Case No.

1596

Application, Transcript,
Small Exhibits, Etc.

EL PASO NATURAL GAS PRODUCTS CO.
HORSESHOE GALLUP DUAL COMPLETION
San Juan County, New Mexico

CASE NO. 1596
EXHIBITS 10 thru 16

HORSESHOE - GALLUP OIL POOL

OIL PRODUCTION

MONTH & YEAR	NO. OF WELLS	OIL PRODUCTION (IN BARRELS)
1956		
OCTOBER	2	1,432
NOVEMBER	2	722
DECEMBER	2	804
TOTAL PRODUCTION		2,958
CUMULATIVE PRODUCTION		2,958
1957		
JANUARY	3	1,476
FEBRUARY	3	1,749
MARCH	3	3,706
APRIL	3	1,842
MAY	3	882
JUNE	3	1,228
JULY	12	9,658
AUGUST	12	5,178
SEPTEMBER	12	3,409
OCTOBER	14	10,046
NOVEMBER	16	8,934
DECEMBER	17	10,747
TOTAL PRODUCTION		58,855
CUMULATIVE PRODUCTION		61,813
1958		
JANUARY	17	5,536
FEBRUARY	17	7,669
MARCH	17	5,191
ABRIL	17	12,370
MAY	19	24,526
JUNE	24	30,240
JULY	27	30,604
AUGUST	28	34,427
SEPTEMBER	28	33,127
OCTOBER	43	56,501
NOVEMBER	50	55,704
DECEMBER	74	96,728
TOTAL PRODUCTION		451,478
CUMULATIVE PRODUCTION		513,291

CASE NO. 1597

THE ATLANTIC REFINING COMPANY

EXHIBIT NO. 5

HORSESHOE - GALLUP OIL POOL - ATLANTIC NAVAJO LEASES

NET PAY - POROSITY & PERMEABILITY OF CORE ANALYSIS

NET PAY 1 MD OR MORE

LEASE & WELL #	NET PAY	AVERAGE POROSITY %	TOTAL MD FT	AVERAGE PERMEABILITY MD
NAVAJO #1	41	19.6	8,907.4	217.5
NAVAJO #2	33	12.5	4,356.0	132.0
NAVAJO #3	48	19.2	13,630.0	284.0
NAVAJO #4	20	14.4	2,406.5	120.3
NAVAJO #5	41	16.2	3,141.0	76.6
NAVAJO #6	29	17.5	5,882.5	202.8
NAVAJO #7	26	16.0	4,648.4	178.8
NAVAJO #8	31	17.8	6,276.3	202.5
NAVAJO #9	17	13.2	1,798.0	105.8
NAVAJO #11	27	17.4	5,337.3	197.7
NAVAJO #14	5	12.5	1,030.0	206.0

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THE ATLANTIC REFINING COMPANY

EXHIBIT NO. 6

HORSESHOE - GALLUP OIL POOL - ATLANTIC NAVAJO LEASES

NET PAY - POROSITY & PERMEABILITY OF CORE ANALYSIS

NET PAY 1 MD OR MORE

LEASE & WELL #	NET PAY	AVERAGE POROSITY %	TOTAL MD FT	AVERAGE PERMEABILITY MD
NAVAJO #16	6	13.0	111.4	18.6
NAVAJO #18	25	15.9	3,396.0	135.8
NAVAJO #20	15	18.1	2,004.0	133.6
NAVAJO #21	7	15.4	417.0	59.5
NAVAJO #22	6	10.7	79.3	13.2
NAVAJO #23	7	14.5	395.2	56.5
NAVAJO #25	7	11.7	27.8	4.0
NAVAJO #28	11	15.5	1,582.6	143.9
NAVAJO #29	21	16.4	2,270.6	108.0
NAVAJO #30	10	15.4	951.8	95.2
NAVAJO B #2	5	14.3	336.3	67.3
NAVAJO B #3	7	16.4	994.1	142.0

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THE ATLANTIC REFINING COMPANY

EXHIBIT NO. 6 Case 1'6

CORE ANALYSIS

HORSESHOE - GALLUP OIL POOL

ATLANTIC NAVAJO LEASES

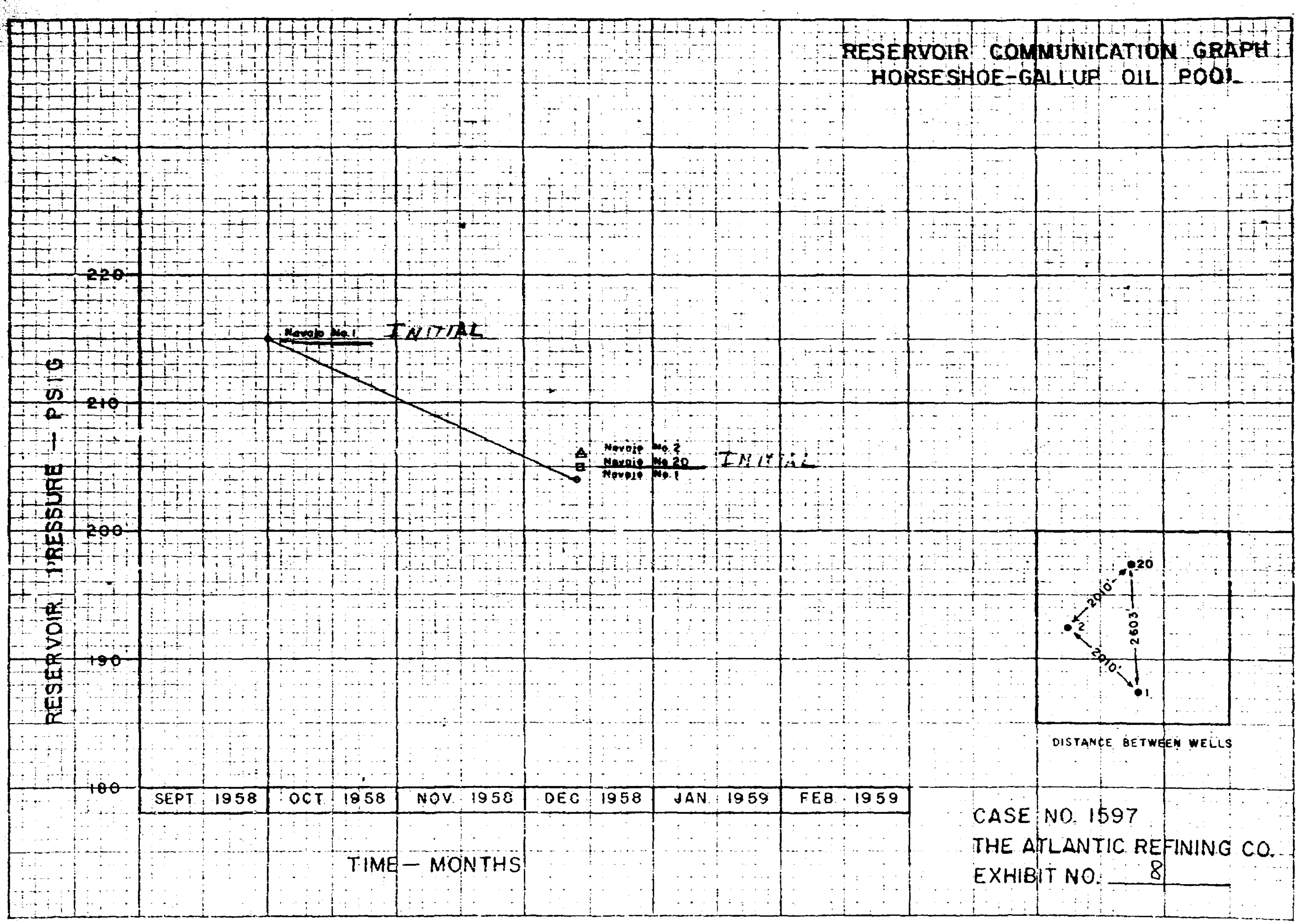
NUMBER OF WELLS CORED	23
NUMBER OF SAMPLES INCLUDED IN AVERAGE (ALL SAMPLES WITH 1.0 MD PERMEABILITY OR MORE)	445
WEIGHTED AVERAGE POROSITY	16.4%
WEIGHTED AVERAGE PERMEABILITY	157.3
AVERAGE NET PAY	19.3
CONNATE WATER (LABORATORY)	30%

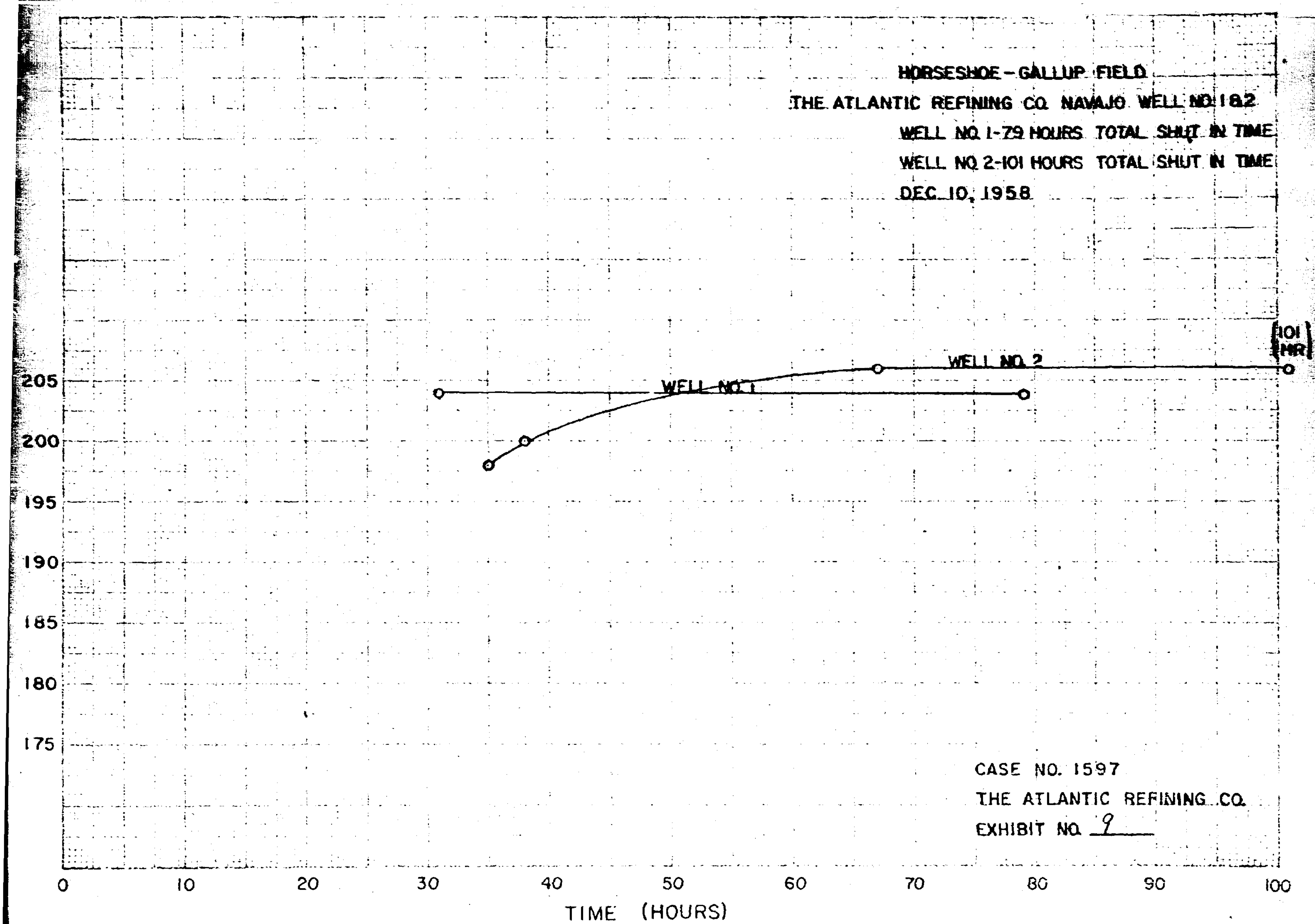
CASE NO. 1597

THE ATLANTIC REFINING COMPANY

EXHIBIT NO. 7.

K&E 10 X 10 TO THE INCH 359-5DG
KEUFFEL & ESSER CO.




HORSESHOE - GALLUP FIELD
THE ATLANTIC REFINING CO. NAVAJO WELL NO. 1 & 2
WELL NO. 1-79 HOURS TOTAL SHUT IN TIME
WELL NO. 2-101 HOURS TOTAL SHUT IN TIME
DEC. 10, 1958
WELL NO. 2
WELL NO. 1
101 HR
205
200
195
190
185
180
175
0
10
20
30
40
50
60
70
80
90
100
TIME (HOURS)
CASE NO. 1597
THE ATLANTIC REFINING CO.
EXHIBIT NO. 9

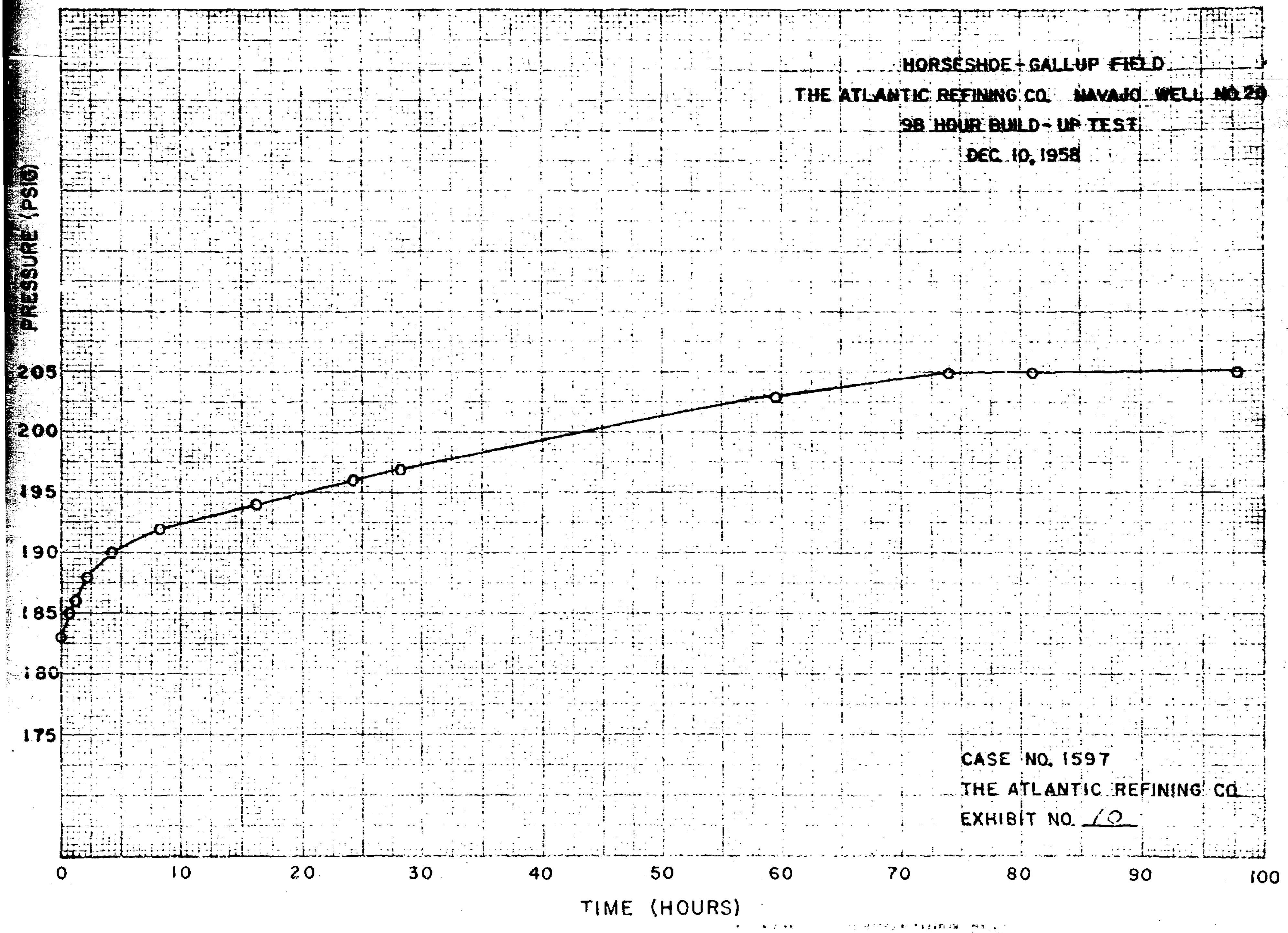

HORSESHOE-GALLUP FIELD
THE ATLANTIC REFINING CO. NAVAJO WELL NO. 20
98 HOUR BUILD-UP TEST
DEC. 10, 1958
PRESSURE (PSIG)
205
200
195
190
185
180
175
0
10
20
30
40
50
60
70
80
90
100
TIME (HOURS)
CASE NO. 1597
THE ATLANTIC REFINING CO.
EXHIBIT NO. 10

EXHIBIT 11

Case 1597

In Reservoir Calculations . . .

EXCLUSIVE

How to use the EXPONENTIAL INTEGRAL

No more difficult than logarithms, Ei-functions solve problems of well interference and effective permeability. Use is demonstrated, abbreviated tables included with examples and simplified curve

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THE Exponential Integral, abbreviated Ei, appears in a mathematical solution of problems involving the flow of a single phase compressible fluid through a homogeneous, infinite, porous medium under non steady state conditions. This solution is based on two assumptions: (1) the porous medium has cylindrical symmetry, and (2) the well radius is very small compared to the effective radius of the porous medium.

This solution has been widely used in recent years, and provides a more realistic answer than is provided by the so-called steady-state solutions.

Exponential Integrals are no more difficult to use than logarithms or the trigonometric functions. There is nothing mysterious or difficult about them. The Exponential Integral arises in the solution of the differential equation for the flow of a single liquid phase of constant compressibility in a homogeneous porous medium. The resulting equation for the case of a constant production rate in a system having cylindrical symmetry is:

$$(1)\quad p_e - p(r,T) = \frac{q_o \mu B}{0.0141\,kh}\left[-Ei\left(-\frac{948.4\,c\mu\phi r^2}{kT}\right)\right]$$

where p_e = formation pressure in psi.
$p(r,T)$ = pressure, in psi, at a radial distance, r, from the well at time T.
T = time in hours after opening up the well.
r = radial distance in feet from the well.
q_o = production rate in stock tank barrels per day.
μ = viscosity, centipoises.
B = formation volume factor (dimensionless).
k = permeability in millidarcys.
h = thickness of producing formation in feet.
c = compressibility of the reservoir fluid in $\frac{1}{psi}$.
ϕ = porosity, fractional.

The Exponential Integral in Equation (1) is the term in the brackets.

$$\left[-Ei\left(-\frac{948.4\,c\mu\phi r^2}{kT}\right)\right]$$

The Exponential Integral is defined as

$$(2)\quad -Ei(-x) = \int_x^{\infty} \frac{e^{-v}}{v}\,dv$$

In this definition v is a dummy variable and disappears upon integration and substitution of the limits. -Ei(-x) is thus a function of x only. The Exponential Integral can also be expressed by means of infinite series, thus:

$$(3)\quad -Ei(-x) = e^{-x}\left(\frac{1}{x} - \frac{1}{x^2} + \frac{2!}{x^3} - \frac{3!}{x^4} + \cdots\right)$$

$$(4)\quad -Ei(-x) = -0.5772 - 2.303\log_{10} x + x - \frac{x^2}{4} + \frac{x^3}{18} - \cdots \frac{x^n}{n \cdot n!}$$

The form given in Equation (4) is particularly useful since it permits a simple evaluation of the Ei function for values of x outside the range of tables, or if no tables are available. It is also used to determine the range of x over which the logarithmic approximation may be used.

Example 1. Calculate -Ei(-0.25). By Equation (4).

$$-Ei(-0.25) = -0.5772 - 2.303\log_{10}(0.25) + 0.25 - \frac{(0.25)^2}{4} + \frac{(0.25)^3}{18}$$

$$= -0.5772 - 2.303(-0.6021) + 0.25 - \frac{0.0625}{4} + \frac{0.015625}{18}$$

$$= -0.5772 + 1.3866 + 0.25 - 0.0156 + 0.0008$$

$$= -0.5928 + 1.6366$$

$$= 1.0438$$

The value 1.0438 may be rounded to the value 1.044 which is usually sufficient for most reservoir problems. It will be noted that the last term in the series (0.0008) was not used. A set of tables, Ref. (4), gives the value of 1.0443. The difference between 1.0443 and 1.0438 is 0.0005 which is less than the value of the last term calculated, but not used. This illustrates the rule that for series of the type of Equation (4) the error resulting from omitting all terms after a certain selected one is less than the first term neglected. In this example all terms after the term $\frac{x^2}{4}$ were neglected and the error is shown to be less than the value of the term $\frac{x^3}{18}$, which is (0.0008). Here the term $\frac{x^3}{18}$ is the first of the terms neglected.

Example 2. Assume that it is desirable to use the logarithmic approximation. Assume further that a value of -Ei(-x) accurate to 0.01 is acceptable. In other words, all [illegible] in Equation (4) are to be neglected after the logarithmic term. What is the largest value that x can have in order that the error in $-Ei(-x)$ shall not exceed 0.01? It was shown in the previous example that the error does not exceed the value of the first term neglected. In this case, the first term neglected is x. Hence, if x does not exceed 0.01, then the error in $-Ei(-x)$ resulting from the use of the logarithmic approximation will not exceed 0.01.

Tables of the Ei function are available and are used in the same manner as logarithmic, or trigonometric tables. A condensed table is given in Appendix A. More complete tables may be purchased from the Superintendent of Documents (4), Washington 25, D. C. For most reservoir work, however, the tables given in Appendix A are sufficiently accurate. For rougher work, a graph based on equation (1) has been prepared and is given in Appendix B.

The two previous examples illustrated the method of calculating the value of the function $-Ei(-x)$. Two more examples are presented illustrating the use of the Exponential Integral in Equation (1).

Example 3. This example applies to the problem of well interference. Assume two wells are separated by a distance of 1100 ft. Both wells have been shut-in for a sufficient length of time that the pressure in each is the static reservoir pressure. Also, assume that the common formation in which these wells are completed is homogeneous and continuous. The problem is to calculate how many hours it will take for a pressure drop of 5 psi to occur in well B after well A commences to produce at a rate of 250 stock tank bbl per day.

Assume further, that the following quantities have previously been determined:

$k = 133$ md
$h = 33$ feet
$kh = 4389$ md-ft
$u = 0.38$ cp
$B = 1.47$
$f = 0.02$
$c = 1.59 \times 10^{-5} \frac{1}{psi}$

The remaining quantities in Equation (1) as previously specified are $r = 1100$ ft, $q_o = 250$ STB/D, $p_e - p(r,T) = \Delta P = 5$ psi.

Substitution of these quantities in Equation (1) gives:

$$\frac{5 \times 0.0141 \times 4389}{250 \times 0.38 \times 1.47} = -Ei\left(-\frac{948.4 \times 1.59 \times 10^{-5} \times 0.38 \times 0.02 \times (1100)^2}{33\,T}\right)$$

$$2.218 = -Ei\left(-\frac{4.202}{T}\right)$$

Thus, $\frac{4.202}{T}$ is the x in $-Ei(-x)$ and 2.218 is the value of the Ei function. The next step is to find the value of x from the tables. The quantity in the body of the table nearest 2.218 is 2.20. Hence, the value of x, to three decimals, read from the table, is 0.065.

$$\frac{4.202}{T} = 0.065$$

$$T = \frac{4.202}{0.065} = 64.6 \text{ hours}$$

Example 4. Two wells, A and B, are separated by a distance of 1100 ft. A well pressure build-up test on A has yielded an effective reservoir productivity of 4400 md-ft (kh). When A is produced at a constant rate of 275 STB/day, a pressure drop of 10 psi is observed at B after 108 hours. Fluid and formation constants are:

$u = 0.40$ cp.
$B = 1.47$
$f = 0.02$
$c = 1.59 \times 10^{-5} \frac{1}{psi}$

What is the effective permeability of the intervening formation?

Substituting these values in Equation (1).

$$\frac{10 \times 0.0141 \times 4400}{275 \times 0.40 \times 1.47} = -Ei\left(-\frac{948.4 \times 1.59 \times 10^{-5} \times 0.4 \times 0.02 \times (1100)^2}{k \times 108}\right)$$

$$4.039 = -Ei\left(-\frac{1.35}{k}\right)$$

$$\frac{1.35}{k} = 0.010 \text{ (from the tables)}$$

$$k = 135. \text{ md. (effective)}$$

Acknowledgment

The author wishes to thank the Management of Phillips Petroleum Company for permission to publish this article.

Bibliography

1. Muskat, M. "Physical Principles of Oil Production" McGraw-Hill (1949) Section 11.7 and 14.8.
2. Horner, D. R. "Pressure Build-Up in Wells". Third World Petroleum Congress. Sect. II, E. J. Brill, Leiden (1951) pp. [illegible].
3. van Everdingen, A. F., Trans AIME Vol. 198 (1953) pp. 171-178.
4. Tables of Sine, Cosine, and Exponential Integrals, Vol. I and Vol. II, priced \$2.75 and \$2.00 respectively. Federal Works Agency, WPA. Available from Superintendent of Documents, Washington 25, D. C.

APPENDIX A

Table of the Exponential Integral

$f(x) = -Ei(-x)$

$0.00 < x < 0.209$, Interval $= 0.001$

X	0	1	2	3	4	5	6	7	8	9
0.00	$-\infty$	6.332	5.639	5.235	4.948	4.726	4.545	4.392	4.259	4.142
0.01	4.038	3.944	3.858	3.779	3.705	3.637	3.574	3.514	3.458	3.405
0.02	3.355	3.307	3.261	3.218	3.176	3.137	3.099	3.062	3.026	2.993
0.03	2.959	2.927	2.897	2.867	2.838	2.810	2.783	2.756	2.731	2.706
0.04	2.681	2.658	2.634	2.612	2.590	2.568	2.547	2.527	2.507	2.487
0.05	2.468	2.449	2.431	2.413	2.395	2.377	2.360	2.344	2.327	2.311
0.06	2.295	2.279	2.264	2.249	2.235	2.220	2.206	2.192	2.178	2.164
0.07	2.151	2.138	2.125	2.112	2.099	2.087	2.074	2.062	2.050	2.039
0.08	2.027	2.015	2.004	1.993	1.982	1.971	1.960	1.950	1.939	1.929
0.09	1.919	1.909	1.899	1.889	1.879	1.869	1.860	1.850	1.841	1.832
0.10	1.823	1.814	1.805	1.796	1.787	1.779	1.770	1.762	1.754	1.745
0.11	1.737	1.729	1.721	1.713	1.705	1.697	1.690	1.682	1.674	1.667
0.12	1.660	1.652	1.645	1.638	1.631	1.623	1.616	1.609	1.603	1.596
0.13	1.589	1.582	1.576	1.569	1.562	1.556	1.549	1.543	1.537	1.530
0.14	1.524	1.518	1.512	1.506	1.500	1.494	1.488	1.482	1.476	1.470
0.15	1.464	1.459	1.453	1.447	1.442	1.436	1.431	1.425	1.420	1.415
0.16	1.409	1.404	1.399	1.393	1.388	1.383	1.378	1.373	1.368	1.363
0.17	1.358	1.353	1.348	1.343	1.338	1.333	1.329	1.324	1.319	1.314
0.18	1.310	1.305	1.301	1.296	1.291	1.287	1.282	1.278	1.274	1.269
0.19	1.265	1.261	1.256	1.252	1.248	1.243	1.239	1.235	1.231	1.227
0.20	1.223	1.219	1.215	1.210	1.206	1.202	1.198	1.195	1.191	1.187

X	0	1	2	3	4	5	6	7	8	9
0.0	∞	4.038	3.355	2.959	2.681	2.468	2.295	2.151	2.027	1.919
0.1	1.823	1.737	1.660	1.589	1.524	1.464	1.409	1.358	1.309	1.265
0.2	1.223	1.183	1.145	1.110	1.076	1.044	1.014	0.985	0.957	0.931
0.3	0.906	0.882	0.858	0.836	0.815	0.794	0.774	0.755	0.737	0.719
0.4	0.702	0.686	0.670	0.655	0.640	0.625	0.611	0.598	0.585	0.572
0.5	0.560	0.548	0.536	0.525	0.514	0.503	0.493	0.483	0.473	0.464
0.6	0.454	0.445	0.437	0.428	0.420	0.412	0.404	0.396	0.388	0.381
0.7	0.374	0.367	0.360	0.353	0.347	0.340	0.334	0.328	0.322	0.316
0.8	0.311	0.305	0.300	0.295	0.289	0.284	0.279	0.274	0.269	0.265
0.9	0.260	0.256	0.251	0.247	0.243	0.239	0.235	0.231	0.227	0.223
1.0	0.219	0.215	0.212	0.208	0.205	0.201	0.198	0.195	0.192	0.189
1.1	0.186	0.183	0.180	0.177	0.174	0.172	0.169	0.166	0.164	0.161
1.2	0.158	0.156	0.153	0.151	0.149	0.146	0.144	0.142	0.140	0.138
1.3	0.135	0.133	0.131	0.129	0.127	0.125	0.124	0.122	0.120	0.118
1.4	0.116	0.114	0.113	0.111	0.109	0.108	0.106	0.105	0.103	0.102
1.5	0.1000	0.0985	0.0971	0.0957	0.0943	0.0929	0.0915	0.0902	0.0889	0.0876
1.6	0.0863	0.0851	0.0838	0.0826	0.0814	0.0802	0.0791	0.0780	0.0768	0.0757
1.7	0.0747	0.0736	0.0725	0.0715	0.0705	0.0695	0.0685	0.0675	0.0666	0.0656
1.8	0.0647	0.0638	0.0629	0.0620	0.0612	0.0603	0.0595	0.0586	0.0578	0.0570
1.9	0.0562	0.0554	0.0546	0.0539	0.0531	0.0524	0.0517	0.0510	0.0503	0.0496
2.0	0.0489	0.0482	0.0476	0.0469	0.0463	0.0456	0.0450	0.0444	0.0438	0.0432

APPENDIX A (Concluded)

Table of Exponential Integral

$f(x) = -Ei(-x)$

$2.0 < x < 10.9$, Interval = 0.1

X	0	1	2	3	4	5	6	7	8	9
2	4.89×10^{-2}	4.26×10^{-2}	3.72×10^{-2}	3.25×10^{-2}	2.84×10^{-2}	2.49×10^{-2}	[illegible]	[illegible]	[illegible]	[illegible]
3	1.30×10^{-2}	1.15×10^{-2}	1.01×10^{-2}	8.94×10^{-3}	7.89×10^{-3}	6.97×10^{-3}	6.16×10^{-3}	5.45×10^{-3}	[illegible]	[illegible]
4	3.78×10^{-3}	3.35×10^{-3}	2.97×10^{-3}	2.64×10^{-3}	2.34×10^{-3}	2.07×10^{-3}	1.84×10^{-3}	[illegible]	[illegible]	[illegible]
5	1.15×10^{-3}	1.02×10^{-3}	9.08×10^{-4}	8.08×10^{-4}	7.19×10^{-4}	6.41×10^{-4}	5.71×10^{-4}	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	2.86×10^{-4}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	1.15×10^{-4}	1.03×10^{-4}	9.22×10^{-5}	8.24×10^{-5}	[illegible]	[illegible]	[illegible]	[illegible]	4.71×10^{-5}	[illegible]
8	3.77×10^{-5}	3.37×10^{-5}	[illegible]	2.70×10^{-5}	2.42×10^{-5}	2.16×10^{-5}	1.94×10^{-5}	1.73×10^{-5}	[illegible]	[illegible]
9	1.24×10^{-5}	1.11×10^{-5}	[illegible]	[illegible]	8.02×10^{-6}	[illegible]	[illegible]	5.77×10^{-6}	5.17×10^{-6}	[illegible]
10	4.15×10^{-6}	3.73×10^{-6}	3.34×10^{-6}	3.00×10^{-6}	2.69×10^{-6}	2.41×10^{-6}	2.16×10^{-6}	1.94×10^{-6}	[illegible]	[illegible]

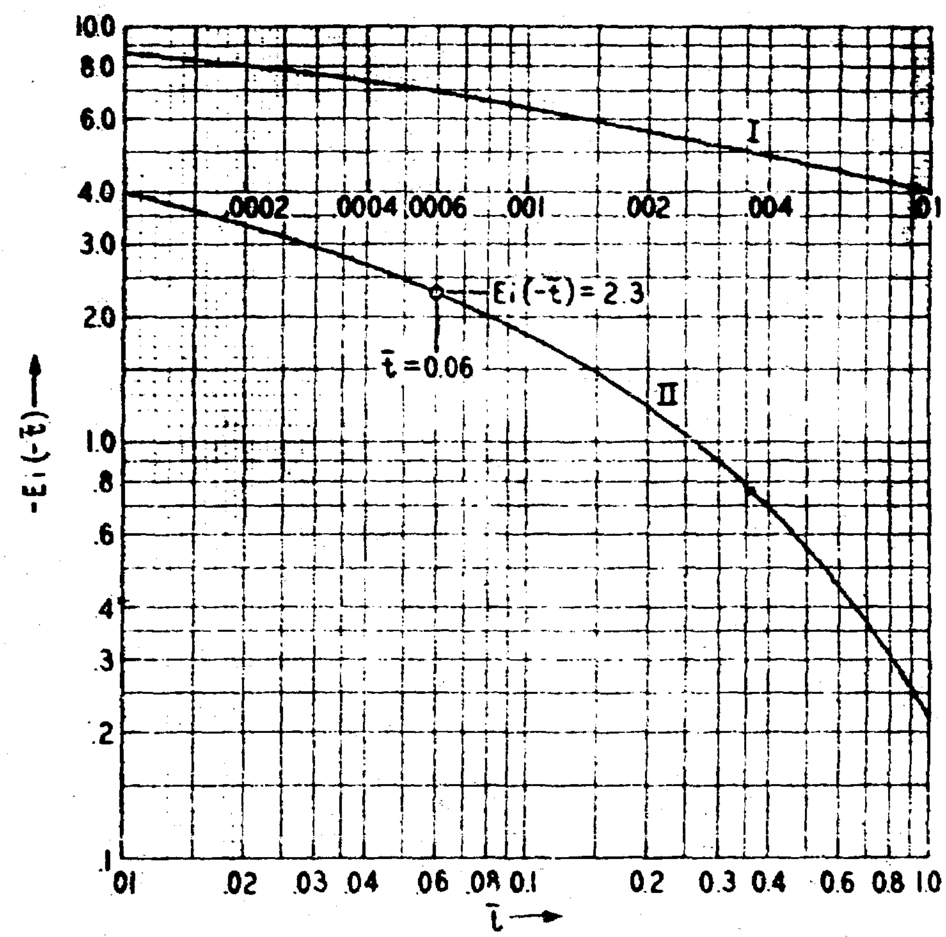


Fig. 1. Graph of the function $f(\bar{t}) = -Ei(-\bar{t})$ can be used when accuracy to two significant figures is adequate.

APPENDIX B

Chart for the Calculation of the Exponential Integral

By rearranging Equation (1) and introducing dimensionless variables, the calculation of Exponential Integrals is simplified. This chart may be used whenever accuracy to two significant figures is adequate for the problem at hand.

Let $\Delta P = p_e - p(r,T)$

$$\bar{P} = \frac{q_o\, u\, B}{0.0141\, k\, h}$$

$$\bar{t} = 948.4 \frac{c\, u\, f\, r^2}{k\, T}$$

Then, Equation (1) may be written

$$\Delta P = \bar{P}\,[-Ei(-\bar{t})]$$

The chart consists of two branches of the Ei-curve plotted on double logarithmic paper. Values of $\bar{t}$ are plotted along the x-axis. Values of $-Ei(-\bar{t})$ are plotted along the Y-axis.

The first branch, marked I, covers the range of $\bar{t}$ from 0.0001 to 0.01; the second branch, marked II, covers the range of $\bar{t}$ from 0.01 to 1.0. Values of $\bar{t}$ are indicated along these curves for convenience in reading. Values of $-Ei(-\bar{t})$ covers the range from 0.22 to 8.6. These are indicated at the left of the chart.

Example 1. Consider the point O_1 $(\bar{t})$ located on Branch II.

$$\bar{t} = 0.06, \; -Ei(-\bar{t}) = 2.3$$

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 10
Date February 18, 1959

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Arizona Explorations, Inc.								
Petro-Atlas-Bolack	1	NW SE 9-30-16	10-28-56	1150-1154 1159-1163 1169-1179 1187-1195		1283	30	
Wagenseller	1	SE SW 9-30-16	6-24-57	1020-1054		1201	55	
Atlantic Refining Company								
Navajo	1	SE SE 32-31-16	10-1-58	1091-1094 1099-1128	1193-1224	1235	131	116/1
Navajo	2	NW SE 32-21-16	10-2-58	1102-1132	1199-1238	1289	133	98/1
Navajo	3	SE NW 32-31-16	10-8-58	1117-1153	1235-1262	1300	135	98/1
Navajo	4	NW NW 32-31-16	10-10-58	1142-1182	1258-1284	1350	137	112/1
Navajo	5	SE SE 30-31-16	10-20-58	1165-1201	1282-1316	1370	125	180/1
Navajo	6	NW SE 30-31-16	10-22-58	1208-1245	1327-1349	1380	127	96/1
Navajo	7	SE NW 30-31-16	10-31-58	1398-1430	1518-1545	1602	128	193/1
Navajo	8	NW NW 30-31-16	11-9-58	1321-1349	1436-1464	1515	132	557/1
Navajo	9	NW NE 30-31-16	11-14-58	1269-1297	1389-1403	1454	124	138/1

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Atlantic Refining Company								
Navajo	10	SE NE 30-31-16	11-17-58	1231-1262	1352-1367	1422	135	291/1
Navajo	11	NW SW 29-31-16	11-24-58	1201-1236	1326-1339	1400	158	
Navajo	12	SE SW 29-31-16	11-30-58	1157-1190	1285-1295	1345	288	
Navajo	13	NW NE 32-31-16	12-8-58	1135-1166	1259-1268	1310	445	
Navajo	14	SE SW 32-31-16	12-27-58	1134-1172		1305	95	
Navajo	15	NW SW 32-31-16	12-31-58	1155-1180		1314	227	
Navajo	16	SE NE 31-31-16	11-26-58		1216-1224	1310	119	243/1
Navajo	17	NW NE 31-31-16	1-6-59	1157-1179	1236-1248	1310	195	
Navajo	18	SE SW 30-31-16	1-20-59	1196-1198 1206-1230	1286-1288 1297-1308	1357	114	
Navajo	19	NW SW 30-31-16	1-20-59	1256-1284	1356-1374	1421	277	
Navajo	20	SE NE 32-31-16	12-9-58	1147-1183	1273-1290	1337	520	
Navajo	21	SE SE 29-31-16	1-28-59	1402-1426		1573	103	
Navajo	22	NW SE 29-31-16	12-16-58	1194-1221	1320-1336	1348	130	
Navajo	25	SE NE 29-31-16	1-14-59	1304-1326		1460	67	
Navajo	27	SE SE 31-31-16	1-28-59	1126-1146		1281	320	
Navajo	26	NW SE 31-31-16	1-12-59	1168-1184		1320	87	

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Atlantic Refining Company								
Navajo	30	NW NW 31-31-16	2-5-59	1170-1189		1315	96	
Ute	1	SW SW 36-31-16	10-31-58	1614-1660		1777	95	TSTM
Banner Drilling Company								
Ute	1	SW SW 34-31-16	6-28-58	1228-1266	1346-1364	1425	85	312/1
Ute	2	NW SW 34-31-16	7-28-58	1214-1254		2050	80	
Ute	3	SE NE 33-31-16	11-8-58	1215-1249		1402	125	
Ute	4	NE NE 33-31-16	11-8-58	1246-1230		1400	125	
Ute	5	SE NW 34-31-16	12-1-58	1362-1398		1420	105	
Ute	6	NE NW 34-31-16	11-28-58	1416-1452		1600	96	
Tom Bolack								
Bolack	1	SW NE 4-30-16	7-16-57	1162-1214	1267-1317	1330	120	196/1
Bolack	2	NW SW 3-30-16	7-3-57	1265-1305	1376-1400	1460	120	250/1
Bolack	3	NW SE 4-30-16	10-6-57	1130-1182	1225-1260	1315	384	220/1
Bolack	4	SW SW 3-30-16	7-20-57	1320-1373	1418-1469	1486	120	205/1
Bolack	5	SE NW 4-30-16	7-12-57	1092-1143	1195-1229	1251	120	150/1
Bolack	6	NE NW 10-30-16	10-29-57		1605-1640	1664	100	
Bolack	7	SW SE 3-31-16	1-14-59	1526-1570	1640-1670	1699	100	
Bolack	8	NW SE 3-31-16	2-1-59	1585-1630		2117	189	

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Tom Bolack								
Bolack	9	SW NE 3-30-16	11-11-57	1588-1612 1614-1616 1620-1624 1628-1632	1714-1722	1760	168	
Bolack	10	SE NW 10-30-16	1-9-59	1452-1456 1466-1488 1494-1500	1544-1568	1601	150	
Bolack	11	SW SE 4-30-16	1-9-59	1462-1466 1474-1492 1501-1505	1551-1555	1600	150	
Bolack	12	NW NE 9-30-16	1-15-59	1490-1494 1500-1534		1650	150	
Bolack	14	SW NE 9-30-16	1-20-59	1234-1302		1425	148	
El Paso Natural Gas Products Co.								
Chimney Rock	1	NE SE 23-31-17	12-1-57	963-990	1042-1050	1800	1,160 MCF	
Chimney Rock	2	NE NE 15-31-17	12-11-57		876-890	948	2,480 MCF	
Chimney Rock	1-A	SE SE 24-31-17	11-29-58	1390-1416	1504-1535	1575	110	45/1
Chimney Rock	2-A	NW SE 24-31-17	12-13-58	1290-1312	1404-1434	1488	105	38/1
Chimney Rock	3-A	SW SE 24-31-17	1-22-59	1301-1326	1406-1438	1478	107	66/1
Horseshoe Canyon	1	NE SE 4-30-16	9-21-56		1300-1324	2075	125	
Horseshoe Canyon	2	SW NW 3-30-16	12-22-56	1306-1351	1424-1446	1485	105	181/1
Horseshoe Canyon	3	SE NE 4-30-16	5-5-57	1188-1231	1300-1336	1380	102	147/1
Horseshoe Canyon	4	SE SW 3-30-16	11-3-57	1504-1532	1593-1623	1669	95	99/1

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential SOPD	Potential GOR
El Paso Natural Gas Products Co.								
Horseshoe Canyon	5	SE SE 4-30-16	5-16-58	1304-1322	1386-1418	1491	89	79/1
Horseshoe Canyon	6	NW NW 10-30-16	5-23-58	1500-1520	1576-1601	1698	118	22/1
Horseshoe Canyon	7	NE SW 3-30-16	5-21-58	1474-1518	1584-1612	1670	130	31/1
Horseshoe Canyon	8	NE SW 4-30-16	5-29-58	1110-1136	1198-1206 1234-1242	1305	128	39/1
Horse hoe Canyon	9	SE NW 3-30-16	4-26-58	1400-1448	1518-1542	1607	100	250/1
Horseshoe Canyon	10	SW NW 10-30-16	12-31-58	1306-1344		1465	121	116/1
Horseshoe Canyon	11	SE SE 3-30-16	12-24-58	1464-1508	1580-1600	1649	106	122/1
Horseshoe Canyon	12	NE SE 3-30-16	12-19-58	1585-1630		1765	118	119/1
Horseshoe Canyon	13	SE SW 4-30-16	1-14-59	1098-1140		1250	79	89/1
Horseshoe Canyon	1-B	NW NW 3-30-16	6-22-57	1617-1661	1735-1757	1789	17	180/1
Horseshoe Canyon	2-B	NE NW 4-30-16	10-5-57	1108-1124	1202-1240	1287	111	90/1
Horseshoe Canyon	3-B	SW NW 4-30-16	11-19-58	1081-1127	1174-1214	1277	113	79/1
Horseshoe Canyon	4-B	NW NW 4-30-16	11-21-58	1072-1109	1172-1212	1283	117	85/1
Horseshoe Canyon	5-B	NE NW 3-30-16	12-16-58	1595-1637		1766	102	138/1
Horseshoe Ute	1	SE SW 33-31-16	5-14-58	1108-1150	1222-1252	1312	95	42/1
Horseshoe Ute	2	SE SE 33-31-16	5-12-58	1186-1220	1300-1324	1386	18	1140/1

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
El Paso Natural Gas Products Co.								
Horseshoe Ute	4	NE SW 33-31-16	11-16-58	1138-1178	1266-1278	1326	130	61/1
Horseshoe Ute	6	NE SE 33-31-16	11-23-58	1180-1215		1376	118	59/1
Horseshoe Ute	7	SW NE 33-31-16	12-1-58	1220-1258		1406	113	53/1
Horseshoe Ute	8	SW NW 34-31-16	12-3-58	1253-1289		1428	106	57/1
Horseshoe Ute	9	NE SW 34-31-16	12-5-58	1250-1288		1447	104	67/1
Horseshoe Ute	10	SE SW 34-31-16	12-7-58	1347-1382		1520	106	66/1
Horseshoe Ute	11	SW SE 34-31-16	12-9-58	1380-1419		1558	103	77/1
Williams	1	SW SE 11-30-16	9-17-58	2288-2314	2382-2404	2459	103	126/1
Williams	1-A	NW NW 12-30-16	10-24-58	1837-1875		2290	54	TSTM
Magnolia Petroleum Company								
Navajo	1-A	SE NE 24-31-17	2-6-59	1397-1405	1500-1515	1565	120	238/1
Monsanto Chemical Company								
State	1-H	SW NW 2-30-16	8-29-57	1530-1593		1720	37	
Pan American Petroleum Corp.								
Aldlin	1-A	NW NE 10-30-16	8-22-58	1492-1512	1582-1614	1685	79	
Aldlin	2-A *	SE NE 10-30-16	11-1-58	1500-1518	1590-1622	1744	240	
O. J. Hoover	2-X-B *	SE NW 11-30-16	12-11-58	1776-1818	1890-1918	1949	96	
O. J. Hoover	3-B *	NW SW 11-30-16	11-30-58	1748-1774	1841-1874	1980	185	

* 4-1/2" Production Casing.

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Pan American Petroleum Corp.								
O. J. Hoover	4-B *	SW NW 11-30-16	1-22-59	1684-1720	1792-1818	1885	59	
O. J. Hoover	5-B	NE SW 11-30-16	1-18-59	1832-1868	1938-1961	2030	165	
O. J. Hoover	6-B	SW SW 11-30-16	2-1-59	1943-1970	2026-2060	2117	189	
O. J. Hoover	1-C *	SE SW 11-30-16	11-14-58	2056-2076	2146-2175	1856	216	
Petro-Atlas, Inc.								
Horseshoe Canyon	1-A	NE NE 4-30-16	7-24-57	1605-1647	1736-1746	1810	113	
Horseshoe Canyon	2-A	NW NE 4-30-16	7-30-57	1162-1206	1278-1306	1365	120	195/1
Horseshoe Canyon	1-B	NE NE 9-30-16	7-23-57	1504-1542		1711	134	
Horseshoe Canyon	2-B	SE NE 9-30-16	12-4-58	1245-1289 1308-1322		1456	102	
Horseshoe Canyon	1-C	NW NE 3-30-16	10-9-58	1522-1566		1730	112	TSTM
Horseshoe Canyon	1-D	NE NE 5-30-16	10-7-58	1088-1133	1182-1222	1265	148	
Horseshoe Canyon	2-D	SE NE 5-30-16	10-10-58	1073-1121		1266	140	
Horseshoe Canyon	3-D	NW NE 5-30-16	10-13-58	1086-1136	1169-1175	1265	133	
Horseshoe Canyon	4-D	SW NE 5-30-16	10-16-58	1070-1101 1104-1114		1240	136	
Horseshoe Canyon	1-E	NE NW 9-30-16	11-22-58	1481-1520		1628	118	
Ute	1	SW SE 33-31-16	9-7-58	1135-1142 1146-1166 1169-1178	1257-1278	1350	128	

* 4-1/2" Production Casing.

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Petro-Atlas, Inc.								
Ute	2	NW SE 33-31-16	9-18-58	1140-1182	1266-1278	1350	131	

CHIMNEY ROCK FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twp-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Bayless Oil Company								
Navajo	2	SE NE 5-31-17	5-18-58		1111-1163 *	1225	60	
Navajo	4	NE NE 5-31-17	5-18-58		1133-1166 *	1166	50	
Honolulu Oil Corporation								
Navajo	2-5	NE SE 5-31-17	12-5-58		1107-1117	1170	59	
Humble Oil & Refining Co.								
Navajo	1-F	NW NW 4-31-17	11-5-58		1147-1160	1227	30	167/1
Navajo	2-F	SW NW 4-31-17	10-20-58		1118-1152 *	1152	39	182/1
Navajo	3-F	NW SW 4-31-17	1-26-59		1084-1116	1126	117	129/1

* Open Hole

HORSESHOE GALLUP POOL
SAN JUAN COUNTY, NEW MEXICO
CORE ANALYSIS OF SANDS "A" AND "B"

	SAND "A"	SAND "B"
Average Porosity	14.3 %	18.1 %
Median Permeability	35 md.	95 md.
Average Connate Water Saturations	40 %	35.5 %
Average Total Water Saturations	40.1 %	40.6 %
Average Residual Oil Saturations	13.5 %	15.5 %
Number of Wells	22	18

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 11
Date February 18, 1959

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 12
Date February 18, 1959

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
BOTTOM HOLE PRESSURES SANDS "A" AND "B"

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Survey Date	Shut-In Time Hours	BHP * Sand "A"	BHP ** Sand "B"	BHP *** Sand "B"	Remarks
El Paso Natural Gas Products Co.								
Horseshoe Canyon	1	NE SE 4-30-16	2-8-59	72		238	201	Natural Completion
Horseshoe Canyon	4	SE SW 3-30-16	11-1-57	48		243	209	Natural Completion Initial BHP Survey
Horseshoe Canyon	6	NW NW 10-30-16	1-28-59	43	194			Sandoil Fractured
Horseshoe Canyon	8	NE SW 4-30-16	1-29-59	192	180			Sandoil Fractured
Horseshoe Canyon	2-B	NE NW 4-30-16	9-24-57	49		276	243	Natural Completion Initial BHP Surveys
			10-4-57	48	221			

Gradient 0.335 psi/ft.

* Datum + 4175'
** Datum + 4075'
*** Datum + 4175'

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 13
Date February 18, 1959

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
INDIVIDUAL PRODUCTION TESTS OF SANDS "A" AND "B"

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Swab Test Sand "A" BOPD	Swab Test Sand "B" BOPD	Pump Test Sand "A" BOPD	Pump Test Sand "A" GOR	Pump Test Sand "B" BOPD	Pump Test Sand "B" GOR	Remarks
El Paso Natural Gas Products Co.									
Horseshoe Canyon	4	SE SW 3-30N-16W			21	TSTM	74	125	Neither sand sandoil fractured.
Horseshoe Canyon	6	NW NW 10-30N-16W			80	175	119	81	Both sands sandoil fractured.
Horseshoe Canyon	8	NE SW 4-30N-16W			109	193	89	79	Both sands sandoil fractured.
Horseshoe Canyon	2-B	NE NW 4-30N-16W		100	50				Neither sand sandoil fractured.
Horseshoe Ute	4	NE SW 33-31N-16W	203	264					Both sands sandoil fractured.
Atlantic Refining Company									
Navajo	1	SE SE 32-31N-16W	512	598					Both sands sandoil fractured.
Pan American Petroleum Corp.									
Allis	1-A	NW NE 10-30N-16W			108		96		Both sands sandoil fractured.

DUAL COMPLETION EQUIPMENT
HORSESHOE GALLUP OIL POOL
San Juan County, New Mexico

Subsurface Equipment

1. 5-1/2", 15.50#, J-55 production casing is set through both producing zones and cemented. Cement is circulated across both zones by the single stage method.

2. 1-1/2", 2.75#, J-55, non-upset tubing will be used to produce the lower zone. A tension type retrievable production packer will be run and set on this tubing string. This will maintain separation between the two zones. A parallel tubing string anchor will be run in this tubing string to anchor the tubing string for the top zone.

3. 1-1/2", 2.75#, J-55 non-upset tubing will be used to produce the top zone. This tubing string will be latched into the parallel tubing string anchor.

4. The pumps for each zone will be a 1-1/4"common working barrel tubing pump. The pumps will be activated by separate rod strings.

Tubing Head

1. The tubing head will suspend the tubing strings separately.

Pumping Unit

1. Existing pumping units are of sufficient rating to pump both zones at the same time.

2. The pumping of both zones at the same time with the same pumping unit can be accomplished by using a dual horse's head.

Metering of Oil

1. Each zone will produce into a separator. The separators will consist of a single unit with a divider between the separator chambers.

2. Oil from the separator will be metered by positive displacement meters. Inidividual meters will be used for each zone.

3. After oil is metered it will be commingled into the existing flow line to the existing battery.

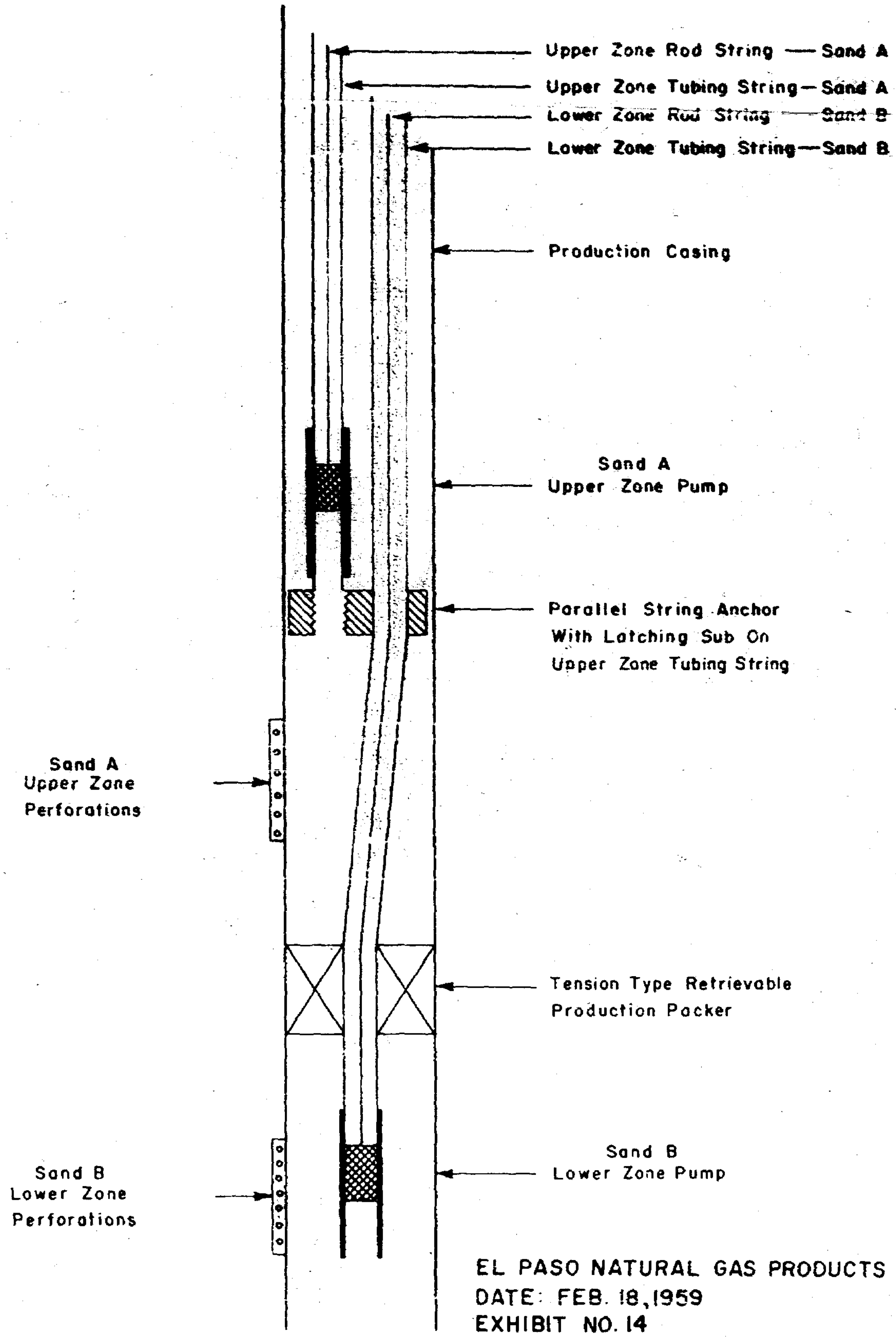
4. By metering the oil in this manner it will not be necessary to construct storage facilities and separate flow lines for each zone.

Schematic Diagram of Subsurface Equipment

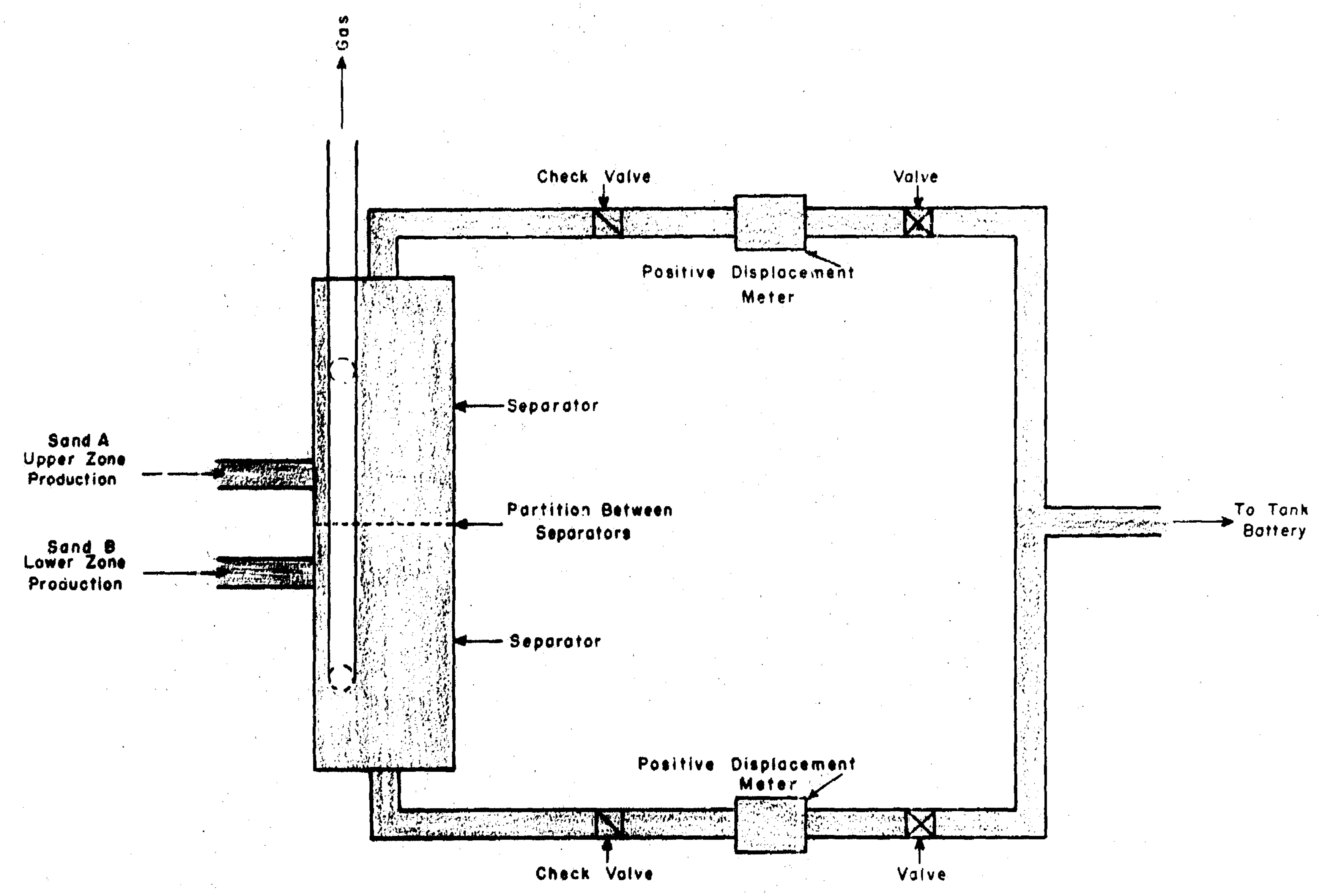
Dual Pumping Installation

Horseshoe – Gallup Oil Pool

San Juan County, New Mexico



EL PASO NATURAL GAS PRODUCTS CO.
DATE: FEB. 18, 1959
EXHIBIT NO. 14
CASE NO. 1596



Schematic Diagram

Separating and Metering Installation

Dual Completion

Horseshoe Canyon–Gallup Oil Pool

San Juan County, New Mexico

EL PASO NATURAL GAS PRODUCTS CO.

