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GRIFFITHSVILLE UNIT TERTIARY RECOVERY CARBON DIOXIDE
PILOT TEST, LINCOLN COUNTY, WEST VIRGINIA

Third and Final Annual Report, August 28, 1977—August 28, 1978

By
Boyd C. McRee

July 1, 1979

Work Performed Under Contract No. EW-76-C-21-8024

Guyan Oil Company, Inc.
Huntington, West Virginia

MASTER

U. S. DEPARTMENT OF ENERGY

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GRIFFITHSVILLE UNIT
TERTIARY RECOVERY
CARBON DIOXIDE PILOT TEST

LINCOLN COUNTY, WEST VIRGINIA

Third and Final Annual Report
August 28, 1977 - August 28, 1978

Prepared By - Boyd C. McRee
Principal Investigator
July 1, 1979

Contract HO - 252001/E(46-18024)
Supplemental Contract EF-76-C-21-8024
Modification No. A002

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INTRODUCTION

A contract was executed between The United States Energy Research and Development Administration (now Department of Energy) and Guyan Oil Company, Inc. on August 28, 1975, for the purpose of a pilot test of enhanced oil recovery by carbon dioxide.

This test is located in the Griffithsville Field, Lincoln County, West Virginia and encompasses 90 acres near the center of a 2,772 acre unit. The contract covered 36 months with a total estimated cost of \$3,246,260 with DOE funding \$1,200,000, or 37%.

Unanticipated environmental requirements and a localized dump flood that had occurred prior to initiation by Guyan resulted in additional cost and a supplemental contract was made with DOE for a sum of \$666,358. The supplemental contract provided for DOE to contribute \$388,300 (58%) of this cost.

The objective of this project is to demonstrate the efficiency of recovery oil from a shallow, low temperature reservoir using carbon dioxide and water to displace oil. The formation being tested is the Berea Sand in the Pocano Series of Mississippian Age.

Background data for this report have been presented in the First and Second Annual Reports. Papers were presented on the project at the ERDA Conference in Tulsa by P. F. Beeler in 1976 and 1977 and by B. C. McRee in 1978.

DISCUSSION

Subsequent to the Second Annual Report, all of the core and electric log data were extensively analyzed and a summary of data for the 90 acre pilot area is as follows:

Gross sand thickness - feet	24
Net sand thickness above 1 md.-- feet	14.4
Permeability (net sand) - md.	14
Porosity - %	12.0
Water saturation - %	18.0

As given in the earlier reports, the measured bottom hole pressure, before any injection, varied from 350 to 965 psi in and around the pilot with the average pressure in the pilot area being 750 psi. The bottom hole pressure had been estimated to be around 100 psi and therefore it was evident that dump flooding from the overlying Salt Sand had occurred. A plot of the production history gave no evidence of water flood response prior to abandonment in 1940.

A comprehensive bottom hole pressure survey made in December, 1977, revealed variations in pressures from 360 to 1092 psi within the pilot and surrounding observation wells. Production tests on all of the nine producing wells showed that none of the producers had similar oil-cut percentages. The center five spot well did not and has not produced oil even though it has the highest porosity and permeability in the project. The exact culprit contributing to the dump flood could not be ascertained. However, oil had been banked and substantial oil has been produced from the pilot area while

performing limited production tests.

Careful control of water injection into the 12 outside input wells has resulted in stabilizing the pressure throughout the pilot and has increased the average pressure from 787 to 1000 psi from December, 1977 to May 31, 1978. Cumulative water injection has been 195,257 barrels to date.

Oil production and water injection during the period of this report were:

<u>Date</u>	<u>Oil Barrels</u>	<u>Water Barrels</u>
1977 - September	2,146	22,355
October	1,393	28,287
November	1,003	17,735
December	-	-
1978 - January	-	-
February	-	647
March	171	6,569
April	66	1,628
May	-	17,337
June	117	16,224
July	1,010	31,608
August	1,516	30,508
Cumulative to 9-1-78	9,235	195,257

A review of all the reservoir data shows that the 8,000 tons originally calculated to fully evaluate the center five spot would not give a representative test of the Griffithsville Field nor the Berea Sand. The dump flood occurred between the time of the original plugging operation and the time the wells were replugged. No oil was produced during that time interval, and the entire 90 acre pilot should be representative. Calculations now show that 30,000 tons will fill 20% of the pore space in the sweep pattern to better evaluate the 90 acre pilot area.

Delays have resulted because of circumstances outside of the immediate scope of the project — weather and environment. Both winters of '76-'77 and '77-'78 were exceptions in terms of low temperatures and snow precipi-

tation in this mountaneous terrain. Significant shut-downs and loss of time resulted.

