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**U.S. Department of Energy
Pittsburgh Energy Technology Center**

**Refining and End Use Study of
Coal Liquids**

Contract No. DE-AC22-93PC91029

**Quarterly Report
January - March 1996**

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Section 1

Introduction and Summary

This report is Bechtel's tenth quarterly technical progress report and covers the period of January 1, 1996 through March 24, 1996.

1.1 Introduction

Bechtel, with Southwest Research Institute, Amoco Oil R&D, and the M.W. Kellogg Co. as subcontractors, initiated a study on November 1, 1993, for the U.S. Department of Energy's (DOE's) Pittsburgh Energy Technology Center (PETC) to determine the most cost effective and suitable combination of existing petroleum refinery processes needed to make specification transportation fuels or blending stocks, from direct and indirect coal liquefaction product liquids. This 47-month study, with an approved budget of \$4.4 million dollars, is being performed under DOE Contract Number DE-AC22-93PC91029.

A key objective is to determine the most desirable ways of integrating coal liquefaction liquids into existing petroleum refineries to produce transportation fuels meeting current and future, e.g. year 2000, Clean Air Act Amendment (CAAA) standards. An integral part of the above objectives is to test the fuels or blends produced and compare them with established ASTM fuels. The comparison will include engine tests to ascertain compliance of the fuels produced with CAAA and other applicable fuel quality and performance standards.

The final part of the project includes a detailed economic evaluation of the cost of processing the coal liquids to their optimum products. The cost analyses is for the incremental processing cost; in other words, the feed is priced at zero dollars. The study reflects costs for operations using state of the art refinery technology; no capital costs for building new refineries is considered. Some modifications to the existing refinery may be required. Economy of scale dictates the minimum amount of feedstock that should be processed.

To enhance management of the study, the work has been divided into two parts, the Basic Program and Option 1.

The objectives of the Basic Program are to:

- Characterize the coal liquids
- Develop an optimized refinery configuration for processing indirect and direct coal liquids
- Develop a LP refinery model with the Process Industry Modeling System (PIMS) software.

The work has been divided into six tasks.

- Task 1 - Development of a detailed project management plan for the Basic Program
- Task 2 - Characterization of four coal liquid feeds supplied by DOE
- Task 3 - Optimization of refinery processing configurations by linear programming

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- Task 4 - Pilot plant analysis of critical refinery process units to determine yield, product quality and cost assumptions. Petroleum cuts, neat coal liquids, and coal liquids/petroleum blends will be processed through the following process units: reforming, naphtha and distillate hydrotreating, catalytic cracking and hydrocracking.
- Task 5 - Development of the project management plan for Option 1
- Task 6 - Project management of the Basic Program and Option 1

The objectives of Option 1 are to:

- Confirm the validity of the optimization work of the Basic Program
- Produce large quantities of liquid transportation fuel blending stocks
- Conduct engine emission tests
- Determine the value and the processing costs of the coal liquids

This will be done by processing the coal liquids as determined by the optimization work, blending and characterizing the product liquids, and running engine emission tests of the blends. Option 1 has been divided into three tasks.

- Task 1 - Based on the pilot plant and linear programming optimization work of the Basic Program, production runs of pilot plants (hydrotreating, reforming, catalytic cracking, and hydrocracking) will be conducted to produce sufficient quantities for blending and engine testing.
- Task 2 - The pilot plant products will be blended, characterized, and engine tested
- Task 3 - An economic analysis will be conducted to determine the costs of processing the coal liquids through the existing refinery

Table 1-1 shows which organization has the primary responsibility for each task.

1.2 Summary

The major efforts conducted during the first quarter of 1996 were in the areas of:

- DL2 light distillate hydrotreating
- DL2 heavy distillate catalytic cracking

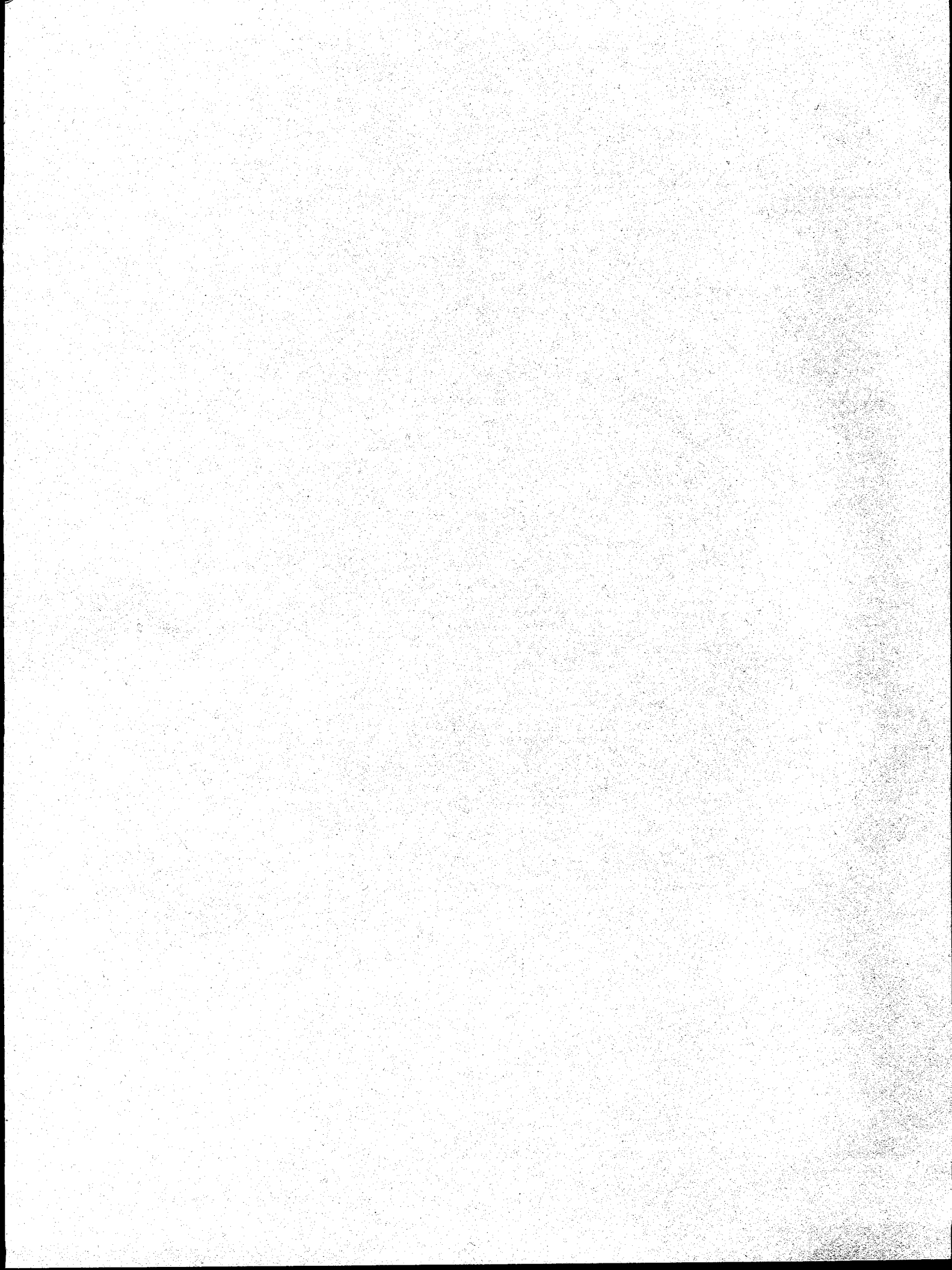
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Table 1-1 Project Task Primary Responsibility Chart

Task	Description	Bechtel	SwRI	Amoco	Kellogg
1	Project Management Plan (PMP) development	x			
2	Feed characterization		x		
3	Linear programming	x			
4	Pilot plant analysis - Cat cracking of DL liquids Cat cracking of indirect wax Hydrocracking of wax Fractionation, reforming, hydrotreating, etc.		x	x x	x
5	Option 1 PMP development	x			
6	Project management	x			
Option 1 - Task 1	Pilot plant production - Cat cracking of DL liquids and wax All other production work		x		x
Option 1 - Task 2	Fuel blending, characterizing, engine testing		x		
Option 1 - Task 3	Economic analysis	x			

x = key participant



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2.0 DL2 Light Distillate Hydrogenation Experiments

The objectives of these experiments were to hydrotreat DL2 light distillate and to obtain process data at various operating conditions. The data from this work will be used in the PIMS linear programming refinery model being developed by Bechtel.

The feedstocks for the experimental points in the run are as follows:

- DL2 light distillate cut, FL-2541 (350 to 500°F TBP).
- Petroleum kerosene hydrotreater feed, FL-2342.
- A blend of 33.3 vol% coal liquid FL-2541 and 66.7 vol% petroleum liquid FL-2342.
- For comparison, a few points were obtained with the DL1 light distillate, FL-2371. The run will not involve any DL1/petroleum blends.

2.1 Planned Test Conditions for DL2 Light Distillate Hydrotreating, Run 55

The results of previous hydrotreater runs were reviewed to define the test conditions necessary for the DL2 light distillate hydrotreating tests. The conditions of the DL1 heavy distillate run (No. 49) were too severe to observe a variation in sulfur removal. More than 90% sulfur was removed at all of the process conditions. The range of conditions were adequate to see a variation in nitrogen removal between 40% and 100%. The DL1 naphtha run (No. 51) results showed the opposite trends for heteroatoms. Sulfur removal varied from 74% to 91%, while virtually all of the nitrogen was removed at each of the conditions.

In considering significantly lower severity processing than in past experiments in this project, it is useful to review the equipment capabilities. Table 2-1 gives the practical extremes for flowrate, temperature, and pressure for the pilot plant.

The least severe condition available from the hydrotreating pilot plant seemed well below the threshold for minimal change to the feed stock. It is also less severe than conditions used in the in-line hydrotreater used during the production of the POC-2 product. Since previous runs showed the most severe conditions exceeded the requirements for processing DL1, and DL2 would seem to require even less severity than DL1, the intent for the DL2 processing is to set the hydrotreating severity from minimal effects on feed properties to sufficient severity to meet the product specifications. In addition, the test conditions should include typical refinery operating conditions which will be used in the LP model. Typical refinery conditions, however, may not coincide with any particular point of the experimental matrix, but are closest to points F-R-S or K-M defined below.

The lowest severity condition should make a minimal change in the most restrictive property. Jet A is a likely finished product, but grade 1D diesel fuel is also possible. Table 2-2 lists a few

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properties likely to be restrictive for either product, and the corresponding value for the neat DL2 light distillate stock.

Hydrotreating at high severity should provide a product meeting the aromatics and specific gravity limits. However, it was a concern that even at low aromatics levels (e.g. below 8%), neither the smoke point nor the cetane number specifications could be met. Should that result occur, it would still provide valuable information for the project. Therefore, the criteria for the highest severity point in the matrix was to reach either the smoke point, or cetane number specification, or, in lieu of those, reaching an aromatics concentration of less than 8%.

In addition to the properties listed in Table 2-2, it is frequently useful to have data on sulfur reduction, although the feed contains only 11 ppmw. Sulfur may be a sensitive indicator of minimal severity hydrotreating to decide if process conditions needed for the hydrogenation of the corresponding petroleum light distillate will accomplish desulfurization for the DL2 light distillate. Smoke point and cetane number analyses were chosen to review processing success; specific gravity and aromatics were measured on all samples, and low severity samples were analyzed for sulfur concentration. The experimental points are shown in Figure 2-1 as a wire-frame diagram in P-T-SV space.

The experimental matrix was modified from the normal rectangular array used in past work. The analyses of Yui and Sanford¹ indicate that aromatics hydrogenation is a reversible reaction, and that thermodynamic equilibrium limits conversion at high temperatures and low pressures. The DL2 light distillate contains an unusually high concentration of naphthenes (66%) which favors the reverse (dehydrogenation) reaction. If the reaction reverses, naphthenes would yield aromatics, and typically some coke on the catalyst. The product could be less likely to meet specifications than the feed. Since the conditions most likely to cause the reverse reaction occur at high temperature and low hydrogen partial pressure, the low-pressure face of the experimental space for varying temperature and LHSV was reduced in range from the 520-680°F used in common practice to only 520-650°F. The corresponding high-pressure face was thought to be adequate, and was left as in previous experiments.

The planned matrix of test conditions is shown in Table 2-3.

2.2 Experimental Results

The experimental sessions occurred before and after Christmas, 1995. The progress of the runs is depicted in Figures 2-2, 2-3, and 2-4. The first two plots represent the conditions during the first processing session, while Figure 2-4 shows the second session.

The process conditions from the operating log are reported in Table 2-4. For LP modeling purposes, petroleum data was required at point A. After obtaining point A, the feed was changed

1. S.M. Yui and E.C. Sanford (Syn crude Canada), "Kinetics of Aromatics Hydrogenation And Prediction of Cetane Number of Synthetic Distillates", Proceedings API Refining Department, May 1985.

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to the DL2 liquid, and point B was obtained at the same conditions as A. Points N, T, M, and the other points were from the matrix as shown.

After point B, the highest severity condition was determined. Because of the naphthenes, achieving severity by increasing pressure was more effective than by increasing temperature. Once points B and C were established, the remaining points were obtained without variation, and were done in alphabetical order.

Recorded in the Table 2-4 are feedstock identity, feed flow rate, system pressure, makeup hydrogen flow rate, and average reactor temperature for each point on the experimental matrix. The analyses of the liquid samples obtained at each point are presented in Table 2-5. The principal measurements were density, hydrogen content, sulfur concentration, nitrogen concentration, and smoke point. The results for heteroatom removal are discussed in the next section.

2.3 Discussion of Results

Sulfur Removal

At the completion of Run 55, all samples were analyzed for sulfur and nitrogen. All the sulfur results were less than 2 ppmw and near the analytical detection limit. Since the sulfur concentration in the feedstock was only 13 ppmw, the removal was essentially complete.

Nitrogen Removal

The DL2 feed contained 64 ppmw nitrogen, and the product nitrogen concentrations varied from 61 to less than 2 ppmw over the range of process severities. The nitrogen variation in the experiments can be examined graphically for each face of the three dimensional experimental space. Figures 2-5 through 2-10 show the nitrogen contents as curves of constant concentration versus severity. It should be noted that the small wiggles in the contour lines are not specific depictions of the data; that is, they are artifacts of the plotting software, which arise when it is used with a data set of limited size.

The variation in nitrogen concentrations over the 500 psig face, is shown in Figure 2-5. The results indicate that nitrogen removal is strongly dependent on both LHSV and temperature. The upper right region of the plot corresponds to higher processing severity than the lower left region. The closer contour spacing in the upper right portion of the diagram means that the dependence is stronger there. That is, a given change in either temperature or LHSV provides more change in nitrogen concentration in the high-severity region than in the low-severity region.

Figure 2-6 shows the corresponding results at 2000 psig. At the higher pressure, the dependence of nitrogen removal on temperature is less pronounced. In addition, the dependence on severity is only slightly stronger in the high-severity region of the plot, (i.e. in the upper right) than in the lower severity region.

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Figures 2-7 and 2-8 show the nitrogen concentration dependence on pressure and temperature at low and high space velocities, respectively. At 1.0 Hr^{-1} LHSV, the pressure dependence is small; most of the change in nitrogen removal results from temperature change. In contrast, Figure 2-8 shows a fairly linear dependence on both parameters at 4.0 Hr^{-1} LHSV over the experimental range.

Figures 2-9 and 2-10 show the low and high temperature faces of the experimental space. The results show marked LHSV dependence in each temperature range, but only a slight pressure dependence. Over the whole range of experiments, the generally weak pressure dependence was untypical of an analogous petroleum stock and unexpected from experience with DL2.

The petroleum-coal liquid blend was not completely denitrogenated at the high-severity corner of the 500 psig face (500 psig, 650 °F, and 1 Hr^{-1} LHSV) as was the coal liquid. The blend started with nitrogen concentration at 25 ppmw, and was reduced to 10 ppmw at the same corner. It was further reduced to 3 ppmw when the pressure was increased to 2000 psig. Compared to most commercial hydrotreating, these are low concentrations.

The concentrations of both sulfur and nitrogen in the pilot plant streams were so small, they frequently did not show up in the gas analyses made during the experiments. As a result, the elemental balances with respect to the gas samples were not meaningful. The overall mass balances have been calculated for both the coal liquid and blend experiments. The complete table is too extensive to include in its entirety here, but Table 2-6 summarizing the main results, is presented. The average deviation from closure was about 6 wt.%.

