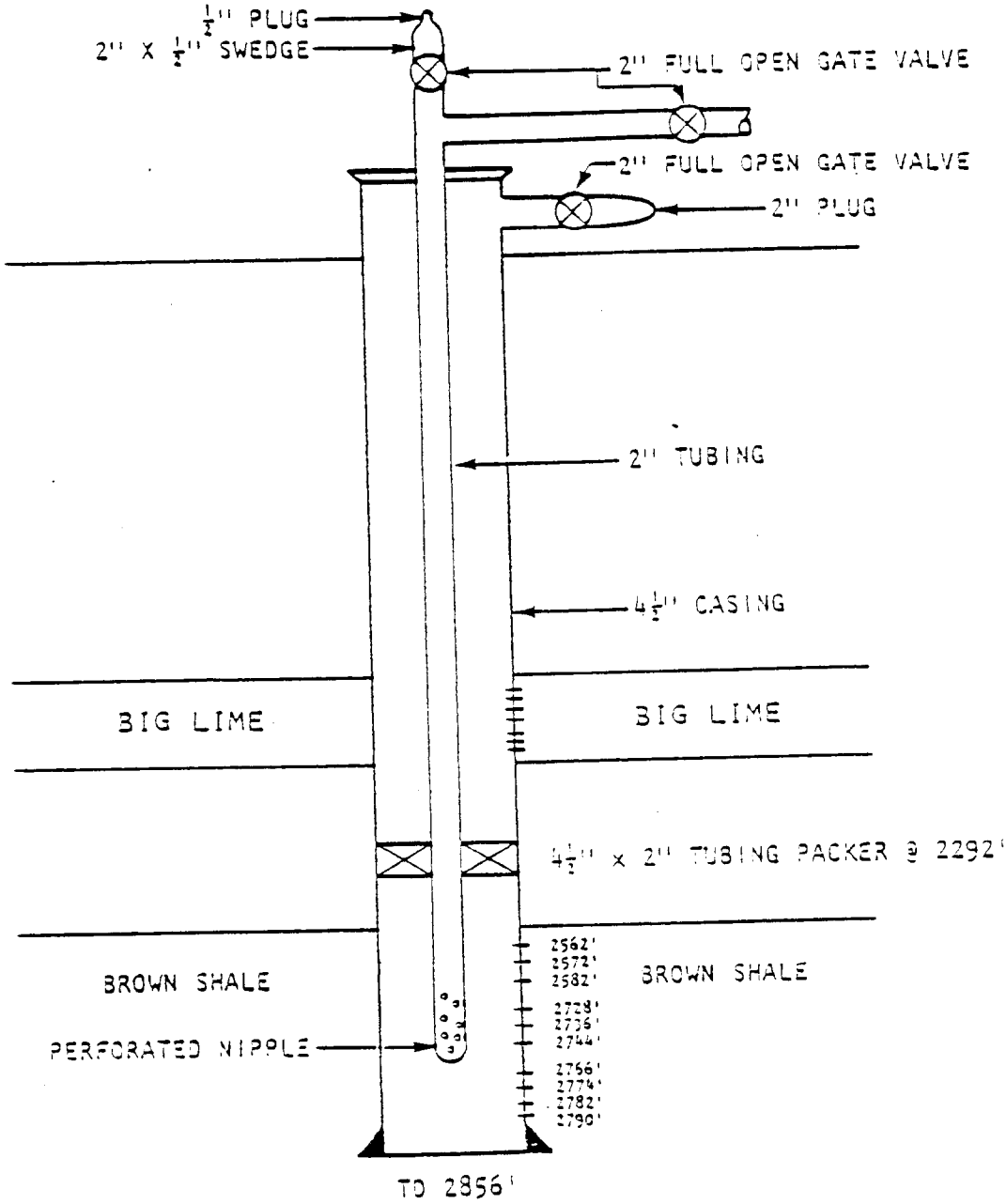
FIGURE 1

WELL SCHEMATIC OF
KENTUCKY - WEST VIRGINIA
GAS COMPANY WELL 1627



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SURFACE FACILITIES

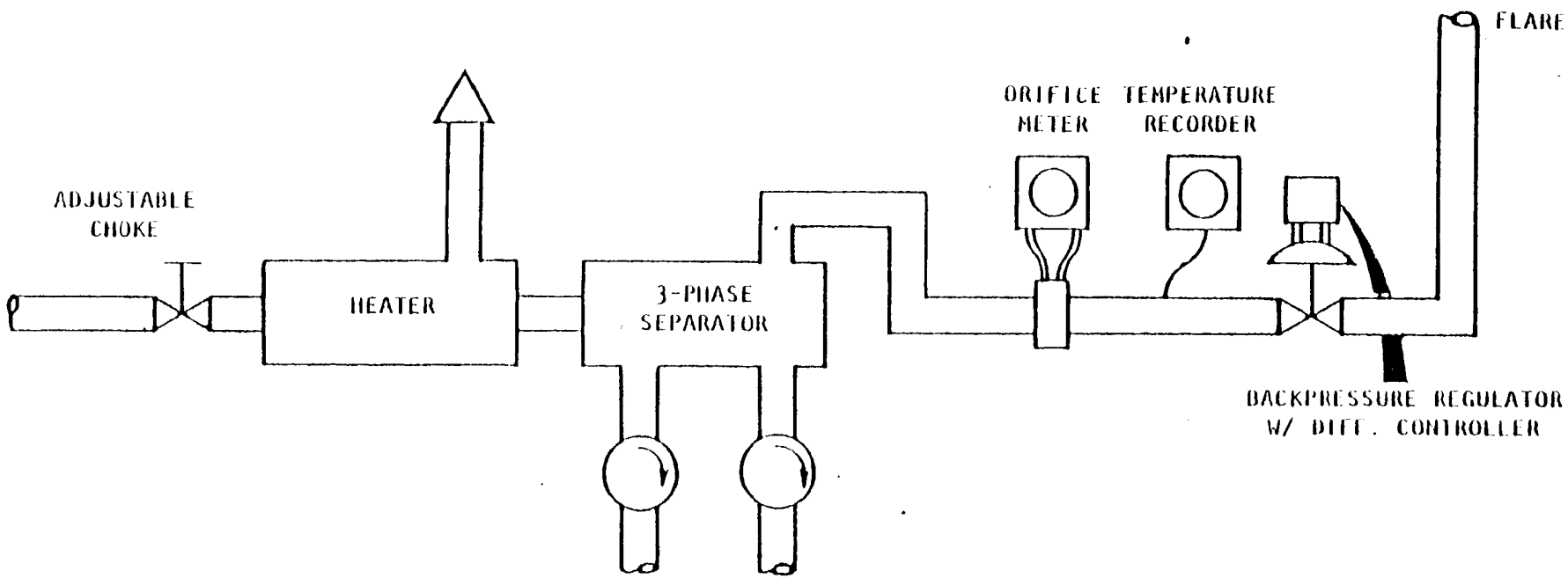

Figure 2

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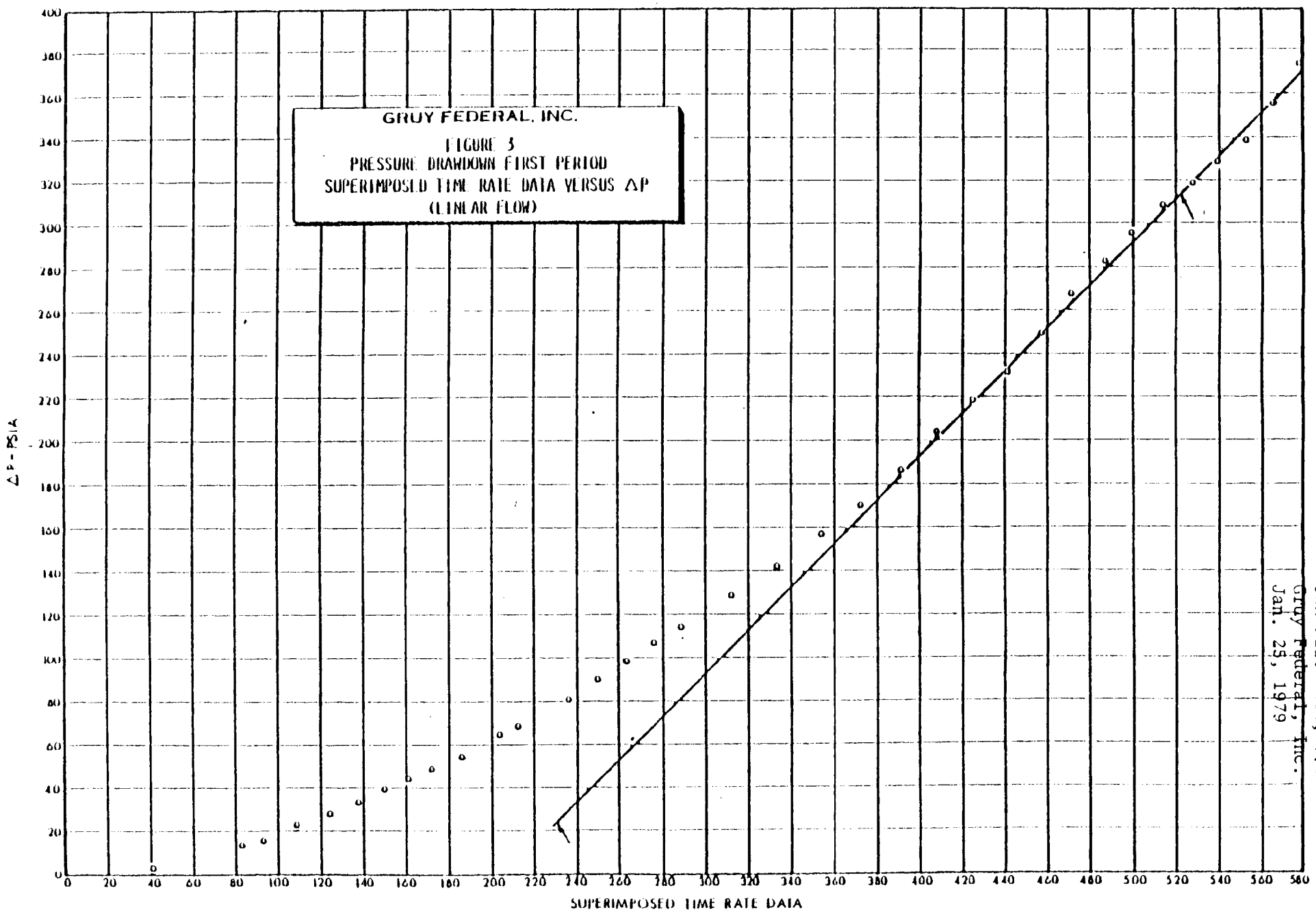