In order for the carbon dioxide to be fully effective, the pressure in the Berea Sand had to be increased to at least 1000 psi. To insure that no leakage could occur through the old wells, plugging and development of observation wells had to be done. The project was severely punished by failure to efficiently plug old oil wells resulting in the necessity to re-enter and correctly plug those even outside the pilot area. Dams, ponds, and dikes had to be built in order that any possible oil or water spill might be contained. Land slides disrupted roads and broke buried lines. The area has been reclaimed, restored, and replanted at a direct cost exceeding \$535,000 or over \$5,800 for each acre in the project. A program of preventive maintenance and monitoring has been instituted.

Twenty-five (25) new wells have been drilled, cored, logged, fractured, and completed. Sixteen (16) of the wells have been completed with injection water quality control, with an injection system, pumps, and meters. Two water supply wells are operating at design capacity of 900 b/d each and 195,000 barrels of water have been injected at predicted rates and pressure response. One well has been tested successfully for CO₂ injection. Several bottom hole pressure surveys have made it possible to predict response to water injection.

Nine (9) of the wells have been completed as producers with electrified pumping units, flow lines, and test equipment. All wells have been tested and nine thousand two hundred (9,200) barrels of oil have been produced from the pilot area demonstrating the presence and mobility of the oil. Production has been carefully programmed by wells for producing rates, water-cuts, pressure draw-downs, etc. Fluid rates have been well over one hundred (100) barrels per day per well with considerable variation in water-cut from fifty

percent (50%) to one hundred percent (100%). Several of the wells flow. Pressure build-up and drawdown tests have been made on every producing well. Skin damage tests are being made on each input well. Seventeen (17) old wells have been redrilled and properly plugged.

Eight (8) wells have been redrilled and completed for observation. All of these wells are outside the pilot and periodic fluid levels are being taken on these wells to monitor reservoir performance and pressure stabilization. Table I gives completion data on all wells drilled or recompleted. Five observation wells were completed during this third year - -

L. E. Holstein #47

Gordon Mason #5

Gordon Mason #16

A. G. Grass #4

John King #24

The A. G. Grass #3 was worked on but was not finished by end of the year.

Figure I shows the geographic location of the pilot project and Figure 2 shows the 90 acres to straddle two ridges with elevations varying from 724 to 1115 feet above sea level. The road system, Figure 3, consists of two main but unconnected branches along each of the ridges. Salt water for injection purposes is obtained from two supply wells completed in the Salt Sand and from produced water returned from the central gathering system. Water tanks are kept covered with an oil blanket with the water filtered through a master filter before being pumped into the 16 input wells. Each input well has a separate water filter and water meter. Figure 4 shows the water injection system. Each producing well has its own storage tank and intermittent electrical pumping system. Flow lines are buried and are shown on Figure 5.

The carbon dioxide system is separate and distinct from the water injection system and is shown in Figure 6. CO₂ storage consists of three refrigerated and pressurized tanks with 38 tons capacity each. This system also has its own pumps for disposal. Currently, only four injection wells are connected to the system but it is planned to extend the lines to eight other wells as shown in Figure 11.

The pilot area is rather sensitive to injection and production. An early bottom hole pressure made in June, 1977 (Figure 7) showed the effect of the dump flood and need for pressure buildup in several areas to reach the 1000 psi required to miscibility. Initial injection was on the West flank only and by December a pressure differential of several hundred pounds per square inch existed across the pilot. Well injection rates were adjusted and by July, 1978, pressures were equalized throughout the area (Figure 9).

All nine producing wells were tested intermittently during the year to determine drawdown and buildup pressures along with oil and water production. Table III shows the wide variation in oil production by wells. As could be expected, wells near the indicated dump area produced the least oil. Well P-21, located in the center of the pilot and the dump flood, has produced no oil since the free oil was pushed away from the well. On the other hand, P-24, with the lowest permeability and porosity, has produced 3100 barrels of oil (7700 to 6-1-79). Core Laboratories predicted that this well would produce no secondary oil.

Dissipation tests on the injection wells, Table IV, showed neither skin damage nor channeling. Several build up and fall off bottom hole pressure tests were conducted on each well. Typical tests are given in Table 5, and show some variation between wells. However, pressures stabilized in two weeks to anticipated levels.

Cross sections and fence diagrams were prepared along with detailed analysis of core and electric log data. From these, it became apparent that the original design for testing the pilot, Figure 10, was inadequate. The test was redesigned, Figure 11, to provide testing of all nine of the 10 acre five spots with greater efficiency. Because of the great variation in residual oil saturation among the tracts, the test will provide a great service for the industry. However, the required carbon dioxide has to be increased from 8000 to 30,000 tons and time for testing extending another two years with attendant costs.

