STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION

BRUCE KING
GOVERNOR

ANITA LOCKWOOD
CABINET SECRETARY

August 5, 1992

POST OFFICE BOX 2088
STATE LAND OFFICE BUILDING
SANTA FE, NEW MEXICO 87504
(505) 827-5800

PMX-153
pPEV0020700153

CF 6580

Conoco, Inc.
10 Desta Drive
Suite 100 W
Midland, Texas 79705-4500

Attention: Jerry Hoover

RE: Injection Pressure Increase
MCA Unit Pressure Maintenance
24 Wells
Lea County, New Mexico

Dear Mr. Hoover,

Reference is made to your request dated July 22, 1992, to increase the injection pressure on 24 wells in the MCA Unit permitted by Division Orders R-6157, R-6157-A and PMX-153. This request is based on declining injection fluid densities monitored and recorded from May 1, 1992 through July 19, 1992 and presented in Exhibits A thru E, included with your request.

The Division Director Finds That:

1) Division Order No. R-6157, issued October 30, 1979, authorized a CO2 pilot project to be initiated in the MCA Unit and to include two (2) injection wells.

2) Order No. R-6157 allowed for the injection of either CO2 or water.

3) Said Order R-6157 allowed a maximum surface pressure of 2150 psi, which consequentially allowed a bottom hole pressure of 3889 psi, using a fluid density gradient of .455 psi/ft for MCA produced water and an average uppermost injection depth of 3822 feet.

4) Division Order No. R-6157-A, issued April 30, 1991, authorized the injection of water, CO2, a mixture of produced carbon dioxide and hydrocarbon gas, or any combination of these fluids, thereby allowing varying injection fluid densities.

5) Division Order No. PMX-153, issued January 13, 1989, authorized the expansion of the MCA Pressure Maintenance/Enhanced Recovery Project to include 22 additional wells for a total of 24 permitted injection wells in the Maljamar Grayburg - San Andres Pool in Lea County, New Mexico.

6) Injection fluid densities have been declining as evidenced by data recorded between May 1, 1992 and July 19, 1992, and submitted with your request as Exhibits A thru E.

It Is Therefore Ordered That:

1) The pressure limit set by Order No. R-6157 as 2150 psi at surface be interpreted to imply a bottom hole pressure of 3889 psi.

2) To maintain a bottom hole pressure of 3889 psi with varying injection fluid densities, the following formula be utilized to calculate the maximum wellhead pressure on an individual well basis:

WELLHEAD PRESSURE = 3889 psi (BHP) - FLUID DENSITY GRADIENT/ft. of Depth to the Uppermost Injection Interval

3) In any case, the wellhead pressure will not exceed 2563 psi.

4) When converting from one injection fluid to another, wellhead pressure will be monitored and brought into compliance with the above formula within 72 hours of the conversion.

5) The operator is hereby authorized to increase the injection pressure on 24 wells in the MCA Unit as needed to obtain the bottom hole pressure as described above.

It Is Further Ordered That:

The subject wells shall be governed by all provisions of Division Order Nos. R-6157, R-6157-A and PMX-153 and Division Rules 702-706 not inconsistent herewith.

The Division Director may rescind this injection pressure increase if it becomes apparent that the injected fluids are not being confined to the injection zone or are endangering any fresh water aquifers.

DONE at Santa Fe, New Mexico, on this 5th day of August, 1992.

State of New Mexico
Oil Conservation Division

William J. LeMay
Director

WJL/BS/jc

cc: Oil Conservation Division - Hobbs
David Catanach
Files R-6157, R-6157-A, PMX-153

August 5, 1992

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10 Desta Drive
Suite 100 W
Midland, Texas 79705-4500

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State of New Mexico
Oil Conservation Division

William J. LeMay
Director

WJL/BS/jc

cc: Oil Conservation Division - Hobbs
David Catanach
Files R-6157, R-6157-A, PMX-153

Midland Division
Exploration Production

Conoco Inc.
10 Desta Drive, Suite 100W
Midland, TX 79705-4500
(915) 686-5400

July 22, 1992

Mr. David Catanach
Oil Conservation Division
P.O. Box 2088
Santa Fe, NM 87504-2088

Dear Mr. Catanach:

Request for Interpretation of Order Nos. R-6157 and R-6157-A to allow a maximum wellhead injection pressure of 2500 psi for CO2 injection wells located in Conoco's Maljamar CO2 Project as required to maintain the maximum bottom hole injection pressure that would be allowed by Order No. R-6157 in its approval to also inject produced water.