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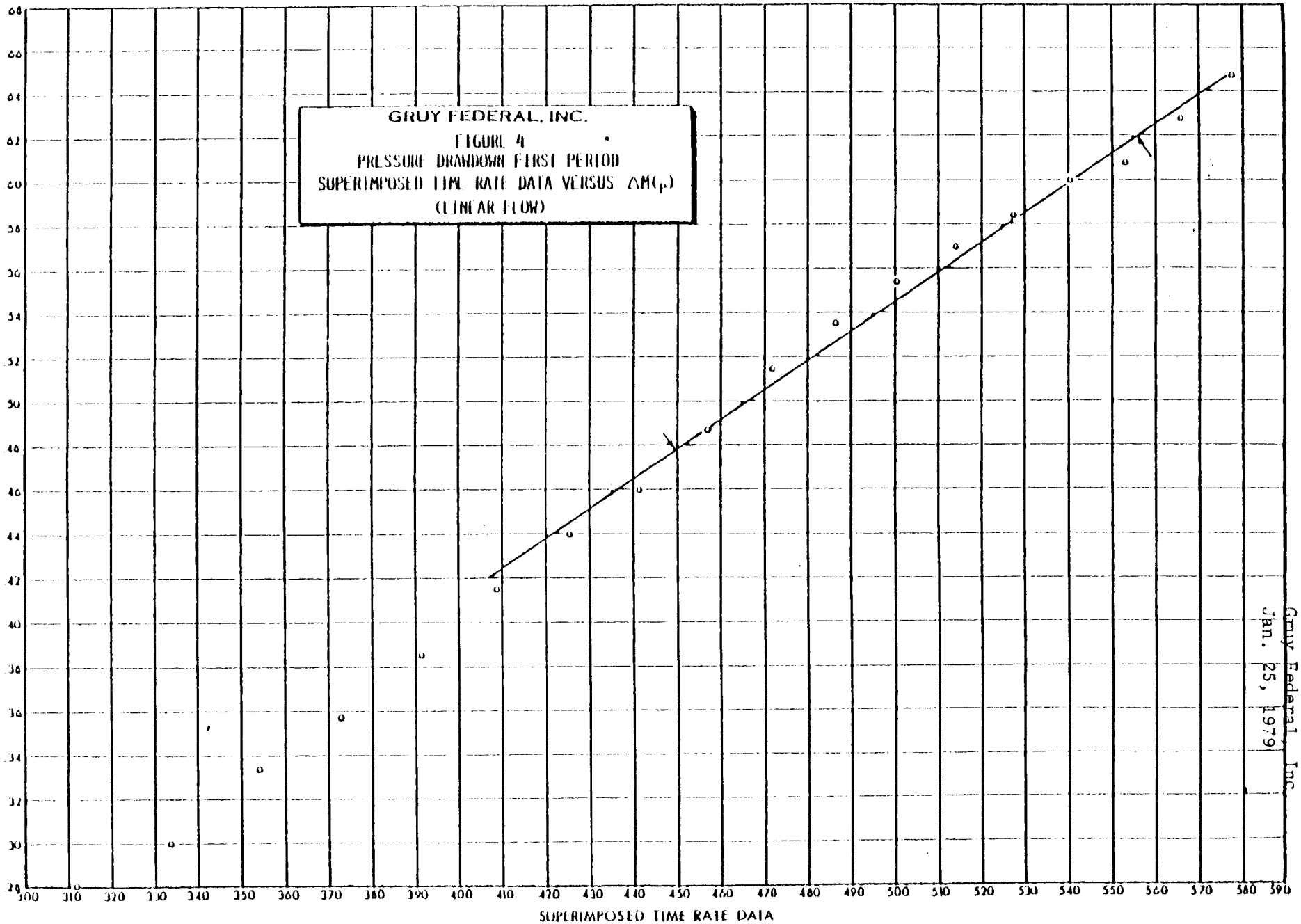

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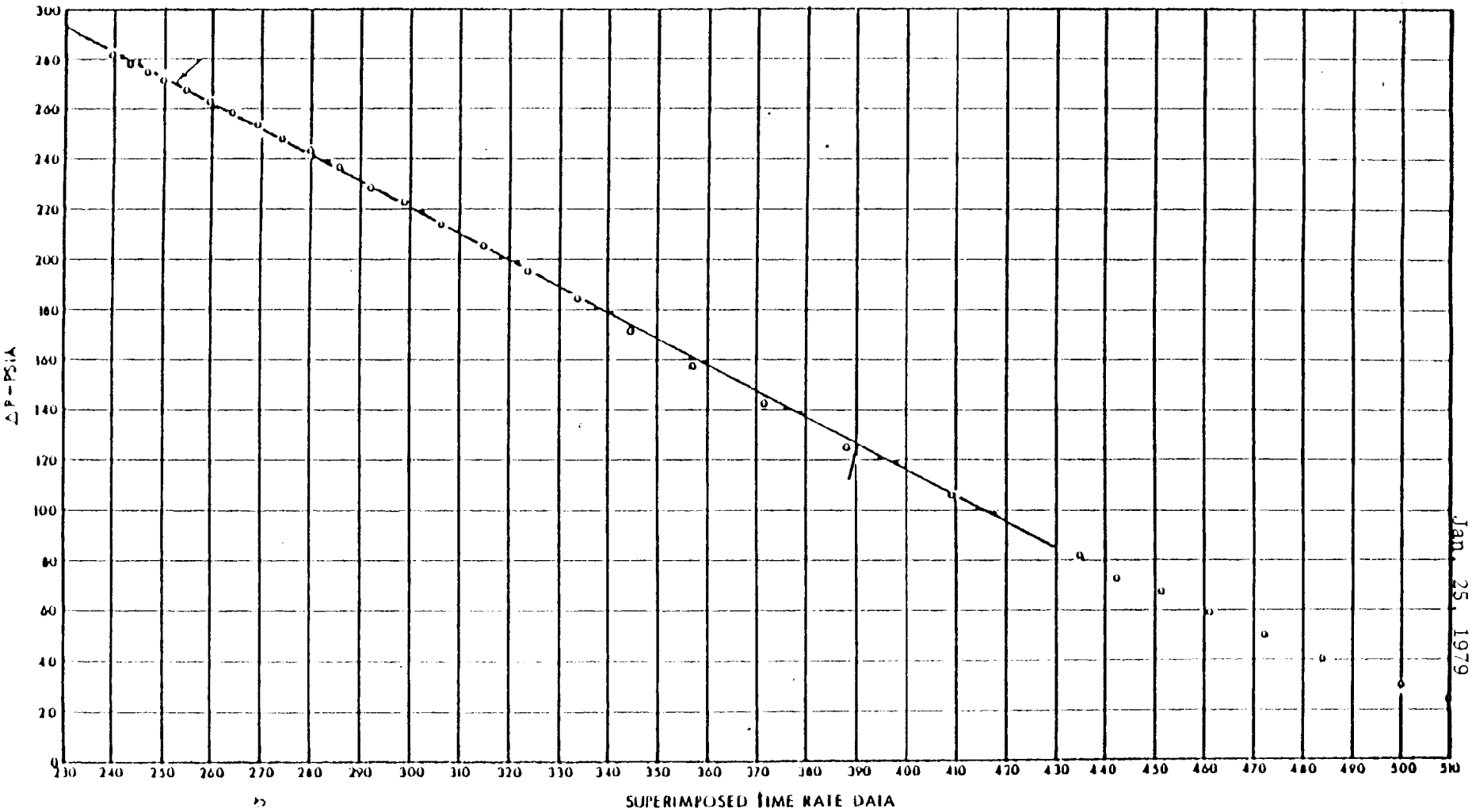
FIGURE 5
PRESSURE BUILDUP
SUPERIMPOSED TIME RATE DATA VERSUS ΔP
(LINEAR FLOW)