The original estimates on cost of the pilot were made in 1974 before the full extent of problems attached to poor plugging operations were known. Nor was it anticipated the environmental control would be so extensive. The cost of carbon dioxide increased from \$30 to \$55 per ton during this period. To insure total control and protection, Guyan has effectively plugged old wells and made observation wells outside the pilot area such that, in effect, the pilot area now is 250 acres instead of 90. The East side of the 90 acre pilot requires additional work which will be done prior to expansion of the CO₂ injection from the four inside injection wells. In the meantime, pumping units have been installed on three of the observation wells outside of the pilot - - Holstein #47, Gordon Mason #16 and King #24. Monthly surveillance and fluid level determinations are being made throughout the 250 acre area.

The major problem encountered in operation of the project to date has involved environmental considerations. A series of untimely and unforeseen conditions contributed these problems among which were -

- 1) The condition of numerous improperly plugged old wells in and around the 90 acre pilot area.
- 2) The dump flood which apparently resulted from the above.

- 3) The extreme winter weather resulting in next to impossible working conditions during the main drilling and redrilling operations.

Still, with the assistance of both the Federal and State agencies including the "Supplemental Contract" (No. EF-76-C-2180A Mod. A002), the advice of the ORNL, and the Oil and Gas Division of the Bureau of Mines, a major effort was made to successfully reclaim the project area.

Cleaning, grading, reseeding, and mulching costs exceeded \$535,000. or \$5,800. for each acre in the project. The additional redrilling and conversion of perimeter wells to observation points cost in excess of \$225,000.

While the major portion of the grading and reseeding operations were done during the second operation year, a considerable amount of reclamation work continued:

- a) Numerous slips aggravated by the melting of record snow falls were cleaned up, and rehabilitated.
- b) The Guyan Soil Conservation seeded and mulched numerous acres. These areas exhibited luxurious growth virtually eliminating erosion.
- c) Fences were constructed around the sediment pond.
- d) Drains were installed and roads were ditched and repaired to divert water from potential slide area.
- e) Numerous abandoned well sites were cleared and diked for insurance against fluid spills.

SUMMARY AND CONCLUSIONS

The three year Contract expired on August 28, 1978, without completion of the original intent of testing the effectiveness of carbon dioxide on effective enhanced oil recovery agent. This was due to unforeseen problems of environment control, the dump flood and extreme weather condition. However, all of the preparations for carbon dioxide has been accomplished and the pilot is

in excellent condition for proceeding with the program. Although cost overruns are now projected to amount to over \$1,500,000, additional testing over that programmed indicates that the pilot operation will be more successful than previously hoped for. Certainly, the degree of testing will be manyfold of what was originally expected by the Department of Energy, because of the dump flood.

Guyan Oil Company has developed a two year plan of operation to complete the program and this plan is shown in Table VIII. Guyan is even more convinced that the program will prove that carbon dioxide is an efficient and economical enhanced oil recovery agent for the Berea Sand in Griffithsville Field and other similar oil reservoirs in the Appalachian area.

EPILOGUE

Subsequent to the expiration of the contract with the Department of Energy, Guyan Oil Company has continued to prepare the field for carbon dioxide injection. Both water injection and production has continued such that as of July 1, 1979, the cumulative volumes of each is - -

Water Injection - Barrels	380,000
Oil Production - Barrels	22,500

Bottom hole pressures have been stabilized and increased somewhat. Drawdown and buildup pressures have been taken and evaluated. Environmental reclamation has been increased and extended. Refinancing has been accomplished and carbon dioxide source for expansion have been secured. Guyan is satisfied that their confidence in the program will be justified by the next two years of operation.