Order No. R-6157 was issued on 10/30/79 to authorize a CO2 Pilot Project in the Maljamar Grayburg-San Andres Pool. It authorized the injection of either water or CO2 into the Pilot Project and provided for administrative approval of its expansion to a full-scale injection project. Order No. R-6157-A was issued on 4/30/91 to clarify the intent of the original order as to authorized injection fluids. The amended order added the following language:

> "Any authority under this order to inject carbon dioxide shall also be considered to authorize the injection of water, carbon dioxide, a mixture of produced carbon dioxide and hydrocarbon gas, or any combination of these fluids."

The order set a wellhead injection pressure limit of 2150 psi. I would assume that this limit was considered by the examiner to fully comply with the requirements of Rule 703-B concerning containment of injected fluids to the approved intervals. With the approved injection of MCA produced water (which EXHIBIT A shows to have a 1.05 specific gravity or a .455 psi/ft gradient) and an average depth to the top perforation in the current 24 CO2 injection wells of 3822 ft, the order would allow a maximum bottom hole injection pressure of 3889 psi as shown in the calculation below:

WHP	WATER GRAD.	DEPTH	BHP

2150 psi + (.455 psi/ft)(3822 ft) = 3889 psi

It seems reasonable to assume that the real intent of setting a surface injection (wellhead) pressure limit would have been to control the bottom hole injection pressure for compliance with Rule 703-B. At the time of the original hearing we did not have the foresight to anticipate that when it became necessary to recycle

the high CO2 content produced gas (see analysis in EXHIBIT B) with the purchased pure CO2 (see analysis in EXHIBIT C) that the fluid density of such a mixed injectant would significantly reduce the bottom hole injection pressure that could be maintained with a 2150 psi wellhead injection pressure limit.

Currently the injection fluid is a 90%-10% mixture of 97% pure CO2 and produced gas that contains 63% CO2. The resulting injection stream currently has a fluid density of just under 50 lbs/cu.ft. EXHIBIT D shows the results of a pressure gradient test run July 10, 1992 in the MCA #94 CO2 injection well. Gradient readings were taken every 1,000 feet and the average fluid gradient for the entire fluid column was .340 psi/ft or 49.0 lbs/cu.ft.

The tables in EXHIBIT E show the daily densitometer readings over the last three months for (a) pure CO2, (b) recycled CO2, (c) each of the three CO2 injection headers after the two injection steams have been mixed, and (d) the average of the three headers. Notice that the monthly averages of the composite fluid density, shown at the bottom of each page, has continued to decline to an average of 49.6 lbs/cu.ft. for the first 19 days of July. The pressure gradient test in MCA #94 and the daily densitometer readings for the entire project both confirm this serious decrease in the injection fluid density.

Injection of this less dense fluid at the wellhead pressure limit of 2150 psi has resulted in a significant decrease in the bottom hole pressure and the injection volumes have declined to approximately 60% of the design rates required for the successful and efficient flooding of this reservoir by CO2. If we could assume that the primary intent of the order was to limit bottom hole pressure to assure containment of the injected fluids in the approved intervals, then an increase in the wellhead pressure that does not cause the maximum bottom injection pressure to exceed that which would have been allowed under the scope of the order with water injection would not appear to violate the real intent of the order's stated pressure limit.

Using (a) the 3822 ft. average depth to the top perforation for the 24 CO2 injection wells currently in the project and (b) the allowed 3889 psi bottom hole pressure at a wellhead pressure limit of 2150 psi and a current produced water gradient of .455 psi/ft, the wellhead pressure required to maintain this bottom hole pressure using any fluid density can be calculated as follows:

(bottom hole pressure) - (fluid gradient)(depth) = (wellhead pressure)

<u>For a produced water fluid density of .455 psi/ft</u>

3889 psi BHP - .455 psi/ft (3822 ft) = 2150 psi WHP

<u>For a current CO2 fluid density of .347 psi/ft (50 lbs/cuft)</u>

3889 psi BHP - .347 psi/ft (3822 ft) = 2563 psi WHP

It is anticipated that a 2500 psi wellhead limit for CO2 injection would (a) be consistent with the intent of the order's pressure limit (b) maintain bottom hole pressure within the limits of the intent of the order, (c) be adequate to return

injection rates to design and efficient recovery levels, and (d) will protect against the waste of reserves that would be unrecoverable at the current lowered injection rates.