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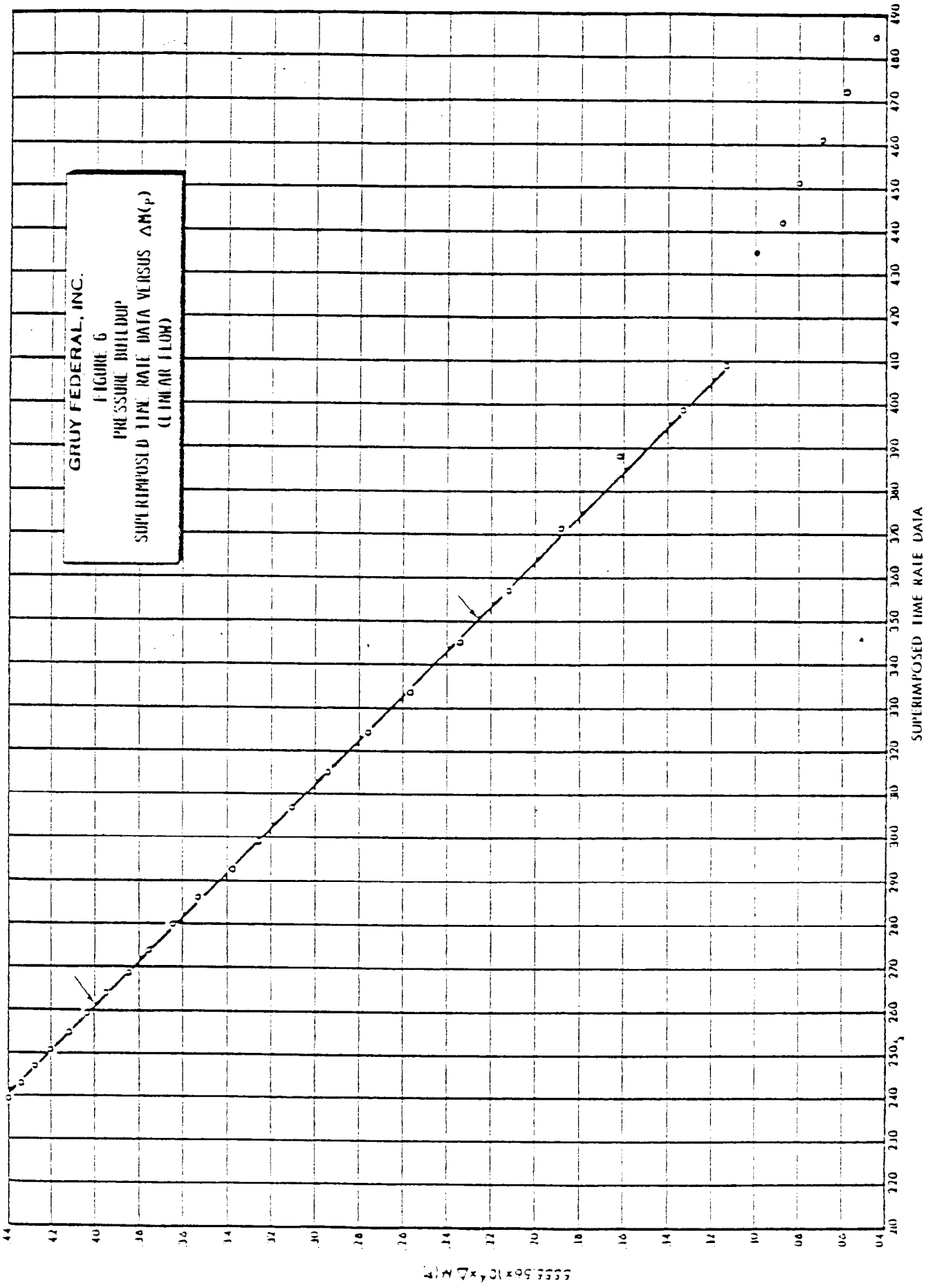
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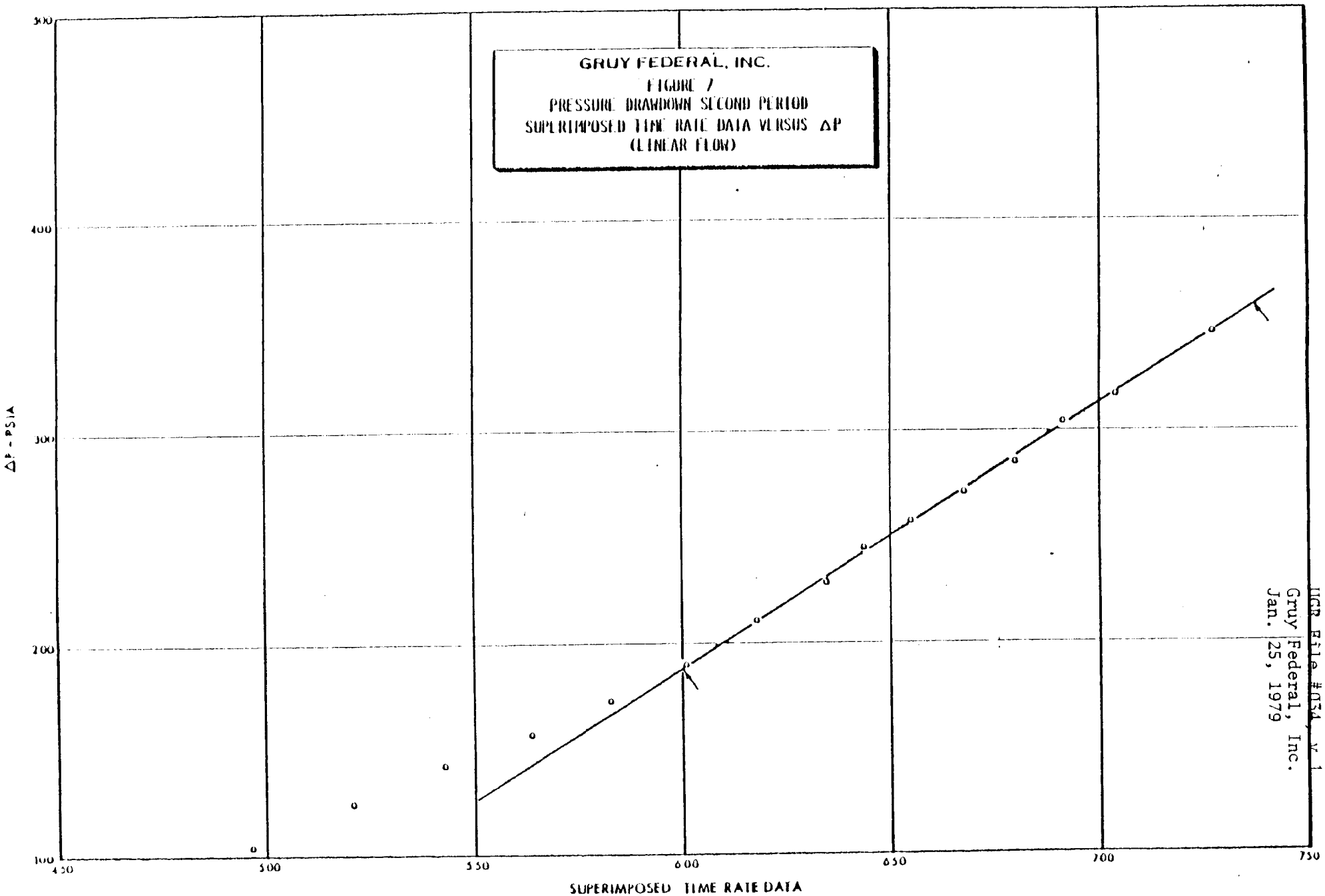
FIGURE 6
PRESSURE BUILDUP
SUPERIMPOSED TIME RATE DATA VERSUS ΔM(p)
(LINEAR FLOW)
SUPERIMPOSED TIME RATE DATA