TABLE I

GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

WELL COMPLETION DATA

		<u>Producing</u> <u>Casing</u>	<u>Date</u> <u>Completed</u>	<u>Total</u> <u>Depth</u>	<u>Ground</u> <u>Elevation</u>	<u>Berea</u> <u>Interval</u>	<u>Gross</u> <u>Sand</u>	<u>Perforations</u>
I-1	C. W. May	4-1/2 at 2595 (1)	3-02-77	2613	1063	2524-45	21	2526-44
I-2	C. W. May	4-1/2 at 2450	2-13-77	2458	821	2352-78	26	2353-71
I-3	C. W. May	4-1/2 at 2492	2-21-77	2500	941	2415-40	25	2420-38
I-4	G. W. May	4-1/2 at 2573 (2)	2-22-77	2596	1023	2496-2518	22	2498-2516
I-5	Gordon Mason	5-1/2 at 2396	6-21-76	2382	823	2309-33	24	2312-2330
I-6	Gordon Mason	7 at 2224 (2)	8-03-76	2265	724	2225-49	24	Open Hole
I-7	Gordon Mason	4-1/2 at 2287	3-21-77	2289	786	2230-54	24	2234-52
I-8	C. W. May	4-1/2 at 2403	1-25-77	2410	801	2329-53	24	2331-49
I-9	John King	4-1/2 at 2391	11-09-76	2410	872	2337-60	23	2339-57
I-10	Gordon Mason	4-1/2 at 2463	11-01-76	2481	903	2393-2417	24	2398-2416
I-11	Gordon Mason	4-1/2 at 2560	12-06-76	2580	1029	2492-2515	23	2494-2512
I-12	Gordon Mason	4-1/2 at 2440	12-20-76	2480	973	2375-2400	25	2382-2400
I-13	John King	4-1/2 at 2515 (1)	1-25-77	2515	988	2443-68	25	2447-65
I-14	Gordon Mason	4-1/2 at 2545	2-15-77	2545	1000	2465-89	24	2468-86
I-15	Gordon Mason	4-1/2 at 2620	7-28-65	2620	1115	2575-2600	25	2582-2594
I-16	Gordon Mason	4-1/2 at 2582 (1)	12-15-76	2590	1043	2510-34	24	2512-30
P-17	C. W. May	4-1/2 at 2471	6-21-76	2461	915	2388-2412	24	2391-2408
P-18	C. W. May	5-1/2 at 2343	1-07-77	2345	862	2292-2316	24	2295-2313
P-19	C. W. May	5-1/2 at 2402	1-14-77	2420	833	2336-2360	24	2340-58
P-20	Gordon Mason	5-1/2 at 2313	6-01-76	2313	731	2222-2247	25	2226-44
P-21	Gordon Mason	5-1/2 at 2490 (1)	11-24-76	2500	914	2398-2423	25	2400-18
P-22	Gordon Mason	5-1/2 at 2396	12-31-76	2395	829	2311-2335	24	2313-31
P-23	Gordon Mason	5-1/2 at 2396	12-08-76	2415	788	2296-2321	25	2300-18
P-24	Gordon Mason	5-1/2 at 2548	10-24-76	2563	1041	2491-2514	23	2495-2513
P-25	Gordon Mason	5-1/2 at 2598	10-12-76	2625	1078	2550-2574	24	2553-71
SW-1	Gordon Mason #7	3-1/2 at 900	12-14-76	2270	737	2210-2234	24	
SW-2	Gordon Mason #54	3-1/2 at 1300	5-16-77	2492	998	2460-84	24	1250-1268

TABLE I

GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

OBSERVATION WELLS COMPLETION DATA

		<u>Producing Casing</u>	<u>Date Completed</u>	<u>Total Depth</u>	<u>Ground Elevation</u>	<u>Berea Interval</u>	<u>Gross Sand</u>
O-1	C. W. May #4	4-1/2 at 2429	5-24-77	2524	1057	2500-2524	24
O-2	Johr. King #53	7-1/2 at 1650	4-29-77	2336	N/A	2324-2336	12 (3)
O-3	L. E. Holstein #47	4-1/2 at 2410	9-12-77	2433	941	2411-2433	22
O-4	Gordon Mason #16	4-1/2 at 2500	10-10-77	2527	1046	2516-2527	11 (3)
O-5	Gordon Mason #5	3-1/2 at 2149	9-09-77	2226	752	2203-2225	22
O-6	A. G. Grass #3		Not Completed	2445	990	2440-2445	5 (3)
O-7	A. G. Grass #4	4-1/2 at 2500	11-07-77	2523	1025	2494-2518	24
O-8	John King #24	4-1/2 at 2570	12-12-77	2579	1111	2574-2579	5 (3)

(1) Cored

(2) Oriented Core

(3) Berea that is Open

TABLE II

GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

SALT WATER INJECTION - BARRELS

Date	<u>I-1</u>	<u>I-2</u>	<u>I-3</u>	<u>I-4</u>	<u>I-5</u>	<u>I-6</u>	<u>I-7</u>	<u>I-8</u>
1976-July	-0-	-0-	-0-	-0-	-0-	1148	-0-	-0-
1977-April	-0-	-0-	-0-	-0-	458	22	-0-	-0-
May	265	-0-	-0-	-0-	1206	178	451	-0-
June	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
July	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Aug.	2179	-0-	-0-	-0-	1845	-0-	776	-0-
Sept.	2293	-0-	-0-	-0-	3007	-0-	2958	-0-
Oct.	4996	27	92	-0-	3353	-0-	2941	-0-
Nov.	2045	1594	1135	-0-	2051	-0-	1545	-0-
Dec.	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Cumulative	11778	1621	1227	-0-	11920	1348	8671	-0-
1978-Jan.	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Feb.	-0-	-0-	-0-	187	-0-	-0-	-0-	203
March	-0-	-0-	-0-	1745	-0-	-0-	-0-	1622
April	-0-	-0-	-0-	589	-0-	-0-	-0-	411
May	1079	2713	1483	2758	1410	-0-	-0-	3265
June	351	1632	813	3210	2562	-0-	-0-	1394
July	2811	4426	2181	962	2710	-0-	-0-	2559
Aug.	1994	4027	1723	2950	2044	-0-	-0-	4044
Cumulative	18013	14419	7427	12401	20646	1348	8671	13498