Since the maximum injection rates that are possible within the current 2150 psi wellhead pressure are already at critical levels, it is urgently requested that you review and respond to this problem at your earliest possible convenience. Thank you for your prompt help in this matter. If I can be of any further help, please call me at (915) 686-6548.

Very truly yours,

Jerry W. Hoover
Senior Conservation Coordinator

UNICHEM INTERNATIONAL
P.O. BOX 1499 707 NORTH LEECH STREET
HOBBS, NEW MEXICO 88240

MCA PRODUCED WATER

Conoco, Inc.
Box 460
Hobbs , NM 88241

Report Date: April 10, 1992
Lab In Date: March 30, 1992
Sample Date: March 24, 1992

Dear Donnie Rogers

Listed below please find our water analysis report from MCA , Filter Inlet :

Specific Gravity:	1.053
Total Dissolved Solids:	74652
PH:	6.20
Ionic Strength:	1.430

		mg/liter
CATIONS:		
Calcium:	(Ca++)	2080
Magnesium:	(Mg++)	1507
Sodium:	(Na+)	24328
Iron (Total)	(Fe++)	.30
Barium	(Ba++)	2.30
Manganese:	(Mn++)	.19
Restivity:		
ANIONS:		
Bicarbonate:	(HCO3-)	1013
Carbonate:	(CO3--)	0
Hydroxide:	(OH-)	0
Sulfate:	(SO4--)	2725
Chloride:	(Cl-)	43000
GASES:		
Carbon Dioxide:	(CO2)	40.0
Oxygen:	(O2)	******
Hydrogen Sulfide:	(H2S)	68.0

SCALE INDEX (Positive Value Indicates Scale Tendency) * indicates tests were not run.

Temperature		CaCO3 SI	CaSO4 SI
86F	30.0C	-.21	-18.73
104F	40.0C	-.00	-18.46
122F	50.0C	.26	-17.85
140F	60.0C	.62	-16.98
168F	70.0C	.97	-16.15
176F	80.0C	1.32	-14.75

If you have any questions or require further information, please contact us.

Sincerely,

Sharon Wright
Laboratory Technician

cc: Tad Buchanan
Donald Blair
Paul Adams
Henry David

bc: Joe Hay
Jay Brown

EXHIBIT A

NONE

RECYCLED PRODUCED GAS COMPOSITION

ANALYSIS

DATE: 07/23/92 ANALYSIS TIME: 925 STREAM SEQUENCE: 1
TIME: 07:45 CYCLE TIME: 930 STREAM#: 1
ANALYZER#: 1 MODE: RUN CYCLE START TIME: 07:29

COMP NAME	COMP CODE	MOLE %	GAL/MCF**	B.T.U.*	SP. GR.*
C 5 +	149	2.216	0.8026	89.04	0.055
I-BUTANE	103	0.722	0.2361	23.54	0.014
N-BUTANE	104	2.101	0.6622	68.72	0.042
C O 2	117	63.048	0.0000	0.00	0.958
ETHANE	101	6.680	1.7856	118.48	0.069
H 2 S	140	1.006	0.1375	6.42	0.011
PROPANE	102	5.692	1.5659	143.56	0.086
OXYGEN	116	0.493	0.0000	0.00	0.005
NITROGEN	114	1.914	0.0000	0.00	0.018
METHANE	100	16.127	0.0000	163.20	0.089
TOTALS		100.000	5.1898	612.97	1.351

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

** @ 14.730 & 60 DEG. F

COMPRESSIBILITY FACTOR (1/Z) = 1.0065
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 617.0
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 606.2
REAL SPECIFIC GRAVITY = 1.3591
UNNORMALIZED TOTAL = 98.02

