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OPERATION OF THE SOLVENT REFINED COAL PILOT PLANT

Annual Technical Report for January—December 1980

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Catalytic, Inc.
Wilsonville, Alabama

U. S. DEPARTMENT OF ENERGY

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SRC-I
SOLVENT REFINED COAL PROCESS
OPERATION OF THE SOLVENT REFINED COAL PILOT PLANT
Wilsonville, Alabama

ANNUAL TECHNICAL REPORT

January - December 1980

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Wilsonville, Alabama

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Subcontractor to
SOUTHERN COMPANY SERVICES, INC.
Birmingham, Alabama 35202

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TABLE OF CONTENTS

	<u>Page</u>
NOMENCLATURE	ix
Definitions.....	ix
Abbreviations.....	x
Symbols.....	xii
Equipment Designations	xiii
Coal Sources.....	xiii
ABSTRACT	1
I. INTRODUCTION.....	2
II. SUMMARY AND CONCLUSIONS.....	5
III. PROCESS DESCRIPTION.....	12
A. Coal Slurry Preparation.....	12
B. Coal Dissolution.....	12
C. High Pressure Gas and Slurry Sepa- ration.....	12
D. Filter Feed Preparation.....	13
E. Filtration.....	13
F. Mineral Residue Processing.....	14
G. Vacuum Flash System.....	14
H. Product Solidification.....	15
I. Critical Solvent Deashing.....	15
J. Gas Recovery and Recompression.....	15
K. Naphtha Recovery.....	15
L. Solvent Fractionation.....	16
M. Solvent Storage.....	16
IV. RUN SUMMARIES.....	17
A. Solvent Refined Coal (SRC) Unit.....	17
B. Critical Solvent Deashing (CSD) Unit..	21
V. PROCESS ANALYSES.....	22
A. SRC Unit Material Balance.....	22
B. CSD Unit Material Balance.....	23
C. Overall Material Balance	25
D. Discussion.....	26

TABLE OF CONTENTS (Continued)

	<u>Page</u>
VI. OPERATIONS AND PROCESS TOPICS.....	29
A. Operations Summary	29
B. Solvent Inventory and Properties...	31
C. Reaction.....	34
D. Filtration.....	37
E. Critical Solvent Deashing Unit.....	39
F. Solvent Recovery.....	41
G. Corrosion.....	43
H. Wastewater Treatment.....	44
I. Laboratory Programs.....	44
VII. MECHANICAL PERFORMANCE.....	46
VIII. PROJECTS.....	53
IX. FUTURE PLANS.....	56
REFERENCES.....	58
APPENDICES.....	60
A. Operating Log.....	60
B. Material Balance Diagrams and Calculations.....	65
C. Resource Conservation and Recovery Act (RCRA) Compliance: Hazardous Waste Disposal.....	72

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1.	SRC Unit and CSD Unit Operating Hours....	97
2.	Operating Data Summary for October 1980..	98
3.	Operating Data Summary for November 1980.	101
4.	Operating Data Summary for December 1980.	103
5.	Conditions and Results Summary	105
6.	Results Summary - Unadjusted Yields (Process Method).....	109
7.	Critical Solvent Deashing Unit.....	110
8.	Coal Feed Summary.....	113
9.	Feed Coal Analyses.....	114
10.	SRC Production Summary.....	115
11.	B102 Slurry Preheater Operating Data (Daily Average).....	116
12.	B102 Slurry Preheater Operating Data (Material Balance Periods).....	117
13.	R101 Dissolver Operating Profile.....	118
14.	Reaction Section Operating Data.....	119
15.	Heteroatom Removal.....	120
16.	High Pressure Vent Separator Gas Analyses (V104).....	121
17.	Decanter Vent Gas Analyses (V105).....	122
18.	Degas Vent Gas Analyses (V132).....	123
19.	Flare Gas Analyses (K110).....	124
20.	T102 Vacuum Column Operating Data.....	125
21.	Naphtha Analyses.....	126
22.	Naphtha Compositions (wt %).....	127
23.	Naphtha Product Analyses.....	129
24.	Naphtha Product Compositions (wt %).....	130
25.	T104 Recovery Column Operating Data.....	132
26.	T104 Overhead Stream Compositions (wt %).	133
27.	Analysis of Plant Component Problems - October to December 1980.....	135

LIST OF FIGURES

<u>Fig.</u>		<u>Page</u>
1.	SRC Flowsheet.....	138
2.	USF Filter Unit Flowsheet.....	139
3.	Industrial Filter Test Unit Flowsheet.....	140
4.	Critical Solvent Deashing Unit Flowsheet..	141
5.	B102 Slurry Preheater Thermocouple Locations.....	142
6.	Dissolver Differential Pressure and Nuclear Density Instrumentation.....	143
7.	Process Solvent Quality.....	144
8.	Ratios of Benzene-Solubles to Benzene- Insolubles in T102 Vacuum Column Bottoms vs T102 Bottoms Temperature.....	145
9.	Ratios of Benzene-Solubles to Benzene- Insolubles in V110 SRC vs V103 High Pressure Separator Temperature.....	146
10.	R101 Dissolver Temperature vs V103 High Pressure Separator Temperature.....	147
11.	E102 Outlet Process and Inlet Skin Temperature vs V103 High Pressure Sepa- rator Temperature.....	148
12.	B103 Vacuum Column Preheater, Mode 1 Operation	149
13.	B103 Vacuum Column Preheater, Mode 2 Operation	150
14.	Process Solvent Distillation Curves (Run 217CD MB by GC and ASTM D-86).....	151
15.	Process Solvent Distillation Curves (Run 219AB MB by GC and ASTM D-86).....	152
16.	Process Solvent Distillation Curves (Run 220AB MB by GC and ASTM D-86).....	153
17.	Process Solvent Distillation Curves (Run 220DE MB by GC and ASTM D-86).....	154
18.	Process Solvent Distillation Curves (Run 221B MB by GC and ASTM D-86).....	155
19.	Process Solvent Distillation Curves (Run 221G MB by GC and ASTM D-86).....	156
20.	Process Solvent Distillation Curves (Run 217CD MB by ASTM D-1160).....	157
21.	Process Solvent Distillation Curves (Run 219AB MB by ASTM D-1160).....	158
22.	Process Solvent Distillation Curves (Run 220AB MB by ASTM D-1160).....	159
23.	Process Solvent Distillation Curves (Run 220DE MB by ASTM D-1160).....	160
24.	Process Solvent Distillation Curves (Run 221B MB by ASTM D-1160).....	161
25.	Process Solvent Distillation Curves (Run 221G MB by ASTM D-1160).....	162
26.	Naphtha Distillation Curves (Run 217CD MB).....	163
27.	Naphtha Distillation Curves (Run 219AB MB).....	164