TABLE II

Page 2 of II

GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

SALT WATER INJECTION - BARRELS

Date								Total
	I-9	I-10	I-12	I-13	I-14	I-15	I-16	Field
1976-July	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1148
1977-April	276	215	-0-	-0-	-0-	-0-	-0-	971
May	758	1202	-0-	652	881	-0-	-0-	5593
June	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
July	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Aug.	1442	2147	-0-	2960	3298	-0-	-0-	14647
Sept.	1830	4465	-0-	2322	4980	-0-	-0-	22355
Oct.	2745	3694	-0-	3617	6822	-0-	-0-	28287
Nov.	2067	2289	-0-	1759	3250	-0-	-0-	17735
Dec.	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Cumulative	9118	14012	-0-	11310	19231	-0-	-0-	90736
1978-Jan.	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Feb.	-0-	-0-	234	-0-	-0-	-0-	23	647
March	-0-	-0-	2166	-0-	-0-	-0-	1036	6569
April	-0-	-0-	424	-0-	-0-	-0-	204	1628
May	-0-	-0-	2486	-0-	-0-	122	2021	17337
June	338	-0-	1598	1433	935	-0-	1958	16224
July	2190	-0-	2710	3716	2884	592	3867	31608
Aug.	1708	-0-	2448	3063	3116	1481	1910	30508
Cumulative	13354	14012	12066	20022	26166	2195	11019	195257

TABLE III

GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

OIL PRODUCTION HISTORY - BARRELS

<u>Date</u>	<u>P-17</u>	<u>P-18</u>	<u>P-19</u>	<u>P-20</u>	<u>P-22</u>	<u>P-23</u>	<u>P-24</u>	<u>P-25</u>	<u>Total</u>
1977-Aug.	126	140	91	267	74	363	562	190	1813
Sept.	168	318	183	302	103	404	416	252	2146
Oct.	38	123	68	139	48	232	479	266	1393
Nov.	35	86	31	184	13	219	328	107	1003
Dec.	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Cumulative	367	667	373	892	238	1218	1785	815	6355
1978-Jan.	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Feb.	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Mar.	12	10	-0-	15	-0-	-0-	62	72	171
April	-0-	-0-	2	-0-	-0-	-0-	61	3	66
May	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
June	-0-	-0-	-0-	-0-	-0-	-0-	82	35	117
July	-0-	102	-0-	-0-	-0-	203	477	228	1010
Aug.	-0-	115	12	6	-0-	384	617	382	1516
Cumulative	379	894	387	913	238	1805	3084	1535	9235

Note: P-21 has been periodically pumped but has produced no oil.

TABLE IV

GUYAN OIL COMPANY, INC.
GRIFFITHSVILLE FIELD, LINCOLN COUNTY, WEST VIRGINIA

BHP DISSIPATION - INJECTION WELLS
August, 1978

	INJECTION WELLS					
	I-1	I-2	I-3	I-4	I-15	I-16
Date	8-24	8-24	8-24	8-24	8-24	8-24
Pump Pressure	850	850	850	850	850	850
B/D when Sl	72	90	57	127	32	18
WHP	680	665	705	570	545	610
Dissipation Time Sec.						
5	679	665	700	565	545	610
15	679	665	700	563	540	610
30	678	665	700	560	540	609
45	678	652	699	560	540	609
60	678	650	698	560	539	608
90	677	645	698	558	538	605
120	676	642	697	555	535	602
180	675	640	696	553	532	602
240	674	639	696	550	530	600
300	672	638	695	545	530	600
360	670	635	695	545	528	600
420	669	633	693	542	525	599
480	665	631	690	542	525	599
540	665	630	690	542	525	599
600	665	630	690	540	523	598