Aromatics Reduction

For use in jet fuel and diesel fuel, the aromatics should be lower than the 24.0 vol% of the light distillate feedstock. The limit for jet fuel use of 22.0 vol% maximum was readily achieved in the matrix of process conditions. The aromatic contents shown in Table 2-5 show a decrease of 0 - 3 vol% or more. (The value of 7 vol% for point C should be checked more carefully.) Other properties for jet fuel use may be obtained by blending. For example, the density of the light distillate products is high, probably from cycloparaffins. The smoke point is improved slightly over the feed and would meet the specification at point C.

This range of aromatics reductions also is reasonable for using the hydrotreated light distillate as a diesel blend stock. Although there is no national aromatics specification at this time, one could be imposed nationally as was done in California.

Cetane Number Control

The change in the cetane number due to hydrotreating was determined by calculating the cetane index of the feed and hydrotreated products. The cetane index of the neat light distillate is 27.6, while the cetane number is 32. The improvement in cetane index across the experimental matrix, 0 - 2.4, (as indicated by the average of cetane indices by ASTM D 976 and D 4737) was not

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enough to meet the cetane number specification minimum of 40 for D1 grade. It should be noted, however, that the difference between the cetane index and the cetane number values seen in the feed material also should be true for the hydrotreated products as well. Therefore, the cetane numbers of the hydrotreating products should be 4 to 5 points higher than the cetane index values shown in Table 2-5. In summary, the products should be acceptable diesel blending components, particularly considering the low heteroatom content.

2.4 Summary

The difficulty observed in the results for partially altering the very low heteroatom contents of the DL2 light distillate and the subsequent difficulty of measuring the low sulfur and nitrogen concentrations thus produced are both indications of the effectiveness of the POC-2 production procedure. The desirable properties of the neat DL2 light distillate are presumably the result of the in-line hydrotreater and/or the switch to western coal. These results show the suitability of the DL2 light distillate for refining with petroleum into specification transportation fuels.

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Table 2-1. Extremes in available processing conditions

Parameter				Units	Maximum	Minimum
Temperature				F	~950	280
Liquid Flow				Pump 1, gph	3.0	0.1
				Pump 2, gph	1.6	0.1
				Total, bbl/H	0.109	0.0024
Vessel volumes, gallons	Vessel**	Empty	Packed	Hr ⁻¹		
	G & R	2.15	1.56		2.9	0.06
	R	1.16	1.05		4.4	0.09
	S	0.507	0.38		7.9	0.26
Pressure				psig	2500	400*
Hydrogen Flow				Makeup, scfh	75	0
				Recycle, scfh	250	25
Contacting Rate				SCFB	>5000	230
* Lower pressures for reforming are arranged by special adjustments						
** G - guard bed, R - main reactor, S - small reactor						

Table 2-2. Properties restricting use of untreated light distillate

Type	Description	ASTM Test No.	Property Limit	Neat DL2 Lt. Distillate
Jet A	Aromatics Volume %, Max	D 1319	22	24.0
Jet A	Specific Gravity, Range	D 1298/D 4052	0.775 to 0.840	0.8638
Jet A	Smoke Point, mm, Min*	D 1322	25*	14.5
Diesel 1D	Cetane Number, Min	D 613	40	32
* The minimum value may be 19, if the naphthalenes (D 1840) meet a 3 volume % limit.				

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Table 2-3. Planned test sequence for DL2 light distillate hydrotreating

Item	Operation	Feed	LHSV	Pres., psi	Temp. °F
A	Start-up, initial data	KTFpet	1.0	500	650
B	Test Reverse Reaction	LD1c, DL2	1.0	500	650
C	Coal Liquid Process Data	LD1c, DL2	1.0	2000	680
D	Coal Liquid Process Data	LD1c, DL2	1.0	2000	520
E	Coal Liquid Process Data	LD1c, DL2	1.0	500	520
F	Coal Liquid Process Data	LD1c, DL2	4.0	500	520
G	Coal Liquid Process Data	LD1c, DL2	4.0	2000	520
H	Coal Liquid Process Data	LD1c, DL2	2.5	2000	600
I	Coal Liquid Process Data	LD1c, DL2	2.5	1250	593
J	Coal Liquid Process Data	LD1c, DL2	2.5	500	585
K	Coal Liquid Process Data	LD1c, DL2	4.0	500	650
L	Coal Liquid Process Data	LD1c, DL2	4.0	2000	680
M	Blend Process Data	LD1c, DL2/ KTFpet	4.0	500	650
N	Blend Process Data	LD1c, DL2/ KTFpet	1.0	500	650
O	Blend Process Data	LD1c, DL2/ KTFpet	1.0	2000	680
P	Coal Liquid Process Data	LD1c, DL1	1.0	2000	680
Q	Coal Liquid Process Data	LD1c, DL1	2.5	1250	593
R	Coal Liquid Process Data	LD1c, DL1	4.0	500	520
S	Coal Liquid Process Data	LD1c, DL1	4.0	500	520
T	Petroleum Process Data	KTFpet	4.0	500	520
U	Petroleum Process Data	KTFpet	1.0	500	650
V	Exptl Sample for FCC	DL2,HD1	1.0	2000	680
W	Petroleum Process Data	KTFpet	1.0	500	650

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Table 2-4. Actual DL2 light distillate test conditions

Item	Feed		GPH*	Psig	Make-up H ₂ , SCFH	Temp. °F
*	FL-2342	KTFpet	~1.0	500	24.2	650
A	FL-2342	KTFpet	0.22	500	6.0	649
B	FL-2541	LD1c	0.23	499	6.0	641
C	FL-2541	LD1c	0.22	2000	6.0	679
D	FL-2541	LD1c	0.17	1995	6.0	520
E	FL-2541	LD1c	0.22	500	6.0	521
F	FL-2541	LD1c	0.84	500	24.2	521
G	FL-2541	LD1c	0.84	2004	24.2	519
H	FL-2541	LD1c	0.50	2005	15.1	598
I	FL-2541	LD1c	0.52	1250	15.1	590
J	FL-2541	LD1c	0.54	501	15.1	580
K	FL-2541	LD1c	0.85	500	24.2	644
L	FL-2541	LD1c	0.84	2000	24.2	681
M	Blend	LD1c+ KTFpet	0.83	499	24.2	649
N	Blend	LD1c+ KTFpet	0.21	490	6.0	650
O	Blend	LD1c+ KTFpet	0.21	1992	6.0	676
P	FL-2371	DL1,KTFc	0.20	2000	6.0	678
Q	FL-2371	DL1,KTFc	0.53	1250	14.0	592
R	FL-2371	DL1,KTFc	0.85	500	24.1	520
S	FL-2371	DL1,KTFc	0.21	500	6.0	680
T	FL-2342	KTFpet	0.83	500	24.5	520
U	FL-2342	KTFpet	0.21	500	6.0	650
V	FL-2539	DL2,HD1	0.24	2000	5.9	680
W	FL-2342	KTFpet	0.24	502	6.0	636

* Catalyst volume = 0.21 gal

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SAMPLE No.	Log Bk/Pg	Temp F Rx Avg	Feed Rates	Pressure Psig	Density SpGr	H ₂ M% NMR	Sulfur PPM	Nitrogen PPM	Equivalent Arom vol%	Cet. Index D976/D4737	Smoke Pt mm
A-16	33-14	649	0.220	499	0.8042	14.08	0.95	1.3	17.0	46.1/47.6	22.0
B-26	33-19	641	0.220	490	0.8612	12.94		1.4	23.8	28.2/28.6	14.4
C-35	33-24	679	0.220	2000	0.8495	13.63	0.5	1.8	7.0	31.8/32.3	23.7
D-46	33-30	520	0.170	1996	0.8593	13.06		36.6	21.0	28.8/29.2	15.2
E-54	33-34	522	0.220	501	0.8621	12.85	<0.1	46.3	23.6	28.0/28.3	14.9
F-65	33-38	521	0.830	499	0.8635	12.90	1.44	61.4	24.1	27.6/27.9	15.0
G-72	33-43	520	0.830	2004	0.8632	12.61	0.67	56.1	23.6	27.6/28.0	15.2
H-80	33-45	599	0.500	2005	0.8616	12.70		34.7	21.8	28.1/28.5	15.2
I-90	33-47	591	0.523	1249	0.8626	12.62	<0.1	42.1	23.2	27.8/28.2	16.1
J-96	33-50	579	0.535	498	0.8634	12.62	<0.1	46.1	24.1	27.6/28.0	15.7
K-105	33-53	642	0.847	499	0.8639	12.57	<0.1	41.2	23.2	27.4/27.8	15.1
L-112	33-56	679	0.847	2000	0.8607	13.01		26.4	21.0	28.4/28.8	15.4
M-120	33-59	649	0.825	499	0.8271	13.65	0.94	10.2	21.6	38.6/39.7	16.3
N-130	33-65	650	0.217	499	0.8268	13.75	<0.1	3.7	21.5	38.2/39.5	16.3
O-138	33-70	671	0.214	2005	0.8165	14.21	0.29	<1	6.0	41.5/42.9	22.1
P-165	34-11	678	0.204	2000	0.8613	15.52		1.1	34.2	29.2/29.4	15.0
Q-173	34-17	592	0.529	1248	0.8740	12.19		344	58.0	25.6/25.7	11.3
R-188	34-29	520	0.850	500	0.8753	12.36		629	59.1	25.3/25.3	11.1
S-155	34-4	680	0.214	500	0.8672	12.27		29.4	58.7	27.5/27.6	11.2

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SwRI Activities**Table 2-5. (cont'd) Feed and product properties - light distillate hydrotreating**

SAMPLE No.	Log Bk/Pg	Temp F Rx Avg	Feed Rates	Pressure Psig	Density SpGr	H ₂ M% NMR	Sulfur PPM	Nitrogen PPM	Equivalent Arom vol%	Cet. Index D976/D4737	Smoke Pt mm
T-195	34-32	520	0.835	499	0.8092	12.82		20.2	20.5	44.0/45.5	21.3
U-205	34-39	650	0.206	500	0.8068	13.96		1.1	18.5	45.0/46.5	24.2
V-177	34-18	680	0.240	1999	0.8993	12.55		20	20.7	38.2/39.1	13.2
W-147	33-80	636	0.240	502	0.8989	13.96		1.1	18.6	43.8/45.3	23.3
FL-2342	33-2	-	-	-	0.8101	13.74	1490	5	20.5	43.6/45.1	22.3
FL-2541	33-15	-	-	-	0.8639	12.79	11	66	24.0	27.4/27.8	14.5
Blend	33-56	-	-	-	0.8218	13.45	997	24	21.7	40.0/41.2	16.6
FL-2371	33-65	-	-	-	0.8762	12.18	230	605	58.7	25.0/25.1	10.9
FL-2539	-	-	-	-	0.9139	12.27	21	43	36.8	34.9/34.6	12.5

Section 2

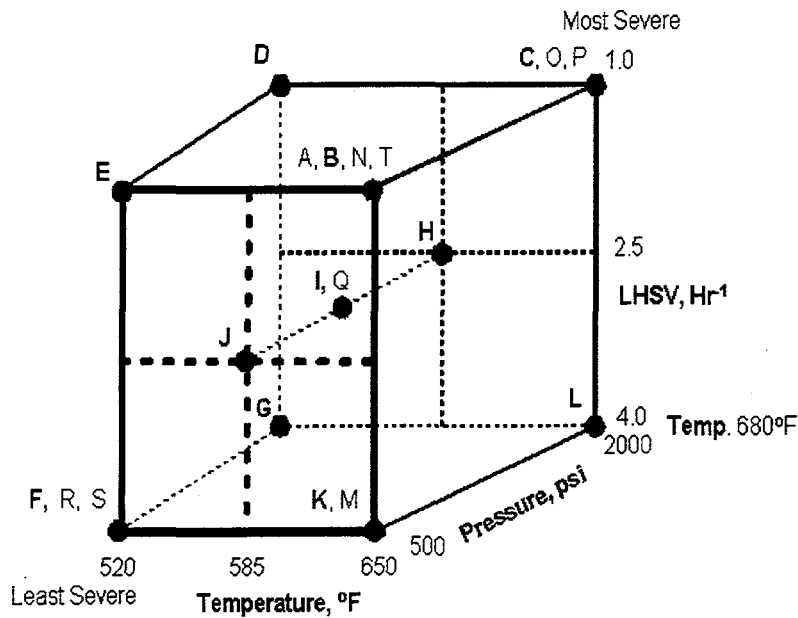
SwRI Activities**Table 2-6. Summary of mass balances for hydrotreating experiments with DL2 light distillate**

Run No./ Feed	Liq Feed Sp. Gr.	React. Temp F	React. psig	LHSV	Gas Feed SCF/Bbl	Recycle SCF/Bbl	Cons. SCF/Bbl	Liq Feed Lbs	Tot. Feed Wt%	Btm Liq Sp. Gr.	Btm Liq Lbs	Btm Liq Gal	Total Product Lbs	Total Product Gal	Gain Wt%
55A/pet	0.8101	649	500	1.04	1219	2290	581	6.01	102.3	0.8042	5.69	0.849	6.20	0.918	2.1
55B/coal	0.8634	641	500	1.08	1284	1806	650	6.31	102.4	0.8612	6.51	0.909	6.88	0.922	6.6
55C/coal	0.8634	678	2000	0.79	1504	2362	958	2.85	102.8	0.8495	2.73	0.386	2.85	0.394	-3.0
55D/coal	0.8634	520	1999	0.80	1488	2485	769	3.79	102.8	0.8593	4.14	0.579	4.39	0.587	12.9
55E/coal	0.8634	521	497	1.07	1113	1827	478	5.66	102.1	0.8621	5.92	0.824	6.31	0.839	9.2
55F/coal	0.8634	521	500	3.97	1483	2414	629	14.62	102.3	0.8635	15.41	2.145	15.69	2.151	5.0
55G/coal	0.8634	519	2000	3.67	1328	2587	753	24.55	102.5	0.8632	25.21	3.513	25.64	3.518	1.9
55H/coal	0.8634	597	2001	2.35	1272	2553	969	14.85	102.4	0.8616	15.53	2.168	15.77	2.177	3.8
55I/coal	0.8634	590	1250	2.41	1235	2498	980	19.88	102.3	0.8626	20.86	2.908	21.13	2.924	3.9
55J/coal	0.8634	580	500	2.51	1206	2410	658	20.33	102.3	0.8634	21.56	3.003	22.12	3.107	6.0
55K/coal	0.8634	642	520	4.02	1179	2403	641	23.81	102.2	0.8639	24.89	3.465	25.32	3.485	4.1
55L/coal	0.8634	678	2000	3.72	1346	2584	771	32.45	102.5	0.8607	33.40	4.667	34.12	4.679	2.6
55M/blend	0.8280	649	500	3.94	1044	2098	629	35.01	102.3	0.8272	37.79	5.489	38.91	5.545	8.7
55N/blend	0.8280	650	500	1.20	1005	1994	383	6.82	101.9	0.8268	6.10	0.894	6.75	0.940	-3.6
55O/blend	0.8280	672	1944	1.04	1154	5816	849	3.00	102.1	0.8165	2.60	0.382	2.63	0.382	-14.7

Section 2

SwRI Activities

Figure 2-1 Test matrix for DL2 light distillate hydrotreating

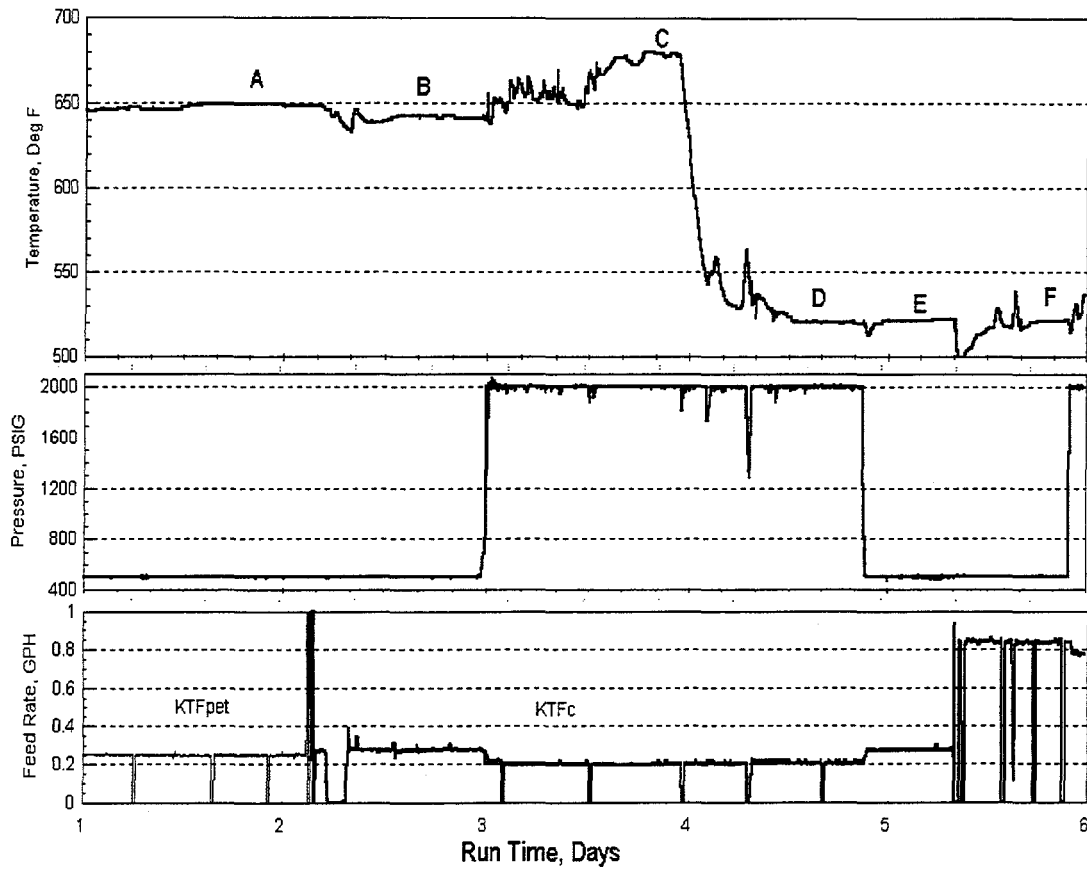


DL2:	{ A, S, and T use LD1pet M, N, and O use LD1b P, Q, and R use LD1c }
DL1:	