LIST OF FIGURES (Continued)

<u>Fig.</u>		<u>Page</u>
28.	Naphtha Distillation Curves (Run 219B MB).....	165
29.	Naphtha Distillation Curves (Run 220AB MB).....	166
30.	Naphtha Distillation Curves (Run 220DE MB).....	167
31.	Naphtha Distillation Curves (Run 221B MB).....	168
32.	Naphtha Distillation Curves (Run 221G MB).....	169
33.	Wastewater Treatment System.....	170
34.	Effluent Trend Chart: Phenol, BOD, pH, and Oil and Grease - January to June 1980.....	171
35.	Effluent Trend Chart: Phenol, BOD, pH, and Oil and Grease - July to December 1980.....	172
36.	Effluent Trend Chart: Solids and Temp- erature - January to June 1980.....	173
37.	Effluent Trend Chart: Solids and Temp- erature - July to December 1980.....	174
38.	Flow Trend Chart - January to June 1980.....	175
39.	Flow Trend Chart - July to December 1980.....	176

FIGURES IN APPENDICES

B1.	Overall Material Balance - SRC and CSD Units	71
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EXHIBITS IN APPENDICES

C1.	Wilsonville SRC Pilot Plant Waste Characterization.....	74
C2.	U. S. EPA Notification of Hazardous Waste Activity.....	78
C3.	U. S. EPA General Information.....	81
C4.	Daily Inspection Report, Hazardous Waste Facilities.....	95
C5.	Weekly Inspection Report, Hazardous Waste Facilities (Fire Protection).....	96

NOMENCLATURE

DEFINITIONS

Solvent refined coal (SRC)	A cresol-soluble product of the coal liquefaction process which is non-distillable at 600°F and 0.1 mm Hg in the laboratory.
Process solvent	A coal-derived distillate fraction with a boiling range between 450°F at 760 mm Hg (GC and ASTM D-86) and 600°F at 0.1 mm Hg in the laboratory (flask).
Middle distillate (wash solvent)	A coal-derived distillate fraction with a boiling range between 350°F and 450°F at 760 mm Hg (GC and ASTM D-86).
Naphtha (light organics)	A coal-derived distillate fraction with a boiling range from that of C ₅ up to but less than 350°F at 760 mm Hg (GC and ASTM D-86).
Light solvent refined coal (LSRC)	A low preasphaltene SRC product of the third stage of the CSD unit.
Deashing solvent (DAS)	A solvent used to deash vacuum column bottoms that are fed to the CSD unit.
Ash	Residual mineral matter after muffle furnace burning at 900°C for 3 hr (adapted ASTM D-482).
Ash concentrate	A product of the Kerr-McGee CSD unit first stage settler that is rich in cresol-insolubles (ash and UC) with lesser amounts of SRC and solvents.
Mineral residue	A residual mixture deposited on the filter after reaction product has passed through it. It contains ash, SRC, UC, and solvents.
Filter cake	A mixture of filter aids and mineral residue containing ash, SRC, UC, and solvent.
Tl02 Vacuum Column bottoms (CSD feed)	A residual mixture of SRC, solvents, ash, and UC.
UC	Organic material that is insoluble in boiling cresol.

ABBREVIATIONS

avg	average
AWS	acetone-washed solids
BP	boiling point
BR	boiling range
btm	bottom, bottoms
Btu	British thermal units
cc	cubic centimeters
CF	capacity factor
cfm	cubic feet per minute
CI	cresol insolubles
cm/sec ²	centimeters per second per second
col	column
comp	composite
conc	concentrate, concentrated, concentration
cons	consumed
conv	conversion
corr	corrected
cp	centipoise
CS	cresol soluble
CSD	Critical Solvent Deashing
cum	cumulative
cyc	cycle
dia	diameter
DOE	United States Department of Energy
DP	differential pressure
EOD	equivalent orifice diameter
EP	end point
EPRI	Electric Power Research Institute
est	estimated
Eq	equation
Fe/S	iron to sulfur atomic ratio
filt	filtered, filtrate, filtration
fps	feet per second
frac	fractionation
ft	feet
ft ⁻¹	reciprocal feet
ft/lb _m	feet per pound mass
ft/sec ²	feet per second per second
ft ²	square feet
ft ³	cubic feet
ft-lb	foot-pounds
g	acceleration due to gravity (32.2 ft/sec ²)
gal	gallons
gm	grams
gph	gallons per hour
gpm	gallons per minute
H/C	hydrogen-to-carbon atomic ratio
HP	high pressure
hp	horsepower

hr	hours
hr ⁻¹	reciprocal hours
HVB	high volatile bituminous
IBP	initial boiling point
ICRC	International Coal Refining Company
ID	inside diameter
IF	Industrial Filter and Pump Manufacturing Co.
in.	inches
k	vapor-liquid equilibrium constant
KM	Kerr-McGee Corporation
lab	laboratory
L/D	length-to-diameter ratio
lb	pounds
lb-ft	pound feet (of torque)
lb/hr-ft ²	pounds per hour per square foot
lb/hr-ft ³	pounds per hour per cubic foot
LP	low pressure
LSRC	light solvent refined coal
lt	light
lt org.	light organic
M	thousand
mA	milliamperes
MAF	moisture and ash free
MASF	moisture, ash and solvent free
max	maximum
MB	material balance
MCIF	moisture and cresol-insoluble free
MF	moisture free
mg/gm	milligrams per gram
mg/l	milligrams per liter
mid	middle
min	minimum, minutes
ml	milliliters
mm	millimeters
MM	million
moist	moisture
mol %	mole percent
mol wt	molecular weight
MP	melting point
mpy	mils per year
MW	molecular weight
NA	not available
ND	not detected
NMR	nuclear magnetic resonance
OD	outside diameter
OF	overflow
OH	overhead
OR	oxygen removed
org	organic
OSR	organic sulfur removal
P	pressure

PA	preasphaltenes
p(H ₂)	hydrogen partial pressure
ppm	parts per million
prod	product, produced
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
qtr	quarter
r	correlation coefficient
ref.	reference
R _m	filter medium resistance
rpm	revolutions per minute
scf	standard cubic feet at 520°R and one atmosphere pressure
scfh	standard cubic feet per hour
scfm	standard cubic feet per minute
sec	second
sec ⁻¹	reciprocal seconds
SLS	solid-liquid separation
SN	sample number
solv	solvent
sp gr	specific gravity
spec	specification
SRC	solvent refined coal
SRT	short residence time
SS	stainless steel
std	standard
TBP	true boiling point
temp	temperature
THF	tetrahydrofuran
TI	terphenyl insolubles
tpd	tons per day
tr	trace
UC	undissolved coal
UCC	undissolved carbon compounds
USF	United States Filter Corporation
vac	vacuum
visc	viscosity
vol	volume
wt	weight