TABLE V

GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

B.H.P. SURVEYS - ECHOMETER - FLUID LEVELS
June, 1978

<u>WELL</u>	<u>DRAWDOWN</u>		<u>BUILD-UP</u>	
	<u>Time</u>	<u>PSI</u>	<u>Time</u>	<u>PSI</u>
P-17	Start	861	on 1 Day	695
	2 Hrs.	840	3 Days si	695
	4 Hrs.	812	2 Hrs.	812
	6 Hrs.	778	4 Hrs.	861
P-18	Start	1056	on 2 Days si	97
	2 Hrs.	918	2 Hrs.	200
	4 Hrs.	835	4 Hrs.	283
	7 Hrs.	738		
P-19	Start	900	on 2 Days si	776
	2 hrs.	845	2 Hrs.	804
	4 hrs.	831	4 Hrs.	824
	6 hrs.	818	6 Hrs.	852
P-20	Start	1024	on 48 Hrs. si	865
	2 Hrs.	1010	2 Hrs.	995
	4 Hrs.	996	4 Hrs.	996
	6 Hrs.	976		
	24 Hrs.	872		
P-21	Start	911	on 2 Days si	-0-
	2 Hrs.	697	2 Hrs.	117
	4 Hrs.	573	4 Hrs.	221
	7 Hrs.	407	6 Hrs.	290
			9 Days	731
			14 Days	1006

TABLE V

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GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

B.H.P. SURVEYS - ECHOMETER - FLUID LEVELS
June, 1978

<u>WELL</u>	<u>DRAWDOWN</u>		<u>BUILD-UP</u>	
	<u>Time</u>	<u>PSI</u>	<u>Time</u>	<u>PSI</u>
P-22	Start	909	on 2 Days si	685
	2 Hrs.	903	2 Hrs.	760
	4 Hrs.	865	4 Hrs.	797
	6 Hrs.	828	6 Hrs.	840
P-23				
P-24	Start	958	on 2 Days si	106
	2 Hrs.	824	2 Hrs.	142
	4 Hrs.	672	4 Hrs.	197
	7 Hrs.	501	9 Days	725
			14 Days	917
P-25	Start	1174	on 48 Hrs. si	346
	2 Hrs.	1160	2 Hrs.	443
	4 Hrs.	1119	4 Hrs.	535
	24 Hrs.	810		

GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

September, 1977 - August, 1978

		1977			1978							
		<u>September</u>	<u>October</u>	<u>November</u>	<u>February</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	
G	1-1	Barrels for Month	2293	4996	2045	-0-	-0-	-0-	1079	351	2811	1994
		Avg. Psig	497	581	563				583	440	608	635
		Avg.Bbls.per Day	76	161	97				180	44	94	64
		Days Operated	30*	31*	21*	-0-	-0-	-0-	6*	8*	30*	31*
	1-2	Barrels for Month	-0-	27	1594	-0-	-0-	-0-	2713	1632	4426	4027
		Avg. Psig		-0-	531				559	496	693	712
		Avg.Bbls.per day		27	315				160	204	184	130
		Days Operated	-0-	1*	6*	-0-	-0-	-0-	17*	8*	24*	31*
	1-3	Barrels for Month	-0-	92	1135	-0-	-0-	-0-	1483	813	2181	1723
		Avg. Psig		-0-	513				501	559	681	690
		Avg.Bbls.per Day		92	224				82	102	70	56
		Days Operated	-0-	1*	6*	-0-	-0-	-0-	18*	8*	31*	31*
	1-4	Barrels for Month	-0-	-0-	-0-	187	1745	589	2758	3210	962	2950
		Avg. Psig					300	132	460	513	551	605
		Avg.Bbls.per Day				94	97	65	131	134	137	95
		Days Operated	-0-	-0-	-0-	2*	18*	9*	21*	24*	7*	31*
	1-5	Barrels for Month	3007	3353	2051	-0-	-0-	-0-	1410	2562	2710	2044
		Avg. Psig	559	596	627				481	485	725	726
		Avg.Bbls.per Day	100	108	114				128	107	87	66
		Days Operated	30*	31*	21*	-0-	-0-	-0-	11*	24*	31*	31*

TABLE VI

GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

INJECTION DATA
September, 1977 - August, 1978

		<div> <div>1977</div> <div>1978</div> </div>									
		<u>September</u>	<u>October</u>	<u>November</u>	<u>February</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>
1-6	Barrels for Month	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
	Avg. Psig										
	Avg. Ebbls. per Day										
	Days Operated	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
1-7	Barrels for month	2958	2941	1545	-0-	-0-	-0-	-0-	-0-	-0-	-0-
	Avg. Psig	576	710	746							
	Avg. Ebbls. per Day	99	95	86							
2	Days Operated	30*	31*	18*	-0-	-0-	-0-	-0-	-0-	-0-	-0-
1-8	Barrels for Month	-0-	-0-	-0-	203	1622	411	3265	1394	2559	4044
	Avg. Psig					192	196	524	523	703	709
	Avg. Ebbls. per Day				102	90	46	148	56	171	130
	Days Operated	-0-	-0-	-0-	2*	18*	9*	22	25*	15*	31*
1-9	Barrells for month	1830	2745	2067	-0-	-0-	-0-	-0-	338	2190	1708
	Avg. Psig	575	595	696					387	704	785
	Avg. Ebbls. per Day	61	89	114					38	73	55
	Days Operated	30*	31*	21*	-0-	-0-	-0-	-0-	9*	30*	31*
1-10	Barrels for Month	4465	3694	2289	-0-	-0-	-0-	-0-	-0-	-0-	-0-
	Avg. Psig	603	667	603							
	Avg. Ebbls. per Day	148	119	145							
	Days Operated	30*	31*	19*	-0-	-0-	-0-	-0-	-0-	-0-	-0-