Section 2

SwRI Activities

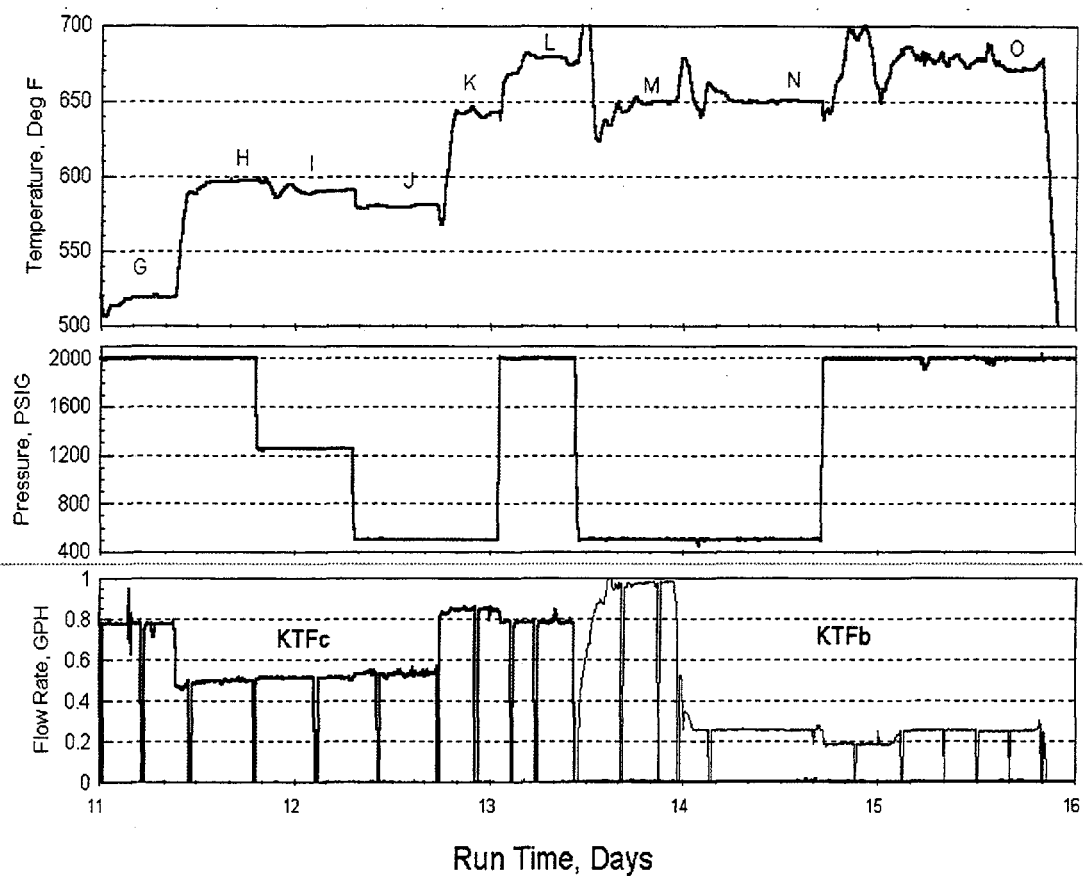
Figure 2-2 Timeline for DL2 light distillate hydrotreating, beginning of Run 55



Section 2

SwRI Activities

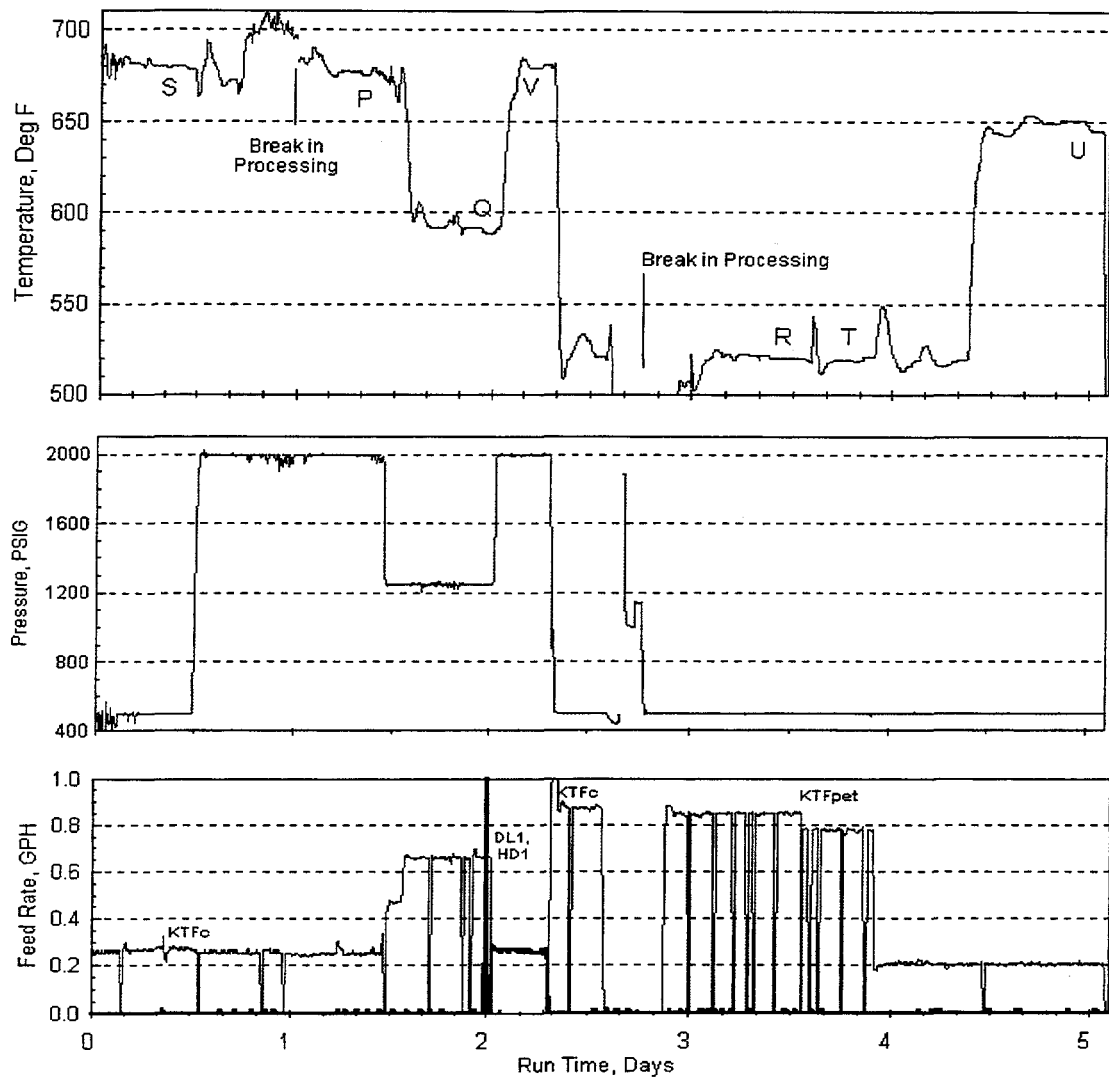
Figure 2-3 Timeline for DL2 light distillate hydrotreating, end of first session of Run 55



Section 2

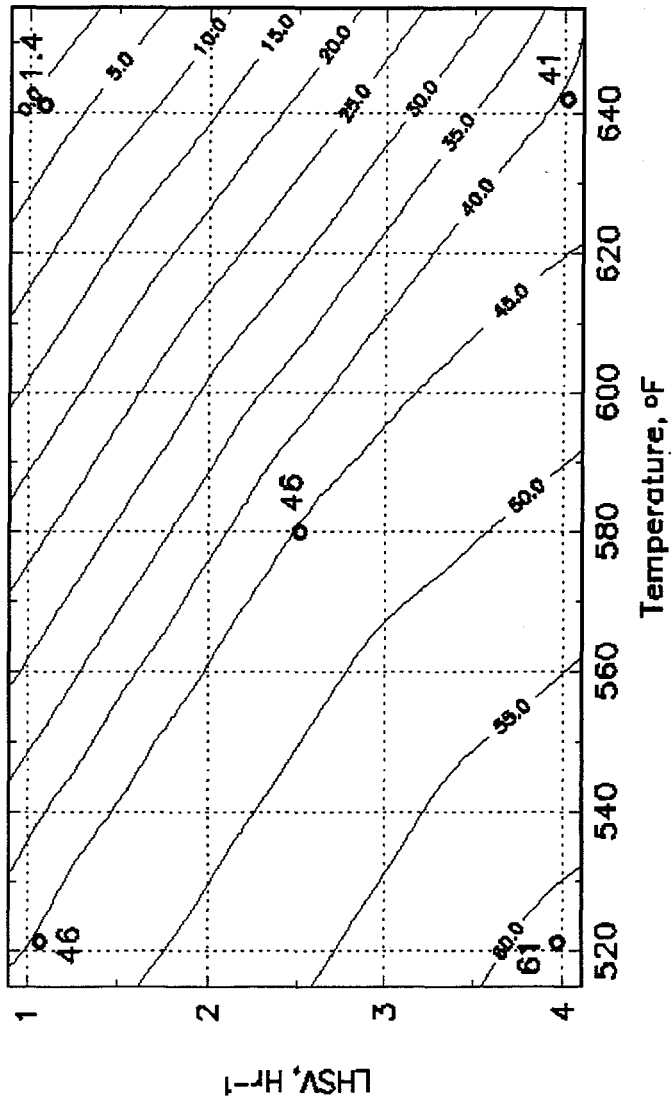
SwRI Activities

Figure 2-4 Timeline for DL2 light distillate hydrotreating, end of Run 55



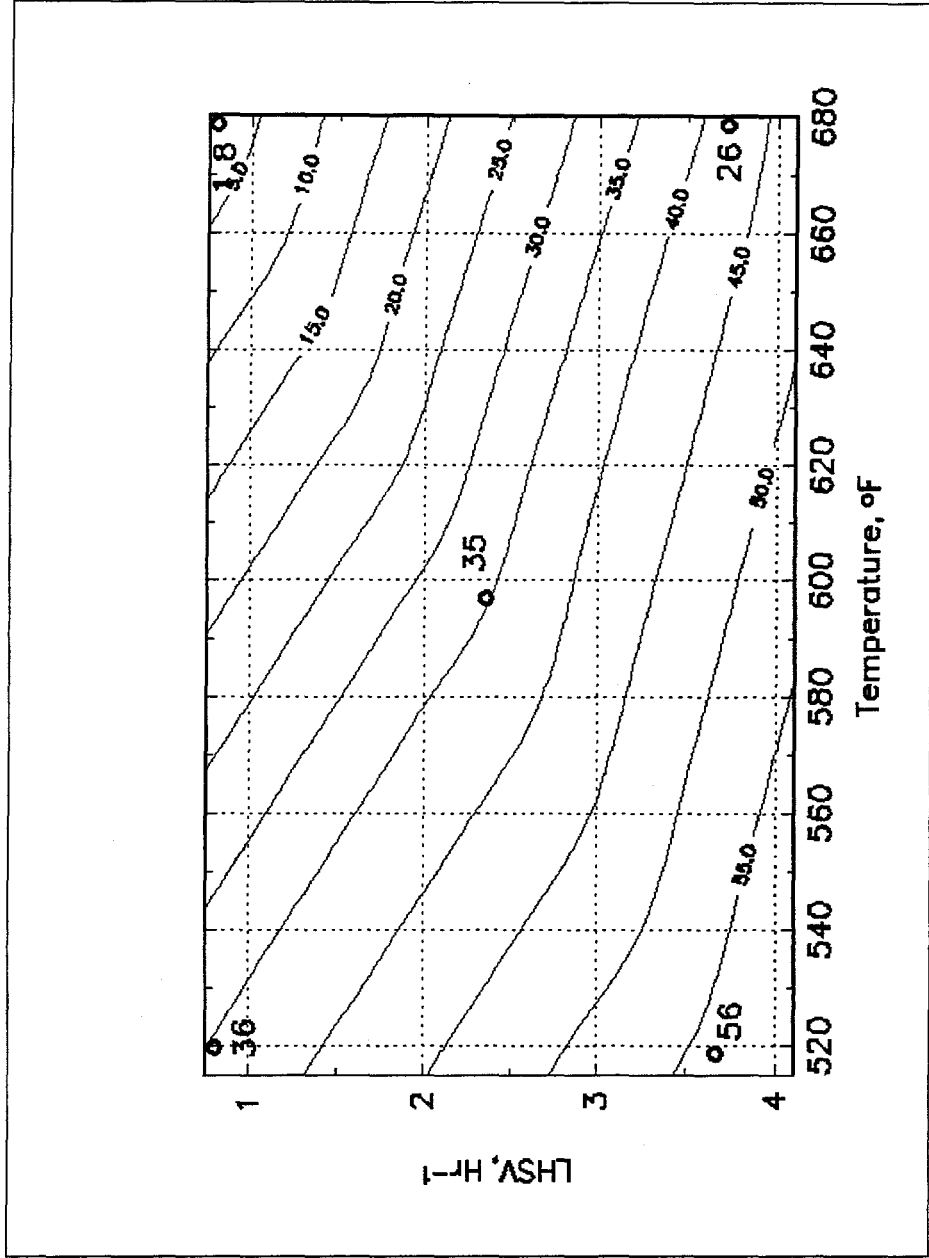
SwRI Activities

Figure 2-5 Contours of nitrogen concentration, ppmw - temperature vs. LHSV at 500 psig



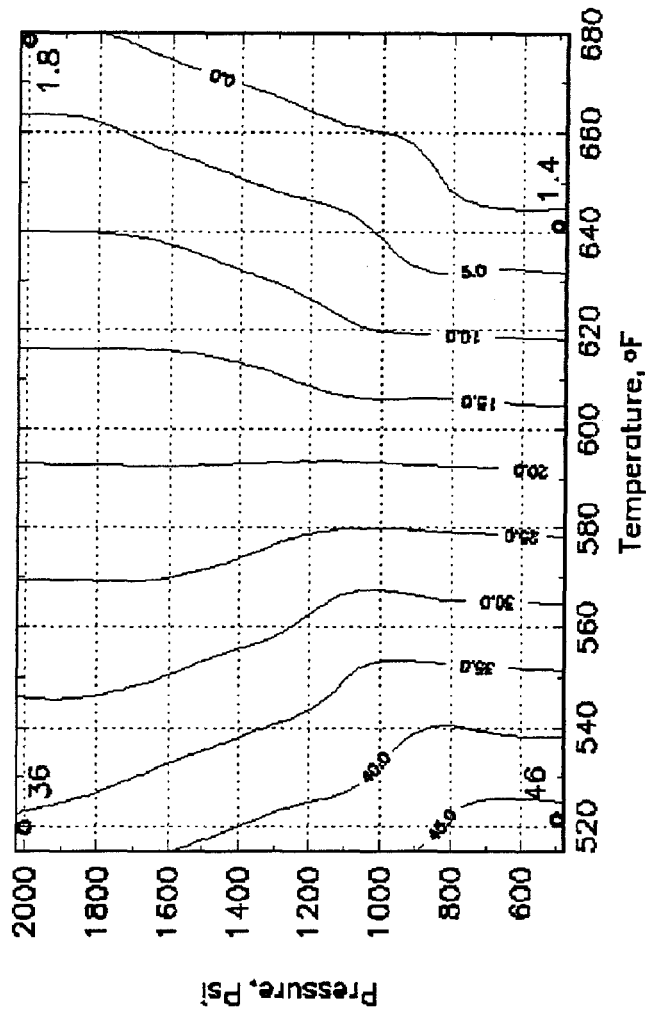
SwRI Activities

Figure 2-6 Contours of nitrogen concentration, ppmw - temperature vs. LHSV at 2000 psig