SYMBOLS

α	average specific cake resistance
°C	temperature, degrees Celsius (centigrade)
°F	temperature, degrees Fahrenheit
°R	temperature, degrees Rankine
ΔH _R	heat of reaction
Δt	temperature differential
ΔP	pressure differential
<	less than
>	greater than
≈	about, approximately equal to
Σ	the sum of

EQUIPMENT DESIGNATIONS

B	boiler, heater
C	compressor
D	dryer
DE	density element
DIT	density indicator transmitter
DPCV	differential pressure control valve
DPSH	differential pressure switch
DPT	differential pressure transmitter
E	exchanger
F	filter
FIC	flow indicator and controller
FR	flow recorder
FV	flow valve
GC	gas chromatograph
GLC	gas/liquid chromatograph
HV	hand valve
LSH	high level switch
LSL	low level switch
L	product cooler or flare
LV	letdown valve
LS	level switch
P	pump
PSH	high pressure switch
PSV	pressure safety valve
PV	pressure valve
R	reactor
SV	safety valve
T	tower; timer
TC	thermocouple
TR	temperature recorder
V	vessel

COAL SOURCES

Period:

1 January through 26 February 1980

Company:	Lafayette Coal Compan
State:	Kentucky
Mine:	Lafayette
Seam:	No. 9
Nomenclature:	Ky 9 Lafayette

Period:

26 February through 9 May 1980 and
3 August through 21 August 1980

Company:	Mapco Coal Company
State:	Kentucky
Mine:	Dotiki
Seam:	No. 9
Nomenclature:	Ky 9 Dotiki

Period:

25 May through 29 July 1980 and
23 August through 31 December 1980

Company: Island Creek Coal Company
State: Kentucky
Mine: Fies
Seam: No. 9
Nomenclature: Ky 9 Fies

ABSTRACT

This report summarizes the operating conditions and test results obtained during 1980 at the six ton per day solvent refined coal (SRC-I) pilot plant in Wilsonville, Alabama. The plant was in operation for the equivalent of 247 days, an on-stream factor of 67.7%. Kentucky 9 coals from the Lafayette, Dotiki and Fies mines were processed.

During 1980, the operating conditions and equipment were adjusted to evaluate potential process improvements. These experiments produced significant results in the following areas:

- Operating V103 High Pressure Separator in the hot mode.
- Varying T102 Vacuum Column operating temperature.
- Adding light SRC (LSRC), a product of the third stage of the Critical Solvent Deashing (CSD) unit, to the process solvent.
- Investigating the effects of the chlorine content of the feed coal on corrosion in the process vessels.
- Evaluating the effects of adding sodium carbonate on corrosion rates.
- Operating under conditions of low severity; i.e., low reactor temperature and long residence time.
- Testing an alternate CSD deashing solvent.

A series of simulation runs investigating the design operating conditions for a planned 6,000 ton per day SRC-I demonstration plant were also completed. Numerous improvements were made in the CSD processing area, and the components for a hydrotreating unit were installed.

I. INTRODUCTION

The solvent refined coal (SRC-I) pilot plant at Wilsonville, Alabama is a six ton per day coal liquefaction facility that removes sulfur from coal by reacting the slurried coal with a process solvent and distilling the reaction products at elevated temperatures and pressures. The reaction product can be deashed either by filtration or by Critical Solvent Deashing (CSD), a proprietary process developed by the Kerr-McGee Corporation.

Sponsorship of the Wilsonville SRC pilot plant combines the participation of several organizations. In March 1972, the Southern Company and the Edison Electric Institute (EEI) initiated a pilot study of key steps in the solvent refining process that produces low sulfur and low ash solid fuel from coal. The pilot plant was designed, constructed, and is being operated by Catalytic, Inc. Southern Company Services, Inc. (SCS) represents the Southern Company System and provides management for the project. In April 1973, the Electric Power Research Institute (EPRI) assumed the functions of project supervision for the utility industry, formerly carried out by EEI. The United States Department of Energy (DOE) became a co-sponsor of the project in 1976.

Operation with coal began in January 1974. This report presents a summary of the progress achieved during 1980 and details the operating results for the fourth quarter of that year. Prior work at the Wilsonville facility is described in Technical Progress Reports for monthly, quarterly, and annual operating periods.

The principal objectives of the 1980 Wilsonville SRC program were:

- To evaluate the following solid-liquid separation methods:
 - (1) Kerr-McGee Critical Solvent Deashing
 - Establish the effects of varied SRC unit and CSD unit operating conditions on yield and performance
 - Evaluate an alternate deashing solvent (DAS)
 - Reduce DAS losses
 - Establish a data base for heat transfer, solids settling rates, solvent losses, and solvent stripping requirements that is suitable for use in process scale-up

- Improve performance generally
- (2) Filtration with a United States Filter Corp. Vertical-Leaf Filter

Investigate its performance in both the precoat and non-precoat modes of operation

- (3) Filtration with an Industrial Filter and Pump Manufacturing Co. Candle Filter

Investigate the capability of this filtering unit to remove ash from SRC

To provide technical support for a planned 6,000 tpd SRC-I demonstration plant, with emphasis on attaining and controlling long-term process stability and evaluating yield structures, hydrogen consumption, process solvent balance, and product specifications

- To establish improvements in process equipment and operations; for example:
 - Hot mode of V103 High Pressure Separator operation
 - Product solidification
- To evaluate potential improvements in the SRC process, including low severity operation and the recovery and recycle of CSD third stage bottom stream (LSRC)
- To study corrosion reduction in the pilot plant processing units, including:
 - Testing coals of varying chlorine content
 - Evaluating corrosion inhibitors
 - Monitoring the effects on the overall process of using sodium carbonate to inhibit corrosion

Kentucky 9 coal, the design coal for the SRC-I demonstration plant, was processed throughout the year. This coal was obtained from either the Lafayette, the Dotiki, or the Fies mine.

Runs 195 through 221 were completed during 1980. The results are documented in the following reports:

<u>Runs</u>	<u>Wilsonville Technical Report</u>
195 through 204	First Quarter: January-March 1980
205 through 210	Second Quarter: April-June 1980
211 through 217	Third Quarter: July-September 1980
218 through 221	Annual Report for 1980: October - December 1980

II. SUMMARY AND CONCLUSIONS

In the solvent refined coal (SRC-I) process, pulverized coal is slurried with a process-derived recirculating solvent. Hydrogen is added to the slurry which is then heated and fed to a dissolver. Effluent from the dissolver is flashed and the gas is separated and scrubbed to remove hydrogen sulfide and carbon dioxide. Makeup hydrogen is added and the scrubbed gas is recycled.