TABLE VI

GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

INJECTION DATA
September, 1977 - August, 1978

		<div style="display: flex; justify-content: space-around; font-weight: normal;"> 1977 1978 </div>									
		<u>September</u>	<u>October</u>	<u>November</u>	<u>February</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>
21	1-12 Barrels for Month	-0-	-0-	-0-	234	2166	424	2486	1598	2710	2448
	Avg. Psig					164	150	526	552	688	704
	Avg.Bbls.per day				117	120	47	155	114	118	79
	Days Operated	-0-	-0-	-0-	2*	18*	9*	16*	14*	23*	31*
	1-13 Barrels for Month	2822	3617	1759	-0-	-0-	-0-	-0-	1433	3716	3063
	Avg. Psig	747	547	613					334	567	592
	Avg.Bbls.per Day	94	117	132					159	120	99
	Days Operated	30*	31*	15*	-0-	-0-	-0-	-0-	9*	31*	31*
	1-14 Barrels for Month	4980	6822	3250	-0-	-0-	-0-	-0-	935	2884	3116
	Avg. Psig	474	532	547					334	525	613
	Avg.Bbls.per day	166	220	244					104	93	101
	Days Operated	30*	31*	15*	-0-	-0-	-0-	-0-	9*	31*	31*
	1-15 Barrels for Month	-0-	-0-	-0-	-0-	-0-	-0-	122	-0-	592	1481
	Avg. Psig							611		543	480
	Avg.Bbls.per day							15		148	53
	Days Operated	-0-	-0-	-0-	-0-	-0-	-0-	8*	-0-	4*	28*
	1-16 Barrels for Month	-0-	-0-	-0-	23	1036	204	2021	1958	3867	1910
	Avg. Psig					75	22	433	427	560	555
	Avg.Bbls.per day				12	58	23	112	89	125	62
	Days Operated	-0-	-0-	-0-	2*	18*	9*	18*	22*	31*	31*
TOTAL		22355	28287	17735	633	6569	1628	17337	16224	31680	30508
Cumulative		43189	71476	89211	89844	97248	99520	116845	133069	164749	195257

* Wells did not avg. 24 hr./day

Note: Weather conditions prevented injection in December 1977 and January 1978.

TABLE VII

GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

PRODUCTION DATA
September, 1977 - August, 1978

		1977			1978						Cumulative Total
		<u>September</u>	<u>October</u>	<u>November</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	
P-17	Bbls. for Month/Oil	168	38	35	12						379
	Avg. % Oil	12%	4%	3%	3%						
	Days Operated	31	31	23	5				21	3	
P-18	Bbls. for Month/Oil	318	123	86	10				102	115	894
	Avg. % Oil	27%	12%	14%	8%				8%	9%	
	Days Operated	31	31	23	3				30	31	
22 P-19	Bbls. for Month/Oil	183	68	31		2				12	387
	Avg. % Oil	14%	7%	7%		3%				1%	
	Days Operated	31	31	15		2			13	18	
P-20	Bbls. for Month/Oil	302	139	184	15					6	913
	Avg. % Oil	24%	13%	13%	9%					1%	
	Days Operated	31	31	23	3				15	21	
P-21	Bbls. for Month/Oil										-0-
	Avg. % Oil										
	Days Operated	31	31	10							
P-22	Bbls. for Month/Oil	103	48	13							238
	Avg. % Oil	9%	5%	4%							
	Days Operated	31	31	17							
P-23	Bbls. for Month/Oil	404	232	219					203	384	1805
	Avg. % Oil	38%	23%	23%					12%	18%	
	Days Operated	31	31	30					25	31	

TABLE VII

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GUYAN OIL COMPANY, INC.
Griffithsville Field, Lincoln County, West Virginia

PRODUCTION DATA
September, 1977 - August, 1978

		<u>1977</u>			<u>1978</u>						<u>Cumulative Total</u>
		<u>September</u>	<u>October</u>	<u>November</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	
P-24	Bbls. for Month/Oil	416	479	328	62	61		82	477	617	3084
	Avg. % Oil	44%	45%	44%	46%	45%		53%	33%	36%	
	Days Operated	31	31	30	3	2		2	21	31	
P-25	Bbls. for Month/Oil	252	266	107	72	3		35	228	382	1535
	Avg. % Oil	23%	25%	27%	31%	2%		16%	14%	19%	
	Days Operated	31	31	23	4	3		3	22	31	
Total Bbls. for Month		2146	1393	1003	171	66		117	1010	1516	9235

NOTE: Weather conditions prevented production in December, 1977 and January, February, 1978.