ACTIVE ALARMS

NONE

24 HR AVERAGES

DATE: 07/23/92 TIME 07:45 ANALYZER#: 1
*AVG TIME 07:30

24HR AVG NAME	24HR AVG CODE	STR #	COMP NAME	COMP CODE	24HR AVG VALUE	PREV 24HR AVG VALUE
24HRAV01	183	1	S. G.	164	1.35000	1.34383
24HRAV02	184	1	C O 2	117	60.3914	60.1498
24HRAV03	185	1	H 2 S	140	1.07606	1.01884

ACTIVE ALARMS

NONE

ANALYSIS

EXHIBIT B

DATE: 07/23/92 ANALYSIS TIME: 925 STREAM SEQUENCE: 1

PURCHASED CO2

BENHAM NATURAL GAS SERVICE
PHONE: 915/335-9222 2317 FIELD, UNIT "J" ODESSA, TX 79761

HYDROCARBON ANALYSIS

LABORATORY REPORT

DATE RECEIVED 06/26/92
DATE OF RUN 06/26/92

A SAMPLE OF GAS FROM BIG THREE INDUSTRIES INC.

STATION NUMBER #6 LEASE CONOCO MALJAMAR

GAS TO BIG THREE INDUSTRIES INC. PLANT CO2

SECURED BY CUSTOMER TIME : DATE 06/25/92

LINE PRESSURE # LINE TEMPERATURE

CHROMATOGRAPH ANALYSIS @ 14.65 PSIG & 60 DEG. F

	GAS VOL. OR MOL.%	GPM
HYDROGEN SULFIDE		
HELIUM		
ARGON		
CARBON MONOXIDE		
OXYGEN		
NITROGEN	1.98	
CARBON DIOXIDE	97.88	
METHANE	0.14	
ETHANE		
PROPANE		
ISO-BUTANE		
N-BUTANE		
ISO-PENTANE		
N-PENTANE		
HEXANES		
HEPTANES		
OCTANES		
	100.00	0.000

GASOLINE CONTENT (G.P.M.)

26/70	GASOLINE	0.000
100%	PROPANE	0.000
EXCESS	BUTANES	0.000
	TOTAL	0.000

OTHER DATA

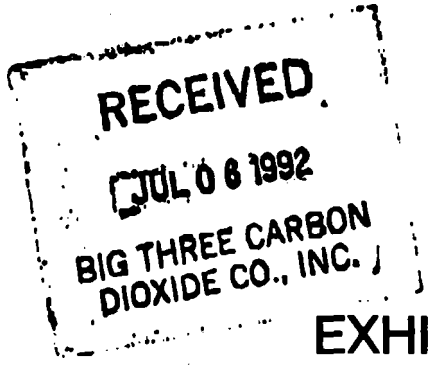
IDEAL BTU/CU. FT.	(WET)	1	(DRY)	1
REAL BTU/CU. FT.	(WET)	1	(DRY)	1

SPECIFIC GRAVITY

MEASURED	0.0000
IDEAL (CALC)	1.5067
REAL (CALC)	1.5127

RUN BY: FARRIS BENHAM CHECKED: RENAY BRUMLEY APPROVED: FARRIS BENHAM

ADDITIONAL DATA AND REMARKS :



COPIES TO :