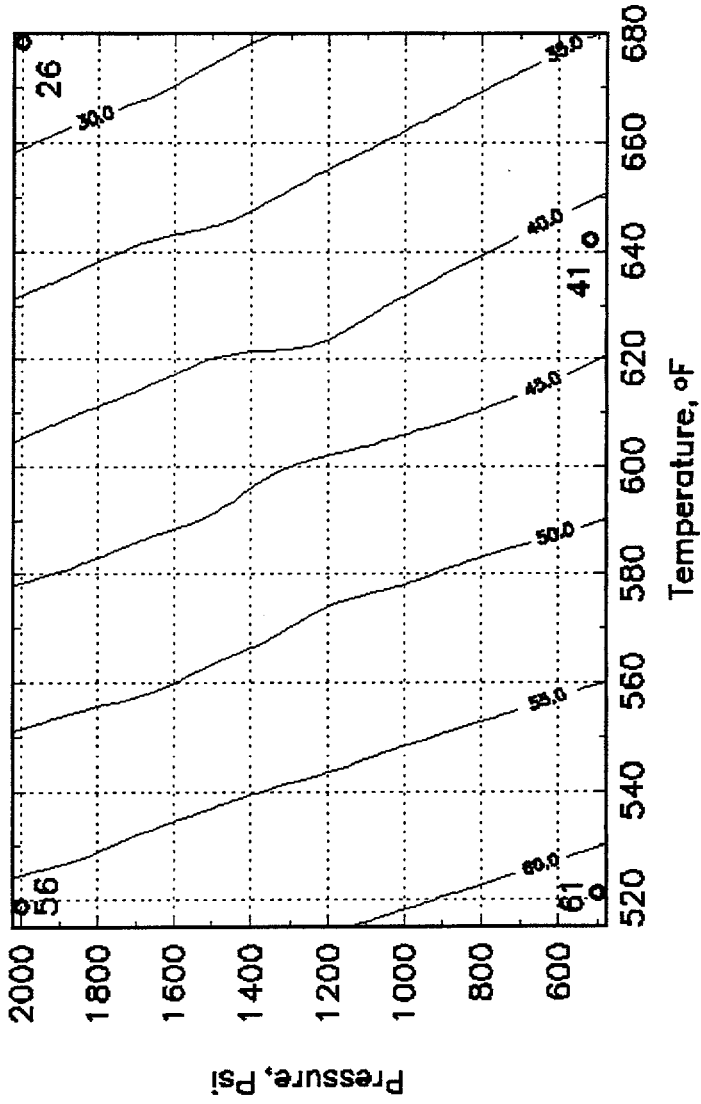
SwRI Activities

Figure 2-7 Contours of nitrogen concentration, ppmw - temperature vs. pressure at 1.0 hr^{-1} LHSV



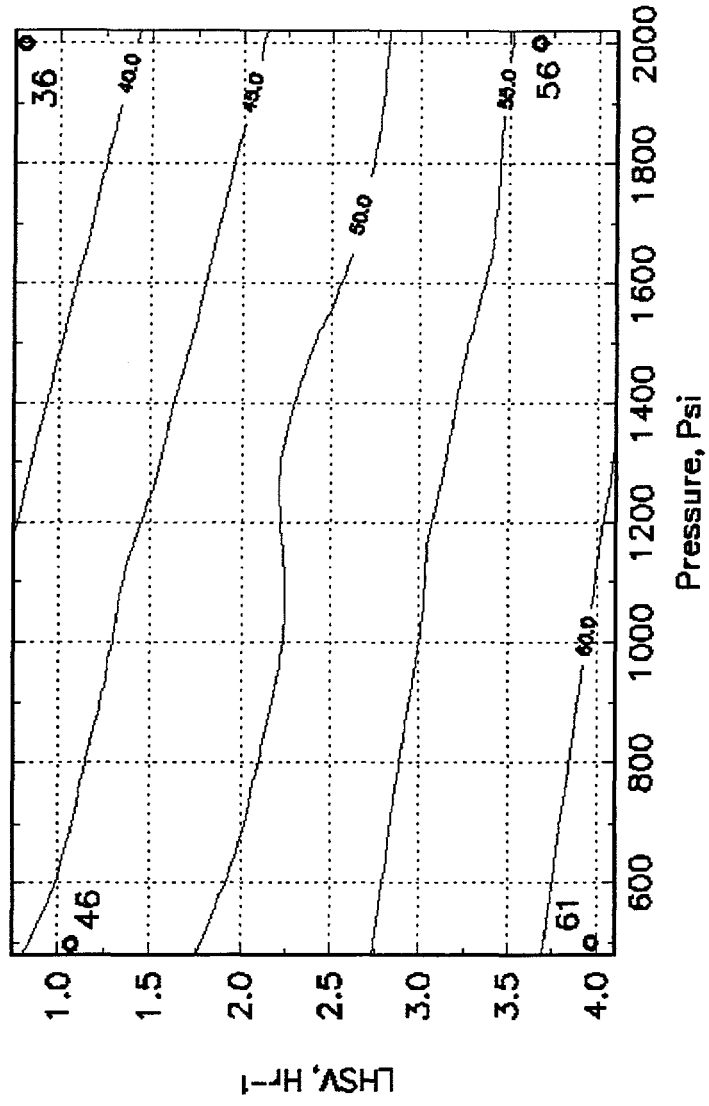
SwRI Activities

Figure 2-8 Contours of nitrogen concentration, ppmw - temperature vs. pressure at 4.0 hr⁻¹ LHSV



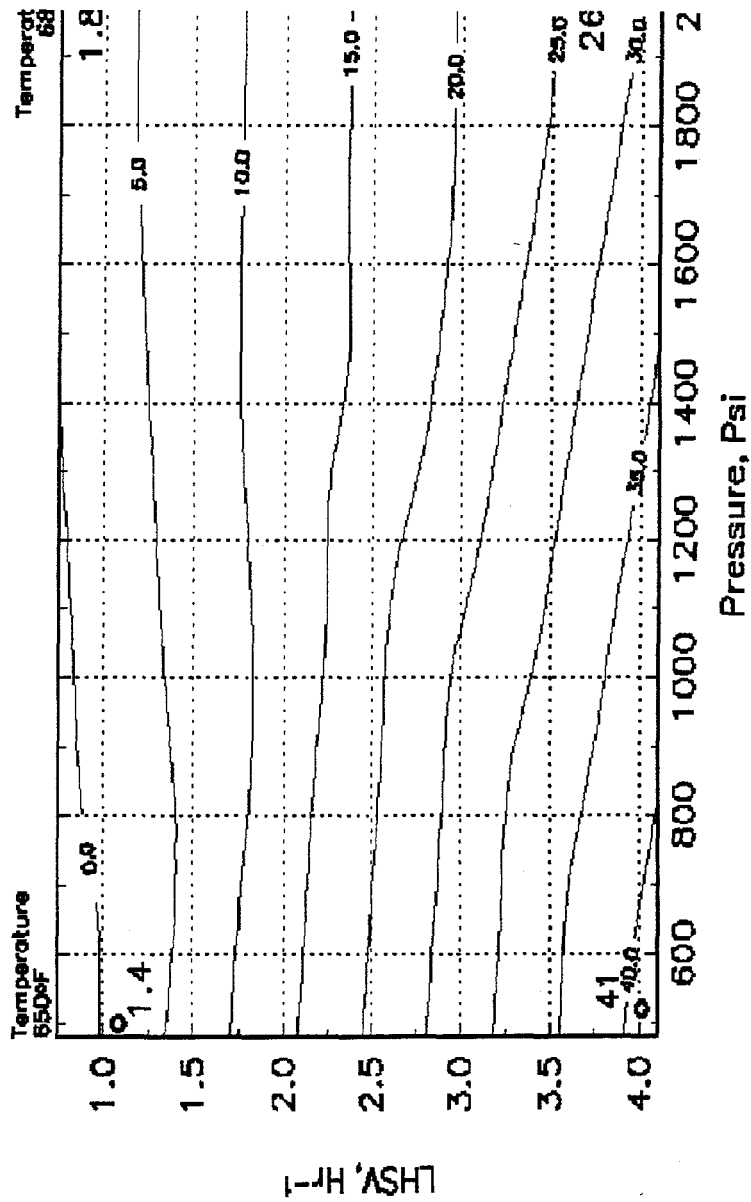
SwRI Activities

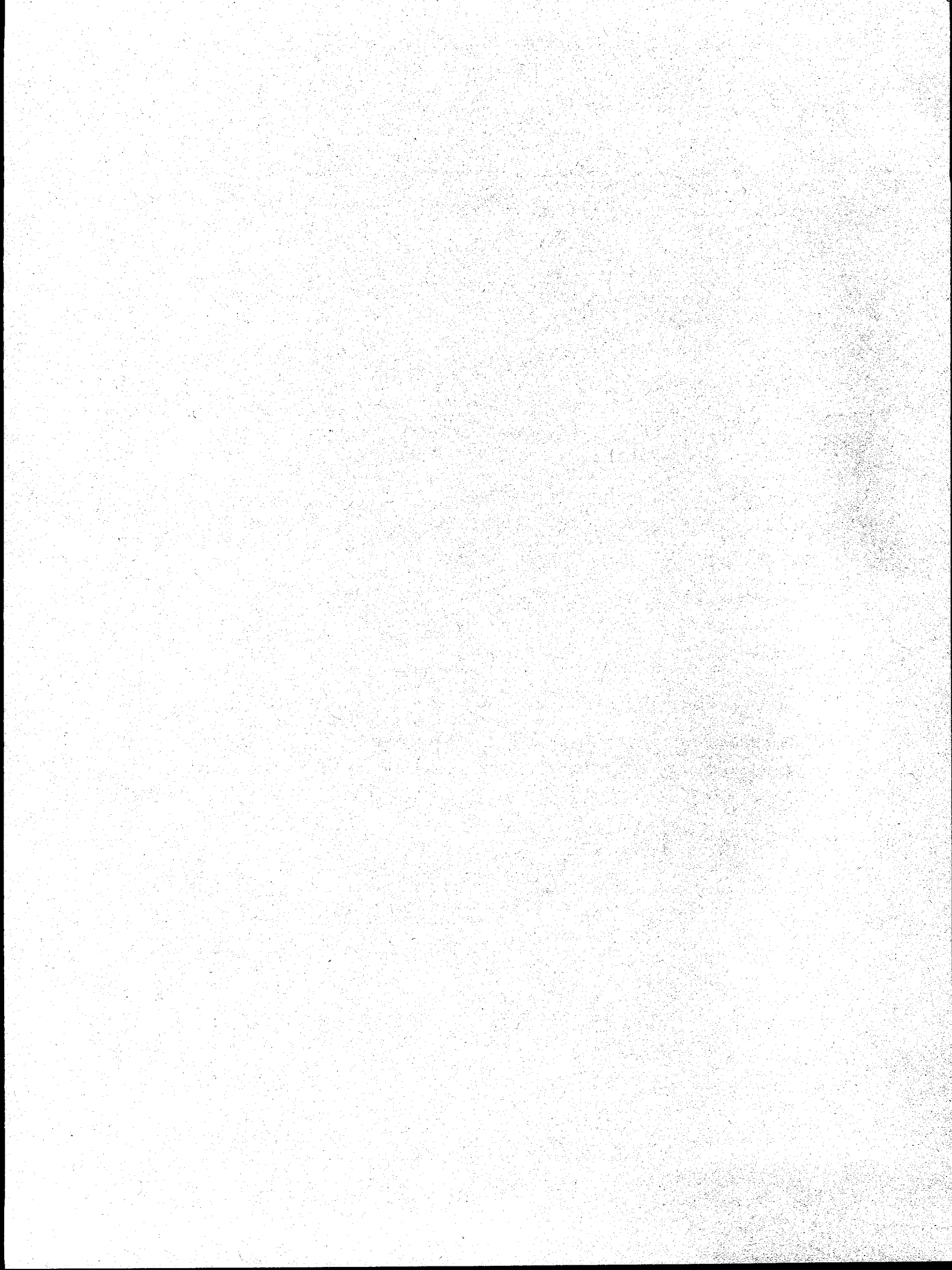
Figure 2-9 Contours of nitrogen concentration, ppmw - pressure vs. LHSV at 520°F



SwRI Activities

Figure 2-10 Contours of nitrogen concentration, ppmw - pressure vs. LHSV at 650-680°F