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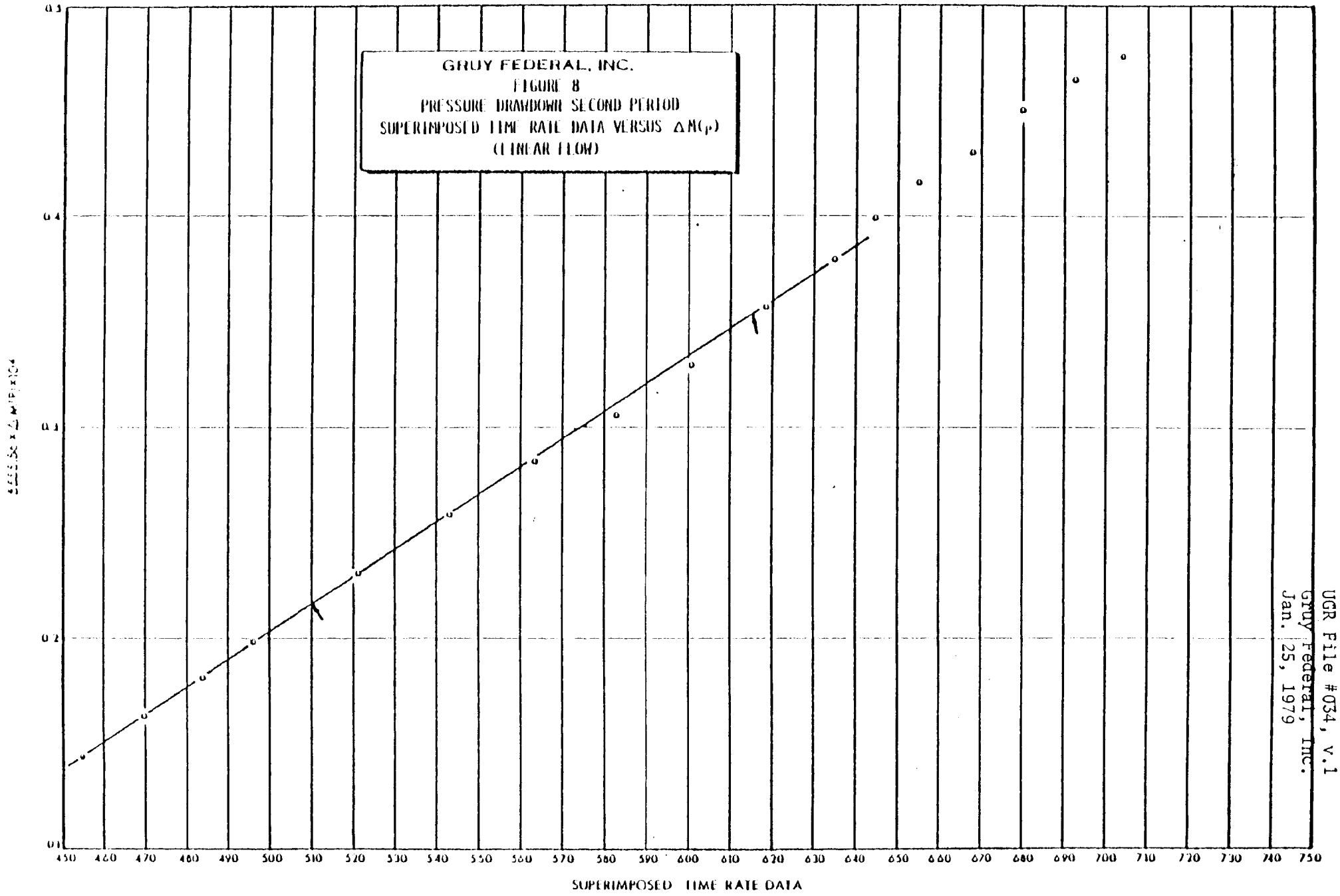

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Jan. 25, 1979

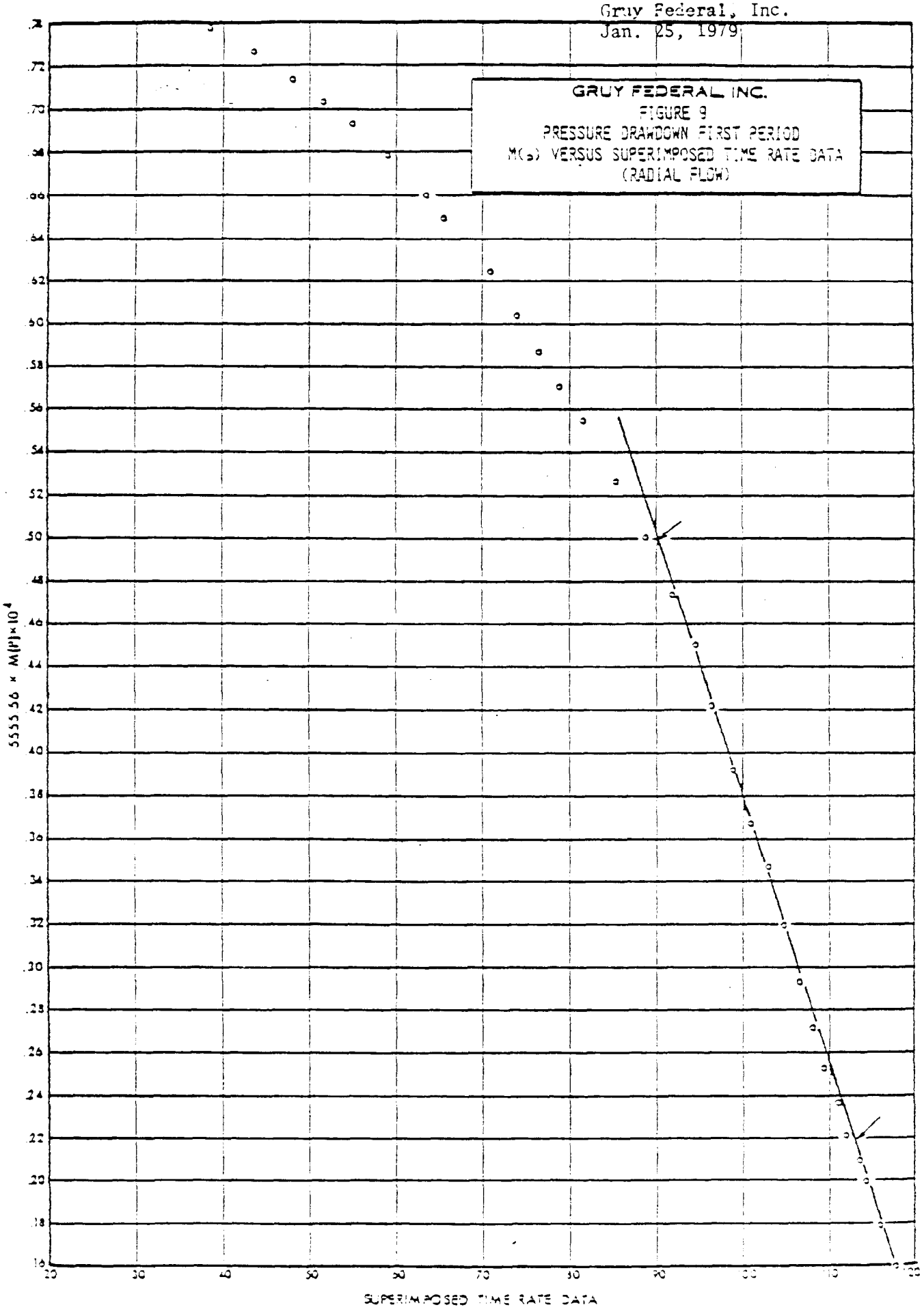
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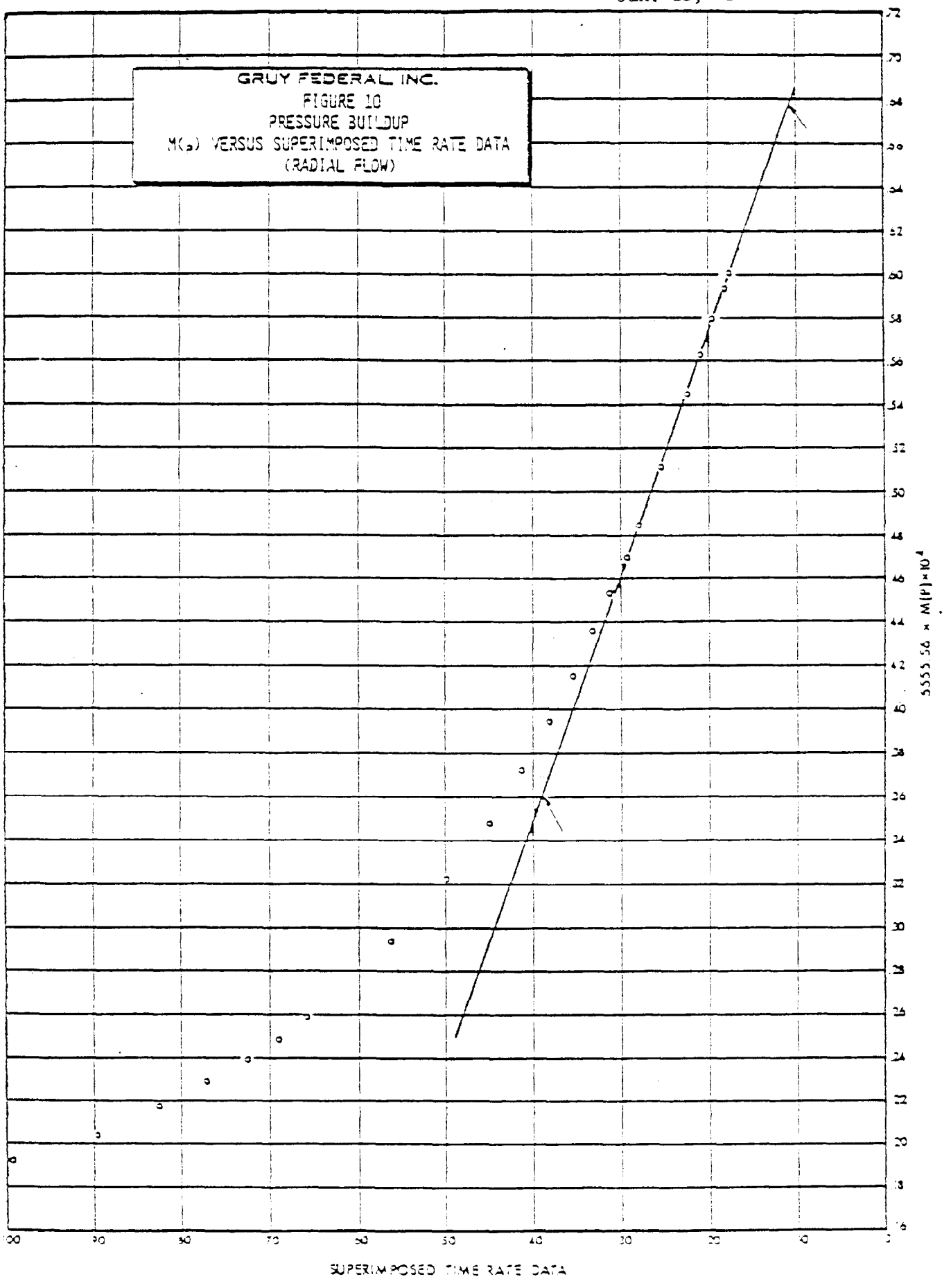
FIGURE 9
PRESSURE DRAWDOWN FIRST PERIOD
M(s) VERSUS SUPERIMPOSED TIME RATE DATA
(RADIAL FLOW)
5555.56 × M(P)×10⁴
SUPERIMPOSED TIME RATE DATA