2 - CHARLES HARPER
1 - PAUL MC KAY
1 - DANNY THOMPSON
1 - FILE

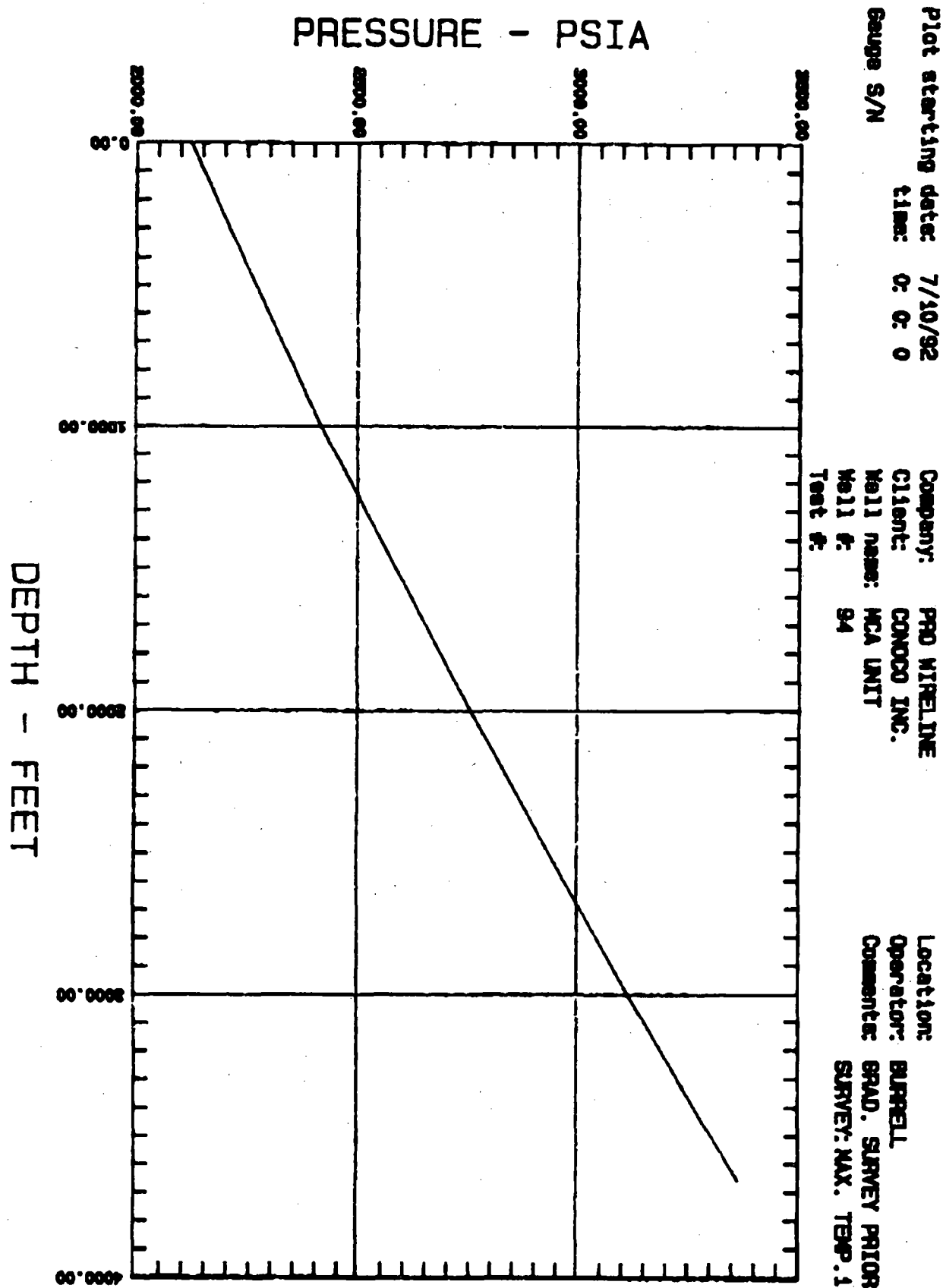
EXHIBIT C

PAGE START DATE: 7/10/92
PAGE START TIME: 0: 0: 0
DATA FILE: 4

MCA #94 PRESSURE GRADIENT TEST

DELTA TIME HRS	DEPTH FEET	PRESSURE PSIA	TEMPERATURE 'F	COMMENTS
0.000	0.00	2123.00		GRADIENT psi/ft
0.000	1000.00	2418.00		.295
0.000	2000.00	2757.00		.339
0.000	3000.00	3117.00		.360
0.000	3652.00	3365.00		.381
0.000	3652.00			Average Gradient = .340 psi/ft or 49.0 lbs/ft3

EXHIBIT D


PRESSURE - PSIA
2000.00
2500.00
3000.00
3500.00
0.00
1000.00
2000.00
3000.00
4000.00
DEPTH - FEET
Plot starting date: 7/10/92
time: 0: 0: 0
Gauge S/N
Company: PRO WIRELINE
Client: CONOCO INC.
Well name: NCA UNIT
Well #: 94
Test #:
Location:
Operator: BURRELL
Comments: BRAD. SURVEY PRIOR TO 6 DAY SURVEY: MAX. TEMP. 112°F