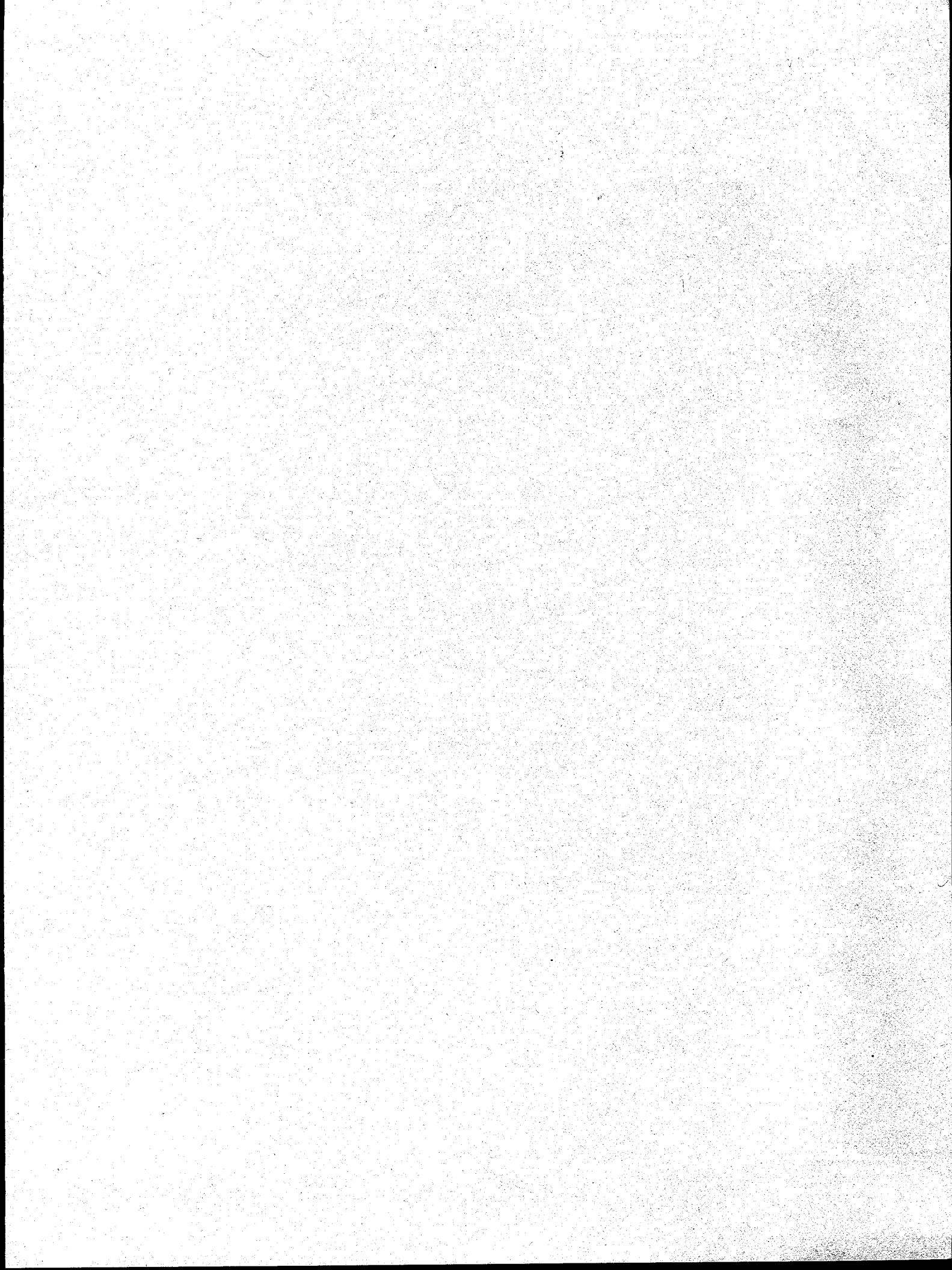


Section 3

Bechtel Activities

3.1 Linear Programming Model - Task 3

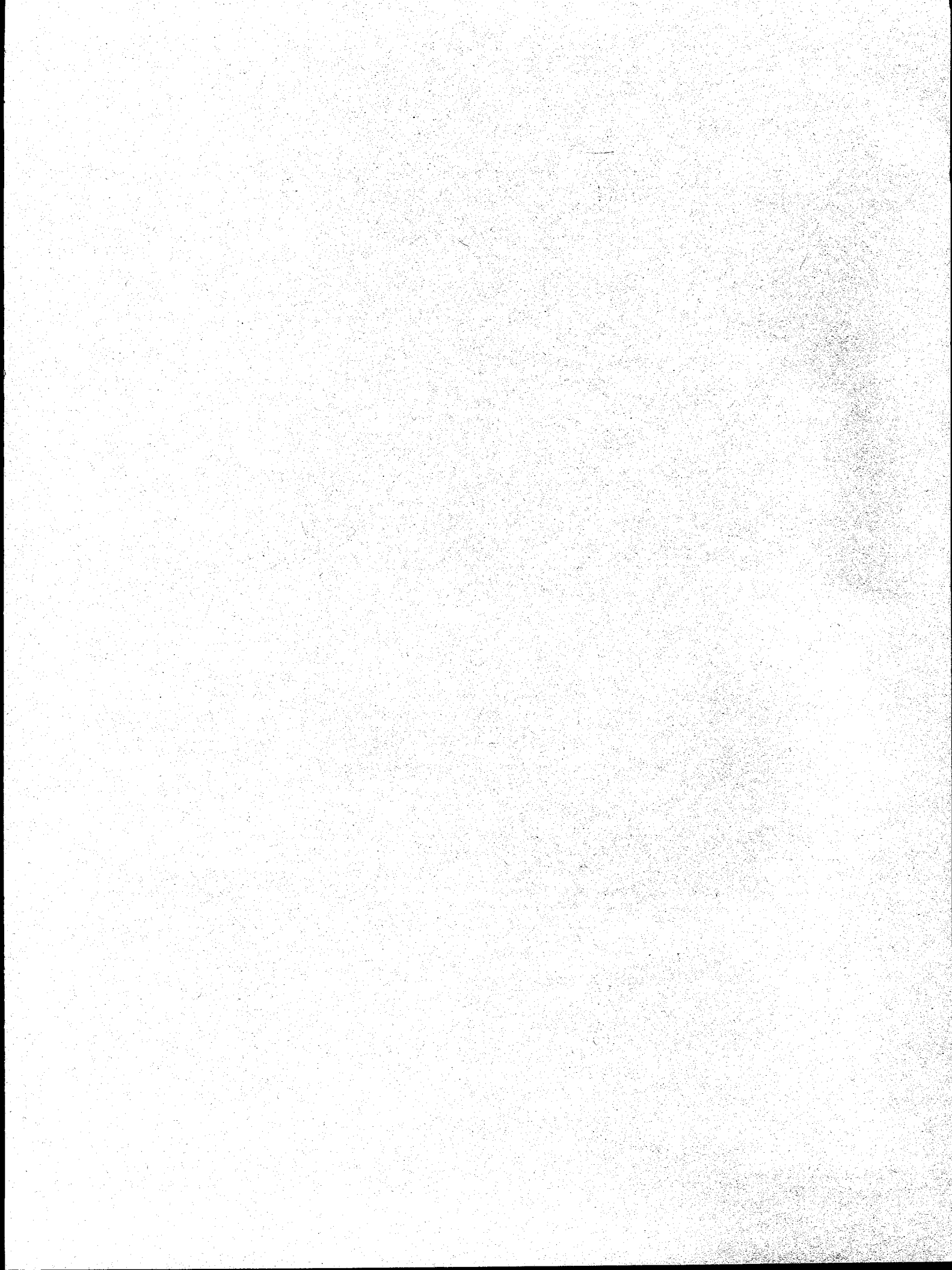
A report on the design basis of the linear programming model for direct coal liquids is being developed.



Section 4

Amoco Activities

There was no project activity for this reporting period.



Section 5

M.W. Kellogg Activities

5.1 Summary - DL2 Heavy Distillate Catalytic Cracking

A MAT (micro activity test) program was carried out to compare catalytic cracking of DL2 neat heavy distillate and DL2 heavy distillate that was hydrotreated at the Southwest Research Institute. The effect of cracking temperature on yields and quality was also studied by making runs at both 970°F and 1010°F. Additionally, to relate these data to the work carried out with DL1 coal liquids in the Kellogg MAT and pilot plant tests of 1995 (April-June 1995 Quarterly progress report), control runs with the same Amoco VGO as was used for baseline data last year were incorporated in the program. All data were plotted and regressed to obtain yields for the products of economic interest as a function of catalyst/oil ratio. Heat balance calculations were made for each feed at each temperature at previously specified operating conditions in order to compare yields at the appropriate cracking severity. GCOCTANE and PIANO analyses have been obtained on products of runs made near these conditions. Data are compared to similar data with DL1 feeds.

The Kellogg pilot plant was then run at the conditions established for heat balance with the VGO at a cracking temperature of 980°F and held at these conditions for runs with the DL2 heavy distillate liquid and with a blend of the two feeds. Yield data have been obtained by GC analysis, and the debutanized products have been shipped to SwRI for distillation and determination of the engine octanes. Preliminary data are compared to similar data with the hydrotreated DL1 feed that was run last year.

The pilot plant results indicate that gasoline yields with neat DL2 heavy distillate are almost identical to those obtained with the severely hydrotreated DL1 heavy distillate. From data supplied by SwRI, it appears that the hydrogen content of the DL2 heavy distillate (12.27%) matches that of the severely hydrotreated DL1 heavy distillate (12.23%). This is in line with the correlation made with coal liquids last year between hydrogen content and gasoline yield

The MAT results at 1010°F show significant losses in gasoline yield counteracted by increases in GCOCTANES and LPG yields with the DL2 heavy distillate. The hydrotreated heavy distillate produced substantially more gasoline than the neat heavy distillate. Temperature effects are similar, but the hydrotreated material did not show higher LPG yields at the higher temperature. These data should prove useful for economic projections.

5.2 Experimental

5.2.1 MAT

Feedstocks for the MAT runs were Amoco VGO (F-9819), neat DL2 heavy distillate (F-9888) and hydrotreated DL2 heavy distillate prepared by SwRI (F-9907). The catalyst was equilibrium Vektor-50 (F-9804) obtained from Conoco (Billings, MT).

Section 5

M.W. Kellogg Activities

The MAT equipment and analytical operations were previously described (April-June 1995 Quarterly progress report). Experiments were designed to show the effects of cracking temperature and hydrotreating on the DL2 liquid. For each feed at each temperature, a series of runs with varying catalyst/oil ratio were made to provide data for interpolation. The VGO was used to set reference conditions and supply base case data. A total of 11 runs were made with the VGO, 8 runs with the DL2 heavy distillate and 8 runs with the hydrotreated DL2 heavy distillate.

5.2.2 Pilot Plant

Three runs were made in the FCC1 pilot plant. Feedstocks were Amoco vacuum gas oil (F-9819), neat DL2 heavy distillate (F-9888), and a 33.3 vol% (33.7 wt%) blend of the neat DL2 heavy distillate and the VGO. The catalyst used in all three runs was a sample of equilibrium Vektor-50 (F-9804) obtained from Conoco (Billings, MT).

The first run (H-2038-1) with VGO was used to set the operating conditions for all three runs. Base operating targets set for the pilot plant operators were:

Catalyst rate, lbs/hr	42.5
Catalyst temperature, °F	1255
Riser outlet pressure, psig	35
Riser isothermal temperatures, °F	985

The key target was a calculated coke yield of 5.0 wt%. In seeking this target, the catalyst rate was fixed, and the oil feed rate adjusted higher to lower coke yield or lower to increase coke yield. All three feedstocks ran well. Riser and stripper filter plugging tendencies appear to be low. This experience would indicate that the production run should proceed well.

5.3 Results

Table 5-1 summarizes the regressed yields from the MAT work at heat balanced conditions, using the convention established earlier that "torch oil" would be added to make up the heat deficiency when coal liquids (with low coke yields) are cracked at the same conditions as the VGO. In a real case, a lower value feed, such as a resid, probably would be added to the feed blend.

In the pilot plant the operating conditions were established to produce the heat-balanced coke yield with the Amoco VGO at the baseline operating temperature, and these conditions were maintained while running the DL2 heavy distillate and a blend of the VGO and DL2 heavy distillate. A summary of the conditions and yields is given in Table 5-2.

Section 5

M.W. Kellogg Activities

Tables giving more detailed component yields and data for individual MAT runs are given in Section 5.5 - Appendix.

5.4 Discussion

Initial screening of the MAT data showed good precision and weight balances (typically 98%), but a difference in results from the Amoco VGO data gathered last year seemed significant.

To establish the baseline for the present work as firmly as possible, an additional 6 runs were made with the Amoco VGO, three at each temperature. It was discovered that an interim recalibration of chromatographic response factors resulted in changes for some of the gas components that accounted for a major part of the difference between the 1995 and 1996 results. Since the new factors are more reliable, they were applied to the earlier data, which caused an overall improvement in the weight balances. A set of corrected data has been prepared for official transmittal. The changes reduced the gasoline yields by about 1% for each feed, but do not influence the conclusions reached on the differences between feeds used as input for the linear model.

Table 5-3 gives a preliminary comparison of the gasoline and coke yields obtained in the MAT unit with the DL1 liquid and its hydrotreated products and with the DL2 liquid and its single hydrotreated product. The cracking conditions established for this comparison include a reaction temperature of 970 to 980°F and provide a heat-balanced coke yield with the Amoco VGO.

Table 5-4 gives a direct comparison of the pilot plant yields with the hydrotreated DL1 heavy distillate used in 1995 (H-2006) to the current pilot plant yields with DL2 heavy distillate. Since 1995, the riser length has been changed from 25 feet to 80 feet, which lowers the catalyst/oil ratio needed to obtain the specified coke yield. Conversion with the reference gas oil is higher this year, but the gasoline yield is the same as last year.

Also of interest is the comparison between a weighted average of the yields from the two runs with neat feeds and those of the run with a blend of these feeds (H-2038-3). For essentially every component and boiling range, the results of the run are not significantly different from the calculated values.

Samples of the condensed total liquid product were debutanized and sent to Southwest Research Institute for fractionation and determination of the octane number of the IBP to 430°F gasoline.

Section 5

M.W. Kellogg Activities

Table 5-1 — Results at heat balanced conditions for Amoco VGO

Cracking Temperature		970°F			1010°F		
Feed Material		VGO	DL2	HT DL2	VGO	DL-2	HT DL2
Heat Required	BTU/#	0	234	291	0	161	249
Regenerator Temp	EF	1286	1301	1308	1333	1341	1349
Cat/Oil	wt	6.0	6.0	6.0	6.2	6.2	6.2
Coke	wt%	5.1	3.2	2.7	5.5	4.1	3.4
Conversion	wt%	77.0	76.8	84.7	77.8	78.3	83.7
Gasoline Yield	wt%	48.6	55.7	61.1	46.1	52.6	58.2
Total C4 Yield	wt%	12.0	9.2	11.1	12.9	10.2	11.2
Total C3 Yield	wt%	8.0	6.4	7.1	9.4	7.8	7.6
C2 Minus Yield	wt%	3.2	2.2	2.5	4.0	3.7	3.3

NOTE: Heat required is assumed to be supplied by torch oil.

Table 5-2 — Pilot plant yields summary

Run number: H-2038-	1	2	3
Feed material	VGO	NEAT DL2	VGO/DL2 BLEND
Catalyst/oil ratio	10.0	10.2	10.3
Temperatures, deg F:			
Oil preheat	224	222	221
Catalyst inlet	1254	1252	1255
Riser average	984	985	985
Material balance:			
Closure, wt%	99.90	101.86	100.71
Conversion, wt%	77.10	76.96	76.15
Total C2 & lighter	2.47	1.76	2.21
Total C3's	7.22	6.14	6.78
Total C4's	12.38	10.34	11.45
Total gasoline	49.99	55.06	51.20
Total cycle oil	22.90	23.04	23.85
Coke	5.04	3.66	4.51

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M.W. Kellogg Activities

Table 5-3 — Comparison of coal liquids as FCC feed (MAT)

Feed	Gasoline Yield, wt%	Coke Yield, wt%
Unhydrotreated DL1	50.1	3.8
Slightly HT DL1	50.8	3.7
V. Severe HT DL1	60.5	2.5
Severe HT DL1	52.5	3.8
Amoco VGO (1995)	48.5	5.2
Amoco VGO (1996)	48.6	5.1
As produced DL2	55.7	3.2
Hydrotreated DL2	61.1	2.7

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Table 5-4 — Comparison of hydrotreated DL1 and DL2 (pilot plant)

Run number:	H-2006-			H-2038-		
	1	2	3	1	2	3
Feed	VGO	HT DL1	BLEND	VGO	DL2	BLEND
Catalyst/oil ratio	12.2	12.2	12.0	10.0	10.2	10.3
Temperatures, deg F:						
Oil preheat	212	212	214	224	222	221
Catalyst inlet	1265	1253	1252	1254	1252	1255
Riser average	984	987	983	984	985	985
Material balance:						
Closure, wt%	98.5	98.5	98.5	99.9	101.9	100.7
Conversion, wt%	74.1	74.2	73.2	77.1	77.0	76.2
Total C2 & lighter	3.34	2.03	2.83	2.47	1.76	2.21
Total C3's	5.99	5.18	5.69	7.22	6.14	6.78
Total C4's	9.38	8.55	9.33	12.38	10.34	11.45
Total gasoline	50.52	55.17	51.01	49.99	55.06	51.20
Total cycle oil	25.87	25.80	26.82	22.90	23.04	23.85
Coke	4.90	3.27	4.32	5.04	3.66	4.51

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M.W. Kellogg Activities

Table 5-5 — Comparison of blend and calculated blend results

Run number: H-2038-	1	2	3	Calc
Feed	VGO	DL2	Blend	Blend
Total C2 & lighter	2.47	1.76	2.21	2.23
Total C3's	7.22	6.14	6.78	6.86
Total C4's	12.38	10.34	11.45	11.69
Total gasoline	49.99	55.06	51.20	51.70
Total cycle oil	22.90	23.04	23.85	22.95
Coke	5.04	3.66	4.51	4.57
Conversion	77.10	76.96	76.15	77.05