GRUY FEDERAL INC.
FIGURE 10
PRESSURE BUILDUP
M(p) VERSUS SUPERIMPOSED TIME RATE DATA
(RADIAL FLOW)
5555.56 × M(P)×10⁴
SUPERIMPOSED TIME RATE DATA

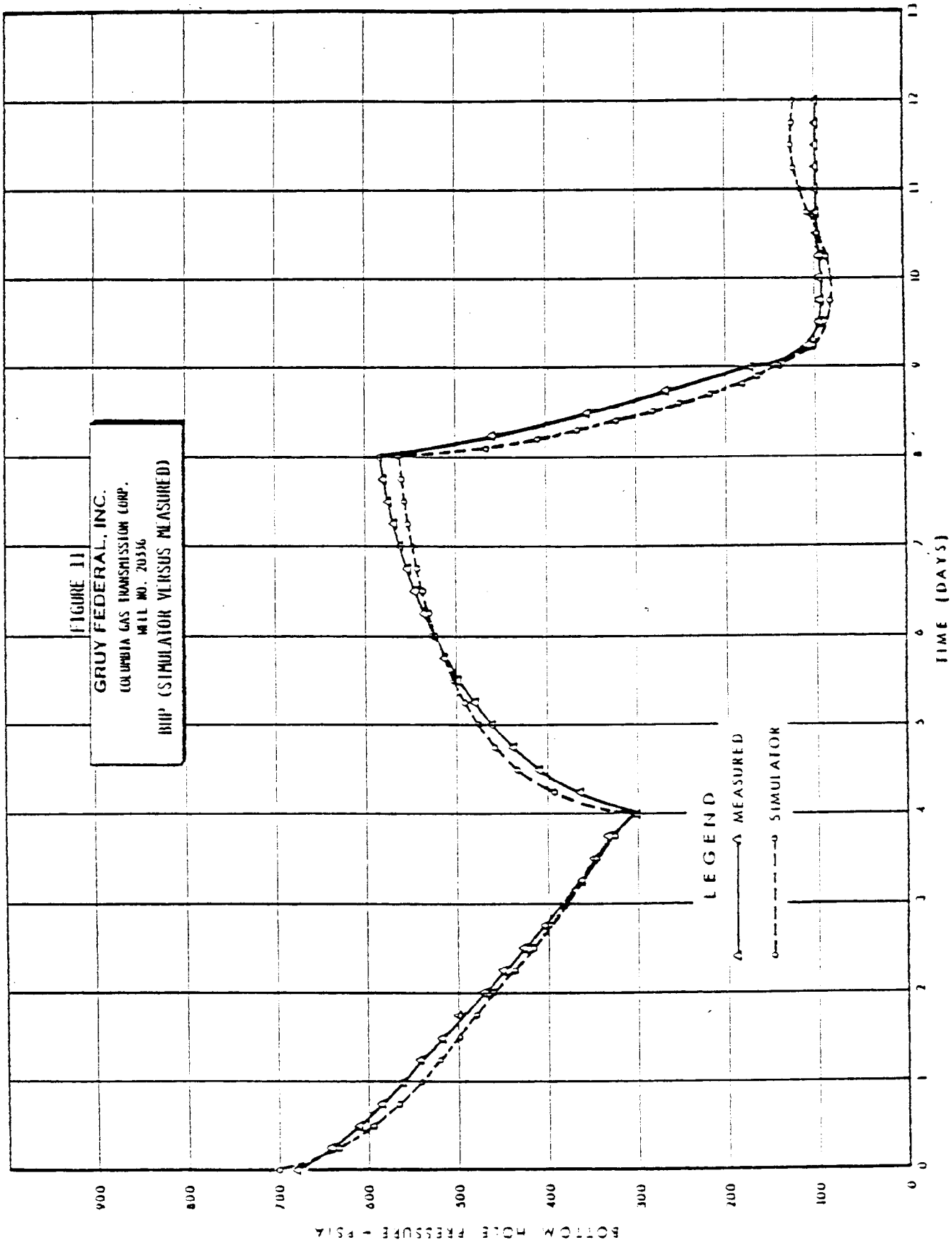


FIGURE 11
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COLUMBIA GAS TRANSMISSION CORP.
WELL NO. 20336
BHP (SIMULATOR VERSUS MEASURED)
LEGEND
MEASURED
SIMULATOR
TIME (DAYS)
BOTTOM HOLE PRESSURE - PSIA
0
100
200
300
400
500
600
700
800
900
1
2
3
4
5
6
7
8
9
10
11
12
13

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GRUY FEDERAL, INC. METC/8096-WTA-3

DOE-METC GAS WELL TESTING SERVICE

CONTRACT NO. EW-78-C-21-8096

WELL TEST ANALYSIS FOR KENTUCKY-WEST VIRGINIA GAS COMPANY WELL NO. 1627

VOLUME II

SUBMITTED TO

U.S. DEPARTMENT OF ENERGY
MORGANTOWN ENERGY TECHNOLOGY CENTER
MORGANTOWN, WEST VIRGINIA

BY

GRUY FEDERAL, INC.
2500 TANGLEWILDE, SUITE 150
HOUSTON, TEXAS 77063

JANUARY 25, 1979

UGR File #054, V.2
Gruy Federal, Inc.
Jan. 25, 1979

GRUY FEDERAL
ions: 2562-2790
v. 21 through Dec. 4, 1978
azard Kentucky

FIELD: BIG WILLARD
LEASE & WELL #: 1627
Test Depth: 2700'

with Mast truck and go into hole with maximum temperature recorder.
tom of well at 2772'. Temperature - 90°F.
t of hole. Rig up with quartz pressure probe and make gradient run.
indication of water on bottom at 15:30:00 hours. Open well at 16:30:00 hours
4" Orifice plate. Only producing approximately 25 MCF/Day diff.
charg shut in well quickly at 17:00:00 hours and change orifice to 1/2"
Stabilized quickly at approximately 68 MCF/day choke on 16/64"
ressure at 65 PSIG.