Effective solids removal is critical to SRC product quality. During 1980, three systems were evaluated for separating undissolved coal solids and ash from SRC. One of these was Critical Solvent Deashing (CSD), a proprietary process developed by Kerr-McGee. The other two utilized state-of-the-art filtration techniques.

In the filtration mode, solids are filtered from the SRC reaction product and the filtrate is distilled to separate the solvent and SRC fractions. In the CSD mode, the unfiltered SRC slurry is distilled to separate the solvent, then the ash-containing SRC fraction is refined with a deashing solvent at conditions near the critical temperature and pressure of that solvent. In the CSD first stage, SRC, light SRC (LSRC), and deashing solvent (DAS) are removed from the heavy ash concentrate in an overhead stream. In the second stage, liquid SRC is the bottom stream product, and the overhead combination of LSRC and DAS flows to the third stage. The DAS is recovered as overhead from the third stage separation vessel and recycled. A portion of the LSRC bottom stream may be recycled and combined with the SRC process solvent.

After deashing by either method, the SRC product is solidified by cooling. The recovered SRC solvent is separated by fractional distillation. The material boiling above 450°F can be used as process solvent. When filtration is used for ash separation, a middle distillate boiling between 350 and 450°F is recovered and recycled for filter cake washing. When the CSD unit is operating, middle distillate is not separated and all material boiling below 450°F is combined and designated as naphtha.

A. OPERATING HIGHLIGHTS

The major objectives of the 1980 pilot plant program were achieved, and several important new projects were started.

Twenty-seven runs (195 through 221) were completed during the year using coals from three different mines. From 1 January to 26 February, Kentucky 9 from the Lafayette mine was processed. From 26 February to 9 May and from 3 to 21 August, Kentucky 9 coal from the Dotiki mine was processed. Kentucky 9 coal from the Fies mine was processed from 25 May to 29 July and from 23 August through 31 December.

There were four major process studies in the SRC section during the year:

- Corrosion Studies Corrosion rates in the fractionation area were measured when using high-chlorine (0.2 to 0.3 wt %) Lafayette and Dotiki mine coals as well as low-chlorine (0.1 wt %) Fies mine coal. Runs 213 and 214 were made with Dotiki mine coal to produce samples for a chlorine balance. The effects of adding sodium carbonate to the feed slurry at rates from 0 to 9.6 lb/hr were investigated.
- V103 High Pressure Separator Operations The separator was tested in the hot mode and its performance was compared with operations in the normal mode. A substantial energy saving is possible by eliminating dissolver slurry cooling and subsequent reheating.
- Demonstration Plant Simulation Tests Operating conditions tentatively established for a planned 6,000 tpd SRC-I demonstration facility were evaluated at Wilsonville in both short and long simulation runs using Fies mine coal. These conditions were evaluated during Runs 209, 210, 218, 219, and 220.
- Low Severity Tests During Runs 216, 217, 221, and 222, Fies mine coal was processed with solvent containing 30 wt % light SRC (LSRC). Low severity SRC reactor conditions (long residence time and low reactor temperature) applicable for two-stage liquefaction were evaluated.

B. CONCLUSIONS

The following conclusions were derived from analyses of the 1980 Wilsonville operating data.

1. Coal Desulfurization Area (SRC Unit)

- Sodium carbonate, when mixed with the feed coal slurry, effectively reduced the corrosion rate in the SRC unit solvent recovery system. (Bench-scale studies indicated that sodium carbonate was the most effective of several corrosion inhibitors evaluated.) However, it apparently contributed to the high sodium level measured in V110 laboratory

filtered and CSD-deashed SRC products. The use of sodium carbonate had no significant impact on product yields.

- There was generally less corrosion in T102 Vacuum Column and in T105 Fractionation Column when processing Fies mine coal with low-chlorine (about 0.1 wt %) than when processing high-chlorine (0.2 to 0.3 wt %) Dotiki and Lafayette mine coals. Processing Dotiki coal in Runs 213 and 214 caused more than double the rate of corrosion experienced with Fies coal; but the Fies coal did require sodium carbonate addition to inhibit corrosion in the solvent recovery fractionation area. Corrosion rates measured in the solvent recovery system when processing Dotiki and Lafayette mine coals were generally similar.
- While processing Dotiki and Fies mine coals, the levels of desulfurization and deoxygenation were:

	Source Mine	
	<u>Fies</u>	<u>Dotiki</u>
Desulfurization, %		
total sulfur	84-89	84-85
organic sulfur	81-82	73-77
Deoxygenation, %	78-81	73-79

- Process solvent produced during runs with Dotiki mine coal had a higher quality than that produced during runs with Lafayette mine coal. However, the solvent quality was not appreciably affected by the change from Dotiki mine to Fies mine coal.
- Silicon and titanium are the prominent trace components present in CSD-deashed SRC. Deashed SRC (containing about 0.05% ash) from Dotiki mine coal, processed with sodium carbonate addition, typically contained about 100 ppm silicon, 70 ppm titanium, 5-25 ppm vanadium, 1-10 ppm arsenic, and 20-30 ppm sodium. Typical analyses for the SRC from Fies mine coal, without sodium carbonate addition, were: 50 ppm titanium, 5-10 ppm vanadium, 1-5 ppm arsenic, and 20 ppm sodium. (The Dotiki coal initially contained about 325 ppm sodium while the Fies coal contained 760 ppm sodium.)