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M.W. Kellogg Activities

5.5 Appendix

Run Number	906a	883a	910a	908a	884a	881a	907a	911a	880a	885a	909a
Date (Day-Mon-Yr)	3/4/96	1/26/96	3/8/96	3/4/96	1/30/96	1/25/96	3/4/96	3/5/96	1/24/96	1/31/96	3/4/96
Catalyst F or AL Number	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804
Catalyst Source	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco
Catalyst Trade Name	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50
Catalyst Activity	66	66	66	66	66	66	66	66	66	66	66
Oil Feed F# or AL#	F-9821	F-9821	F-9821	F-9821	F-9821	F-9821	F-9821	F-9821	F-9821	F-9821	F-9821
Feed API	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6
Company supplying feedstock	AMOCO	AMOCO	AMOCO	AMOCO	AMOCO	AMOCO	AMOCO	AMOCO	AMOCO	AMOCO	AMOCO
Special Features	A 3L	A 4.5L	A 4.5L	A 6L	A 6L	A 3H	A 3H	A 4.5H	A 4.5H	A 6H	A 6H
Catalyst Charge, grams	3.00	4.50	4.51	6.01	6.01	3.01	3.00	4.51	4.50	6.01	6.01
Feed Charge, grams	1.01	1.00	0.99	1.00	0.99	1.00	0.99	1.00	0.99	0.99	0.96
Catalyst/Oil Ratio	2.99	4.51	4.54	6.01	6.07	3.02	3.04	4.51	4.53	6.09	6.25
Initial Bed Temperature, deg F	1000	1000	1000	1000	1000	1035	1035	1030	1040	1035	1030
Average Bed Temperature, deg F	975	975	980	978	975	1015	1005	1007	1014	1010	1008
Oil Inject Time, seconds	30	30	30	30	30	30	30	30	30	30	30
Paraffins, wt%	NA	NA	NA	NA	5.6	NA	NA	NA	NA	5.9	NA
Isoparaffins, wt%	NA	NA	NA	NA	41.8	NA	NA	NA	NA	36.5	NA
Naphthenes, wt%	NA	NA	NA	NA	10.2	NA	NA	NA	NA	10.2	NA
Aromatics, wt%	NA	NA	NA	NA	31.3	NA	NA	NA	NA	36.3	NA
Olefins, wt%	NA	NA	NA	NA	11.1	NA	NA	NA	NA	11.1	NA
GCRON	NA	NA	NA	NA	93.7	NA	NA	NA	NA	95.9	NA
GCMON	NA	NA	NA	NA	82.3	NA	NA	NA	NA	83.8	NA
Conversion, Wt %	62.50	70.22	73.43	78.09	74.96	63.35	68.80	73.67	74.94	76.17	77.36
Weight % Yields, normalized: H2S	0.54	0.52	0.62	0.07	0.08	0.47	0.62	0.51	0.00	0.08	0.08
H2	0.11	0.16	0.24	0.16	0.17	0.15	0.13	0.28	0.19	0.26	0.23
CH4	0.00	0.00	0.00	0.00	0.00	0.70	0.68	0.96	1.09	1.30	1.22
C2H2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2H4	0.67	0.93	1.14	1.24	1.06	0.90	0.88	1.15	1.30	1.46	1.33
C2H6	0.39	0.59	0.72	0.76	0.64	0.57	0.53	0.76	0.80	0.97	0.89
C3H4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3H6	4.17	4.71	6.13	6.29	5.64	4.64	5.32	6.12	6.42	7.17	6.82
C3H8	0.85	1.35	1.45	2.06	1.74	0.91	1.01	1.35	1.72	2.13	2.03
C4H6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-C4H8	0.89	1.01	1.27	1.26	1.10	0.97	1.11	1.30	1.43	1.36	1.30
1-C4H8	1.15	1.05	1.45	1.01	0.90	1.56	1.46	1.47	1.47	1.27	1.22
c-2-C4H8	0.81	0.86	1.06	1.09	0.92	0.97	0.95	1.10	1.13	1.16	1.05
1-2-C4H8	1.10	1.19	1.44	1.48	1.26	1.30	1.29	1.50	1.55	1.57	1.45
1-C4H10	3.08	4.18	4.41	6.35	5.42	2.99	3.29	4.16	5.50	5.94	5.64
N-C4H10	0.88	1.20	1.24	1.75	1.47	0.90	1.05	1.20	1.43	1.57	1.63
C5-430 deg F	44.91	47.99	47.25	48.25	48.72	43.96	48.02	47.96	46.97	44.53	46.93
430-680 deg F	27.24	23.51	21.23	17.38	18.84	27.03	24.17	20.84	19.60	17.97	17.87
680-800 deg F	7.07	4.53	3.70	3.18	3.57	6.82	5.01	3.82	3.69	3.55	3.26
800 deg F+	3.19	1.75	1.65	1.35	2.64	2.81	2.02	1.67	1.77	2.32	1.51
COKE	2.45	3.74	4.02	5.29	4.97	2.36	2.46	3.86	3.94	5.39	5.53
Weight Balance, %	99.17	98.31	98.03	98.71	99.38	98.51	99.08	100.28	98.61	99.40	99.51

Run Number	890a	886a	894a	891a	893a	895a	889a	892a
Date (Day-Mon-Yr)	2/5/96	1/31/96	2/6/96	2/5/96	2/6/96	2/6/96	2/1/96	2/5/96
Catalyst F or AL Number	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804
Catalyst Source	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco
Catalyst Trade Name	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50
Catalyst Activity	66	66	66	66	66	66	66	66
Oil Feed F# or AL#	F-9888	F-9888	F-9888	F-9888	F-9888	F-9888	F-9888	F-9888
Feed API	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
Company supplying feedstock	SWRI	SWRI	SWRI	SWRI	SWRI	SWRI	SWRI	SWRI
Special Features	B 3L	B 4.5L1	B 4.5L2	B 6L	B 3H	B 4.5H1	B 4.5H2	B 6H
Catalyst Charge, grams	3.00	4.49	4.51	6.02	3.00	4.01	4.50	6.00
Feed Charge, grams	1.00	1.04	1.02	1.02	1.02	1.02	1.02	1.01
Catalyst/Oil Ratio	2.99	4.31	4.42	5.90	2.95	3.91	4.40	5.92
Initial Bed Temperature, deg F	1015	1015	1000	1015	1060	1060	1055	1055
Average Bed Temperature, deg F	974	967	970	970	1010	1010	1010	1012
Oil Inject Time, seconds	30	30	30	30	30	30	30	30
Paraffins, wt%	NA	NA	NA	3.1	NA	NA	NA	3.0
Isoparaffins, wt%	NA	NA	NA	41.8	NA	NA	NA	39.4
Naphthenes, wt%	NA	NA	NA	11.8	NA	NA	NA	10.8
Aromatics, wt%	NA	NA	NA	38.6	NA	NA	NA	41.4
Olefins, wt%	NA	NA	NA	4.7	NA	NA	NA	5.4
GCRON	NA	NA	NA	94.3	NA	NA	NA	97.3
GCMON	NA	NA	NA	83.4	NA	NA	NA	84.9
Conversion, Wt %	69.44	74.54	74.18	75.76	73.08	75.49	77.29	77.23
Weight % Yields, normalized: H2S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2	0.14	0.14	0.16	0.21	0.19	0.27	0.24	0.38
CH4	0.33	0.43	0.39	0.62	0.51	0.74	0.80	1.09
C2H2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2H4	0.63	0.40	0.72	0.99	0.84	1.07	1.17	1.32
C2H6	0.26	0.33	0.31	0.48	0.36	0.50	0.56	0.73
C3H4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3H6	3.62	3.92	3.57	4.21	4.56	4.91	4.98	5.05
C3H8	1.01	1.70	1.36	2.18	1.23	1.60	2.04	2.32
C4H6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-C4H8	0.81	0.82	0.53	0.81	0.96	1.57	1.02	0.89
1-C4H8	0.38	0.34	0.40	0.30	0.56	0.00	0.54	0.50
c-2-C4H8	0.62	0.61	0.72	0.61	0.69	0.69	0.79	0.62
t-2-C4H8	0.84	0.83	1.01	0.84	0.96	0.96	1.07	0.87
1-C4H10	3.25	4.43	3.77	4.99	3.63	4.00	5.42	5.03
N-C4H10	1.02	1.38	1.40	1.58	1.18	1.37	1.69	1.56
C5-430 deg F	55.26	57.01	57.52	54.90	55.94	55.51	54.26	53.03
430-680 deg F	26.49	21.54	22.45	20.14	23.54	20.76	19.65	18.68
680-800 deg F	3.54	2.89	2.84	3.41	2.83	2.95	2.50	3.42
800 deg F+	0.53	1.02	0.53	0.68	0.55	0.81	0.56	0.67
COKE	1.28	2.19	2.31	3.04	1.48	2.29	2.72	3.84
Weight Balance, %	98.15	97.44	96.94	98.14	98.85	97.51	99.79	98.24

Run Number	904a	897a	901a	902a	899a	896a	905a	903a
Date (Day-Mon-Yr)	2/12/96	2/8/96	2/9/96	2/12/96	2/8/96	2/6/96	2/12/96	2/12/96
Catalyst F or AL Number	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804
Catalyst Source	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco	Conoco
Catalyst Trade Name	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50	Vector-50
Catalyst Activity	66	66	66	66	66	66	66	66
Oil Feed F# or AL#	F-9907	F-9907	F-9907	F-9907	F-9907	F-9907	F-9907	F-9907
Feed API	25.8	25.8	25.8	25.8	25.8	25.8	25.8	25.8
Company supplying feedstock	SWRI	SWRI	SWRI	SWRI	SWRI	SWRI	SWRI	SWRI
Special Features	C 3L	C 4.5L1	C 3.5L2	C 6L	C 3H	C 4.5H1	C 6H	C 6H
Catalyst Charge, grams	3.01	4.50	4.51	6.00	3.00	4.51	6.00	6.00
Feed Charge, grams	1.01	1.00	1.00	0.99	1.01	0.99	1.02	1.01
Catalyst/Oil Ratio	2.98	4.48	4.52	6.05	2.95	4.55	5.91	5.92
Initial Bed Temperature, deg F	1000	1000	1000	1000	1055	1055	1050	1050
Average Bed Temperature, deg F	966	966	968	971	1006	1014	1010	1005
Oil Inject Time, seconds	30	30	30	30	30	30	30	30
Paraffins, wt%	NA	NA	NA	3.2	NA	NA	NA	4.2
Isoparaffins, wt%	NA	NA	NA	45.6	NA	NA	NA	42.9
Naphthenes, wt%	NA	NA	NA	13.5	NA	NA	NA	11.1
Aromatics, wt%	NA	NA	NA	31.1	NA	NA	NA	35.8
Olefins, wt%	NA	NA	NA	6.5	NA	NA	NA	6.1
GCRON	NA	NA	NA	94.5	NA	NA	NA	96.2
GCMON	NA	NA	NA	83.4	NA	NA	NA	84.5
Conversion, Wt %	75.00	80.52	81.98	84.05	79.54	81.93	84.35	82.48
Weight % Yields, normalized: H2S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2	0.18	0.18	0.16	0.26	0.16	0.28	0.37	0.30
CH4	0.23	0.40	0.48	0.66	0.35	0.81	0.94	0.77
C2H2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2H4	0.52	0.79	0.94	1.09	0.81	1.24	1.38	1.16
C2H6	0.18	0.31	0.35	0.46	0.27	0.54	0.63	0.51
C3H4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3H6	3.24	3.80	4.38	4.63	4.69	5.52	5.34	4.63
C3H8	0.93	1.56	1.79	2.36	1.23	2.02	2.49	2.06
C4H6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-C4H8	1.31	0.90	0.99	0.94	1.01	1.12	0.99	0.99
I-C4H8	0.00	0.40	0.39	0.44	0.58	0.61	0.55	0.54
c-2-C4H8	0.68	0.68	0.69	0.91	0.75	0.77	0.77	0.69
t-2-C4H8	0.91	0.95	0.96	0.98	1.03	1.08	1.05	0.98
I-C4H10	3.41	4.55	5.04	6.03	4.36	5.61	6.59	5.12
N-C4H10	1.16	1.50	1.60	1.92	1.25	1.69	1.95	1.73
C5-430 deg F	60.99	62.78	62.29	60.49	61.79	58.18	57.88	60.04
430-680 deg F	22.90	16.81	15.64	13.61	18.33	15.38	13.36	15.00
680-800 deg F	1.34	2.10	1.92	1.91	1.62	2.02	1.77	1.92
800 deg F+	0.76	0.57	0.46	0.43	0.51	0.67	0.52	0.61
COKE	1.25	1.72	1.91	2.88	1.25	2.47	3.42	2.94
Weight Balance, %	96.72	97.18	98.77	97.05	98.73	99.39	96.80	99.81

1996 PILOT PLANT RESULTS

OPERATING CONDITIONS

FEEDSTOCK:	F-9819	F-9888	F-9819/9888
CATALYST:	F-9804	F-9804	F-9804
RUN NUMBER:	H-2038- 1	2	3
OIL FEED RATE , GRAM/HR	1924	1887	1912
CATALYST RATE , LB/HR	42.5	42.3	43.3
CATALYST/OIL RATIO	10.0	10.2	10.3
MATERIAL BALANCE:			
CLOSURE, WT%	99.90	101.86	100.71
GASOLINE, WT%	49.99	55.06	51.20
CONVERSION, WT%	77.10	76.96	76.15
COKE YIELD, WT%	5.04	3.66	4.51
SELECTIVITY, W/W	0.65	0.72	0.67
C/(1-C), W/W	3.37	3.34	3.19
RISER OUTLET PRESSURE , PSIG	35.0	35.0	35.0
TEMPERATURES, DEG F:			
OIL PREHEAT	224	222	221
CATALYST INLET	1254	1252	1255
RISER PROFILE, FT			
0.58 (MIXING ZONE)	984	997	994
5.47	992	992	992
9.22	985	986	986
17.10	985	987	986
19.18	979	981	978
22.87	989	991	990
26.12	980	982	980
33.99	991	993	992
36.08	986	988	987
41.33	982	982	981
45.08	982	980	978
50.92	990	991	991
55.64	991	992	992
60.45	974	975	975
64.78	987	988	987
69.53	974	974	974
75.45	987	987	987
RISER AVERAGE (EX MIX ZONE)	984	985	985

1996 PILOT PLANT RESULTS

PRODUCT YIELD SPECTRUM

NORMALIZED, BASIS FRESH FEED, WT%

FEEDSTOCK: CATALYST: RUN NUMBER:	H-2038-	F-9819 F-9804 1	F-9888 F-9804 2	F-9819/9888 F-9804 3	AVG
H2S		0.00	0.00	0.00	0.00
H2		0.13	0.17	0.14	0.14
CH4		1.16	0.77	1.02	1.03
C2H4		0.36	0.30	0.34	0.34
C2H6		0.82	0.52	0.71	0.72
C3H6		5.78	4.37	5.24	5.30
C3H8		1.44	1.77	1.54	1.55
C4H6		0.09	0.04	0.03	0.07
1-C4H8		2.04	1.13	1.61	1.73
I-C4H8		1.95	0.74	1.29	1.54
T-2-C4H8		1.74	1.07	1.49	1.51
C-2-C4H8		0.96	0.61	0.86	0.84
IC4H10		4.32	5.12	4.79	4.59
NC4H10		1.28	1.63	1.38	1.40
C5+ IN GAS		4.32	4.03	4.48	4.22
IBP-430 F		45.67	51.03	46.72	47.48
430-650 F		17.21	19.33	18.84	17.93
650+ F		5.69	3.70	5.01	5.02
COKE		5.04	3.66	4.51	4.57
TOTAL		100.00	100.00	100.00	100.00

SUMMARY

TOTAL C2 & LIGHTER	2.47	1.76	2.21	2.23
TOTAL C3'S	7.22	6.14	6.78	6.86
TOTAL C4'S	12.38	10.34	11.45	11.69
TOTAL GASOLINE	49.99	55.06	51.20	51.70
TOTAL CYCLE OIL	22.90	23.04	23.85	22.95
COKE	5.04	3.66	4.51	4.57
CONVERSION	77.10	76.96	76.15	77.05

-----1995 FEED INSPECTIONS-----

-----1996 INSPECTIONS-----

SOURCE TREATMENT	1995 FEED INSPECTIONS				1996 INSPECTIONS			
	DL1 F-9827	DL1 F-9824	DL1 F-9826	DL1 F-9823	DL2 F-9888	DL2 F-9803	DL2 F-9907	DL2 F-9907
API	22.5	23.3	31.7	24.2	23.3	27.6	23.3	25.9
Sp Gr	0.9188	0.9141	0.8670	0.9088	0.9139	0.8894	0.9139	0.8987
H, wt%	12.03	12.13	12.69	12.23	12.27	NA	12.27	12.55
Sulfur, wt%	0.035				0.002		0.002	
Nitrogen, wt%	0.059				0.0043		0.0043	
Basic N, wt%	0.041				0.0047		0.0047	
Aniline Pt, F	Too dark				121.6			
HC Type, wt%								
Paraffins	11.7				11.6			
Cycloparaffins	35.3				52.3			
Alkyl Benzenes	6.7				25.9			
PAH	53.0				10.2			

BOILING RANGE DISTRIBUTION BY GCSD

WT%	1995 FEED INSPECTIONS		1996 INSPECTIONS	
	DEG. F	DEG. F	DEG. F	DEG. F
0.5	453	168	284	336
5	499	378	484	458
10	512	464	502	516
20	529	502	521	579
30	544	520	537	629
40	561	536	554	673
50	576	554	571	710
60	593	573	587	750
70	610	591	605	792
80	632	614	628	840
90	663	647	659	901
95	689	674	684	942
99	749	730	733	993
EP	788	758	753	>1014
Wt% at 430 F	0	7.6	1.8	3.1
				0
				1.3
				2.8

- NOTES:
- 1) Analysis of coal-derived feeds by SwRI
 - 2) Used combined analysis of Hvy Distillate and Residue for S, N, Basic N and Aniline Point.
 - 3) Used only Hvy Distillate analysis for HC Type.
 - 4) Analysis of petroleum feed for hydrogen by Amoco
 - 5) Distillation data obtained by Kellogg using chromatography (ASTM D2887)