DATE: FEB. 18, 1959

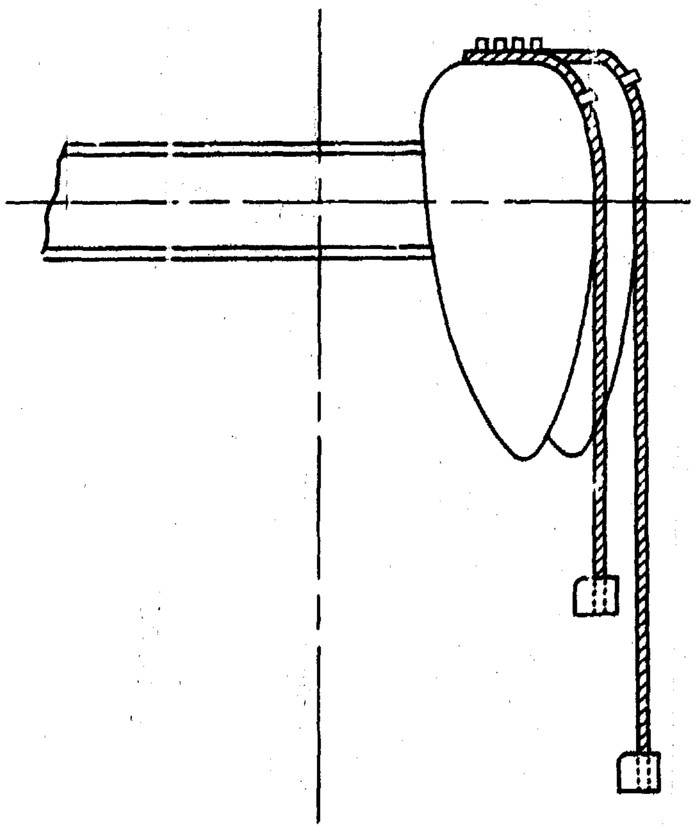
EXHIBIT NO. 15

CASE NO. 1596

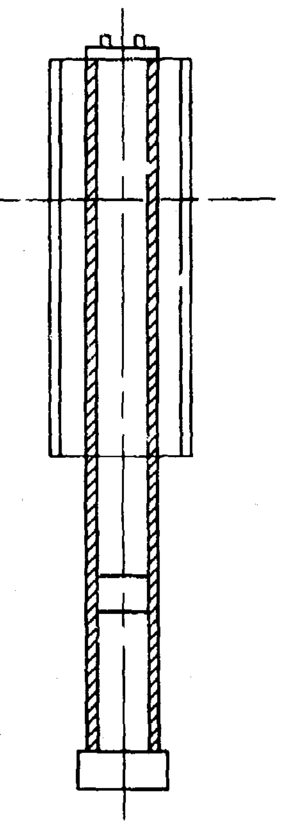
HORSESHOE GALLUP FIELD

SAN JUAN COUNTY, NEW MEXICO

DUAL CARRIER BAR HORSEHEAD INSTALLATION



SIDE VIEW



FRONT VIEW

EL PASO NATURAL GAS PRODUCTS CO.
DATE: FEB. 18, 1959
EXHIBIT NO. 16
CASE NO. 1596

EL PASO NATURAL GAS PRODUCTS CO.
HORSESHOE GALLUP DUAL COMPLETION
San Juan County, New Mexico

CASE NO. 1596
EXHIBITS 10 thru 16

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 10
Date February 18, 1959

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Arizona Explorations, Inc.								
Petro-Atlas-Bolack	1	NW SE 9-30-16	10-28-56	1150-1154 1159-1163 1169-1179 1187-1195		1283	30	
Wagenseller	1	SE SW 9-30-16	6-24-57	1020-1054		1201	55	
Atlantic Refining Company								
Navajo	1	SE SE 32-31-16	10-1-58	1091-1094 1099-1128	1193-1224	1285	131	116/1
Navajo	2	NW SE 32-21-16	10-2-58	1102-1132	1199-1238	1289	133	98/1
Navajo	3	SE NW 32-31-16	10-8-58	1117-1153	1235-1262	1300	135	98/1
Navajo	4	NW NW 32-31-16	10-10-58	1142-1182	1258-1284	1350	137	112/1
Navajo	5	SE SE 30-31-16	10-20-58	1165-1201	1282-1316	1370	125	180/1
Navajo	6	NW SE 30-31-16	10-22-58	1206-1245	1327-1349	1380	127	96/1
Navajo	7	SE NW 30-31-16	10-31-58	1398-1430	1518-1545	1602	128	193/1
Navajo	8	NW NW 30-31-16	11-9-58	1321-1349	1436-1464	1515	132	557/1
Navajo	9	NW NE 30-31-16	11-14-58	1269-1297	1389-1403	1454	124	138/1

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Atlantic Refining Company								
Navajo	10	SE NE 30-31-16	11-17-58	1231-1262	1352-1367	1422	135	291/1
Navajo	11	NW SW 29-31-16	11-24-58	1201-1236	1326-1339	1400	158	
Navajo	12	SE SW 29-31-16	11-30-58	1157-1190	1285-1295	1345	288	
Navajo	13	NW NE 32-31-16	12-8-58	1135-1166	1259-1268	1310	445	
Navajo	14	SE SW 32-31-16	12-27-58	1134-1172		1305	95	
Navajo	15	NW SW 32-31-16	12-31-58	1155-1180		1314	227	
Navajo	16	SE NE 31-31-16	11-26-58		1216-1224	1310	119	243/1
Navajo	17	NW NE 31-31-16	1-6-59	1157-1179	1236-1248	1310	195	
Navajo	18	SE SW 30-31-16	1-20-59	1196-1198 1206-1230	1286-1288 1297-1308	1357	114	
Navajo	19	NW SW 30-31-16	1-20-59	1256-1284	1356-1374	1421	277	
Navajo	20	SE NE 32-31-16	12-9-58	1147-1183	1273-1290	1337	520	
Navajo	21	SE SE 29-31-16	1-28-59	1402-1426		1573	103	
Navajo	22	NW SE 29-31-16	12-16-58	1194-1221	1320-1336	1348	130	
Navajo	25	SE NE 29-31-16	1-14-59	1304-1326		1460	67	
Navajo	27	SE SE 31-31-16	1-28-59	1126-1146		1281	320	
Navajo	28	NW SE 31-31-16	1-12-59	1168-1184		1320	87	

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Page No. 3
Exhibit No. 10

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Atlantic Refining Company								
Navajo	30	NW NW 31-31-16	2-5-59	1170-1189		1315	96	
Ute	1	SW SW 36-31-16	10-31-58	1614-1660		1777	95	TSTM
Banner Drilling Company								
Ute	1	SW SW 34-31-16	6-28-58	1228-1266	1346-1364	1425	85	312/1
Ute	2	NW SW 34-31-16	7-28-58	1214-1254		2050	80	
Ute	3	SE NE 33-31-16	11-8-58	1215-1249		1402	125	
Ute	4	NE NE 33-31-16	11-8-58	1246-1280		1400	125	
Ute	5	SE NW 34-31-16	12-1-58	1362-1398		1420	105	
Ute	6	NE NW 34-31-16	11-28-58	1416-1452		1600	96	
Tom Bolack								
Bolack	1	SW NE 4-30-16	7-16-57	1162-1214	1267-1317	1330	120	196/1
Bolack	2	NW SW 3-30-16	7-3-57	1265-1305	1376-1400	1460	120	250/1
Bolack	3	NW SE 4-30-16	10-6-57	1130-1182	1225-1260	1315	384	220/1
Bolack	4	SW SW 3-30-16	7-20-57	1320-1373	1418-1469	1486	120	205/1
Bolack	5	SE NW 4-30-16	7-12-57	1092-1143	1195-1229	1251	120	150/1
Bolack	6	NE NW 10-30-16	10-29-57		1605-1640	1664	100	
Bolack	7	SW SE 3-31-16	1-14-59	1526-1570	1640-1670	1699	100	
Bolack	8	NW SE 3-31-16	2-1-59	1585-1630		2117	189	

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Tom Bolack								
Bolack	9	SW NE 3-30-16	11-11-57	1588-1612 1614-1616 1620-1624 1628-1632	1714-1722	1760	168	
Bolack	10	SE NW 10-30-16	1-9-59	1452-1456 1466-1488 1494-1500	1544-1568	1601	150	
Bolack	11	SW SE 4-30-16	1-9-59	1462-1466 1474-1492 1501-1505	1551-1555	1600	150	
Bolack	12	NW NE 9-30-16	1-15-59	1490-1494 1500-1534		1650	150	
Bolack	14	SW NE 9-30-16	1-20-59	1234-1302		1425	148	
El Paso Natural Gas Products Co.								
Chimney Rock	1	NE SE 23-31-17	12-1-57	963-990	1042-1050	1800	1,160 MCF	
Chimney Rock	2	NE NE 15-31-17	12-11-57		876-890	948	2,480 MCF	
Chimney Rock	1-A	SE SE 24-31-17	11-29-58	1390-1416	1504-1535	1575	110	45/1
Chimney Rock	2-A	NW SE 24-31-17	12-13-58	1290-1312	1404-1434	1488	105	38/1
Chimney Rock	3-A	SW SE 24-31-17	1-22-59	1301-1326	1406-1438	1478	107	66/1
Horseshoe Canyon	1	NE SE 4-30-16	9-21-56		1300-1324	2075	125	
Horseshoe Canyon	2	SW NW 3-30-16	12-22-56	1306-1351	1424-1446	1485	105	181/1
Horseshoe Canyon	3	SE NE 4-30-16	5-5-57	1188-1231	1300-1336	1380	102	147/1
Horseshoe Canyon	4	SE SW 3-30-16	11-3-57	1504-1532	1593-1623	1669	95	99/1

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Page No. 5
Exhibit No. 10

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential SOPD	Potential GOR
El Paso Natural Gas Products Co.								
Horseshoe Canyon	5	SE SE 4-30-16	5-16-58	1304-1322	1386-1418	1491	89	79/1
Horseshoe Canyon	6	NW NW 10-30-16	5-23-58	1500-1520	1576-1601	1698	118	22/1
Horseshoe Canyon	7	NE SW 3-30-16	5-21-58	1474-1518	1584-1612	1670	130	31/1
Horseshoe Canyon	8	NE SW 4-30-16	5-29-58	1110-1136	1198-1206 1234-1242	1305	128	39/1
Horseshoe Canyon	9	SE NW 3-30-16	4-26-58	1400-1448	1518-1542	1607	100	250/1
Horseshoe Canyon	10	SW NW 10-30-16	12-31-58	1306-1344		1465	121	116/1
Horseshoe Canyon	11	SE SE 3-30-16	12-24-58	1464-1508	1580-1600	1649	106	122/1
Horseshoe Canyon	12	NE SE 3-30-16	12-19-58	1585-1630		1765	118	119/1
Horseshoe Canyon	13	SE SW 4-30-16	1-14-59	1098-1140		1250	79	89/1
Horseshoe Canyon	1-B	NW NW 3-30-16	6-22-57	1617-1661	1735-1757	1789	17	180/1
Horseshoe Canyon	2-B	NE NW 4-30-16	10-5-57	1108-1124	1202-1240	1287	111	90/1
Horseshoe Canyon	3-B	SW NW 4-30-16	11-19-58	1081-1127	1174-1214	1277	113	79/1
Horseshoe Canyon	4-B	NW NW 4-30-16	11-21-58	1072-1109	1172-1212	1283	117	85/1
Horseshoe Canyon	5-B	NE NW 3-30-16	12-16-58	1595-1637		1766	102	138/1
Horseshoe Ute	1	SE SW 33-31-16	5-14-58	1108-1150	1222-1252	1312	95	42/1
Horseshoe Ute	2	SE SE 33-31-16	5-12-58	1186-1220	1300-1324	1386	18	1140/1

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
El Paso Natural Gas Products Co.								
Horseshoe Ute	4	NE SW 33-31-16	11-16-58	1138-1178	1266-1278	1326	130	61/1
Horseshoe Ute	6	NE SE 33-31-16	11-23-58	1180-1215		1376	118	59/1
Horseshoe Ute	7	SW NE 33-31-16	12-1-58	1220-1258		1406	113	53/1
Horseshoe Ute	8	SW NW 34-31-16	12-3-58	1253-1289		1428	106	57/1
Horseshoe Ute	9	NE SW 34-31-16	12-5-58	1250-1288		1447	104	67/1
Horseshoe Ute	10	SE SW 34-31-16	12-7-58	1347-1382		1520	106	66/1
Horseshoe Ute	11	SW SE 34-31-16	12-9-58	1380-1419		1558	103	77/1
Williams	1	SW SE 11-30-16	9-17-58	2288-2314	2382-2404	2459	103	126/1
Williams	1-A	NW NW 12-30-16	10-24-58	1837-1875		2290	54	TSTM
Magnolia Petroleum Company								
Navajo	1-A	SE NE 24-31-17	2-6-59	1397-1405	1500-1515	1565	120	238/1
Monsanto Chemical Company								
State	1-H	SW NW 2-30-16	8-29-57	1530-1593		1720	37	
Pan American Petroleum Corp.								
Aidlin	1-A	NW NE 10-30-16	8-22-58	1492-1512	1582-1614	1685	79	
Aidlin	2-A *	SE NE 10-30-16	11-1-58	1500-1518	1590-1622	1744	240	
O. J. Hoover	2-X-B *	SE NW 11-30-16	12-11-58	1776-1818	1890-1918	1949	96	
O. J. Hoover	3-B *	NW SW 11-30-16	11-30-58	1748-1774	1841-1874	1980	185	

* 4-1/2" Production Casing.

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Pan American Petroleum Corp.								
O. J. Hoover	4-B *	SW NW 11-30-16	1-22-59	1684-1720	1792-1818	1885	59	
O. J. Hoover	5-B	NE SW 11-30-16	1-18-59	1832-1868	1938-1961	2030	165	
O. J. Hoover	6-B	SW SW 11-30-16	2-1-59	1943-1970	2026-2060	2117	189	
O. J. Hoover	1-C *	SE SW 11-30-16	11-14-58	2056-2075	2146-2175	1856	216	
Petro-Atlas, Inc.								
Horseshoe Canyon	1-A	NE NE 4-30-16	7-24-57	1605-1647	1736-1746	1810	113	
Horseshoe Canyon	2-A	NW NE 4-30-16	7-30-57	1162-1206	1278-1306	1365	120	195/1
Horseshoe Canyon	1-B	NE NE 9-30-16	7-23-57	1504-1542		1711	134	
Horseshoe Canyon	2-B	SE NE 9-30-16	12-4-58	1245-1289 1308-1322		1456	102	
Horseshoe Canyon	1-C	NW NE 3-30-16	10-9-58	1522-1566		1730	112	TSTM
Horseshoe Canyon	1-D	NE NE 5-30-16	10-7-58	1088-1133	1182-1222	1265	148	
Horseshoe Canyon	2-D	SE NE 5-30-16	10-10-58	1073-1121		1266	140	
Horseshoe Canyon	3-D	NW NE 5-30-16	10-13-58	1086-1136	1169-1175	1265	133	
Horseshoe Canyon	4-D	SW NE 5-30-16	10-16-58	1070-1101 1104-1114		1240	136	
Horseshoe Canyon	1-E	NE NW 9-30-16	11-22-58	1481-1520		1628	118	
Ute	1	SW SE 33-31-16	9-7-58	1135-1142 1146-1166 1169-1178	1257-1278	1350	128	

* 4-1/2" Production Casing.

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Exhibit No. 10

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Pan American Petroleum Corp.								
O. J. Hoover	4-B *	SW NW 11-30-16	1-22-59	1684-1720	1792-1818	1885	59	
O. J. Hoover	5-B	NE SW 11-30-16	1-18-59	1832-1868	1938-1961	2030	165	
O. J. Hoover	6-B	SW SW 11-30-16	2-1-59	1943-1970	2026-2060	2117	189	
O. J. Hoover	1-C *	SE SW 11-30-16	11-14-58	2056-2076	2146-2175	1856	216	
Petro-Atlas, Inc.								
Horseshoe Canyon	1-A	NE NE 4-30-16	7-24-57	1605-1647	1736-1746	1810	113	
Horseshoe Canyon	2-A	NW NE 4-30-16	7-30-57	1162-1206	1278-1306	1365	120	195/1
Horseshoe Canyon	1-B	NE NE 9-30-16	7-23-57	1504-1542		1711	134	
Horseshoe Canyon	2-B	SE NE 9-30-16	12-4-58	1245-1289 1308-1322		1456	102	
Horseshoe Canyon	1-C	NW NE 3-30-16	10-9-58	1522-1566		1730	112	TSTM
Horseshoe Canyon	1-D	NE NE 5-30-16	10-7-58	1088-1133	1182-1222	1265	148	
Horseshoe Canyon	2-D	SE NE 5-30-16	10-10-58	1073-1121		1266	140	
Horseshoe Canyon	3-D	NW NE 5-30-16	10-13-58	1086-1136	1169-1175	1265	133	
Horseshoe Canyon	4-D	SW NE 5-30-16	10-16-58	1070-1101 1104-1114		1240	136	
Horseshoe Canyon	1-E	NE NW 9-30-16	11-22-58	1431-1520		1628	118	
Ute	1	SW SE 33-31-16	9-7-58	1135-1142 1146-1166 1169-1178	1257-1278	1350	128	

* 4-1/2" Production Casing.

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Petro-Atlas, Inc.								
Ute	2	NW SE 33-31-16	9-18-58	1140-1182	1266-1278	1350	131	

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Exhibit No. 10

CHIMNEY ROCK FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Bayless Oil Company								
Navajo	2	SE NE 5-31-17	5-18-58		1111-1163 *	1225	60	
Navajo	4	NE NE 5-31-17	5-18-58		1133-1166 *	1166	50	
Honolulu Oil Corporation								
Navajo	2-5	NE SE 5-31-17	12-5-58		1107-1117	1170	59	
Humble Oil & Refining Co.								
Navajo	1-F	NW NW 4-31-17	11-5-58		1147-1160	1227	30	167/1
Navajo	2-F	SW NW 4-31-17	10-20-58		1118-1152 *	1152	39	182/1
Navajo	3-F	NW SW 4-31-17	1-26-59		1084-1116	1126	117	129/1

* Open Hole

HORSESHOE GAL' UP POOL
SAN JUAN COUNTY, NEW MEXICO
CORE ANALYSIS OF SANDS "A" AND "B"

	SAND "A"	SAND "B"
Average Porosity	14.3 %	18.1 %
Median Permeability	35 md.	95 md.
Average Connate Water Saturations	40 %	35.5 %
Average Total Water Saturations	40.1 %	40.6 %
Average Residual Oil Saturations	13.5 %	15.5 %
Number of Wells	22	18

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 11
Date February 18, 1959

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 12
Date February 18, 1959

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
BOTTOM HOLE PRESSURES SANDS "A" AND "B"

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Survey Date	Shut-In Time Hours	BHP * Sand "A"	BHP ** Sand "B"	BHP *** Sand "B"	Remarks
El Paso Natural Gas Products Co.								
Horseshoe Canyon	1	NE SE 4-30-16	2-8-59	72		238	201	Natural Completion
Horseshoe Canyon	4	SE SW 3-30-16	11-1-57	48		243	209	Natural Completion Initial BHP Survey
Horseshoe Canyon	6	NW NW 10-30-16	1-28-59	43	194			Sandoil Fractured
Horseshoe Canyon	8	NE SW 4-30-16	1-29-59	192	180			Sandoil Fractured
Horseshoe Canyon	2-B	NE NW 4-30-16	9-24-57	49		276	243	Natural Completion Initial BHP Surveys
			10-4-57	48	221			

Gradient 0.335 psi/ft.

* Datum + 4175'
** Datum + 4075'
*** Datum + 4175'

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 13
Date February 18, 1959

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
INDIVIDUAL PRODUCTION TESTS OF SANDS "A" AND "B"

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Swab Test Sand "A" BOPD	Swab Test Sand "B" BOPD	Pump Test Sand "A" BOPD	Pump Test Sand "A" GOR	Pump Test Sand "B" BOPD	Pump Test Sand "B" GOR	Remarks
El Paso Natural Gas Products Co.									
Horseshoe Canyon	4	SE SW 3-30N-16W			21	TSTM	74	125	Neither sand sandoil fractured.
Horseshoe Canyon	6	NW NW 10-30N-16W			80	175	119	81	Both sands sandoil fractured.
Horseshoe Canyon	8	NE SW 4-30N-16W			109	193	89	79	Both sands sandoil fractured.
Horseshoe Canyon	2-B	NE NW 4-30N-16W		100	50				Neither sand sandoil fractured.
Horseshoe Ute	4	NE SW 33-31N-16W	203	264					Both sands sandoil fractured.
Atlantic Refining Company									
Navajo	1	SE SE 32-31N-16W	512	598					Both sands sandoil fractured.
Pan American Petroleum Corp.									
Aldlin	1-A	NW NE 10-30N-16W			108		96		Both sands sandoil fractured.

DUAL COMPLETION EQUIPMENT
HORSESHOE GALLUP OIL POOL
San Juan County, New Mexico

Subsurface Equipment

1. 5-1/2", 15.50#, J-55 production casing is set through both producing zones and cemented. Cement is circulated across both zones by the single stage method.

2. 1-1/2", 2.75#, J-55, non-upset tubing will be used to produce the lower zone. A tension type retrievable production packer will be run and set on this tubing string. This will maintain separation between the two zones. A parallel tubing string anchor will be run in this tubing string to anchor the tubing string for the top zone.

3. 1-1/2", 2.75#, J-55 non-upset tubing will be used to produce the top zone. This tubing string will be latched into the parallel tubing string anchor.

4. The pumps for each zone will be a 1-1/4"common working barrel tubing pump. The pumps will be activated by separate rod strings.

Tubing Head

1. The tubing head will suspend the tubing strings separately.

Pumping Unit

1. Existing pumping units are of sufficient rating to pump both zones at the same time.

2. The pumping of both zones at the same time with the same pumping unit can be accomplished by using a dual horse's head.

Metering of Oil

1. Each zone will produce into a separator. The separators will consist of a single unit with a divider between the separator chambers.

2. Oil from the separator will be metered by positive displacement meters. Inidividual meters will be used for each zone.

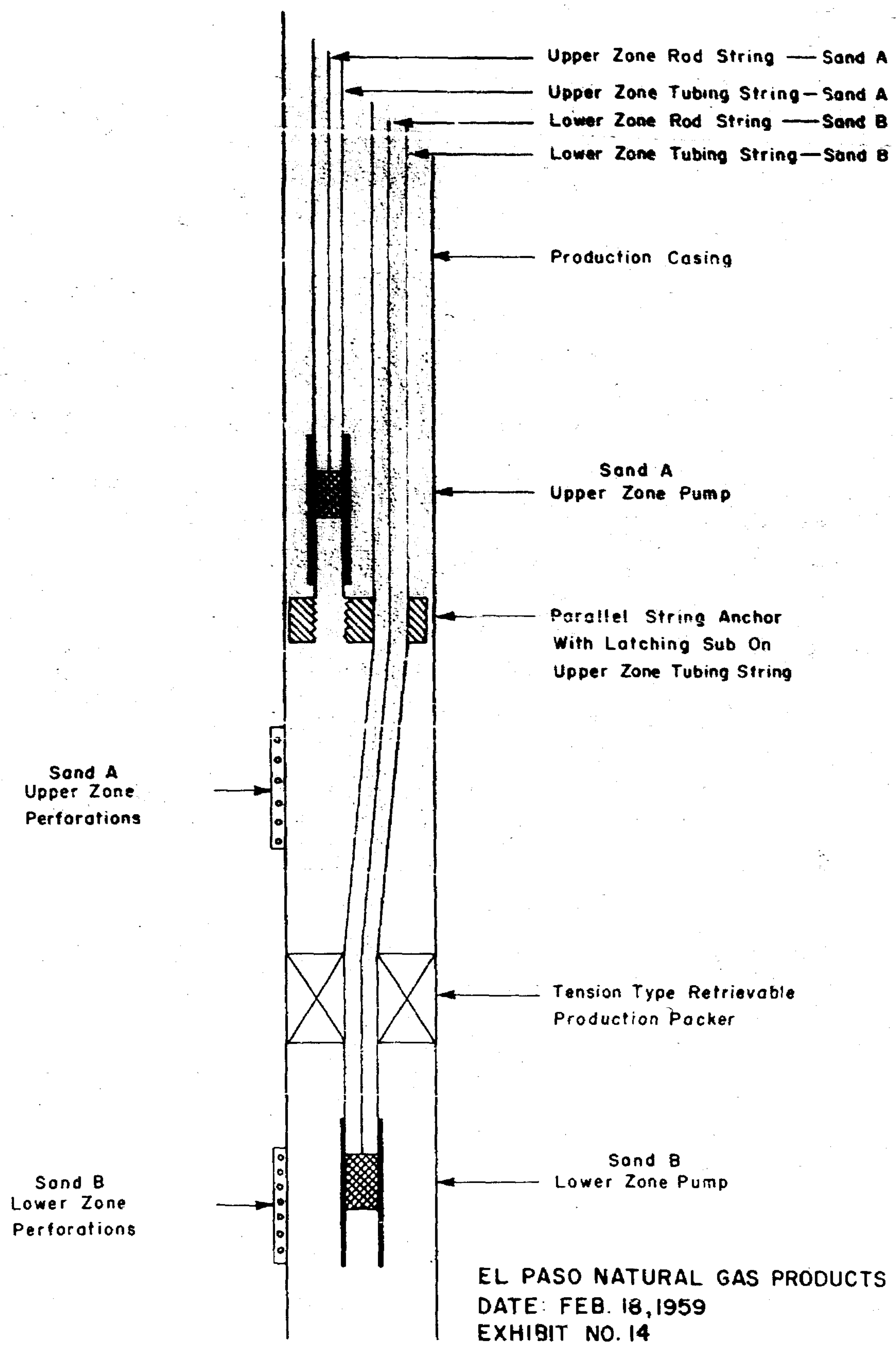
3. After oil is metered it will be commingled into the existing flow line to the existing battery.

4. By metering the oil in this manner it will not be necessary to construct storage facilities and separate flow lines for each zone.

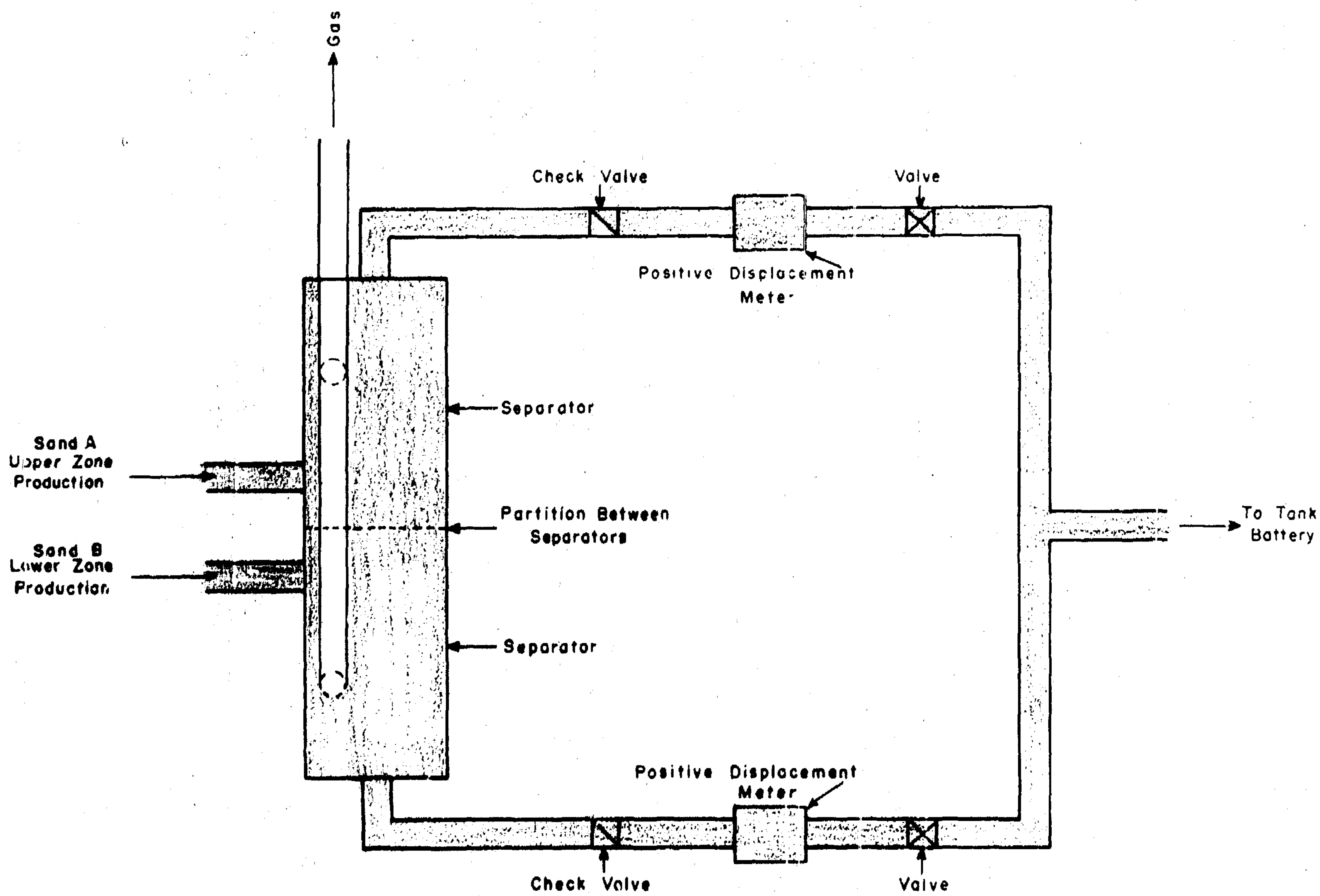
Schematic Diagram of Subsurface Equipment

Dual Pumping Installation

Horseshoe – Gallup Oil Pool
San Juan County, New Mexico



EL PASO NATURAL GAS PRODUCTS CO.
DATE: FEB. 18, 1959
EXHIBIT NO. 14
CASE NO. 1596



Schematic Diagram
Separating and Metering Installation
Dual Completion

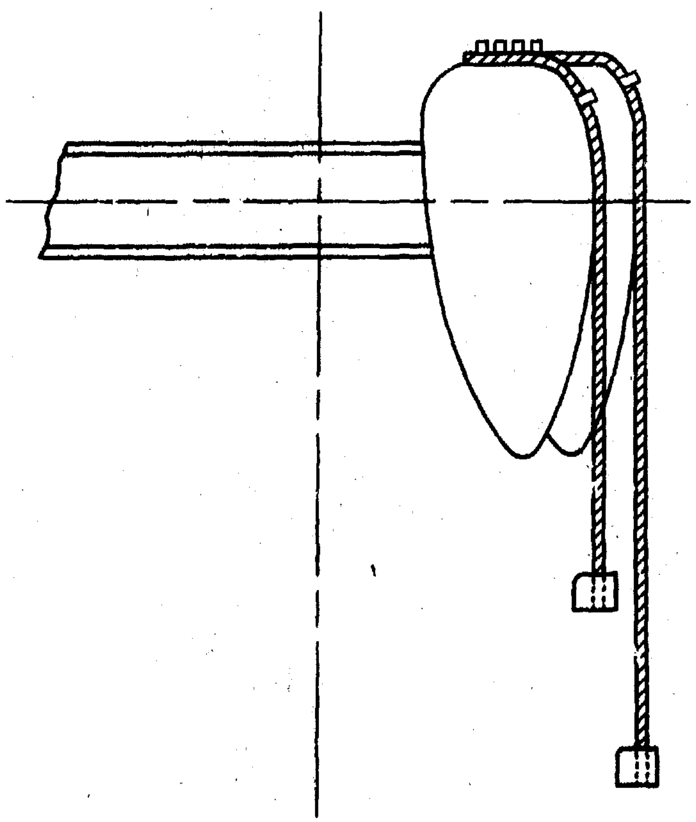
Horseshoe Canyon-Gallup Oil Pool
San Juan County, New Mexico

EL PASO NATURAL GAS PRODUCTS CO.
DATE: FEB. 18, 1959
EXHIBIT NO. 15
CASE NO. 1596

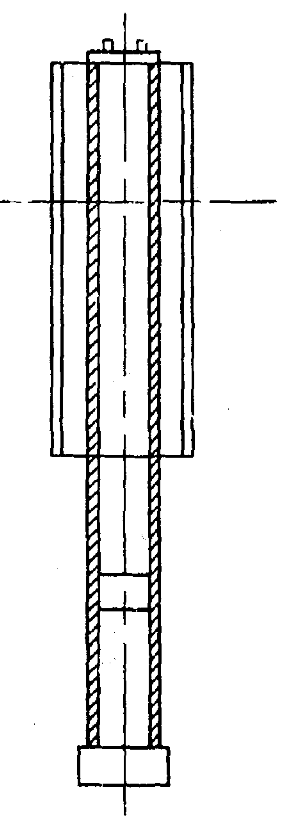
HORSESHOE GALLUP FIELD

SAN JUAN COUNTY, NEW MEXICO

DUAL CARRIER BAR HORSEHEAD INSTALLATION



SIDE VIEW



FRONT VIEW

EL PASO NATURAL GAS PRODUCTS CO.
DATE: FEB. 18, 1959
EXHIBIT NO. 16
CASE NO. 1596

Case No.

1596

Application, Transcript,
Small Exhibits, Etc.

NO. | NAME

EL PASO NATURAL GAS PRODUCTS CO.
HORSESHOE GALLUP DUAL COMPLETION
San Juan County, New Mexico

CASE NO. 1596
EXHIBITS 10 thru 16

1A

CORE ANALYSIS REPORT

FOR

EL PASO NATURAL GAS PRODUCTS COMPANY

LOWER GALLUP SAND RESERVOIR

HORSESHOE CANYON NO. 4 WELL

HORSESHOE CANYON FIELD

SAN JUAN COUNTY, NEW MEXICO

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
1596 EXHIBIT No. 23
CASE 1596

Reservoir Engineering Laboratories
607 SOUTH HASKELL AVENUE
Dallas 10, Texas

Reservoir Engineering Laboratories
A DIVISION OF TEKOIL CORPORATION
407 SOUTH HASKELL AVENUE
Dallas 10, Texas

TELEPHONE
TAYLOR 4-0173

April 15, 1958

FILE NO.
EP-3037

El Paso Natural Gas Products Company
Box 1161
El Paso, Texas

Attention: Mr. Roy Allen

Gentlemen:

Routine Core Analysis Results
Lower Gallup Sand Reservoir - Horseshoe Canyon No. 4 Well
Horseshoe Canyon Field--------San Juan County, New Mexico

You will find enclosed the results of the routine analyses of samples of cores from the Lower Gallup Sand Reservoir in the Horseshoe Canyon No. 4 Well, Horseshoe Canyon Field, San Juan County, New Mexico.

The entire interval from 1500 feet to 1631 feet was cored using rotary coring tools. Samples of the recovered core were selected in the field by a representative of the El Paso Natural Gas Products Company and shipped to our laboratory in Dallas for plug type analysis.

Samples from the depth interval 1588 feet to 1623 feet representing the most obviously productive portion of the formation were frozen and shipped in insulated freeze boxes. The remaining cores were shipped unpreserved in cardboard cartons. With the exception of any feet which were solid shale, complete routine analysis results were requested on each foot of core submitted. Also, it was requested that each foot of core be carefully examined for fractures by a qualified geologist, and that mention be made of the absence or presence of such fractures in the written report.

The examination for fractures was conducted as requested, and no fractures were found.

Arithmetic averages of the results of the analyses are shown below. Permeability values which are less than 0.05 md. are reported as zero and all of the results obtained for the samples reported as having zero permeability are omitted from the averages.

FORM 10

Reservoir Engineering Laboratories

El Paso Natural Gas Products Company

File No. EP-3037

	Horizontal Air Permeability (md.)	Porosity (% bulk volume)	Liquid Saturation (% pore space) Residual Oil	Liquid Saturation (% pore space) Total Water
All Cores Received	60	13.1	6.7	25.9
Preserved Cores Only (Frozen)	183	18.3	12.6	39.1
Nonpreserved Cores Only	5.8	10.8	4.1	20.1

Information pertinent to the interpretation of the results will be found listed in note form on the tabular data sheets.

A coregraph depicting the results obtained will be found following the tabular data.

This opportunity to be of service to you is sincerely appreciated.

Yours very truly,

RESERVOIR ENGINEERING LABORATORIES

Harold S. Deyo

Harold S. Deyo, Laboratory Manager

Copies to:

Roy Allen
Truett Hollis
Wm. R. Speer
R. E. Houser
Rex Corey

FORM 10

Reservoir Engineering Laboratories

ROUTINE CORE ANALYSIS RESULTS

Company: El Paso Natural Gas Products Company

Date: April 15, 1958

Well: Horseshoe Canyon No. 4

File No.: EP-3037

Reservoir: Lower Gallup Sand

Core Diameter: 3½"

Field: Horseshoe Canyon

Coring Fluid: --

County: San Juan

Coring Tools: Diamond

State: New Mexico

Remarks: ---

Note: Permeability results which are less than 0.05 md. are reported as zero.

Sample Number	Depth (ft.)	Description of Formation	Horizontal Air Permeability (md.)	Porosity (% bulk volume)	Liquid Saturation (% pore space) Residual Oil	Liquid Saturation (% pore space) Total Water
1	1500-01	shy calc ss w/ sh lam	0.2	9.2	4.5	23.1
2	1501-02	shy calc ss w/ sh lam	0.2	10.0	2.2	18.4
3	1502-03	shy calc ss w/ sh lam	0.3	10.4	0	28.2
4	1503-04	calc ss w/ sh lam	0.2	4.4	0.4	13.7
5	1504-05	calc ss w/ sh lam	0.5	13.6	4.1	14.5
6	1505-06	calc ss w/ thin sh lam	1.0	14.5	5.8	17.4
7	1506-07	calc ss w/ sh lam	0.2	6.1	4.3	19.4
8	1507-08	calc ss w/ sh lam	0.9	12.9	4.2	19.2
9	1508-09	shy calc cgl	0.1	5.0	0.2	19.4
10	1509-10	ss w/ sh lam	165	20.5	3.9	15.5
11	1510-11	ss w/ sh lam	0.9	12.5	5.9	14.6
12	1511-12	ss w/ sh lam	82	19.4	8.2	8.2
13	1512-13	shy ss w/ sh lam	67	18.5	5.3	13.2
14	1513-14	shy ss w/ sh lam	8.7	15.9	1.7	17.1
15	1514-15	ss w/ thin sh lam	114	11.8	3.1	6.2
16	1515-16	ss w/ sh lam	0.2	8.3	0	16.1
17	1516-17	ss	2.9	13.9	0	11.1
18	1517-18	shy calc ss w/ sh lam	0.3	7.2	0	18.8
19	1518-19	shy calc ss w/ sh lam	0.2	5.7	5.6	16.3
20	1519-20	calc ss w/ thin sh lam	1.3	5.6	0	12.5
21	1520-21	shy calc ss w/ sh lam	0.6	14.5	0	15.4
22	1521-22	calc ss w/ thin sh lam	0.3	4.7	1.4	12.5
23	1522-23	shy calc ss	0.3	6.3	0	21.2
24	1523-24	calc ss w/ sh lam	0.3	6.8	0	29.3
25	1524-25	calc ss w/ sh lam	0.1	2.9	0	24.0
26	1525-26	sdy calc sh w/ thin ss strk	0.5	13.7	0	18.8
27*	1526-27	shy calc ss w/ sh lam	0	13.2	0	12.8
28	1527-28	shy calc ss	0.2	9.6	0	23.8
29	1528-29	shy calc ss	0.1	8.1	0	26.3
30*	1529-30	sdy sh w/ thin calc ss lam	0	12.2	0	26.4

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Reservoir Engineering Laboratories

File No. EP-3037

Sample Number	Depth (ft.)	Description of Formation	Horizontal Air Permeability (md.)	Porosity (% bulk volume)	Liquid Saturation (% pore space) Residual Oil	Total Water
31	1530-31	shy calc ss	0.2	7.1	0	20.9
32	1531-32	calc ss w/ thin sh lam	0.1	11.2	0	24.7
33	1532-33	shy calc ss	0.2	12.3	0	28.6
34	1533-34	shy calc ss	0.1	10.4	0	27.2
35	1534-35	shy calc ss	0.2	12.2	0	31.3
36	1535-36	shy calc ss	0.1	12.6	0	25.6
37	1536-37	shy calc ss	0.1	12.3	0	17.6
38	1537-38	shy calc ss	1.0	11.8	0	19.9
39	1538-39	shy calc ss	0.3	10.7	0	21.2
40	1539-40	shy calc ss	0.2	13.7	0	28.7
41	1540-41	shy calc ss	0.1	15.4	3.6	15.5
42	1541-42	shy calc ss	0.3	13.2	0	22.5
43	1542-43	shy calc ss	0.5	11.3	3.0	20.2
44	1543-44	shy calc ss	0.3	14.2	3.5	14.8
45	1544-45	shy calc ss w/ sh lam	0.2	10.8	3.7	21.3
46	1545-46	shy calc ss w/ sh lam	0.2	14.4	2.6	14.9
47	1546-47	shy calc ss	0.3	13.3	5.1	13.8
48	1547-48	shy calc ss	0.1	13.0	4.1	17.0
49	1548-49	shy calc ss w/ sh lam	0.2	12.5	4.9	18.4
50	1549-50	calc ss w/ sh lam	0.2	11.4	6.3	22.0
51	1550-51	shy calc ss w/ sh lam	0.6	12.4	8.8	13.2
52	1551-52	shy calc ss	0.2	11.9	8.0	14.3
53	1552-53	shy calc ss	0.3	12.5	6.6	16.0
54	1553-54	shy calc ss w/ shy sh lam	0.2	9.3	7.5	17.5
55	1554-55	shy calc ss w/ sdy sh lam	0.2	9.0	4.9	19.0
56	1555-56	sdy sh w/ thin calc ss strk	0.4	12.7	8.2	19.0
57	1556-57	shy calc ss	0.1	11.7	7.5	13.9
58	1557-58	shy calc ss w/ sdy sh lam	0.2	10.9	6.7	17.2
59	1558-59	shy calc ss w/ sdy sh lam	0.2	11.3	7.1	21.3
60	1559-60	shy calc ss w/ sdy sh lam	0.1	9.7	8.3	18.2
61	1560-61	shy calc ss w/ sdy sh lam	0.3	10.1	6.6	19.1
62	1561-62	shy calc ss w/ sdy sh lam	0.1	6.0	7.6	22.3
63	1562-63	shy calc ss	0.1	8.9	9.1	19.6
64	1563-64	shy calc ss	0.2	10.4	7.9	22.3
65	1564-65	sdy sh w/ thin calc ss strk	0.1	11.1	1.1	21.6
66	1565-66	sdy sh w/ thin calc ss strk	0.2	9.7	7.9	18 0
67	1566-67	sdy sh w/ thin calc ss strk	0.2	11.7	10.3	18.1
68	1567-68	shy calc ss w/ sdy sh lam	0.1	10.6	12.5	13.6
69*	1568-69	shy calc ss w/ sdy sh lam	0	12.1	13.9	16.8
70	1569-70	shy calc ss	0.1	12.2	9.9	15.8
71*	1570-71	shy calc ss w/ sdy sh lam	0	8.7	10.9	22.7
72	1571-72	shy calc ss w/ sdy sh lam	0.1	6.7	12.2	21.7
73	1572-73	shy calc ss w/ sdy sh lam	0.6	8.2	2.8	27.1
74	1573-74	sdy sh w/ thin calc ss strk	1.9	8.1	10.5	22.4
75*	1574-75	sdy sh w/ thin calc ss strk	0	10.6	12.1	25 4

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Sample Number	Depth (ft.)	Description of Formation	Horizontal Air Permeability (md.)	Porosity (% bulk volume)	Liquid Saturation (% pore space) Residual Oil	Liquid Saturation (% pore space) Total Water
76*	1575-76	sdy sh w/ thin calc ss strk	0	11.0	3.8	25.5
77*	1576-77	sh w/ thin calc ss strk	0	9.8	3.0	25.1
78*	1577-78	sh w/ thin calc ss strk	0	10.9	0.5	20.9
79	1578-79	shy calc ss w/ sdy sh lam	0.4	8.4	0	20.0
80*	1579-80	sdy sh w/ thin calc ss strk	0	10.2	9.3	21.9
81	1580-81	shy calc ss w/ sdy sh lam	0.4	10.7	0.6	29.9
82	1581-82	sdy sh w/ thin calc ss strk	0.1	9.6	13.3	43.4
83	1582-83	sdy sh w/ thin calc ss strk	1.5	12.4	6.6	29.0
84	1583-84	sdy sh w/ thin calc ss strk	0.2	11.2	7.6	19.6
85	1584-85	sdy sh w/ thin calc ss strk	1.4	10.9	6.7	32.6
86	1585-86	sdy sh w/ thin calc ss strk	0.3	12.0	8.0	27.7
87	1586-87	sdy sh w/ thin calc ss strk	0.7	10.9	6.8	22.8
88	1587-88	sdy sh w/ thin calc ss strk	0.2	9.4	2.7	28.3
		The samples which were preserved by freezing begin here.				
89	1588-89	shy calc ss w/ sh lam	2.3	14.2	4.0	54.7
90	1589-90	shy calc ss w/ sdy sh lam	2.5	13.3	19.2	41.0
91	1590-91	shy calc ss w/ sh lam	2.6	4.8	32.2	43.2
92	1591-92	shy calc ss	2.2	6.6	14.9	51.6
93	1592-93	shy ss w/ sh lam	83	23.0	13.6	29.2
94	1593-94	shy ss w/ sh lam	374	21.8	15.2	33.5
95	1594-95	shy ss w/ sh lam	186	21.4	16.6	31.7
96	1595-96	shy ss w/ sh lam	587	21.3	12.9	26.3
97	1596-97	shy ss w/ sh lam	291	20.3	15.3	34.7
98	1597-98	shy ss w/ sh lam	417	19.0	11.4	38.6
99	1598-99	ss w/ thin sh lam	702	22.1	12.2	36.9
100	1599-00	ss w/ sh lam	297	17.6	11.7	45.6
101	1600-01	ss w/ sh lam	50	17.3	11.0	23.2
102	1601-02	calc ss w/ sh lam	0.8	16.4	1.9	51.2
103	1602-03	shy ss w/ sh lam	45	15.9	11.7	48.1
104	1603-04	shy ss w/ sh lam	371	13.3	10.8	35.7
105	1604-05	shy ss w/ sh lam	86	18.8	13.7	38.7
106	1605-06	shy ss w/ sh lam	739	19.7	17.7	32.7
107	1606-07	shy ss w/ sh lam	1.3	14.9	19.1	36.0
108	1607-08	shy ss w/ sh lam	343	21.5	15.7	37.4
109	1608-09	shy ss w/ sh lam	75	20.9	15.4	33.1
110	1609-10	shy ss	261	21.2	15.6	39.5
111	1610-11	shy ss w/ sh lam	368	22.6	15.9	39.4
112	1611-12	shy ss w/ sh lam	53	23.5	12.2	30.4
113	1612-13	ss	354	24.4	11.8	34.0
114	1613-14	ss	268	24.4	11.9	35.0
115	1614-15	shy ss	70	23.7	11.0	35.3
116	1615-16	shy ss w/ sh lam	36	21.1	7.4	42.1
117	1616-17	shy ss	214	14.4	9.5	41.3
118	1617-18	shy calc ss	1.5	18.6	9.5	40.3
119	1618-19	shy calc ss	48	19.7	11.4	37.6

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Reservoir Engineering Laboratories

File No. EP-3037

Sample Number	Depth (ft.)	Description of Formation	Horizontal Air Permeability (md.)	Porosity (% bulk volume)	Liquid Saturation (% pore space) Residual Oil	Total Water
120	1619-20	ss w/ sh lam	51	18.4	11.2	43.8
121	1620-21	shy ss w/ sh lam	4.6	10.5	17.7	41.1
122	1621-22	shy calc ss w/ sh lam	3.0	14.9	0.2	52.6
123	1622-23	sh w/ thin calc ss strk	2.1	18.0	1.0	52.3
	The samples which were preserved by freezing end here.					
124*	1623-24	sh w/ thin calc ss strk	0	10.2	10.1	56.3
125*	1624-25	sh w/ thin calc ss strk	0	5.5	5.1	32.7
126	1625-26	shy calc ss w/ sdy sh lam	0.3	7.8	6.3	20.3
127*	1626-27	sh w/ thin calc ss strk	0	6.6	0	16.5
128*	1627-28	sh w/ thin calc ss strk	0	9.2	0	28.2
129*	1628-29	sh w/ thin calc ss strk	0	14.1	14.5	34.5
130*	1629-30	sh w/ thin calc ss strk	0	11.0	12.4	37.3
131*	1630-31	sh w/ thin calc ss strk	0	12.1	4.0	30.5

* The results obtained on this sample are omitted from the averages shown below due to the extremely low permeability (essentially zero).

Samples number 89 through 123 were preserved by freezing. All other samples were shipped in cardboard cartons and were not preserved.

ARITHMETIC AVERAGES

	Horizontal Permeability (md.)	Porosity (% bulk volume)	Liquid Saturation (% pore space) Residual Oil	Total Water
All Cores Received	60	13.1	6.7	25.9
Preserved Cores Only	183	18.3	12.6	39.1
Nonpreserved Cores Only	5.8	10.8	4.1	20.1

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE NO. 1596
Order No. R-1342

APPLICATION OF EL PASO NATURAL GAS
PRODUCTS COMPANY FOR THE ESTABLISH-
MENT OF TWO SEPARATE COMMON SOURCES
OF SUPPLY IN THE HORSESHOE-GALLUP OIL
FIELD, SAN JUAN COUNTY, NEW MEXICO,
AND FOR THE ESTABLISHMENT OF AN
ADMINISTRATIVE PROCEDURE FOR APPROVAL
OF WELLS DUALLY COMPLETED IN SAID PROPOSED
COMMON SOURCES OF SUPPLY UTILIZING A
CERTAIN TYPE OF MECHANICAL INSTALLATION.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on February 18, 1959, at Santa Fe, New Mexico, before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission."

NOW, on this 2nd day of March, 1959, the Commission, a quorum being present, having considered the application and the evidence adduced and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, El Paso Natural Gas Products Company, proposes that the producing interval of the Gallup formation in the Horseshoe-Gallup Oil Field, San Juan County, New Mexico, be segregated to form two separate common sources of supply.

(3) That the applicant further proposes the establishment of an administrative procedure for approval of wells dually completed in said proposed common sources of supply utilizing a certain type of mechanical installation in exception to Rule 112-A of the Commission Rules and Regulations.

(4) That the applicant failed to prove by a preponderance of the evidence that the producing interval of the Gallup formation underlying the said Horseshoe-Gallup Oil Field consists of two separate common sources of supply with no communication between the two.

(5) That accordingly the subject application should be denied.

IT IS THEREFORE ORDERED:

That the application of El Paso Natural Gas Products Company for the establishment of two separate common sources of supply in the producing interval of the Gallup formation underlying the Horseshoe-Gallup Oil Field in San Juan County, New Mexico, be and the same is hereby denied.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY E. MORGAN, Member

A. L. PORTER, Jr., Member & Secretary

ir/

Case 1596

GRANTHAM, SPANN AND SANCHEZ
ATTORNEYS AT LAW
904 SIMMS BUILDING
POST OFFICE BOX 1031
ALBUQUERQUE, NEW MEXICO

EVERETT M. GRANTHAM
CHARLES C. SPANN
MAURICE SANCHEZ

TELEPHONE
CHAPEL 3-3525

December 29, 1958

Set for
Feb Reg.

Secretary
Oil Conservation Commission
107 Mabry Hall, Capitol Building
Santa Fe, New Mexico

Dear Sir:

I enclose herewith application in behalf of El Paso Natural Gas Products Company in triplicate, which application has been signed by myself as attorney and is self explanatory.

We would like to request that if it is in order that this application be set down for hearing before an examiner on January 22nd which is a date heretofore fixed for examiner's hearing, as I understand it. If it is felt that the matter is one for consideration of the entire Commission, we would like to request that it be set down for hearing at the February meeting of the Commission.

Very truly yours,

GRANTHAM, SPANN AND SANCHEZ

By Charles C. Spann

CCS/bb
enclosures (3)

Docket Mailed
2-5-59
BP

BEFORE THE OIL CONSERVATION COMMISSION OF THE
STATE OF NEW MEXICO

IN THE MATTER OF THE APPLICATION)
OF EL PASO NATURAL GAS PRODUCTS)
COMPANY FOR AN ORDER ESTABLISHING)
AND DELINEATING TWO SEPARATE COM-)
MON SOURCES OF OIL IN THE HORSESHOE -)
GALLUP FIELD OF SAN JUAN COUNTY, NEW) CASE NO. 1596
MEXICO; PROHIBITING THE COMMINGLING)
OF OIL PRODUCED FROM SAID COMMON)
SOURCES IN THE WELL BORE AND PRO-)
VIDING FOR THE SEPARATE MEASUREMENT)
OF SUCH PRODUCTION; AND PERMITTING)
THE DUAL COMPLETION OF OIL WELLS)
COMPLETED IN BOTH OF SAID COMMON)
SOURCES OF SUPPLY AS AN EXCEPTION)
TO RULE 112A OF THE COMMISSION'S)
GENERAL RULES)

APPLICATION

COMES NOW, El Paso Natural Gas Products Company, a Texas Corporation, authorized to do business in the State of New Mexico, which alleges and states:

1. El Paso Natural Gas Products Company is the owner of oil and gas leases in the Horseshoe-Gallup Field of San Juan County, New Mexico, and is the operator of oil wells completed in two separate common sources of supply of oil found within the areal limits of said Field.

2. The first of these common sources of supply, hereinafter called Horseshoe-Gallup Sand A, is found at subsurface depths ranging from 1496' to 1536' in El Paso Natural Gas Products Company-Horseshoe Canyon #4 Well, located in the SE/4 SW/4 Section 3, Township 30 North, Range 16 West, San Juan County, New Mexico. The probable productive areal limits of the Horseshoe-Gallup Sand A include all or a portion of the following described lands in said County, to wit:

T 30 N, R 16 W Sec. 1, 2, 3, 4, 5, 9, 10, 11, 12, 14
T 31 N, R 16 W Sec. 19, 20, 27, 28, 29, 30, 31, 32,
33, 34, 35, 36
T 31 N, R 17 W Sec. 11, 13, 14, 15, 23, 24, 25

all as more particularly defined as the lands lying within the dashed red outline shown on Exhibit "A", attached hereto and made a part hereof.

3. The second common source of supply of oil covered by this application hereinafter called Horseshoe-Gallup Sand B, is found at subsurface depths ranging from 1598' to 1630' in applicant's said Horseshoe Canyon #4 Well. The probable productive areal limits of the Horseshoe-Gallup Sand B include all or a portion of the following described lands in San Juan County, New Mexico, to wit:

T 30 N, R 16 W Sec. 3, 4, 5, 9, 10, 11, 14
T 31 N, R 16 W Sec. 19, 29, 30, 31, 32, 33
T 31 N, R 17 W Sec. 3, 4, 5, 9, 10, 11, 13,
14, 15, 23, 24, 25

all as more particularly defined as the lands lying within the dotted green outline shown on Exhibit "A", attached hereto and made a part hereof.

4. The said Horseshoe-Gallup Sands A and B are separated vertically by an impervious shale body approximately 60' thick, and no communication of oil and gas exists between said separate common sources of supply.

5. An order establishing and delineating said separate common sources of supply, prohibiting the commingling of oil produced from said common sources in the well bore, and providing for the separate measurement of production from each of said common sources is necessary for the prevention of waste and the protection of correlative rights.

6. The procedures for the dual completion of oil wells in said common sources and the separate measurement of production therefrom, as described in Exhibit "B", attached hereto and made a part hereof, are in conformity with prudent operating practices and will not result in waste or violate the correlative rights of any person.

7. The names and addresses of all owners and operators of record within the area covered by this application are appended hereto as Exhibit "C". Copies of this application, with Exhibits, have been sent to all of said owners and operators by registered mail.

WHEREFORE, applicant respectfully requests that this matter be set down for hearing before this Commission, and that upon due notice and hearing the Commission enter its order establishing and delineating the separate common sources of supply, herein designated as Horseshoe-Gallup Sand A and B, prohibiting the commingling of oil produced from said common sources in the same well bore and requiring separate measurement of production therefrom, and permitting dual completion of oil wells in said common sources in accordance with the procedures described herein and upon administrative approval by the Secretary of the Commission as an exception to Rule 112A of the Commission's General Rules, and for such further or additional relief as may be required for the prevention of waste or protection of correlative rights in respect of this application.

GRANTHAM, SPANN AND SANCHEZ

By: [signature]

Attorneys for Applicant
904 Simms Building, Albuquerque, N. M.

EXHIBIT "B"

DUAL COMPLETION EQUIPMENT
HORSESHOE GALLUP OIL POOL
San Juan County, New Mexico

Subsurface Equipment

1. 5-1/2", 15.50#, J-55 production casing is set through both producing zones and cemented. Cement is circulated across both zones by the single stage method.

2. 1-1/2", 2.75#, J-55, non-upset tubing will be used to produce the lower zone. A tension type retrievable production packer will be run and set on this tubing string. This will maintain separation between the two zones. A parallel tubing string anchor will be run in this tubing string to anchor the tubing string for the top zone.

3. 1-1/2", 2.75#, J-55 non-upset tubing will be used to produce the top zone. This tubing string will be latched into the parallel tubing string anchor.

4. The pumps for each zone will be a 1-1/4 common working barrel tubing pump. The pumps will be operated by separate rod strings.

Tubing Head

1. The tubing head will suspend the tubing strings separately.

Pumping Unit

1. Existing pumping units are of sufficient rating to pump both zones at the same time.

2. The pumping of both zones at the same time with the same pumping unit can be accomplished by using a dual horse's head.

Metering of Oil

1. Each zone will produce into a separator. The separators will consist of a single unit with a divider between the separator chambers.

2. Oil from the separator will be metered by positive displacement meters. Individual meters will be used for each zone.

3. After oil is metered it will be commingled into the existing flow line to the existing battery.

4. By metering the oil in this manner it will not be necessary to construct storage facilities and separate flow lines for each zone.