	GRADIENT RUN	REMARKS
	636.42	NOTE: Not staying at any stop long enough for tool to stablilze fully-but accurate enough for gradient.
	640.48	
	652.55	
	659.79	
	670.84	
	675.45	

COMPANY: GRUY FEDERAL
DATE: November 21, -December 4, 1978
Perforations: 2562-2790

FIELD: BIG WILLARD
Lease & Well #: 1627
Test Depth: 2700'

DATE & TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
11-21-78							
15:58:00	675.45						
15:59:00	675.65						
	677.39						Stabilized pressure before opening well.
16:30:00	677.39	612	60°	98°		1818.5	Start point.
16:31:00	677.40						
16:32:00	676.90						
16:33:00	676.72						Taking about 5 minutes to open well. Due to wing valve being stuck. Also, having trouble with 1/4" orfice plate. Rate approximately 25,000 diff. Pen going off chart.
16:34:00	676.81						
16:35:00	675.95						
16:36:00	675.67						
16:37:00	675.73						
16:38:00	675.53						
16:39:00	675.22						
16:40:00	675.37						
16:42:00	675.59						
16:44:00	675.39						
16:46:00	675.12						
16:48:00	674.95						
16:50:00	674.76						
16:52:00	674.63						
16:54:00	674.52						
16:56:00	674.66						
16:58:00	674.88						
17:00:00	674.58	612	67°	99°	63.5		Shut-in well quickly and change orifice plate to 1/2" Rate 68,000.
17:02:00	674.15						
17:04:00	673.92						
17:06:00	673.54						
17:08:00	673.12						
17:10:00	672.79						
17:12:00	672.50						
17:14:00	672.21						
17:16:00	671.99						
17:18:00	671.78						
17:20:00	671.69						
17:30:00	670.63					1820.5	
17:50:00	668.09						

Jan. 25 1979

DATE & TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	VOL. MCF DAY	CUM. GAS MCF	REMARKS
11-21-78							
18:00:00		607	69°	97°	67.8		Printer mal-functioned.
18:30:00	663.32					1824.0	
19:00:00	660.01	600	67°	98°	66.8	1825.7	
19:30:00	656.91						
20:00:00	653.90	592	68°	96°	66.3	1829.0	
20:30:00	651.02						
21:00:00	648.21	589	69°	97°	65.9	1832.2	
21:30:00	645.50						
22:00:00	642.81	586	68°	96°	65.1	1835.4	
22:30:00	640.24						
23:00:00	637,70	580	68°	96°	64.1	1838.6	
23:30:00	635.11						
11-22-78							
00:00:00	632.69	576	67°	98°	64.5	1841.8	
00:30:00	630.27						
01:00:00	627.93	571	70°	97°	64.9	1845.0	
01:30:00	625.59						
02:00:00	623.26	565	69°	99°	64.1	1848.2	
02:30:00	621.05						
03:00:00	618.81	563	68°	96°	63.6	1851.4	
03:30:00	616.61						
04:00:00	614.47	560	69°	96°	64.9	1854.6	
04:30:00	612.37						
05:00:00	610.29	554	69°	94°	64.5	1857.8	
05:30:00	608.23						
06:00:00	606.18	549	68°	95°	64.1	1861.0	
06:30:00	604.22						
07:00:00	602.21	545	69°	96°	63.4	1864.3	
07:30:00	600.29						
08:00:00	598.22	540	68°	95°	63.0	1867.6	Slightly adj-usted choke.
08:30:00	595.82						
09:00:00	593.48	533	69°	94°	65.5	1870.9	
09:30:00	591.19						
10:00:00	588.93	530	70°	94°	66.3	1874.2	
10:30:00	586.76						
11:00:00	584.54	529	72°	95°	65.9	1877.5	
11:30:00	582.35						
12:00:00	580.21	528	73°	94°	65.5	1880.8	
12:30:00	578.09						
13:00:00	576.07	520	75°	94°	64.5	1884.1	
13:30:00	574.00						
14:00:00	571.91	516	74°	95°	64.5	1887.3	
14:30:00	569.89						
15:00:00	567.87	510	74°	96°	64.9	1890.5	

DATE & TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
11-22-78							
15:30:00	565.95						Continued to flow well.
16:00:00	563.94	507	73°	95°	64.1	1893.6	
16:30:00	562.07						
17:00:00	560.13	505	71°	94°	64.5	1896.7	
17:30:00	558.32						
18:00:00	556.46	504	68°	95°	63.0	1899.8	
18:30:00	554.65						
19:00:00	552.92	501	68°	93°	62.6	1902.8	
19:30:00	551.14						
20:00:00	549.48	496	69°	93°	61.1	1905.8	
20:30:00	547.78						
21:00:00	546.17	495	69°	94°	60.6	1908.8	
21:30:00	544.54						
22:00:00	542.93	493	70°	94°	61.4	1911.7	
22:30:00	541.38						
23:00:00	539.82	492	70°	94°	60.2	1914.7	
23:30:00	538.25						
11-23-78							
00:00:00	536.67	488	70°	94°	64.5	1917.6	Slightly adjusted choke.
00:30:00	534.52						
01:00:00	532.47	484	69°	94°	64.1	1920.6	
01:30:00	530.51						
02:00:00	528.56	480	66°	94°	63.6	1923.5	
02:30:00	526.67						
03:00:00	524.85	475	66°	93°	64.1	1926.6	
03:30:00	523.00						
04:00:00	521.22	470	65°	93°	63.2	1929.7	
04:30:00	519.46						
05:00:00	517.78	468	63°	94°	62.2	1932.8	
05:30:00	516.14						
06:00:00	514.47	468	65°	94°	61.7	1936.0	
06:30:00	512.87						
07:00:00	511.28	464	64°	94°	59.8	1939.1	
07:30:00	509.64						
08:00:00	568.17	461	66°	94°	60.2	1941.9	
08:30:00	506.62						
09:00:00	505.06	460	68°	95°	60.6	1944.8	
09:30:00	503.53						
10:00:00	501.96	456	69°	94°	60.2	1947.3	
10:30:00	500.34						
11:00:00	498.80	450	70°	94°	64.0	1950.8	
11:30:00	496.02						
12:00:00	493.78	444	70°	95°	66.9	1953.9	
12:30:00	490.79						

Jan. 25, 1979

DATE & TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
11-23-78							
13:00:00	488.28	440	71°	96°	67.3	1957.1	Continued to flow well.
13:30:00	485.84						
14:00:00	483.54	436	71°	94°	66.9	1960.3	
14:30:00	481.25						
15:00:00	479.08	432	72°	94°	65.9	1963.9	
15:30:00	476.97						
16:00:00	474.88	427	70°	95°	65.5	1966.9	
16:30:00	472.83						
17:00:00	470.82	427	72°	94°	65.9	1970.0	
17:30:00	468.87						
18:00:00	466.96	417	71°	96°	63.6	1973.1	
18:30:00	465.04						
19:00:00	463.17	411	72°	94°	64.1	1976.3	
19:30:00	461.44						
20:00:00	459.61	408	73°	95°	65.9	1979.6	
20:30:00	457.92						
21:00:00	456.25	405	74°	94°	62.6	1982.8	
21:30:00	454.73						
22:00:00	453.09	402	70°	95°	62.2	1986.0	
22:30:00	451.55						
23:00:00	450.00	399	71°	95°	63.0	1989.3	
23:30:00	448.43						
11-24-78							
00:00:00	446.99	396	70°	94°	62.6	1992.6	
00:30:00	445.50						
01:00:00	440.04	390	70°	96°	62.1	1995.9	
01:30:00	442.55						
02:00:00	441.15	384	70°	94°	61.1	1999.1	Slightly adjusted choke.
02:30:00	439.60						
03:00:00	436.75	380	70°	94°	70.1	2002.4	
03:30:00	433.55						
04:00:00	430.58	376	71°	95°	68.2	2005.7	
04:30:00	427.84						
05:00:00	425.14	372	71°	96°	67.8	2008.9	
05:30:00	422.61						
06:00:00	420.14	360	70°	95°	65.9	2012.2	
06:30:00	417.84						
07:00:00	415.54	359	70°	94°	66.3	2015.5	
07:30:00	413.32						
08:00:00	411.22	359	68°	95°	65.9	2018.8	
08:30:00	408.08						
09:00:00	407.11	358	70°	95°	64.5	2022.0	
09:30:00	405.13						
10:00:00	403.29	357	68°	94°	64.1	2025.3	