M.W. KELLOGG MAT RESULTS

DOE/BECHTEL: REFINING AND END USE STUDY OF COAL LIQUIDS

"A" UNHYDROTREATED FEED

Run Number	790	786	802	810	814	805
Date (Mon-Day-Yr)	DEC-21-94	DEC-20-94	JAN-05-95	JAN-09-95	JAN-10-95	JAN-06-95
Catalyst F or AL Number	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804
Catalyst Source	CONOCO	CONOCO	CONOCO	CONOCO	CONOCO	CONOCO
Catalyst Trade Name	Vektor 50	Vektor 50	Vektor 50	Vektor 50	Vektor 50	Vektor 50
Catalyst Activity	66	66	66	66	66	66
Oil Feed F# or AL#	F-9827	F-9827	F-9827	F-9827	F-9827	F-9827
Specific Gravity	0.919	0.919	0.919	0.919	0.919	0.919
Feed API	22.5	22.5	22.5	22.5	22.5	22.5
Feed 430 minus, wt%	0.0	0.0	0.0	0.0	0.0	0.0
Company supplying feedstock	SwRI	SwRI	SwRI	SwRI	SwRI	SwRI
Special Features	A-4.5	A-6	A-6	A-6	A-7.5	A-7.5
Catalyst Charge, grams	4.51	6.01	6.00	6.01	7.50	7.50
Feed Charge, grams	1.03	1.02	1.03	1.02	1.02	1.01
Catalyst/Oil Ratio	4.39	5.90	5.85	5.91	7.36	7.41
Initial Bed Temperature, deg F	998	995	999	999	999	999
Average Bed Temperature, deg F	987	970	980	975	980	975
Oil Inject Time, seconds	30	30	30	30	30	30
Weight % Yields, normalized: H2S	0.01	0.00	0.00	0.01	0.04	0.01
H2	0.15	0.32	0.19	0.17	0.24	0.25
CH4	0.40	0.55	0.50	0.64	0.89	0.81
C2H2	0.00	0.00	0.00	0.00	0.00	0.00
C2H4	0.63	0.68	0.69	0.83	0.98	0.92
C2H6	0.37	0.47	0.43	0.53	0.69	0.64
C3H4	0.00	0.00	0.00	0.00	0.00	0.00
C3H6	3.43	3.50	3.24	3.89	3.90	3.69
C3H8	1.04	1.11	1.27	1.59	1.96	1.87
C4H6	0.00	0.00	0.00	0.00	0.00	0.00
1-C4H8	0.94	0.93	0.87	0.90	0.83	0.86
I-C4H8	0.41	0.39	0.34	0.39	0.38	0.38
c-2-C4H8	0.73	0.72	0.67	0.71	0.63	0.65
t-2-C4H8	0.99	1.00	0.92	0.97	0.88	0.91
I-C4H10	3.00	2.98	2.97	3.84	3.67	3.54
N-C4H10	1.30	1.32	1.36	1.47	1.51	1.54
C5-430 deg F	51.08	50.79	51.14	50.13	48.59	50.61
430-680 deg F	29.85	27.84	28.60	27.17	26.57	25.41
680-800 deg F	2.89	3.06	3.10	3.12	3.18	3.09
800 deg F+	0.61	0.79	0.71	0.76	0.88	0.75
COKE	2.17	3.54	3.02	2.90	4.20	4.10
New Weight Balance, %	98.60	97.50	98.62	99.29	98.81	98.04
%Conversion, wt	67.32	68.96	68.25	69.65	70.08	71.43
100-TCO	66.64	68.31	67.60	68.94	69.37	70.75
C2 Minus	1.55	2.02	1.80	2.18	2.83	2.63
Total C3	4.47	4.61	4.51	5.47	5.86	5.56
Total C4	7.38	7.34	7.13	8.27	7.89	7.86
C5-430F	51.08	50.79	51.14	50.13	48.59	50.61
430-680	29.85	27.84	28.60	27.17	26.57	25.41
680+	3.50	3.85	3.81	3.88	4.06	3.84
Coke	2.17	3.54	3.02	2.90	4.20	4.10
	100	100	100	100	100	100

M.W. KELLOGG MAT RESULTS

DOE/BECHTEL: REFINING AND END USE STUDY OF COAL LIQUIDS

"B" SL. HYDROTREATED FEED

Run Number	800	793	818	821
Date (Mon-Day-Yr)	DEC-28-94	DEC-27-94	JAN-11-95	JAN-12-95
Catalyst F or AL Number	F-9804	F-9804	F-9804	F-9804
Catalyst Source	CONOCO	CONOCO	CONOCO	CONOCO
Catalyst Trade Name	Vektor 50	Vektor 50	Vektor 50	Vektor 50
Catalyst Activity	66	66	66	66
Oil Feed F# or AL#	F-9824	F-9824	F-9824	F-9824
Specific Gravity	0.914	0.914	0.914	0.914
Feed API	23.3	23.3	23.3	23.3
Feed 430 minus, wt%	0.8	0.8	0.8	0.8
Company supplying feedstock	SwRI	SwRI	SwRI	SwRI
Special Features	B-4.5	B-6	B-6	B-7.5
Catalyst Charge, grams	4.50	6.00	6.00	7.50
Feed Charge, grams	1.03	1.02	0.99	1.01
Catalyst/Oil Ratio	4.36	5.89	6.05	7.45
Initial Bed Temperature, deg F	998	998	999	999
Average Bed Temperature, deg F	972	976	977	987
Oil Inject Time, seconds	30	30	30	30
Weight % Yields, normalized: H2S	0.00	0.01	0.00	0.02
H2	0.27	0.30	0.24	0.26
CH4	0.42	0.63	0.67	0.74
C2H2	0.00	0.00	0.00	0.00
C2H4	0.62	0.78	0.83	0.86
C2H6	0.34	0.49	0.54	0.60
C3H4	0.00	0.00	0.00	0.00
C3H6	3.63	3.75	3.95	3.65
C3H8	1.05	1.37	1.61	1.78
C4H6	0.00	0.00	0.00	0.00
1-C4H8	0.93	0.91	0.93	0.70
I-C4H8	0.40	0.40	0.40	0.28
c-2-C4H8	0.71	0.70	0.71	0.55
t-2-C4H8	0.98	0.96	0.98	0.75
I-C4H10	3.06	3.51	3.66	3.42
N-C4H10	1.23	1.40	1.48	1.29
C5-430 deg F	52.05	51.42	50.88	50.36
430-680 deg F	28.57	26.38	26.27	26.68
680-800 deg F	3.05	3.10	2.99	3.14
800 deg F+	0.70	0.78	0.77	0.85
COKE	1.99	3.09	3.09	4.07
Weight Balance, %	96.69	99.22	99.67	99.16
%Conversion, wt	68.32	70.39	70.66	69.96
100-TCO	67.68	69.74	69.97	69.33
C2 Minus	1.65	2.21	2.29	2.47
Total C3	4.68	5.12	5.56	5.43
Total C4	7.31	7.89	8.16	6.99
C5-430F	52.05	51.42	50.88	50.36
430-680	28.57	26.38	26.27	26.68
680+	3.75	3.88	3.75	3.99
Coke	1.99	3.09	3.09	4.07
	100	100	100	100

M.W. KELLOGG MAT RESULTS

DOE/BECHTEL: REFINING AND END USE STUDY OF COAL LIQUIDS

"C" V. SEVERE HYDROTREATED FEED

Run Number	803	794	788	811	807	815
Date (Mon-Day-Yr)	JAN-05-95	DEC-27-94	DEC-21-94	JAN-09-95	JAN-06-95	JAN-10-95
Catalyst F or AL Number	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804
Catalyst Source	CONOCO	CONOCO	CONOCO	CONOCO	CONOCO	CONOCO
Catalyst Trade Name	Vektor 50	Vektor 50	Vektor 50	Vektor 50	Vektor 50	Vektor 50
Catalyst Activity	66	66	66	66	66	66
Oil Feed F# or AL#	F-9826	F-9826	F-9826	F-9826	F-9826	F-9826
Specific Gravity	0.867	0.867	0.867	0.867	0.867	0.867
Feed API	31.7	31.7	31.7	31.7	31.7	31.7
Feed 430 minus, wt%	7.6	7.6	7.6	7.6	7.6	7.6
Company supplying feedstock	SwRI	SwRI	SwRI	SwRI	SwRI	SwRI
Special Features	C-3	C-4.5	C-6	C-3	C-4.5	C4.5
Catalyst Charge, grams	3.01	4.51	6.01	3.00	4.51	4.51
Feed Charge, grams	0.98	1.01	0.97	1.00	1.00	1.01
Catalyst/Oil Ratio	3.06	4.48	6.17	3.01	4.51	4.46
Initial Bed Temperature, deg F	1005	998	995	999	999	999
Average Bed Temperature, deg F	975	973	974	980	978	981
Oil Inject Time, seconds	30	30	30	30	30	30
Weight % Yields, normalized: H2S	0.00	0.01	0.01	0.00	0.01	0.02
H2	0.11	0.18	0.21	0.11	0.13	0.15
CH4	0.27	0.40	0.47	0.28	0.38	0.43
C2H2	0.00	0.00	0.00	0.00	0.00	0.00
C2H4	0.52	0.71	0.74	0.56	0.68	0.72
C2H6	0.22	0.32	0.37	0.23	0.30	0.35
C3H4	0.00	0.00	0.00	0.00	0.00	0.00
C3H6	3.43	4.06	3.82	3.47	3.93	3.98
C3H8	0.85	1.32	1.56	0.86	1.37	1.35
C4H6	0.00	0.00	0.00	0.00	0.00	0.00
1-C4H8	1.05	0.94	1.06	1.04	0.99	1.08
I-C4H8	0.56	0.42	0.45	0.55	0.44	0.47
c-2-C4H8	0.81	0.72	0.81	0.77	0.80	0.78
t-2-C4H8	1.12	0.99	1.12	1.07	1.09	1.10
I-C4H10	3.19	3.78	4.15	2.99	4.46	3.98
N-C4H10	1.44	1.41	1.80	1.43	1.57	1.62
C5-430 deg F	59.88	60.33	60.70	60.59	59.81	60.76
430-680 deg F	23.45	20.23	18.36	22.93	20.02	19.30
680-800 deg F	2.23	1.97	2.28	2.18	2.24	2.35
800 deg F+	0.00	0.54	0.00	0.00	0.00	0.00
COKE	0.86	1.68	2.09	0.95	1.72	1.57
New Weight Balance, %	97.99	97.47	98.16	98.16	98.41	97.45
%Conversion, wt	74.87	77.76	79.87	75.42	78.26	78.87
100-TCO	74.32	77.26	79.35	74.89	77.73	78.36
C2 Minus	1.13	1.61	1.80	1.16	1.49	1.66
Total C3	4.28	5.38	5.38	4.34	5.35	5.33
Total C4	8.18	8.26	9.39	7.86	9.35	9.04
C5-430F	59.88	60.33	60.70	60.59	59.81	60.76
430-680	23.45	20.23	18.36	22.93	20.02	19.30
680+	2.23	2.51	2.28	2.18	2.24	2.35
Coke	0.86	1.68	2.09	0.95	1.72	1.57
	100	100	100	100	100	100

M.W. KELLOGG MAT RESULTS

DOE/BECHTEL: REFINING AND END USE STUDY OF COAL LIQUIDS

"D" SEVERLY HYDROTREATED FEED

Run Number	789	797	819	822
Date (Mon-Day-Yr)	DEC-21-94	DEC-27-94	JAN-11-95	JAN-12-95
Catalyst F or AL Number	F-9804	F-9804	F-9804	F-9804
Catalyst Source	CONOCO	CONOCO	CONOCO	CONOCO
Catalyst Trade Name	Vektor 50	Vektor 50	Vektor 50	Vektor 50
Catalyst Activity	66	66	66	66
Oil Feed F# or AL#	F-9823	F-9823	F-9823	F-9823
Specific Gravity	0.909	0.909	0.909	0.909
Feed API	24.2	24.2	24.2	24.2
Feed 430 minus, wt%	1.8	1.8	1.8	1.8
Company supplying feedstock	SwRI	SwRI	SwRI	SwRI
Special Features	D-3	D-4.5	D-4.5	D-6
Catalyst Charge, grams	3.00	4.50	4.50	6.00
Feed Charge, grams	1.03	1.01	1.02	0.99
Catalyst/Oil Ratio	2.92	4.47	4.43	6.04
Initial Bed Temperature, deg F	995	998	999	999
Average Bed Temperature, deg F	975	978	978	978
Oil Inject Time, seconds	30	30	30	30
Weight % Yields, normalized: H2S	0.00	0.01	0.01	0.02
H2	0.12	0.24	0.19	0.25
CH4	0.25	0.42	0.46	0.61
C2H2	0.00	0.00	0.00	0.00
C2H4	0.62	0.86	0.91	1.03
C2H6	0.22	0.35	0.37	0.49
C3H4	0.00	0.00	0.00	0.00
C3H6	3.42	3.64	3.67	3.50
C3H8	1.04	1.39	1.56	1.99
C4H6	0.00	0.00	0.00	0.00
1-C4H8	1.21	1.23	1.43	1.11
I-C4H8	0.42	0.40	0.48	0.34
c-2-C4H8	0.96	0.96	1.06	0.84
t-2-C4H8	1.30	1.32	1.47	1.17
I-C4H10	3.07	3.12	3.36	3.45
N-C4H10	1.34	1.64	1.97	1.80
C5-430 deg F	54.41	53.24	53.26	52.84
430-680 deg F	27.52	25.43	24.31	23.80
680-800 deg F	3.00	2.82	2.66	2.78
800 deg F+	0.00	0.73	0.69	0.87
COKE	1.12	2.20	2.14	3.13
New Weight Balance, %	96.83	97.34	101.35	98.57
%Conversion, wt	70.20	71.79	73.15	73.30
100-TCO	69.48	71.03	72.34	72.56
C2 Minus	1.20	1.88	1.95	2.39
Total C3	4.46	5.03	5.22	5.49
Total C4	8.30	8.68	9.76	8.70
C5-430F	54.41	53.24	53.26	52.84
430-680	27.52	25.43	24.31	23.80
680+	3.00	3.54	3.35	3.65
Coke	1.12	2.20	2.14	3.13
	100	100	100	100

M.W. KELLOGG MAT RESULTS

DOE/BECHTEL: REFINING AND END USE STUDY OF COAL LIQUIDS

"E" AMOCO VIRGIN GAS OIL

Run Number	787	792	804	812	808	816
Date (Mon-Day-Yr)	DEC-21-94	DEC-27-94	JAN-05-95	JAN-09-95	JAN-09-95	JAN-10-95
Catalyst F or AL Number	F-9804	F-9804	F-9804	F-9804	F-9804	F-9804
Catalyst Source	CONOCO	CONOCO	CONOCO	CONOCO	CONOCO	CONOCO
Catalyst Trade Name	Vektor 50	Vektor 50	Vektor 50	Vektor 50	Vektor 50	Vektor 50
Catalyst Activity	66	66	66	66	66	66
Oil Feed F# or AL#	F-9821	F-9821	F-9821	F-9821	F-9821	F-9821
Specific Gravity	0.896	0.896	0.896	0.896	0.896	0.896
Feed API	26.4	26.4	26.4	26.4	26.4	26.4
Feed 430 minus, wt%	3.1	3.1	3.1	3.1	3.1	3.1
Company supplying feedstock	AMOCO	AMOCO	AMOCO	AMOCO	AMOCO	AMOCO
Special Features	E-3	E-4.5	E-4.5	E-4.5	E-6	E-6
Catalyst Charge, grams	3.01	4.50	4.50	4.50	6.00	6.00
Feed Charge, grams	0.99	1.00	1.00	1.00	1.00	0.99
Catalyst/Oil Ratio	3.04	4.51	4.51	4.52	5.98	6.07
Initial Bed Temperature, deg F	995	998	999	999	999	999
Average Bed Temperature, deg F	980	982	982	989	982	983
Oil Inject Time, seconds	30	30	30	30	30	30
Weight % Yields, normalized: H2S	0.48	0.63	0.55	0.63	0.63	0.68
H2	0.12	0.15	0.15	0.14	0.17	0.20
CH4	0.49	0.67	0.82	0.74	0.84	1.03
C2H2	0.00	0.00	0.00	0.00	0.00	0.00
C2H4	0.65	0.85	0.95	0.88	0.95	1.12
C2H6	0.43	0.56	0.65	0.61	0.67	0.83
C3H4	0.00	0.00	0.00	0.00	0.00	0.00
C3H6	4.01	4.83	5.05	4.58	4.69	5.47
C3H8	0.66	1.06	1.17	1.06	1.34	1.60
C4H6	0.00	0.00	0.00	0.00	0.00	0.00
1-C4H8	1.06	1.19	1.28	1.12	1.11	1.29
I-C4H8	1.28	1.14	1.24	1.13	0.89	1.03
c-2-C4H8	0.86	0.98	1.04	0.88	0.87	1.10
t-2-C4H8	1.17	1.34	1.42	1.21	1.20	1.49
I-C4H10	2.62	3.81	3.95	3.34	3.82	4.92
N-C4H10	1.07	1.31	1.39	1.29	1.44	1.46
C5-430 deg F	48.27	49.00	48.37	47.59	50.01	47.90
430-680 deg F	28.15	24.22	23.22	25.30	22.15	20.62
680-800 deg F	4.95	4.00	4.10	4.72	3.49	3.45
800 deg F+	1.79	1.47	1.69	1.79	1.27	1.47
COKE	1.93	2.79	2.95	2.99	4.48	4.35
New Weight Balance, %	97.46	100.13	98.03	98.72	98.91	99.07
% Conversion, wt	65.85	71.09	71.79	68.98	73.79	75.24
100-TCO	65.11	70.31	70.99	68.19	73.09	74.46
C2 Minus	2.17	2.85	3.11	3.00	3.26	3.87
Total C3	4.67	5.89	6.22	5.64	6.03	7.06
Total C4	8.06	9.77	10.33	8.97	9.32	11.28
C5-430F	48.27	49.00	48.37	47.59	50.01	47.90
430-680	28.15	24.22	23.22	25.30	22.15	20.62
680+	6.74	5.46	5.79	6.51	4.76	4.92
Coke	1.93	2.79	2.95	2.99	4.48	4.35
	100	100	100	100	100	100