EXHIBIT "C"

NAMES AND ADDRESSES OF OWNERS
AND OPERATORS IN THE HORSESHOE-
GALLUP FIELD

Tennessee Gas Transmission Company
P. O. Box 847
Durango, Colorado

Standard Oil Co. of Texas
P. O. Box 1249
Houston, Texas

Ralph Lowe
P. O. Box 832
Midland, Texas

J. Felix Hickman
3010 Monte Vista Blvd., N.E.
Albuquerque, New Mexico

Monsanto Chemical Co.
1310 Denver Club Bldg.
Denver, Colorado

El Paso Natural Gas Co.
P. O. Box 1492
El Paso, Texas

Colorado Oil & Gas Corp.
1000 Denver Club Bldg.
Denver, Colorado

Pan American Petroleum Corp.
P. O. Box 1714
Albuquerque, New Mexico

Petro-Atlas, Inc.
2000 National Bank of Tulsa Bldg.
Tulsa, Oklahoma

Arizona Explorations, Inc.
418 Meadows Bldg.
Dallas, Texas

Clark & Cowden
5543 Yale Blvd.
Dallas 6, Texas

The El Dorado Refining Co.
729 E. Main St.
Farmington, New Mexico

Charles B. Gonsales
Box 993
Santa Fe, New Mexico

J. R. Abraham
814 Mercantile Bank Bldg.
Dallas, Texas

Atlantic Refining Co.
P. O. Box 379
Durango, Colorado

Banner Drilling Co.
602 Gladeview Dr.
Farmington, New Mexico

Three States Natural Gas Co.
1700 Corrigan Tower Bldg.
Dallas, Texas

Reynolds Mining Corp.
1911 Melrose Bldg.
Houston, Texas

Magnolia Petroleum Co.
P. O. Box 900
Dallas, Texas

Humble Oil & Refining Co.
P. O. Box 2180
Houston, Texas

Honolulu Oil Corp.
P. O. Box 1417
Farmington, New Mexico

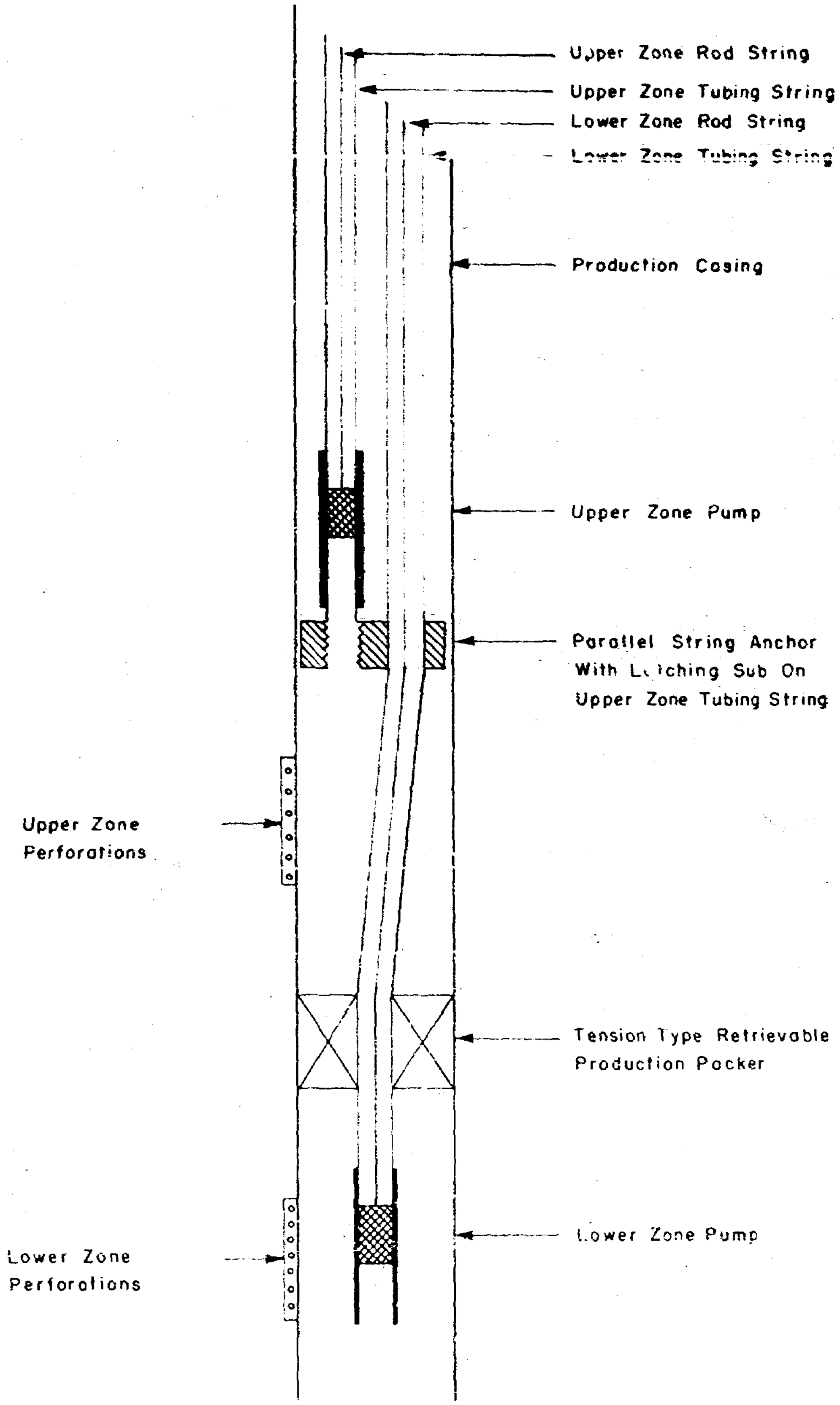
Tom Bolack
1010 N. Dustin
Farmington, New Mexico

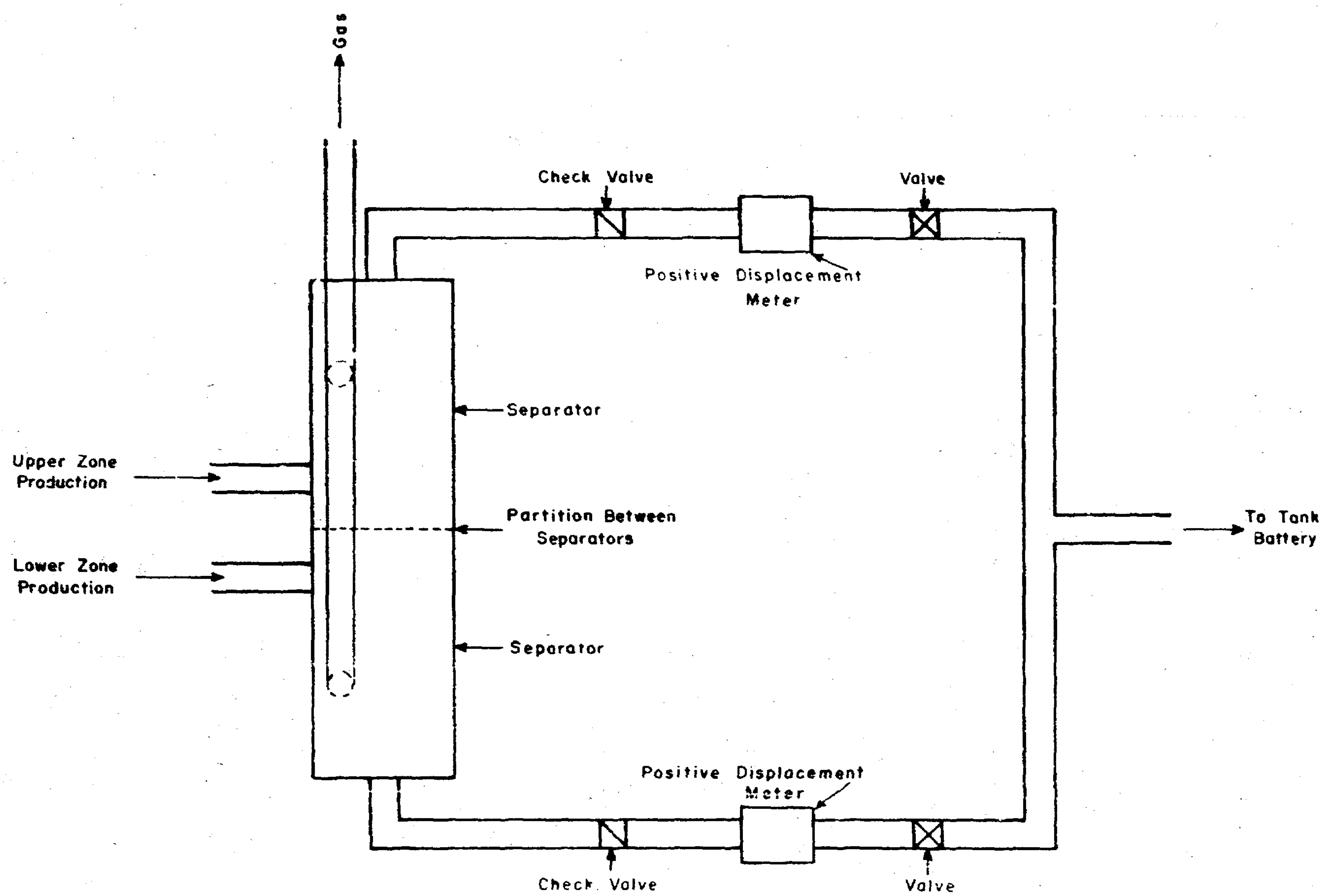
Schematic Diagram of Subsurface Equipment

Dual Pumping Installation

Horseshoe – Gallup Oil Pool

San Juan County, New Mexico





Schematic Diagram
Separating and Metering Installation
Dual Completion

Horseshoe Canyon-Gallup Oil Pool
San Juan County, New Mexico

EXHIBIT "C"

NAMES AND ADDRESSES OF OWNERS
AND OPERATORS IN THE HORSESHOE-
GALLUP FIELD

Tennessee Gas Transmission Company
P. O. Box 847
Durango, Colorado

Standard Oil Co. of Texas
P. O. Box 1249
Houston, Texas

Ralph Lowe
P. O. Box 832
Midland, Texas

J. Felix Hickman
3010 Monte Vista Blvd., N.E.
Albuquerque, New Mexico

Monsanto Chemical Co.
1310 Denver Club Bldg.
Denver, Colorado

El Paso Natural Gas Co.
P. O. Box 1492
El Paso, Texas

Colorado Oil & Gas Corp.
1000 Denver Club Bldg.
Denver, Colorado

Pan American Petroleum Corp.
P. O. Box 1714
Albuquerque, New Mexico

Petro-Atlas, Inc.
2000 National Bank of Tulsa Bldg.
Tulsa, Oklahoma

Arizona Explorations, Inc.
418 Meadows Bldg.
Dallas, Texas

Clark & Cowden
5543 Yale Blvd.
Dallas 6, Texas

The El Dorado Refining Co.
729 E. Main St.
Farmington, New Mexico

Charles B. Gonsales
Box 993
Santa Fe, New Mexico

J. R. Abraham
814 Mercantile Bank Bldg.
Dallas, Texas

Atlantic Refining Co.
P. O. Box 379
Durango, Colorado

Banner Drilling Co.
602 Gladeview Dr.
Farmington, New Mexico

Three States Natural Gas Co.
1700 Corrigan Tower Bldg.
Dallas, Texas

Reynolds Mining Corp.
1911 Melrose Bldg.
Houston, Texas

Magnolia Petroleum Co.
P. O. Box 900
Dallas, Texas

Humble Oil & Refining Co.
P. O. Box 2180
Houston, Texas

Honolulu Oil Corp.
P. O. Box 1417
Farmington, New Mexico

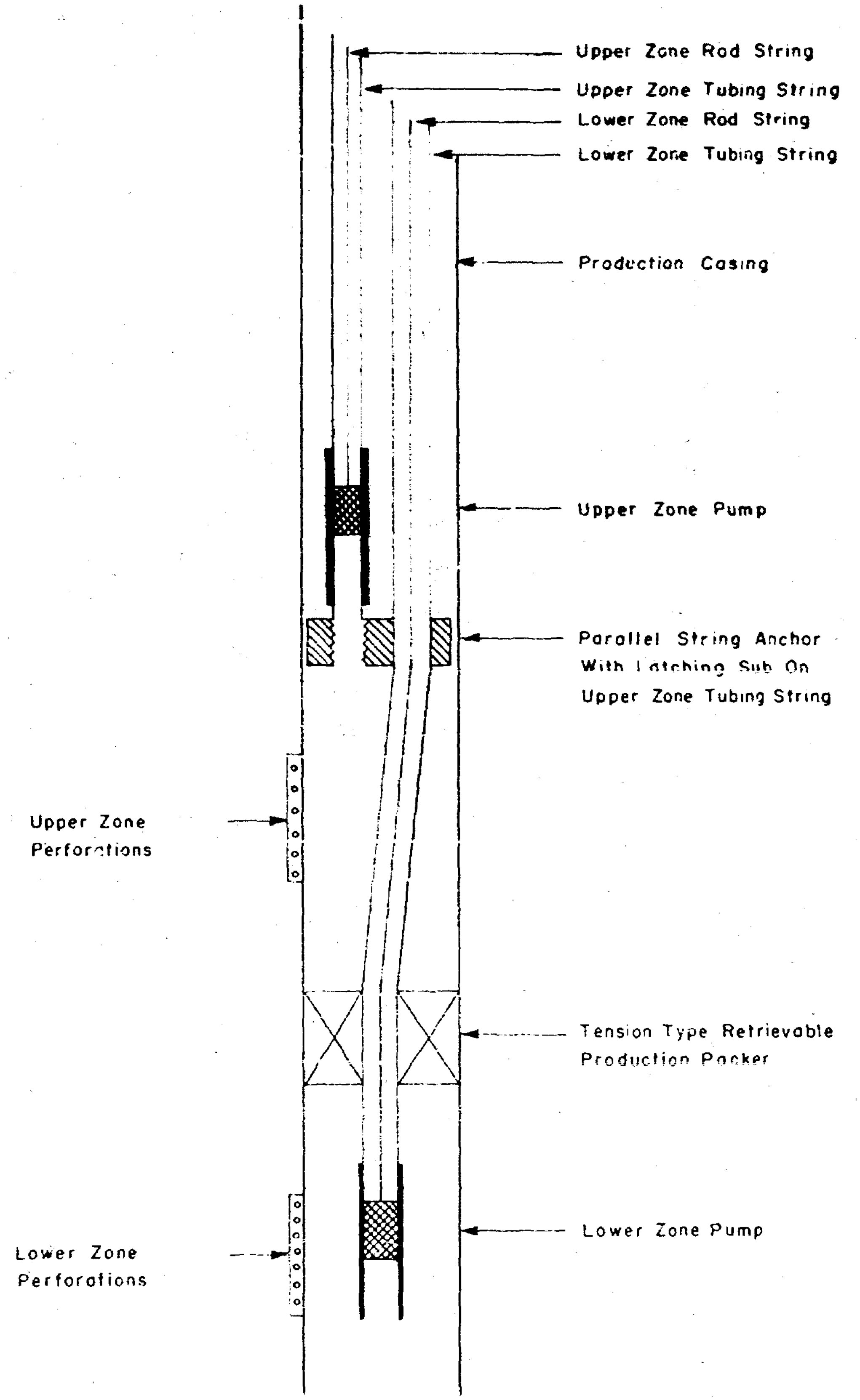
Tom Bolack
1010 N. Dustin
Farmington, New Mexico

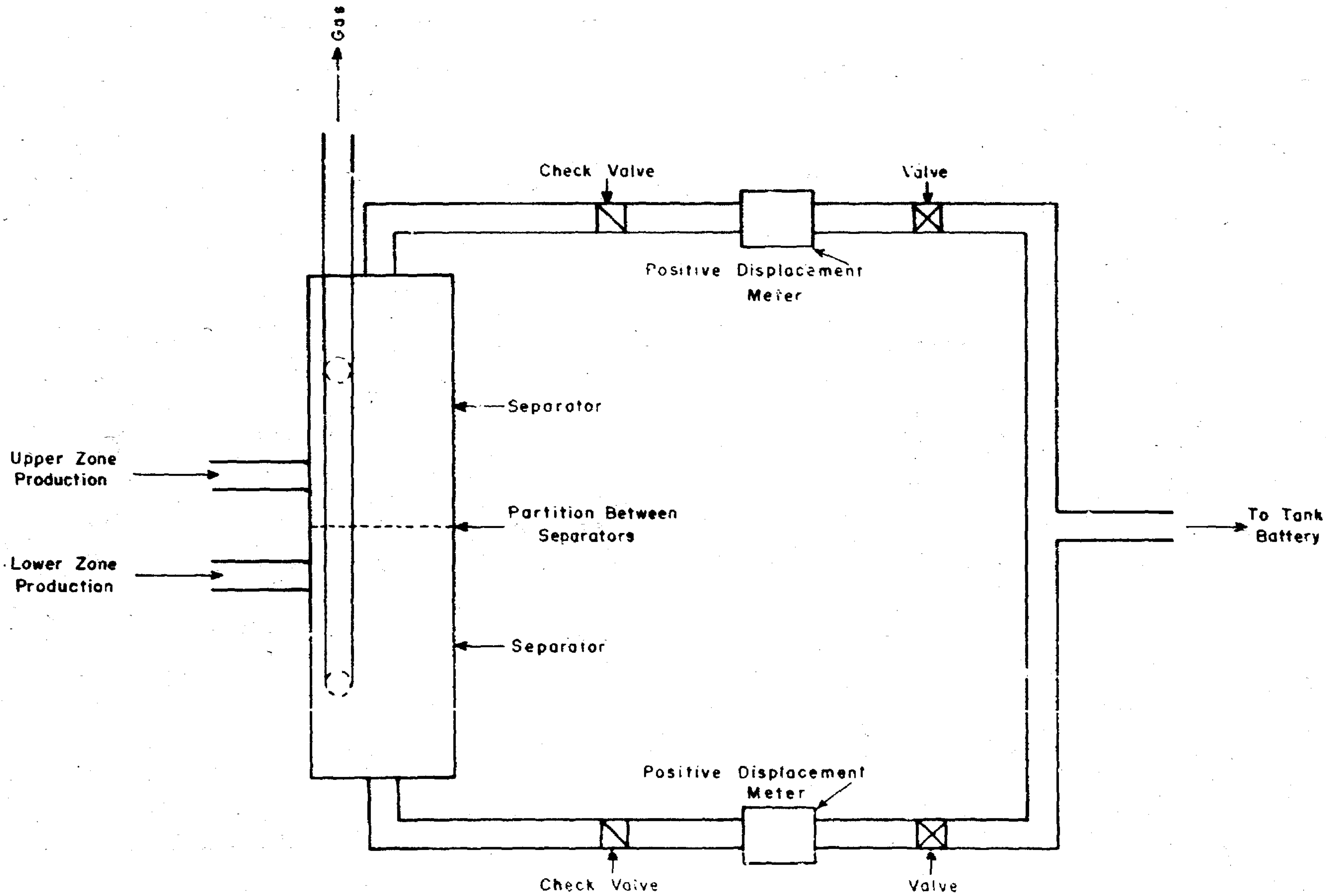
Schematic Diagram of Subsurface Equipment

Dual Pumping Installation

Horseshoe – Gallup Oil Pool

San Juan County, New Mexico





Schematic Diagram
Separating and Metering Installation
Dual Completion

Horseshoe Canyon-Gallup Oil Pool
San Juan County, New Mexico

BEFORE THE OIL CONSERVATION COMMISSION OF THE
STATE OF NEW MEXICO

IN THE MATTER OF THE APPLICATION OF EL PASO NATURAL GAS PRODUCTS COMPANY FOR AN ORDER ESTABLISHING AND DELINEATING TWO SEPARATE COMMON SOURCES OF OIL IN THE HORSESHOE - GALLUP FIELD OF SAN JUAN COUNTY, NEW MEXICO; PROHIBITING THE COMMINGLING OF OIL PRODUCED FROM SAID COMMON SOURCES IN THE WELL BORE AND PROVIDING FOR THE SEPARATE MEASUREMENT OF SUCH PRODUCTION; AND PERMITTING THE DUAL COMPLETION OF OIL WELLS COMPLETED IN BOTH OF SAID COMMON SOURCES OF SUPPLY AS AN EXCEPTION TO RULE 112A OF THE COMMISSION'S GENERAL RULES	)	CASE NO. 1596

APPLICATION

COMES NOW, El Paso Natural Gas Products Company, a Texas Corporation, authorized to do business in the State of New Mexico, which alleges and states:

1. El Paso Natural Gas Products Company is the owner of oil and gas leases in the Horseshoe-Gallup Field of San Juan County, New Mexico, and is the operator of oil wells completed in two separate common sources of supply of oil found within the areal limits of said Field.

2. The first of these common sources of supply, hereinafter called Horseshoe-Gallup Sand A, is found at subsurface depths ranging from 1496' to 1536' in El Paso Natural Gas Products Company-Horseshoe Canyon #4 Well, located in the SE/4 SW/4 Section 3, Township 30 North, Range 16 West, San Juan County, New Mexico. The probable productive areal limits of the Horseshoe-Gallup Sand A include all or a portion of the following described lands in said County, to wit:

T 30 N, R 16 W Sec. 1, 2, 3, 4, 5, 9, 10, 11, 12, 14
T 31 N, R 16 W Sec. 19, 20, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36
T 31 N, R 17 W Sec. 11, 13, 14, 15, 23, 24, 25

all as more particularly defined as the lands lying within the dashed red outline shown on Exhibit "A", attached hereto and made a part hereof.

3. The second common source of supply of oil covered by this application hereinafter called Horseshoe-Gallup Sand B, is found at subsurface depths ranging from 1598' to 1630' in applicant's said Horseshoe Canyon #4 Well. The probable productive areal limits of the Horseshoe-Gallup Sand B include all or a portion of the following described lands in San Juan County, New Mexico, to wit:

T 30 N, R 16 W Sec. 3, 4, 5, 9, 10, 11, 14
T 31 N, R 16 W Sec. 19, 29, 30, 31, 32, 33
T 31 N, R 17 W Sec. 3, 4, 5, 9, 10, 11, 13, 14, 15, 23, 24, 25

all as more particularly defined as the lands lying within the dotted green outline shown on Exhibit "A", attached hereto and made a part hereof.

4. The said Horseshoe-Gallup Sands A and B are separated vertically by an impervious shale body approximately 60' thick, and no communication of oil and gas exists between said separate common sources of supply.

5. An order establishing and delineating said separate common sources of supply, prohibiting the commingling of oil produced from said common sources in the well bore, and providing for the separate measurement of production from each of said common sources is necessary for the prevention of waste and the protection of correlative rights.

6. The procedures for the dual completion of oil wells in said common sources and the separate measurement of production therefrom, as described in Exhibit "B", attached hereto and made a part hereof, are in conformity with prudent operating practices and will not result in waste or violate the correlative rights of any person.

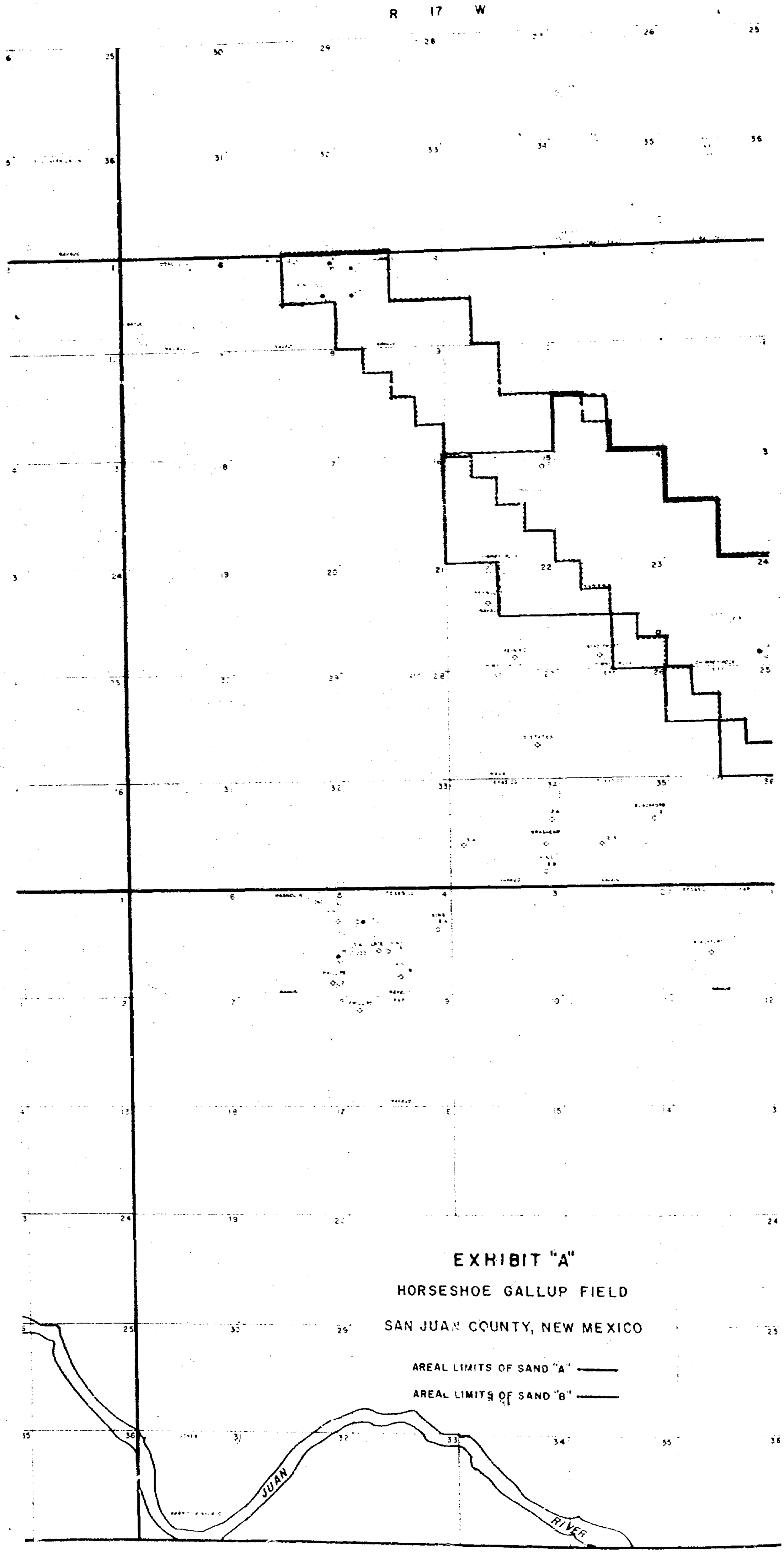
7. The names and addresses of all owners and operators of record within the area covered by this application are appended hereto as Exhibit "C". Copies of this application, with Exhibits, have been sent to all of said owners and operators by registered mail.

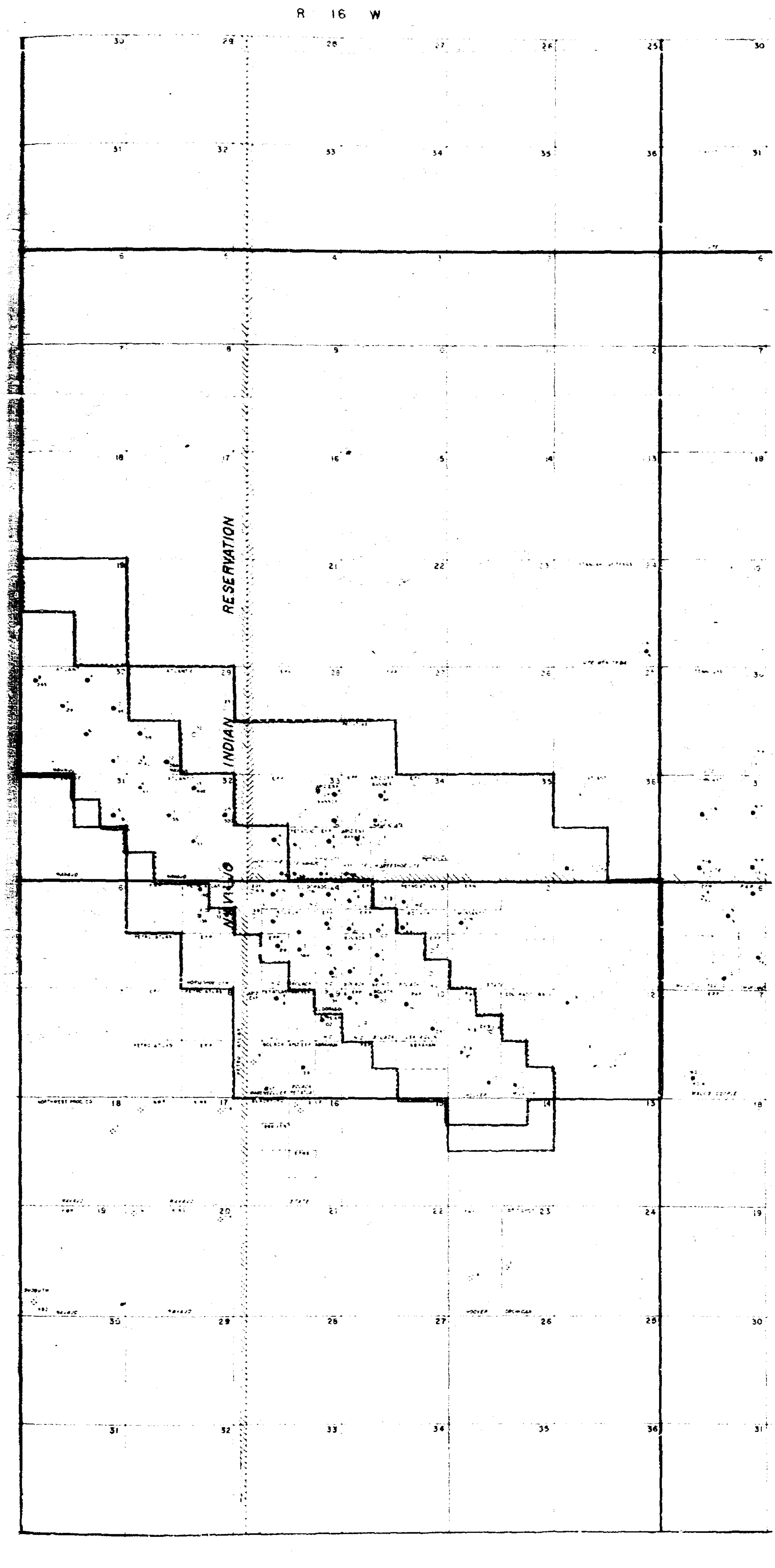
WHEREFORE, applicant respectfully requests that this matter be set down for hearing before this Commission, and that upon due notice and hearing the Commission enter its order establishing and delineating the separate common sources of supply, herein designated as Horseshoe-Gallup Sand A and B, prohibiting the commingling of oil produced from said common sources in the same well bore and requiring separate measurement of production therefrom, and permitting dual completion of oil wells in said common sources in accordance with the procedures described herein and upon administrative approval by the Secretary of the Commission as an exception to Rule 112A of the Commission's General Rules, and for such further or additional relief as may be required for the prevention of waste or protection of correlative rights in respect of this application.

GRANTHAM, SPANN AND SANCHEZ

By: Thos. Spann

Attorneys for Applicant
904 Simms Building
Albuquerque, New Mexico


R 17 W
EXHIBIT "A"
HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
AREAL LIMITS OF SAND "A"
AREAL LIMITS OF SAND "B"
JUAN
RIVER


R 16 W
RESERVATION
INDIAN

No. 6-59

DOCKET: REGULAR HEARING FEBRUARY 18, 1959

Oil Conservation Commission 9 a.m., Mabry Hall, State Capitol, Santa Fe

ALLOWABLE: (1) Consideration of the oil allowable for March 1959

(2) Consideration of the allowable production of gas for March 1959 from six prorated pools in Lea County, New Mexico; also consideration of the allowable production of gas from seven prorated pools in San Juan and Rio Arriba Counties, New Mexico, for March 1959.

NEW CASES

CASE 1596: Application of El Paso Natural Gas Products Company for the establishment of two separate common sources of supply, for administrative procedure for dual completions, and for commingling of production from separate oil pools. Applicant, in the above-styled cause, seeks an order segregating the producing interval of the Gallup formation in the Horseshoe-Gallup Field, San Juan County, New Mexico, into two separate common sources of supply. Applicant further seeks the establishment of an administrative procedure for approval of wells dually completed in said common sources of supply utilizing a certain type of mechanical installation in exception to Rule 112 (A) of the Commission Rules and Regulations. Applicant further seeks permission to commingle the production from said separate pools after metering the production from each.

CASE 1597: Application of the Atlantic Refining Company for an order promulgating temporary special rules and regulations for the Horseshoe-Gallup Oil Pool in San Juan County, New Mexico. Applicant, in the above-styled cause, seeks an order promulgating temporary special rules and regulations for the Horseshoe-Gallup Oil Pool in San Juan County, New Mexico, to provide for 80-acre proration units in said pool.

CASE 1598: Application of Phillips Petroleum Company for an order establishing 80-acre spacing units in the Ranger Lake-Pennsylvanian Pool, Lea County, New Mexico, and for extension of the horizontal limits of said pool. Applicant, in the above-styled cause, seeks an order promulgating special rules and regulations for the Ranger Lake-Pennsylvanian Pool, Lea County, New Mexico, to provide for 80-acre spacing units. Applicant further seeks an order extending said pool to include the following described acreage: W/2 W/2 of Section 13; All of Sections 14, 15, 22, 23, 26, and 27; W/2 NW/4 and SW/4 SW/4 of Section 24; and W/2 W/2 of Section 25, all in Township 12 South, Range 34 East, Lea County, New Mexico.

CASE 1599: Application of El Paso Natural Gas Company for 320-acre spacing, promulgation of special rules and regulations and for a redetermination of the vertical limits of the Angels Peak-Dakota Gas Pool, San Juan County, New Mexico. Applicant, in the above-styled cause, seeks an order establishing 320-acre spacing in the Angels Peak-Dakota Gas Pool in San Juan County, New Mexico, and for the promulgation of special rules and regulations for said pool. Applicant further seeks to change the vertical limits of the Angels Peak-Dakota Gas Pool to include the interval lying between the base of the Greenhorn limestone and the base of the upper productive portion of the Morrison formation.

CASE 1600: Application of M. A. Romero and Robert Critchfield concerning the operation of gas prorationing in the Blanco Mesaverde Gas Pool and the Choza Mesa-Pictured Cliffs Gas Pool in Rio Arriba County, New Mexico, and the ratable taking of gas from said pools.

CASE 1601: Southeastern New Mexico nomenclature case calling for an order for the extension of existing pools in Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico.

(a) Extend the Acme Pool to include:

TOWNSHIP 7 SOUTH, RANGE 27 EAST, NMPM
Section 32: SE/4
Section 33: SW/4

(b) Extend the North Allison-Pennsylvanian Pool to include:

TOWNSHIP 8 SOUTH, RANGE 36 EAST, NMPM
Section 35: NE/4

(c) Extend the Atoka-Pennsylvanian Gas Pool to include:

TOWNSHIP 18 SOUTH, RANGE 26 EAST, NMPM
Section 15: SE/4

(d) Extend the Caprock-Queen Pool to include:

TOWNSHIP 14 SOUTH, RANGE 31 EAST, NMPM
Section 29: E/2 NE/4

(e) Extend the West Henshaw-Grayburg Pool to include:

TOWNSHIP 16 SOUTH, RANGE 30 EAST, NMPM
Section 7: SE/4

(f) Extend the Justis-Ellenburger Pool to include:

TOWNSHIP 25 SOUTH, RANGE 37 EAST, NMPM
Section 24: SW/4
Section 25: NE/4

(g) Extend the Justis-Montoya Pool to include:

TOWNSHIP 25 SOUTH, RANGE 37 EAST, NMPM
Section 24: SE/4
Section 25: NE/4

(h) Extend the Maljamar Pool to include:

TOWNSHIP 18 SOUTH, RANGE 33 EAST, NMPM
Section 2: NW/4

(i) Extend the Red Lake-Pennsylvanian Gas Pool to include:

TOWNSHIP 18 SOUTH, RANGE 27 EAST, NMPM
Section 8: NE/4

CASE 1663: Northwestern New Mexico nomenclature case calling for an order for the extension of existing pools in San Juan and Rio Arriba Counties, New Mexico:

(a) Extend the Aztec-Fruitland Pool to include:

TOWNSHIP 29 NORTH, RANGE 10 WEST, NMPM
Section 30: N/2

TOWNSHIP 29 NORTH, RANGE 11 WEST, NMPM
Section 25: NE/4

(b) Extend the Aztec-Pictured Cliffs Pool to include:

TOWNSHIP 29 NORTH, RANGE 10 WEST, NMPM
Section 19: SE/4
Section 30: NE/4

(c) Extend the Blanco-Pictured Cliffs Pool to include:

TOWNSHIP 29 NORTH, RANGE 9 WEST, NMPM
Section 8: E/2

(d) Extend the Gavilan-Pictured Cliffs Pool to include:

TOWNSHIP 25 NORTH, RANGE 1 WEST, NMPM
Section 30: NE/4

(e) Extend the South Blanco-Pictured Cliffs Pool to include:

TOWNSHIP 25 NORTH, RANGE 6 WEST, NMPM
Section 22: SE/4
Section 23: W/2

TOWNSHIP 27 NORTH, RANGE 7 WEST, NMPM
Section 3: All

TOWNSHIP 28 NORTH, RANGE 7 WEST, NMPM
Section 15: SW/4
Section 21: SE/4
Section 22: N/2 & SW/4
Section 28: All
Section 31: E/2
Section 32: All
Section 33: All
Section 34: All
Section 35: SW/4

TOWNSHIP 28 NORTH, RANGE 8 WEST, NMPM
Section 29: All

(f) Extend the Tapacito-Pictured Cliffs Pool to include:

TOWNSHIP 25 NORTH, RANGE 3 WEST, NMPM
Section 23: SW/4

TOWNSHIP 26 NORTH, RANGE 3 WEST, NMPM
Section 27: SW/4

TOWNSHIP 27 NORTH, RANGE 4 WEST, NMPM
Section 19: S/2
Section 20: E/2 & SW/4
Section 29: NW/4

(g) Extend the Blanco-Mesaverde Pool to include:

TOWNSHIP 26 NORTH, RANGE 2 WEST, NMPM
Section 17: W/2
Section 18: All (partial)

(h) Extend the South Blanco-Dakota Pool to include:

TOWNSHIP 27 NORTH, RANGE 6 WEST, NMPM
Section 19: E/2

(i) Extend the Bisti-Lower Gallup Oil Pool to include:

TOWNSHIP 24 NORTH, RANGE 10 WEST, NMPM
Section 2: SE/4

TOWNSHIP 25 NORTH, RANGE 11 WEST, NMPM
Section 7: S/2 SE/4
Section 16: NW/4
Section 30: N/2 NW/4

TOWNSHIP 25 NORTH, RANGE 12 WEST, NMPM
Section 11: NW/4

(j) Extend the Chimney Rock-Gallup Oil Pool to include:

TOWNSHIP 31 NORTH, RANGE 17 WEST, NMPM
Section 5: NE/4 SE/4

(k) Extend the Escrito-Gallup Oil Pool to include:

TOWNSHIP 24 NORTH, RANGE 7 WEST, NMPM
Section 24: SW/4 & NW/4 SE/4
Section 25: NW/4

(l) Extend the Horseshoe-Gallup Oil Pool to include:

TOWNSHIP 30 NORTH, RANGE 16 WEST, NMPM
Section 9: E/2 NW/4 & SE/4 NE/4
Section 10: S/2 NW/4

TOWNSHIP 31 NORTH, RANGE 16 WEST, NMPM
Section 29: SE/4 & SE/4 NE/4
Section 31: SE/4
Section 32: SW/4
Section 34: E/2 SW/4

TOWNSHIP 31 NORTH, RANGE 17 WEST, NMPM
Section 24: SE/4
Section 25: NE/4

(m) Extend the Verde-Gallup Oil Pool to include:

TOWNSHIP 30 NORTH, RANGE 15 WEST, NMPM
Section 5: N/2 SW/4

CONTINUED CASE

CASE 1526: Northwestern New Mexico nomenclature case calling for an order for the extension of an existing pool in San Juan County, New Mexico.

(h) Extend the Angels Peak-Dakota Pool to include:

TOWNSHIP 26 NORTH, RANGE 10 WEST, NMPM
Section 2: NW/4

TOWNSHIP 27 NORTH, RANGE 10 WEST, NMPM
Section 35: SW/4

TOWNSHIP 28 NORTH, RANGE 10 WEST, NMPM
Section 27: W/2
Section 28: E/2

ir/

(OVER)

No. 6-59

SUPPLEMENTAL DOCKET: REGULAR HEARING FEBRUARY 18, 1959

Oil Conservation Commission 9 a.m., Mabry Hall, State Capitol, Santa Fe, NM

CASE 1603: In the matter of the application of Gulf Oil Corporation for an order authorizing it to prorate the purchase of sour crudes only from twenty-five pools in Lea and Eddy Counties, New Mexico, during the course of the Port Arthur Refinery strike.

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE NO. 1596
Order No. R-1342

APPLICATION OF EL PASO NATURAL GAS
PRODUCTS COMPANY FOR THE ESTABLISH-
MENT OF TWO SEPARATE COMMON SOURCES
OF SUPPLY IN THE HORSESHOE-GALLUP OIL
FIELD, SAN JUAN COUNTY, NEW MEXICO,
AND FOR THE ESTABLISHMENT OF AN
ADMINISTRATIVE PROCEDURE FOR APPROVAL
OF WELLS DUALLY COMPLETED IN SAID PROPOSED
COMMON SOURCES OF SUPPLY UTILIZING A
CERTAIN TYPE OF MECHANICAL INSTALLATION.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on February 18, 1959, at Santa Fe, New Mexico, before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission."

NOW, on this 2nd., day of March , 1959, the Commission, a quorum being present, having considered the application and the evidence adduced and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, El Paso Natural Gas Products Company, proposes that the producing interval of the Gallup formation in the Horseshoe-Gallup Oil Field, San Juan County, New Mexico, be segregated to form two separate common sources of supply.

(3) That the applicant further proposes the establishment of an administrative procedure for approval of wells dually completed in said proposed common sources of supply utilizing a certain type of mechanical installation in exception to Rule 112-A of the Commission Rules and Regulations.

(4) That the applicant failed to prove by a preponderance of the evidence that the producing interval of the Gallup formation underlying the said Horseshoe-Gallup Oil Field consists of two separate common sources of supply with no communication between the two.

(5) That accordingly the subject application should be denied.

IT IS THEREFORE ORDERED:

That the application of El Paso Natural Gas Products Company for the establishment of two separate common sources of supply in the producing interval of the Gallup formation underlying the Horseshoe-Gallup Oil Field in San Juan County, New Mexico, be and the same is hereby denied.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY F. MORGAN, Member

A. L. PORTER, Jr., Member & Secretary

S E A L

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BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE NO. 1596
Order No. R-1342

APPLICATION OF EL PASO NATURAL GAS PRODUCTS COMPANY FOR THE ESTABLISHMENT OF TWO SEPARATE COMMON SOURCES OF SUPPLY IN THE HORSESHOE-GALLUP OIL FIELD, SAN JUAN COUNTY, NEW MEXICO, AND FOR THE ESTABLISHMENT OF AN ADMINISTRATIVE PROCEDURE FOR APPROVAL OF WELLS DUALLY COMPLETED IN SAID PROPOSED COMMON SOURCES OF SUPPLY UTILIZING A CERTAIN TYPE OF MECHANICAL INSTALLATION.

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(3) That the applicant further proposes the establishment of an administrative procedure for approval of wells dually completed in said proposed common sources of supply utilizing a certain type of mechanical installation in exception to Rule 112-A of the Commission Rules and Regulations.

(4) That the applicant failed to prove by a preponderance of the evidence that the producing interval of the Gallup formation underlying the said Horseshoe-Gallup Oil Field consists of two separate common sources of supply with no communication between the two.

(5) That accordingly the subject application should be denied.

IT IS THEREFORE ORDERED:

That the application of El Paso Natural Gas Products Company for the establishment of two separate common sources of supply in the producing interval of the Gallup formation underlying the Horseshoe-Gallup Oil Field in San Juan County, New Mexico, be and the same is hereby denied.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY E. MORGAN, Member

A. L. PORTER, Jr., Member & Secretary

S E A L

ir/

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE NO. 1596
Order No. R-1342

APPLICATION OF EL PASO NATURAL GAS PRODUCTS COMPANY FOR THE ESTABLISHMENT OF TWO SEPARATE COMMON SOURCES OF SUPPLY IN THE HORSESHOE-GALLUP OIL FIELD, SAN JUAN COUNTY, NEW MEXICO, AND FOR THE ESTABLISHMENT OF AN ADMINISTRATIVE PROCEDURE FOR APPROVAL OF WELLS DUALLY COMPLETED IN SAID PROPOSED COMMON SOURCES OF SUPPLY UTILIZING A CERTAIN TYPE OF MECHANICAL INSTALLATION.

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(2) That the applicant, El Paso Natural Gas Products Company, proposes that the producing interval of the Gallup formation in the Horseshoe-Gallup Oil Field, San Juan County, New Mexico, be segregated to form two separate common sources of supply.

(3) That the applicant further proposes the establishment of an administrative procedure for approval of wells dually completed in said proposed common sources of supply utilizing a certain type of mechanical installation in exception to Rule 112-A of the Commission Rules and Regulations.

(4) That the applicant failed to prove by a preponderance of the evidence that the producing interval of the Gallup formation underlying the said Horseshoe-Gallup Oil Field consists of two separate common sources of supply with no communication between the two.

(5) That accordingly the subject application should be denied.

IT IS THEREFORE ORDERED:

That the application of El Paso Natural Gas Products Company for the establishment of two separate common sources of supply in the producing interval of the Gallup formation underlying the Horseshoe-Gallup Oil Field in San Juan County, New Mexico, be and the same is hereby denied.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY E. MORGAN, Member

A. L. PORTER, Jr., Member & Secretary

S E A L

ir/

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE NO. 1596
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APPLICATION OF EL PASO NATURAL GAS
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(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, El Paso Natural Gas Products Company, proposes that the producing interval of the Gallup formation in the Horseshoe-Gallup Oil Field, San Juan County, New Mexico, be segregated to form two separate common sources of supply.

(3) That the applicant further proposes the establishment of an administrative procedure for approval of wells dually completed in said proposed common sources of supply utilizing a certain type of mechanical installation in exception to Rule 112-A of the Commission Rules and Regulations.

(4) That the applicant failed to prove by a preponderance of the evidence that the producing interval of the Gallup formation underlying the said Horseshoe-Gallup Oil Field consists of two separate common sources of supply with no communication between the two.

(5) That accordingly the subject application should be denied.

IT IS THEREFORE ORDERED:

That the application of El Paso Natural Gas Products Company for the establishment of two separate common sources of supply in the producing interval of the Gallup formation underlying the Horseshoe-Gallup Oil Field in San Juan County, New Mexico, be and the same is hereby denied.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY E. MORGAN, Member

A. L. PORTER, Jr., Member & Secretary

S E A L

ir/

OIL CONSERVATION COMMISSION
P. O. BOX 871
SANTA FE, NEW MEXICO

COPY

March 3, 1959

Mr. Charles C. Spann
Grantham, Spann & Sanchez
P.O. Box 1031
Albuquerque, New Mexico

Dear Mr. Spann:

On behalf of your client, El Paso Natural Gas Products Company, we enclose two copies of Order R-1342 issued March 2, 1959, by the Oil Conservation Commission in Case 1596, which was heard on February 18th.

Very truly yours,

A. L. Porter, Jr.
Secretary - Director

bp
Encls.

Duplicated copies of R-1342
sent to:
Kirk Newman
Guy Buell
Jason Kellahin
Burns Errebo
Geo. Verity
Norman Dove
3-6-59
BP
& Clarence Hinkle

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO

IN THE MATTER OF:

CASE NO. 1596

TRANSCRIPT OF HEARING

FEBRUARY 18, 1959

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO

IN THE MATTER OF:

CASE 1596 Application of El Paso Natural Gas Products Company for the establishment of two separate common sources of supply, for administrative procedure for dual completions, and for commingling of production from separate oil pools. Applicant, in the above styled cause, seeks an order segregating the producing interval of the Gallup formation in the Horseshoe-Gallup Field, San Juan County, New Mexico, into two separate common sources of supply. Applicant further seeks the establishment of an administrative procedure for approval of wells dually completed in said common sources of supply utilizing a certain type of mechanical installation in exception to Rule 112 (A) of the Commission Rules and Regulations. Applicant further seeks permission to commingle the production from said separate pools after metering the production from each.

Mabry Hall
Santa Fe, New Mexico
February 18, 1959

BEFORE:

A. L. Porter
Murray Morgan
Governor John Burroughs

TRANSCRIPT OF HEARING

MR. PORTER: We will take up now Case 1596.

MR. PAYNE: Case 1596, "Application of El Paso Natural Gas Products Company for the establishment of two separate common sources of supply, for administrative procedure for dual completions, and for commingling of production from separate oil pools."

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MR. SPANN: My name is Charles C. Spann of Grantham, Spann and Sanchez, Albuquerque, New Mexico, and I have with me Mr. John Woodward of El Paso Natural Gas Products Company representing the applicant. This is an application of El Paso Natural Gas Products Company for an order establishing two separate common sources of oil in the Horseshoe Canyon Field and providing for the separate production and measurement of oil from these common sources through the dual completion of wells on that--in both reservoirs.

At this hearing, El Paso proposes to show that the two reservoirs consist of well-developed sand bodies which were laid down under different depositional conditions, are separated by an impervious layer of shale and have measurably different reservoir characteristics.

It further proposes to show that the aereal limits of the two reservoirs are not co-extensive and that some of the wells can be completed in both zones while others can be completed in only one zone with the result that disproportionate withdrawals from the common zone by offset operators is causing and will continue to cause drainage and injury to correlative rights and might reduce the ultimate recovery of oil from the field.

My first witness is Mr. William R. Speer.

MR. PORTER: Before we ask Mr. Speer to be sworn, I would like to have other appearances at this time.

MR. HINKLE: If the Commission please, Clarence Hinkle, Hervey, Dow and Hinkle of Roswell representing the Atlantic Refining Company. We will have evidence in the case.

MR. NEWMAN: If the Commission please, Kirk Newman, Atwood and Malone, Roswell, and Guy Buell of the Texas bar representing Pan American Petroleum Corporation. We will have a witness.

MR. KELLAHIN: If the Commission please, Jason Kellahin, Kellahin and Fox, Santa Fe, New Mexico, representing Tom Bolack. We will likewise have some testimony.

MR. ERREBO: If the Commission please, Burns Errebo of Modrall, Seymour, Sperling, Roehl and Harris of Albuquerque representing Magnolia Petroleum Company.

MR. VERITY: If the Commission please, George L. Verity of Farmington representing Southern Union, and we may have some testimony.

MR. PORTER: Will there be any other appearances in this case?

MR. GOVE: Norman Gove of Petro-Atlas. We have none except that we just want to object, however.

MR. PORTER: Mr. Speer, do you want to stand and be sworn, please?

(Witness sworn in.)

WILLIAM R. SPEER

called as a witness, having first been duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. SPANN:

Q Would you state your name and residence, please?

A My name is William R. Speer and I live in Farmington, New Mexico.

Q By whom are you employed and in what capacity?

A I am employed by the El Paso Natural Gas Products Company as a division geologist over the San Juan Division.

Q Would you detail your education and experience as a petroleum geologist?

A I received a Bachelor of Arts Degree from the University of New Mexico in 1952, was employed by El Paso Natural Gas Products Company in February of that year as a petroleum geologist in Farmington. I became division geologist of El Paso Natural Gas Products Company, San Juan Division, in April of 1956, transferred to El Paso Natural Gas Products Company as division geologist in August of 1957 and have served in that capacity to the present time.

Q Have you made any study of the Horseshoe Canyon oil field?

A I have.

Q Now, El Paso's Exhibits One through Nine have been placed on the board and copies furnished to the various individuals involved. Are you familiar with those exhibits?

A I am.

Q Would you direct your attention to Exhibit One and will you state what that shows?

A El Paso Exhibit Number One is an index map of the Horseshoe Canyon Field area in San Juan County, New Mexico, showing the location, name, number and operator of all wells drilled in the area as of February 11 of this year. The purple lines are traces of cross sections which will be introduced at a later time as exhibits, the red outline is our outline of proposed probable productive limits of Lower Gallup Sand A, the green outline is the outline of proposed probable production limits of Lower Gallup Sand B.

These outlines have been altered somewhat from our original application in the following manner: The application was made on the basis of late well control. In the case of the red outline, a proposed probable productive limit of Lower Gallup Sand A, we have included in the outline the south half of Section 10 of Township 31 North, Range 17 West. We have added the Southwest quarter of Section 23, 31 North, 17 West, we have added the west half and the southeast quarter of Section 31, 31 North, 16 West, and we have deleted the southwest quarter of Section 15 of 31 North, 17 West. All of these changes have been made in our probable productive limits of Sand A.

In the case of Sand B, the green outline, we have added the following acreage: In Section 5 of 31 North, 17 West, we have added in the southwest quarter of the southeast quarter, the north half and the southeast quarter quarters. We have added in Section 9 of 31 North, 17 West, the northwest quarter of the northwest quarter, the southeast quarter of the northwest quarter, the northwest quarter of the southeast quarter and the southeast quarter of the southeast quarter. We have deleted from the outline in Section 14 of 30 North, 16 West, the northwest quarter of the northeast quarter.

MR. SPANN: At this time, I would like to move the Commission that our application be amended, insofar as Exhibit A is concerned, to conform to the testimony just given by Mr. Speer as to the outlines of the two sands and additional well control, since the figures of the application --

MR. PORTER: Is there objection to the amendment of the application at this time?

Let the record show that the application has been amended as noted by Counsel for the applicant.

Q (By Mr. Spann) Now, what does Exhibit Two show, Mr. Speer?

A El Paso Exhibit Number Two is a graphic presentation of the electrical induction log and core analysis data run on the Lower Gallup section from El Paso Natural Gas Products Company Number 4 Horseshoe Canyon well in the Horseshoe Canyon Field area. The upper red line had a depth of 1494 feet, we have designated that as the top of Sand A. The lower red line had a depth of 1536 feet, we have designated that as the bottom of

Sand A. The upper green line had a depth of 1598 feet, we have designated that as the top of Sand B, and the lower green line had a depth of 1630 feet that we have designated as the bottom of Sand B.

The thicknesses of the respective units, the Sand A interval has a thickness of 42 feet, the thickness of the Sand B unit is 32 feet, and the intervening shale body has a thickness of 62 feet.

Q Now, will you locate on Exhibit One this El Paso Products Number Four Horseshoe Canyon Well and give me the description of this location?

A The El Paso Products Number 4 Horseshoe Canyon Well is located 330 feet from the south line, 1650 feet from the west line in Section 3 of Township 30 North, Range 16 West.

Q What do El Paso's Exhibits Number Three and Four show?

A El Paso Exhibit Number Three is a transparent isopach that's overlaid showing the thickness of the Lower Gallup Sand A contoured on a five-foot interval. Exhibit Number Four is also a transparent isopach that's overlaid showing the thickness of the Lower Gallup Sand B, also contoured on a five-foot interval.

Q From what information were these exhibits prepared?

A These exhibits were prepared from a study of all available electric logs run in the field area, and in some cases gammaray logs have been utilized where electric logs were unavailable. The paramete- used in selecting probable productive thickness is that portion of the spontaneous potential curve of the electric log which is in excess of 15 milivolts above the established shale line. This 15 milivolt value was selected from a study of the logs, the electric logs, against the available core analyses and represents the cleaner portions of Sand A and Sand B.

Q What differences, if any, in Sand A and Sand B are indicated by these maps?

A To refer to the isopach in the overlay of Sand B first, you will notice that Sand B is a long, linear deposit with a relatively uniform thickness along its long axis. It extends for a distance of some twelve miles in length, it is approximately one mile in width, there is a very abrupt pinch-out of the sand along the southwestern margin, and a somewhat less abrupt pinch-out along the northern margin.

In the case of the isopach that's overlaid, Exhibit Number Three, which is an overlay of the index map showing the thickness of the Lower Gallup Sand A, we have evidence of a much more irregular type of deposit. The irregularity of sand cleanup is indicated by the changes in the contouring lines.

Q In your opinion, what do these differences indicate?

A In my opinion, these differences indicated by the isopach maps indicate that Sands A and B were layed down under different depositional conditions.

Q Can you state what Exhibits Five, Six, Seven and Eight show?

A El Paso Exhibits Five, Six, Seven and Eight are electric log cross sections as constructed from logs run in the Horseshoe Canyon area. On each cross section, we have the established base line of the cross section at the top of the Lower Gallup Sand A. Sand A has been correlated throughout the length of the cross sections and is shaded in red. Sand B has likewise been correlated and is shaded in green. For purposes of showing the horizontal relationship of the wells used, we have added at the bottom of each cross section a stick or line diagram which utilizes the same wells that appear in the electric log cross section. This line diagram has been horizontally scaled to give a true horizontal relationship in the wells, if you want to know it. The lines have been numbered for reference to the numbers on the electric log of each well. In the case of Exhibits Six, Seven and Eight, we have also added an index map showing the trace of cross section.

Q Would you locate these cross sections on Exhibit One?

A El Paso Exhibit Number Five, which is cross section AA prime, is the longitudinal cross section extending from the Davis Number 5 Navajo Well in Section 5 of 31 North, Range 17 West, extending the length of the field to Pan American's Cougher Number 6-B Well, which is located in Section 11, Township 30 North, Range 16 West.

Cross section BB prime, which is Exhibit Number Six, is going into right angles to cross section AA prime and extends from Bolack's Number 14 Bolack Well, which is located in the southwest quarter of the northeast quarter of Section 9, 30 North, Range 16 West, to the Federal Atlas Number 1-C Bolack Horseshoe Canyon Well in the southwest quarter of the northeast quarter of Section 3, Township 30 North, Range 16 West.

CC prime, which is Exhibit Number 7, extends from the Atlantic Number 28 Navajo Well, which is located in the northwest quarter of the southeast quarter of Section 31, Township 31 North, Range 16 West, extends through to Atlantic's Number 25 Navajo Well, which is located in the southeast quarter of the northeast of Section 29, Township 31 North, Range 16 West.

DD prime extends from a projection of El Paso Natural Gas Products Company Number 1 Chimney Rock Well, which is located in the northeast quarter of the southeast quarter of Section 23, Township 31 North, Range 17 West, to the Magnolia Number 1-A Navajo Well, which is located in the southeast quarter of the northeast quarter of Section 24, Township 31 North, Range 17 West.

Q Directing your attention back to Exhibits Five through Eight, will you just describe what they show individually, each exhibit?

A El Paso Exhibit Number Five, which is a longitudinal cross section, AA prime, extends throughout the length of the field area, shows the Lower Gallup Sand B to maintain a relatively uniform thickness throughout the length of the cross section, which is some twelve miles in length. It shows Sand A likewise to extend throughout the length of the cross section, thinning somewhat toward the northwest. It shows the intervening shale interval to also extend throughout the length of the field, varying somewhat in thickness from approximately 47 feet on Atlantic's Number 1 Navajo to a maximum of some 97 feet on the Davis Number 5 Navajo Well.

Cross section BB prime, which is Exhibit Number 6, is a transverse cross section at right angles to the long axis of the field, indicates Sand A to maintain a relatively uniform thickness throughout the length of the cross section. Sand B, however, is shown to pinch out to the southwest abruptly, and somewhat less abruptly to the northeast. It probably can be better seen on the stick diagram, the actual configuration cross sectionally of the sand body. The abruptness of the termination of Sand B along the southwestern axis is more ably illustrated on the stick diagram and it has a more gradual pinching out of the sand tothe northeast. You will notice that the bottom of Sand B is concave downward, the top is relatively flat, tilted to the northeast. Sand A extends on laterally beyond the pinch-out limits of Sand B in both directions on this cross section. The shale overlieing Sand B between Sand B and Sand A is continuous throughout and neither is beyond the pinch-out limits of Sand B with the shale underlieing Sand B.