- Viscosity peaks (heats of dissolution) were observed in B102 Slurry Preheater in the temperature ranges of 600 to 650°F with Dotiki mine coal and 550 to 600°F with Fies mine coal (at different operating conditions). The highest differential (skin/fluid Δt) was 70°F with Dotiki, 90°F with Fies, and about 110°F with Lafayette mine coal.
- Short and long demonstration plant simulation runs were completed with the Fies mine coal. (See Runs 209, 210, 219, and 220.) The average conversion to cresol-soluble organics was 93 to 94 wt % of MAF coal. The average yield of solvent-free SRC from T102 Vacuum Column bottoms was 54 to 57 wt % of MAF coal. The average process solvent quality and recovery of SRC in the CSD unit was low for Runs 209 and 210 and was high for Runs 219 and 220. The hydrogen consumption was 2.4 wt % of MAF coal. The sulfur content of V110 laboratory filtered and distilled SRC was 0.8 to 0.9 wt %.
- The hot mode of V103 High Pressure Separator operation was shown to be generally preferable to the normal mode. It should be noted, however, that operating in the hot separator mode above 740°F and with more than 20 minutes retention time produced SRC of comparatively poorer quality (higher preasphaltene contents in the V110 laboratory filtered SRC and in the T102 Vacuum Column bottoms than the normal mode). It was concluded that the product quality was inversely proportional to the T102 bottoms temperature. (See Runs 204, 206, 208, 209, 210, 217, and 221.)
- For the normal separator mode of operation, T102 Vacuum Column and T104 Recovery Column were operated in tandem to achieve the desired separation of distillates. This was accomplished during the fourth quarter. Until October 1980, T105 Fractionation Column was also used. The T102 operating data indicated that a process solvent (containing more than 85% of the fraction boiling above 450°F) can be produced with only two columns. Furthermore, T104 data showed that adding 30 wt % LSRC to the process solvent stream and reducing the coal rate yielded less feed to T104 column.

- The data from Runs 216 and 217 showed strong promise for the use of CSD-derived LSRC as a feed solvent component in the SRC unit. With a recycle solvent stream composition of 30 wt % LSRC and 70 wt % process solvent, coal was liquefied at low process severity conditions (about 785 F dissolver outlet temperature compared to 825 to 850°F for conventional SRC liquefaction). In the "conventional" cases, the feed solvent contained 0 to 5 wt % LSRC, as in Runs 211 and 212.
- A major effect of LSRC recycle was to produce a higher yield of process solvent and a lower yield of gases, naphtha, and SRC. Based on the material balances, the highest SRC recoveries (by the forced ash balance method) were recorded during the runs in which the process solvent contained 30% LSRC. The solvent quality by the microautoclave short test, of the 30/70 wt % (LSRC/recycled solvent) mixture was high (about 83 to 86% THF conversion); but the solvent quality by the long test was lower (about 62% THF conversion). For a prehydrogenated creosote oil sample, both solvent qualities were very high (85 to 89% THF conversion for the short test and 92 to 93% for the long test).
- Initial low severity test results, when there was 30 wt % LSRC in the process solvent stream, were promising. (See Runs 216, 217, 221, and 222.) It appeared that when the R101 Dissolver operating temperature increased, sulfur removal and deoxygenation also increased. (See Runs 217 and 221.) The products from Runs 217 and 221 were almost identical, except for a higher SRC sulfur content during Run 221 that was apparently due to a lower dissolver temperature. The average conversion to cresol-soluble organics was 92 to 93 wt % of MAF coal. The average yield of solvent-free SRC from T102 Vacuum Column bottoms was 60 to 64 wt % of MAF coal. The average process solvent quality was 83 to 84% THF conversion by the short test and 57 to 63% by the long test. The hydrogen consumption was 1.6 to 2.8 wt % of MAF coal. The elementally balanced hydrogen consumptions for MB Runs 217AB, 217CD, 221B, and 221G ranged from 1.3 to 1.9 % of MAF coal. The sulfur content of V110 laboratory filtered and distilled SRC was 0.9 to 1.2 wt %.

- In B102, the skin and fluid temperature differential at turns 35 and 37 generally provided the most reliable means of predicting coke buildup in the coil.
- The process solvent and the naphtha inventories increased during the last quarter of 1980.

2. Product Deashing Areas (CSD and Filtration Units)

- Modifications to the Critical Solvent Deashing (CSD) system produced several process improvements, among them:
 - Ash concentrate receiver modifications now enable deashing of the entire SRC plant production.
 - A more effective deashing solvent (DAS) recycle method was initiated.
 - Concerted efforts to reduce DAS losses yielded run periods (late in 1980) in which the rates of DAS losses were about 50% less than those recorded in 1979 and in early 1980. A major improvement was noted when operating the modified CSD unit ash receiver as a closed system.
 - Recovery of CSD-deashed SRC was improved slightly by using a different deashing solvent. When using DAS "B", SRC recovery was about 80%, as compared to 77% when using DAS "A".
- In general, SRC recovery in the CSD unit increased with an increase in the benzene-soluble content of the feed. With reduced SRC quality during hot separator mode tests, the SRC recovery decreased.
- CSD-deashed SRC derived from Dotiki mine coal with sodium carbonate addition met the 0.16 wt % ash specification.
- LSRC production in the CSD unit was maintained at a rate equivalent to 30 wt % of the recycle process solvent stream.

- Neither the United States Filter Corporation (USF) nor the Industrial Filter and Pump Manufacturing Co. (IF) filters were able to produce SRC that was consistently below the maximum ash specification of 0.16%.
- Solution-annealed screens on the USF filter leaves did not corrode and fail as the previous leaves had. The annealed screens were in operation for 43 days.
- The USF filter cycle was improved by shortening the filter washing step while using precoat.
- The IF filter was operated with only a carbonaceous feed (no precoat) as the result of mechanical problems. This, together with screen blinding, prevented the accumulation of definitive data for the vibratory method of cake discharge and the body feed test program.
- There was no long term evidence to show that the IF filter filtration rates were faster than those for the USF filter.
- The carbonaceous body feed rate recommended by IF and used for the filter tests amounted to 4 wt % of the slurry feed. The USF filter precoat usage amounted to 0.8 wt % (0.35 lb/ft²) and 0.2 (0.07 lb/ft²) of the slurry feed.

III. PROCESS DESCRIPTION

This section describes the process operations of the Wilsonville SRC-I pilot plant. A process flowsheet for the SRC unit is provided in Figure 1.

A. COAL SLURRY PREPARATION

Pulverized coal, 95% of which passes through a 200 mesh screen (74 by 74 microns), is mixed with a process-derived solvent in V101A Slurry Blend Tank. The boiling range of this solvent is 450 to 900°F. The resulting slurry is transferred to V101B Slurry Feed Tank where it is agitated to maintain a uniform suspension. P102B Slurry Circulating Pump circulates the slurry and also feeds P103A or B Slurry Preheater Feed Pumps.

Feed gas, which consists of scrubbed recycle gas plus makeup hydrogen, is normally added to the coal slurry upstream of the preheater inlet. The feed gas is usually 85% hydrogen by volume.

The mixture of coal slurry and feed gas in B102 Slurry Preheater flows upward through a helical coil of 1.25 in. schedule 160, 316 SS pipe, 600 ft long. The coil is heated by a burner located in the bottom of the preheater.