Jan. 25, 1979

DATE & TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
11-24-78							
10:30:00	401.41						Continued to flow well.
11:00:00	399.62	354	68°	94°	63.6	2028.7	
11:30:00	397.82						
12:00:00	396.11	352	70°	93°	64.1	2031.9	
12:30:00	394.44						
13:00:00	392.82	349	68°	93°	63.2	2035.1	
13:30:00	391.11						
14:00:00	389.49	348	70°	93°	63.6	2038.2	
14:30:00	387.92						Slightly adj-usted Choke.
15:00:00	385.99	348	64°	94°	63.6	2041.4	
15:30:00	384.14						
16:00:00	382.43	348	63°	94°	64.1	2044.5	
16:30:00	380.71						
17:00:00	379.00	347	62°	95°	63.2	2047.5	
17:30:00	377.38						
18:00:00	375.76	346	62°	95°	62.2	2050.4	
18:30:00	374.14						
19:00:00	372.65	342	61°	94°	62.6	2053.4	
19:30:00	371.16						
20:00:00	369.73	340	60°	94°	61.7	2056.3	
20:30:00	368.32						
21:00:00	366.94	336	61°	93°	60.7	2059.4	
21:30:00	365.58						
22:00:00	364.25	336	58°	93°	60.3	2062.3	
22:30:00	362.92						
23:00:00	361.68	331	57°	94°	59.9	2065.2	
23:30:00	360.47						
11-25-78							
00:00:00	359.07	325	59°	94°	60.9	2068.1	
00:30:00	357.55						
01:00:00	356.13	324	58°	93°	59.9	2071.0	
01:30:00	354.70						
02:00:00	353.27	324	59°	94°	60.3	2073.8	
02:30:00	352.00						
03:00:00	350.62	322	57°	94°	59.9	2076.5	
03:30:00	349.30						
04:00:00	348.09	318	57°	94°	59.5	2079.2	
04:30:00	346.87						
05:00:00	345.69	317	55°	95°	59.5	2081.9	
05:30:00	344.54						
06:00:00	343.47	315	56°	96°	57.5	2085.6	
06:30:00	342.33						
07:00:00	341.25	313	55°	95°	57.2	2087.4	
07:30:00	340.17						

DATE & TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
11-25-78							
08:00:00	339.17	312	55°	95°	57.5	2090.3	
08:30:00	338.18						
09:00:00	337.16	310	54°	94°	57.2	2093.0	
09:30:00	336.23						
10:00:00	335.23	308	54°	94°	66.0	2095.8	Slightly adjusted choke.
10:30:00	332.67						
11:00;00	329.30	306	58°	94°	66.0	2098.6	
11:30:00	326.26						
12:00:00	323.41	298	63°	95°	66.5	2102.0	
12:30:00	320.75						
13:00:00	318.14	294	69°	94°	65.5	2105.3	
13:30:00	315.71						
14:00:00	313.34	291	76°	94°	65.1	2108.6	
14:30:00	311.05						
15:00:00	308.90	281	76°	95°	64.6	2111.9	
15:30:00	306.83						
16:00:00	304.80	281	74°	94°	63.2	2115.2	
16:30:00	302.99					116.7	Shut-in well. Bottom Hole Pressure Building.
17:00:00	312.32	278					
17:30:00	319.58						
18:00:00	326.17	276					
18:30:00	332.18						
19:00:00	337.84	228					
19:30:00	343.16						
20:00:00	348.14	300					
20:30:00	352.96						
21:00:00	351.49	310					
21:30:00	361.81						
22:00:00	365.98	316					
22:30:00	370.07						
23:00:00	373.87	324					
23:30:00	376.00						
11-26-78							
00:00:00	381.22	331					
00:30:00	384.70						
01:00:00	388.08	337					
01:30:00	391.32						
02:00:00	394.54	343					
02:30:00	397.62						
03:00:00	400.61	349					
03:30:00	403.49						
04:00:00	406.38	354					
04:30:00	409.16						
05:00:00	411.91	360					

DATE & TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
11-26-78							
05:30:00	414.60						Continued to monitor Bottom hole Pressure.
06:00:00	417.15	366					
06:30:00	419.50						
07:00:00	421.89	372					
07:30:00	424.23						
08:00:00	426.52	375					
08:30:00	428.76						
09:00:00	430.90	379					
09:30:00	433.18						
10:00:00	435.27	384					
10:30:00	437.36						
11:00:00	439.47	387					
11:30:00	441.49						
12:00:00	443.36	390					
12:30:00	445.46						
13:00:00	447.57	392					
13:30:00	449.40						
14:00:00	451.32	394					
14:30:00	453.17						
15:00:00	454.99	396					
15:30:00	456.94						
16:00:00	458.65	399					
16:30:00	460.62						
17:00:00	462.39	402					
17:30:00	464.13						
18:00:00	465.90	408					
18:30:00	467.66						
19:00:00	469.41	413					
19:30:00	470.90						
20:00:00	472.56	417					
20:30:00	474.17						
21:00:00	475.95	420					
21:30:00	477.68						
22:00:00	479.33	423					
22:30:00	480.84						
23:00:00	482.12	426					
23:30:00	483.80						
11-27-78							
00:00:00	485.36	429					
00:30:00	486.95						
01:00:00	488.43	432					
01:30:00	489.95						
02:00:00	491.42	435					
02:30:00	492.89						
03:00:00	494.28	438					

DATE & TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
11-26-78							
03:00:00	495.72						Continued to monitor Bottom Hole Pressure. Well Shut-in.
03:30:00	495.72						
04:00:00	497.09	441					
04:30:00	498.40						
05:00:00	499.77	443					
05:30:00	501.03						
06:00:00	502.33	444					
06:30:00	503.62						
07:00:00	504.90	448					
07:30:00	506.11						
08:00:00	507.36	450					
08:30:00	508.53						
09:00:00	509.71	455					
09:30:00	510.84						
10:00:00	512.03	456					
10:30:00	513.12						
11:00:00	514.27	457					
11:30:00	515.46						
12:00:00	516.52	461					
12:30:00	517.58						
13:00:00	518.16	462					
13:30:00	519.70						
14:00:00	520.75	463					
14:30:00	521.77						
15:00:00	522.78	466					
15:30:00	523.82						
16:00:00	524.82	468					
16:30:00	525.74						
17:00:00	526.72	470					
17:30:00	527.65						
18:00:00	528.58	472					
18:30:00	529.52						
19:00:00	530.42	474					
19:30:00	531.37						
20:00:00	532.23	476					
20:30:00	533.10						
21:00:00	534.01	478					
21:30:00	534.85						
22:00:00	535.73	480					
22:30:00	536.56						
23:00:00	537.41	481					
23:30:00	539.29						
1-28-78							
00:00:00	539.08	483					

DATE & TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
11-28-78							
00:30:00	539.84						Continued to monitor Bottom Hole Pressure with Well shut-in.
01:00:00	540.67	484					
01:30:00	541.50						
02:00:00	542.23	485					
02:30:00	543.02						
03:00:00	543.81	486					
03:30;00	544.56						
04:00:00	545.33	487					
04:30:00	546.06						
5:00:00	546.80	488					
05:30:00	547.50						
06:00:00	548.23	490					
06:30:00	548.93						
07:00:00	549.64	492					
07:30:00	550.35						
08:00;00	551.02	493					
08:30:00	551.71						
09:00:00	552.40	494					
09:30:00	553.07						
10:00:00	553.72	495					
10:30:00	554.38						
11:00:00	555.04	497					
11:30:00	555.68						
12:00:00	556.29	498					
12:30:00	556.91						
13:00:00	557.54	504					
13:30:00	558.16						
14:00:00	558.78	504					
14:30:00	559.42						
15:00:00	560.01	505					
15:30:00	560.61						
16:00:00	561.21	505					
16:30:00	561.81						
17:00:00	562.40	506					
17:30:00	562.99						
18:00:00	563.56	506					
18:30:00	564.11						
19:00:00	564.68	507					
19:30:00	565.24						
20:00:00	565.77	507					
20:30:00	566.31						
21:00:00	566.86	507					
21:30:00	567.38						
22:00:00	567.90	508					

	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIA)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
	568.43						Continued to monitor Bottom Hole Pressure.
	568.94	509					
	569.48						
	569.97	510					
	570.50						
	571.01	511					
	571.52						
	572.05	515					
	572.53						
	573.01	515					
	573.53						
	73.96	516					
	574.46						
	74.91	517					
	575.38						
	575.86	517					
	576.29						
	576.74	518					
	577.18						
	577.62	518					
	578.09						
	578.50	519					
	578.95						
	578.36	520					
	579.80						
	580.25	521					
	580.67						Checked 1/2" Orfice plate.
	581.11	522					
	581.34						Set Choke at 5/64".
	581.90	523					
	582.30						
	582.70	524					
	583.10						
	583.53	525					
	583.92						
	584.29	526					
	584.71					2116.8	Opened well. Started 1 minute reading of data.
	584.73						
	584.08						
	583.69						
	583.30						
	582.85						
	582.02						

BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIA)	SEPERATOR GAS TEMP. OF	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
581.19						Well continued to be open. Still recording at 1 minute intervals.
580.72						
580.19						
579.82						
579.04						
578.47						
578.14						
577.77						
577.28						
576.93						
576.58						
576.21						
575.81						
577.34						
574.88						
574.67						
574.34						
573.91						
573.56						
573.25						
572.82						
572.48						
572.12	527	90°	150°	42/11.7	2119.3	Opened Choke.
561.41						
551.29	518	90°	150°	41.11.6	2125.6	Open Choke.
541.32						
531.40	504	90°	120°	42/11.7	2132.0	
521.12						
510.28	480	85°	120°	44/13.3	2138.9	
499.73						
489.30	468	85	120°	44/13.3	2145.9	Open Choke.
479.21						
469.39	444	85°	110°	44/12.5	2151.9	
460.03						
450.96	420	88°	110°	41/11.6	2157.9	
442.34						
434.03	408	88°	110°	40/11.5	2163.9	
425.98						
418.22	390	88°	110°	40/11.9	2169.9	
410.70						
403.38	378	88°	100°	38/11.6	2176.0	Open Choke to 12/64"
393.88						
383.63	366	86°	100°	44/12.0	2182.0	

BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
373.97						
364.92	347	85°	100°	42/11.7	2188.0	
356.37						
348.25	330	84°	100°	40/11.5	2194.0	
340.56						
333.31	314	85°	110°	39/10.4	2200.0	
326.38						
319.82	300	90°	110°	36/11.3	2206.1	
313.61						
307.72	288	90°	115°	35/10.7	2212.1	Opened choke to 20/64".
299.68						
289.09	276	85°	100°	44/12.0	2218.1	
279.60						
270.99	263	85°	100°	41/10.7	2224.1	
263.11						
255.79	240	85°	98°	39/10.4	2330.2	
249.01						
242.73	226	80°	95°	36/10.0	2236.2	
236.87						
231.34	214	88°	98°	34/11.7	2242.2	
226.24						
221.46	204	88°	98°	32/11.3	2248.2	Opened Choke to 24/64".
216.41						
205.26	183	85°	98°	42/12.2	2254.3	
		88°		No Data Due To OWAN. Opened choke to 30/64".		
172.77						
162.49	154	84°	98°	40/11.9	2266.5	
153.63						
145.46	137	82°	98°	40/10.1	2272.7	Choke full open. No back pressure. Orifice holding natural back pressure.
139.58						
133.28	120	80°	90°	36/9.6	2278.2	
127.54						
122.61	114	80°	90°	32/9.0	2283.1	
118.12						
114.89	106	77°	88°	30/8.75	2288.0	
112.32						
110.01	96	76°	88°	28/8.29	2291.3	
107.92						
106.39	84	74°	85°	26/6.9	2294.7	
104.80						
103.52	72	70°	80°	25/6.7	2298.1	
101.78						

DATE TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
	100.02	66	70°	80°	24/6.6	2301.5	
	98.62						
	97.35	58	68°	80°	23/6.5	2304.9	
	96.51						
	95.92	56	60	80°	19/5.9	2308.3	
	95.18						
	94.50	54	55	80°	19/5.9	2311.7	
	93.82						
	93.52	53	54°	75°	19/5.9	2315.1	
	93.10						
	92.86	52	88°	70°	19/5.9	2318.5	
	92.66						
	92.71	51	88°	110°	19/5.9	2321.9	
	92.38						
	92.52	50	85°	110°	19/5.9	2324.6	
	92.33						
	92.57	50	80°	110°	19/5.9	2327.3	
	92.75						
	93.08	50	90°	110°	19/5.7	2330.0	
	93.09						
	93.21	48	90°	110°	19/5.5	2332.8	
	93.40						
	93.48	48	90°	110°	19/5.0	2335.5	
	93.49						
	93.60	48	90°	100°	19/5.0	2338.3	
	93.90						
14:00:00	94.22	48	85°	100°	19/5.0	2341.0	
14:30:00	94.60						
15:00:00	94.69	48	75°	100°	19/5.0	2343.6	
15:30:00	95.00						
16:00:00	95.12	48	80°	90°	19/5.0	2346.2	
16:30:00	94.86						
17:00:00	94.95	48	80°	90°	19/5.0	2348.7	
17:30:00	94.60						
18:00:00	94.60	47	85°	90°	19/5.0	2351.3	
18:30:00	94.53						
		6	85°	88°	19/5.0	2353.9	
			85°	88°	19/5.0	2356.2	
			80°	87°	19/5.0	2358.5	
			75°	85°	19/5.0	2360.8	

BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
94.76	43	78°	80°	19/5.0	2363.1	
95.32						
95.44	42	76°	80°	18/4.92	2365.4	
95.45						
95.36	42	70°	78°	18/4.92	2367.7	
95.39						
95.42	41	65°	78°	18/4.92	2370.1	
95.59						
95.67	40	65°	70°	18/4.92	2372.4	
95.76						
95.81	40	65°	80°	18/4.92	2374.7	
95.90						
95.94	39	65	90°	18/4.92	2377.0	
96.14						
96.14	39	65	70°	18/4.92	2379.3	
96.33						
96.11	38	70°	70°	18/4.92	2381.6	
96.30						
96.09	38	75°	80°	17/47.9	2384.0	
96.13						
96.28	37	85°	84°	18/49.2	2386.3	
96.02						
96.16	37	85°	90°	17/47.9	2388.6	
96.20						
96.23	37	85°	100°	18/49.2	2390.9	
96.33						
96.43	36	85°	90°	17/47.9	2393.2	
96.63						
97.40	36	80°	90°	18/49.2	2395.5	
						No Date Due to Orian.
96.65	36	80°	90°	17/47.9	2397.9	
96.95						
97.82	37	75°	80°	18/44.5	2400.0	
97.33						
97.41	37	70°	80°	18/44.5	2402.1	
97.43						
97.92	37	68°	78°	17.43.3	2404.2	
97.88						
97.33	37	65°	76°	18/44.5	2406.3	
97.82						
97.98	36	60°	75°	17/43.3	2408.4	
98.31						
98.25	35	60 °	74°	18/44.5	2410.5	

DATE TIME	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
12-							
20	98.24						
	98.02	35	60°	73°	17/43.3	2412.6	
	98.90						
	98.34	34	60°	74°	18/44.5	2414.7	
	98.33						
	98.16	33	60°	74°	17/43.3	2416.8	
	98.14						
	98.05	33	60°	70°	18/44.5	2419.0	
	98.45						
	97.87	32	65°	70°	17/43.3	2421.1	
	98.03						
	98.83	31	65	70°	18/44.5	2423.2	
	98.83						
	98.76	31	60°	70°	18/44.5	2425.3	
	99.07						
	98.45	30	60°	70°	17/43.3	2427.5	
	98.28						
	98.40	30	60°	70°	18/44.5	2429.6	
	99.02						
	98.77	29	60°	70°	18/44.5	2431.7	
	98.82						
	98.47	28	60°	70°	18/44.5	2433.8	
	98.11						
	99.36	28	60°	70°	18/44.5	2435.9	
	98.58						
	99.07	27	60°	70°	17/43.3	2438.0	
[illegible]	98.89						
[illegible]	99.57	26	60°	70°	16/42.0	2440.2	
[illegible]	99.51						
[illegible]	99.70	26	60°	70°	18/44.5	2442.3	
[illegible]	99.62						
12:[illegible]:00	99.51	26	60°	70°	16/42.0	2444.4	
[illegible]	99.64						
[illegible]	99.03	26	60°	70°	18/44.5	2446.5	
[illegible]	99.37						
[illegible]	99.24	26	60°	70°	16/42.0	2448.6	
[illegible]	99.39						
15:00:00	99.89	26	60°	70°	16/42.0	2450.7	
15:30:00	100.15						
16:00:00	99.85	26	60°	70°	16.42.0	2451.7	
16:30:00	99.59					2452.9	Shut well iv. Raiwivg. Let well build uwtil morwivg.
16:31:00	99.84						
16:32:00	100.00						

	BOTTOM HOLE PRESSURE (PSIA)	SURFACE PRESSURE (PSIG)	SEPERATOR GAS TEMP. °F	HEATER TEMP. °F	GAS VOL. MCF DAY	CUM. GAS MCF	REMARKS
-3-78							
16:33:00	101.50						Well Shut in.
16:34:00	102.63						
16:35:00	104.09						
16:36:00	105.00						
16:37:00	105.49						
16:38:00	104.88						
16:39:00	103.01						
16:40:00	101.28						
16:41:00	101.25						
16:42:00	101.21						
16:43:00	101.21						
16:44:00	101.12						
16:45:00	101.03						
16:46:00	100.97						
16:47:00	100.94						
16:48:00	100.92						
16:49:00	100.89						
16:50:00	100.84						
16:51:00	100.83						
16:52:00	100.82						
16:53:00	100.79						
16:54:00	100.71						
16:55:00	100.58						
16:56:00	100.49						
16:57:00	100.33						
16:58:00	100.21						
16:59:00	100.03						
17:00:00	99.84						
17:30:00	98.39						
18:00:00	108.34						
18:30:00	126.91						
19:00:00	146.01						
19:30:00	151.63						
20:00:00	157.18						
20:30:00	162.88						
21:00:00	168.37						
21:30:00	173.81						
22:00:00	179.14						
22:30:00	184.23						
23:00:00	189.29						
23:30:00	194.23						
12-4-78							
[illegible]	198.93						