Cross Section CC prime, Exhibit Number 7, is also another cross section oriented at right angles to the axis, long axis of the field, indicates Sand A to be relatively uniform in thickness throughout, although varying considerably within the interval of the sands, two sands, Sand B again pinching out to the southwest and to the northeast, having a concave downward bottom and a relatively flat northeastward tilt on top. Again Sand A extends laterally beyond the pinch-out limits of Sand B. The intervening shale interval extends beyond the pinch-out limits of Sand B and merges more or less with the shale underlying Sand B. The control is somewhat less good in this area due to the wider spacing of the wells. We have relatively the same configuration of the sand as shown on BB prime cross section.

BB prime cross section also is a transverse cross section with some projection of wells into the cross sectional phase, indicates essentially the same points as brought out on Exhibits Seven and Six, that is, that Sand A is continuous and relatively uniform throughout the length of the cross section. Sand B is pinching out to the southwest. The well control in this area prevents the showing of a complete pinch-out of Sand B, but we have again the configuration of a concave downward bottom of Sand B and a relatively flat northeastward tilted top of Sand B. I might point out also that cross section BB prime was placed in the field area to give a maximum of control. These wells have been projected in the area in which they were drilled so they represent a more accurate picture of the cross sectional relationship of Sand A and Sand B.

Q Now, do these cross sections indicate any reasonable possibility of communication between the two zones?

A No, I believe they do not.

Q Now, what does the configurations of the sands, as shown on the cross sections, indicate with respect to the conditions under which they were deposited?

A The long, linear nature of Sand B with its uniform thickness along its long axis, and this cross sectional view of the bottom is concave downward and a flat, tilted top, indicates to me a deposition within a submarine trough or channel. Sand A, with a relatively uniform thickness throughout the length and width of the field area, but with considerable variations in the mythology within Sand A, that is, interbedded sands, shales and silts, is indicative of a normal marine offshore deposit where the sand cleanup is indicating fluctuations in the shoreline.

Q Would you give your opinion or reconstructed deposition history of Sands A and B in the Horseshoe Canyon area?

A One method of reconstruction of the depositional history in the Horseshoe Canyon area would begin with the deposition of these fine grain sediments below Sand B, which are silty limestones and shales. These deposits are normal deposits of some substance that came offshoe from a sea. At some period, an erosional or submarine offshore current gouged out a trough or channel in these unconsolidated sediments, and this channel was paralleling the shoeline, which laid out the southwest of the present field area and also oriented that shoreline in a northwest-southeast direction.

When the current ceased to scour this channel, it began to deposit the coarser grain sediments in the channel. These coarser grain sediments which were cleaned by the residing action of the current filled the channel with the coarse grain sediments, then the normal offshore deposition of fine grain sediments continued to bury this complete lens of Sand B with fine grain sediments which are now represented by shales in the intervening-- in the interval between Sand A and Sand B, as is to be determined at a later time. Then we have a movement of the shoreline, of the Lower Gallup C, probably to the northeast, bringing in coarser grain sediments into the area of the present Horseshoe Canyon Field depositing them as irregularly interbedded sands, shales and silts, very irregularly interbedded. The cleaner sand lenses are indicating periods of time in the movement of the lower shoreline, then a retreat of the lower shoreline to the southwest occurred and fine grain sediments of the mica, of the mica-shale overlying the entire area were deposited.

Q The photographs you have placed on the board constitute El Paso's Exhibit Nine. Would you state what that shows?

A El Paso Exhibit Nine is a series of photographs taken of cores cut in the Lower Gallup section of the El Paso Natural Gas Products Company Number 4 Horseshoe Canyon Well. The depths shown on the cores are shown in red in the interval of the Lower Gallup Sand A. The depths shown in black indicate the cores taken in the intervening shale interval, the depths shown in green are the cores taken from our Sand B interval. I might add that there was a depth correction necessary after the photos had been taken, a correction of some seven feet, and this correction has been made on the depth shown on the photographs.

Q Now, Exhibit Nine is--those are cores from the wells shown on Exhibit Two, is that correct?

A That is correct.

Q Now, what examinations were made of those cores?

A A one-foot interval microscopic examination was made of these cores, and then a conventional core analysis was run also on one-foot interval basis.

Q What did the examination reveal as to the mythology of Sands A and B and the interval between them?

A Well, beginning with a depth of 1507--I'll refer to Exhibit Two to locate us--the core began actually within Sand A with a shale interval of some two feet. At that point, we began to show the fine and coarser grain sediments with numerous lenses, pods of shale interbedded from a depth of some 1509 down to approximately 1514½. At 1514½, the sand was somewhat cleaner with less abundant interbedded shale and silt, all saturated as indicated by the cores, the darker color being oil saturation. Extended down to approximately 1523, this was the cleaner interval of Sand A. At 1523, again the interbedded shale was abundant with our sand zones extending all the way down to a depth of 1536, the bottom of Sand A becoming increasingly shalier toward the bottom.

and you can tell from the photograph the very irregularly interbedded nature of this Sand A.

Beginning at 1537, the photographs show a shale interval extending throughout to a depth of 1597, an occasional irregularly interbedded sand or silt indicated by the lighter band in the core. At 1596, or 98, I beg your pardon, top of Sand B, we get an abrupt change. This is evidenced in the core photographs. The top foot of our Sand B was a conglamaristic sand of medium diveroose grain size, having nodules of shale within it, that's the top foot.

At 1599, we began our very clean sand sequence, thick-bedded nature extending to the bottom of Sand B. At a depth of some 1630 feet, we had a shale break which is also evidenced on the log here at a depth of approximately 1610, which is this lighter banding through here, some shale interbedded. The lower portion of the core was somewhat less clean and staining was not so thorough as in the upper portion of the core, as indicated by the mode of appearance of the core in the photographs.

At 1630, the bottom of Sand B, we had a two-foot black type shale interval; at 32, 1632 to 1634, a very silty limestone, the cenosity formation below to a total depth of 1639, black, hard-type shale.

Q Now, are any differences in characteristics between Sand A and B shown by this core?

A In gross aspect, there is a marked difference in the sands in that in Sand A you can see is a very irregularly inter-bedded sand interval, interbedded with shales and silts, the bedding planes are curved, whereas Sand B is more of a clean, thick sand body with only occasional shale intervals.

Q Does your examination and analysis of core indicate any reasonable probability that Sand A and Sand B may be connected by vertical fractures in the intervening shale body?

A No, they do not. The only interval shown in the core which is visible on the photographs having vertical fracturing begins at about a depth of 1589 and extends down to 1593, a thickness of four feet, which has exhibited some vertical fracturing. This interval occurs at about five feet off of the top of Sand B.

Q Now, what is the significance of the fact that Sands A and B were laid down under different depositional environments?

A Sands A and B being laid down under different depositional conditions would indicate to me that there is no connection between the two sands through a common sand body.

Q Would they have a connection by permeability of any sort?

A I do not believe so.

Q Now, in the absence of a common sand body or significant vertical fractures in the intervening shale body, what is your opinion as to the possibility of communication outside of the well bore between these two sands?

A I do not believe that there is any evidence of communication between Sand A and B under these conditions.

Q Now, are the aerial limits of production from Sands A and B co-extensive?

A No, they are not.

Q Show on Exhibit One the areas--show on Exhibit One the area in which only one of the sands is productive and the area in which both sands are productive.

A Sand B is productive in all wells--Sands A and B are productive in all wells that lie within the green outline on our Exhibit Number One with the exception of the field area in the northwestern direction, northwest from Section 10, Township 31 North, Range 17 West. The wells in this area are productive from Sand B only. The wells that occur outside of the green outline but inside of the red outline on Exhibit One are productive from Sand A only.

Q Now, can you point out wells on Exhibit One which are completed in both sands and are directly offset by wells which are completed or can be completed in only one sand?

A I can.

Q Would you do so?

A In Section 10 of Township 30 North, Range 16 West, the Bolack Number 10 Bolack Well, which is located in the southeast quarter of the northwest quarter of Section 10, is productive from both Sands A and B. Directly offsetting it to the west in the southwest quarter of the northwest quarter is El Paso Natural Gas

Products Company Number 10 Horseshoe Canyon Well, which has only Sand A developed and is productive from Sand A only. I might point out here that the El Paso Number 10 Well is included within the green outline, the reason being that a portion of Sand B is developed on this and can be seen on the isopach on Sand B in the northern portion of that 40 acres upon which the well was drilled. We have included within the green outline all 40 acres which have even a portion of Sand B present under them.

Another example is in Section 4 of Township 31 North, Range 16 West in the southwestern quarter of the southeastern quarter of Section 4, Tom Bolack's Number 11 Bolack is productive from both Sand A and Sand B, offset directly to the west by El Paso Natural Gas Products Number 13 Horseshoe Canyon Well, which is producing from Sand A only. These conditions can exist anywhere along this long axis of the Sand B deposit in which Sand B is present and offset by 40 acres of Sand A in which Sand B is not present.

Q The entire length of the --

A That is correct.

Q --field?

A Outside of the--anywhere out of the zero line of pinch-out of Sand B.

MR. SPANN: At this time, I would like to offer El Paso Exhibits One through Nine in evidence.

MR. PORTER: Is there objection to the admissibility of these exhibits?

Exhibits One through Nine will be admitted for the record.

MR. SPANN: That's all we have from this witness.

MR. PORTER: The hearing will recess until 1:15.

(Noon recess.)

AFTERNOON SESSION

MR. PORTER: The meeting will come to order, please. We will continue Case 1596. Mr. Spann, had you completed your direct examination?

MR. SPANN: If the Commission please, I would like to ask one more question, if I may.

MR. PORTER: Yes, sir.

Q (By Mr. Spann) Mr. Speer, are you familiar with the Commission's definition of common source of supply or pool?

A I am.

Q In your opinion and based on the examination you have made in which you testified here, are Sands A and B separate common sources of supply under that definition?

A Yes, they are separate common sources of supply.

MR. SPANN: That's all.

MR. PORTER: Anyone have a question of Mr. Speer?

MR. BUELL: Yes, sir.

MR. PORTER: Mr. Buell?

CROSS EXAMINATION

BY MR. BUELL:

Q Mr. Speer, my name is Guy Buell with Pan American Petroleum Corporation. Up until your last answer, Mr. Speer, I got the impression that--maybe wrongly--that you were qualifying some of your testimony in conclusion with respect to separation or communication. Are you now stating flatly that there is an effective sealing barrier between Sand A and Sand B?

A Yes sir, I am.

Q Okay, sir. You made a very excellent discussion, Mr. Speer, and I want to compliment you on your testimony relating to the possibility of how these sands were laid down. You didn't mean to use that testimony to indicate, did you, that that of itself showed that they were separate?

A My--you are referring to my discussion of the possible environmental conditions under which these sediments were laid down?

Q Yes, sir.

A My discussion was for the purposes of indicating the possibilities, the possible environmental conditions in the present Horseshoe Canyon Field area under which the sands and their eminating shales were laid down.

Q You would certainly agree with me, would you not, that regardless of the depositional history or process, that if these two sands were in communication, they should be treated and prorated as one reservoir?

A Were they connected?

Q Yes, sir. I realize that your position is that they are not, but assuming that they are?

A Yes.

Q Regardless of the depositional history of the two sands?

A Yes, if they --

Q Will you also agree with me, Mr. Speer, that in an admittedly common reservoir we have varying degrees of porosity vertically in any formation?

A It's possible, yes.

Q Is it not also possible to pick say two of the highest zones of porosity and isopach them as you have done you Sands A and B?

A It's possible in a common source of supply to isopach sand members, yes.

Q So the mere fact that it is feasible or possible to prepare an isopach could have little or nothing to do with separation or communication?

A Within a common source of supply, yes.

Q I am referring now to your Exhibits Three and Four.

A Yes.

Q That in an admittedly common reservoir, you can isopach two zones of porosity?

A It's possible, yes.

Q I wonder, Mr. Speer, what are we looking at from a structural dip standpoint in the area that you have outlined as the productive limits?

A Well, it's not--we have not introduced any present structural configuration in this particular field area of our testimony.

Q In that connection, why haven't you?

A Well, we do not feel it is related to the separation of Sand A from B --

Q In other words --

A --because this present structural condition configuration is something that occurred after the deposition of these particular sands.

Q Are you saying, Mr. Speer, that in your opinion, admittedly both sand members are on a common structure?

A They are structurally related at the present time, yes.

Q All right, sir. Would you now give us the benefit of your knowledge on the dip of this structure?

A Generally speaking, this present structural condition in the Horseshoe Canyon area, we have a regional depth into the San Juan Basin to the southeast. There is in this area some change in the stripe of the beds, generally speaking, in this portion of the field area. The stripes at the bed are north and south, and in this area we begin to get a more westerly and north stripe of the beds.

Q But if I understood you correctly, Mr. Speer, starting up there at the northwestern extremity of your productive limits and then going in a southeasterly direction, we have a dip of the structure?

A That is correct, back to the southeast.

Q Well, would you explain then for me, please, sir, what are the symbols of the wells in the northwestern limits--what exhibit are we looking at now?

A Well, you are looking at Exhibit Number Four overlaying Exhibit Number One.

Q All right, sir. What type of wells are those wells furtherest to the northwest on those exhibits?

A These wells and these wells?

Q Yes, sir.

A We have both oil wells and gas wells. We have used the --

Q Let's come on down structure, Mr. Speer, will you point-- come on down the structure. All right, now, what are we looking at where your pointer is now?

A El Paso Natural Gas Products Number 2 Chimney Rock Well, which is a --

Q Where is that well completed?

A That well is completed in the lower Sand B. May I point out further the structural configuration in this area?

Q I thought we just did.

A Generally speaking, in the original dip there are some features in the field area, particularly in this area, with which most geologists are familiar with. We have a structure whose axis runs approximately in here in the Chimney Rock Structure on which several Pennsylvanian tests have been drilled, such that in this area in here where this well is located on the flange of that structure, there is a small roll-over in this particular area such that there is a low area in this region here.

Q I believe you anticipated what was puzzling me, Mr. Speer, and that was, how could a gas well be down-structure from an oil well?

A Structurally, this well here is higher than some of the oil wells in this area.

Q So then our dip isn't from the northwest to the south-east, is it?

A Well, from this area on, it is, yes. In this area here, we have some local features which are changing the regional structure.

Q Were you making the same explanation for the original gas wells in your productive limits in that area?

A In this portion of the field?

Q No sir, it's south of the El Paso well you were just discussing, and locate on the record where that El Paso well is we have been talking about?

A The El Paso Products Number 2 Chimney Rock Well is in the northeast quarter of the northeast quarter of Section 15, Township 31 North, Range 17 West, the well to which we referred.

Q Mr. Speer, let me apologize to you. We have that well on our map, but I recall now that it wasn't on yours, so we will skip the reference to the other gas well. I wish you would go now to your Exhibit Number Two, Mr. Speer. I want to be sure that I understand your opinion with respect to that exhibit. What is this interval within your red horizontal lines?

A This interval within my red horizontal lines, we have designated as the interval of Sand A.

Q And the interval within your green line?

A The interval of Sand B.

Q All right, sir. Now then, the interval between your bottom red horizontal line, or the bottom of Sand A, and the top of Sand B, that is the interval that effects the seal between the two?

A Yes.

Q Would you say that that log characteristic that we note on Exhibit Two, this characteristic of shale, would be on a log of that type?

A Yes, it is

Q To you geologists, it's pretty obvious that that shale is an impermeable barrier, is that correct?

A Yes, except as to minor variations in mythology, it is dominantly shale.

Q Do you feel that Sand B is a common source of supply?

A Yes, I do.

Q One single, common source of supply?

A Yes.

Q Do you think that Sand A is?

A Yes, I do.

Q Let me direct your attention then, Mr. Speer, to the interval at the top of Sand A where you have the characteristic of your log right at the top coming out and then coming back.

A Are you referring to the resistivity curve?

Q No sir, the one at the left of the --

A The SP curve?

Q SP.

A Self-potential.

Q Yes, sir. Do you see that interval I am talking about?

A You are referring to this interval from 1500 to approximately 1510?

Q Yes.

A Yes.

Q In your opinion, is that pay there?

A It would be included in what we have designated as the pay area, and --

Q Now--excuse me for interrupting if you weren't through.

A No.

Q I want you to look at that, Mr. Speer, the hard interval we are talking about immediately at the top of Sand A and just let your eye run down the exhibit and tell me whether or not that log in that area doesn't reflect a more density of rock in that interval than it does in your interval of separation between the two sands?

A Referring to this area in here, I am not sure exactly whether it depicts the permeability or not. The self-potential curve of an electric log could be affected by a number of things other than impermeability.

Q And you realize the interval I am talking about is immediately below your 1500 datum?

A That is correct.

Q Does not this log reflect that this interval at the 1500 datum line is more dense and more shaly than your separation interval between Sands A and B?

A Well, I don't believe you can relate this particular curve on the electric log directly to density.

Q What does it show, if anything?

A Well, it is indicative of density and --

Q All right, I'll change my question. Does that not indicate that this interval immediately below your 1500-foot datum lines is more dense, indicate more density, than the indication you get between your bottom of Sand A and your top of Sand B?

A It could, yes.

Q Do you think that this interval, the top of Sand A immediately above your 1500-foot datum, is separate from the rest of Sand A?

~~A On this particular well, yes, it could be separate.~~

Q Then are you recommending that that be set up as a separate reservoir?

A No, I am not.

Q Why not?

A It is a portion of this depositional interval here which is related on a depositional basis.

Q Are you now saying that you may have more than one source of supply in Sand A?

A I think we pointed out that there are a number of interlensing lenticular types of sand within the interval that we have designated as Sand A.

Q Would you have us believe that every common source of supply should be regulated and prorated as a common source of supply?

A Yes.

Q Then why are you not so recommending?

A Because these particular sands are related to one another. Maybe at some point outside of this particular well here that we see, it is possible that this sand can control this sand down in this area. Any particular sand body within what we have depicted as Sand A could coalesce with any particular sand that we show in a single hole at another depth within that interval.

Q Could it be, Mr. Speer, that this separate dip in

Sand A we are talking about is not separate from the rest of Sand A, could that be the case?

A It's possible.

Q Well, if that is possible, is it not possible that Sand A and Sand B are connected?

A No.

Q When you set the log up on the top of Sand A, that indicated a more dense material than your separating interval between the two sands?

A Would you re-state your question again?

MR. BUELL: Would you read the question back?

REPORTER READING: "When you set the log up on the top of Sand A, that indicated a more dense material than your separating interval between the two sands?"

MR. PORTER: I don't believe you read the whole question.

REPORTER READING: "When you set the log up on the top of Sand A, that indicated a more dense material than your separating interval between the two sands?"

A Is that a question?

Q (By Mr. Buell) Do you understand the question?

A No, I don't.

Q Let me try to ask it again. You testified, Mr. Speer, that the log indication in the major structure immediately below your 1500-foot datum line indicated it to be more dense than any of the interval you say separates Sands A and B; you further testified that it was possible that that upper kick in the top of Sand A that we are talking about was in communication with the rest of Sand A. I asked you, in view of that testimony, why would it not be similarly possible for Sands A and B to be in communication?

A I believe the answer to that question is more fully shown in our cross sections that --

Q We are talking about Exhibit Two. Is it your position that your Exhibit Two does not show separation of Sands A and B?

A No, it does not.

Q Then why can't we answer that question looking at Exhibit Two?

A Because we are relating this particular well to a large area.

Q No sir, right now I am just interested in this particular well. I want your opinion if could not the possibility exist for communication between Sand A and Sand B in this well be reflected on your Exhibit Two?

A If I have stated that this sand as depicted in this well is connected with this sand which we show here, I am in error. In this particular well, there is an impervious interval. For that reason, I do not believe that there is a likelihood of connection of permeability by what we see depicted of Sand A and Sand B.

Q All right.

~~A Does that answer the question?~~

Q Is that your answer?

A Yes.

Q Okay. Do we have the complete core analysis reflected on Exhibit Two?

A No, the conventional core analysis was run on this and also a water and oil saturation was run on it.

Q I am particularly interested, Mr. Speer, in what the core analysis reflected with respect to permeability in this dense separating interval between Sands A and B. Is that reflected on Exhibit Two?

A Yes, it is. We have noted graphically the permeability as being from zero to some 600 milidarcies. The graph shows the permeability at each foot interval.

Q Well now, to my untrained eye, looking at that exhibit, Mr. Speer, it would appear to me that no permeability whatsoever existed between the bottom of Sand A and the top of Sand B, and we know that's not right, don't we?

A Top of Sand A and bottom of Sand B?

Q Bottom of Sand A and the top of Sand B, I'm sorry.

A No marked permeability, that's true.

Q Is it your testimony now that no permeability exists in the interval between the bottom of Sand A and Sand B?

A No permeability, that is correct.

Q Have you averaged the permeability reflected in the core analysis for the particular interval we are talking about, the separating interval?

A No, I have not.

MR. BUELL: May it please the Commission, I would like to request that he average, from his core analysis, the permeability encountered and reflected by that core in the dense interval that he claims separates Sand A and Sand B. I think it is critical to the case that we have that average permeability figure in the record. It might take him a little time is the reason I am directing my request to the Commission and to his Counsel rather than to the witness.

MR. SPANN: I would like to state that I believe we will furnish that through Mr. Walsh, who will be our next witness, if that's satisfactory, rather than to --

MR. BUELL: I would kind of like to talk to Mr. Speer about it, too, if he can tell me, so I'll know.

MR. SPANN: I am sure he could.

MR. PORTER: Could you supply those figures, Mr. Spann?

MR. SPANN: I think we can.

MR. BUELL: I believe it is critical to our case and I am sure that you will want them in the record.

MR. PORTER: You go ahead and get those figures for us.

MR. BUELL: Off the record.

(Discussion off the record.)

Q (By Mr. Buell) Mr. Speer, do you have the information requested?

A Yes, I do. The information asked for and is supplied to me, covering the interval from the bottom of Sand A at a depth of 1536 to 1598, has an average permeability of .14 milidarcies. It is perhaps significant to note that in our averages, much of the permeability through this interval has been designated as a zero average. It may or may not reflect that.

Q Excuse me, Mr. Speer, in that calculation, what consideration did you give the fractures?

A There are no considerations for it.

Q Fractures do have permeability?

A I am sure they do.

Q They have infinite permeability, do they not, Mr. Speer?

A Yes, they do.

Q So it could be defined that you encountered permeability in this dense shale interval?

A Permeability in the fracturing system, yes.

Q And permeability is reflected in that core analysis that you had in your hand just then?

A .41 milidarcies, yes, average.

Q Do you want to change your prior testimony then that no permeability existed in that interval that we are speaking of?

A Well, when I refer to permeability, I am speaking of effective permeability, and I do not consider that .41 hundredths is effective permeability. If you take a definition of permeability, then certainly some permeability exists.

Q And in arriving at that average that you gave, which you say is not effective, you had some permeability of a greater magnitute and some permeability of a lesser magnitude, did you?

A Yes.

Q And that's how you got your average?

A That's true.

Q So that in the dense interval, we have some permeability that would even meet your definition of effective permeability?

A In the fracturing system, yes. In the four feet that we have shown in this 62-foot interval, yes.

Q Do you happen to have a log of your Williams Number 1 Well with you?

A I believe so.

MR. PORTER: Is that the El Paso Williams Number 1 Well?

MR. BUELL: Yes.

Q (By Mr. Buell) I see, Mr. Speer, that the log you are looking for is bound there, I have one here that's loose. I will apologize because it has scribbling on it, but I think for our purposes we can look at it. Will you locate what you consider to be the top of Sand A? Just take a pencil and draw a horizontal black line at that location.

A The log which you are referring to is the electric induction log of El Paso Natural Gas Products Company Number 1 Williams Well, which is located in the southeast southwest quarter

~~of the southeast quarter of Section 11, Township 30 North, Range~~ 16 West. I have marked what I would pick as the correlative top of Sand A at a depth of 2272 on this particular log.

Q All right, sir. Now, are you familiar enough with the log and the location of that well to know that it has both your Sand A and your Sand B in it?

A Yes, it does have both sands.

Q And does that characteristic of the log in the interval between these two sands indicate to you a dense impermeable material?

A Yes, it does.

Q What would you say the log characteristic reflects immediately above the top of where you picked Sand A?

A It reflects itself as a shale.

Q Does it look impervious to you, the shale that separates your Sands A and B?

A A portion of it appears to be as impervious and a portion not as impervious. If by drawing a shale line, which we do down here, establishing the shale line, a portion of the interval between the two sands will fall to the inside and a portion to the outside.

Q But the characteristic of the log above Sand A indicates to you an impervious shale?

A That is correct.

Q What do you geologists mean, Mr. Speer, when you say on a drilling well, you say you have lost circulation, what do you

~~mean by that term? Don't put the log up yet.~~

A Lost circulation?

Q Yes.

A Lost circulation zone, lost circulation material--lost circulation zone indicates some zone of which we lose our circulated drilling fluid into the formation.

Q It would be just the opposite of impervious then, wouldn't it, in the sense that it transmits fluids readily? In fact, it seals them in the well core and you have trouble even drilling, do you not?

A That's correct.

Q So it would be just the opposite of impervious?

A Yes.

Q Would you relate to the Commission the lost circulation trouble your company had in that impervious shale immediately above Sand A?

A I am not familiar --

MR. SPANN: If the Commission please, we made no point of the impervious shale above Point A, and he is referring to the shale between A and B, to which I made no reference. This is immaterial.

MR. BUELL: May it please the Commission, I think it is material. He is saying that the interval between Sand A and Sand B is impervious. The log shows him that it is and he also says that immediately above Sand A, the point that he picked on this log, that that was equally impervious; in fact, in some places more impervious in the structure. This structure between Sand A and Sand B, he says is separating the two, but yet in this impervious shale that you couldn't penetrate with a hammer, his company encountered lost circulation trouble.

A I didn't state that we encountered lost circulation, but you asked me for an interpretation of this particular log in the interval above Sand A, which I would interpret as a shale. This is not--no electric log can indicate fracturing, which is permeability, agreed, but on this log I cannot pick out any fracture type of permeability.

Q (By Mr. Buell) Would you not suspect, Mr. Speer, assuming for the purpose of this question, that your company did encounter lost circulation trouble in that shale, would you not suspect that perhaps fracturing was responsible for it?

A I would think, from looking at this log, that possibly there was fracturing if we had lost circulation, yes.

Q Would you then rule out the possibility of the existence of similar fracturing on this so-called dense interval between Sand A and Sand B?

A I have a record of this particular well and the well was cored throughout. And if I may check my files, I believe that we'll find we have no record of any fracturing occurring in this interval between the bottom of Sand A and the bottom of Sand B.

Q Would you look at your core analysis again?

A All right.

Q I recall, Mr. Speer, in your earlier testimony you mentioned the core reflected fractures in that dense interval?

A The core photographs showed the fracturing, yes; the analysis did not.

Q But then you do have evidence that you believe the photographs that fractures do exist?

A Yes.

Q And is dense?

A In this particular well, the Horseshoe Canyon Number 4, I do have the core analysis of the Williams and have a tabulation in which I have indicated the intervals cored and the presence or absence of fracturing and this tabulation indicates that there was no fracturing in the interval between A and B Sands.

MR. BUELL: Perhaps I should direct this question to your Counsel, but I wonder if you all intend later on direct testimony to introduce a complete core analysis on the wells which you used a portion thereof on your Exhibit Two?

A I am not certain whether we intend to introduce that or not.

MR. BUELL: I would like to request, if the Commission please, that they be required to submit a complete core analysis, only a portion of which they have reflected on their Exhibit Two. In all fairness to the record, I don't believe that it can be adequately analyzed unless we do have, and the Commission has, the benefit of the complete core analysis. They used a part of it, why not all of it.

MR. SPANN: We will be happy to furnish the complete core analysis of the well.

Q (By Mr. Buell) Mr. Speer, while we are back on Exhibit Two, would you mind going over this again a minute? Directing your attention now to the dense interval which in your opinion forms a effective sealing barrier of communication between Sand and Sand B, I want you to look at the portion of that exhibit which reflects what the metric rock in that core was composed of. Let's just start right there and run your eye up and down that interval and tell me if you see any interval there that does not contain some sand?

A You are speaking of the lithology column?

Q Yes, lithology.

A This column.

Q All right, sir.

A We have indicated sand symbols within this intervening shale body, floating sand grains occur within the shale in this interval. In fact, I believe we pointed out in testimony that occasionally there were thin sandstone lamina within this shale, but in a gross aspect, this interval is shaly.

Q Does shale usually contain the magnitude of porosity which you reflect in your Exhibit Two?

A Something on that order, yes.

Q Actually, your porosity in the dense interval looks somewhat better than in your Sand A, does it not, Mr. Speer?

A In individual feet, yes. There are individual --

Q It appears to be overall more consistent, does it, and more uniform --

A Yes.

Q --than in Sand A?

A Yes.

Q Do you happen to know the average porosity of Sand A?

A On this particular well?

Q Yes.

A No, I do not.

Q All right, sir. Find a single foot in that lithology interval there that shows a complete absence of sand?

A In the interval between Sand A and Sand B?

Q Yes.

A Complete absence of --

Q Sand.

A --sand?

Q Yes.

A Well, we had a small bed here which did not include--which I don't believe contained any sand.

Q Would you give us the depth figure on that?

A That depth goes at 1592 to 90 feet, depicted on graphic presentation.

Q About a two-foot interval has an absence of sand?

A Yes. Specifically, there may be other individual shale beds within this interval --

Q On the lithology --

A --without sand.

Q The lithology column does not show that, does it, with the exception of the 1 two-foot interval on the lithology column that does not reflect sand?

A There is some sandiness within the shale, yes.

Q You have found 1 two-foot interval where sand is not present?

A I can't make the statement definitely that there is not shale within this intervening interval that does not have sand in it. We are not--I could not possibly find a detailed lithologic microscopic description of every foot in here and determine it that way, but from what information I have here, I can't say whether there is --

Q Mr. Speer, all I am asking you to do is to testify as to what your own exhibit reflects, and you found one small two-foot interval where your exhibit shows an absence of sand in that dense interval, did you not?

A That is correct

Q And do you recall your earlier testimony, Mr. Speer, that it was at that depth that you observed your fractures in your core pictures, wasn't it?

A No, that is not true, the interval in the core pictures occurred below that bentonite bed.

Q And you have no data available to you that would indicate to you that you have fracturing present at that depth in this well?

A We have evidence that there is fracturing occurring at this depth of 1590 feet to 94 feet. I believe that was the interval shown on the core photos.

Q Which is pretty close to the dense interval, isn't it?

A Well, I believe we can actually pick out this bentonite bed on the photographs, if you would like to do that. In fact, I would like to do that. At 1588, if you will notice, there's an indentation here in the photograph of the core that is reflective of that bentonite bed, then we have possibly a six-foot interval and then our fracturing. There is a space, then our fracture occurs and continues down to a depth of 93, so actually there is some separation between where our fracturing shows on here and this bentonite bed.

Q Would you, as a geologist, Mr. Speer, ever recommend to your company that they perforate and attempt a completion in an interval as reflected by the log characteristics that we encountered between the bottom of Sand A and the top of Sand B?

A If there was evidence of fracturing between that interval, it might be possible to recommend a completion on it.

Q Well, you keep talking about fractures. You agree, do you not, Mr. Speer, that fracturing is pretty extensive in this field, in this area, it's common, isn't it?

A No, it is not.

Q You don't agree to that?

A No, I do not. Fracturing is not extensive in this particular field area.

Q And you have encountered very little fracturing in this pool?

A In the present limits of this pool, yes.

MR. BUELL: Could I have this marked as Pan American Exhibit One?

(Whereupon, the document was marked as Pan American Exhibit Number One for identification.)

Q (By Mr. Buell) Mr. Speer, I hand --

MR. PORTER: Just a moment, Mr. Buell. Mr. Spann, do you have any objection to receiving this exhibit?

MR. SPANN: I certainly do, I don't even know what it is. I would like to find out.

MR. BUELL: Would you like to see it? It's a log of one of your wells, I'm sure you have all seen it before.

MR. PAYNE: You are not offering it in evidence at the present time, are you, Mr. Buell?

MR. SPANN: I have no objection to Mr. Buell questioning Mr. Speer using that exhibit. I do object to it being introduced or received in evidence at this time.

MR. BUELL: I am not offering it.

MR. SPANN: I see.

MR. BUELL: I had it marked as Exhibit One so I could refer to it.

Q (By Mr. Buell) I hand you what has been marked as Pan American Exhibit One, and which will be offered in evidence later, and it reflects a portion of the log on El Paso Horseshoe Canyon Number 8 Well. Where is that well completed, Mr. Speer?

A This well as is shown by your exhibit would be completed in a portion of what we have selected and designated as Sand A, and also in Sand B, and I believe that's where the well is completed. There are additional perforations below Sand B as shown on your log here at a depth of approximately 1236 feet to 1242 feet.

Q All right. You can find on this log the interval that separates your Sand A and your Sand B, can you not?

A Yes, I can.

Q How does it look to you, pretty dense, impervious?

A I would interpret the interval to be very shaly.

Q Well, do you think that the possibility of communication exists between Sand A and B through this interval?

A No, I don't.

Q You think it is impervious, that you could not transmit fluid through it?

A That's true.

Q All right, sir. I want you to examine the log in the area of your bottom perforations from the standpoint of being dense, impervious, shaly. How does it compare with your separating interval between Sand A and Sand B?

A It is also dense, possibly more dense.

Q Yes sir, it would sure --

A As interpreted from this log.

Q It would sure appear to be from this log?

A Yes.

Q So the shale outline on the interval between Sands A and B as reflected on the log opposite your bottom perforations, would indicate that they were more shaly than your separation interval?

A That's true.

Q Are you aware of the fact, Mr. Speer, that these perforated intervals were selectively tested? Would you be surprised if your company recovered oil out of that dense, that impervious shale opposite the bottom perforations?

A I perhaps misunderstood your previous question. I was referring to the impervious interval that occurs between the depth of 1206 down to approximately the top of where you show we have perforated. I would agree that what we have perforated in the bottom set of perforations is in all probability impervious also.

Q But yet out of this impervious shale that the bottom performations are completed in, you got a better test out of that impervious shale than you did out of what you are calling Sand B, did you know that?

A I would be surprised to learn that.

Q You tested fourteen barrels of oil an hour out of Sand B.

A Sand B, that's the interval from a depth of 1198 to --

Q Yes, sir.

A --1206, fourteen barrels per hour.

Q Fourteen barrels of oil per day out of Sand B, but out of this hard, impervious formation that won't transmit fluid, you recovered eighty-six barrels of oil --

MR. SPANN: I am going to object to Mr. Buell testifying. This witness said he didn't know and those are not the facts in evidence. As to Mr. Buell's direct statements, I think he ought to be under oath if he is going to testify.

MR. PORTER: The Commission will sustain the objection. Just ask the witness if he knows.

MR. BUELL: Yes, sir.

Q (By Mr. Buell) You were not aware of these tests, Mr. Speer, were you?

A Not as to the exact amounts of oil recovered.

Q Would not information such as this, Mr. Speer, make a dent in your opinion that Sand A and Sand B are irretrievably, forever separated by impervious shale?

A No, it wouldn't. What you are referring to is the bottom extent of the perforations here, they are below the depth that we have shown as Sand B. We have not discussed what the possibility of oil production is below that depth to date that I know of. I know also that there is a possibility in individual testing of some communication behind a pipe, a number of things are possible to account for, but in this particular case, I would be surprised that oil could be recoverable from this silt zone that we show here perforated below Sand B.

MR. BUELL: That's all I have, if it please the Commission.

MR. PORTER: Anyone have a question of the witness?

CROSS EXAMINATION

BY MR. KINKLE:

Q Mr. Speer, I direct your attention to your Exhibit Four. That exhibit, I believe, purports to show all the wells which have been drilled in the Horseshoe Gallup area?

A The overlay itself indicates the wells that were drilled up to, as far as I know, the time that the index map, Exhibit Number One, was made which was February 11.

Q It is Exhibit One then that shows the wells?

A Yes.

Q Approximately how many wells have been drilled in the area?

A I believe that there are approximately 110 wells.

Q Of these 110 wells, how many have been completed in both the A and B formations?

A I have a tabulation of that figure. My figures indicate that there were a total of 110 wells drilled at the time that the exhibits were prepared, and 64 produced from Sands A and B, 36 from Sand A only and 10 from Sand B only.

Q Those 64 wells, they have an open well bore for both formations, A and B?

A That is correct.

Q They have been opened for sometime?

A Yes.

Q In actual practice, the operators, all of the operators, have treated both formations, A and B zones, as one reservoir, isn't that right, up to this time?

MR. SPANN: Object to that as calling for a conclusion. He couldn't possibly answer what the other operators have done or how they treated these.

MR. HINKLE: He testified that 64 wells have been completed that way.

Q (By Mr. Hinkle) Do you know of any case where an operator has penetrated both A and B zones and they have not perforated, tried to make the well in both A and B zones?

A No, I do not.

Q Well, isn't it a fact then that the operators have treated both of these zones up to this time as a common reservoir?

MR. PORTER: Do you still object to that?

MR. SPANN: I still object, for the reason that he can't answer as far as the other operators are concerned.

Q (By Mr. Hinkle) Isn't it a fact that --

MR. PORTER: Just a moment, Mr. Hinkle.

MR. HINKLE: I'll withdraw the question.

MR. PORTER: Thank you, that simplifies it.

Q (By Mr. Hinkle) Isn't it a fact that up to this time, both the A and B zones have been in actual communication through these 64 wells which you mentioned above?

A Yes.

MR. HINKLE: That's all.

MR. PORTER: Anyone have a question?

MR. GOVE: Norman Gove of Petro-Atlas. I want to point out something, if the Commission please --

MR. PAYNE: Do you have a resident Counsel, Mr. Gove?

MR. GOVE: No sir, but I want to find out if Mr. Speer has made an error. He shows a well of ours being nine feet above Sand A and does not have it included in this area. That's my only --

MR. PAYNE: Is that an error, Mr. Speer?

A Which particular well?

MR. GOVE: Navajo Number 2 in Section 33, in the southwest of the southeast of 33? You have that at nine feet and I don't know whether you indicated that as a change in the very beginning or not on your Exhibit Four.

A You are correct, we indicated a nine-foot thickness for it.

MR. GOVE: That's in the Ute-Navajo?

A Ute-Navajo, yes.

MR. GOVE: That's just an error then?

A Yes.

MR. GOVE: In other words, that forty acres should be included in that --

A That is correct.

Q Sand pit?

A Yes.

MR. GOVE: I thought you had just overlooked it, thank you.

MR. PORTER: Does anyone else have a question?

MR. FISCHER: Yes, sir.

MR. PORTER: Mr. Fischer?

CROSS EXAMINATION

BY MR. FISCHER:

Q Mr. Speer, I just want to ask you about this one, this Atlantic Well Number 31 in 31, 31, 16. Is that actually a producing well at the present time, is it called a producing well?

A We have it so indicated on this map, yes.

Q And your cross section through this field is shown here only to correlate your logs, is that correct?

A That is correct.

Q You have no exhibits showing the structure of this sand or those two sands in that area?

A No, I don't.

Q Are you aware of the fact that the sand down toward the southeast on your map there dips pretty sharply?

A In this particular area?

Q Yes.

A Yes, it reflects a hogback monocline and dips very abruptly in through this area into the basin.

Q Is that a--would you give me your explanation of the cause for that dip, that steep dip in that area?

A The steep dip in that area, as I say, reflects a hogback monocline, a feature which is--a change which is developed in this particular area, a definite depositional sand that we have been talking about today. Part of the San Juan Basin is reflected by this steep dip. There are relatively gentle dips here and along about in this area we had a steepening of the dip up to as high as 60 degrees.

Q Well, isn't it possible that t. .t shale might be fractured down there due to the flexing after deposition?

A We have fracturing evidence in the Verde-Gallup field, which lies to the northeast of our map here, yes, and we believe that the fracturing is a result of this abrupt flexing along the hogback monocline.

Q You don't believe that --

A We believe that this is a result of this flexing, the recession of the beds in that producing interval at Verde, that this stress was by fracturing. As you move to the southwest, or back to the source area of the producing interval at Verde, the section that produces in the Verde field becomes extremely--an extremely productive sand barrier, as would be expected in moving in the direction of the source. At a point somewhere along through El Paso's Malcocum Lease and on this map in Section 6 of 30 North, Range 15 West, we have sand bodies appearing in the producing interval, which is correlative with Sand A over the Horseshoe Canyon area. We believe that this increase in the sandiness back to the southwest is affecting the ability of these rocks to fracture. As so stated in 1957 in an article in the Four Corners Guidebook by myself, we believe that probably the stratographic flow would eventually eliminate the fracturing system. That is evidenced in Verde and evidenced on the basis of our wells drilled in the Malcocum area, that is becoming evident.

This Number 10 Well, which is in the extreme--Number 10 Malcocum Well located in Section 6 of 30 North, 15 West, was a very weak well producing on the order of some five or ten barrels a day. The Number 5 Well, which is also down in the extreme southwestern end of Verde, is also very weak, a very weak well. The Malcocum Number 1 is temporarily abandoned, produces no oil, and it is perforated and was fraced in the interval which is productive in the Verde field. So that what we believe is happening is that the fracturing system is playing out into this area of the Verde field.

Q Playing out?

A Yes, dissipating, and that's probably the result of this increased sandiness in the beds down in this area reacted by the bending or flexing rather than breaking because of their better competency. As you move up in the better area of Verde, the producing interval is dominantly shale, fractured shale, and Verde, of course, produces from a fractured reservoir whereas Horseshoe produces from a sand reservoir.

Q This El Paso well in the northeast, or rather the northwest northwest of Section 12, 30, 16, do you have any core analysis of that well?

A The El Paso Products 1-A Williams?

Q Yes.

A May I check my books here? I don't believe that we have, but let me make sure. No, the Williams 1-A Well was not cored.

Q It was not cored?

A That's correct.

Q Do you have a log on that well, an electric log?

A Yes, a portion of an electric log. I have a copy of the log.

Q Would you put that over the board, please? Just a minute, are you going to enter the rest of those logs, or could you enter that log as an exhibit in this case?

A I could if it is desired, yes, a portion of the log. What we have done is cut out the Lower Gallup section and attached the heading to the back of it for reference.

MR. FISCHER: All right, that's all I have. Would you enter that, please?

MR. PORTER: Is there objection to the admission of this exhibit?

It will be received in the record.

MR. FISCHER: Mr. Speer, would you consider the well in the Horseshoe-Gallup pool to be producing from the Horseshoe-Gallup pool?

A The Williams 1-A well?

MR. FISCHER: The well in the northwest northwest of Section 12, 30, 16?

A Yes, I would consider it to lie within the Horshoe-Canyon field.

MR. FISCHER: Thank you, that's all.

MR. PORTER: Mr. Verity?

MR. VERITY: Verity for Southern Union,

CROSS EXAMINATION

BY MR. VERITY:

Q Mr. Speer, you say that these two sand bodies were layed down at different times and different methods, I believe?

A Yes.

Q Is it never an eventuality that we have two different sands, producing sand bodies, layed down at different times and different methods that there is no producing or permeable formation in between?

A It is possible to have a permeable body, via fracturing or --

Q In other words, the fact that these two bodies were layed down at different times in different ways does not necessarily indicate that the interval in between is not permeable, does it?

A No, that is correct.

Q So any conclusion that might have been made with regard to the impervious nature of the interval in between because of the two bodies being layed down at different times is erroneous, is that correct?

A In the sense that you have discussed it, yes.

Q And I wonder if for the minute, are you familiar with the producing horizon in the wells in the Bisti-Gallup pool?

A Yes, I am.

Q Are you familiar with the fact that there you also have two producing sand bodies that are divided by an interval?

A Yes.

Q Isn't there a comparison between the situation there and the situation here?

A A comparison in what manner?

Q With regard to separation of the two zones?

A Well, the two sands that I believe you referred to in the Bisti area were related in a depositional manner. They are separated and I believe they are producing from the Bisti.

Q Would you say that the Bisti also is two separate, common sources of supply?

A That the Bisti sand produced at --

Q That the upper and the lower member there are separate, common sources of supply?

MR. SPANN: Object to that as being immaterial to the issue before us here.

MR. PORTER: Objection sustained.

Q (By Mr. Verity) Turning then for the moment, Mr. Speer, to the core, how large a core did you take in this well, that you presented?

A I believe the core diameter is four inches.

Q Can you tell us whether--I believe you testified that at one place you did encounter a vertical fracture in it?

A Yes.

Q Can you tell us whether that vertical fracture is 100 per cent vertical?

A I don't know that it was 100 per cent vertical. I think that it can be observed on here that the vertical line is 90 degrees to the --

Q Then if it were only 90 degrees, it would run out of the core, would it not, or it might run out of the core?

A If it were only 90 degrees, it might run off the core.

Q Well, at 90 degrees, couldn't it run off the core?

A At the bottom, yes.

Q It could also run off the core into your so-called impervious interval? In other words, couldn't that fracture be picked up at another core in this producing pool?

A The same fracture, it's conceivable.

Q Suppose you moved over three feet and took another core? Wouldn't it be obvious that you could encounter the same or a similar fracture at a different depth?

A Well, that would be supposition on my part.

Q Well, it would be possible that you could, wouldn't it?

A If we started fracturing three feet over?

Q That's right, at a different level.

A That's true.

Q Have you taken other cores of the interval in between the producing zones in this pool?

A Yes, we have.

Q I believe you stated earlier to Mr. Buell that you would introduce later the core analyses on this core?

A That's true.

MR. VERITY: That's all.

MR. PORTER: Anyone else have a question of Mr. Speer?

MR. STAMETS: Yes, sir.

~~MR. PORTER: Mr. Stamets?~~

CROSS EXAMINATION

BY MR. STAMETS:

Q Mr. Speer, how did you hang the logs shown on Exhibits Five, Six, Seven and Eight?

A The base line for the Exhibits Five, Six, Seven and Eight is the top of what we have designated as the Sand A interval. The logs are hung on that datum.

Q In other words, if one were to see a true picture of these distances at the time they were layed down or as they are currently standing, it would not be the same as this, it would be some other configuration?

A If the logs were hung on a structural datum?

Q Yes.

A That's true, they would not be showing what is shown here.

Q I would like to hear again your idea of the sedimentary history of Sand B, just how it was layed down?

A Briefly, I believe that Sand B was deposited in an off-shore channel or trough that has been eroded out of the silt-shale interval below Sand B on these logs, deposited by the acredes and the velocity of the current, and that completely filled the trough, and then the normal sedimental circle, fine grain sediments were layed down, which buried Sand B.

Q What forces created this channel, do you have an idea?

A I am not certain as to the erosive agent, no. I suggest that I believe in the testimony that it may possibly be a submarine off-shore, long shore current. There are probably other explanations, but the point was that there was a channel, excavation of these sediments.

Q That's the point I am not sure of. Can you show me today where such a channel or such a line off of the shoreline was?

A Well, we do not have anywhere in the world today that I know of a comparison of the upper cretacious sea, and the condition, I doubt if it could exist in the present offshore coast. And I am not aware of any similar occurrence in the present day, no.

Q Are these types of channels a major geological occurrence throughout the world?

A I would interpret it as a localized situation, but I am sure that they occur around the world today or in the past.

Q Have you found evidence of a beach to the southwest of this exposed --

A Near the hogback field, which lies to the southwest some six or eight miles from the present Horseshoe Canyon field, there might be an outcrop of Gallup which we have interpreted as a beach type deposit.

Q Going on from that, if beds such as you have depicted here were dipping at say a rate of one hundred feet per mile and then within the length of one section would change to a depth of nine hundred to a thousand feet per mile, would these beds normally be fractured?

A I would not expect the beds--it would depend on what stresses were exerted. I am assuming that you are speaking of the beds after they have solidified and become rock?

Q Right.

A The fracturing I think would depend upon the amount of fractural deformation to the beds and in this particular area, if that's what you have reference to, I don't know for sure what the dips of the beds are at the present time in terms of feet per mile, but I would not expect fracturing to occur in the area of a dip of a depth that occurs in the Horseshoe Canyon area.

Q That's exactly what I asked. I asked that if beds such as these would go from a depth of one hundred feet to nine hundred to a thousand feet per mile within the distance of one section, would you normally expect fracture?

A It would --

Q Would you mind explaining that?

A It would depend on the lithology of the particular beds of which you were speaking.

Q Beds such as we have here, sands and shales such as you have encountered here?

A With sand and shale, I believe it would be competent enough to resist fracturing.

Q Competent enough to resist fracturing?

A Yes.

Q Do incompetent beds fracture?

A In the sense that you are using it, yes.

Q Is that in a normal geological sense?

A That would depend a lot on the ability of competency and incompetency of the beds that you refer to specifically. Perhaps I should state that differently, that these particular beds that you are referring to, Sand A and the intervening shale in Sand B, I do not believe would react to the type of structural deformation when you are speaking about fractures.

Q How about the shale?

A No, I do not believe so.

Q It would not fracture either?

A No.

Q How do you account for the fracture that you have down there?

A Well, for one thing, we are, even in this particular case shown on Exhibit Number Nine, we are not entirely certain that this is actually formation fracturing, it may actually be due to stress of the--during the course of the coring operation.

Q In other words, more stress would be exerted to the bed during a coring operation than wouldbe exerted for the bending of these --

A It could possibly be a fracture that we have noted or described and contributed to the industry in general. Of course, we make no note of whether they are mechanical fractures or actuel lithologic fracturing normal to formation, so that you may actually have a listing of fracturing, new description of cores that may not be the formation itself.

MR. STAMETS: That's all I have.

MR. PORTER: Mr. Verity?

CROSS EXAMINATION

BY MR. VERITY:

Q Mr. Speer, how much permeability do you consider necessary for a zone to be produced?

A Well, it would be difficult to hang it on a specific number or rule of the thumb. In this particular area, something in excess of one milidarcy permeability.

Q And as to the amount required, it would depend on whether or not it was producing through fractures or through normal permeability, wouldn't it?

A The amount required of what?

A To produce, the amount of permeability?

A Would depend upon --

Q It would depend upon whether or not there was vertical fracturing, would it not?

A I am not sure I understand your question. Would you re-state it, please?

Q Where you have vertical fracturing, it will produce a lot smaller degree of permeability, a measured permeability, than it will where you have no vertical fracturing, is that right?

A That's true.

MR. PORTER: Anyone else have a question?

MR. SPANN: If the Commission please, I have here the core analysis report that Mr. Buell wanted. Do you want this in evidence?

MR. BUELL: Yes, I think it should be in the record.

MR. SPANN: That should be marked Exhibit Nine-B.

(Whereupon, the document was marked as Applicant's Exhibit Number Nine-B for identification.)

MR. SPANN: I think that if he is going to cross examine further about that, Mr. Speer ought to have a chance to look at it if he hasn't seen it. If you just want it in --

MR. BUELL: That's all, I'm through. Did you say Mr. Speer hadn't seen it?

MR. SPANN: I said I didn't know whether he had and I thought he should have a chance to look at it if you were going to question him about it.

MR. PORTER: The witness may be excused.

(Witness excused.)

MR. PORTER: How many more witnesses do you have, Mr. Spann?

MR. SPANN: Two.

MR. PORTER: Two more. We will have a short recess.

(Short recess.)

MR. PORTER: The meeting will come to order. Mr. Spann, will you proceed.

MR. SPANN: Could we ask Mr. Speer a couple of questions on redirect examination?

MR. PORTER: Surely.

MR. SPANN: Mr. Woodward has a couple of questions to ask him.

REDIRECT EXAMINATION

BY: MR. WOODWARD:

Q Mr. Speer, considering the lithology and configuration of Sands A and B as you have testified to those matters, does the particular depositional history of Sands A and B indicate two zones?

A The depositional history in this particular area would indicate separation rather than communication.

Q Is there separate depositional history to indicate anything about the likelihood or the possibility of communication through a common sand body?

A No, there is not.

Q There are instances, are there not, where the separate sands may be connected to a common sand body as the fingers of the hand are connected to the palm, is that true?

A That is true. There are examples in the San Juan Basin and Mesaverde sections of other upper cretaceous beds where they have connected as you have depicted it. In this particular area, as we have shown in our cross sections, there is very little likelihood of this type of connection between Sand A and Sand B at some point further away.

Q Are you saying that this depositional history eliminates that possibility or makes it less likely?

A Yes, in this particular area.

Q Now, Mr. Speer, why did you hang your cross sections on the top of Sand A?

A As has been previously pointed out, we have hung all of our cross sections on this base line, which is the top of Sand A. The first prerequisite for a base line that you look for in hanging your cross sections is something that can be correlated throughout the area that you are trying to lay your cross section on. Now, when the field was first discovered and immediately after the first few wells were drilled, we sought a common datum point that we could correlate the area, and it seemed likely that probably the cenosity would be one of these, the limestone that forms the cenosity would be the best thing to attempt to put our cross sections on, but we found after the drilling, density, the density of drilling increased and we had no more control. What happened was that these particular thin beds, and we have described them from cores and samples as this upper kick which you see on this well, the Petro Atlas 1 B Horseshoe Canyon Well on Exhibit 6 at a depth of approximately 1620, this is a calcareous siltstone. That is, this particular bed here that is depicted on the electric log is a limestone very silty. These things, as you can see from this cross section, can be carried for some distance. What happened when we got out and got control of Sand B deposition was that--and we felt that we could correlate these particular beds with some accuracy because they have distinctive characteristics, different from one another on the electric log--what happened when we got out in the area of deposition of Sand B was that the top bed that I have shown here disappears or coalesces with Sand B and also that the first limestone kick does the same thing. I think it is shown in this particular well here, Tom Bolack No. 2 Bolack.

The first limestone stringer and the overlying calcareous siltstone have both disappeared in this particular well, and I believe that is further proof of this errosion of the trough in this area.

Now, the third kick, of course, is not shown over the field area for the simple reason that most of the wells didn't go deep enough to pick it up, so it did not serve as a good correlative point over the entire field. Of course, we did not want to use the top and bottom of Sand B because we were attempting to discover what the configuration was. Likewise, Sand A presented difficulties. However, the top of Sand A is overlain by a bentonite bed, and in every instance that I know of, which varies in thickness, gets down as low as eight inches. Some course bentonite, of course, is a good time marker, according to my geologic understanding. It offered a point that we could select over the entire field area with accuracy, and serves as the best point to hang our cross sections from. If you attempt to hang a cross section on any one of these cenosity kicks where you could correlate them, when you get out in the edge area of Sand B deposition where the base line is picked, say to this limestone here, you would not get essentially a picture of a channel or trough through it because of this distance between the up-dip bench out of Sand B and the cenosity, but what you would get would be fluxuation in this up and down movement of the section lines of Sand B, so we felt that this particular point offered the only reliable datum point on which we could hang a cross section.

MR. WOODWARD: That's all.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused.)

MR. SPANN: Mr. Walsh will be our next witness.

EWELL N. WALSH

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY: MR. SPANN:

Q Would you state your name, please.

A Ewell N. Walsh.

Q Where do you live?

A Farmington, New Mexico.

Q By whom are you employed and in what capacity?

A Employed by El Paso Natural Gas Products Company as division petroleum engineer, San Juan Division.

Q Have you previously qualified before this Commission as a petroleum engineer?

A I have.

Q In your capacity as a petroleum engineer, have you made a study of the Horseshoe Canyon Field?

A I have.

Q Mr. Walsh, you have Exhibits 10 through 16 before you, is that correct?

A That's correct.

Q El Paso's exhibits?

A Yes.

Q Are you familiar with those exhibits?

A I am.

Q Were they prepared under your supervision or direction?

A They were.

Q What does Exhibit No. 10 show?

A El Paso Natural Gas Products' Exhibit No. 10 is a tabulation showing the operator, lease, well number, location, completion date, perforations in Sand A and/or Sand B, the total depth of the well, and the potential.

Q Now, when was the discovery well completed in this field?

A The discovery well is the Horseshoe Canyon No. 1 located in the NE of the SE of Section 4, Township 30 North, Range 16 West. This well was originally drilled by Arizona Exploration and during September, 1957, was purchased by the El Paso Natural Gas Products Company. Completion date for this well was September 6th. Pardon me, September 21st, 1956.

Q How many wells are now completed in the field?

A There are a total of one hundred and ten wells in this field area.

Q And how many are completed in Sand A and B, and how many in Sand A alone and how many in Sand B alone?

A There are thirty-six wells completed in Sand A alone, ten wells completed in Sand B alone, sixty-four wells completed in both sands.

MR. PORTER: Sixty-four?

A Yes, sir.

Q Now, what does El Paso's Exhibit 11 show?

A El Paso's Exhibit 11 is a tabulation of the average properties determined by core analyses of Sands A and B. In the case of Sand A, the core analyses from twenty-two wells were used. In Sand B, the core analyses of eighteen wells. These properties are: Average porosity for Sand A, 14.3 per cent. For Sand B, 18.1 per cent. The medium peremeability for Sand A

35 millidarcies. For Sand B, 95 millidarcies. Average connate water saturation determined from capillary tests for Sand A, 40 per cent; for Sand B, 35.5 per cent. Average total water saturation, 40.1 per cent for Sand A; for Sand B, 40.6 per cent. Average residual oil saturations, Sand A, 13.5 per cent; Sand B, 15.5 per cent.

Q What does Exhibit 12 show?

A El Paso Natural Gas Product Company's Exhibit No. 12 is a tabulation of the bottom hole pressures that were run on El Paso Natural Gas Product Company's wells in the Horseshoe-Gallup field. There were individual pressures taken for each of the sands. In the case of Sand A, a plus datum of 41.75 was used throughout these wells. In the case of Sand B, a plus datum of 40.75 was used throughout these wells. We have included a third column in which Sand B is corrected to the datum plus 41.75. In some cases there are companies that will determine the pressures at one datum even from individual zones. From this exhibit, relating to the Horseshoe Canyon No. 2 "B", located in the NE of the NW of Section 4, Township 30 North, Range 16 West, the pressure measured by bomb for Sand A at the 41.75 datum was 221 pounds. The pressure measured for Sand B at a plus datum of 40.75 was 264 pounds. The pressure as calcualted for Sand B at a plus datum of 41.75 was 243 pounds. This is to show that there is a difference in bottom hole pressure. On the other wells you might note that there is also a difference between the two pressures of the sand. The Horseshoe Canyon 2 "B" Well is the only one to my knowledge that has had a bomb run to determine the bottom hole pressures of the sands individually. In the case of the Horseshoe Canyon No. 1 and No. 4 and No. 2 "B", these wells are natural, completed naturally, not fractured. Due to the time the Horseshoe Canyon No. 4 and 2 "B" were drilled and completed, we considered this initial bottom hole pressure survey for that field area.

Q Now, referring to Exhibit 13, what does that show?

A El Paso Natural Gas Products Company's Exhibit No. 13 is a tabulation of individual production tests that have been made on Sands A and B in the Horseshoe-Gallup field. In the case of the Horseshoe Canyon No. 4, you might note that this well has not been sand-oil fractured in either sand. There is in Sand A only a 21 barrel per day volume. This well was tested in each sand for an average, for seven days, and the average production calculated over that seven-day period. You might also note the difference in the gas-oil ratios, on Horseshoe Canyon No. 6 and 8. In these wells, both sands were sand-oil fractured. Again, these wells were produced for seven days in each sand, and this is the average production during that seven-day period. Again, I might indicate not only the differences in amount of production, but also the differences in GOR. The Horseshoe Canyon 2 "B" as I stated before has not been sand-oil fractured. We ran a swab test on the lower sand, or Sand B, and then pumped the upper sand of the Horseshoe No. 4. In both cases, the sands were tested by a swab using a casing swab to produce the oil.