TABLE VIII

PROPOSED WORK SCHEDULE TO COMPLETE THE
GUYAN OIL COMPANY CARBON DIOXIDE ENHANCED OIL RECOVERY
PROJECT - LINCOLN CO., WEST VIRGINIA

8-1-79 to 10-1-79	Redrill and replug 2 wells from Phase 2 (Mason 3 & 13).
9-1-79 to 6-1-80	Inject 8000 tons CO ₂ in 4 center wells.
8-1-79 to 10-1-79	Extend roads to observation wells.
8-1-79 to 2-1-80	Redrill and complete 9 new observation wells. Mason #6 Mason #45 May #6 Grass #5 Grass #6 Holstein #3 King #12 King #30 Mason #21
8-1-79 to 9-1-79	Install new filter system.
8-1-79 to 10-1-79	Rock roads.
8-1-79 to 11-1-79	Complete ponds and environmental work.
8-1-79 to 10-1-79	Extend electric lines, flowline and install production equipment on observation wells.
8-1-79 to 12-1-79	Extend CO ₂ injection line to 8 outside wells.
9-1-79 to 3-1-80	Develop simulation model.
11-1-79 to 2-1-80	Redrill and plug 2 wells outside of pilot (Mason 2 & Burton 46).
3-1-80 to 6-1-81	Inject 22,000 tons of CO ₂ .

FIGURE 1
GRIFFITHSVILLE FIELD
GUYAN OIL COMPANY

— CO₂ PILOT PROJECT —

FIGURE 2

GRIFFITHSVILLE FIELD — LINCOLN COUNTY, W. VA.
GUYAN OIL COMPANY CO₂ PILOT PROJECT

— TOPOGRAPHY —

- Injection
- Production
- ⊙ Observation
- Replugged by Guyan
- ▲ Salt Water Supply

FIGURE 5

GRIFFITHSVILLE FIELD — LINCOLN COUNTY, W. VA.
GUYAN OIL COMPANY CO₂ PILOT PROJECT

OIL FLOW LINES

4 1/2" ——— 2" ———

- Injection
- Production
- ⊙ Observation
- Replugged by Guyan
- ▲ Salt Water Supply

FIGURE 6

GRIFFITHSVILLE FIELD — LINCOLN COUNTY, W. VA.
 GUYAN OIL COMPANY CO₂ PILOT PROJECT

— CO₂ INJECTION SYSTEM —

○ Injection	▨ Production	⊗ Observation
✓ Replugged by Guyan	▲ Salt Water Supply	

FIGURE 7

GRIFFITHSVILLE FIELD — LINCOLN COUNTY, W. VA.
GUYAN OIL COMPANY CO₂ PILOT PROJECT

— BHP JUNE, 1977 —

- Injection
- Production
- ⊙ Observation
- Replugged by Guyan
- △ Salt Water Supply

FIGURE 8

Scale: 1"=500'

GRIFFITHSVILLE FIELD — LINCOLN COUNTY, W. VA.
GUYAN OIL COMPANY CO₂ PILOT PROJECT

— BHP DECEMBER, 1977 —

- Injection
- Production
- ⊙ Observation
- ✱ Replugged by Guyan
- △ Salt Water Supply

FIGURE 9

GRIFFITHSVILLE FIELD — LINCOLN COUNTY, W. VA.

GUYAN OIL COMPANY CO₂ PILOT PROJECT

— BHP JULY, 1978 —

- Injection
- Production
- ⊙ Observation
- ✱ Replugged by Guyan
- △ Salt Water Supply

FIGURE 12

GRIFFITHSVILLE FIELD — LINCOLN COUNTY, W. VA.
GUYAN OIL COMPANY CO₂ PILOT PROJECT

-CUMULATIVE WATER INJECTION-
9-1-78 (Subscripts - 1000 Barrels)

● Injection ● Production ● Observation
✓ Replugged by Guyan ▲ Salt Water Supply

FIGURE 13
— WATER INJECTION HISTORY —

FIGURE 14
— OIL PRODUCTION HISTORY —