MCA INJECTION HEADER CO2 DENSITIES
FROM DAILY DENSITOMETER READINGS

MAY 1992

			MIXED INJECTION STREAM: PURE CO2 + RECYCLED GAS			
DATE	PURCHASED CO2 FROM BIG THREE (LBS/CUFT)	RECYCLED PRODUCED GAS (LBS/CUFT)	CO2 HEADER I2A (LBS/CUFT)	CO2 HEADER I2C (LBS/CUFT)	CO2 HEADER I2F (LBS/CUFT)	AVERAGE OF ALL THREE HEADERS (LBS/CUFT)
01-May-92	56.9	35.8	52.6	52.5	52.9	52.7
02-May-92	56.9	37.4	53.1	52.9	53.1	53.1
03-May-92	56.8	37.4	53.1	52.7	53.3	53.0
04-May-92	56.8	37.8	53.5	52.9	54.0	53.4
05-May-92	56.7	36.9	52.7	52.6	53.4	52.9
06-May-92	56.7	38.0	53.4	52.9	53.9	53.4
07-May-92	56.7	37.9	53.6	52.9	53.8	53.4
08-May-92	*	38.4	53.4	52.5	53.6	53.2
09-May-92	*	34.1	53.9	53.3	54.5	53.9
10-May-92	*	34.4	53.9	52.9	54.3	53.7
11-May-92	*	34.7	53.1	52.6	53.6	53.1
12-May-92	56.3	35.9	52.7	52.6	53.1	52.8
13-May-92	56.4	35.2	53.2	52.8	53.6	53.2
14-May-92	56.4	34.6	53.3	52.8	54.1	53.4
15-May-92	56.2	36.2	53.2	52.4	53.1	52.9
16-May-92	56.3	37.7	52.9	52.3	53.5	52.9
17-May-92	56.2	37.1	52.4	51.8	52.8	52.3
18-May-92	56.1	36.8	52.6	51.9	53.0	52.5
19-May-92	56.1	36.5	52.8	52.1	53.4	52.7
20-May-92	56.2	38.1	53.3	52.4	53.4	53.0
21-May-92	55.9	37.8	53.2	52.8	53.7	53.2
22-May-92	56.5	38.6	53.1	51.3	52.5	52.3
23-May-92	56.3	37.9	53.8	52.4	53.9	53.3
24-May-92	56.1	35.5	54.2	53.1	55.1	54.1
25-May-92	56.2	34.5	53.8	53.1	54.7	53.9
26-May-92	56.4	37.3	54.1	52.8	54.2	53.7
27-May-92	56.3	36.8	53.8	53.2	54.2	53.7
28-May-92	56.4	37.2	55.0	53.9	55.6	54.9
29-May-92	56.5	36.2	53.6	52.0	53.3	53.0
30-May-92	56.4	36.3	54.2	53.3	54.4	53.9
31-May-92	56.3	35.0	53.4	52.6	53.7	53.2
						----
	* BAD DATA TRANSMISSION				MAY AVERAGE ------>	53.3