The Atlantic Refining Company's Navajo No. 1 was sand-oil fractured and this well was tested in each zone by swabbing. Pan American Corporation's Aidlin No. 1 "A", both sands were sand-oil fractured and each of the two zones were put on the pump for testing. In each of the cases where an individual test was made on each of the sands, either a bridge plug was set between the sands or a packer.

Q Mr. Walsh, do these tests indicate that each sand can produce more than a 40-acre allowable?

A To me they do indicate that the sands are capable of producing a normal 40-acre unit allowable.

Q You were here and heard Mr. Speer's testimony?

A I was.

Q Incidently, were any other tests made other than those that you have testified to on those wells?

A There might be other tests throughout the field that I do not have knowledge of.

Q Considering Mr. Speer's testimony and the results of these tests that you just testified to, have you an opinion as to the possibility of communication between the two sands?

A In my opinion, Mr. Speer's testimony and the pressure surveys we have run and these producing tests indicate to me that there is separation between the sands and they are not in communication.

Q Well, in your opinion, based on these tests and on Mr. Speer's testimony, are Sands A and B separate common sources of supply?

A They are in my estimation common separate sources of supply.

Q Under the definition of that term as retained in the Oil Conservation Commission's Rules and Regulations?

A As the definition retained in the Rules and Regulations, yes.

Q Now, considering the results of the bottom hole pressure test, the core analyses, the pumping and swabbing test, what acreage in your opinion can be drained by a well completed in each of these sands?

A In my opinion a well could at least drain 40-acres from each of the sands.

Q Now, assuming we have wells completed in both the sands, Sand A and B, and offset wells in Sand A, what will occur as between those wells insofar as drainage is concerned?

A Going to Exhibit 1 to use possibly an example, using the same two wells that Mr. Speer used, that being the Bolack 10 in the SE of the NW of Section 10, Township 30 West, Range 10 West, and the El Paso Natural Products Company's Well No. 2 in the SW of the NW of Section 10, Township 30 North, Range 16

West, in the case of Mr. Bolack's well, he had both sands opened and producing. In the case of the Products Company's well No. 10, there is only the A Sand opened and producing. In this area, which Mr. Bolack is producing from, he is producing the normal unit allowable with both sands opened, and most likely producing a substantial portion of his allowable from each.

In the case of the El Paso Products' No. 10, there is one sand opened, and in this case, the well is producing its normal unit allowable from one sand. Considering the rate of withdrawal that Mr. Bolack is using over here in comparison to the rate of withdrawal in the El Paso Well No. 10, there is the chance of creating the lower pressure area around the El Paso Well No. 10 in comparison to the pressure drawdown from Mr. Bolack's No. 10. In doing that, creating unstable condition of pressure between the two wells, there is a considerable chance for fluid within Sand A to move towards the El Paso Well No. 10. In order for fluid to do that, it would have to cross the lease line, the line between the two 40-acre tracts. Now, this is not the only instance in which this could happen. It could also happen, as Mr. Speer has stated, with Mr. Bolack's No. 11 and the El Paso Products' No. 13, and along both of the flanks in which the probably productive limits of Sand B are. This condition could exist.

Looking at it, the whole field, we have wells on this northeast flank that not only El Paso Products, but other operators have completed in Sand B only. Looking at the field drainage, the two wells on this flank or possibly on this flank are producing from one sand only, producing their normal unit allowable, and then having wells within the area that you can effectively produce from both sands. Over a period of time you would have the same situation exist as you would have between the Bolack No. 10 and the El Paso Products' No. 10 in that there conceivably could be a movement of fluid in Sand A from the major portion of the field to the outside due to the drawdown in pressure of Sand A in the flank area as compared to the drawdown in Sand A in the other portion of the field.

Q Is there any way an operator from both zones can protect himself from such drainage under present rules and regulations?

A Under present rules and regulations, no, there is no way an operator can protect himself.

Q Do you have any recommendations how an operator might be afforded an opportunity to produce this oil underlying his property?

A I would recommend that the operators be given the opportunity to completely separate and produce the two sands, Sand A and Sand B individually.

Q And have you an opinion as to what production techniques will result in the greatest ultimate recovery of oil from Sands A and B?

A From a study of our company and other companies in the area, the way to recover the greatest ultimate amount of oil from this area will be going to secondary recovery by water flood.

Q Well now, are separate programs for each sand required in your opinion?

A In my opinion it would require separate injection programs and separate producing programs.

Q Now, can this be done, or is it practical to undertake such a program as long as production from the two sands is commingled through the same well bore?

A In my opinion, it would not be practical to undertake such a program in which, on the producing well, the production was commingled in the well bore.

Q Will you explain that, Mr. Walsh?

A In this area, still using the thought of water flood through the evidence presented here, the sands evidently have different formation characteristics. In order to effectively water flood an area such as this, the injection wells will have to have the installation in which the water will be injected into each of the sands separately. With such conditions of the different formation characteristics of the two sands and having to have a separate water flood program for each of the sands, unless the producing wells also have the production from each of the sands separated, the water flood, of course, the front would be moving through these sands, and due to the different formation characteristics would most likely reach the producing wells at a different time. Using for instance Sand A, this well was not set up to produce the two sands separately. Sand A's water flood front would reach the well and start watering out this Sand A in that immediate area. In Sand B, the water flood front had not reached that yet. Without separation of production you would have to produce not only the volume of oil and water produced or coming into the well bore here, but could also, due to this water breaking into the well bore creating a hydrostatic head which would be enough to cause water from this sand, Sand A, to go into Sand B; by having this done you would not only disrupt the flood that you carry on in Sand A, but in Sand B you would have water going into the formation ahead of the time at which your front is to come through. By increasing this hydrostatic head, increasing your pressure at this point, it could be possible to create a high-pressure area around the well in Sand B disturbing the effectiveness of the flood in Sand B and possibly even causing the by-passing of your flood around that area.

Q In other words, any practical secondary recovery program would have to be initiated separately in each of these sands?

A Yes, it would. I am speaking not only of water flood, but any other type of secondary recovery.

Q Now, Mr. Walsh, would you look at Exhibit 14, please. Now, what does that show?

A Exhibit 14 is a schematic diagram of the subsurface equipment the El Paso Natural Gas Products Company proposes to use in this type of dual completion in these wells. In our wells we have 5-1/2 inch producing casing run through both of the sands to TD and cemented with enough cement to give positive separation and protection of the sands. We propose to use a tension type retrievable production packer which will be run in the well on -- made up in the tubing string for producing the lower zone, Sand B. This tubing string we propose to use is 1-1/2 inch non-upset 2.75 pound J-55 tubing. In setting this production packer between Sand B and Sand A, we will have a positive seal to prevent communication between the two sands at this point and commingling of the fluids. The tubing string for the lower zone will go to the surface and into its own line. The tubing string for the upper zone, or Sand A, is of the same type tubing that we will use for the tubing string for Sand B. This tubing string will be run and latched into the parallel string anchor and pulled in tension. This will be used to increase the efficiency of a pump and also relieve some of the strain from the first string in holding the tension on the packer. The pumps, subsurface pumps we propose to use are common working barrel pumps 1-1/4 inch with a two-cup standing valve and a six-cup traveling valve. The rod strings for both Sand A and Sand B will be 1/2 inch rods with paraffin scrapers.

Q Do you know of any areas where that type of installation is presently being used in dually completed wells?

A There is one area, the Walnut-Bend Field in Cook County, Texas in which they have used a very similar type of installation. They have used common working barrel pumps, tension retrievable packers, and 1-1/2 inch non-upset tubing.

Q And that will separate the production from the two zones as required by the Rules of the Commission for new completions?

A They have been very successful in this area with this type of completion.

Q Now, what would an installation like that cost, Mr. Walsh, if you know?

A This subsurface installation, along with the necessary installation we propose to use, will be approximately $3,600 above the cost of the completion of a well now.

Q Well now, will you turn to Exhibit 15 and what does that show, Mr. Walsh?

A Exhibit 15 is a schematic diagram of the equipment that the El Paso Natural Gas Products Company proposes to use on the surface for separate metering of the two fluids, from each of the sands, Sand A and Sand B. This unit here is essentially two separators in one with a partition, solid steel partition between the two separators. The production from Sand A will enter this separator, the gas being vented out the gas-vent line; the oil will go through a positive displacement meter and then into the flow line which now exists and from thence to the tank battery that now exists. Sand B's production would enter this separator, the gas being vented all through the gas-vent line, the oil going through this positive displacement meter to be commingled with this production from Sand A through the existing flow lines to the existing flow batteries. At no time prior to metering will the two fluids have the possibility of commingling.

Q Now, was that installation included in your cost figure of $6,400?

A It was included in my cost figure.

Q Now, referring to El Paso's Exhibit No. 16, what does that show?

A El Paso Natural Gas Products Company's Exhibit No. 16 is a drawing of a dual carrier bar horsehead. This is essentially one horsehead here with an extension out between the bridle with a configuration of another horsehead. From each of these hang your bridle and carrier bar. In using this type of horsehead we are able to use the units that we now have installed to produce both of the wells at the same time since the polish rod for Sand A and polish rod for Sand B will be planted on to these carrier bars. Also in the event that there is one zone that reaches its allowable before the other, it will be possible to lower the polish rod, clamp it off at the wellhead, take your clamp from above your carrier bar in that zone and continue to produce the other zone.

Q Now, is this also part of the installation involved in the cost figure that you gave?

A This is also included.

Q Now, in your opinion is the production from Sand A and Sand B sufficient to drill and dually complete wells in the Horseshoe-Gallup field with a reasonable profit to the operators after payment for the drilling and operators --

A Yes, it is.

Q In your opinion can an operator or owner in the Horseshoe Canyon field who produces from both Sand A and B, be assured of producing his just and equitable share of oil unless the two zones are separately produced and prorated?

A The only other way would be to plug off one of the zones, but still in effect, an offset operator, if he didn't have the same zone plugged could drain in the same manner. As there is indicated now, there are two wells with both zones opened and a well with one zone opened.

Q Now, in your opinion could separate wells be drilled to each of these zones and sufficient oil be recovered to pay for the cost of drilling with a reasonable profit to the operators?

A Yes, it could, but this field has been developed as such, and I do not believe that it would be necessary to drill another well with our proposed dual completion installation.

Q In other words, you are proposing a more economical method of producing these two zones?

A That is correct.

Q Than drilling separate wells. And I believe you testified that in order to initiate a satisfactory secondary recovery program, the zones would have to be separately, or your program would have to be separately initiated in each zone?

A That is correct.

Q And would the separate production of each zone and a secondary recovery program initiated in this zone tend to prevent waste in the field?

A Yes, I believe it will.

MR. SPANN: At this point I would like to offer in evidence our Exhibits 10 through 16.

MR. PORTER: Is there objection to the admission of El Paso's Exhibits 10 through 16? They will be admitted. Anyone have a question of Mr. Walsh?

MR. BUELL: Yes.

MR. PORTER: Mr. Buell.

CROSS EXAMINATION

BY: MR. BUELL:

Q Mr. Walsh, in the interest of saving time I am going to divide my questioning up into three parts. First, I want to talk with you about separateness and communication; secondly, I want to talk to you about water floods, and third, I want to talk to you about correlative rights and prevention of waste.

Now, which of your exhibits have anything to do with the question of ascertaining whether we have one reservoir or two? Did Exhibit 10?

A No, Exhibit 10 is just to show the perforated intervals in each sand.

Q How about Exhibit 11?

A Exhibit 11 is to show the different characteristics as determined by core analyses.

Q Do you feel that is an engineering tool to ascertain communication or separation?

A I don't believe you can take just one thing, you have to look at all of them before you can directly --

Q You believe in the area in question here that that is a valid engineering tool, is that your answer?

A In consideration -- to show the difference between the two sands?

Q Yes, sir.

A Yes.

Q Actually, all you are reporting there is averages, isn't it, Mr. Walsh?

A Yes.

Q And averages sometimes can be misleading, can't they? A man on a horse, each of them wouldn't have three feet, would they?

A No.

Q But that would be the average feet?

A Right.

Q Because you take high, you take low, and you get your average?

A Yes.

Q And each one of those average figures that you have, you had higher figures and you had lower figures, didn't you?

A That's right.

Q But you still think that is a valid tool in this area to ascertain separation or communication?

A Looking at it on a field-wide basis, yes.

Q Mr. Walsh, probably if you divided Sand A equally into two parts and took your rock characteristics of the top half and averaged them --

A Yes.

Q --and averaged the rock characteristics of the bottom half, your average would probably be different, wouldn't it?

A In relation to these?

Q Yes, sir.

A I would have no doubt they would.

Q They would be, wouldn't they?

A Yes.

Q Would that indicate to you then that Sand A is actually two reservoirs? It wouldn't, would it?

A No.

Q And you still think this is a valid engineering tool?

A It is one of the tools you have to use.

Q All right, sir. What other of your exhibits -- What about Exhibit 12?

A Exhibit 12 is the bottom hole pressure survey.

Q Is there any data contained in that exhibit, in your opinion, that indicate separation of these two sands?

A Yes, in the, difference, although slight, in the bottom hole pressures.

Q You think separation is indicated because your values are slightly different?

A Take the case of this Horseshoe Canyon 2 "B", we even corrected both sands to the same datum, and we see a difference in pressure. Now, if you take any sands, anything that is in communication, and correct them to the same datum, essentially they should have the same pressure.

Q All right, sir. I see. Would you agree with me, Mr. Walsh, which both you and Mr. Speer have testified, that for a period of time, two years, we have had high communication in the well bore? I am assuming that you and Mr. Speer are right and we have separation.

A In that we have both sets of perforations opened in a common well bore?

Q Yes.

A Yes.

Q If we have not been bothered by communication by nature, man has made communication for two years now, has he not?

A Yes.

Q Under these circumstances, how do you explain the pressure differential existing?

A This pressure--I am taking the example here--was on essentially initial.

Q You mean that is the discovery pressure?

A That pressure was taken as soon as that well was completed.

Q Is that a pressure on the discovery well in this Gallup formation, either Sand A or B?

A No.

Q It isn't. Production had occurred from other wells in the field when you took that first well, the completed well, hadn't it, Mr. Walsh.

A Yes, but in a small magnitude.

Q And that had been completed in the field with both sands opened in the well bore when you completed that well, hadn't it?

A True.

Q Why, in that period of time, with all the production we have had, if the two were actually separate, with different pressures, why haven't we had an interchange of fluids and balancing of these pressures?

A We are looking at a relative short period of time that it would take essentially to establish both pressures throughout the area. I had not had the count of the number of wells in this field when we took the pressures, but there was only a relative small amount of production, and it still would take a long time for the two sands to adjust.

Q Actually, Mr. Walsh, the precluding of the interchange of fluid from one common source of supply to another common source of supply is one of the scientific reasons that you engineers say common reservoirs should be produced as one reservoir and not two of them, commingled together to obliterate that, that interchange of fluid?

A If there is definite communication between the two.

Q That is one engineering basis for making a recommendation like that, isn't it?

A Well, it wouldn't even be practical, if there were definite communication between two reservoirs, to isolate the production.

Q But yet you are stating here that although we have had communication, which you recognize and honestly state exists, still you are trying to use pressure differential to indicate separation. Are you sure about it, Mr. Walsh?

A In my mind, yes.

Q And that indicates to you separateness although we have had man-made communication for two years?

A It gives me another indication of separateness.

Q With datum like that, and the interpretation you put on it, there is probably, even assuming that these two are actually separate, no harm would come from producing them, would it, because they are not doing anything because of it?

A No harm?

Q Yes, sir.

A In what way?

Q In the form of waste.

A In the form of waste and future secondary recovery, yes.

Q Let's go back to the original premise. One of the engineering basis for recommending that separate reservoirs be produced as separate reservoirs is to avoid the interchanging of fluid from one common source of supply to another, do we agree on that?

A That's one of the points.

Q All right, sir. It is obvious, from the datum you have there and your interpretation there, that such has not occurred, so immediately that engineering basis falls, does it not?

A Not all the way.

Q All right, sir. What about your Exhibit 13?

A 13 is the individual production tests of Sand A and Sand B.

Q What does that have to do with separation or communication?

A From this I can give you an instance, one case.

Q Please do.

A The Horseshoe Canyon No. 4, El Paso Natural Gas Products Company. This well was completed naturally in Sand A. Over a seven-day period of production, it was produced for twenty-one barrels a day GOR. Actually, gas was too small to measure, although in producing Sand B for the seven-day period, the average production was seventy-four barrels per day, with a GOR of 125 cubic feet of gas per barrel of oil.

Q What are you leaning on, Mr. Walsh, the amount of oil or the difference in the gas-oil ratio?

A Both in this case.

Q Let's talk about the volume of oil first. Certainly, I believe you will agree with me that, admittedly, common reservoir wells have varying producing capabilities, do they not?

A Yes.

Q Actually, that's the rule, not the exception, isn't it?

A Right.

Q If you try to divide reservoirs up by producing capacity of the individual wells, you would have thousands of oil fields, wouldn't you?

A Well, I believe you would have to take specific reservoirs like we have taken this one.

Q Well then, why, with your background, knowing that ability to produce varies so widely, why do you think that that is evidence of separation?

A Well, if you didn't have complete separation, you produce that bottom zone, Sand B, at seventy-four barrels a day, and you produce the top zone, or Sand A, at twenty-one barrels a day, how much communication can you have there?

Q Oh, you are just saying then, on this particular well, that based on this production test, that maybe vertical communication from Sand A to Sand B is just not instantaneous, is that all you are saying?

A Personally, I don't think it exists.

Q What about gas-oil ratios, are you saying something like this indicates that the crude characterisitics are different?

A Just in the case of your gas in solution.

Q Well now, you have available to you bottom hole sample analysis taken from the A and taken from the B which gave you the exact crude characteristics in each one of these sands, so why do you try to rely on measured gas-oil ratio on a production test?

A If a surface measured gas-oil ratio is taken, one of the things it is used for is as a production tool in your production of oil.

Q Now, you have the bottom hole sample analysis visible to you?

A I do.

Q What does it reflect from the standpoint of crude characteristics? Let's see if the characteristics of crude are different.

A The two samples that we took in the Horseshoe Canyon field, one of the samples was from Sand B, from the Horseshoe Canyon No. 4. Actually the PBT analysis shows very little, if any, difference in the two crudes between Sand B and the Horseshoe Canyon No. 4, Sand A, Horsehoe Canyon No. 2 "B". I might state that we tried to take a lower sample of Sand B in the 2 "B" in order to have a sample between the two wells, I mean, the two sands, but it was unsuccessful.

Q But all of the criteria which you measured that goes into making up a crude permeability, you might say with respect to the A and B, they are extremely similar, are they not?

A The type crudes?

Q Yes, sir.

A Yes, sir.

Q Gravity, solution, gas-oil ratio, all of those measurable indices are extremely similar, aren't they?

A They are major in some cases, I don't believe they are in this one.

Q ~~So we are certainly here dealing with just one~~ type of crude, aren't we?

A From all indications that I have, yes.

Q Do you feel that that is a valid engineering tool, for example, bottom hole data, to see if there is communication?

A Yes, it definitely is.

Q And it doesn't show separation, does it, Mr. Walsh?

A It will not show separation or communication.

Q It does not show separation, does it, Mr. Walsh?

A No.

Q What was your next exhibit, Exhibit 14?

A Yes.

Q I will just ask you one question on that exhibit, Mr. Walsh. Could that type of an installation be made under the Commission's present rules?

A No, sir.

Q Thank you. Now, Mr. Walsh, let's talk a little about migration. Now, if I understood your testimony correctly, you stated the present means and methods of prorating the field is violating correlative rights?

A In some cases.

Q In that for instance, and I am referring to Exhibit what?

A This is Exhibit 6.

Q In pointing out the Well No. 4 on that exhibit, --

A Which is the Petro Atlas 1 "B", Horseshoe Canyon, and I am also pointing to well No. 5.

Q All right, sir, also pointing to Well No. 5, which is Tom Bolack's No. 11 Bolack, as I understood your testimony, you said the present system was inequitable in that while you were prodcing one allowable, or rather, in this case, the Bolack No. 11 Bolack was producing one allowable from two formations, the Petro Atlas 1 producing one allowable from only one formation, and therefore, migration would occur away from the Bolack well in the direction of the Petro Atlas Well?

A Right.

Q Did I understand you correctly?

A Yes.

Q Do I further understand that it is your testimony that if your application is approved by the Commission, that migration will cease?

A I wouldn't say it will completely cease, there would be the chance of greatly eliminating it.

Q All right, sir. I will point your attention then again to Exhibit 5. I mean, Well No. 5 on your Exhibit 6. I will go on over to Well No. 6, on that, which is one of your wells, your Horseshoe Canyon No. 6, and assume that the Commission approves your application and operators are allowed to dual their wells, tell me whether or not migration will occur away from your Horseshoe Canyon No. 6 and in the direction of Tom Bolack's

No. 11 Bolack?

A Away from this?

Q From your well to his well?

A To that one with dual completion?

Q I am talking now about this Sand B, if it is completed and away from Sand B.

A A?

Q Yes.

A No, sir.

Q Now, do you think that the Bolack Well has as much net pay and net reserve as you have in the No. 6?

A No.

Q Sir?

A No.

Q All right, sir. How is this field prorated, how will it be prorated if your application is approved?

A They will have to be prorated on the basis it is now, each will have to be considered two common sources of supply.

Q All right, sir. Under that assumption, and with the net pay and amount of reserves, we can see, based on these logs, you are going to suffer migration to the Bolack Well?

A To the Bolack Well?

Q Yes, sir.

A No, not from our well to theirs.

Q Even though you admit that it is pretty obvious you have much more oil in place?

A Well now, when we are producing this lower sand separately?

Q Yes, sir.

A Are we going to be caused migration in that case?

Q Yes.

A No, sir.

Q He is producing his separate lease?

A He is producing his separate lease, I understand.

Q Mr. Walsh, I am having trouble understanding. Is it your testimony, as an engineer, that you will not experience migration where two wells are producing the same volume of oil, you will not have migration from an area of high reserves to an area of low reserves?

A I see what you mean. In my opinion, by producing both of these sands separately, you will essentially cause a stabilized condition half way between, quarter of the way between--I don't know--between the two wells.

Q Now, Mr. Walsh, listen carefully, please, sir. Actually, all we are looking for in our second situation, we are looking at the B only, we are looking at exactly the same principle which you say is causing migration. Now, we are looking for oil migration from more net pay to less net pay. We just moved it down a notch, that's all, and if you contend that migration will occur as the field is now being prorated, are you sure, Mr. Walsh, that you don't feel that it will occur under your application?

A I'd say there is a bit of a chance.

Q In this situation on these two wells that we have just been discussing, migration would occur, wouldn't it?

A Possibly so.

Q If it does occur, Mr. Walsh, the approval of your application is not going to eliminate the violation of correlative rights which you say is occurring, would it?

A It will, maybe not to the greatest effect in an area like this, but you take, for example, these two wells here --

Q That's a problem all we producers in every oil field are faced with when a location is based on something other than reserves, we have migration from the high reserve area to the low reserve area, we live with it in every field, don't we, Mr. Walsh?

A Yes.

Q And your application is not going to change it, is it, because all we are looking at under either hypothesis is migration of more oil in place to the less oil in place, whether you are looking at two zones of porosity or one of them?

A Yes.

Q Let me ask you this about correlative rights --

MR. WOODWARD: If the Commission please, I ask that this line of testimony be stricken on the ground that it constitutes a unilateral attack on the proration formula that the Commission has already adopted. They have so far prorated this area on an acreage basis which makes certain necessary assumptions that may or may not be true that the correlative rights of the operators in a single common source of supply are protected by granting them an equal share of the allowable and equal amount of acreage. I don't see that it is relative to this situation as to whether or not, within a single common source of supply, there is a certain amount of migration in the adoption of an acreage formula. The issue that is presented here is the migration that results from having half an allowable for wells completed in a sand, and a full allowable for other wells completed in the same sand.

MR. BUELL: May I assure the Commission that I was not making an attack on the allocation formula. It is an allocation formula of the type that my company recommends quite often, and we are not necessarily unhappy with it here. My whole point was to show that where this witness has testified that the approval of their application would eliminate migration, my only point was to show, and he has admitted, that it would not, that we would still be faced with migration.

MR. WOODWARD: If the Commission please, we ask that it consider two types of migration involved. One is a migration that results from a failure to separate two separate common sources of supply, the other type of migration results in the adoption of an acreage formula. Inasmuch as this line of questioning is devoted entirely to migration that results with the adoption of an acreage formula, we do not consider it relevant to this case where the issue has been raised --

MR. BUELL: May it please the Commission, both migrations occur under both hypothesis for the same reason as the witness has testified to.

MR. PORTER: The Commission will overrule the objection and the testimony will be considered for whatever we feel it is worth.

Q (By Mr. Buell) All right. Mr. Walsh, let's look at these same two wells on your Exhibit 6. I am referring to Tom Bolack's No. 11 Bolack and your Horseshoe Canyon No. 6, both of those zones have both Sand A and Sand B present, do they not?

A They do.

Q The No. 11 Bolack has a much smaller section than your well?

A True.

Q Actually, would you say just roughly about a third less or a third as much as your well?

A Roughly.

Q Would you agree with me, Mr. Walsh, that it costs more to drill and complete a dual well than it would cost to drill and complete a well as we have been doing?

A Yes, I have stated so.

Q Do you not visualize, Mr. Walsh, that in certain areas of the field around the perimeter of the productive limits of your Sand B, you are going to run into a situation where a well would have Sand B present, it would have enough present to justify completing, as long as it were completed with Sand B, but it might not be economically justifiable to spend the additional money to dually complete the well? Will you agree with me that that could possibly occur around the perimeter of the productive limits?

A Very much so.

Q For the purpose of this question, let's assume that such is the case here on No. 11 Bolack, and the operator of that well decides that he is not economically justified in expending the additional money to dual that well, and El Paso duals its Horseshoe Canyon No. 6 and produces from Sand B, what happens to the correlative rights of the oil under the Bolack Well under those circumstances?

A If we did not try to produce Sand B at all --

Q You would lose it, wouldn't you?

A I would say in effect, yes.

Q So then will you agree with me that under those circumstances, there is the possibility for violation of correlative rights, if your application is granted?

A In this case the operator of this well would have the opportunity to protect himself as much as possible too.

Q By making an uneconomic investment, in my opinion, and we must remember, Mr. Walsh, I realize that both you and Mr. Speer are sincere in your belief that these zones are separate, but other people are equally sincere that we have communication.

A Yes.

Q We have to keep that in mind.

MR SPANN: Well now, I will object to that statement and move that it be stricken. I think that is a matter of evidence.

MR. PORTER: The Reporter will strike that statement from the record. The Commission will not consider that testimony, Mr. Buell.

Q (By Mr. Buell) All right, let's talk about water floods, Mr. Walsh. As I understood your testimony, you said it would be impossible to water flood the field as it is now regulated because of the irregular events of your water flood.

A Yes.

Q I summarized a lot, but that was the gist of your testimony. How many water floods have you had experience with?

A None.

Q Do you know through general knowledge, Mr. Walsh, that that is a problem that water flooders are faced with, and admittedly, in a common reservoir, an irregular advance of their water front?

A They have that, yes.

Q Are you aware of that?

A Yes.

Q You also realize that you would have irregular advance in Sand A and Sand B even if you separated it in the well and dualled them, wouldn't you?

A Yes.

Q So you are not eliminating a problem by dually completing this well.

A You are eliminating it to the effect in case one waters out ahead of the other.

Q Have you ever heard of selective completion of injective wells?

A Yes, sir, you can selectively inject.

Q I said selective completion, I will come to selective inject.

A Oh, selective completion?

Q Yes, sir.

A No, sir.

Q How could you selectively inject without selective completion?

A Selectively inject.

Q You recognize that the water --

A Your injection well pumps water into each sand individually.

Q You could also, by your method of completing your injection well, determine the intervals of your reservoir which the water would enter, couldn't you?

A Yes.

Q They do it all the time, don't they, Mr. Walsh?

A Yes, sir.

Q They also control the rate of injection, so putting a packer in these sixty-six wells is not going to eliminate any water flooders' problem of irregular approach of a water flood?

A In my own mind I believe you more or less eliminate watering out one sand ahead of the other and producing into a common well bore.

Q How many wells in this field, in your opinion, would be dually completed in Sand A and Sand B?

A That would be hard to say on account of each of the sands would have to be individually tested before you could determine.

Q Well, let's go to this general basis. At the present time we have sixty-six?

A Sixty-four.

Q Sixty-four. For the purpose of this question, let's assume that all sixty-four wells that now are opened in both zones of porosity are dualled. Assume they are. How much would the allowable for this field be increased?

A For this field?

Q Yes, sir.

A I haven't taken that into effect.

Q Would you multiply sixty-four times sixty-two for me.

A Sixty-four times sixty-two. It would be three thousand four hundred and thirty-two.

Q Would you agree with me that fifty-two is the present allowable.

A As stated by Mr. Porter this morning, yes. That's for next month, excuse me.

Q So we have sixty-four wells that we assume could be dualled, and we will assume they are, and all you can make is the top allowable, so the allowable would be increased over three thousand barrels a day?

A Using this calculation, yes.

Q Without another productive acre being proved, without another well being drilled, without proving one barrel additional reserve of oil, the allowable of this field would be increased three thousand barrels, wouldn't it?

A Yes.

MR. BUELL: That's all.

MR. PORTER: Anyone else have a question of Mr. Walsh? Mr. Hinkle.

MR. HINKLE: I represent Atlantic Refining Company.

QUESTIONS BY MR. [illegible]:

Q Mr. Walsh, I believe that your Exhibits 14, 15, and 16 are designed to illustrate your completion method or technique in completion, are they not?

A That's true.

Q I believe you also testified in response to Mr. Buell's question, that this method of completion is not now permitted by the Commission, is that right?

A It is not now permitted by the rules to the effect that they are not considered two different common sources of supply.

Q Are you asking the Commission to make this a special rule and mandatory on all operators on the field, that they have to use this technique in completion?

A No, sir.

Q This is just your --

A This is our proposed type of installation.

Q That you propose to use. I believe you testified that your estimate of the cost of this installation was about sixty-three hundred dollars?

A Above the cost of the well completed in the present manner.

Q Yes. Does that include any additional storage?

A Yes.

Q You figured the tank storage in there? You would have to have additional storage because you have an increased allowable?

A In some tank batteries it would be necessary to put additional storage, yes.

MR. KIMKLE: That's all.

MR. PORTER: Mr. Kellahin.

MR. KELLAHIN: Jason Kellahin for Tom Bolack.

QUESTIONS BY MR. KELLAHIN:

Q Mr. Walsh, in connection with your testimony in regard to secondary recovery, am I correct in saying that you feel that secondary recovery is necessary in this pool?

A To get the greatest ultimate recovery, yes.

Q Is that for both zones?

A Yes.

Q Now, in order to be effective, do you feel that oil would be lost in the reservoir if secondary recovery is not instituted in these two zones?

A When you got primary, you would still have oil in the ground.

Q Then in the absence of a secondary recovery program, there would be oil lost in the reservoir, is that true?

A True.

Q When do you feel that that secondary recovery program should be initiated?

A We haven't exactly calculated the time that we believe it should.

Q As a general matter of practice, it is more effective when instituted early in the life of the field?

A Depending on the type of reservoir.

Q Have you made an analysis of this reservoir with that in mind?

A Generally speaking, this type of reservoir, I don't believe secondary recovery would have to be initiated for quite a period of time. Actually how long, I couldn't say.

Q I mean as to the time in the life of the pool, of the field, as to when it should be initiated.

A Oh, in my opinion, near the end of primary.

Q Now, as I understand your testimony, a secondary recovery program of the type you propose would not be effective unless the zones are separated?

A In my opinion, no.

Q Then whether the two separate sands are set up by this Commission as two separate pools or not, in your opinion, it will then be necessary to separate the zones anyway?

A Essentially, yes.

Q With regard to your Exhibit 14, the diagram, what is the smallest size casing in that type of installation to be used?

A Five and a half inches.

Q Five and a half inches. You are aware of the fact that there are some wells in the area with four and a half inch casing?

A I am.

Q Now, in regard to your pumping equipment, you testified as to the method to be used for cutting off one zone where that zone has produced its allowable, and continue to produce the other zone. What do you do about your counter weights on the pump equipment in that event?

A You would have to adjust them.

Q They would have to be manually adjusted on each well?

A True.

Q As I understand your testimony, this would be merely your proposal. Would you have any objection to other types of dual completion so long as there is effective separation of the producing horizon?

A No, sir, not upon approval by the Commission.

MR. KELLAHIN: That's all the questions I have, thank you sir.

MR. PORTER: Anyone else have a question? Mr. Fischer.

QUESTIONS BY MR. FISCHER:

Q Mr. Walsh, do you have knowledge of the producing mechanism of these two individual sands?

A Sir?

Q Do you have knowledge of the producing mechanism that produces the oil to the surface in each of these individual sands?

A Yes.

Q Could you tell me what that is?

A Solution gas.

Q In each case?

A Yes.

Q With both zones opened in wells that have both sands opened, do you, in your opinion, do you think there is any injury occurring to either one of the zones on account of having them both open on the same well bore?

A On the primary or secondary recovery?

Q On your primary.

A There is nothing under primary.

Q Do you think there is seepage of oil from one zone to the other?

A If there is, it is very little.

Q Under this present producing program that is now in effect in the field of producing both sands into the same well bore, do you feel, from your knowledge of the wellsyou might have looked at, do you feel there is going to be possibly ultimate loss or more loss of oil in one with both of them going into the same well bore? Do you think that one sand or one zone is possible of losing oil on account of this?

A Under which type of production?

Q Under the present type of production.

A Under primary?

Q Yes.

A No.

Q There isn't?

A No.

Q Could you give me your opinion as to what you think is the better sand of the two in an average case, or an average throughout the field?

A B Sand.

Q The B Sand. Thank you. That's all.

MR. PORTER: Mr. Payne.

QUESTIONS BY MR. PAYNE:

Q Mr. Walsh, you may have testified to this, but I didn't get you. What do you propose to do with the sixty-three or sixty-four wells that are completed in both zones, do you have any recommendation in that regard?

A Well, do I have to talk about the whole field or our wells only?

Q Sir?

A Is that in relation to the whole field, you mean?

Q These sixty-three or sixty-four wells that are now completed in what you consider two separate pools, is it your recommendation that these wells now be dually completed, assuming your application were granted?

A Yes.

Q What about an operator who had perforations in both zones and one of the zones in his area was marginal and he did not feel that he could justifiably dually complete, would you recommend that he squeeze off the perforations in that zone?

A I imagine it would be mandatory if the two zones were considered by the Commission as common sources and dual completions were allowed, wouldn't it.

Q Do you believe that will result in leaving oil in the ground that would otherwise be recovered under the present method?

A Possibly.

Q Now, on this horsehead pump, or whatever it is --

A Dual horsehead.

Q Under that method, can you pump both zones simultaneously if necessary?

A Yes.

MR. PAYNE: Thank you, that's all.

MR. PORTER: Does anyone else have a question of Mr. Walsh? You may be excused.

MR. SPANN: Mr. Roy Hamblin.

MR. PORTER: I believe Mr. Hamblin was sworn with Mr. Walsh, is that right?

MR. SPANN: Yes.

ROY L. HAMBLIN

called as a witness, having been first duly sworn, testifed as follows:

DIRECT EXAMINATION

BY: MR. SPANN:

Q Would you state your name and residence, please?

A My name is Roy Hamblin, I am residing in El Paso, Texas.

Q By whom are you employed and in what capacity?

A I am employed by El Pasc Natural Gas Products Company as manager of their Land Department.

Q Would you state your educational background and experience in this field?

A I graduated from the University of Arizona with an LL.B degree in January, 1948. I was admitted to the Arizona State Bar but did not practice. I went to work for the El Paso Natural Gas Company in February 8, 1948 in the Contract Department. After approximately two years I was transferred to the Oil and Gas Lease Department. Sometime in 1950 I was placed in charge of that department. I continued in that capacity until August 1957 at which date I transferred to El Paso Natural Gas Products Company as manager of the Land Department. I have continued in that capacity until the present time, with the El Paso Natural Gas Products Company.

Q You have been present here and heard the testimony of Mr. Speer and Mr. Walsh?

A Yes, sir, I have.

Q Are you familiar with the ownership of the oil and gas leases and other mineral leases in the Horseshoe Canyon Field?

A In general, yes.

Q Now, in the course of your employment for El Paso Products Company, have you negotiated unitization agreements for the operation of oil and gas leases in connection with pressure maintenance or secondary recovery programs?

A While with El Paso Natural Gas Products Company -- El Paso Natural Gas Company, I negotiated and helped in the actual signing and in the operation of numerous unit agreements. A considerable portion of my time was involved with unit work. Since I have transferred to El Paso Natural Gas Products Company, a considerable portion of my time has been taken up with formation of secondary recovery units.

Q Now, under these agreements, how is unit production allocated to various leaseholders and other mineral interests?

MR. BUELL: May it please the Commission, I wonder as to the pertinency of this testimony with respect to whether we have one common source of supply or two. I have no particular objection to it, except it doesn't seem pertinent or germane or material.

MR. SPANN: Of course, that is only one issue in the case. We have additional issues; the problem of initiating a secondary recovery program, and the problem of getting unitization agreements and so forth. This is one phase of the case that we are attempting to establish through Mr. Hamblin. He had nothing to do with separation, at this point, of the same.

MR. BUELL: I must have read the wrong notice of hearing, because I see nothing in this notice about unit negotiations. I thought we were going to try to ascertain whether we had separation or communication, not negotiating units.

MR. WOODWARD: If it please the Commission, I think Mr. Hamblin's testimony as it develops will indicate the necessary pratical legal steps involved in effecting the greatest ultimate recovery of oil from this field. It bears directly on the question of waste.

MR. BUELL: May it please the Commission, this is El Paso's hearing, they requested it. The notice was issued at their request, and I defy Mr. Woodward or anyone else to find anything about unit negotiations in the application. I thought we were to resolve whether we had one reservoir or two.

MR. WOODWARD: We feel the issue of waste is self-evident in a hearing of this kind, but if the Commission requires any further elaboration as to the exact connection, we can furnish it.

MR. PORTER: Mr. Woodward, how do you propose to tie this witness' testimony which he will give, or Mr. Spann, whoever spoke, with this matter, whether or not there is one or two separate reservoirs here.

MR. WOODWARD: We propose to show with the testimony of Mr. Hamblin not that there are one or two separate common sources of supply, we feel that other testimony has established that there are two separate common sources of supply, but to show that a failure to segregate the production from these two common sources of supply or reservoirs, will materially impede the adoption of the most efficient recovery program; that the ultimate recovery of oil from these two sands will be prejudiced by a failure to segregate the production from the two zones, to recognize them as separate common sources of supply. To a great extent his testimony is of a specialized nature. We feel that he should be permitted to continue. He can satisfactorily establish that link as to why the failure to segregate not only results in a prejudice to correlative rights, but could result in a failure to recover the greatest amount of oil that might otherwise be obtained.

MR. BUELL: May it please the Commission, Mr. Woodward admitted in his opening words that the testimony of this gentleman is clearly outside the call and the scope of this hearing when he admitted that it had nothing to do with whether or not we had one or two reservoirs in this pool. We had no notice --

MR. WOODWARD: If the Commission please, the call of the hearing clearly states that in our opinion, granting of the application is necessary for the prevention of waste, and we propose to make that showing at this time.

MR. BUELL: Through a lawyer?

A Landman, not a lawyer.

MR. KELLAHIN: If the Commission please, I would like to make this observation. I believe Mr. Woodward has covered this quite thoroughly, but I would like to point out that the witness offered by El Paso has testified that there is separation here. They have further testified that under present producing conditions, no great real harm will result from production of the two separate zones as though they were one common source of supply. However, in order to prevent waste, it is going to be necessary to separate these zones, regardless of whether the Commission feels they are one common source of supply or two. In order to achieve the greatest ultimate recovery, it is necessary that secondary recovery procedures be instituted, and we certainly feel that the testimony which is now being offered is quite pertinent to this issue to show the Commission that in discussing the problem of secondary recovery, we are not talking about a hypothetical issue that exists out here in someone's mind; that it is a practical approach and will result in the prevention of waste, which is certainly within the call of this hearing.

MR. BUELL: May it please the Commission, apparently Mr. Kellahin and I have been listening to different testimony.

The only testimony I have heard from these witnesses was that, whether or not the wells were dualled or remained completed as they are, they were going to have a problem of water flooding on an uneven approach of the water flood, and the witnesses readily admitted they would be faced with the same problem, whether the wells were single or whether they were dual completions.

MR. WOODWARD: The applicant does not accept that version of the testimony.

MR. PAYNE: Mr. Woodward, does the testimony of this witness go solely to the fact that unit agreements are difficult to execute and are time consuming?

MR. WOODWARD: It goes to the particular problem encountered in negotiating the unit agreement, particularly where you have two separate common sources of supply, and in the adoption of an appropriate participation formula, and it would indicate the great disadvantage, if not complete barrier, to the unitization agreement which must precede a secondary recovery operation, if these reservoirs are not recognized as separate common sources of supply and segregated. I think that we have completely paraphrased a large part of the testimony without going into the valuable connecting link, which I think Mr. Hamblin can.

MR. VERITY: May it please the Commission, George Verity for Southern Union. We would like to object to this line of testimony and call to the Commission's attention the fact that if there are two common sources of supply here, they are entitled to what they are asking for, and if there isn't, then they are not, and what difficulties may be encountered one way or the other, I don't think is germane to determining whether or not there are two separate common sources of supply. Therefore, we think that the objection is valid and that that is improper testimony in this hearing at this time because it doesn't throw weight on whether there are two common sources.

MR. SPANN: I would like to state something for the record, Mr. Porter, if I may. Testimony was introduced through Mr. Walsh to the effect that there were practical engineering difficulties involved in initiating secondary recovery programs without segregating these two zones. Now, there was no objection to that by Mr. Buell or anyone else. Now, we are merely proposing through this witness to show the legal difficulties encountered in initiating or obtaining unitization agreements which are essential in initiating a secondary recovery program. It would seem that one is as pertinent as the other, and they have permitted this type of questioning to open up, without questioning it, and it goes to the question of waste, which is also an issue before this Commission.

MR. BUELL: That argument is not sound, that they be allowed to put on a witness to testify that they are going to have legal difficulites. It is all vague, and does not relate to the question here. The thing to be resolved is whether there is one or two reservoirs.

MR. PORTER: The Commission will take administrative notice that it is difficult to execute these unit agreements. They are necessary, but we do not feel this testimony is necessary at this time. The witness may be excused.

(Witness excused.)

MR. WOODWARD: May I ask leave to submit to the Commission a statement as to what this witness would have testified to had he been permitted to continue with his testimony for the purpose of determining its relevancy or lack of relevancy.

MR. PAYNE: For the purpose of building a record, Mr. Woodward?

MR. WOODWARD: Yes, sir.

MR. PORTER: Yes, the Commission would accept such a statement.

MR. BUELL: At this time, Mr. Porter, I will request that you have him dictate it to the Reporter after the hearing is recessed.

MR. PORTER: I believe he said --

MR. BUELL: Isn't it proper in New Mexico to tender a proof of this kind, to dictate it to the Reporter after the hearing rather than take up the time of all of us? They do so in Oklahoma.

MR. WOODWARD: That's what we had in mind.

MR. PORTER: He had intended to submit the statement later, I believe, that was my understanding.

MR. WOODWARD: That is what I was requesting.

MR. PORTER: And that's what I ruled on.

THE WITNESS: Mr. Buell has called me an attorney; I would like to say I am a landman.

MR. PORTER: Sounds like he is bragging. Does that conclude your testimony?

MR. SPANN: That concludes our testimony.

MR. PORTER: Who would like to present testimony next?

MR. KELLAHIN: If the Commission please, Jason Kellahin of Kellahin and Fox, Santa Fe, New Mexico, representing Tom Bolack. I would like to call as our first witness, Tom Bolack.

TOM BOLACK

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY: MR. KELLAHIN:

Q State your name, please.

A Tom Bolack.

Q Mr. Bolack, are you engaged in the oil business?

A Yes, I am.

Q Do you have any interest in the area which is under consideration in this case?

A I have thirteen wells in the area.

Q Are these owned by you or by someone other than you, a corporation?

A They are owned totally by me with the exception of one-eighth that Uncle Sam gets.

Q Now, Mr. Holack, what experience have you had in the oil business?

A Well, I started out as a tool dresser when I was sixteen, and I have been in the oil business ever since.

Q Now, have you worked for any Commission or had any duties in connection with the regulation of oil and gas?

A I was with the State Commission of Kansas, the Oil Commission, for two years.

Q In what capacity?

A As a field agent.

Q Have you had any practical field experience on your own?

A Yes, sir, I have.

Q Will you describe that briefly?

A Well, it has been on my own as well as working with a number of different companies through the midwest, Texas, Oklahoma, Kansas, and I have been out in this country since '42 with several companies in charge of wells from time to time.

Q Since 1942 where have you been working?

A Most of this time in San Juan Basin.

Q In connection with your work, do you personally supervise any of the work involved?

A In all cases. One hundred per cent, I would say.

Q Do you run the operation yourself?

A Yes.

Q Do you supervise the taking of cores?

A I would be considered, I guess, the same as what would be considered a superintendent, geologist, engineer, the whole combination. I set the pipe, cut the cores, everything but the actual engineering reports.

Q Supervise any testing procedures?

A All the testing.

Q Fracturing?

A Fracturing.

MR. KELLAHIN: Are the witness' qualifications acceptable to the Commission?

MR. PORTER: Yes, sir.

Q (By Mr. Kellahin) Now, Mr. Bolack, in the -- As I understand, you have operations in the Horseshoe Canyon Gallup Pool as it is presently defined?

A That is correct.

Q Now, have you made any study of the reservoir in that area?

A Well, I made quite a lot of study of it from the initial drilling. Some of the very first wells in there, among the first eight wells in there, I had five, I believe. Four, four of the first eight, and then I've had numerous engineering studies and pressure tests since then.

Q Now, you have heard the testimony which was offered by El Paso Natural Gas Products Company in regard to their conclusion that there are two separate reservoirs, which they have designated as Sand A and Sand B. How do you feel in regard to that?

A I am in total accord with the interpretation that they presented of the two separate sands with no connection, either vertically or by sand deposition.

Q Now, what do you base your conclusion on?

A Well, I base it on a number of things. First, the fact that both sands have been so plainly defined, and being separated, together with things that we found out on the fracturing and microscopic and black-light examination of this interval that we have heard so much about today. I don't know how much detail the Commission wants at this point. One interesting thing, I think, is the fact that this one interval of communication, if any, shows absolutely no hydrocarbons at any place throughout that zone under black-light examination, and that applies to thirteen wells through the center of this field.

Q Now, did you make that examination yourself?

A I did.

Q Now, in regard to your fracturing of the wells, you mentioned that as an indication that there is separation between the two sands, what is your experience in that regard?

A In a number of cases we've fractured the lower zone, of course, with recorded build up pressure breakdown, and after a well is fractured in this field, any additional fluids from any additional oil administered to the sand, it will start with very little build up, if any, usually it will take fluid on a vacuum, following a fracture, and we've tripped a plug, go in and test the upper zone on a natural flow, and in no case have we found a well, or found producing capacity to indicate there has been any communication from the first frac job. Then, in the first frac job, having been thoroughly tested by removing all the frac oil and considerable oil beyond frac oil to establish the well's size, what its capability would be, then perforating the upper zones, we, in all cases found a much, much better amount of oil, and going into frac, that build up is as high as 2250 pounds. That has been required to break that zone down. Now, had there been any formational connection in the vicinity, or had there been any fractures, I do not feel that this situation would have existed. By fractures I mean any fractures that would connect the A and B Sand, because had that been the case, it certainly would not have required 2200 pounds to break a formation that was actually making free oil at that time.

Q Now, you heard the testimony which was offered in regard to the permeabilities of the two sands and the intervening non-permeable area. Do you have any comments on that?

A Well, the only comment that I would have probably made at that time would be any effective permeability. It is actually a very dark and impervious shale, and since there has been so much testimony on that, I regret that I didn't bring some of the cores from that particular area. It resembles this picture in a lot of cases. There is a lot of sand grains in it. It reaches from the Mancos shale to the top of the Dakota, and it has sand and silt clear through it, and if it were just isolated grains, they wouldn't change the permeability or the ability of the formation to transmit oil or gas from one to the other. It is a very hard waxy shale, as those that are here are familiar with the Mancos. This interval between the two, I can't tell any difference in it from any other Mancos shale, with maybe the exception of that one little streak on top of the B Sand.

Q Now, in regard to cores, have you examined any cores yourself?

A Yes, I have, all of my own, and a few of my offset operators when I wasn't riding herd.

Q In that examination, did you find any evidence of fractures?

A Effective fractures, no. It was brought out in the latter part of Mr. Speer's testimony that very likely some of the fractures were seen or created from core barrel stress, and no indication would indicate any calcification deposition in the fracture or the fact that it had been open, or whether it even existed prior to the coring of time, and I think from the cores, there has been no evidence of that, and when you spread a core out, you have certain impervious sand or combination sand and shale stringers that are very hard, very brittle, and if it were a fractured area, I would strongly suspect that you would find your fractures in that particular bed rather than, often times, where it was found, in a zone that wasn't actually softer. I suspect the core barrel had something to do with that. In all the coring I have done, I have never found any fracturing at all, not even two, three inches. I have not found it at all.

Q Now, you heard the testimony and saw the exhibits offered by El Paso in connection with bottom hole pressures in the two zones, Sand A and Sand B. Do you have any comment in regard to those pressures?

A Well, I could say to that the bottom hole pressure differential at this time is not from the tests that we have run, and we've even gone to using two bombs, and calibrate them both before and after they are run, to once and for all get to an accurate point to work from. I do not feel that pressure differential between the two Sands today is enough to give us any great damage today, but from the very characteristics of drawdown in an area of drainage, and the way these sands behave when they are swabbed at a higher rate, or maximum capacity of the well, I feel that in a very short time we will find a greater pressure differential in the upper sand, and a complete recovery, ahead of the lower zone.

Q For what reason do you reach that conclusion?

A The very way that sand behaves under extreme producing capacity is the main thing, plus the fact that we have some streaks of very high permeability in the upper zone. That serves as well to give you a real high streak of high permeability, whereas the permeability in the lower sand is more consistent, more of a general nature.

MR. VERITY: Your Honor, we object to this last testimony and move it be stricken because we think that it assumes a fact that this Commission must determine. In other words, he is assuming that there is a barrier between these common sources, and that therefore, at a later date, there is going to be a differential. We say that that is the question that is here to be determined, and his conclusion as to what it might be based on at a later date is not proper testimony.

MR. PAYNE: Would you preface your question, Mr. Kellahin, with the remark, "Assuming that there are two common sources of supply," because that fact is in evidence, and you can't ask the witness --

MR. KELLAHIN: If the Commission please, we will not preface our question because we assume that. The witness has testified that in his opinion, there is effective separation between the two sands, and based upon his testimony, he has reached his conclusion.

Q (By Mr. Kellahin) Now, Mr. Bolack, there was some testimony in regard to drainage. I think, in particular, in reference to your Tom Bolack Well No. 11, isn't it?

A No. Yes, 11, I think.

Q 11. If the zones are not separated, what is your conclusion as to the question of drainage under present circumstances?

A Well, from the tests that have been run on the individual sands, one separately from the other, I am convinced that at this time at least, I am producing about three wells, possibly four in toto, or very near in toto, from the lower sand, and to follow that further, I have a tool that we intend to discuss here further with the Commission. I am considering, if there is no ruling of two separate reservoirs, I am considering running that tool on my own part, because -- rather than producing twenty-five barrels or twenty-six barrels per day from each zone. I have some marginal uppers, and the upper is very spasmatic it sort of comes. It is not as much a blanket in consistence as the lower. I am producing probably one hundred per cent of my allowable from the B Sand and on my own, if they are not separated, if they are considered one, I intend to run the Brown Tool, which you will hear about more later, to at least get some of the upper oil before it goes over the hill.

Q Now, will you be willing to dually complete your well No. 11 in the event this Commission determines that there are two separate common sources of supply?

A With all respect to the others concerned with it, I would be willing to dual complete that well.

Q Now, in that regard, the question of secondary recovery, how do you feel about that?

A Well, from previous experience, and particularly some of the sand fields in Kansas, I am very much in favor of a secondary recovery program, and I am in favor of it in the near future, and again, more or less seconding the testimony of El Paso, I feel that the separation of the zones, whether it be by the Commission or by the operators' own decision, will in that event be necessary because I do believe that any water going into those permeabilities of two thousand or better, will have a tendency to certainly sweep through at a greater rate and probably in a hard to explain manner, sincerthere is so much difference between wells in the upper sand compared to what it would be in the lower.

Q In the event that the two zones are not separated either by action of the Commission in designating them as a separate producing horizon, or by action of the operators themselves, would, in your opinion, any oil be lost in the reservoir?

A I think that oil would be unavoidably lost, and that plus the inconvenience and the problems that would arise with having water reaching one zone first, which could be either zone, and flooding out something that could be allotted from either of the zones, plus the complication of operation would be greater than if they were handled separately, both by injection and --

Q Under secondary procedures, would communication between the two zones through the well bore pose any problems?

A I think it would, unless -- I think it would at this time. The pressures have been so close together that I question whether there has been any great amount of communication, but by the time we have reached secondary, and certainly with mining water and oil in the bore, we could really have a problem. I think that is what will necessitate separating them one day. That is my estimation.

Q Have you had any experience with dual completions, Mr. Bolack?

A Yes, I have.

Q You have heard the testimony which was offered as El Paso's proposal to the manner of dualling these wells. How do you feel about that system of dualling?

A Well, I have the other witness here, and I am convicted -- and I am convinced that it offers more of a feasible situation for us in this field, particularly from the matter of cost and the convenience of operation.

Q Now, would the cost be any factor in your operation in dualling these wells?

A Well, I think it is something that we should consider. Certainly, a lot of these fields have not responded the way we might think, and we might go out at this situation in one way and might well end up changing our mind, and the cost that would involve the Brown Tool is small, compared to the others, that is, if there is any element of experiment in these floods, and so on, I would much rather have a tool that I can use on practically all the equipment that we have now, and then even face later, some day, possibly, changing that, if it doesn't work.

Q Now, do you know of any instances in the pool where dual completions as that proposed by El Paso could not be utilized?

A Just in the instance where the pipe casing is too small to accommodate the tubing.

Q Are there casings in the area where that situation exists?

A Yes.

Q Do you have anything further you want to add, Mr. Bolack?

A Well, I think not. Perhaps there would be a little bit on this Brown Tool. There are a lot better tests than what I have, but it is being used in other states successfully, and experience that I have had with it in other places, it has worked successfully.

Q What areas would that be in?

A In Kansas.

Q You have had experience with the Brown Tool in Kansas?

A That's right, and some in Oklahoma where there wasn't a Commission ruling on it, of course, but it was, as far as the operators were concerned, working effectively.

MR. KELLAHIN: That's all.

MR. PORTER: Any questions of Mr. Bolack?

MR. BUELL: May it please the Commission, in view of the fact this witness has simply given the Commission the benefit of his conclusion with no supporting data or evidence, in the interest of saving time I have no questions.

MR. PORTER: Any questions of Mr. Bolack? The witness may be excused.

(Witness excused.)

MR. KELLAHIN: I would like to call Mr. J. B. Davis.

J. B. DAVIS

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY: MR. KELLAHIN:

Q Will you state your name, please, sir.

A J. B. Davis.

Q By whom are you employed, Mr. Davis?

A By Brown Oil Tool, Incorporated.

Q What is your position?

A Sales engineer, I guess, reflects it as accurately as anything else.

Q How long have you had that position with Brown Oil Tools, Incorporated?

A For a year and a half.

Q And what engineering training and experience have you had, Mr. Davis?

A I have a bachelor of science degree in chemical engineering from the Rice Institute, and eleven and a half years experience in engineering and operations for Shell Oil Company.

Q In what department are you employed in with Shell Oil Company?

A With the Production Department.

Q What are your duties in connection with that position?

A Engineer with the mechanical equipment, processes, and techniques relative to the drilling and production of oil.

Q Did you have anything to do with the dual completion of wells in that business?

A Yes.

Q Did you supervise the work?

A Yes, sir.

Q Now, in connection with your experience with Brown

Oil Tools, Incorporated, have you made any study of the equipment and facilities of that company?

A Yes, sir.

Q Are you familiar with the operation of their equipment?

A Yes, sir.

MR. KELLAHIN: Are the witness' qualifications acceptable?

MR. PORTER: Yes, sir.

Q (By Mr. Kellahin) Now, Mr. Davis, do you have a picture of the assembly which is proposed by Mr. Bolack?

A Yes, sir, I do.

Q Now, in regard to what has been marked as Exhibit No. 1, Mr. Davis, will you state what that shows?

A On the front page of Exhibit 1 is shown a diagram of the complete installation for dually producing a well producing each zone alternatively. That is, the zones are not produced simultaneously.

Q What is the instrument designated as?

A Well, the principle tool used in that is designated as the Brown Type Zone A Selector.

MR. BUELL: May it please the Commission, I wonder if I may ask Mr. Kellahin if the purpose of presenting datum on this tool is to seek Commission approval of it at this time, assuming the Commission holds that we have two separate reservoirs, or is he simply just being helpful in showing that a tool does exist. There is a big difference, you know.

MR. PORTER: Mr. Kellahin, will you state --

MR. KELLAHIN: The purpose, obviously, is to seek Commission approval of this tool as a means of dually completing wells in the event the Commission --

MR. PAYNE: Mr. Buell, you probably don't know this, but I talked to Mr. Kellahin before this case was advertised, and we purposely advertised it broad enough so we could listen to testimony as to any method of dual completion which would be an exception of Rule 112 (A).

MR. BUELL: I sure did not know that, Mr. Payne.

MR. PAYNE: That is in the advertisement, Mr. Buell.

MR. BUELL: Diligently reading the notice as issued, I see nothing in there relating to exceptions to any rules.

MR. PAYNE: Let me read it to you then. "Applicant further seeks the establishment of an administrative procedure for approval of wells dually completed in said common sources of supply utilizing a certain type of mechanical installation in exception to Rule 112 (A) of the Commission Rules and Regulations." Now, it is our feeling that is broad enough to allow anybody to discuss any type of tool which would be an exception to Rule 112 (A), and provides for administrative approval.

MR. BUELL: I will read the notice.

MR. PORTER: Mr. Kellahin, will you proceed with this witness.

Q (By Mr. Kellahin) Now, referring to what has been marked as Exhibit No. 2, will you state what that shows, Mr. Davis?

A Well, Exhibit No. 2 is merely a lay out or a line diagram in a larger scale of the same installation going into greater detail as to the construction of the equipment.

Q Could you furnish this exhibit to the Commission and describe its operation so that they can follow your testimony.

A Exhibit No. 2, going back, and if I may use El Paso's very nice illustration here, would consist of putting the packer or a packer here above it, a zone selector valve. The diagram shows there also a hydraulic hold-down, which may or may not be necessary, depending upon the characteristics of the well, and from the testimony given here today, it would not be necessary. We go up to the wellhead, which can be special made rotating head with a rotating assembly in it, or a regular pumping head with the rotating slip assembly mounted on top of that to support the weight of the tubing and allow the tubing to rotate to change the valve. The valve is merely a two-way valve which can be operated by rotating the tubing to permit flow from either the bottom zone through the packer and through the valve, or to shut off that zone and to permit production from Zone A above the packer into the tubing and on up. Of course, the pump can be installed above this installation. A bottom hole pressure pump can be installed above this valve.

Q With this type of equipment is the pump ever installed below the packer?

A No, sir.

Q Now, is it possible with this type of installation to produce both zones at the same time?

A No, sir. During the operation of switching from one zone to the other by rotating the tool, the ports in the valve go through a packing element which effectively prevents commingling or communication between the two zones during the switching operation.