B. COAL DISSOLUTION

The coal slurry and gas mixture leaves the preheater and flows upward through R101 Dissolver. The dissolver is 24 ft high and one foot in diameter, centrifugally cast of high-chrome stainless steel. It can be operated at 800 to 875°F, 1,400 to 2,500 psig, and can provide residence times of 15 to 60 minutes. Outlets are located at the 25, 50, 75, and 100% volume levels to permit changes in residence time. Effluent from the dissolver is cooled to between 600 and 650°F by E102 Dissolver Product Cooler.

Improvements to the original dissolver include the installation of a distributor plate in September 1977; a solids density monitoring system in November 1977; and a solids withdrawal system in February 1978.

C. HIGH PRESSURE GAS AND SLURRY SEPARATION

The vapor and slurry phases are separated in V103 High Pressure Separator. Vapor from the separator is cooled to about 150°F by E103 High Pressure Cooler and then passes to the V104 High Pressure Vent Separator. Water and organic compounds condensed in E103 are fed through LV430 Letdown Valve to V105 Solvent Decanter. Vapor from V104 includes unreacted hydrogen, light hydrocarbon gases, hydrogen sulfide, and carbon oxides.

D. FILTER FEED PREPARATION

Slurry from V103 is flashed through LV415A or B High Pressure Letdown Valves to V110 Flash Tank. The 115 psig vapor goes to E107 Flash Condenser. The V110 liquid phase flows to V111 Reclaim Tank which serves as a feed reservoir for the batch filtration system. Noncondensed vapors from E107 and vapors from V104 are vented from V105 to K110 Flare. Organic liquids from E107 and V104 are separated from the water phase in V105 Solvent Decanter.

E. FILTRATION

The removal of ash and unreacted coal from the reaction product stream can be accomplished in several ways; for example, this stream can be filtered or it can be fed to the Critical Solvent Deashing (CSD) unit described later in this section. The F125 United States Filter Corporation (USF) filter unit is available for filtering operations. An Industrial Filter and Pump Manufacturing Co. (IF) candle filter is also being tested. A Funda horizontal pressure-leaf filter was used to filter reaction product until October 1978.

The USF filter unit, a vertical pressure-leaf filtration system, is shown in Figure 2. Filtration is accomplished by four vertical, circular filter leaves with metal wire screens and a total effective filtration area of 87.2 ft². The filter unit operates at 480 to 580°F and 150 to 200 psig, with a maximum pressure drop of 100 psi between the slurry inlet and the filtrate outlet. The leaves are cleaned by sluicing with wash solvent at high pressure (up to 2,000 psig).

The following batch filtration operations are automatically controlled by a programmer:

- precoating or no precoating
- filtration
- washing with sluice wash solvent
- cake blowing
- depressurization
- vacuum flash drying
- cake discharging
- repressurization
- sluicing

A high boiling (above 450°F) process solvent is used for precoat makeup and deposition. The washing step uses low boiling range (350 to 450°F) middle distillate as the wash solvent. Nitrogen is used for cake blowing and repressurization.

The Industrial Filter and Pump Manufacturing Company (IF) skid-mounted candle filter (Figure 3) was tested during the second and third quarters of 1980. The unit has three tubular elements with a total area of 5.5 ft². All filtration operations are done manually. The sequence of operations is essentially the same as for previous filters. Major exceptions are that body feed is added to the filter feed (the elements are not precoated); the filter cake is blown dry with nitrogen rather than being vacuum-dried; and that the cake is discharged from the tubular elements by vibration rather than by scraping with a knife and sluicing.

F. MINERAL RESIDUE PROCESSING

After depressurization, the pressure in the filter unit is reduced to 1-2 psia for 10 minutes. Most of the residual wash solvent in the filter cake flashes to K115 Dryer Vent Gas Scrubber where it is condensed by a circulating stream of cold solvent. The cake, now containing less than 5% residual solvent, is cooled and discharged into storage drums. The recovered solvent is pumped to V111 Reclaim Tank.

G. VACUUM FLASH SYSTEM

Filtered SRC solution flows to V120 Vacuum Preheater Surge Drum. P116A or B Filter Pumps transfer the solution through B103 Vacuum Preheater to T102 Vacuum Column where it flashes as it enters. The primary function of T102 is to separate SRC from organic liquid boiling at temperatures up to 900°F. The following streams are removed from T102: liquid SRC (from the bottom), solvent fractions (from trays 3 to 8), and vapors (from the overhead). The overhead vapor passes through a vacuum-jet precondenser and the trays 3 and 8 naphtha (light organic) condensate is pumped to V164 Feed Tank and then to T104 Recovery Column.

Column T102 is three feet in diameter and contains valve trays, tunnel cap trapout trays, and Koch-Sulzer packing. Overhead pressure is maintained at 0.3 to 1.5 psia by a two-stage jet, K111 (with before and after condensers). The column feed is heated in B103 to maintain a bottom temperature of approximately 600°F. A portion of the liquid SRC is recirculated and mixed with the material from V110 Flash Tank.

H. PRODUCT SOLIDIFICATION

Liquid SRC from T102 is fed to the vibrating water-cooled trays of K125 Product Cooler. Two trays provide a total surface area of 30 ft². The SRC solidifies into brittle sheets which shatter into small fragments. The fragmented SRC is conveyed to storage.

I. CRITICAL SOLVENT DEASHING

A flow diagram of the Kerr-McGee Critical Solvent Deashing (CSD) unit is shown in Figure 4. When this system is used as an alternative to filtration, the V111 material is routed through B103 to T102. The bottoms concentrate from T102 is transferred to the CSD system, which separates the feed and discharges ash concentrate at the first stage, deashed SRC at the second stage, and light SRC (LSRC) at the third stage. The separations are made using a proprietary deashing solvent operating in the region of its critical temperature and pressure. Under these conditions, 65 to 85% of the SRC is dissolved. Deashing is accomplished in two steps. The ash-containing feed, mixed with solvent at near critical conditions, flows to the first stage settler where the mineral matter and undissolved coal separate as a heavy phase which is withdrawn from the bottom of the settler. Solvent is stripped and the solids become a free-flowing powder which is discharged. The overhead stream is reduced in density and fed to the second stage. The ash-free SRC (heavy phase material) settles and is removed as the underflow. Solvent in the SRC is stripped for recycle. The second stage overhead undergoes a third stage separation into deashing solvent for recycle (overhead) and LSRC (underflow). When the CSD unit is in operation, V131B becomes the process solvent surge tank, receiving the third stage LSRC and the T105 bottoms fraction. V131A tank and the filter surge vessel are bypassed. In-process solvent inventory is approximately 50% less in the CSD operating mode than in the filtration mode.