EXHIBIT E

MCA INJECTION HEADER CO2 DENSITIES
FROM DAILY DENSITOMETER READINGS

JUNE 1992
=========

			MIXED INJECTION STREAM: PURE CO2 + RECYCLED GAS			
DATE	PURCHASED CO2 FROM BIG THREE (LBS/CUFT)	RECYCLED PRODUCED GAS (LBS/CUFT)	CO2 HEADER I2A (LBS/CUFT)	CO2 HEADER I2C (LBS/CUFT)	CO2 HEADER I2F (LBS/CUFT)	AVERAGE OF ALL THREE HEADERS (LBS/CUFT)
01-Jun-92	56.4	36.2	53.8	52.5	53.5	53.3
02-Jun-92	56.4	37.4	53.8	52.9	54.1	53.6
03-Jun-92	56.2	36.8	52.9	52.4	53.0	52.8
04-Jun-92	56.2	35.6	53.2	53.2	53.6	53.3
05-Jun-92	56.1	35.8	52.4	52.0	52.3	52.2
06-Jun-92	56.1	37.2	53.0	52.1	52.6	52.6
07-Jun-92	56.1	37.4	53.3	52.4	52.9	52.9
08-Jun-92	56.0	37.5	52.9	52.4	53.0	52.8
09-Jun-92	56.0	35.9	52.9	52.2	52.9	52.6
10-Jun-92	55.9	35.6	52.2	51.8	52.4	52.1
11-Jun-92	55.8	35.7	52.2	51.7	52.1	52.0
12-Jun-92	55.9	36.2	52.4	52.0	52.4	52.2
13-Jun-92	55.7	35.5	52.1	51.9	52.2	52.1
14-Jun-92	55.6	35.4	51.7	51.6	51.8	51.7
15-Jun-92	55.6	35.6	51.7	51.5	51.8	51.7
16-Jun-92	55.5	35.7	51.7	51.5	51.9	51.7
17-Jun-92	55.4	34.8	51.3	51.2	51.6	51.4
18-Jun-92	55.3	34.9	51.3	51.4	52.0	51.6
19-Jun-92	55.3	35.6	51.1	50.8	51.2	51.0
20-Jun-92	*	36.9	50.4	49.3	51.4	50.4
21-Jun-92	*	37.2	51.1	50.9	51.6	51.2
22-Jun-92	*	35.9	51.9	51.2	52.4	51.9
23-Jun-92	*	34.8	51.3	50.9	52.0	51.4
24-Jun-92	*	34.6	51.5	51.3	52.0	51.6
25-Jun-92	*	35.3	51.7	50.8	52.1	51.5
26-Jun-92	*	36.0	51.8	50.9	51.9	51.5
27-Jun-92	*	35.4	51.2	50.6	51.4	51.1
28-Jun-92	*	35.2	51.2	50.9	51.9	51.3
29-Jun-92	*	34.1	51.0	50.0	51.0	50.7
30-Jun-92	*	32.4	48.5	46.5	47.5	47.5
						----
	* BAD DATA TRANSMISSION				JUNE AVERAGE ----->	51.8

MCA INJECTION HEADER CO2 DENSITIES
FROM DAILY DENSITOMETER READINGS

JULY 1992

			MIXED INJECTION STREAM: PURE CO2 + RECYCLED GAS			
DATE	PURCHASED CO2 FROM BIG THREE (LBS/CUFT)	RECYCLED PRODUCED GAS (LBS/CUFT)	CO2 HEADER I2A (LBS/CUFT)	CO2 HEADER I2C (LBS/CUFT)	CO2 HEADER I2F (LBS/CUFT)	AVERAGE OF ALL THREE HEADERS (LBS/CUFT)
01-Jul-92	*	32.6	47.6	47.6	48.2	47.8
02-Jul-92	*	32.1	50.3	50.2	51.4	50.6
03-Jul-92	*	32.6	50.2	49.5	50.4	50.0
04-Jul-92	*	33.1	49.9	49.4	50.2	49.8
05-Jul-92	*	33.5	50.0	49.4	50.5	50.0
06-Jul-92	*	33.2	49.4	48.9	49.8	49.4
07-Jul-92	*	33.3	49.9	49.0	50.1	49.7
08-Jul-92	*	33.1	49.2	48.1	48.9	48.7
09-Jul-92	*	32.8	49.9	49.4	50.5	49.9
10-Jul-92	*	33.3	48.2	48.1	49.4	48.6
11-Jul-92	*	33.6	49.7	49.3	50.2	49.7
12-Jul-92	*	32.7	50.4	49.3	50.8	50.2
13-Jul-92	*	32.3	49.8	48.9	50.0	49.6
14-Jul-92	*	31.2	49.7	49.8	51.0	50.2
15-Jul-92	*	31.4	49.5	49.3	50.5	49.8
16-Jul-92	*	32.3	49.0	46.6	48.4	48.0
17-Jul-92	*	33.5	50.8	49.5	50.5	50.2
18-Jul-92	*	32.0	50.2	49.4	50.7	50.1
19-Jul-92	*	35.6	51.0	50.4	51.7	51.0
					JULY AVERAGE ----->	49.6

* BAD DATA TRANSMISSION