Q There would be no commingling during the change from one producing interval to the other?

A No, sir.

Q Is that correct?

A That's right, sir.

Q Now, referring to what has been marked as Exhibit No. 3, would you state what that shows?

A Exhibit No. 3 merely shows the valve in the three different positions.

Q That would be Exhibits 3, 4, and 5?

A Yes, Exhibits 3, 4, and 5. Exhibit 3 shows the position where it is opened to production from below the packer straight up the tubing. Exhibit 4 then shows it during the transition stage where the ports in the valve are passing through the packing element and production from either direction is sealed off.

Exhibit 5 illustrates it with the ports opened to the zone above the packer and the zone below the packer being shut off.

Q Now, does that effectively prevent communication between the two zones?

A Yes, sir.

Q Now, referring to Exhibit No. 6, would you state what that is?

A Exhibit No. 6 merely shows the lay out and line diagram of the swivel T itself. Rather, the rotating slip assembly which goes on top a standard pumping head to support the weight of the tubing and allow it to be rotated easily.

Q Now, referring to what has been marked as Exhibit No. 7, will you state what that shows?

A Exhibit No. 7 is a swivel T or a pump through which the tubing may be rotated without rotating the T, without disconnecting the flow line.

Q Does that enable an operator to operate this tool switching over from one zone to the other without hauling in additional help?

A Yes, sir. At the depth that we are discussing here, and on up to 5000 feet, one pumper, one man with a 24 inch wrench would be able to turn it.

Q Now, have you any models of this quipment, Mr. Davis?

A Yes, sir, sure do.

Q Referring to the model, would you describe briefly how it works?

A The first model is the tool itself. I will take off the bottom connection here. The tool is, at the present time, in the position, or I will put it in position, where the ports are opened to the bottom section. This flow gear is down all the way, and by rotating it in the other direction, we pass the ports through the packing element and up to a point that they are opposite in the ports here, so that production from above the packer can enter the tubing.

Q That then, is placing it in the two different positions?

A Yes, sir.

Q Now, in the operation of this tool, do you have any difficulties with corrosion?

A No, sir, we haven't to date. It's being used in a very sour crude area in West Texas, and it has been used for some years there with no apparent difficulty due to corrosion from sour crude.

Q Does sand pose any problem?

A Not any more than one experiences in any other type of normal pumping installation.

Q In other words, sand would only affect the pumping installation and not the operation of the tool, is that what we are to understand?

A That's right.

Q Now, are these tools in use in other states?

A Yes, sir, they are in use in Kansas, Oklahoma, Louisiana, and Texas.

Q Are you personally familiar with the situation in these various states as to the use of these tools and the requirements of the regulatory authorities in connection with them?

A Yes, sir.

Q What is the situation in Kansas?

A In Kansas, and may I use the prototype of the swivel T with the indicator, the zone indicator fits on here, and as the tubing is rotated relative to the pumping T, the pointer on the indicator moves to indicate whether it is producing from the lower to the upper zone, or lower zone, and in Kansas, it is required to be sealed, an order requires them to be sealed in each position and moved only on permission from the Commission.

Q What is the situation in Oklahoma?

A Oklahoma has no requirements like that.

Q Are these tools in use in Oklahoma?

A Yes, sir.

Q Are they used extensively in Oklahoma?

A Yes, sir, in Oklahoma more than any other state.

Q What is the situation --

MR. PORTER: May I ask a question? Are they used in dual completion equipment?

A That's the purpose of dual completing, alternating from two distinct reservoirs.

Q Mr. Davis, are you familiar with the New Mexico Statute in regard to a definition of a pool as being a separate common source of supply?

A Yes, sir, I think I am.

Q With that in mind, is this tool used for the production of separate pools in the states which you have mentioned?

A Yes, sir.

Q They are designated as common sources of supply, is that correct?

A Yes, sir.

Q Now, what provisions are generally made to prevent the production of the major portion of your allowable from one zone as against the other aside from the seals which you mentioned in use in the State of Kansas?

A Well, no other legal provision as far as I know, except in one field in Texas where the lower zone is very sour and the upper zone is sweet. In that case, quarterly tests are required to show the presence of sulfide.

Q Is it possible to install, in connection with this type of equipment, some type of visual control which may be seen at a distance to determine from some distance which zone is being produced?

A Yes, sir, an extension may be applied to this indicator arm.

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A Yes, sir, an extension may be applied to this indicator arm.

Q Which would --

A Which could be seen at some distance.

Q Now, what tests can be made to determine whether there is communication between the two producing zones with the use of this equipment?

A Well, with the tool opened to the lower sand so that you have a straight through communication to the lower sand, straight through the tubing and the angular area, the perforations are plugged offfrom the angular area, and pressure can be applied to the angulars to see that you have no communication, no flow or circulation by this tool or by the packer and up through the tubing.

Q Can the conventional pressure tests be made with the use of this tool?

A Yes, sir, I think so.

Q Can a pressure bomb be run?

A With the rods out, of course.

Q Can a pressure bomb be run in both zones?

A It can be run as far down as this tool.

Q Now, can any test be made by the zonic method to determine --

A Yes, sir. A test could be made by the zonic method into the casing annulus, of course.

Q By use of that method, could the existence or non-existence of communication be determined?

A It would present some evidence, of course.

Q Now, assuming, Mr. Davis, that a pressure differential did exist between the two separate horizons, would it then be necessary to pressure up one zone or the other in order to determine communication by the method you have prescribed?

A No, sir, I don't think so.

Q Now, has this tool been pressure tested?

A Yes, sir.

Q What were the results of your pressure test?

A Well, we pressure tested up to about five thousand pounds.

Q Did you find any leakage at that pressure?

A No, sir.

Q In your opinion, is this type of tool feasible for achieving separation between two producing horizons?

A Yes, sir, I think that has been borne out by its acceptance in the other states.

Q Now, you heard, I believe, the testimony presented by El Paso in connection with the cost of the type installation they are proposing for dual completion of wells in this area. What is the cost of the installation such as you have here?

A Over and above the cost of the present installation, the addition of this equipment would entail expenditure of approximately $1,750.

MR. KELLAHIN: That's all the question I have.

Q (By Mr. Kellahin) Mr. Davis, were Exhibits 1 through 6 prepared by you or under your direction and supervision?

A Well, they were prepared by the engineering department of our company.

Q Exhibit 1, is that a standard brochure used in connection with the sale of this equipment?

A Yes, sir.

MR. KELLAHIN: At this time we would like to offer in evidence Exhibits 1 through 7 inclusive.

MR. PORTER: Aby objection to the admission of these exhibits? They will be admitted.

MR. KELLAHIN: That's all the questions I have.

MR. PORTER: Any questions of Mr. Davis?

MR. BUELL: I have one, Mr. Porter.

MR. PORTER: Mr. Buell.

CROSS EXAMINATION

BY: MR. BUELL:

Q Mr. Davis, why does Kansas require seals?

A Just as an administrative, I guess, assurance, that no one is going to come out there and turn the tool to the other position without their permission, because in order to do that, they also require that you pay a $25.00 fee each time.

Q In other words, anyone with normal strength and a 24 inch wrench could turn it?

A Yes, sir.

MR. BUELL: That's all.

QUESTIONS BY MR. HINKLE

Q Mr. Davis, what other states beside Kansas and Oklahoma have authorized the use of this tool?

A Louisiana has, and Texas has, and --

Q Has it been used in those states?

A Yes, sir.

Q Can you use this particular tool in connection with water flood projects?

A You could, sir, to selectively inject alternatively into two different zones.

Q You couldn't use them in producing wells where you had two zones?

A Yes, sir to alternatively produce from those wells.

Q You wouldn't want to alternatively produce the water flood project, would you?

A Depending on the circumstances, I think.

Q Do you know of any water flood projects where they have been in use?

A No, sir, I don't.

MR. HINKEL That's all.

MR. PORTER: Mr. Nutter.

QUESTIONS BY MR. NUTTER:

Q Mr. Davis, did I understand you to say that with this installation, the pump is not set above the packer, merely the tool --

A The tool is set above the packer and requires the pump to be set above the packer too, because it is not straight through because you couldn't run the pump through the rod.

Q Do you pump the well if the pump is standing below the level of the packer?

A You couldn't do it, sir.

Q It is only possible to pump one zone at a time with this installation, is it not, sir?

A That's right, sir.

Q How do you make your allowable then if you have a dual completion and two pools?

A Well, for example, in October, in the month of October, those zones, where it is used there, each of the zones will produce its allowable within fifteen calendar days, so they switch it the 15th of every month and produce the last half of the month from say the lower zone, and the first half of the next month from the lower zone, and switch it and produce the upper zone.

Q What if they have two marginal zones that just produce a little bit, each one produces one half the time?

A Yes, sir.

Q Are you acquainted with the Commission's Rule A-502, Paragraph Roman Numeral I, Sub Paragraph A that requires the wells to be produced within one hundred twenty-five per cent of the daily allowable?

A No, sir, I am not. I am not too familiar with the Commission's rules.

Q You would have to exceed one hundred twenty-five per cent daily allowable to produce your top given allowable in fifteen days, would you not?

A That's right, sir.

MR. NUTTER: Thank you.

MR. PORTER: Anyone else have a question? The witness may be excused.

THE WITNESS: Sir, if it please the Commission, may I add that this can only be used in wells that are cased with four and a half inch casing.

MR. PORTER: Does anyone desire to question the witness about this last statement? The witness may be excused.

(Witness excused.)

MR. KELLAHIN: That's all we have at this time.

MR. PORTER: The Commission is going to recess the hearing until nine o'clock tomorrow morning, but I thought perhaps that in view of the fact that Mr. Morgan will not be here, I shall explain his absence, due to the fact that he has been so diligent during the last two years in attending the hearings. We regret that he will have to be away, but he has to attend a meeting in Salt Lake City, at which there will be present representatives from fifteen states and one territory, and it concerns some land problems, and it is a meeting that was set up some time ago, and he didn't have enough influence to get it changed. Governor Burroughs has assured me that he will be here in the morning at nine o'clock, although he is having a difficult time attending the hearing too, because of the fact that the legislature is in session. We would like to start as promptly as we can in the morning, if he can get here at nine o'clock. We would like to start right off and wind up this docket as soon as we can.

(Whereupon the hearing was recessed to 9:00 a.m., Thursday, February 19, 1959.)

MORNING SESSION
FEBRUARY 19, 1959
9:00 a.m.

(Whereupon, the documents were marked for identification as Atlantic's Exhibits One through Six.)

MR. PORTER: The hearing will come to order, please, and we will continue with Case 1596. Mr. Kellahin has asked the privilege of making a statement at this time.

MR. KELLAHIN: If the Commission please, it was announced last night that we would present before the completion of the case the core. I was informed last night that the core of the zone which is of interest in this case will be available but has not yet arrived and we would like to offer it at a later date.

MR. PORTER: Do you think you will have it before the end of the day?

MR. KELLAHIN: I imagine that we should.

MR. PORTER: Thank you. Mr. Hinkle, are you ready to testify?

MR. HINKLE: Yes, I assume that all the testimony will be put on that is pertinent in this case. We would like to put on three witnesses for Atlantic in opposition to the application. I would like to have all three witnesses sworn.

MR. PORTER: Will the witnesses stand, please?

(Witnesses sworn in.)

ROBERT AGATSTON

called as a witness, having first been duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. HINKLE:

Q State your name, please?

A Robert Agatston.

Q By whom are you employed?

A I am employed by the Atlantic Refining Company.

Q In what capacity?

A District geologist at Durango, Colorado.

Q How long have you been employed by Atlantic?

A Almost eleven years.

Q Are you a graduate geologist?

A I received my Bachelor of Science Degree at Ohio State University and my Master's and PHD at Columbia University.

Q In what years?

A Bachelor's in '43, my Master's in '47, my PHD in '48 to '52.

Q Have you practiced your profession since your graduation?

A Yes, I have been with Atlantic since 1948.

Q In what areas have you been with Atlantic?

A I worked in Wyoming and Southern Montana, the Four Corners area and West Texas.

Q Are you familiar with the development in the Four Corners area?

A I am.

Q Have you made a study of the area in which the Horseshoe-Gallup field is located?

A I have.

Q What does that study consist of?

A Well, the study of electric logs and sonic logs and cores, as well as information from the adjacent areas.

Q Have you ever testified before the Conservation Commission?

A No, I haven't.

MR. HINKLE: Are the qualifications of the witness acceptable?

MR. PORTER: Yes, sir.

Q (By Mr. Hinkle) I wish you would refer to Atlantic's Exhibit One and explain to the Commission what it is and what it shows?

A This is a repetition of what you saw yesterday, it is a pool map of the Horseshoe Canyon field. The wells just shown as a dot are producing from the upper or A zone, the wells with a dot and a circle are producing from the upper and lower, A and B zones, the wells with a triangle are the--the wells with triangles are producing from the lower zone only. I want to stress that the information is accurate on our tract that we have. As far as other people's wells, we got that information second hand and there may be a mistake here or there. I would like to stress that if you keep your enclosure, your Exhibit One out at all times, I think you'll be better able to keep up with the description of the cross sections. I think this map also shows that the limits of the Horseshoe-Gallup field had not been defined to the northwest or to the southeast. Atlantic drilled a dry hole at the southwesternmost side of the field and there is some question as to whether the limits of this field have been defined on the northeast side. I believe that's all I have to say.

Q Will you refer to Atlantic's Exhibit Two and explain it to the Commission?

A I don't have a large scale map of Exhibit Two because it isn't too important to the case, but you have it, it's a structure contour map of the Horseshoe-Gallup field drawn on top of this point shown on the cross sections. You will remember yesterday that El Paso hung their cross sections on this line. This contour point is about thirty feet above that line. Now, the exhibit shows, for the most part, regional dip to the east and northeast. Now, you will notice as you come to the southeast corner of your map, the contours get closer and closer, and Mr. Speer referred yesterday to as much as a sixty-degree dip of the south end of the Horseshoe-Gallup field.

Now, I would again point out that the limits of this field had not been defined either to the northwest or the southeast. Some discussion was made of fracturing yesterday and to a large extent, there are things that we don't understand about fracturing.

However, in an area where there is sixty degrees of dip within less than one mile and the change has occurred from two or three degrees to sixty degrees and then flattens out again to a matter of two or three degrees, there has been a great amount of stress exerted on sandstone and shale bodies and it is very conceivable that these bodies will fracture.

I will point out something else, that in the Colorado Plateau area, of which the San Juan Basin is considered a part, there are many of these steeply dipping fractures which we have called monoclines, and Doctor Kelley and many of the men at the University of New Mexico have suggested that these steeply dipping features go into falls at depths. Now, whether an actual fall takes place opposite the A and B zones or upper and lower zones of the Gallup, I do not know. I do know that this particular area has an excellent chance of being extremely fractured, so that if the field was continued to the southeast end, and it undoubtedly will be, it will cross this area of pronounced fractures, thus providing a means of communication between the lower sand and the upper sand.

MR. HINKLE: If the Commission please, we have another exhibit, Exhibit Three, which is a longitudinal cross section of the entire field or area and is practically the same as El Paso's Exhibit Number Five, I believe, which was introduced yesterday. We hadn't put up our large map on that, but you do have the exhibit before you. I don't know whether Mr. Agatston wants to refer to it at this time or not.

A This is one of the rare cases where geologists agree, and Mr. Speer's and my cross sections are identical. The only thing I have to say is that the so-called--I want to reiterate that the so-called shale zone in between the upper and lower sands or A and B sands contains a great deal of sand included, that the shales are sandy, that there are sand stringers within the sandy shale and shaly sand and that it is not sixty feet of shale.

Q (By Mr. Hinkle) Mr. Agatston, will you refer to cross section B or B prime --

A Yes, sir.

Q --and first identify on Exhibit One where this cross section is and then explain to the Commission what it shows?

A If you will look on your small scale map, this is a cross section which goes from the northeast end of the field. You will notice that as the line passes through there, there are little arrows that shoot over from the line and cross section BB prime, it is the middle cross section that goes from northeast to southwest and includes wells 25, 22, 12, 4, 16 and 28. The same cross section appeared in the exhibits yesterday. Now, I think it was called CC prime. I believe Exhibit Five, is that correct?

Q Number Seven, I believe.

A Number Seven it is, I believe.

Q El Paso's Number Seven.

A And if you can, I wish you would refer to that Exhibit

Seven because here lies the difference of opinion. As I mentioned before, this upper line is our contour point. We tilted this cross section to take into consideration the regional dip, and this point here is the top of the A Sand or the upper sand, and both of these points are considered to be critical points in that they were deposited at the same time or nearly the same time. This yellow shaded area is the upper or A Sand and you will notice that as you go from the northeast to the southwest, even assuming that these correlations are incorrect, that the sand content at the top of the A zone increases as you go to the southwest, until finally when you have reached Well Number 28, there is at least one hundred feet of predominantly sandy section. There are sandy shale stringers in here, but the predominance of the section is sandstone.

Now, you will also notice that in the lower zone or B Sand, the sand, as you go from northeast to southwest, picks up from the section at the top, so that in this direction, the top porosity rises all the time as you go to the southwest so that as you reach Well Number 16, and that appears on El Paso's map, the top of the lower sand, and this is the exact same correlation as El Paso's, this point is now a matter of 10, 20, 30, 40, almost 50 feet above this correlating point, whereas when we started, it was only a matter of 20 feet to the top of the sand. In other words, to this point, all you see on their cross section is that when you pinch this sand out, it is pinched out upward, it is not pinched out level with a correlated bed. You will see that as you go in this direction, the sane rises all the time in the section.

Now, the difference of opinion lies in our correlation from Well Number 16 to Well Number 28. We had said, and we do this conservatively, that where this sandy section--and it is not as good as this section up here--comes in, this correlates with the lower part of Well Number 16, B Sand, and is it not unreasonable to assume that if a sand in going across a field, crosses from 20 feet above the sandy--I now speak of the Juana Lopez--to almost 50 feet above, that for another 80 acres we cannot be permitted to carry the correlation up another 10 feet, because that's exactly what's been happening as you go across the field.

Now, at a later date, at a later part in this presentation, I will show what I think of the conditions and deposition, but let's just accept this for the moment. Now, we have a log that we have --

Q Mr. Agatston, let me interrupt you just a minute.

A Yes, sir.

Q What is the interval between the upper and lower zones in Well 16 as shown on your exhibit?

A The interval between the upper and lower zones?

Q How many feet?

A That's a matter of 6, 10, 20, 30, 37 feet.

Q Then it has risen from--what is the interval on the extreme right?

A This is about 100 feet.

Q From there to 20 feet?

A To 37 feet.

Q To 37 feet?

A That's correct. We have Well Number 30 here that I'll pass out to you. We have called it Exhibit Number Seven, because it has two positions in the agenda, but I would appreciate if you would let them have this log Number 30. And now if you will look at the middle scale on this log, which is marked, this Well Number 30 is a half mile to the northwest of Well Number 28. Now, I would like you to take this log, if you would, and where it says upper zone, if you would place that line, upper zone, against the mark, upper zone, in Number 28, and correlate down --

Q Mr. Agatston, we have a larger scale, if you would care to compare it on the board there.

A All right. You will see that the porosity which I have colored in red ties in very closely with this porosity which is shown on 28 and that in effect, the porosity in 30 was built down still further in this section by as much as, oh, twelve to fourteen feet, Now, if you will move this log over to Well Number 16 and put it on your base line of the cross section, of both cross sections, you will see that the porosity colored in red is opposite the porosity shown in Well Number 16, which we have all identified as the upper part of the B or lower zone.

So we maintain that on this cross section, that the porosity is continuous from wells in line with 16 to a line somewhat similar to wells in line with 20, 30, 29 and 28. Now, 29 has the same porosity, and we can leave you an exhibit of 29, I will put it up here at a later time. Now, this is not the--I beg your pardon--cannot possibly rest on one direction of cross section, so we'll go to CC prime, the next exhibit. What exhibit is that?

Q Exhibit Number Five.

A Exhibit Number Five. I will not dwell on this long because I feel that our greatest knowledge is in the area of our acreage and we are trying to prove connection in that particular area. However, this is a cross section similar to one that El Paso showed yesterday, and you see that as you go from the northeast--this is cross section CC prime--it begins in El Paso's Number 11 Well and cuts across the field southwestward so that the last well on the cross section is Petro-Atlas Horseshoe Canyon A-1, I think it is, E-1 right there. Now, you will see again in the upper zone whereas we start with forty feet of predominantly sand and continue across the field to the southwest, by the time we hit the Petro-Atlas E-1, we now have approximately 85 feet of predominantly sandstone section in the upper zone, and here there is a suggestion on the log of porosity. In fact, Petro-Atlas perforated that section.

Q I refer you now to Atlantic's Exhibit Number Six.

A This is very important and I hope I won't lose you here. This is a dogleg cross section. If you will refer to your map, if you will refer to your index map, this is a rather unorthodox method of drawing a cross section. Section DD prime starts at the D prime end, Well Number 15 in Section 32 and proceeds in the northwest direction to Well Number 19; in other words, Well Number 15, 16, 17 and 19.

Now, let's just for the moment forget the dogleg, we'll just talk about moving up straight northwest. Now, here I have Well Number 16 that we have identified and all of us agree that this is the upper part of the lower sand or B Sand. Now, we have shown that as we move at least in an eastward direction in their cross sections, the sand rises higher in the section, and if you remember, I pointed out that in Well Number 16, we were as much as 50 feet now above a correlating horizon, the cenosity of the Juana Lopez. And now, as we move to Well Number 1?, we are 60 feet higher now, the sand has risen still higher.

Now, if you will take your Log Number 30 again, that small log that I placed on your desks, you can put the upper sand opposite Well Number 15, and you'll find that the thickness between the upper zone and the Juana Lopez is almost identical and that the porosity in Well Number 30 occurs opposite porosity in the upper part of the B zone in Well Number 15.

And I am speaking--this is Well Number 30--I am speaking of the shaded in red area, the porosity at the base of the upper sand or A zone, so apparently through a carrier horizon, despite the fact that it is spinning, we have connected the two zones together. Now, we have carried this cross section back to the

12. northeast to show that we are again connecting to the middle of the field and you see that this is almost an elementary procedure. Here is a well on that line, Number 19, as we go back to the northeast, we pick up the center of the best development in the B or lower zone and then as we continue to the northeast, we lost sand off the top.

Now, I would like to explain this cross section and what is shown and why it is a good direction. We are so used to seeing cross sections go in a straight line up the center of the field or at right angles to that line that we assume that sand trends follow that line, and in this case they do not exactly follow that line. Now, I think that we will all agree that taking the Well Number 11 here --

Q You are referring to Atlantic's Exhibit Number One now?

A I am referring to Atlantic's Exhibit Number One, Well Number 11, which is Mr. Bolack's, and El Paso's Number Eight and Atlantic's 16, that's this well, and El Paso's Well in Section 23, that all of these logs, they show a similar characteristic in the lower sand, or the upper part of the lower sand. Now, if this were a straight line of deposition following the drilling program, we would not start in the northeast of the southwest--or rather the southwest of the southeast quarter of a section and end up in the northeast of the southeast quarter of a section. The fact is that the deposition pattern of this particular sand has faded off, as it were, to the east so that in going in this direction, and it

13. doesn't really make a lot of difference whether you go by 40 acres or 80 acres, or skip so much, this change is very, very subtle. However, by going in a northwest southeast direction, you come closer and closer to this line of depositional pattern, thus when you go back to this cross section --

Q What cross section are you referring to, Mr. Agatston?

A DD prime, which is Exhibit Six, and we are moving from 19 to 15, from 19 to 15, we are crossing a depositional phase and we are very gradually, as it were, five acres, by five acres, following the changes that are taking place in the lower sand. That is why as we move northwest southeast, we can catch the subtle rise of this lower sand, the upper part of the lower sand, until finally it is correlative with the lower part of the upper sand as seen in Wells Number 28, 29 and 30.

Now, there is another point, no matter what your opinion is as to the connection out here, I do not bring that up at this point, I merely point out that the rising in this respect and the critical point of connection is out here because this is where all the sand was deposited, where the predominance of sand was deposited, and if you want to carry that further, you may look at El Paso's isopach map of the lower sand, which is the first illustration in their book, you will find that at the southeast end of the field, that is a very narrow band compared with the north end of the field. In other words, the sand trend starts here and widens, fortunately, as you go to the northwest, because if it didn't widen, we would have only the equivalent of 280-acre locations, or El Paso some 340-acre locations, whereas now the width of this well up here is 200 acres, a total of 200 acres, so there's more sand being deposited out here than there is down here and the reason for that is, I think, as my interpretation, that we're coming nearer the source.

Now, I would like to discuss Well Number 28 before I go into what I think is the depositional history out here. Now, we took a core analysis of Well Number 29, which is --

Q Is that identified as an exhibit?

A I am going to discuss it as seen on the cross section. We have cored 29 and the engineers will discuss the core analysis of this well in separate testimony, but on 28, we almost cored the whole thing. I have here a sample log which is merely a proof of the characteristics that this electric log shows and a visual core description of this well by the geologist in the field. Now, he has logged, if you will look at your cross section BB prime, you can follow the depths, he's logged sandstone, he's logged sandstone from 56 to 60, that is, 1156 to 60, he's logged from approximately 56½ to 60, 60 to 63½, shale, sandy with sandstone lamina. He's then logged from 63 to 74, 10.5 feet of sandstone. He's logged from 1174 to 83, another 9½ feet of sandstone. He's then logged from 83 to 89 or 90, sandstone with 40 per cent shale lamina. He's logged from 89 to 1205, sandstone and shale 50/50, or shaly sand.

Now then, we skip an interval there from 1505 to 21 which we did not core, but notice in the characteristics of this curve that sand is indicative or going to the left on this side and to the right on that side and it shows a sandy section. In effect, when we recorded samples of this interval, we picked up about 50 per cent sand and 50 per cent shale. Some of it, of course, may be due to the fact that in the initial microscopic description of the first five feet show the fact that they did bring their hole up here with the sandstone cavings and cleaned it up, but nevertheless, the resistivity characteristic of this log shows that section is more sandy than the section that we have identified as 50 per cent sand and 50 per cent sandy shale.

Now, I would like to give you my version or my interpretation of what happened out here in terms of depositional history. We will request that this back be set up and I'll draw it for you rather roughly as I go along. I would like to take a few minutes to discuss or point out differences of opinion from the very start between El Paso's interpretation of what the depositional histories were in that area and mine. I must, to start with, question a few statements --

MR. HINKLE: Excuse me. If the Commission please, we would like to identify this paper that's being drawn as Atlantic's Exhibit Number Seven so that we --

A It won't be very pretty, but if you want me to --

MR. HINKLE: Let's call it Seven-A.

A Now, the first --

Q (By Mr. Hinkle) Your exhibit numbers go beyond seven?

A The last number--seven is the last.

(Whereupon, the document was marked as Atlantic's Exhibit Number Seven-A for identification.)

A Yesterday we discussed the idea of whether different depositional environments meant different reservoirs and I thought we hacked at it pretty well in the morning, but in the afternoon El Paso reiterated the statement that different depositional environments meant different reservoirs. Now, that doesn't seem to hold up under analysis of other oil fields because I have seen many cases where sandstones and limestones went a hundred feet in the same reservoirs, both producing oil, and certainly limestone and sandstone represent different depositional environments. In fact, the Old Lost Soldier Field in Wyoming produces from the Gerasic, the Cretaceous, the Pennsylvanian, the Permian, the Mississippian, the Cambrean and the Precambrean. Well, there was communication there at one time along fracs and changes out there, but certainly they represent different depositional environments and yet they are all producing exactly the same oil and the oil analyzed from the Cretaceous is exactly the same as the oil analyzed from the Precambrean so that really doesn't hold up because oil will go where it is able and if there is a porous medium or a fracturing area, it will move up into the porosity, and we wouldn't be producing oil in this country if it would all stay in the shales or the beds only, so that really doesn't hold up too well.

Now, let's discuss whether this is a channel sand or not. El Paso alluded to submarine canyons and they also made reference to long shore currents. These are currents which travel parallel to the shore line. Now, I want to clear this up on the submarine canyons. We submit that submarine canyons are followed also at right angles and parallel our present-day shore lines, that is, off the Atlantic Coast and off the Pacific Coast, and these submarine canyons are in the order of hundreds of feet, thousands of feet deep, and we are here talking about a 40-feet channel. These submarine canyons do not occur on what we call the Continental Shelf, the Continental Shelf is a gently sloping sea floor coming out from the Continent and it reaches a point where it suddenly breaks off in a sharp drop toward the Continental slope and finally into the basin dip.

As far as I can tell, these sands were deposited under a very gently sloping ocean floor which I consider due to the proximity of the land in the Continental Shelf, and an examination of our submarine canyons reveals that they are found not on the Continental Shelf, but that they are found in the ocean depths along the Continental Slope, so I wouldn't compare our present-day submarine canyons to anything that happened in Gallup time.

The second thing, is a rule, at least in the channel sands that I have seen, cross bedding as a common factor. This is a particular type of bedding that is similar to individual thin beds fanning out from a central point almost like a fan. It is like a fan in effect.

Now, we have examined more than fifteen cores of the upper and lower sands since we cored, we have cored over 50 per cent of our wells in the 4-section block, and we find that cross bedding is a very minor factor indeed. In face, we have found that it forms a small percentage of the total sand thickness so that in addition, we have found cross bedding in the upper and the lower part, which would indicate that the upper and lower sands have similar characteristics.

I also point out that the lithologic characteristics of the upper and lower sands were porous and very much alike; where they are tight, they are less porous, less permeable, they are very much alike. Channel sand, as I know it, occurs at right angles to the shore, they do not occur parallel to the shore. I would like to quote a few examples with which you may or may not be familiar with. The Old Fiddler Creek Field is in Wyoming and there are channel sands. They occur at right angles to the shore and they are extremely cross bedded in nature. The Jewel's Peak Basin clay is based upon a search for channel sands. These are sands that occur at right angles to the land that occurred farther to the east, so I find no evidence out here to indicate these are channel sands.

Now, let's take long shore currents. According to what I know, and I admit that we do not know everything about how sands are deposited in the ocean, we are attempting to learn, there are large scale projects going on now supported by the oil companies so that we can try and understand how present-day deposition occurs so that we can take present-date deposition and compare with the sections such as the Gallup. As far as I know, long shore currents do not cut channels, they distribute sands, they distribute blanket sands along the shore, and furthermore, going back to submarine concepts, the submarine concept doesn't find anything, it is just wiped clean down there.

So I, on the basis of this, I say let's look at another interpretation. Suppose that the lower sand was not a channel sand. Let's suppose now that it is a sand bar and we will operate on that theory. Here is the southwest, here is the northeast. Now, this is the ocean floor. That's too steep, it's a very gently dipping feature. Assume that's only a matter of a degree, and this represents a time line. This is the Juana Lopez cenosity --

Q (By Mr. Hinkle) Is the Juana Lopez a definite marker in this area?

A Yes, it's either a very limy shale or a limy limestone. We have found an abundance of fossils of clams, clam-type fossils, in the Juana Lopez cores, it's a very fossiliferous limy sh[illegible] or shaly lime. Now, that's found all over the San Juan Basin. Now, we have that deposited and that represents the ocean floor.

Now, let's go to the northeast end of the field. Now, I can't show you that, but we are going to divide this up, say 20 or

30 feet at a time.

MR. FISCHER: Could you draw that line a little heavier, please?

A Oh, yes sir. Can you see that now?

MR. FISCHER: Yes, thank you.

A Now, we're in the northeast end of the field and we are at the center of the field. Coming from northeast to southwest, let's just look at the first twenty feet that were deposited and it's sand. And over here on this side, less permeable--I am not going to get into that fight--and this is permeable, and then less permeable.

Now, let's take the next twenty feet or so. We are now moving more toward the center of the field. Here is the second sand body deposited. Now, why is this sand moving in this direction? It is moving in this direction because the sea is moving in this direction. Only sand bars are deposited at a certain distance offshore at a certain depth because waves exert a certain effect on the distribution of sands. If the sea moves in, this point becomes too deep for adjusting of sand and the adjustment moves to a depth, a shallower depth, which is a depth which was the equivalent of one, where this layed at one time, so the sand has moved up.

Now, that is actually what is shown on the cross section to the northeast. You have a sand developed, but as you go up in the section, the upper part of the sand is not there and the

21. buildup occurs as you go to the southwest, and why is it that the center of the field produces the most oil and has the most sand? Because it is in a fortunate position, it is on the updip side of the first depositional circle and it is on the downdip side of the second depositional circle, so one overlaps the other. However, as you continue to go to the southwest, the amount of shale between the Juana Lopez cenosity and the B, or lower sand, as we have identified it, becomes thicker.

Now, let's carry it a little farther. The sea moves in some more and we get something like this. That's Well Number 16 right here. Again the thickness of the shale has increased until finally it's 50 feet from the top of this sand to the Juana Lopez. Now, we have carried it farther. We say that there is an additional depositional circle right there and that if you go farther, say to Well Number 30, you get an additional porosity on the top. Now, let's draw, let's connect all the points on the cross section to even it off and we come out with a sand body the exact shape of the one that Mr. Speer showed on his cross section. This is not a channel sand, a channel sand looks like that. This thing is a flattened "S" going up in this direction. All the channel sands I have seen pinch out on the flanges unless the channel is swaying and if the channel is swaying, it really doesn't make a heck of a lot of difference because it still brings the upper part of the lower and the lower part of the upper sand as you go to the southwest. That is not the shape, however, of channel sand now.

22. We will continue with the history. We have reached this point right here. Now, at that particular time, if the sand stayed right where it was or very close, or very close to it and not a heck of a lot of it, not as much sand coming into this area as there was in earlier times, and so that at this point you get a lot of sand laminated with shales and sandy shales and they are not continuous, but they may connect vertically. You always must look at this thing dimensionally and a core is only a two-dimensional picture. You cannot assume when you see a three-foot shale in a core that it goes for 60 miles or even 50 miles or even a half a mile, so that at this particular time there is a certain amount of sand being deposited in there. Some of the distribution may have been porous and some of them were less porous and that went on to this point.

And then your supply was increased again by probably an uplift, but this uplift did not have the same effect of moving this sand forward or backward because it wasn't sufficient, so that you had more of a blanket type of sand deposited throughout the entire area.

Now, some of this sand down here infiltrated all over the area. In some places it had a little more argillaceous content than others, but I stress that this was at a time in which not as much sand was going into the area. But at the close of the Gallup interval here, more sand moved into the area and was deposited all over a very, very wide area.

23. Now, there is no reason to believe that these were not porous elements in this upper sand, were not sand bars, too, just because they are not as well defined as the lower one. That doesn't mean that the adjustment was not as good. There was better adjustment in the lower time of definite alinements of sands than there was an upper time. However, we have taken a gross interval and there is nothing to say that if we break this down, we wouldn't get a better alinement than we are getting now. However, the porous trend of this upper sand still followed definite lines, so I suggest here as another interpretation that the lower sand is a sandbar type of deposit and furthermore, was what we call a transgressive sand because it transgressed on the land, that the upper sand was deposited in a very similar manner by the same sand streams, probably, in this interpretation of the lower sand, and that these two were adjusted by waves into alinements that were sandbars also.

So what I am trying to get at is to break down the argument that these types of deposits are different. They aren't different in this interpretation, they are the same.

Q (By Mr. Hinkle) Now, Mr. Agatston, will you refer back to cross section BB prime, Exhibit Four, and compare the well logs with the visual core analysis?

A Well, I have compared the sand as evidenced --

Q Yes.

A --by the lithology. We have alluded to this before, referred to it, and we'll give you 29 as an exhibit then, is that right?

Q Yes, that's right.

A This is 28.

Q This will be Exhibit Seven-B.

(Whereupon, the document was marked as Atlantic's Exhibit Number Seven-B for identification.)

MR. PORTER: Mr. Hinkle, how are you identifying this?

MR. HINKLE: As Seven-B. We have one as Number 30, the electrical log on Well Number 30.

MR. PORTER: Is Seven?

MR. HINKLE: Is Seven, and this will be Seven-B because he identified the drawing up here as Seven-A.

A I don't imagine you can see this too well, but these are three logs that I had spoken of, 28, 29 and 30, going in a northwest direction. And you notice in 30, there is a --

Q (By Mr. Hinkle) You are referring to what log, what well number?

A Number 30, Well Number 30, which is the northwesternmost well. We have a fairly porous section here of about 16 feet. It appears down lower in the section than on Log Number 29 immediately to the southwest where you have approximately 14 feet, 12 feet of porous section, which compares with this Log 29. Additionally to the southwest, there's approximately 6 feet--I am best trying to show how this is shaping farther and farther down the section. Now, remember the line of deposition is this way, that if we keep going in this way --

Q You are referring to Exhibit Number One?

A Exhibit One. The line of deposition is in this direction. As we go this way, we hit 30; we go a little farther, we hit 29; we go a little farther, we hit 28, and so that as you go in that direction, the sand should rise in this section. That's what it does. It goes up, the porosity gets higher and higher as you go from northwest to southeast. Now, we showed the same thing in this cross section here. We went from 15 to 16 to 17 to 18 and 19. That is--do you want me to give you the number on that?

Q Yes, sir.

A That's Exhibit Six. 11, 15, 16 to 17 to 19, the sand grows in the section and it did it because the line is this way. We hit 19, we hit 18, we hit 17 and we hit 16 and we hit 15, and each time we went in that direction, the sand went up in the section, which is what its been doing all across this field.

Now, on this log, one more thing on the sand content of the section. Between here and here, Well Number 30, this is a sonic log, it's a different type of log than an electric log, it's a log based on transmissions of sound through beds. This is shale and this is shaly. I should say that there is also sand in here because if this is basically shale and so is this, this is porosity, this is not as porous, if these beds were shaly in here, they would kick back to this point, but they don't kick back, they stay out here and this, on a sonic log, is a characteristic of a very sandy section, so that you have sand over an interval of almost 100 feet, predominantly sand, an interval of more --

Q What log were you referring to at that time?

A Log Number 30, or I can--that will be the same thing. I am referring to Log Number 29, which in the exhibit it shows exactly the same thing.

Q Do you have any recommendation to make to the Commission as to whether they should treat Zones A and B, or the upper and lower zones, as we have referred to them, as one reservoir or separate reservoir?

A I have attempted to show that the upper part of the lower sand connects with the lower part of the upper sand in the southwestern portion of the field, that the sand deposition between the upper part of the lower sand and the upper sand are continuous.

Q Were Exhibits One through Six inclusive prepared by you or under your direction?

A That's correct.

MR. HINKLE: We would like to offer in evidence Exhibits Ont to Six inclusive, also Seven-A and Seven-B and Seven.

MR. PORTER: Is there objection to the admission of Atlantic's exhibits?

They will be received into the record.

MR. HINKLE: I believe that's all.

MR. PORTER: Any questions?

27. Mr. Fischer?

MR. WOODWARD: John Woodward representing El Paso Natural Gas Products.

MR. PORTER: Mr. Woodward?

CROSS EXAMINATION

BY MR. WOODWARD:

Q Mr. Agatston, I would like, if I can, to explore the areas of agreement so we can find out any differences of interpretation with respect to the question of separation or continuity of what we have designated as Sand A and Sand B. Have you made a longitudinal cross section of this field?

A Yes sir, we have called that Exhibit Number Three and we referred to it. That is similar to yours.

Q Has that been introduced in evidence?

A Yes, we just didn't want to refute yours.

Q That exhibit essentially agreed with El Paso's Exhibit Number Five, being their AA prime cross section?

A In terms of correlation, yes.

Q Have you had occasion to examine cores taken from wells penetrating both Sands A and B?

A That's correct.

Q Have you made a lithological examination of those cores?

A Right.

Q Do you, in general, agree with Mr. Speer in the lithology of Sands A and B?

A Well, I didn't hear any detailed description on what he considered Sands A and B. It was referred to as sandstone, coarser in some places than in others and also finer in other places with some sandy shale and shale intervals. To that point, I agree. There are additional things or characteristics that might be mentioned.

Q Do you recall Mr. Speer's testimony that the upper sand, or Sand A, was a less clean sand than the lower sand and contained a number of silts and shaly stringers throughout the interval designated as Sand A?

A I recall his testimony.

Q And that Sand B was a more uniform sand, again ranging from medium to coarse and much less interbedding or lensing of silts and shale stringers?

A Right, I remember that testimony.

Q Mr. Agatston, do you concede the impossibility that a offshore current running parallel to the shore line may have gouged out a shallow trough or channel?

A I do not.

Q You do not concede that that is possible under any circumstances?

A I know of no cases or fields producing right now where positively the deposition accumulation of sands are due to long shore currents. Frankly, I don't understand fully, and neither does Mr. Speer or any other geologist, the full effects of long shore currents. It is a term that geologists conveniently used or plased into use because he wishes to deposit something parallel to a shore.

Q Of course, you recognize the sands of a long shore current as a geologist for scouring out a channel or trough?

A No.

Q You don't?

A No.

Q Mr. Agatston, do you recognize Mr. Robert R. Shrock, Professor of Geology at Massachussets Institute of Technology, as the recognized authority in the field of geology?

A He's a very, very well know geologist.

Q You recognize him as an authority in that field?

A I realize you are now going to read from Shrock's textbook, but that textbook was written when, sir?

Q Mr. Shrock's textbook was written in 1948, some ten years ago. He discusses geology features, however, that had been laid down for several million years before.

A Yes, but he didn't start studying it several million years ago.

Q I doubt that that would have anything to do with his qualifications.

A You would have a hard time finding an expert to accept his qualifications.

Q Mr. Agatston, I will ask you to read from Section 132

30. from this text to this point. You may read the entire article if you desire.

A Where do you want me to begin?

Q Begin at the beginning. Will you read that aloud?

A "Erosional features-Scour and Fill channels, potholes, et cetera. Under certain local conditions the erosive power of streams and water currents becomes great enough so that shallow depressions are scoured out of the loose, unconsolidated bottom sediments or out of the solid rock over which the water is flowing. Some excavations so produced are asymmetrical pits and troughs. Usually they have the upstream slope much steeper than the down-stream and are disposed transverse to the general current direction."

May I allude as I go along?

Q You may.

A He has just said that the sands are deposited transverse to the current direction. As I understand it, that means at right angles to the current direction, is that correct?

Q It may be. Continue.

A All right. "When the current ceases excavating and starts depositing sediment, the depression is backfilled, often with more coarsely textured material than that in the substratum. As the current sweeps detritus along the bottom, some is washed into the depression, the coarser grains rolling down the steep slope as the deposit advances across the excavation"--still transverse--"and the filling thus made is an asymmetrical lens of cross-laminated detritus fairly flat along its upper boundary and rounded along its lower contact with the substratum."

Q All right.

A I don't see what he's saying there that's any different.

Q Beginning right here, Mr. Agatston, will you continue to read in the same section?

A "Strong bottom currents may scour out linear troughs of more or less symmetrical cross section trending in the same direction as the flow. Twenhofel, 1932, mentions such channels in certain formations on Anticosti Island and states that 'the channel fillings in some instances resemble casts of logs.'" I'm sorry I couldn't be there. "Grabau described and illustrated a broad, shallow channel eroded into the Silurian Manlius limestone of New York and then backfilled with Devonian clastics and later Onondage limestone. In other places the Onondage rests directly in the irregular surface of the Manlius with a clean contact. Many years ago Williams, 1881, described sandfilled channels in the upper Devonian Portage shales of New York and ascribed them to icebergs dragging across the soft muddy bottom."

Q Thank you. Would you reconsider your statement that you now have no instance in which geological agents have cut troughs or channels of some sort?

A Well, let me put it this way: Geology is a progressing science. The men that started out and formed the backbone of our thinking and they did a very wonderful job and we have carried their thinking forward. It doesn't mean to say that if a man back in 1920 maintained that a certain condition exists, it exists today because if we were to go on that assumption, there is no science or no profession that would move forward. The oil companies have felt that we know little enough about depositional conditions to support by hundreds of thousands of dollars a study of the Gulf Coast. They are finding things out there now that people didn't know of before, so that if a man has said something and I do not agree with him, he's an experienced professor at a university and has a reputation and he is a better man than I am, that doesn't mean he's right and I'm wrong. This, in summary, is the difference in what I have said and what Mr. Speer has said and the other authorities that he cites.

Q That it is possible to have an offshore channel or trough?

A My experience in the case of channel oil fields in the Rocky Mountains has been that they occur at right angles to a shore and that there are sediments within them and there are highly cross bedded characteristics which I do not see here.

Q It would then appear that we have reached the limit of our area of agreement. Now, at the outset, Mr. Agatston, you testified that there was a steep dip at the northeast end --

A Southeast end.

Q --southeast end of Sand B. Would you show where that thinking and they did a very wonderful job and we have carried their thinking forward. It doesn't mean to say that if a man back in 1920 maintained that a certain condition exists, it exists today because if we were to go on that assumption, there is no science or no profession that would move forward. The oil companies have felt that we know little enough about depositional conditions to support by hundreds of thousands of dollars a study of the Gulf Coast. They are finding things out there now that people didn't know of before, so that if a man has said something and I do not agree with him, he's an experienced professor at a university and has a reputation and he is a better man than I am, that doesn't mean he's right and I'm wrong. This, in summary, is the difference in what I have said and what Mr. Speer has said and the other authorities that he cites.

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A Southeast end.

Q --southeast end of Sand B. Would you show where that

33. dip occurs?

A On Exhibit Two, it occurs south of the El Paso Williams producing well as the so-called hogback that goes around a large portion of the San Juan Basin.

Q Will you point it out?

A Approximately in here. Here is the contour map of that well, this is the hogback as the contours get closer.

MR. HINKLE: What exhibit are you referring to?

A Exhibit Number Two.

Q (By Mr. Woodward) Now, on what information do you predicate your opinion as to the existence of this dip or break?

A Surface evidence.

Q Now, do you have any --

A I might say subsurface evidence, too, because the wells on the northwest side of the hogback reach the Gallup at depths shallower than two thousand feet, whereas you will notice on the other side, they reach the Gallup at four thousand feet, some two thousand feet of difference.

Q Do you have any direct evidence of fracturing either at the hinge in this hogback or any other position of the field?

A The San Juan Basin is just completely covered with fractures and in the case of the hogback further in the surface outcrop, you will find that the Mesa Verde sandstone is extremely fractured.

Q Confine your testimony to the area outlined in red and green in El Paso's Exhibit Number One. Within that area, have you seen any cores that indicate a general fracturing condition?

A No, I agree with Bill on that. I mean, Bill's idea is, as you get away from the hogback, there is a decrease in the number of fractures. Now, I am not outruling that in some places there is connection by fractures, in some particular places, between the upper and lower --

Q Do you have any --

A But I see a decrease in fractures, as Bill has said.

Q North and west of the hogback, do you have any evidence of such fractures?

A North and west?

Q Yes.

A We have seen some fractures in our cores, but I would not say that it is an outstanding thing.

Q You would not say it indicated a fracture system that connects the upper and lower sands on the base?

A I have not seen in any core in Atlantic's lease an indication, but then they have not cored the entire interval of any system of fractures going up through that. We have only cored one well entirely through but I--may I point out here, may I reiterate--what difference does it make whether the fracture comes through, only comes through in one place? That connects a reservoir. If you took a piece of steel or any hard or even pliable or semi-pliable material and bent it sixty degrees, the place where the curviture occurs, there is such tension in pulling the material apart that a series of fractures occur on the curviture and this is known in many fields.

Q We will concede that great stress can cause fractures. The question is, do you have any evidence of a fracture system within the Horseshoe Canyon field that would link Sands A and B together?

A Well, I have evidence in the case of the Verde-Gallup field that the production decreases as you go to the southwest and there are still numerous fractures in those wells that are --

Q That is not the question, Mr. Agatston.

A Yes.

Q The question is, within the Horseshoe Canyon field, do you have any evidence of connection between Sands A and B by means of fractures?

A As with all geological facts, we take our information and we interpret it. My interpretation is that in the region of the hogback, that there's much stress, and seeing similar stress on the surface and what has happened, that I would assume that at depth there would be very pronounced fracture in the Gallup section. I have not seen it.

Q That is a matter of speculation on your part, is it not?

A All our cross sections and presentations are.

Q I would agree with you.

~~A Well, on both sides.~~

Q That steep dip to which you referred in this area of completion which you speculate exists is outside the present limits of the Horseshoe Canyon field, is it not?

A What is identified as the present limits of the Horseshoe Canyon field, the limits of the Horseshoe Canyon field have not been delineated and you will note that in your illustration, you have extended it to connect the well production from the north end of the field with the main production in the Horseshoe-Gallup field as part of the field. I am merely asking that we extend the south end of the field, not three miles, but another mile.

Q You would concede that there is no well control in that direction at this time?

A No well control in the other direction three miles away.

Q You are questioning an inclusion of the wells to the northeast as part of Sand B?

A No, I just--what I am trying to say here is if you can extent that field three miles on the northwest side, it ought to be no less permissable for me to extend the field one mile on the southeast side.

Q In the absence of well control on the southeast?

A In the absence of well control on the southeast.

Q Mr. Agatston, let me see if I understand your theory of how these two sands were laid down.

A Do you want me to get these back up?

~~Q If you will, please, put it back on the board.~~

A Yes, sir.

Q Mr. Agatston, will you state again what Line JL and Line J-4 represent, as I read those figures?

A That is what we call the Juana Lopez, as you have spoken of cenosity, isn't that correct?

Q Yes. Now, this line shows a dip to the east, is that correct, sir?

A To the north.

Q To the northeast?

A Yes, but don't let that--you see, in these cross sections, you don't want to take these scales literally. You realize that I have moved almost three quarters--well, moved more than a mile or a matter of over a mile. From here to here is approximately forty feet, that is a half a degree. So don't be misled by the schematic diagram, from here to here is a mere half a degree.

Q You did not intend to indicate by the dip of JL to J-4 that it represented an offshore slope?

A I think it does at the particular time.

Q That parallels the bedding plane of the --

A At the particular time that the lowermost sands of the lower zone were deposited, I think the Juana Lopez was quite representative of what the sea floor looked like. Now, we can't --

Q That would be mostly a coincedence, wouldn't it?

A No, I don't think so.

~~Q If indeed there is a dip, the short line would be the~~ same --

A Oh absolutely, the real tilt didn't occur until much, much later in the structure. This is only the sand base, I know that.

Q That is the point that I am trying to get here, that this dip does not represent an offshore slope, it represents a tilt that occurred much later, is that not correct?

A The dip, as we see it today, added to the tilt that was there on the offshore slope. There was tilt, it wasn't level.

Q Now, it is your position that this lower Sand A represents a sandbar, is that correct?

A It is my interpretation, that's correct.

Q And that the sand buildup moves to the southwest?

A That is correct.

Q That is, the shoreline receded in that direction, is that correct?

A The shoreline advanced, sir.

Q It advanced?

A Yes, sir.

Q Causing an earlier deposition on the southwest flank of Sand B?

A On the southwest--well, the sand that was deposited on the southwest margin of what we have spoken of as the lower sand or B Sand, the sand on the southwest is younger as it was

39. deposited later than the sand at the northeast margin of the sand body.

Q When we speak in relative terms of the shoreline, where was the lower line when this section of sand that you have labeled "p" --

A Yes, that's porous.

Q All right.

A Let me try and clear this up. Give me another color, will you, so we can understand this exhibit after I'm through with it. These are time lines. There is a tremendous problem in geology in which we are always trying to make sands equal to each other and say they are equal when they are not equal in time at all and it is a problem in all the cretaceous sands in the San Juan Basin or most of them. These are time lines. Now, see that --

MR. HINKLE: You indicate those are time lines?

A Time lines. We'll draw another one here. Earlier, there was sand deposited here and if you took a vertical section through here, by drilling wells we find from sand into shale and sand or sandy shale. As you move over here you get all sand and a very thin interval of shaly material. As you move over here you get shale and the last deposition is sand and there is the sea, you might say. I am not using any scale for these sands because it may be about twenty miles, it might be forty miles offshore. As you know the Gulf Coast, there is a very gentle shelfing of the Gulf Coast. There are wells being drilled ninety miles off and in a hundred and twenty-five feet of water, so how close this sand is to the shore is a matter of tilt. But here let's assume that the shore is here and this is being deposited, and then the shore moved here and this is being deposited, and then the shore moved there and that was being deposited. Each time the margin of the sea moved in this direction, it was necessary for the sand to move in that direction because that is the optimum position in which the shale and sand is to be deposited.

Q (By Mr. Woodward) Now, would you explain again the conditions under which the upper sand was layed down? Again trace the movement of the shore ennudation.

A You see, that is a relative period of sand and this extreme center is still carrying material in, to be sure, but under the shelf they weren't carrying as much sand, I think there's no doubt about that. These are beds of sand, of shale lamina and sandy shale lamina, but something happened out here to increase the amount of material which was being dumped into the stream that you are feeding in this area. A lot of things could have happened, you could have had a rain fallout there and there could have been minor uplifts. Now, this must have been a blanket sand because it occurred over a tremendous area and is more of a blanket sand than this, certainly.

Q Would you say it had any features of a typical off-shore body?

A We have found on our acreage that the best upper sand

41. ~~development and the porosity overlies the lower sand.~~

Q Does it indicate that the shoreline moved to the northeast during the period that the upper sand was passed out?

A There couldn't have been too much movement for this reason: This is so consistent, this doesn't show any transgression or regression. You might say that you are going to interpret this thing, it would be fine, it would be perfect if we could bring this sand up here to this point and then regress it as the shoreline gently moved to the northeast. In other words, we would come out with something like this and that would be fine, that would just create a perfect picture. The only trouble is that there's sand there and there's sand there, so it doesn't appear to have done that. There's not shale up here, there's sand. You see what I mean, if you had a regressive front, a regressive shoreline, there is sand here and then like so, if you go back in this direction, this ought to be sand in here and this should be less permeable or shaly material. But that isn't what has taken place, there is sand clear across here, so you can't really adjust the shoreline too much during our time.

Q You find no evidence that the shoreline moved in a northeast direction and that during the period of deposition of Sand A that it fluctuated, permitting the interbedded deposits of silts and shale?

A Suppose it did, the reservoir would still be sand to sand back in that direction and would be almost in the same state

~~of affairs that you are now, it would still be a continuous sand~~ body. Just suppose I'm wrong.

Q The question here is whether you recognize through an examination of the lithology of these two sands any difference --

A There is.

Q --in the depositional conditions responsible for the mythology of these two sands?

A Well, I think what you are driving at here is that admittedly the lower sand is cleaner and more continuous than the upper sand, which Bill has said. But what does that show? There are still numerous porous streaks in the upper sand and it does not mean that laterally they are not connected by porosity and good permeability. I am not now discussing whether .4 millidarcies is sufficient for oil to move from one reservoir to another. I don't know enough about it, I am not an engineer, but I am pointing out that we must not look at a core as a two-dimensional feature. These sands may connect in one place though they look apart in another.

Q Then to summarize your picture of how these sands were laid down, you had, to begin with, an offshore sandbar running parallel to the shoreline, is that correct?

A That's right.

Q Now, as the streams fed into the sea behind this sandbar, there was a check in velocity of the current, is that correct?

A Yes. Are you talking about the lower sand now?

Q Talking about Sand B, this sandbar.

A Well, yes. It reached such a position offshore where it was deposited on the ocean floor.

Q It would start to have a check in velocity?

A Yes, sure.

Q Now, where would the buildup in your sand occur in a typical formation?

A It would occur a certain distance offshore. I think you have seen in the New England Coast there are just loads of them, along Rhode Island. It may occur a matter of--well, you have been in the beach and you have seen this type of sandbar. It may be three hundred yards off the shore or it may be farther than that..

Q Where would your sand buildup occur in the shore side of the side of the bar?

A It would occur on both--I don't know what you mean by that.

Q At what point does the check in velocity occur as a current crosses a bar?

A It may not necessarily. We see no evidence of scouring out in the bar, at least I haven't seen any in this field. You mean a stream cutting, actually cutting through the bar going right past this inlet, is that what you are driving at?

Q I am talking about a stream feeding into an inland sea.

A This is not an inland sea, this is an ocean.

Q I think that's a --

A The cretaceous is a typical mark in the United States.

Q We will concede that it is an ocean. I am not sure that there's any great difference for our purposes here. Where does the check in velocity occur as the current, penpendicular to the shoreline, is affected by a bar condition running parallel to the shoreline?

A When the velocity of the stream, you are asking me to give you a statistical answer as to what change occurs or what velocity occurs. I can't say that. When the stream, of course, goes at a certain velocity, in doing so it carries certain weights of sand or gravel or boulders or what have you, in the water. When this thing is slowed down, it leaves the heavier constituents, according to their weight, and obviously the stream goes out into the ocean and the ocean waves are coming in back and forth. It's going to exert some slowdown on the velocity of the stream. That's exactly what happened or must have happened because that's where all the sand is.

Q My question is that actually the current striking the bar because of the reduction in velocity, there is sand buildup to a large extent on the shore side of the bar, is that not correct?

A There is sand on the shore side of the bar.

Q Now, moving from the area of this sandbar to the ocean shoreline, you have deposited shale, is that not correct?

A We have something that is more, that is composed of

45. shale material and sand.

Q And you have a very sharp break in the northeast of this Sand B going lithologically into Sand B from the shale?

A Not too sharp, a gradual bend, because you are talking about one degree. When you are talking about the thickness of the sand body, that is a maximum of sixty feet thick over a distance of one mile. Sixty feet thick, that sure isn't very much, this thing is foot by foot. In fact, every hundred feet, you might say, this sand body thins. I wouldn't call that very abrupt.

MR. PORTER: We'll have a ten-minute break.

(Short recess.)

MR. PORTER: The meeting will come to order, please. We will proceed with Case 1596.

Q (By Mr. Woodward) Now, Mr. Agatston, to use an analogy that was used yesterday concerning separate sand bodies to a common sand body, much as the fingers of a hand are joined to a palm, it is your contention, as I understand it, that Sand A and B are joined on the southwest flank by common sand bodies, is that correct?

A That is correct.

Q Now, on your cross section CC prime --

A Yes, sir.

Q You project continuity as Sand B between the Petro Atlas Horseshoe Canyon E No. 1 and the Tom Bolack 11, is that correct?

A That is correct.

Q If your hypothesis is correct, Sand B should be present thoughout this interval?

A What interval, sir?

Q The distance between these two wells that you have shown. You have projected an area of continuity between those two wells?

A That yellow line represents a continuity between those two wells.

Q Right. Now, then, Mr. Agatston, the link that you project connects between Well 1 E, Petro Atlas 1 E and Tom Bolack

11 --

A Yes.

Q --what is the distance between these two wells?

A Approximately a quarter of a mile.

Q Now then, would additional well control in that interval assist you in determining whether the sand was continuous between these two wells?

A Are we talking about continuous sand or what you consider to be a continuous porous reservoir?

Q I believe you have testified that if this hypothesis is correct, you have a continuation of Sand B between these two wells?

A That is correct, as sand.

Q Now, Mr. Agatston, I call your attention to El Paso's Exhibit No. 6, being their cross section BB prime, this cross section approximately parallels your cross section, does it not?

A That is correct.

Q It is substantially the same transverse of the field?

A That is correct.

Q Now, you will observe --

A From 11 to 1 B to 12 to 2 B.

Q Now, you will observe on the cross section BB Prime, being El Paso's Exhibit No. 6, that this gap between your

Petro Atlas I E Well and Bolack 11 Well has been represented on this cross section?

A That is correct.

Q Now, do you find any evidence in the Tom Bolack No. 12 or the Petro Atlas 1 B Horseshoe Canyon of the continuity of Sand B ?

A I sure do.

Q Will you point it out?

A This is sand right here, the velocity that this sand goes, but this is still the sand zone and I feel that that sand zone, which I have said is right here, can either tie into this or may tie into the sandy base, into the base.

Q Does this line indicate to you effective permeability?

A I do not presume to know what effective permeability is, that is an engineering problem.

Q Do you have any idea what type of permeability may be illustrated?