J. GAS RECOVERY AND RECOMPRESSION

Vapor from V104 High Pressure Vent Separator contains 60 to 80% hydrogen by volume, plus hydrocarbon gases, hydrogen sulfide, and carbon dioxide. The hydrogen sulfide and carbon dioxide are removed by a dilute solution of caustic soda in T101 Hydrogen Scrubber. The exit gas from T101 is scrubbed with water in V106 Recycle Hydrogen Water Scrubber to remove entrained caustic. Excess scrubbed gas is vented to K110 Flare. C104 Fresh Hydrogen Compressor brings pure hydrogen from storage to C102 Hydrogen Recycle Compressor which boosts the feed gas stream to the inlet pressure of B102 Slurry Preheater.

K. NAPHTHA RECOVERY

Organic liquid from V105 Solvent Decanter and the condensed overhead from T102 are combined in V164 and fed to T104

Recovery Column. Components boiling below 350°F are collected in V170 Storage Tank. Liquids boiling at 350°F or higher are combined in V160 with the material withdrawn from T102 at trays 3 and 8.

T104, six inches in diameter, contains two 5 ft sections. The top section contains 1/4 in. Pro-Pak packing, and the bottom section is packed with 5/8 in. SS Pall rings. The bottom section also contains an internal reboiler coil which is heated by Dowtherm. Reboiler rating is 104,000 Btu/hr, and the overhead condenser rating is 30,000 Btu/hr.

L. SOLVENT FRACTIONATION

The material from V160 is heated to 220°F by the T104 bottom product stream and is then fed to T105 Fractionation Column. It may enter at tray 10, 12, 14, or 16, depending upon the feed composition.

The T105 bottoms, with a boiling range from 450 to 900°F, are sent to V131A Recovered Solvent Tank for use as a recycle process solvent. The overhead has a boiling range between 350 to 450°F and is recycled to the filter section for use in filter cake washing.

T105 contains 20 valve trays. Heat is supplied by a Dowtherm reboiler, E173. The overhead vapor is condensed by a fan cooler, E170. The reboiler design duty is 3.3 MM Btu/hr and the overhead condenser duty is 2.9 MM Btu/hr.

M. SOLVENT STORAGE

The following solvent storage is provided:

- V123 Makeup Solvent Storage Tank (15,000 gal) for startup and makeup;
- V131A Recovered Solvent Tank (4,750 gal) for recycle process solvent (boiling range 450 to 900°F);
- V131B Recovered Process Solvent Tank (1,250 gal) for recycle process solvent plus CSD third stage (LSRC);
- V124B Naphtha (Middle Distillate/Wash Solvent) Storage Tank (10,000 gal) for filter washing (350 to 450°F boiling range); and
- V124A Naphtha (Light Organics) Storage Tank (10,000 gal) for light organic liquids and excess middle distillate as total naphtha by-product (boiling range normally below 350°F).

IV. RUN SUMMARIES

Summaries of Run 195 through Run 204 are presented in the first quarterly report for 1980. Run 205 through the start of Run 209 are summarized in the second quarterly report. Run 209 through Run 217 are summarized in the third, and data for Run 218 through the start of Run 222 are presented in this report.

A. SOLVENT REFINED COAL (SRC) UNIT

Operating conditions and results for Runs 218 through 222 are summarized in Tables 2 through 6 of this report, including material balance data for Runs 217CD, 219AB, 220AB, 220DE, 221B, and 221G.

1. Purposes of Runs

<u>No.</u>	<u>Date</u>	<u>Purpose</u>
218	1-10 Oct	The purpose of this run was to treat process solvent, derived from the previous low severity run, at demonstration plant design conditions and to lower its quality per the microautoclave tests. The solvent was also to contain no more than 35% of the above 650°F boiling point fraction. On 8 October, the recycle gas flow was changed from 10,000 to 8,000 scfh.
219	11-23 Oct	This run was made to simulate the demonstration plant design conditions and to accumulate data over an extended period of time.
220	23 Oct - 9 Nov	This was a continuation of the extended demonstration plant simulation run (Run 219) with an increase in LSRC addition to 60 lb/hr in coal slurry.
221	9-28 Dec	This was a low severity run with 30 wt % LSRC in the recycle process solvent stream. It was made to investigate SRC dissolver conditions with long residence time and low dissolver temperatures (applicable for two-stage liquefaction).

<u>No.</u>	<u>Date</u>	<u>Purpose</u>
222	29-31 Dec	This was a continuation of the low severity run (Run 221) with a reduction in the amount of sodium carbonate added to the coal slurry from 0.7 to 0.4 wt % and with a decrease of the dissolver temperature by 15°F. Run 222 was completed on 4 January 1981.

2. Operating Conditions

The average operating conditions for the reaction section during Runs 218, 219, 220, 221, and 222 are listed below. The operating data for the B102 Slurry Preheater, R101 Dissolver, and the reaction section during each material balance period are summarized in Tables 12, 13, and 14.

<u>Operating Conditions</u>	<u>Run 218</u>	<u>Run 219</u>	<u>Run 220</u>	<u>Run 221</u>	<u>Run 222</u>
Coal	Ky 9, Fies	Ky 9, Fies	Ky 9, Fies	Ky 9, Fies	Ky 9, Fies
Date, 1980	1-10 Oct	11-23 Oct	23 Oct-9 Nov	9-28 Dec	29-31 Dec
Solids withdrawal, % of slurry feed	6	6	6	6	6
R101 pressure, psig	2,100	2,100	2,100	2,000	2,000
temperature, °F	840	840	840	769(c)	755(c)
dissolver volume used, %	75	75	75	100	100
Space rate, lb/hr-ft ³ dissolver vol.	39.0	39.4	40.4	17.6	18.1
Coal feed rate, MF lb/hr	529	535	549	324	332
Slurry concentration, wt % MF coal	37.3	36.6	36.4	31.2	29.2
LSRC feed rate, lb/hr	37.6	45.4	58.8	194	199
Na ₂ CO ₃ addition, wt % of feed coal	0.7	0.7	0.7	0.7	0.4
Gas hydrogen purity, mole %	86	85	85	90	88
Gas rate, scfh	9,920	7,850	7,780	3,600	3,380
Mscf/ton of coal	37.5	29.4	28.3	22.2	20.4
Separator mode	hot(a)	hot(a)	hot(a)	hot(b)	hot(b)

(a) E102 Product Cooler and B103 Vacuum Column Preheater bypassed.

(b) R101 effluent flowing through heavily insulated E102. B103 bypassed.

(c) This data is for the 75% position of R101 Dissolver. The thermocouple reading was not reliable for the 100% position of R101 Dissolver.