M.W. KELLOGG MAT RESULTS

DOE/BECHTEL: REFINING AND END USE STUDY OF COAL LIQUIDS

"F" BLEND OF "D" AND "E"

Run Number	796	798	820	824
Date (Mon-Day-Yr)	DEC-27-94	DEC-27-94	JAN-12-95	JAN-13-95
Catalyst F or AL Number	F-9804	F-9804	F-9804	F-9804
Catalyst Source	CONOCO	CONOCO	CONOCO	CONOCO
Catalyst Trade Name	Vektor 50	Vektor 50	Vektor 50	Vektor 50
Catalyst Activity	66	66	66	66
Oil Feed F# or AL#	F-9823/F-9821	F-9821/F-9823	F-9821/F-9823	F-9821/F-9823
Specific Gravity	0.902	0.902	0.902	0.902
Feed API	25.4	25.4	25.4	25.4
Feed 430 minus, wt%	2.5	2.5	2.5	2.5
Company supplying feedstock	NA	NA	NA	NA
Special Features	F-3	F-4.5	F-4.5	F-6
Catalyst Charge, grams	3.01	4.50	4.50	6.00
Feed Charge, grams	1.01	0.99	1.00	1.01
Catalyst/Oil Ratio	2.97	4.53	4.49	5.93
Initial Bed Temperature, deg F	998	998	999	999
Average Bed Temperature, deg F	977	975	986	975
Oil Inject Time, seconds	30	30	30	30
Weight % Yields, normalized: H2S	0.31	0.38	0.33	0.34
H2	0.11	0.15	0.18	0.22
CH4	0.39	0.54	0.75	0.82
C2H2	0.00	0.00	0.00	0.00
C2H4	0.61	0.76	0.92	0.94
C2H6	0.34	0.45	0.60	0.66
C3H4	0.00	0.00	0.00	0.00
C3H6	3.83	4.27	4.77	4.47
C3H8	0.73	1.10	1.39	1.58
C4H6	0.00	0.00	0.00	0.00
1-C4H8	1.05	1.00	1.19	1.14
I-C4H8	0.73	0.60	0.71	0.62
c-2-C4H8	0.81	0.77	0.99	0.88
t-2-C4H8	1.10	1.06	1.33	1.21
I-C4H10	2.83	3.42	4.43	4.12
N-C4H10	1.22	1.24	1.43	1.66
C5-430 deg F	51.81	52.62	49.41	51.71
430-680 deg F	28.17	25.20	24.54	21.99
680-800 deg F	3.24	3.27	3.35	3.01
800 deg F+	0.99	1.03	1.15	0.81
COKE	1.74	2.13	2.51	3.80
New Weight Balance, %	98.03	98.49	99.05	98.42
%Conversion, wt	68.27	71.17	71.75	74.88
100-TCO	67.60	70.51	70.97	74.18
C2 Minus	1.75	2.29	2.79	2.99
Total C3	4.56	5.38	6.16	6.06
Total C4	7.73	8.09	10.10	9.62
C5-430F	51.81	52.62	49.41	51.71
430-680	28.17	25.20	24.54	21.99
680+	4.23	4.30	4.50	3.83
Coke	1.74	2.13	2.51	3.80
	100	100	100	100

M.W. KELLOGG MAT RESULTS

DOE/BECHTEL: REFINING AND END USE STUDY OF COAL LIQUIDS

ASTM REFERENCE FEED

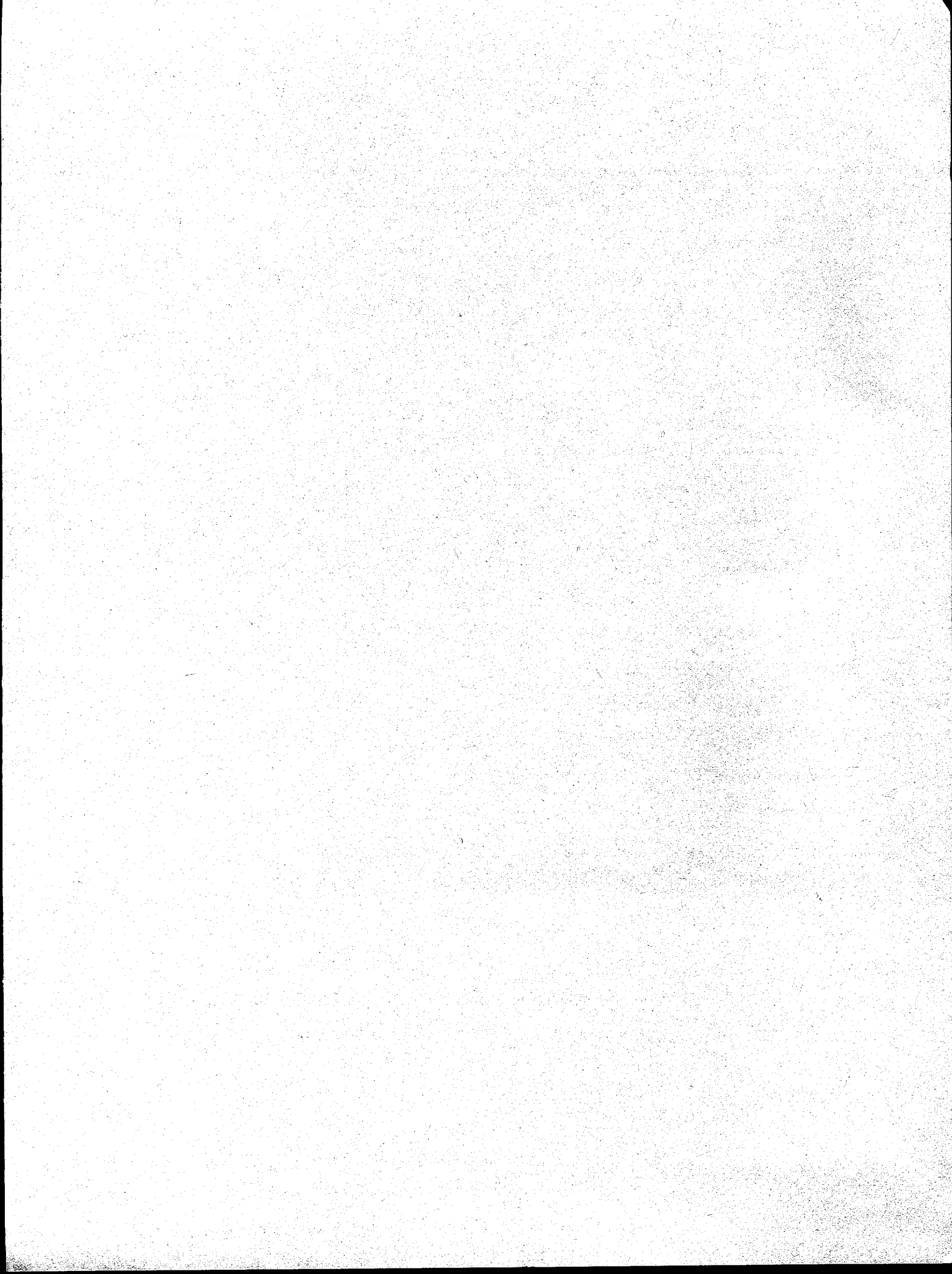
Run Number	806	813	809	817
Date (Mon-Day-Yr)	JAN-06-95	JAN-10-95	JAN-09-95	JAN-10-95
Catalyst F or AL Number	F-9804	F-9804	F-9804	F-9804
Catalyst Source	CONOCO	CONOCO	CONOCO	NA
Catalyst Trade Name	Vektor 50	Vektor 50	Vektor 50	NA
Catalyst Activity	66	66	66	NA
Oil Feed F# or AL#	F-9603	F-9603	F-9603	F-9603
Specific Gravity	0.889	0.889	0.889	0.889
Feed API	27.6	27.6	27.6	27.6
Feed 430 minus, wt%	2.0	2.0	2.0	2.0
Company supplying feedstock	ASTM	ASTM	ASTM	ASTM
Special Features	ASTMGO-3	ASTMGO-3	ASTMGO-6	ASTMGO-6
Catalyst Charge, grams	3.00	3.00	6.00	6.00
Feed Charge, grams	0.98	1.00	0.97	1.01
Catalyst/Oil Ratio	3.05	2.99	6.19	5.94
Initial Bed Temperature, deg F	999	999	999	999
Average Bed Temperature, deg F	980	985	980	985
Oil Inject Time, seconds	30	30	30	30
Weight % Yields, normalized: H2S	0.25	0.25	0.33	0.34
H2	0.09	0.11	0.18	0.19
CH4	0.52	0.61	1.09	1.16
C2H2	0.00	0.00	0.00	0.00
C2H4	0.64	0.78	1.16	1.25
C2H6	0.43	0.53	0.84	0.90
C3H4	0.00	0.00	0.00	0.00
C3H6	4.01	4.26	5.72	6.28
C3H8	0.71	0.76	1.60	1.72
C4H6	0.00	0.00	0.00	0.00
1-C4H8	1.05	1.09	1.21	1.33
I-C4H8	1.31	1.39	1.11	1.24
c-2-C4H8	0.87	0.89	0.95	1.03
t-2-C4H8	1.18	1.21	1.31	1.42
I-C4H10	2.69	2.69	4.42	4.79
N-C4H10	1.09	1.16	1.41	1.45
C5-430 deg F	46.45	47.62	50.61	48.58
430-680 deg F	26.33	25.65	18.84	18.54
680-800 deg F	7.27	6.16	3.45	3.41
800 deg F+	3.18	2.70	1.61	1.75
COKE	1.94	2.13	4.19	4.64
New Weight Balance, %	97.60	99.32	98.17	97.73
%Conversion, wt	63.99	66.24	76.77	77.01
100-TCO	63.23	65.49	76.11	76.30
C2 Minus	1.92	2.28	3.60	3.84
Total C3	4.72	5.02	7.31	8.00
Total C4	8.19	8.43	10.40	11.25
C5-430F	46.45	47.62	50.61	48.58
430-680	26.33	25.65	18.84	18.54
680+	10.45	8.86	5.05	5.15
Coke	1.94	2.13	4.19	4.64
	100	100	100	100

PIANO AND GCOCTANE ANALYSES FOR 1995 AND 1996 MAT RUN PRODUCTS

Run	ID	FEED	TEMP, F	884 A6L VGO	885 A6H VGO	891 B6L DL2	892 B6H DL2	902 C6L HT DL2	903 C6H HT DL2	905 C6H HT DL2	802 DL1A DL1	793 DL1B DL1	788 DL1C DL1	822 DL1D DL1	816 DL1E VGO	824 DL1F BLEND
				970	1010	970	1010	970	1010	1010	980	980	980	980	980	980
				5.19	5.36	2.81	2.38	2.96	3.90	2.65	3.54	3.28	4.03	3.31	5.12	4.78
				38.85	33.00	37.62	31.34	41.84	39.93	37.08	33.27	32.03	34.68	33.56	37.49	38.00
				9.48	9.20	10.65	8.58	12.43	10.36	10.50	19.94	19.12	21.98	19.66	9.35	13.50
				29.06	32.90	34.77	32.90	28.57	33.32	38.56	36.31	38.29	32.31	37.32	33.00	32.20
				10.29	10.08	4.24	4.31	5.99	5.64	4.86	6.02	5.90	5.49	4.73	11.43	9.05
				5.33	6.18	5.59	5.91	6.05	4.03	3.67	0.93	1.37	1.51	1.42	3.61	2.47
				1.79	3.30	4.33	14.60	2.15	2.82	2.67	0.00	0.00	0.00	0.00	0.00	0.00
				5.92	5.92	3.12	2.99	3.22	4.19	2.83	3.57	3.33	4.09	3.36	5.31	4.90
				41.83	36.45	41.76	39.42	45.58	42.87	39.59	33.58	32.48	35.21	34.04	38.89	38.96
				10.21	10.16	11.82	10.79	13.54	11.12	11.21	20.13	19.39	22.32	19.94	9.70	13.84
				31.29	36.34	38.59	41.38	31.13	35.77	41.17	36.65	38.83	32.81	37.86	34.24	33.02
				11.08	11.13	4.71	5.42	6.53	6.05	5.19	6.08	5.98	5.57	4.80	11.86	9.28
				93.7	95.9	94.3	97.3	94.5	96.2	95.5	91.2	NA	91.2	92.6	NA	NA
				82.3	83.8	83.4	84.9	83.4	84.5	82.9	82.7	NA	81.6	83.7	NA	NA
				5.92	5.92	3.12	2.99	3.22	4.19	2.83	3.57	3.33	4.09	3.36	5.31	4.90
				41.83	36.45	41.76	39.42	45.58	42.87	39.59	33.58	32.48	35.21	34.04	38.89	38.96
				10.21	10.16	11.82	10.79	13.54	11.12	11.21	20.13	19.39	22.32	19.94	9.70	13.84
				31.29	36.34	38.59	41.38	31.13	35.77	41.17	36.65	38.83	32.81	37.86	34.24	33.02
				11.08	11.13	4.71	5.42	6.53	6.05	5.19	6.08	5.98	5.57	4.80	11.86	9.28
				93.7	95.9	94.3	97.3	94.5	96.2	95.5	91.2	NA	91.2	92.6	NA	NA
				82.3	83.8	83.4	84.9	83.4	84.5	82.9	82.7	NA	81.6	83.7	NA	NA

PIANO AS REPORTED, WT%

PIANO, NORMALIZED, WT%



Section 6

Project Management

6.1 Plans

6.2 Reports and Schedules

The milestone schedule and status for the Basic Program and Option 1 is shown in Figure 6-1.

Figure 6-1 Milestone Schedule for Basic Program & Option 1

PLAN STATUS REPORT

1. TITLE		2. REPORTING PERIOD												3. IDENTIFICATION NUMBER					
Refining and End Use Study of Coal Liquids		1/1/96 to 3/31/96												DE-AC22-93PC91029					
4. PARTICIPANT NAME AND ADDRESS		5. START DATE												6. ESTIMATED COMPLETION DATE					
Bechtel Corporation 50 Beale Street San Francisco, CA 94105		11/1/93												9/30/97					
7. ELEMENT CODE	8. REPORTING ELEMENT	93			FY94			FY95			FY96			FY97			10. PERCENT COMPLETE:		
		D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	a. Plan	b. Actual	
Task 1	Project Work Plan																	100	100
Task 2	Feed Characterization																	100	69
Task 3	Linear Programming (LP) Analysis																	93	78
Task 4	Pilot Plant Analysis																	93	6.5
Task 5	Option 1 Work Plan																	100	0
Task 6	Administration Task																	61	61
Option 1 Task 1	Pilot Plant Analysis (Produce Fuels)																	43	0
Option 1 Task 2	Characterization, Blending, and Testing																	0	0
Option 1 Task 3	Economic Study																	0	0
1 Submit Final Work Plan 2 Characterize DL1 liquid 3 Characterize IL liquid 4 Characterize DL2 liquid 5 Develop LP model 6 Input DL pilot plant data 7 Input IL pilot plant data 8 Conduct evaluation runs 9 Conduct DL1 pilot plant tests 10 Conduct IL pilot plant tests 11 Conduct DL2 pilot plant tests 12 Production runs for DL1 (deleted from program) 13 Production runs for IL 14 Production runs for DL2 15 ASTM tests for DL1 (deleted from program) 16 ASTM tests for IL 17 ASTM tests for DL2																			
11. SIGNATURE OF PARTICIPANT'S PROJECT MANAGER AND DATE																			

Chiff Jan 4/30/96