A I don't think it is low permeability; you are going to ask me what low permeability is, but that's as far as I am going to go. I am not an engineer. We have engineers here who will testify on the permeability of sands and their effectiveness.

Q As a geologist, do you know in millidarcies approximately what --

A I wish you would object. As a geologist, I don't know.

MR. HINKLE: We object.

MR. WOODWARD: I object to the witness objecting.

MR. PORTER: Mr. Woodward, will you refer your question to the engineering witness.

MR. HINKLE: We have an engineering witness, who will testify.

MR. WOODWARD: We will refer it to the engineering witness.

A May I carry this point a little bit farther? Since, as you are pointing out, it would be perfect for us if we could eliminate these two legs in the light of everybody here and connect that with that, and that's what you are trying to do.

Q Which is what you did yourself?

A That's right.

Q CC Prime?

A Now, can I put this back? I would like to go over the arguments. I don't know what exhibit you are to call this. Actually, what we are up against here is instead of Well No. 28 being here on this --

Q You are referring to what exhibit?

A 7 A. Instead of Well No. 28 being here, this is a one-quarter of a mile break, and we don't pick up what El Paso will consider sufficient porosoty and permeability until we get here. There is a quarter of a mile, and then this little bitty porosity which is shown on 26, and then in these wells here it is isolated from the main bed by a still sandy zone because that is what these cross sections here will show, that there is lots of sand in that interval. I refer you again to El Paso's structure contour map. I mean, isopach map which is the first illustration, and I pointed out before that that map shows that as you go to the north, you are getting closer and closer to what must have been the source area of the sand moving into the Horseshoe Canyon field. That is simply on the basis that if you took this four-section block, 5, 3, 4, and 9 and 10 and compute the total feet of sand, compute the total feet of sand here, you will find that there is more sand. We are not banking on this block then, under this block.

Now, the width of the sand belt in the lower sand is wider in this area. El Paso is getting a very good lower sand zone here. We are still getting it, and we are still getting it over here. That's to be compared with a much narrower zone here, so that as you go the northwest, the porosity becomes more continuous, so since 28, 29, and 30 are on the northwest and are coming toward the area of greater sand deposition, I mean, that this little quarter of a mile zone in here, which they feel between these wells separates this porous spot from that porous spot is not present in the north. Now, we are still going in one line, or a very narrow line. That is to say, in the middle, that continued porosity might not be developed. In other words, we have as good a chance of being right as you do.

Q Does not the discussion of these two cross sections, CC Prime and El Paso's DD Prime boil down to this: The line that you are attempting to establish occurs between two wells, that additional well logs within that link indicate very little permeability, that had additional 40-acre wells been drilled between these two that you are using to establish the link, it is more likely that you would experience the same condition as has been experienced in a substantial parallel cross section?

A No, because I am trying to point out that down here, here is less sand being deposited, and you, with such reasoning as you propose here, since the lower sand and some of the upper is getting thinner out there, we better start farming this stuff out there. These wells in here we can give you a fair idea what is going to happen, but when it comes down to predicting, this is not going to present, on the basis of ten feet, more or less, I don't think you can fall on a statement like that, but we are trying to show here, and your own isopach map shows that there is more sand being deposited up here, you don't have any well down there, your area to the southeast, to compare with a porosity of sixteen feet. In the lower part of the upper sand there is nothing there.

Q Very frankly, Mr. Agatston, I don't understand the point of the greater deposition to the north or its relevancy.

A You don't?

Q I think --

A Well --

Q I think the point that we are discussing here is simply that of a link as shown by the cross section. It is all the evidence we have to go on at this time, and if that link--Your company sought to establish it in your cross section CC Prime --

A Well, we are in a --

Q --is fully explored in El Paso Exhibit B, BB Prime --

A We are now in a very strange state, sir, because we started off worrying about the distance between this sand and that sand, and now we are reduced to the problem of deciding whether a quarter of a mile or less over an interval of ten feet is sufficient to separate a reservoir. In other words, we have now bridged the sixty or seventy feet of shale that you have placed in between the two sands.

Q What is the distance between the bottom of Sand A and the top of Sand B as shown in the Tom Bolack 1?

A I have a little trouble understanding your scale here.

Q I think you have the same --

A I think maybe it is about fifty, sixty feet. It's on here. That's pretty sandy down to here, and this is less sandy, so it is approximately forty feet.

Q What is your next well?

A It is one half mile away.

Q And what is it?

A Or less. It is the 2 "B". No, it is the 1 "E".

Q No, I am moving now in a northeast direction.

A Quarter of a mile?

Q Another quarter of a mile, the same distance as the Petro Atlas 1 "E", is that correct?

A Yes.

Q What is the thickness of the shale interval in El Paso Product's No. 1 between the bottom of Sand A and the top of Sand B?

A Where is that please? You mean No. 6?

Q That's No. 6, and that's No. 1 here, parallelling.

A It increases to -- listen, I want to get at the point here. This is not shale, and no sample log or any core will ever show that this is all shale here.

Q Nevertheless you have shown --

A It is approximately fifty, sixty feet.

Q So progressing on your cross section one half mile in a southwest direction, you are beginning with the Molack 11 Well, you have fifty feet of separation?

A Now, wait, I don't know. Let's say that there is fifty feet between what we have called upper zone and lower zone.

Q What is the difference between upper and lower zone a half mile to the northeast?

A Still farther, it becomes greater. That's the premise of our argument.

Q So it is sixty feet, is that correct?

A Right.

Q Now, moving a half mile to the southwest, what is that interval?

A Wait a minute, I am lost.

Q Now, we moved in this direction, and there was a fifty foot separation, Bolack 15 1, sixty foot in the El Paso Product's No. 1 and the Petro Atlas 1 "E". Why is that?

A We have joined these two, whereas you haven't. You come awfully close to it. Actually, I would say there is no difference because we have picked the base of our Sand A or upper zone at the base of the predominently sandy section, so I would say there is no difference there.

Q Relatively speaking, the sand of Sand A is some forty feet to the southeast and has dropped --

A You mean the base?

Q All right, the base, some forty feet, half a mile to the southeast and has dropped --

A That's right.

Q --ten feet to the northeast?

A You see, we once again arrive at trying to put this thing on a foot-by-foot basis. This is a gradual change. On some characteristics we have to draw a line, but this doesn't go from sand to shale. Bank, bank like that, it goes from sand to shaly sand to sandy shale. It just doesn't --

Q What happens to the shale in the middle?

A The shale, there is a shale in a finger with this sand.

Q I see. Now, let's discuss this shale body, or this sandy shale, shaly sand.

A That's right.

Q Do you note any difference between the shale body, between Sand A and B and the shale below Sand, the base of Sand B or above the top of Sand A?

A In all those four units, you mean, do I notice any difference?

Q Yes.

A Yes, there is a difference.

Q What is it?

A In degree.

Q It is one of degree, is that correct?

A Yes.

Q What is that degree?

A There is some shale that is found in the section, shale content.

Q Is it more or less shale found at the top of Sand A?

A As a matter of fact, that kick at the top of Sand A has quite a bit of sand in it, because that's our core, that's our marker. When we hit that point, we get sand in the samples. We had thirty feet we went in and cored, so there is quite a bit of sand. There is shale above, however.

Q There is more sand in this shale than there is in this shale?

A There is probably more sand in this shale than there is in that.

Q How about this shale?

A That is pretty shaly.

Q Now, is this shale interval sandy shale throughout?

A It is intermixed shale and sand shaly sand and sandstone.

Q You don't notice any particular lithology break in this shale?

A This is more sandy than that.

Q In other words, there is a shale break to the southwest?

A We don't have to worry about that because we have already come above it.

Q I am asking you about the condition of this shale?

A I would say that this is more shaly than that.

Q I see. Let me ask you one other thing. You recognize this on the basis of well control shown as a representative contour of Sand B? Is that an accurate horizontal scale of the configuration of Sand B?

A Well, I would say to this point.

Q This little point right here?

A I would agree with your cross section to this well.

Q This is the part that you disagree with, the distance between wells four and five?

A That is correct.

Q It is your opinion that this continues to rise into Sand A, is that right? Draw this thing to scale. Now, do you agree with this point here?

A It doesn't rise. You see, it hits the lower part of this zone, this zone is shown as shale down here, or is assumed to be shale. It is not shale. It is predominantly sand. It is at least fifty per cent sand, and if you had drawn a diagram as we see it, you would find that there is quite a bit of sand in this section here. The connecting point is right here. It is a long, a very narrow line. It may be forty acres wide. We don't disagree with your work on that side other than we disagree with your interpretation of that section. The crux is over here.

Q Now we are understanding the difference in this kick. In the Petro Atlas Horseshoe Gallup is it my understanding that this interval below Sand A to the top of Sand B is a permeable sand body?

A We go back to the old point as to what is permeable. There are various degrees of --

Q You concede that it is an area of lower permeability?

A Yes.

Q All right. Now, I believe you testified that there was the shale break, as I construe it, to this interval somewhere in here in relation to this bar deposit?

A Oh, yes, sure there is.

Q In other words, you say the denser shale is right in here, is that right?

A Yes.

Q And then as you come up in this direction, your shale becomes somewhat sandy, is that right?

A No, I said that in the section above No. 16, I am not talking about this section anymore, we don't really have to worry about it, because you and I have tied this sand into this sand, so our problem is, how does this connect with this? This doesn't even enter in the problem any more, but what this section does is the problem, and I say that that section is sandy.

Q Rather than reading the record back, let's see if we can straighten this thing out. You stated that you were not concerned with this shale interval between the base of Sand B. Now, I'm interested in this shale interval. Now, is there a difference between the shale, between the base of Sand A and the top of Sand B and the shale below the base of Sand B?

A The amount of shale is greater below the base of Sand B in this well.

Q Is that the general condition you observed?

A I would say as that sand migrates upwards in the section, the shale below that sand -- there is more shale content in that section than there is in the other sand.

Q All right. We will return to your Exhibit 7, or is it --

MR. HINKLE: 7 A.

Q There is a denser shale section which would be approximately here in relation to your first bar deposit, is that correct?

A Right.

Q And as you come up the section and as the bar is moved toward the ancient shoreline in a southwest direction, the shale becomes somewhat sandy, is that correct?

A Oh, no. No, this shale is about the same. All this shale below this point is about the same character.

Q It's shalyer than this?

A It is shalyer than this here.

Q Now then, if you had a typical lagoonal deposit between the shoreline and the bar that you have projected, would you expect that deposit to be a dense shale?

A It isn't a dense shale, it is more shaly than the top. Yes, a lagoonal shale deposit is a very common --

Q What would such a deposit contain?

A It is not exactly a lagoonal in the sense that you may be thinking in that it is cut off from everything in that there is coal and plant life and everything in there. It is not that because this sand bar may be a considerable distance from the shore. It contains, it is not out of lime, and contains a shale, sandy shale deposit.

Q Now, if you checked the velocity of the stream approaching the bar and a normal sand built up in the inside of that bar, would you not expect this to be a very sandy shale?

A Oh, no, because you only have to be along the coast. There are streams running along the cost every two hundred feet, each one bringing different deposits. The Mississippi Delta for example, it is the main feeding stream to the gulf coast. This tremendous amount of sand, which incidently is seasonal, uplifts those in the spring time up these sand pools into the Mississippi River and runs it out in gulf coast waves which do not move directly in and out of the shore, but move diagonally carrying that sand along the shore and deposits it in a blanket from the same way it is coming in and out and groups that sand together, the porous separated from the fine sand bars.

Q You would not concede then that on the inland side of a sand bar that you, through a check of velocity, you would tend to have a thinning out of the sand section?

A You do, thinning out. It thins out from the bottom.

Q Yet you are willing to accept this contour of Sand B until you get to this point, isn't that your statement?

A Yes.

Q Which was your shore sand of Sand B?

A This side.

Q Now then, if it were a typical sand bar, wouldn't you expect this situation to be directly reversed, the thinning out occurring on the shore side?

A No. You cannot look at this as one sand bar, this is a series of sand bars. This is a sand bar, that's a sand bar, that's a sand bar, and that's a sand bar. You have evened them altogether.

Q This is a series of sand bars?

A Yes, there may be six of them.

Q There is no silty significance, silty lensing between these various sand bars? I believe that reasonably uniform sand --

A Of course, they overlap. The definition is not that close together, but our seaward side of a sand bar, there is a sharp drop off and we have shown it because when we go to the northeast, we lose the sand. Here again --

Q This is sharper than this one?

A I don't think so, you must get back to looking at your vertical relief. There is a half a degree of dip coming off the shore. The thinning of this sand, as I said before the Commission, is probably in the order of one foot per mile. How can you get sharp? It is unfortunate that we cannot show in cross sections vertical and horizontal relief the same, we would really show what really happened.

MR. WOODWARD: That concludes our cross examination.

MR. PORTER: Anyone else have a question of the witness? Mr. Fischer.

QUESTIONS BY MR. FISCHER:

Q Mr. Agatston, in your Exhibit 6 you left out Well No. 18, and I wanted to ask you if you had a chance to study the log of that well?

A Well No. 18?

Q Yes, do you have the log to that?

A If I remember correctly, it had less sand than that, but we will look at it. You see, when we started this line out here, drilling, we really didn't expect anything like this, and as we went to the north, we started picking up sand on the bottom which showed that, the belt-wide end. It was a great surprise to us, a very pleasant surprise.

Q From your interpretation of that log you have -- I just wanted to ask you if it was similar to the other logs.

A That is correct.

Q Could you give me your interpretation of the boundaries of Sand A and Sand B? I think it is on your cross section BB Prime.

A Sand A and Sand B?

Q Just take each individual log, give me your interpretation as to the vertical limits of Sand A and Sand B as to depth. It would be the third log from your left.

A No. 4?

Q Yes, sir.

A We have picked the top of Sand A at 1140 feet. The bottom at 1134 feet. We are a little bit low, I think, on the lower sand, but we picked it within three feet of being one way or another. It's 1247, and the base is 1288.

Q All right. Could you give me your interpretation as to the limits, the vertical limits of Sand A on the -- or both vertical productive limits on the left log, the last log on this cross section?

A You are talking about productive limits or vertical limits of sand, because here --

Q The vertical limits of sand, let's put it that way.

A All right. I would say that from this point at 1156 down to 1200, or even a little farther down than 1250 feet, we've carried it down actually to 1268 feet, that this section is predominently sand. Our cores show that even in the poorest portion of this section there was fifty per cent sand and fifty per cent shalyer beds.

Q Do you have knowledge of your perforating interval in that well?

A We perforated the upper part and did not perforate the lower, the reason for that was that we did not think at the time that we had a commercial reservoir, as the engineer will discuss the analysis on that section.

Q Would you give me your top of your cemsaity or Juana Lopez in that particular log?

A 1320 feet.

MR. FISCHER: Thank you, that's all.

A There is one thing that you might look at. Well, I will let that go.

MR. PORTER: Any further questions? I would like to summarize all these questions. Do you think there is communication between these two sands?

A If I may put on a geologist's opinion, I think that I have attempted to show that there is a depositional continuity between the upper part of the lower sand and the upper sand.

MR. PORTER: Anyone else have a question?

MR. HINKLE: I would like to ask him another one or two questions.

REDIRECT EXAMINATION

BY: MR. HINKLE:

Q Do you agree with El Paso in that this area has not been fully developed?

A I do.

Q Is it likely, through the further development and expansion of the producing area, that it will be shown more conclusively that these sands or porous zones do merge or that there is fracture showing communication between the two sands?

A There is, particularly in the north end, additional control; I believe that'll show that the lower part will add to the case, that the lower part of the upper sand does go into the upper part of the lower sand.

Q And that also may be true along the flanks?

A I restrict my argument to the four section block in which we have drilled and in which I have seen cores and know the most.

Q And what about the southeast portion extension?

A Well, I think -- There are no dry holes down there, so the way I will go is southeast.

Q And it could be in a fractured area?

A I doubt that anybody is going to drill a monocline because they would have to drill straight down, they wouldn't get to their beds, but they will drill on the other side of the monocline. Now, you don't have to drill through fractures. It is conceivable that a well on the down dip side of the monocline will show more fracture, but you don't have drill wells to get fractures, to get communication. The communication may, of course, be in between the wells, the monocline is a likely place for fractures.

MR. HINKLE: That's all.

MR. PORTER: Are there any questions?

MR. WOODWARD: One question.

RECROSS EXAMINATION

BY: MR. WOODWARD:

Q Mr. Agatston, are you familiar with the wells that have been drilled in the extreme northwest portion of the field?

A Not too well, for this reason, that, you see, we have ran in this part of the field induction logs and sonic. Now, when Bayless first made its discovery up there and Humble offset them, they ran radioactivity logs and frankly, I couldn't tell a darn thing about the radioactive logs, but I do agree with Mr. Speer that the lower sand is present in that particular pool.

Q Those wells are completed in the lower sand, is that correct?

A Yes.

Q Is the upper sand present?

A Well, again, you see, they drilled those things with air, and the samples are, we haven't seen any samples and they are pretty worthless, but you know, it is a funny thing about that tract, if you want to speculate on it. Somebody pay $175.00 per acre for the acreage rights next to it, and neither El Pasonor Atlantic apparently thought too much of it.

Q The only point that I am trying to establish is that those wells, to your knowledge, are completed in the lower section rather than the upper?

A Yes.

Q And they are, both are present in the upper zone and we could speculate --

A What was that last question?

Q And both sands are distinct and present in the northwest part of the field in which you speculate there will be a joinder or merger of sand?

A Both sands are present in these wells, but as you go in this direction, you'll notise that they come closer and closer. That's not true, strike that statement.

Q It doesn't correspond with your AA Prime, that statement, does it?

A AA Prime really doesn't prove a thing. It is not the right direction. Everything is the same on AA Prime. Essentially, we are looking for changes.

Q But both the AA Prime of Atlantic and El Paso indicate separation along a longitudinal line of the field, do they not?

A They indicate that there are two more porous sand bodies separated by a less porous permeable interval.

MR. WOODWARD: That's all.

MR. PORTER: The witness may be excused.

(Witness excused.)

MR. PORTER: The hearing will recess until 1:15.

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Hinkle, will you call the next witness, please.

MR. HINKLE: Mr. Bruce Verner.

BRUCE VERNOR

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY: MR. HINKLE:

Q State your name, please.

A Bruce Vernor.

Q Were you sworn this morning, Mr. Verner?

A Yes, I was.

Q By whom are you employed?

A Atlantic Refining Company.

Q In what capacity?

A As area reservoir engineer for the Rocky Mountain Region.

Q Where do you reside?

A Casper, Wyoming.

Q Are you a graduate engineer?

A Yes, I am. I got a bachelor of science in chemical engineering in 1953 from Rice Institute.

Q Have you been engaged in any sort of engineering since your graduation?

A Yes, I have.

Q With Atlantic all the time?

A Yes.

Q What areas have you worked in?

A West Texas and Rocky Mountain.

Q Are you familiar with the area in which the Horseshoe Gallup Pool is located?

A Yes.

Q Have you made a study of that field?

A Yes, I have.

MR. KINKLE: Are the witness' qualifications acceptable?

MR. PORTER: They are. How do you spell your last name?

A V-E-R-N-O-R. The only people that spell it right are those people from Detroit and that area, they have a ginger ale by that name over there.

Q Mr. Verner, you heard the testimony of Mr. Agatston this morning?

A Yes, I did.

Q And in his testimony I believe he referred to Well No. 29.

A Yes, he did.

Q Do you have a core analysis of that well?

A Yes, I do.

Q It has been marked, I believe, as Atlantic's Exhibit

No. 8. Will you refer to that and tell the Commission what it shows?

A First, I would like to show where this well is. The Atlantic No. 29 Well is in the southeast --

Q What exhibit are you referring to?

A Exhibit No. 1. The Atlantic Exhibit No. 1, which is a map of the field. The Atlantic No. 29 Well is in the southeast of the northwest of Section 31. This core was taken from a depth of 1221 feet.

Q First, who prepared this core analysis?

A The Core Laboratories, Incorporated. Their office is in Farmington. The core was taken throughout the entire interval, which is being designated Sand A and Sand B, and the intervening zone. It is taken from the depth of 1221 feet to a depth of 1311 feet. The intervening zone, which has been described as a combination of sand and shale by our geological witness runs from approximately 1253 feet to 1299 feet. There is permeability throughout this zone. The average horizontal permeability is .22 millidarcies, and the average vertical permeability is apporximately .1 millidarcy. Granted, permeability is not very high, but let us consider this permeability is acting over a large area of the field. The total millidarcy capacity of that area would be relatively high. The porosity interval ranges from 6.1 per cent to 15.8 per cent, with one exception, which is 2.7 per cent further. We had oil saturation throughout the interval, except for 2, 1 foot intervals which are not together. I call attention to Mr. Bolack's testimony of yesterday, in which he stated that oil is never found in the intervening interval by, as he called it, black-light examination. This core analysis shows that there is oil saturation. I would like to emphasize that this so-called permeable zone has measurable permeability.

MR. NUTTER: Mr. Verner, I wonder if you could tell me, do we have an electric log introduced as an exhibit on any of these cross sections or anything?

A I think we introduced it as 7 or 7 B.

MR. PORTER: 7 B. I have a copy of that.

Q Do you have any further comment with respect to that?

A Did you have a question on this log, Mr. Nutter?

MR. NUTTER: No, sir, I just wanted to correlate it.

A I might mention, since you are referring to the log --

MR. NUTTER: Is there an electric log? We have a sonic log.

A No. Excuse me. We follow a policy of running GR sonic logs in the wells which we cored and adding in additions, and those we have not. I might point out, as Mr. Agatston did this morning, that the zone between Zone A, say from about 1260 to about 1290 it is shown as a sand or as a sandy zone on the sonic log. If it were entirely shale, it would be more like the zone A above 1190 or below 1315.

Q Do you have any further comment with respect to core analysis on Well No. 29?

A No, I do not.

Q Do you have a core analysis of Well No. 28?

A Yes, I do.

Q This well, I believe, is shown on one of the cross sections, is it not?

A Well No. 28 is shown on cross section BB which is our Exhibit No. 3, is it not?

Q Exhibit No. 4.

A This, at the left end of Exhibit BB, is Atlantic's No. 28 Well, and it is an induction electric log.

Q What does the core analysis of Well 28 show?

A It shows substantially what Mr. Agatston was testifying about the No. 28 this morning, based on his description. We, as Mr. Agatston pointed out, did not core the entire interval between so-called Sand A and Sand B on this core, but of the interval which we did core, which corresponds to the interval Mr. Agatston was describing, we cored from 1163 feet to 1184, or we analyzed that section, and a section from 1221 to 1233, and with two exceptions all of that interval shows permeability, porosity and residual oil saturation.

Q Will you have the Reporter identify the core analysis of 28 as Exhibit No. 9?

MR. HINKLE: The same situation exists as to Well 30 which we are going to refer to next, in that we only have one copy, but we can furnish you with another copy.

Q (By Mr. Hinkle) Now, will you refer to the core analysis of Well No. 30 which you have identified as Exhibit No. 10?

A I refer again to Exhibit No. 1 and point out that the three wells which we are discussing are in a southeast, northwest line in Section 31. We have Well No. 28 in the northwest of the southeast of 31, 29, and the southeast, and 30 in the northeast of the northeast of Section 31. In the Navajo No. 30 Well we have analysis from 1160 to 1165, which is the zone above so-called Zone A which the permeability ranges from .01 to .03. We have analysis from 1169 to 1180, 1187 to 1190 and from 1233 to 1246. This core analysis shows very little of the zone between Zone A and Zone B. However, it does show that Zone B has three feet of permeability greater than one millidarcy. One of them is 1.2, another one is 96 millidarcies. Another one is 176 millidarcies. I might add that we perforated our well, our No. 30 Well, in both the so-called A Zone and B Zone.

Q Is that all?

A Yes.

Q Do you have a copy of El Paso's Exhibit No. 12?

A Yes, I do.

Q I would like to call that to your attention and if the Commission will refer to that also, the staff. Do you have any comments to make to the Commission with respect to this Exhibit?

A I would like to point out that El Paso has attempted to show by difference in pressure that Sand A and Sand B are not connected. They used Horseshoe Canyon No. 2, El Paso's Horseshoe Canyon No. 2 B as an example, and they have a pressure in Sand A of 221 pounds; Sand B of 243 pounds at the same datum. I might point out that on the same exhibit taken within a month, the pressure in the Horseshoe Canyon No. 4, taken of Sand B, was 209 pounds, I fail to see how this data can be used to show one way or the other.

Q Does it indicate anything to you?

A It indicates to me that the pressures are very close and that you couldn't say from this whether the pressure in Sand A was higher or lower than Sand B.

Q Does it show that the pressure of 209 in Sand B is less than the 221 in Sand A?

A Yes, it does, which means that the data contradicts itself or contradicts what it was supposed to show.

Q Now, refer to El Paso's Exhibit No. 13.

A El Paso's Exhibit No. 13 is entitled "Individual Production Tests of Sand A and B." The first test is of the El

Paso Production Company's Horseshoe Canyon No. 4 in which they have a test in Sand A of 21 barrels of oil per day with a gas-oil ratio too shallow to measure, and Sand B a test of 74 barrels per day and a 125 cubic feet per barrel gas-oil ratio. On the second line down, which would be the Horseshoe Canyon No. 3, they show the exact opposite. Sand A has 109 barrels of oil per day potential with 193 GOR. Sand B has 39 barrels of oil per day potential and 79 to 1 GOR. I say that this data contradicts itself and I don't think that --

Q In what way does it contradict itself?

A In one case we have higher ratio and higher production test in Sand A; in the other case we have higher ratio and higher production test in Sand B. This merely shows the same variation you have within the field.

Q Now, Mr. Vernor, from your reservoir study of the Horseshoe-Gallup area, state whether or not, in your opinion, the present method of completion of wells will cause a result in waste.

A I cannot see any possibility that the present method of completion will result in waste. First, the pressures appear to be the same or very nearly so, so, at present, there should be no migration from one zone to the other. The pressure difference between the zones could not become very high because there is not very high pressure in either zone at present. Further, we do not believe flow would occur between zones, but if we postulate for a moment that it might, I do not see how any loss could be caused because we are producing oil from both zones.

Q I believe the test has shown that there has been some 63 wells completed with both zones opened in the well bore. What effect, if any, has this had on the communication on the two zones, A and B?

A Our geological witness has shown that we believe the two zones are connected, they were not, in the completion of the 63 wells, as man has connected the two zones.

Q In your opinion, does the present method of completion in the two zones by open hole method present any particular water flooding problem?

A No. We would, under water flooding in a situation of this sort, which is not different in that sense than say a limestone reservoir with two reservoirs within a massive limestone, we would in that case attempt to, or we would inject in the two zones separately so we could control our rate of frontal advance. We would calculate the displaceable volume of oil from the area around the injection well, attempt to equalize our injection rates on a per volume basis. Of course, this isn't perfect, it is quite possible that some water would come through into one zone before it did in the other, but this calculation should make the time of arrival relatively close. Further, suppose for a moment, that water did get in one zone first, was produced in the well bore along with oil from a water-free zone, we postulate for a moment that it might, I do not see how any loss could be caused because we are producing oil from both zones.

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Q In your study of the reservoir conditions in the Horseshoe-Gallup area, do you have any recommendations to make to the Commission as to whether or not these zones A and B should be treated or continued to be treated as one reservoir?

A I recommend that they should continue to be treated as a common reservoir.

MR. HINKLE: That's all.

MR. PORTER: Anyone have a question of this witness?

CROSS EXAMINATION

BY MR. WOODWARD:

Q Mr. Vernor, all of the core analyses you have introduced here in evidence are taken from wells on the Southwest flank of the field, is that correct?

A That is correct.

Q Each of these core analyses, in your opinion, analyses, in your opinion, show a relatively thick permeable sand body saturated with oil?

A Which part are you talking about? Are you referring to the zones characterized as Zones A and B?

Q You have stated that these analyses show a thick permeable sand body, is that correct?

A Yes, it shows two thick very permeable sand bodies, and the zone in between of lower permeability.

Q In each of these cores?

A Actually, it only shows that in one of them. I presented the other two cores to show that it, as much of the core as we had, backed up our earlier contention.

Q Is it your opinion that there is vertical communication throughout this sandy interval?

A It is my opinion that over the large area involved it is very possible for communication to exist through this admittedly low permeability. Secondly, a specific core would be Well No. 23. Unfortunately, we didn't core the center interval. As much of the core as we have shows that the interval between say 1190, 1220 is sandy, or rather shows that there is permeability and soil oil saturation. Well No. 29, the log does not look quite as good as Well No. 23. We think that, by showing Well No. 29, that there is permeability. There most certainly is permeability, or there most certainly is a zone of somewhat better characteristics here on Well No. 23.

Q Is it your opinion that the core from Well 23 penetrated both Sand A abd B to some extent?

A Yes, it did.

Q Now, do you believe there is effective permeability throughout this vertical section?

A What do you mean by effective permeability?

Q Well now, as a petroleum engineer, you are aware of the standard usage of that term in the movement of fluid through a sand body, I am sure. During the producing life of the field, say 20 or 30 years, would you have effective communication of fluid through this sand body?

A I think that is very possible. In fact, very probable, and especially in the zone characterized by the well log No. 28.

Q You feel that there could be effective communication throughout that vertical column?

A I think that the communication would be low, but that there could be communication.

Q Within the producing life of the field, say 20 or 30 years?

A Yes.

Q Now, Mr. Vernor, unless it is clearly shown that both Sand A and B are represented in that column, that is, that Sand B has not played out between these three wells and the heart of the trend, this evidence indicates nothing about communication between Sand A and B, does it? You must assume a horizontal continuation of Sand B to the sand interval you have cored in these three wells, is that not correct?

A For a specific showing, yes. However, I believe that by showing the nature of this sandy interval, one may very well extend the same reasoning to the other parts of the field.

Q That is a matter of speculation, is it not?

A That's my opinion.

Q Considering for the moment, Mr. Vernor, the man made avenues of communication between these two sands, do you believe that a well completed in one of the sands would effectively drain the other during the producing life of these two fields?

A I didn't say that.

Q I asked you do you believe that?

A I think that the rate would be low enough to be much more economically to be completed through both sands.

Q Do you believe that you could drain one reservoir by completing the well in the other?

A You are not leading me to time when you say --

Q During this period of twenty to thirty years.

A You want to postulate that is the producing life of the field?

Q We are making that assumption for the purposes of this question.

A Well, I will answer the question this way. If you had no wells completed in the lower zone and you complete all the others in the upper zone, it is quite probable that in time you would drain the lower zone.

Q How much time?

A Quite a length of time.

Q More than thirty years?

A It would be difficult to say how long, I couldn't put a number on it. You realize the communication, or rather drainage, is a relative thing.

Q Am I to understand that you don't know whether a well completed in one of these sands would effectively drain the other within a period of thirty years?

A I think it is an impractical solution to the problem.

Q That is not the question. The question is whether or not you know or have any opinion as to how long it would take to drain one of these reservoirs by completing the well in the other?

A I think it would take quite a long time, although if you want to allow drainage along the lower zone and around through this zone that Mr. Agatston has described, along the southwest side of the field rather than directly through this zone that you are discussing, the time might be considerably reduced.

Q Mr. Vernor, you mentioned El Paso's Exhibit No. 12. You would recognize that there are differences in pressures within a single common source of supply depending on the time of completion, the nature of completion, and the duration of production at the time of completion, would you not?

A You are saying that pressure changes as the field is produced?

Q Yes.

A Yes.

Q Now, would you recognize, in comparing the pressures of two reservoirs, that a range of pressures is a fair comparison, more than individual well pressures?

A You have only one here. I would say if you looked at it alone you might be able to draw a conclusion.

Q Now, Mr. Vernor, what is the range of pressures in the three wells tested in Sand A?

A Ranges from 180 pounds to 221 pounds.

Q What is the range of pressures at common datum for Sand B?

A 201 to 243 pounds. However, I would like to point out just what you brought out; the other two pressures on Sand A were taken in January of 1959, whereas the pressures I referred to were all taken in September, October and November of 1957.

Q Is it not true that the pressures taken from the Horseshoe Canyon 6 Well in Sand A were after sand oil fracing?

A Are you implying that would have some effect on the pressure? They were, yes, according to the Exhibit. I don't see that that bears on the problem.

Q Now, on a natural completion, the Horseshoe Canyon No. 1, also completed in 1959, you note the significant difference from pressure?

A As compared to what?

Q As compared to Horseshoe Canyon 6 and 8, the pressures in Sand A?

A It is 201 pounds as compared to 194 pounds and 130 pounds.

Q On a common datum?

A On a common datum.

Q Do you think the adoption of commor datum is a good comparison?

A That depends for what purpose you want to use it. What purpose do you want to use it for?

Q For the purposes of this hearing and comparing.

A For the purposes of this hearing, I think it is a good idea. I might point out that the other thing I had in mind would be for a material balance calculation.

Q Have you observed any cores taken from wells in the heart of the field? The three that you testified to deal with wells in the southwest flank, have you observed any cores taken in the heart of the field?

A The cores themselves or the analysis?

Q Either.

A I have not seen the cores. I have seen the analysis.

Q What do those analyses indicate about the intervening shale body between Sand A and B?

A You mean the intervening sand and shale?

Q Sandy shale and shaly sand?

A Well, since we attempted to select the best part of the core to have analyzed in order to save money, we did not have the center section analyzed.

Q You do not know what the permeability of that center section is?

A That is correct.

Q Mr. Vernor, as a petroleum engineer, does your profession generally recognize that it is a wasteful and dangerous price to permit water in one reservoir to penetrate another reservoir?

A Under what circumstances?

Q We are asking this as a general observation or practise of the profession. Do you generally permit, or would you advocate permitting the injection of water into one reservoir and then permitting it to penetrate another?

A Well, for water flooding that would be normal to use water from some other reservoir and inject it into the oil reservoir.

Q And then permitted it to go from that reservoir still to another one?

A Only if we are water flooding both reservoirs. I am contending here that these are not two reservoirs. Consequently, we would not be going to another reservoir. I say that is no difference in the condition of two zones which may need to be separated in any water flood.

Q Do you expect the advance of water to be in a uniform configuration?

A You heard my earlier testimony. I said that by our calculation we might make the frontal advance relatively uniform and if it were not, it would not adversely affect the water flood.

Q Mr. Vernor, you have seen the isopachous map introduced as El Paso's Exhibit No. 2, I believe?

A Yes.

Q Have you seen the isopachous map of Exhibit No. 4 of Sand B?

A Yes.

Q Now, looking at the configuration and contours of these two sands as shown on those isopachous maps, can you suggest any program of injection which would assure a uniform flood throughout these two sands so that you could in any way calculate the arrival of the flood at the same time in the same well or even approximately the same time?

A I have no intention of making a complete water flood study of this field until we have at least our lease; we have not decided upon a pattern.

Q In looking at the two sands, however, your testimony is that you are not prepared to say how you could institute such a flood?

A I will say --

Q That you could insure the water in the well bore at the same time through both sands?

A I feel sure that we can design a flood such that the frontal advance would be relatively uniform. You are assuming, in your question, that the arrival of one before the other is detrimental; I say it is not.

Q I am simply asking you.

A I feel sure that we can.

MR. WOODWARD: We have no further questions.

MR. PORTER: Anyone else have a question of the witness?

MR. HINKLE: We would like to offer Atlantic's Exhibits 8, 9 and 10 in evidence.

MR. PORTER: Is there objection to the admittance of these Exhibits? They will be received. The witness may be excused.

(Witness excused)

MR. HINKLE: I would like to call Mr.T.O.Davis.

T. O. DAVIS,

called as a witness, having been first duly sworn on oath, testified as follows:

DIRECT EXAMINATION

BY MR. HINKLE:

Q State your name, please.

A T. O. Davis

Q Where do you reside, Mr. Davis?

A Casper, Wyoming.

Q By whom are you employed?

A The Atlantic Refining Company.

Q In what capacity?

A Regional petroleum engineer.

Q Are you a graduate petroleum engineer?

A Yes, I graduated from the University of Texas, received a B.S. in petroleum engineering in 1947.

Q Have you been employed by the Atlantic since 1947?

A Yes, I have.

Q And where have you held positions with Atlantic, in what areas?

A I've worked in Texas and the Rocky Mountain area.

Q Are you familiar and made a study of the Horseshoe-Gallup area and the reservoir conditions there, as petroleum engineer for Atlantic?

A I have made a study of the mechanical aspects of the field, yes.

Q And you are familiar with the production and the drilling costs --

A Yes.

Q -- and production costs?

A Yes, I am.

MR. HINKLE: Are the qualifications of the witness acceptable?

MR. PORTER: They are.

Q (By Mr. Hinkle) Have you prepared estimates of the cost of dual wells on your leases, the Atlantic leases, in the Horseshoe-Gallup area?

A Yes, I have. Our present wells are completed with five and a half inch casing, and I estimate that it will cost $14,400 more to dual one of our present wells; for wells that we haven't drilled yet, I estimate that it will cost $12,400 per well more to drill.

Q This figure is considerably higher than the figure that was given yesterday by El Paso. Do you have any explanation for that?

A Yes. I think that this is due to the fact that we would use a different end hole arrangement for one reason, and we would use a separate pumping unit to pump the lower zone, another reason. Actually, we looked at El Paso's proposal for duals for application on our lease, and we decided that although it might be satisfactory for them, if duals were ordered, that it wouldn't be satisfactory for us. They propose using inch and a half tubing, and an inch and a fourth pump is the largest pump you can use in this tubing. If we hung both of our rod strings on one pumping unit, as they propose, the most production we could get would be from 50 to 75 barrels a day per zone. And, in our opinion, this is not enough productive capacity. We think that this field will be water flooded and that we should have a productive capacity of three or four times the allowable for each zone.

Q Can you describe briefly to the Commission the type of equipment that you would prefer to use?

A If duals were ordered, we would run two strings of two and one-sixteenth inch OD flush joint tubing. You can use an inch and a half pump with this tubing, and we would hang the rod strings for the lower zone on a separate pumping unit. We think that that is necessary for the lower zone because all the gas that comes out of the lower zone must go through the pump. This is going to lower the volumetric effeciency of the lower pump, and we think we would have to put a larger pumper unit to pump the lower zone.

Q That is the type of equipment you are using at the present time?

A We are presently using two inch tubing in five and a half casing, and if we dual, we would have to remove the two inch string and run two strings of two and one-sixteenth inch.

Q Now, as to the wells drilled in the future, how would you equip those?

A We would run seven inch casing on wells in the future and run two strings of two inch non-upset tubing. This would allow us to use greater pumps and have greater capacity.

Q Do you agree with El Paso's projected method for separation and metering of the oil?

A I agree with the concept they propose for metering the oil for the two zones should a dual be ordered, but I don't agree with the equipment that they propose or the method they propose for doing this. They would use a compartmental separator with two meters for each well, and we anticipate that on our two leases we would have 50 dual wells and about 16 singles, a total of 66 wells, and that would require us to use 66 separators and about 116 meters. Now, this would be burdensome from an operating standpoint, and although we don't object to El Paso's use of that method, we wouldn't do it that way ourselves.

Q What would be your additional or initial investment if you had to go to dual completions? What is your estimate of it?

A We would have 50 dual completions, approximately, and we would have 23 five and a half inch cased wells at $14,400 each, which would cost an additional $331,000. We would have 27 seven inch cased wells at $12,400 each, which would cost an additional $335,000, and the total additional cost for 50 wells would be $666,000.

Q That is your additional cost for dual completions in the event that you were required to do it?

A That's correct.

Q What about your operating expenses, would they be higher?

A In our opinion, the operating expenses, if duals were ordered, would double. I say this because we would have twice as many pumps and rod strings and tubing strings; would have twice as many pumping units and engines, flow lines, meters, twice as much storage, twice as much labor to handle this additional equipment and production. In my opinion, from an operating cost standpoint, it would be the same as doubling the number of wells on our leases.

Q Will duals have any effect on the economic life of these wells?

A I think duals would cause an earlier abandonment of the wells. It follows that if your operating costs are twice as high, then the economic limit on a well will occur at a producing rate twice as high as for a single, so I think the duals would undoubtedly be abandoned earlier than single completion.

Q Would the earlier abandonment, in effect, cause waste?

A It would leave more oil in the reservoir, in my opinion, than single completions would because you would abandon these wells earlier.

Q Have you made any estimate as to how much your operating costs might increase if you went into dual completion?

A Well, our present operating costs are running a hundred dollars a well a month right now on single completions.

In my opinion, these costs would double if we had to go to duals and we would have approximately 50 duals, and 50 times $100 a month is $5,000 a month that I think our operating costs would increase.

Q What is your opinion of the dual completions by using the Brown zone selector which was described in the testimony here yesterday?

A Well, mechanically, I think this tool is satisfactory. I don't have anything against the tool from a mechanical standpoint. We wouldn't want to use it on our leases because I think we would have trouble making our allowable when this field starts to decline because you would only be able to produce each zone half the time. Also, for water flooding, I think both zones should be produced continuously. Also, I would object to another operator using this tool if duals were ordered unless the Commission assured us that some satisfactory method of sealing the tool could be provided. Now, what I am getting at there, let's say a pumper is having trouble making his allowable from one zone, then he is going to be tempted to switch the tool over and get it out of another zone. So I think if such a tool were used, the Commission would have to assure everybody that the thing is sealed in one direction or the other.

Q From an operating standpoint, what is your opinion of duals versus single completions?

A Well, let me state that Atlantic is not opposed to duals as a policy. We have many dual completions in operation and we propose them and recommend them when we think they are necessary. In this particular field, from a reservoir engineering standpoint, Mr. Vernor has already gone over reasons why we think duals are unnecessary. Now, from an operating standpoint, duals would cost us an additional $660,000 more than single completions. We think that our operating costs would go up $5,000 a month. I believe that duals would be abandoned earlier than single completions, and that duals would cause more oil to be left in the ground than single completions. For these reasons it would be my recommendation that El Paso's application for duals be denied.

MR. HINKLE: That's all.

MR. PORTER: Anyone have a question?

CROSS EXAMINATION

BY MR. BURROUGHS:

Q I would like to ask one question. Did I understand you, sir, to say that in your opinion dual completion would result in earlier abandonment?

A Yes, sir.

Q Is that a broad statement applying to all dual completions, sir?

A Well, in some cases I think duals are necessary to prevent waste.

Q The question was, do you think that dual completions result in earlier abandonment?

A If you are looking at two reservoirs being singly completed versus the same two reservoirs being dually completed, I think the answer is yes, it would cause earlier abandonment.

Q Which in every case would mean more waste in that more oil would be left in the reservoir?

A That is right, except in some cases you might want to dual the well to prevent the waste. For instance, if you had a gas reservoir and an oil reservoir, you wouldn't want to singly complete wells like that.

MR. BURROUGHS: Thank you.

MR. PORTER: Anyone else have a question?

QUESTIONS BY MR. FISCHER:

Q Mr. Davis, in line with this dual completion, then, do you think that if you dually completed in two oil reservoirs that that would cause premature abandonment of either one of the two reservoirs regardless of the separation between the two?

A As opposed to putting these two oil reservoirs together?

Q Just for this question, yes.

A Yes. It would cause earlier abandonment than if the two reservoirs were singly completed.

Q Would you recommend to your company that this Horseshoe-Gallup both sands be water flood?

A We are going to make a water flood study, and the early results indicate that this is an excellent place to water flood, so I am sure the study will bear out that we will recommend a water flood program.

Q Well, if it does bear that out, you, in your opinion, would recommend a water flood program to your company? Wouldn't you initiate your water flood before primary abandonment?

A We would initiate it as early as possible to maintain allowables on these wells, and whenever that would occur, we would try to arrest the decline early enough to maintain the current allowable.

MR. FISCHER: Thank you.

MR. PORTER: Anyone else have a question?

QUESTIONS BY MR. WOODWARD:

Q Mr. Davis, what would a single well completed in Sand A cost, approximately, to drill it and equip it?

A About $24,000, $25,000.

Q And what would a single well drilled and completed in Sand B cost?

A Approximately the same cost.

Q Approximately the same. Now, is there, in your opinion, sufficient recoverable reserves by primary means to recover the cost of a single well and return a reasonable profit to the operators?

A A single well in a single zone, you mean?

Q That is correct.

A Depending on what part of the field you are talking about, yes, in the majority of the field that would be true.

Q In both zones?

A Yes.

Q As a matter of fact, there are a number of single completions in Sand A,--

A That's right.

Q -- isn't that correct?

A Yes.

Q All right, now, let's compare the cost of two single wells, one completed in Sand A and one completed in Sand B, and a well, a single well completed in both zones, and dually completed in both zones as your company would prefer to complete it, and a single well completed in both zones but not dually completed so as to segregate production. What would be the total cost of the two single wells?

A Be around $50,000.

Q And of the dual completion by means of one well, in both zones?

A Be about $25,000.

Q Does that include the cost of the dual equipment?

A I misunderstood you. Would you ask that again?

Q What would be the cost of the dually completing a single well in both Sand A and B?

A On one of your present wells it would cost, the initial cost would be around $25,000, and we would have another $14,400 to dual it, which would be $39,400.

Q All right, then, if each of these sands would produce enough oil to pay the cost of two separate wells, certainly they will pay the cost of the dual completion, will they not?

A Yes. I think the testimony has been earlier that we think that duals are unnecessary. We haven't said that you couldn't pay it out.

Q It is possible to dually complete these wells and still receive a reasonable profit on your investment?

A You wouldn't receive as much profit as you would if they were singly completed, but you would in all probability make a profit.

Q Now, Mr. Davis, you have testified that in failing to -- or as a result of segregating the production from these two zones you would effect an earlier abandonment of wells due to the increased operating cost, with the result that some oil would be left in the ground, is that correct?

A That's my opinion, yes.

Q Is that observation not likewise true of any two sands underlying the same area separated by as much as two or three thousand feet?

A If you dual any two sands as opposed to putting them together with a single completion, you would always have the higher operating cost on the duals, you would always have to abandon the dual wells earlier as opposed to the single well.

Q Now, that would likewise be true of two separate completions, let's say, in two sands separated by as much as two or three thousand feet?

A That's true.

Q However, on either dual completion or an open hole completion, if I may use that term, you have the production from both zones contributing to your cost of operation, do you not?

A Yes, but the cost of operation is twice as high on the dual.

Q As a matter of policy, do you advocate separate completions in separate reservoirs?

A When we think waste will occur, we do.

Q In the absence of waste, you favor open hole completions?

A Waste has many definitions. You could have two crudes, one sour and one sweet, you could have a different gravity of the crudes. I think when anything would affect your operation so as to cause waste, Atlantic would certainly recommend dual completions.

Q You have more reservoir control in two separate common sources if they are separately completed?

A You can tell more accurately how much each zone produces, yes, provided you meter the separate zones.

Q Is there any way that you can actually tell how much each zone produces when the production is not segregated?

A There is no way that I know of, unless you make periodic tests on the different zones.

Q Now, on the assumption that water flooding will be instituted, in the event that the dual completion does result in an earlier abandonment, for primary purposes, would not that remaining oil be picked up by the water flood as well as much additional recovery?

A I would think the water would sweep that area, yes. You would always have wells on a lease, even with water flood, that eventually would be abandoned, and I think dual completions would be abandoned earlier than single completions.

Q Does it make very much difference if you went to a water flood?

A Even if you went to a water flood, you would still have some wells on your lease that were abandoned when the lease was finally completed, you would be abandoning these wells earlier than you would if the wells were singly completed.

MR. WOODWARD: We have no further questions.

MR. PORTER: Mr. Hinkle.

REDIRECT EXAMINATION

BY: MR. HINKLE:

Q Mr. Davis, getting back to the Governor's question of dual completions, in this case we are talking about supposedly a single reservoir and completions in two zones, you might say, of a common reservoir?

A Yes.

Q Under the Rules and Regulations of the Oil Conservation Commission, where you have two distinct reservoirs separated by a wide interval, for instance, if you had production in the Pennsylvanian formation and production in the Devonian formation, and you had a thick interval, and there is no question about them being separate reservoirs, in that case you would not be permitted to complete that hole by open hole methods, would you?

A No, if it was established that these were separate reservoirs, no communication between them, we could not complete these as an open hole completion.

Q In that case, you have one of two alternatives; either to make a dual completion in both reservoirs, or to drill two separate wells, one to say the Pennsylvanian formation, that reservoir, and the other one dwon to the Devonian?

A That is right.

Q Now, that involves an economic problem in the cost of drilling a completely new well, does it not?

A Yes, it does, and in nine cases out of ten, it would be more economic to dual a well than it would be to drill a separate well.

Q Well, now, is it true in that case that you might leave some oil because of premature abandonment because of dual completion?

A In a case like that it would be the dual compared to two wells instead of one well, --

Q That's right.

A -- so the abandonment would be approximately the same. It might even be a little less.

Q But really you didn't intend to convey the impression in your answer to the Governor's question that your statement was true generally of dual completions?

A No, I didn't.

MR. HINKLE: That's all.

MR. PORTER: Any further questions? Mr. Fischer.

RECROSS EXAMINATION

BY: MR. FISCHER:

Q Mr. Davis, you mentioned a hundred dollars a month per well as essentially what you would call a list cost, is that right?

A That is our direct operating cost. It includes pumpers, laborers, plugging job, et cetera.

Q What is the greatest single item in that one hundred dollars?

A I don't think I could answer that, I haven't analyzed our cost that thoroughly. I am sure labor is a large item and maintenance and repair of hole and surface equipment is a large item.

Q Your pumping units, those wells that are pumping, are they run on an electric motor or gas?

A Electricity is not available in that area, so we are running these with gas engines.

Q But possibly your pumpers' wages would be the greatest single item?

A It's one of the largest items, I wouldn't say it was the greatest.

Q How many pumpers are you using on your lease in the Horseshoe-Gallup at the present time?

A We have one full time pumper and we have one contract pumper that works nearly full time.

Q Would you have to double the amount of labor or pumpers if it so happened that these were determined to be two separate sources of supply and you dualled the wells?

A Oh, I am sure that we would. We would have twice as many things for the pumper to do.

MR. FISCHER: Thank you.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused)

MR. HINKLE: That's all we have.

MR. BUELL: May it please the Commission if we could have a short recess to arrange our exhibits? I believe we will have a net saving of time overall.

MR. PORTER: I favor that.

(Short recess)

MR. PORTER: The meeting will come to order, please.

MR. KELLAHIN: In my testimony this morning I announced that we would have some core samples. They are now present here in the hearing room and they are on the table in the back. They consist of cores from the Bolack No. 11 Well between the depth of 1536 feet and 1540 feet, and from the Bolack No. 6 Well between the range of 1570 feet to 1589 feet. The exact depth from which the various core samples were taken are marked on the boxes, and at this time we would like to offer them for the benefit of the Commission.

MR. PORTER: Any objection to the admittance of these cores into the record? They will be made a part of the record.

MR. KELLAHIN: In addition, there was some mention yesterday that the testimony of Mr. Bolack was not supported by any factual data. I have present here in the hearing room for the benefit of any who care to look at it [illegible]re analysis on the No. 6 Well, upper zone, lower sand; the core analysis on the No. 10 and No. 1[illegible] Well [illegible] the lower sand, and an engineering report on the Well No. 10 and Core Laboratories' reports on the area, dated December 22, 1957, and March the 25th, 1958. Within about a week we will have an additional report from Core Laboratories in the area under date of February, 1959.

MR. NUTTER: Those core analyses will not be offered as Exhibits, however?

MR. KELLAHIN: If you so desire, they will be.

MR. NUTTER: The staff would like to see the core analysis.

MR. KELLAHIN: We would gladly offer them as an exhibit if they so desire. They are here. I have no witness to identify them here.

MR. NUTTER: Are the core analyses identified? I think we would appreciate having those in the record.

MR. KELLAHIN: Just the core analyses?

MR. NUTTER: Yes. Mr. Porter, we would like to compare these with these electric logs.

MR. PORTER: Mr. Buell, will you proceed with your testimony, please?

MR. BUELL: We have one witness who has not been sworn.

(Witness sworn)

MR. BUELL: I might point out at the outset, may it please the Commission, we will be extremely careful to avoid any unnecessary duplication since there has been a tremendous amount of testimony already placed in the record.

CHARLES R. MARSHALL,

called as a witness, having been first duly sworn on oath, testified as follows:

DIRECT EXAMINATION

BY: MR. BUELL:

Q State your full name, by whom you are employed and in what capacity and what location, please.

A My name is Charles R. Marshall. I am employed by Pan American Petroleum Corporation as a petroleum engineer in their Farmington office.

Q What is your educational background with respect to pertoleum engineering, Mr. Marshall?

A I received a B. S. degree in petroleum engineering from the University of Texas in 1955.

Q What have you done since graduation?

A I have been employed with Pan American except for six months in the Armed Services.

MR. BUELL: Any questions as to his qualifications?

MR. PORTER: No, sir.

Q (By Mr. Buell) You said you were employed and worked out of Pan American's Farmington office, is that correct?

A That's correct.

Q Does that office have direct supervision over Pan American's operations in the Horseshoe-Gallup area?

A It does.

Q In connection with your duties with Pan American, Mr. Marshall, have you made an investigation and study to ascertain whether or not in the Horseshoe-Gallup Pool we are dealing with one common source of supply or we are dealing with two separate and distinct sources of supply?

A I have made such a study.

Q What is your opinion based on such a study with regard to that question?

A My opinion is that in this situation we are dealing with a common source of supply.

Q All right, sir, thank you. I direct your attention now to what has been marked as Pan American's Exhibit No. 2 and for the benefit of the record, I will state here that Pan American's Exhibit No. 1 was used in cross examining an El Paso witness. What does Exhibit 2 reflect?

A Exhibit 2 is a structural map contoured on top of the Gallup on a one hundred foot interval of the Horseshoe-Gallup field.

Q All right, sir. I realize there has been some general testimony on structure, but since it is one critical aspect of the problem we are faced with here, Mr. Marshall, would you briefly describe your structural interpretations as reflected by Exhibit 2?

A This interpretation of the structure indicates that the formations have a rather gentle dip to the southeast in the northwest portion of the field. This dip changes abruptly along a line somewhere near the diagonal, the northeast, southwest diagonal of Section 10 to a considerably greater dip angle.

Q Is that where the hogback is encountered? I have heard that word mentioned during this case.

A I believe what is termed the hogback is off just to the southeast of this particular diagonal.

Q And that is where your deeply steeping beds begin and start in that general southeastern area?

A That is correct.

Q All right, sir, what is the significance of the red line I see on Exhibit 2?

A The red line is the trace of the cross section which is shown on Section AA price which I will use later.

Q Are you ready to discuss that now?

A Yes.

Q Let me direct your attention to what has been marked as Pan American's Exhibit No. 3, the cross section to which you just referred. What does it reflect, Mr. Marshall?

A This section reflects, in my opinion, that we are dealing with a common source of supply in this field.

Q How many are the wells which have been included in that Exhibit?

A There are six wells represented on this Exhibit, six electric log, and also we have a sonic log for one of the wells.

Q Of course, those wells are shown on the trace on Exhibit 2, but would you, for the benefit of the record, name the northernmost well and the southernmost well that appear on that section?

A The northernmost well is El Paso Natural Gas Production Company's Horseshoe Canyon No. 1 B located in the northwest of the northwest quarter of Section 3, Township 30 North, Range 16 West. The southernmost well is Pan American's Joseph Aldin's No. 2 located in the southeast quarter of the northeast quarter of Section 10, Township 30 North, Range 16 West.

Q What is that log on the extreme right of Exhibit 3?

A This is a sonic log on the same wells, Pan American's, Pan American's Joseph Aldin's No. 2.

Q What is the significance of a portion of each log that you have covered in yellow, what is the significance of the yellow coloring?

A I have colored in yellow on each of these logs the section in the interval that we are considering, which I interpret to be sand.

Q Do the logs of the wells used on this section, do they reflect the interval that has been referred to in this hearing as A and B and upper and lower?

A No, sir, not in every case they do not.

Q What wells on that Exhibit do not reflect the interval that has been referred to here as A and B and upper and lower?

A Well, you'll note that Pan American's Joseph Aldin

No. 1, the interval which has been defined as A, the bottom of this interval, it would be rather difficult to pick on this log since the log is indicating sand development over the majority of the interval except for perhaps the bottom 10 to 15 feet, the 15 feet between 1565 to 1580.

Q I understand your answer now, Mr. Marshall. In other words, some of these logs don't reflect A and B and upper and lower because actually they show them as one zone of porosity?

A That's correct. And if you will note, the electric log on Tom Bolack's Bolack No. 8 located in the northwest quarter of the southeast quarter of Section 3, Township 30 North, Range 16 West, this log indicates a well developed sand section from the top of what has been called zone A throughout the producing interval in this field, or to the bottom of what has been called zone B.

Q Mr. Marshall, for the purpose of this question, assume the Commission approves El Paso's application. How could you physically dual Bolack's Bolack No. 8?

A As we are considering dual completions here, it would be physically impossible to dually complete this well.

Q Would it do you any good at all to set a packer in that well between what has been referred to as A and B and upper and lower?

A Well, as you will notice, this well happens to be perforated over the intervals 1585 to 1630 and over the interval

1700 to 1720. Now, this is a similar completion to other wells in the field and you could set a parker between those two sets of perforations which would, of course, increase the allowable if you had a dual completion, but your seal would be in the parker, nowhere else.

Q In other words, you would have a seal in the well bore and immediately adjacent to the well bore you would have communication?

A That's correct.

Q Do some of the logs on that section, Mr. Marshall, reflect an interval between two zones of porosity where you do not interpret sand to be?

A Yes. As I pointed out in the A No. 1, there was approximately 15 feet, and the No. 2 there is 15, 20 feet perhaps, or maybe 22 feet that is indicated to be rather impervious.

Q Are large volume frac treatments commonly used to complete in this field?

A Yes, sir, they are.

Q In your opinion, as a reservoir engineer, do you feel that 6 or 10 feet of perhaps dense interval could form an effective barrier between the two major zones of porosity?

A In talking of intervals in that depth range, 6 feet, and the volumes of fracture that we give these wells, I do not think you could.

Q All right, sir, let's go back to Bolack No. 3 for just a moment. Immediately to the right of the interval you have colored in yellow, I notice a blue dashed line. What is the significance of that?

A The interval immediately above the sand section, say, over the interval 1400 down to the top of the sand, is what I interpret to be shale, the SP or self potential curve is reflecting it is shale. I have merely extended that shale line to the total depth of the well to show what you would expect the log to indicate where that interval shale --

Q In other words, is that the shale line that I have heard referred to --

A That's correct.

Q -- in this hearing before?

A The shale base line.

Q Have you done that for each and every log on that Exhibit?

A I have.

Q Mr. Marshall, let me direct your attention now to El Paso Natural Gas Products Company's Horseshoe Canyon No. 9, which is a well immediately to the left of Bolack's No. 3 Well. From here it appears to have an apparent dense interval between the two major zones of porosity?

A That is correct, approximately 12 feet.

Q All right, sir. Assume, for the purpose of this question, that the Commission approves El Paso's application and these wells are dualled, even assuming in that event that El Paso could set a packer and separate the two major zones of porosity in that well, would you have the two zones separated in the reservoir when the well adjacent to it has sand continuity from the top to the bottom?

A No, sir, you would not.

Q Again, you would have separation in the well bore, but you would still have communication in your reservoir?

A That's correct.

Q Why have you included this sonic log?

A The sonic log is included to further verify my interpretation that a rather well developed sand exists through the interval from the top of the upper sand to the bottom of the major sand. The sonic log, which is Pan American's Joseph Aldin's No. 2, is indicating shale from approximately 1450 feet up to the top of where we have the log shown. It is also indicating shale over the interval 1445, approximately, down through the interval we have shown on the log. Now, you will note that there is a rather wide difference in log response through the interval from the top of the upper sand to the bottom of the lower sand. This, in my opinion, is indicating the existence of sand development throughout this section.

Q And you use the sonic log as a tool to depict your sand on the log?

A Yes.

Q Have you compared sonic logs and electric logs with other wells in the field?

A I have.

Q Did they verify the interpretation that you reflected on Exhibit 3?

A They did.

Q Do you have any other comments on this Exhibit, Mr. Marshall?

A I might point out that in El Paso Natural Gas Products Company's Horseshoe Canyon No. 2 B located in the northwest of the northwest quarter of Section 3, which is, I believe, the discovery well in this field, in this well the log indicates the existence of sand development from the top of the upper sand to the bottom of the lower zone except for a shale kick that is almost just needle-point wide, perhaps a foot, foot and a half.

Q Let's assume that that is, that foot or half a foot, is completely impervious shale, do you feel that a shale barrier a half a foot, six inches or twelve inches thick would form effective separation between those two zones of porosity?

A No, sir, I do not.

Q All right, sir, let me direct your attention now to Exhibit No. 4. What does that Exhibit reflect?

A Exhibit 4 is an electric log on Pan American's Joseph Aldin's No. 1, and also an individual core description, of course, taken from this well. I've also indicated permeability and porosity as they were indicated on the core analysis for this well. Permeability is indicated by the green coloring, and the porosity scale is crossways.

Q In other words, you plotted porosity and permeability as reflected by your core analysis on the left side of the well bore, and I assume that white line is the well bore?

A That's correct.

Q I mean the white vertical line?

A Yes.

Q What are you doing here, then, Mr. Marshall, you are comparing core data with log data, is that correct?

A That's correct.

Q With respect to this so-called dense interval, did we obtain a core on any portion of that dense interval?

A We did obtain a core on a portion of this dense interval between what has been defined as Land A and B.

Q What did it reflect with respect to porosity and permeability?

A Over the portion that we covered, the last three feet, which are well down into this interval between the better developed portions of the reservoir, we had one foot that had a permeability of 2.3 to 4 millidarcies; one foot that had a permeability of 4.2 millidarcies, and one foot that had a permeability of less than 1. The average though, that six is approximately 2 millidarcies permeability and seven and a half percent porosity.

Q We've heard some testimony in this hearing with respect to effective permeability. In your opinion, if there is an average permeability of 2 millidarcies, do you think that would meet any one's definition of effective --

A It would certainly meet mine.

Q Okay, sir, have you then related the data you obtained from the core, along with the comparison of the log at the interval that was cored to other portions of the electric log on that Exhibit?

A Yes, I have. You will notice that the interval which I was referring to, the three feet that we had cored and which I was just describing, is located between 1525 feet and 1530 feet. You will notice that the electric log, the SP curve, or the left track of the electric log, the response opposite that interval is essentially the same response down to approximately 1550 feet. Also, the curves reflected on this electric log are similar to that interval. In fact, the other curves are similar to it, but the SP curve describes it at approximately 1550 feet. Now, this to me means that you could expect the same type of porosity and permeability down to 1550 feet with probably decreasing values down to 1572, 1573 feet, where they are indicated to be approximately 4 to 5, 6 feet of fairly impervious shale.

Q All right, sir, in other words, in your opinion, the data reflected on that Exhibit show that with the exception of — did you say 6 feet?

A Correct.

Q Six feet through the so-called dense interval, we have both porosity and permeability?

A We do.

Q Do you feel, in a reservoir of this type, that 6 feet is effective separation?

A I do not.

Q And, of course, Mr. Marshall, we are simply looking at what we found in one well bore here, aren't we?

A That is correct.

Q Can you tell me whether or not 10 feet, 20 feet out from that well laterally this same 6 foot interval will continue?

A No, sir, I cannot.

Q But even assuming that it does, in your opinion, that 6 feet is not effective separation?

A That's correct.

Q Do you recall El Paso's Exhibit No. 2, which was, I think, an exhibit somewhat similar to this?

A Yes.

Q Have you examined the core analysis that they submitted on the well that was reflected on that exhibit?

A I have.

Q Did you observe also on that well through this so-called dense interval we had both permeability and porosity?

A Yes, sir, we had permeability and porosity, and the porosity was of a good magnitude, of a significant magnitude.

Q Did you average the permeability that the core data reflected through this so-called dense interval?

A I did.

Q What was the result of that?

A My average was .45 millidarcies throughout the interval.

Q .45 millidarcies?

A Yes.

MR. BUELL: In that connection, may it please the Commission, I believe that Mr. Speer, when he was testifying at one time said .41, and another time said .14. I thought possibly for the record at this time we might clear that up. I am sure it is .41 since that is so closely comparable to ours.

MR. PORTER: Mr. Speer, do you recall?

MR. SPEER: I believe that is correct, .41. I would like to ask if the average that Mr. Marshall made of our analysis is adjusted for the seven foot depth correction.

A It is not.

MR. SPEER: There is a seven foot correction which by taking the depth shown on the core analysis you actually include part of the lower sand that is shown on the electric log at the same depth.

MR. BUELL: I don't want to leave the impression that we are quibbling between their peaks of .41 and our peak of .41.

A I would like to point out one thing, I made no adjustment. However, I used permeability in excess of either one and a half to two millidarcies. That might have been high.

Q (By Mr. Buell) Mr. Marshall, do you know of any wells that Pan American is producing that haven't averaged permeability of that magnitude?

A Yes, sir.

Q What type wells are they? I mean oil or gas, and in what formation?

A We have gas wells in the Pictured Cliffs Formation which have average permeability on that order of magnitude.

Q And they are producing?

A They are producing gas wells.

Q All right, sir, thank you. Going to Exhibit 4, what is the significance of the intervals on the right-hand side of the log there that you have blocked in, in red?

A The intervals that are blocked in, in red are the footages which this visual core description indicates were vertically fractured or indicates were vertically fractured.

Q Will you go to Exhibit No. 2 and point out the location of that well?

A The Joseph Aldin No. 1 is located here in the northwest portion.

Q Is that at or near or in the area where you would expect the most fracturing, Mr. Marshall, due to the steeply dipping beds?

A According to this structurally interpretation, it is just before you begin to get into this area. It is on the edge, so to speak.

Q Let me ask you your opinion with respect to fracturing, Mr. Marshall. Do you feel in certain areas of that pool that it is going to be a common occurrence?

A I definitely feel that.

Q Would you go back to Exhibit 2 and point out where you think it will occur and why?

A From our experience in the Gallup, in that area, we would expect the formation to be highly fractured in this area through here, off where the bed is dipping in a rather steep angle.

Q What portion of the pool is that, the southeast portion?

A That is in the southeast portion of the field.

Q All right, sir. Are you familiar with Pan American's operations in the Verde-Gallup Field?

A I am.

Q Do you agree with previous witnesses who testified here that extensive fracturing exists there?

A I am.

Q Do you recall the testimony, I believe it was by El Paso, Mr. Spear, to the effect that he would not anticipate as extensive fracturing in Horseshoe-Gallup as occurs in Verde due to the fact that the pay zone here is more sandy?

A I remember that.

Q I might not have said it exactly as he did, but I want you to get the idea. Actually, from the standpoint of communication, Mr. Marshall, are we too concerned about whether or not fracturing occurs in sand?

A No, we are not.

Q Can you see any reason why the shale or the impermeable zones that might form an effective barrier of separation in this area would be any less susceptible to fracturing than the shale in the Verde-Gallup area?

A The shale or sandy shale in the Verde-Gallup area is, in my opinion, identical or very similar, from coring inspection and logging inspection, to the shales or sandy shales and sand and shales that we are talking about here even though in some portions the sand development may increase, and I would not argue that the change in character of the rock might change its reaction to stress. The shales are still there, and I fail to see how their reactions of stress could change over that 7 or 8 mile interval.

Q And it is your opinion that in the Horseshoe-Gallup Pool in the area you have been discussing that fracturing will be a common occurrence?

A In the southeastern portion of the field, that's right.

Q Yes, sir. Do you have any other comments on Exhibit No. 4, Mr. Marshall?

A I believe not.

Q Let me direct your attention now to what has been marked as Pan American's Exhibit No. 5. What does that Exhibit reflect?

A This Exhibit is an induction electric log on El

Pasc Natural Gas Products Company's Williams No. 1 located in the southeast quarter of the southeast quarter of Section 11, Township 30 North, Range 16 West.

Q All right, sir. Here again you have the electric log of the well on this Exhibit?

A That's correct.

Q And you are comparing the electric log with data available through core description?

A That's right, this is a visual core description of the cores taken in this well.

Q All right, sir. Let's look just at the electric log feature of that Exhibit. Initially, do we find in that well that the so-called A sand is separate from the so-called B?

A We find that it is separated by approximately 8 feet.

Q Is the blue dashed line to the right of the portion colored in yellow, is that the same shale line that you have extended on down through the well?

A That is correct.

Q Now, what was the extent of the apparent dense vertical interval in that well?

A The fracturing which was described on this, from this core description, started occurring approximately --

Q I don't believe you understood me, Mr. Marshall. Let's back up just a minute. I ask you to repeat again the vertical extent of this apparent dense interval and give me the footages where it occurred.

A The apparent shale, from inspection of the electric log, appears between 2372 and 2378. That looks more like 6 feet.

Q All right, sir. Looking at that log alone, then, the conclusion might be formed that the possibility of separation, at least in this well bore, does exist, looking at the log alone?

A Yes.

Q And ignoring all the other data you have on this reservoir --

A The separation, before we attempted the large --

Q Let me ask you this question again, sir. Of course, you have no way of knowing how far out laterally away from this well this foot interval exists?

A That's correct.

Q I am going to ask you the question that Mr. Woodward asked one of the Atlantic witnesses. Have you ever seen a well in this field where the so-called A and so-called B was connected through fracturing?

A Yes.

Q Where?

A This well right here, El Paso's Williams No. 1.

Q Would you describe what has occurred as reflected by El Paso's core description?

A Their core description indicates a zone of fracturing at approximately one and a half, two feet thick, and in the center of this shale, six foot shale that we are talking about, also there is fracturing reported just above that through the depth 2369 to 2370, fractures are reported there. They are reported in the middle of the interval that we are referring to, the depth 2375 to 2377 or 2378 and also down into the -- over some 2, 4, 6, 8 feet in the lower portion of the sand.

Q How are these fractured intervals reflected on Exhibit 5?

A They are denoted in red.

Q All right, sir, with respect to the fracturing, let's look again at Exhibit 2 and see what area in the field this well is located in.

A This well is located here in this area that we referred to that has relatively high steeply dipping beds.

Q All right, sir. Do you have any other comments you would like to make on Pan American's Exhibit 5?

A I might point out that I also colored in yellow on this log, what, in my opinion, the log indicated to be sand. This log indicates better sand development perhaps than the one we had previously in that the SP is diverting further from the base line.

Q In the Horseshoe-Gallup Pool, Mr. Marshall, in your opinion and as reflected by your testimony, we have two opportunities for communication. First, complete sand development from the top of the so-called A, all the way to the bottom of the so-called B. Also, the opportunity for communication between the two members of existing fractures?

A That's correct.

Q All right. Is it your opinion, then, that even should the Commission approve El Paso's application and each operator in this pool diligently dualled his wells or tried to separate so-called A and so-called B to the best of his ability, even assuming both those things, in your opinion, will two separate reservoirs exist by nature?

A No, sir.

Q All right, sir. You can come back to your seat now. Mr. Marshall, in the interest of saving time, let me ask you whether or not you generally agree with the additional cost that the approval of this application will necessitate?

A Agree with which cost?

Q The additional cost like dually completing the well, additional pumps, the cost estimates?

A It would cost more to dually complete than singly.

Q Do you generally agree with Atlantic's cost estimates that were submitted here?

A I do.

Q In addition to those as related by that witness, does Pan American have a particular and peculiar problem?

A Yes, sir, they do.

Q What is that?

A Pan American has six wells completed in the Horseshoe-Gallup Field through four and a half inch casing.

Q Let me ask you this, Mr. Marshall. Were you present in the hearing room when testimony was presented with respect to two that would fit in four and a half inch casing?

A I was.

Q Would you recommend to your management that Pan American attempt to dual one of its four and a half inch tubing in that pool?

A No, sir, I don't.

Q Do you know of any tool that you would recommend?

A No, sir.

Q What would you recommend to your company?

A That we drill a twin well beside each one, and complete with four and a half inch casing.

Q In other words, if this application is approved, Pan American would have to drill six additional wells to a common reservoir on acreage that is already dedicated to a well presently completed in that reservoir?

A Six unnecessary wells, that's right.

Q What would be the cost of each of those wells?

A In the area that we would be drilling, as I might point out, the cost figure varies because of the steeply dipping beds, but in that area around 130,000 or 150,000 total.

MR. BUELL: I believe that's all we have at this time, may it please the Commission, and I would like to offer our Exhibits 1 through 5 inclusive?

MR. PORTER: Without objection, the Exhibits will be received. Anyone have a question?

MR. WOODWARD: We also are concerned about saving time at this late date, and we suggest a somewhat unusual but not unheard of procedure. I believe the witness has gotten into several technical matters concerning log interpretation, and while technical people are writing the necessary questions and giving them to counsel, I believe it would save time if they were permitted to question this witness concerning the method by which he arrives at his conclusions.

MR. BUELL: May it please the Commission, I have no particular objection. I would like to make this observation, that in states where I have practiced that allow such examining and questioning, it is my experience that rather than save time, we'll be involved in more time.

MR. PORTER: Our counsel advises us, Mr. Woodward, that to allow the technical people to cross examine the witness would be in violation of the recent opinion of the Attorney General, so we will have to deny that request.

MR. WOODWARD: I should have mentioned, of course, that counsel would adopt the questions asked.

MR. PAYNE: You can ask them yourself, can't you, Mr. Woodward?

MR. WOODWARD: Yes, we can proceed with the questioning. I am interested here in saving a little time.

MR. PORTER: We certainly share that interest, Mr. Woodward, but we feel it would be in violation of the Attorney General's opinion.

CROSS EXAMINATION

BY MR. WOODWARD:

Q Mr. Marshall, what is your position with the Pan American Company?

A I am a petroleum engineer.

MR. BUELL: May it please the Commission, probably a short statement on my part here might save time. It is the policy of our company that all production geology is done by our engineers, so I realize that in Mr. Marshall's testimony here he might have gone slightly into the geological field, but our production geology is done by our engineers, by our reservoir engineers.

MR. WOODWARD: I would like a little clarification of that statement; if it is to the effect that this witness may have gone into some geologic matter, but that it is a general practice of Pan American. Is that understanding correct?

MR. BUELL: I am making the statement again. It is the policy of Pan American that all of our production geology is done by our reservoir engineers. I don't make that statement in any sense of the word attempting to limit Mr. Marshall's cross examination. He is certainly available for cross examination on everything that he has testified to.

Q (By Mr. Woodward) In the normal course of your work, Mr. Marshall, as a petroleum engineer, do you evaluate electrical logs?

A Yes, sir.

Q Are you aware that there is normal drift and spontaneous curve of an electric log in this field area?

A Yes, sir, I am.

Q Has not the area colored in yellow on the Bolack No. 3 been due to this drift or to a malfunction of the dual?

A No, sir, it could not. I will refer to this Exhibit.

MR. BUELL: What Exhibit is that?

A That is Exhibit 5, the drift of the SP log, which is caused by --

MR. WOODWARD: Excuse me, I am directing my attention to the Bolack No. 3 Well.

A All right, sir. This drift that you speak of in the SP log is caused by the fact that the SP is measuring potential difference, and by increasing the cable length, there is a difference in potential, which they attempt to compensate for. In all cases this is not compensated for, and we do have the drift. However, the drift is in such a manner as had I allowed for drift, the sand content would be more predominant.

Q Now, if this SP reflects sand, where is your corresponding kick on the resistivity curve?

MR. BUELL: Are we still on Bolack No. 3?

Q (By Mr. Woodward) Still talking about Bolack No. 3, and I believe you testified it was a continuous sand body?

A I don't follow your question. The resistivity curve has nothing to do with the sand content.

Q The question was if the SP curve reflects sand, where is your corresponding kick on the resistivity curve?

A Well, there are several kicks on the resistivity curve. I don't think it has any relation to the sand. There is a corresponding kick here, there is one here. It is reading off values of resistivity.

Q Did you examine any cuttings from this well?

A Cuttings, no, sir.

Q Do you know whether the well was cored at this interval in which you colored it in yellow?

A I do not know whether it was cored.

Q You have not examined any cores or cuttings from the well?

A Not from this particular well.

Q Now, in the absence of cores and cuttings, are you in any position to say what the possibilities of communication throughout that vertical interval may be?

A Yes, sir. I believe that when the SP curve is responding as it does, that it is a normal conclusion that the sand is rather similar throughout.

Q What cores have you examined?

A I have examined analyses on cores of our Pan American's Joseph Aldin No. 1, several of the ones that have been presented in this case. I have visually observed portions of cores on Atlantic's Navajo No. 29 as well as our Pan American's Joseph Aldin No. 1.

Q I believe you testified that the average permeability, and by the way, you would agree that it is permeability and not porosity which determines the ability of a fluid to pass through a sand or shale, is that correct?

A The rate at which it will pass through if you have any permeability is determined by the permeability.

Q All right. Now, I believe you testified that the average permeability in the Horseshoe Canyon 2 B Well, previously discussed, was .45, is that right?

A That was my interval, yes.

Q Millidarcy?

A That was of the interval that we are speaking that we would compare to the interval between 1520 and 1580 on Pan American's Joseph Aldin No. 1.

Q In the absence of fractures, considering the reservoir mechanism involved in these two sands, do you believe that there could be any effective communication through a shale body having such permeability?

A I don't believe it is a shale body that has such permeability, but I do believe that there can be effective communication through a body with a permeability of this magnitude.

Q Of .45 millidarcies --

A Yes, sir.

Q -- without fractures --

A Yes, sir.

Q -- during the producing life of the field?

A Yes, sir.

Q Now, have you any illustrations in which oil has moved through such a body?

A I am afraid that I couldn't produce them. I believe that I in time -- given the time -- could produce wells completed in the Gallup formation producing from intervals that have no permeability in excess of [illegible] and probably an average in the order of .45 millidarcies.

Q Mr. Marshall, you have stated, I believe, that this sand in some of the wells is present from what we are calling the top of the Sand A to the bottom of Sand B? In other words, it is a continuous sand body?

A Yes, sir. Such wells as Tom Bolack's Bolack No. 8.

Q Now, in the cross section introduced both by El Paso and Atlantic in the Horseshoe-Gallup Field; that is, away from the southwest flank, a clear cut line has been drawn as to the producing interval, although there has been some discussion of sandy shale and shaly sand between. Now then, in this sandy shale or shaly sand interval, do you know of any well that is being completed as a producing well?

A I know of a well that has been completed in an interval in this shaly sand, not the particular interval between them, but a similar interval below them.

Q You know of no well that is completed in this interval in this Field?

A Just a second, I think maybe I have one here. I am sorry, I don't have one here. I do know of cases in which the perforations in the upper interval have extended well down into what has been defined previously in this hearing as an impermeable barrier.

Q You don't have the name of that well?

A Not right offhand, no, sir.

Q Mr. Marshall, would this interval in the Tom Bolack No. 3 Well below the upper perforations and above the lower fit your definition of a sand body?

A Fit my definition of what?

Q A sand body?

A This log indicates that is a sand body similar to the ones that we perforated.

Q Do you feel that there is continuous permeability from the bottom of the area shaded in yellow to the top?

A Yes, sir. I have not seen a core analysis on this well, but I would certainly --

Q Have you seen any core analysis or any cuttings? How could you tell?

MR. BUELL: Mr. Woodward, let's let him finish his answer before you interrupt.

MR. WOODWARD: I was not aware that the witness had not finished. I had no intention of being discourteous to the witness.

A I would be surprised if there were no permeability measured in a core analysis through that interval.

Q Mr. Marshall, do you know of any case in this Field in which you have a complete continuous vertical fracture extending from the top of Sand B to the base of Sand A?

A No, sir, I don't.

MR. WOODWARD: That's all the questions I have.

MR. PORTER: Does anyone else have a question of Mr. Marshall? Mr. Fischer.

QUESTIONS BY MR. FISCHER:

Q Mr. Marshall, when you speak of high fractures, do you mean large volumes of fracture fluid, or high pressure?

A I am referring to both large volumes and high injection rates.

Q In any of your observations of any cores that you might have seen -- have you noticed any fracturing in any of the two logs that you have seen?

A I have not noticed any, but it has been reported that there was some.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused)

MR. PORTER: Does that conclude your testimony, Mr. Buell?

MR. BUELL: Yes sir, it does.

MR. PORTER: Does anyone have testimony to present in Case 1596?

MR. KELLAHIN: If the Commission please, at the request of the Commission's technical staff, we would like at this time to offer in evidence Tom Bolack's Exhibits Number Eight and Nine, being core analyses of reports of the Bolack Number 6 Well.

MR. PORTER: Would anyone like to look at these exhibits, proposed exhibits?

(Whereupon, the documents were marked as Tom Bolack's Exhibits No. 8 and 9 for identification.)

MR. PORTER: Without objection, they will be admitted.

Does anyone have anything further to offer in Case 1596, any statements?

MR. ERREBO: If the Commission please, on behalf of Magnolia Petroleum Company, I wish to go on record as supporting the position as taken here in this hearing by Pan American Petroleum Corporation and by the Atlantic Refining Company in opposition to that case. This is based upon the evidence which we have seen produced and submitted here today and also upon our own studies. We believe that certainly there is one reservoir here, not two, and the Commission should so treat it.

Magnolia Petroleum Company is a relatively new operator in this field with only a small amount of development at this time. However, the matter of water flooding and secondary recovery has been brought up and Magnolia wants to go on record as strongly recommending to the other operators that a study be initiated as soon as possible of unitization and possible secondary recovery methods.

MR. VERITY: If the Commission please, on behalf of Southern Union Gas Company, we have no testimony to put on, but we do want to join in the opposition to this application and state that we are in agreement with the testimony put on by Pan American and Atlantic, and we would also like to point out to the Commission that if they find two separate common sources of supply at this particular time, it will set a dangerous precedent because we believe that there are other areas in the State where the situation is very similar where the Commission would not want to come up with two common sources, and yet if such a determination is made here, the door is going to be opened and I am sure the Commission will be flooded with other applications of a similar nature.

MR. BUELL: May it please the Commission, if we haven't made Pan American's position clear by our presentation of this hearing, I could never do it in a closing statement. In the interests of time, I'll make none.

MR. HINKLE: If the Commission please, the proponent of this case, El Paso, of course has the burden of proof. We don't believe that they have carried that burden. We think that the evidence, overall, introduced in this case clearly shows that it is one reservoir, one source of supply and should be so treated. We think also, as has been stated by Southern Union, that it would be an extremely bad precedent to set to determine in this case that there were two reservoirs because you would certainly have a lot to contend with in the future in the fields where you had a situation of this kind.

MR. PORTER: Anyone else have a statement to make?

MR. KELLAHIN: If the Commission please, I will be very brief to say that on behalf of Tom Bolack, we are in general support of the application of El Paso Natural Gas Company in this case with the exception that we submit our proposal as to the manner in which the actual completion is to be made.

MR. PORTER: Mr. Spann?

MR. SPANN: On behalf of the applicant, I would like to briefly summarize our position. Of course, the issues here are these, as we see them: Are Sands A and B separate, common sources of supply, is the first one, and two, will the separate establishment, production and proration of production from these two sands result in waste or prejudice correlative rights.

Now, the evidence in the case, as far as we were concerned, the direct evidence we had available clearly established that we do have here two separate distinct common sources of supply. Now, Atlantic's evidence, evaluating first the geologist's testimony, was to the effect that the presentation and the exhibits were based upon pure speculation. I believe he made that statement in those words. Now, the only direct evidence we had controverting our position was put on by Pan American's last witness. In effect, he says that a shale or shaly sand with a permeability of .45 millidarcies will permit communication of oil. Now, we can't dispute the figure, we do dispute the conclusion, and we will just have to leave that up to the staff. If they think that a shale or shaly sand with a permeability of .41 or .45, as he testified, will permit communication between these two reservoirs, then of course we would have to admit that we do not have two separate and distinct reservoirs. But we very vigorously dispute that evidence and would rest our position on the staff's judgment about that.

Now, if the staff concludes that we are right and that that is not sufficient permeability to permit the passage of oil, then I submit that Pan American's position, or its evidence, is completely lacking as a basis for refusing our application, it's that simple. Now, we contend and safely state that we do have these two separate common sources of supply which are separated by this impervious shale formation.

Now, on these facts, then we think that we should consider the rules of the Commission and the statutes of New Mexico, and considering them, we believe that it is inescapeable that we are entitled to the granting of our application. Now, Definition 46 of the Rules states: "Pool means any underground reservoir containing a common accumulation of crude petroleum oil or natural gas, or both. Each zone of a general structure which zone is completely separated from any other zone in the structure is covered by the word "Pool" as used herein. "Pool" is synonymous with "Common source of supply" and with "Common reservoir."

Definition 36 of the Rules states that: "Dual completion shall mean the completion of any well so as to permit the production from two common sources of supply, with the production from each common source of supply completely segregated."

Rule 112-A, of course, permits dual completions by order of the Commission upon hearing, that's why we are here. Rule 304 provides that multiple completed wells which have been authorized by the Commission shall at all times be operated, produced and maintained in a manner to insure the complete segregation of the various common sources of supply.

Now, other States adopting conservation measures have adopted general rules prohibiting the commingling of production from separate reservoirs in the well bore. A few of them have permitted such commingling only where it was clearly shown that the several reservoirs could not produce enough oil to repay the cost of drilling and dual completion, plus a reasonable profit. That is not the situation here in the Horseshoe Canyon Field. In fact, each sand will produce enough oil to repay the cost of drilling and completing a well to such sand. The choice is not between dual completions or unsegregated completions in the same well bore. Under the law and the facts, assuming you agree these are separate pools or reservoirs, the choice is between dual completions or separate well completions.

Now, Section 65-3-13A of the Statute provides that the Commission shall prorate and distribute the allowable production among the producers in a pool upon a reasonable basis and recognizing correlative rights. Section 65-3-29H defines correlative rights as "The opportunity afforded, so far as it is practicable to do so, to the owner of each pool to produce without waste his just and equitable share or the oil or gas, or both, in the pool, being an amount, so far as can be practicably determined, and so far as can be practicably obtained without waste, substantially in the proportion that the quantity of recoverable oil and gas, or both, under such property bears to the total recoverable oil or gas, or both, in the pool, and for such purpose to use his just and equitable share of the reservoir energy.

Now, it has been shown that it is practical to protect the correlative rights of all owners in the Horseshoe Canyon Field through the dual completion of wells in both sands and the assignment of a separate allowable to each sand. It has also been demonstrated that such segregation will tend to reduce waste and promote the greatest ultimate recovery of oil from each of these reservoirs.

Section 65-3-11 of the Statute provides that the Commission is authorized, among other things, for the purpose of, A, preventing

7. crude petroleum oil, natural gas or water from escaping from the strata in which they are found into another stratum or other strata. B, preventing the drowning by water of any stratum or part thereof capable of producing oil or gas or both oil or gas, in paying quantities, and to prevent the premature and irregular encroachment of water or any other kind of water encroachment which reduces or tends to reduce the total ultimate recovery of crude petroleum oil or gas or both such oil and gas, from any pool.

And in that connection, of course we again contend that the greatest ultimate recovery from these two sands is a result of secondary recovery programs, that these programs must be initiated separately in each of these sands. Mr. Walsh testified to that, and he also testified that the most effective program cannot be instituted in either sand until their production is segregated. In other words, sooner or later in the secondary recovery program we are going to have to segregate these two sands to initiate or institute an effective secondary recovery program.

Now, we have also, of course, presented here an installation or a facility which we believe is proper to dually complete these wells and keep the production from each sand separated. We don't say it is the only installation, we say it is an effective and feasible one. There was some testimony, I believe from the opponents here, that their facility or installation would be much more extensive, but we are not insisting that they all be required to use this, it is merely a suggestion. We think it is a good one, and Mr. Buell had another one that perhaps is also effective.

But in summary, we say we have presented a case requiring production from two separate common sources of supply and we have proposed a feasible and economically sound method of producing these common sources by dual completion methods.

MR. VERITY: Petro-Atlas requested that I make this statement for them, that they also oppose this application and think that it would be unsound for the Commission to grant an order that would determine two common sources of supply in this pool, and they also would like to underscore that part of the testimony given by Atlantic to the effect that it is not economically sound to produce this reservoir, or reservoirs, even though they may be two, as two common sources of supply because of the cost of the dual completion and the cost of producing the two reservoirs. They think that it would be improper and that it would create waste to determine two reservoirs here or to allow the pool to be produced as two reservoirs.

MR. BUELL: May it please the Commission, I didn't want to interrupt Mr. Spann during his closing statement, he was doing so well, but I must observe that several times he strayed from his interpretation of the evidence and introduced new matter. I would simply like to ask the Commission not to consider the new matter and only his interpretation of the evidence.

MR. PORTER: Any further statements in this case? We will take the case under advisement.

STATEMENT OF ROLAND L. HAMBLIN

MR. SPANN: Roland Hamblin, if permitted to continue, would testify in substance as follows:

"A secondary recovery program in the Horseshoe Canyon Field is not practicable until and unless the owners of tracts covered by the program execute Unitization Agreements. Under these agreements such owners receive a percentage of the production from the entire unit area in accordance with some participation formula. Such a formula may be based on oil in place, total recoverable reserves, reserves recoverable by primary methods, or reserves recoverable by secondary methods. The object of all such formulae is to give each owner his fair share of total unit production from a unitized field or pool although the amount of such recovery cannot be determined with accuracy in advance of secondary recovery operations.

In order to arrive at a satifactory participation formula covering unitized production from two separate common sources of supply having different areal limits and reservior characteristics, a separate participating formula should be established for each such pool and the two formulae weighted in accordance with the total unit production from each such pool. As stated above, total unit production from neither pool can be determined with accuracy in advance of secondary operations, thus making it extremely difficult, if not impossible, to obtain the requisite agreement with respect to the weighted, average participation formula to be employed.

While it is recognized that the Commission may not have the authority to issue compulsory field-wide unitization orders, the failure to segregate Sands "A" and "B" will create a situation that, in all probability, will either prevent or unduly delay adoption of a voluntary secondary recovery program designed to effect the greatest ultimate recovery of oil from the Horseshoe-Gallup Field."

MR. SPANN: The applicant excepts and objects to the exclusion of such evidence on the following grounds: The evidence is relevant and material and tends to show that from a practical and legal standpoint, a failure to segregate Sands "A" and "B" will make it difficult, if not impossible, to obtain the unitization agreements which are necessary for any efficient secondary recovery program, thus resulting in waste and the impairment of correlative rights, all of which are in issue in this proceeding.

STATE OF NEW MEXICO)
: ss
COUNTY OF BERNALILLO)

WE, J. A. TRUJILLO and JERRY MARTINEZ, Notaries Public in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Hearing was reported by us in Stenotype and that the same was reduced to typewritten transcript by us and contains a true and correct reord of said hearing, to the best of our knowledge, skill and bility.

DAED this 14th day of March, 1959, in the City of Albuquerqu, County of Bernalillo, State of New Mexico.

Joseph A. Trujillo
Notary Public

My Commision Expires:
Octobe 5, 1960

Jerry Martinez
Notary Public

My Commiion Expires:
Janua 24, 1962

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 10
Date February 18, 1959

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Arizona Explorations, Inc.								
Petro-Atlas-Bolack	1	NW SE 9-30-16	10-28-56	1150-1154 1159-1163 1169-1179 1187-1195		1283	30	
Wagenseller	1	SE SW 9-30-16	6-24-57	1020-1054		1201	55	
Atlantic Refining Company								
Navajo	1	SE SE 32-31-16	10-1-58	1091-1094 1099-1128	1193-1224	1285	131	116/1
Navajo	2	NW SE 32-21-16	10-2-58	1102-1132	1199-1238	1289	133	98/1
Navajo	3	SE NW 32-31-16	10-8-58	1117-1153	1235-1262	1300	135	98/1
Navajo	4	NW NW 32-31-16	10-10-58	1142-1182	1258-1284	1350	137	112/1
Navajo	5	SE SE 30-31-16	10-20-58	1165-1201	1282-1316	1370	125	180/1
Navajo	6	NW SE 30-31-16	10-22-58	1208-1245	1327-1349	1380	127	96/1
Navajo	7	SE NW 30-31-16	10-31-58	1398-1430	1518-1545	1602	128	193/1
Navajo	8	NW NW 30-31-16	11-9-58	1321-1349	1436-1464	1515	132	557/1
Navajo	9	NW NE 30-31-16	11-14-58	1269-1297	1389-1403	1454	124	138/1

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Atlantic Refining Company								
Navajo	10	SE NE 30-31-16	11-17-58	1231-1262	1352-1367	1422	135	291/1
Navajo	11	NW SW 29-31-16	11-24-58	1201-1236	1326-1339	1400	158	
Navajo	12	SE SW 29-31-16	11-30-58	1157-1190	1285-1295	1345	288	
Navajo	13	NW NE 32-31-16	12-8-58	1135-1166	1259-1268	1310	445	
Navajo	14	SE SW 32-31-16	12-27-58	1134-1172		1305	95	
Navajo	15	NW SW 32-31-16	12-31-58	1155-1180		1314	227	
Navajo	16	SE NE 31-31-16	11-26-58		1216-1224	1310	119	243/1
Navajo	17	NW NE 31-31-16	1-6-59	1157-1179	1236-1248	1310	195	
Navajo	18	SE SW 30-31-16	1-20-59	1196-1198 1206-1230	1286-1288 1297-1308	1357	114	
Navajo	19	NW SW 30-31-16	1-20-59	1256-1284	1356-1374	1421	277	
Navajo	20	SE NE 32-31-16	12-9-58	1147-1183	1273-1290	1337	520	
Navajo	21	SE SE 29-31-16	1-28-59	1402-1426		1573	103	
Navajo	22	NW SE 29-31-16	12-16-58	1194-1221	1320-1336	1348	130	
Navajo	25	SE NE 29-31-16	1-14-59	1304-1326		1460	67	
Navajo	27	SE SE 31-31-16	1-28-59	1126-1146		1281	320	
Navajo	28	NW SE 31-31-16	1-12-59	1168-1184		1320	87	

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Page No. 3
Exhibit No. 10

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Atlantic Refining Company								
Navajo	30	NW NW 31-31-16	2-5-59	1170-1189		1315	96	
Ute	1	SW SW 36-31-16	10-31-58	1614-1660		1777	95	TSTM
Banner Drilling Company								
Ute	1	SW SW 34-31-16	6-28-58	1228-1266	1346-1364	1425	85	312/1
Ute	2	NW SW 34-31-16	7-28-58	1214-1254		2050	80	
Ute	3	SE NE 33-31-16	11-8-58	1215-1249		1402	125	
Ute	4	NE NE 33-31-16	11-8-58	1246-1280		1400	125	
Ute	5	SE NW 34-31-16	12-1-58	1362-1398		1420	105	
Ute	6	NE NW 34-31-16	11-28-58	1416-1452		1600	96	
Tom Bolack								
Bolack	1	SW NE 4-30-16	7-16-57	1162-1214	1267-1317	1330	120	196/1
Bolack	2	NW SW 3-30-16	7-3-57	1265-1305	1376-1400	1460	120	250/1
Bolack	3	NW SE 4-30-16	10-6-57	1130-1182	1225-1260	1315	384	220/1
Bolack	4	SW SW 3-30-16	7-20-57	1320-1373	1418-1469	1486	120	205/1
Bolack	5	SE NW 4-30-16	7-12-57	1092-1143	1195-1229	1251	120	150/1
Bolack	6	NE NW 10-30-16	10-29-57		1605-1640	1664	100	
Bolack	7	SW SE 3-31-16	1-14-59	1526-1570	1640-1670	1699	100	
Bolack	8	NW SE 3-31-16	2-1-59	1585-1630		2117	189	

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Tom Bolack								
Bolack	9	SW NE 3-30-16	11-11-57	1588-1612 1614-1616 1620-1624 1628-1632	1714-1722	1760	168	
Bolack	10	SE NW 10-30-16	1-9-59	1452-1456 1466-1488 1494-1500	1544-1568	1601	150	
Bolack	11	SW SE 4-30-16	1-9-59	1462-1466 1474-1492 1501-1505	1551-1555	1600	150	
Bolack	12	NW NE 9-30-16	1-15-59	1490-1494 1500-1534		1650	150	
Bolack	14	SW NE 9-30-16	1-20-59	1234-1302		1425	148	
El Paso Natural Gas Products Co.								
Chimney Rock	1	NE SE 23-31-17	12-1-57	963-990	1042-1050	1800	1,160 MCF	
Chimney Rock	2	NE NE 15-31-17	12-11-57		876-890	948	2,480 MCF	
Chimney Rock	1-A	SE SE 24-31-17	11-29-58	1390-1416	1504-1535	1575	110	45/1
Chimney Rock	2-A	NW SE 24-31-17	12-13-58	1290-1312	1404-1434	1488	105	38/1
Chimney Rock	3-A	SW SE 24-31-17	1-22-59	1301-1326	1406-1438	1478	107	66/1
Horseshoe Canyon	1	NE SE 4-30-16	9-21-56		1300-1324	2075	125	
Horseshoe Canyon	2	SW NW 3-30-16	12-22-56	1306-1351	1424-1446	1485	105	181/1
Horseshoe Canyon	3	SE NE 4-30-16	5-5-57	1188-1231	1300-1336	1380	102	147/1
Horseshoe Canyon	4	SE SW 3-30-16	11-3-57	1504-1532	1593-1623	1669	95	99/1

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

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Exhibit No. 10

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
El Paso Natural Gas Products Co.								
Horseshoe Canyon	5	SE SE 4-30-16	5-16-58	1304-1322	1386-1418	1491	89	79/1
Horseshoe Canyon	6	NW NW 10-30-16	5-23-58	1500-1520	1576-1601	1698	118	22/1
Horseshoe Canyon	7	NE SW 3-30-16	5-21-58	1474-1518	1584-1612	1670	130	31/1
Horseshoe Canyon	8	NE SW 4-30-16	5-29-58	1110-1136	1198-1206 1234-1242	1305	128	39/1
Horseshoe Canyon	9	SE NW 3-30-16	4-26-58	1400-1448	1518-1542	1607	100	250/1
Horseshoe Canyon	10	SW NW 10-30-16	12-31-58	1306-1344		1465	121	116/1
Horseshoe Canyon	11	SE SE 3-30-16	12-24-58	1464-1508	1580-1600	1649	106	122/1
Horseshoe Canyon	12	NE SE 3-30-16	12-19-58	1585-1630		1765	118	119/1
Horseshoe Canyon	13	SE SW 4-30-16	1-14-59	1098-1140		1250	79	89/1
Horseshoe Canyon	1-B	NW NW 3-30-16	6-22-57	1617-1661	1735-1757	1789	17	180/1
Horseshoe Canyon	2-B	NE NW 4-30-16	10-5-57	1108-1124	1202-1240	1287	111	90/1
Horseshoe Canyon	3-B	SW NW 4-30-16	11-19-58	1081-1127	1174-1214	1277	113	79/1
Horseshoe Canyon	4-B	NW NW 4-30-16	11-21-58	1072-1109	1172-1212	1283	117	85/1
Horseshoe Canyon	5-B	NE NW 3-30-16	12-16-58	1595-1637		1766	102	138/1
Horseshoe Ute	1	SE SW 33-31-16	5-14-58	1108-1150	1222-1252	1312	95	42/1
Horseshoe Ute	2	SE SE 33-31-16	5-12-58	1186-1220	1300-1324	1386	18	1140/1

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
El Paso Natural Gas Products Co.								
Horseshoe Ute	4	NE SW 33-31-16	11-16-58	1138-1178	1266-1278	1326	130	61/1
Horseshoe Ute	6	NE SE 33-31-16	11-23-58	1180-1215		1376	118	59/1
Horseshoe Ute	7	SW NE 33-31-16	12-1-58	1220-1258		1406	113	53/1
Horseshoe Ute	8	SW NW 34-31-16	12-3-58	1253-1289		1428	106	57/1
Horseshoe Ute	9	NE SW 34-31-16	12-5-58	1250-1288		1447	104	67/1
Horseshoe Ute	10	SE SW 34-31-16	12-7-58	1347-1382		1520	106	66/1
Horseshoe Ute	11	SW SE 34-31-16	12-9-58	1380-1419		1558	103	77/1
Williams	1	SW SE 11-30-16	9-17-58	2288-2314	2382-2404	2459	103	126/1
Williams	1-A	NW NW 12-30-16	10-24-58	1837-1875		2290	54	TSTM
Magnolia Petroleum Company								
Navajo	1-A	SE NE 24-31-17	2-6-59	1397-1405	1500-1515	1565	120	238/1
Monsanto Chemical Company								
State	1-H	SW NW 2-30-16	8-29-57	1530-1593		1720	37	
Pan American Petroleum Corp.								
Aidlin	1-A	NW NE 10-30-16	8-22-58	1492-1512	1582-1614	1685	79	
Aidlin	2-A *	SE NE 10-30-16	11-1-58	1500-1518	1590-1622	1744	240	
O. J. Hoover	2-X-B *	SE NW 11-30-16	12-11-58	1776-1818	1890-1918	1949	96	
O. J. Hoover	3-B *	NW SW 11-30-16	11-30-58	1748-1774	1841-1874	1980	185	

* 4-1/2" Production Casing.

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

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Exhibit No. 10

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Pan American Petroleum Corp.								
O. J. Hoover	4-B *	SW NW 11-30-16	1-22-59	1684-1720	1792-1818	1885	59	
O. J. Hoover	5-B	NE SW 11-30-16	1-18-59	1832-1868	1938-1961	2030	165	
O. J. Hoover	6-B	SW SW 11-30-16	2-1-59	1943-1970	2026-2060	2117	189	
O. J. Hoover	1-C *	SE SW 11-30-16	11-14-58	2056-2076	2146-2175	1856	216	
Petro-Atlas, Inc.								
Horseshoe Canyon	1-A	NE NE 4-30-16	7-24-57	1605-1647	1736-1746	1810	113	
Horseshoe Canyon	2-A	NW NE 4-30-16	7-30-57	1162-1206	1278-1306	1365	120	195/1
Horseshoe Canyon	1-B	NE NE 9-30-16	7-23-57	1504-1542		1711	134	
Horseshoe Canyon	2-B	SE NE 9-30-16	12-4-58	1245-1289 1308-1322		1456	102	
Horseshoe Canyon	1-C	NW NE 3-30-16	10-9-58	1522-1566		1730	112	TSTM
Horseshoe Canyon	1-D	NE NE 5-30-16	10-7-58	1088-1133	1182-1222	1265	148	
Horseshoe Canyon	2-D	SE NE 5-30-16	10-10-58	1073-1121		1266	140	
Horseshoe Canyon	3-D	NW NE 5-30-16	10-13-58	1086-1136	1169-1175	1265	133	
Horseshoe Canyon	4-D	SW NE 5-30-16	10-16-58	1070-1101 1104-1114		1240	136	
Horseshoe Canyon	1-E	NE NW 9-30-16	11-22-58	1481-1520		1628	118	
Ute	1	SW SE 33-31-16	9-7-58	1135-1142 1146-1166 1169-1178	1257-1278	1350	128	

* 4-1/2" Production Casing.

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location: 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations: Sand "A"	Perforations: Sand "B"	Total Depth	Potential: BOPD	Potential: GOR
Petro-Atlas, Inc. / Ute	2	NW SE 33-31-16	9-18-58	1140-1182	1266-1278	1350	131	

CHIMNEY ROCK FIELD
SAN JUAN COUNTY, NEW MEXICO
WELL COMPLETIONS AS OF FEBRUARY 11, 1959

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Completion Date	Perforations Sand "A"	Perforations Sand "B"	Total Depth	Potential BOPD	Potential GOR
Bayless Oil Company								
Navajo	2	SE NE 5-31-17	5-18-58		1111-1163 *	1225	60	
Navajo	4	NE NE 5-31-17	5-18-58		1133-1166 *	1166	50	
Honolulu Oil Corporation								
Navajo	2-5	NE SE 5-31-17	12-5-58		1107-1117	1170	59	
Humble Oil & Refining Co.								
Navajo	1-F	NW NW 4-31-17	11-5-58		1147-1160	1227	30	167/1
Navajo	2-F	SW NW 4-31-17	10-20-58		1118-1152 *	1152	39	182/1
Navajo	3-F	NW SW 4-31-17	1-26-59		1084-1116	1126	117	129/1

* Open Hole

HORSESHOE GALLUP POOL
SAN JUAN COUNTY, NEW MEXICO
CORE ANALYSIS OF SANDS "A" AND "B" &

core anal
22 wells

18 wells

	SAND "A"	SAND "B"
Average Porosity	14.3 %	18.1 %
Median Permeability	35 md.	95 md. - millidarcy
Average Connate Water Saturations	40 %	35.5 %
Average Total Water Saturations	40.1 %	40.6 %
Average Residual Oil Saturations	13.5 %	15.5 %
Number of Wells	22	18

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 11
Date February 18, 1959

El Paso Natural Gas Products Company
Case No. · 1596
Exhibit No. 12
Date February 18, 1959

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
BOTTOM HOLE PRESSURES SANDS "A" AND "B"

Operator / Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Survey Date	Shut-In Time Hours	BHP * Sand "A"	BHP ** Sand "B"	BHP *** Sand "B"	Remarks
El Paso Natural Gas Products Co.								
Horseshoe Canyon	1	NE SE 4-30-16	2-8-59	72		238	201	Natural Completion
Horseshoe Canyon	4	SE SW 3-30-16	11-1-57	48		243	209	Natural Completion Initial BHP Survey
Horseshoe Canyon	6	NW NW 10-30-16	1-28-59	43	194			Sandoil Fractured
Horseshoe Canyon	8	NE SW 4-30-16	1-29-59	192	180			Sandoil Fractured
Horseshoe Canyon	2-B	NE NW 4-30-16	9-24-57	49		276	243	Natural Completion
			10-4-57	48	221			Initial BHP Surveys

A 221
B 276

Gradient 0.335 psi/ft.

* Datum + 4175'
** Datum + 4075'
*** Datum + 4175'

El Paso Natural Gas Products Company
Case No. 1596
Exhibit No. 13
Date February 18, 1959

HORSESHOE GALLUP FIELD
SAN JUAN COUNTY, NEW MEXICO
INDIVIDUAL PRODUCTION TESTS OF SANDS "A" AND "B"

Operator Lease	Well No.	Location 1/4 1/4 Sec.-Twn-Rng	Swab Test Sand "A" BOPD	Swab Test Sand "B" BOPD	Pump Test Sand "A" BOPD	Pump Test Sand "A" GOR	Pump Test Sand "B" BOPD	Pump Test Sand "B" GOR	Remarks
El Paso Natural Gas Products Co.									
Horseshoe Canyon	4	SE SW 3-30N-16W			21	TSTM	74	125	Neither sand sandoil fractured.
Horseshoe Canyon	6	NW NW 10-30N-16W			80	175	119	81	Both sands sandoil fractured.
Horseshoe Canyon	8	NE SW 4-30N-16W			109	193	69	79	Both sands sandoil fractured.
Horseshoe Canyon	2-B	NE NW 4-30N-16W		100	50				Neither sand sandoil fractured.
Horseshoe Ute	4	NE SW 33-31N-16W	203	264					Both sands sandoil fractured.
Atlantic Refining Company									
Navajo	1	SE SE 32-31N-16W	512	598					Both sands sandoil fractured.
Pan American Petroleum Corp.									
Aldlin	1-A	NW NE 10-30N-16W			108		96		Both sands sandoil fractured.

DUAL COMPLETION EQUIPMENT
HORSESHOE GALLUP OIL POOL
San Juan County, New Mexico

Subsurface Equipment

1. 5-1/2", 15.50#, J-55 production casing is set through both producing zones and cemented. Cement is circulated across both zones by the single stage method.

2. 1-1/2", 2.75#, J-55, non-upset tubing will be used to produce the lower zone. A tension type retrievable production packer will be run and set on this tubing string. This will maintain separation between the two zones. A parallel tubing string anchor will be run in this tubing string to anchor the tubing string for the top zone.

3. 1-1/2", 2.75#, J-55 non-upset tubing will be used to produce the top zone. This tubing string will be latched into the parallel tubing string anchor.

4. The pumps for each zone will be a 1-1/4"common working barrel tubing pump. The pumps will be activated by separate rod strings.

Tubing Head

1. The tubing head will suspend the tubing strings separately.

Pumping Unit

1. Existing pumping units are of sufficient rating to pump both zones at the same time.

2. The pumping of both zones at the same time with the same pumping unit can be accomplished by using a dual horse's head.

Metering of Oil

1. Each zone will produce into a separator. The separators will consist of a single unit with a divider between the separator chambers.

2. Oil from the separator will be metered by positive displacement meters. Inidividual meters will be used for each zone.

3. After oil is metered it will be commingled into the existing flow line to the existing battery.

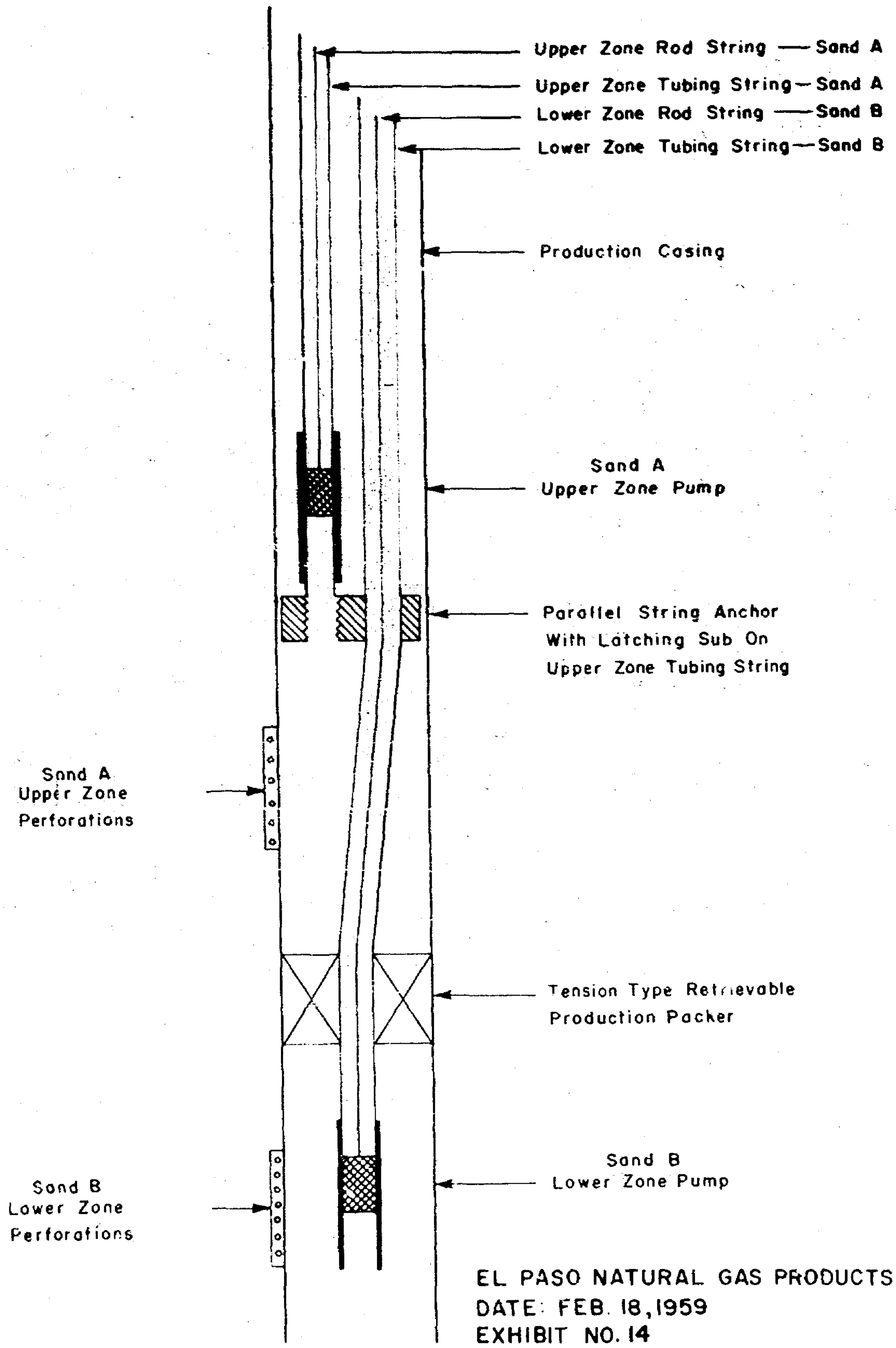
4. By metering the oil in this manner it will not be necessary to construct storage facilities and separate flow lines for each zone.

Schematic Diagram of Subsurface Equipment

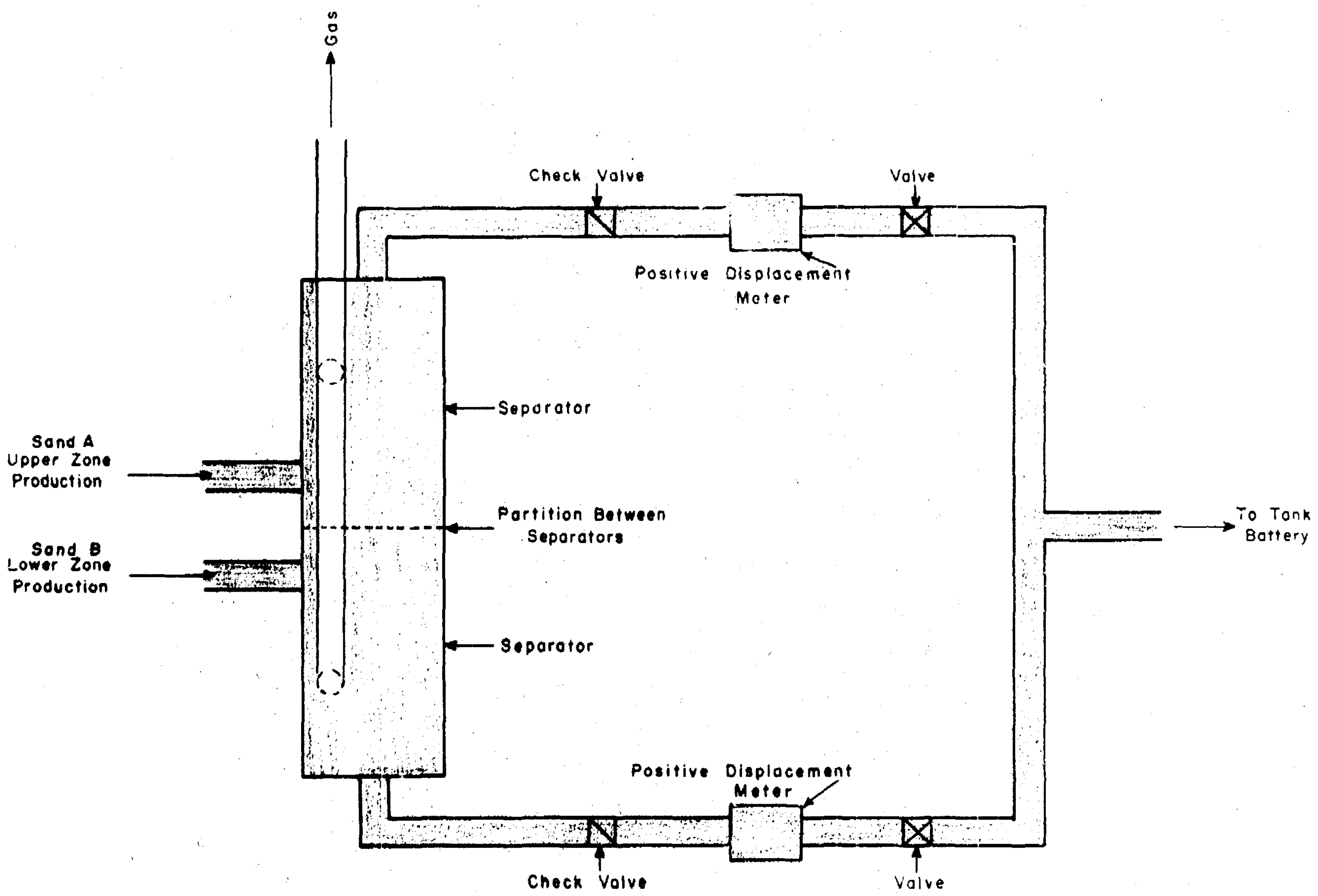
Dual Pumping Installation

Horseshoe – Gallup Oil Pool

San Juan County, New Mexico



EL PASO NATURAL GAS PRODUCTS CO.
DATE: FEB. 18, 1959
EXHIBIT NO. 14
CASE NO. 1596



Schematic Diagram
Separating and Metering Installation
Dual Completion

Horseshoe Canyon–Gallup Oil Pool
San Juan County, New Mexico

EL PASO NATURAL GAS PRODUCTS CO.
DATE: FEB. 18, 1959
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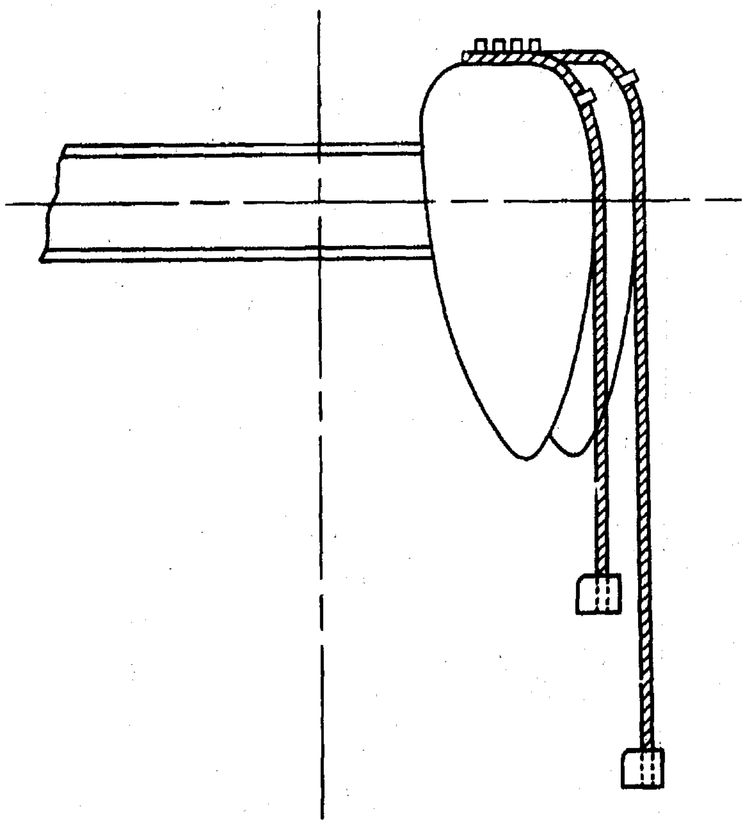
CASE NO. 1596

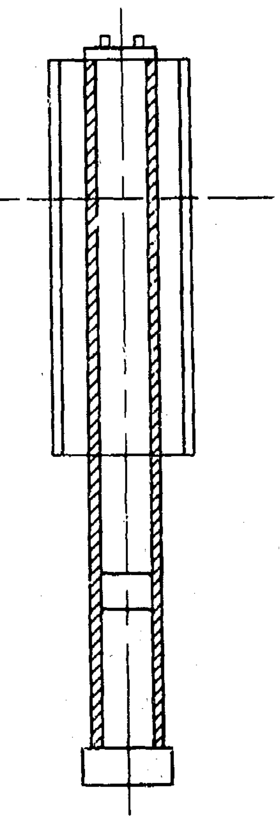
HORSESHOE GALLUP FIELD

SAN JUAN COUNTY, NEW MEXICO

DUAL CARRIER BAR HORSEHEAD INSTALLATION



SIDE VIEW



FRONT VIEW

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