3. Performance Summary

The SRC pilot plant was on-stream for 247 days, or 67.7% of the 1980 calendar year. The on-stream factor for the fourth quarter was 65.0%. Table 1 summarizes the pilot plant operating hours since 1974. Tables 8 and 10 show the coal feed and SRC production summaries for the fourth quarter.

Table 9 presents analyses of the Kentucky 9 (Fies) coal that was processed during the fourth quarter.

Tables 11 and 12 contain typical performance data for the B102 Slurry Preheater during the fourth quarter. Thermocouple locations are shown in Figure 5. The B102 Slurry Preheater was decoked on 10-11 November and clean coil tests were conducted on 7 December. The temperature differences between turn 35 skin and fluid as well as those between turn 37 skin and fluid, including the differential pressure measurements, are summarized as follows:

Date	Run	skin/fluid Δt , °F		ΔP , psi			
		Turn 35	Turn 37	Bottom	Middle	Top	Total
26-27 Sept	217CD MB	33	51	16	4	-	-
8 Oct	218	55	46	25	13	15	53
13 Oct	219	57	54	24	11	12	47
19 Oct	219	80	78	22	12	11	45
20-21 Oct	219AB MB	77	77	25	20	21	66
22 Oct	219	83	75	22	15	23	60
27 Oct	220	83	81	21	14	26	61
28-29 Oct	220AB MB	80	80	26	16	27	69
3 Nov	220	92	76	28(a)	14(a)	>30	-
5 Nov	220	90	84	23(a)	14(a)	29	-
7-9 Nov	220DE MB(b)	67	46	27	9	23	59
10-11 Nov	Decoking	-	-	-	-	-	-
7 Dec	Clean coil test	11	14	-	-	-	4.5
16 Dec	221	8	13	16	5	1.5	22.5
20 Dec	221B MB	15	13	17	3	1.5	21.5
27 Dec	221G MB	15	15	17	4	1.5	22.5
28 Dec	221	16	16	18	4	1.5	23.5
31 Dec	222	16	16	15	3	1.5	19.5

(a) Data questionable.

(b) Δt and ΔP decreased for unknown reasons.

Until 5 November, there was a progressive increase in the temperature differences at turns 35 and 37, which indicated a strong possibility of coke buildup in the preheater coil. After decoking, Δt and ΔP decreased significantly from about 85°F to about 15°F and from 70 to 20 psi, respectively.

Figure 6 is a schematic of the R101 Dissolver showing its withdrawal system, and differential pressure and nuclear density instrumentation.

The run average results for Runs 218 to 222 are listed below:

Run Average Results	Run 218	Run 219	Run 220	Run 221	Run 222
Coal conversion(a), % of MAF coal	93.5	93.7	93.7	92.9	92.5
Yield(b), % of MAF coal					
SRC	53.8	54.7	56.7	59.9	63.6
process solvent (450°F-EP)	22.7	21.3	21.2	18.1	14.1
light oil + wash solvent (IBP-450°F)	11.1	11.2	8.8	6.8	5.3
Sulfur content of V110-SRC, wt %	0.83	0.84	0.88	1.06	1.20
Hydrogen consumption(c), % of MAF coal	2.4	2.4	2.4	2.0	1.6
Apparent solvent quality					
% THF conversion, short method	75.2(d)	76.6(d)	78.2(d)	84.0/77.1(e)	NA/NA(e)
long method	67.5(d)	68.3(d)	67.0(d)	57.1/68.5(e)	63.1/69.8(e)

(a) Based on V110 analyses and forced ash balance.

(b) Based on T102 bottoms rate and analyses, SRC is on solvent free basis.

(c) Based upon on-line analyzer's hydrogen analyses of vent gas streams.

(d) With V131B samples.

(e) With V101B lab-filtered samples with LSRC/V131A samples without LSRC.

Runs 218, 219, and 220 were extended simulations of the demonstration plant operating conditions and produced stable results. The average conversion to cresol-soluble organics was 93.5 to 93.7 wt % of MAF coal. The average yield of solvent-free SRC from T102 Vacuum Column bottoms was 53.8 to 56.7 wt % of MAF coal. The average process solvent quality was 75.2 to 78.2% THF conversion by the short microautoclave method and 67.0 to 68.3% by the long method. The hydrogen consumption was 2.4 wt % of MAF coal. The sulfur content of V110 laboratory filtered and distilled SRC was 0.83 to 0.88 wt %.

Runs 221 and 222 were low severity runs with 30 wt % LSRC in the recycle process solvent stream to investigate SRC dissolver operation with long residence time and low dissolver temperature as potential conditions for two-stage liquefaction. Run conditions were similar to those for Run 217 (17-18 September 1980). A summary of operating conditions and results for Runs 217, 221, and 222 is presented below for comparison:

<u>Operating Conditions</u>	<u>Run 217</u>	<u>Run 221</u>	<u>Run 222</u>
R101 temperature, °F	785	769(a)	755(a)
volume used, %	50	100	100
Gas rate, scfh	5,500	3,600	3,380
Separator mode	normal	hot	hot
Na ₂ CO ₃ addition, wt % of feed coal	0.7	0.7	0.4

Results

Hydrogen consumption, % of MAF coal	2.8	2.0	1.6
Sulfur content of V110-SRC, wt %	0.96	1.06	1.20
Yield, % of MAF coal			
SRC	59.8	59.9	63.6
Process solvent (450°F-EP)	19.3	18.1	14.1
Naphtha and middle distillate (IBP-450°F)	6.1	6.8	5.3
Gases (C ₁ -C ₅ and others)	7.5	6.7	7.2
Solvent quality by microautoclave			
% THF conversion, short method(b)	83.3	84.0	NA

(a) TR401 pt 37 data for 75% position of R101 Dissolver. The thermocouple reading was not reliable for the 100% position.

(b) With V101B laboratory filtered samples containing LSRC.

Run 217 operated at a higher R101 Dissolver temperature than Runs 221 and 222. In comparison to Runs 221 and 222, Run 217 data indicated:

- more hydrogen consumption
- more sulfur removal, and
- slightly less SRC yield.

B. CRITICAL SOLVENT DEASHING (CSD) UNIT

The principal objectives of CSD unit operations were to:

- Evaluate the effects of varied SRC and CSD unit operating conditions on yield and performance
- Reduce deashing solvent (DAS) losses
- Establish a data base for heat transfer, solids settling rates, solvent losses, and solvent stripping requirements that is suitable for use in process scale-up
- Evaluate an alternate DAS, and
- Improve performance generally.

Additional objectives during 1980 were to modify the CSD unit for increased capacity, improved operability, partial heat recovery, simplified DAS clean-up, and to reduce non-product related DAS losses.

The principal objectives were addressed in each run, while the additional objectives noted above were achieved and described in the first, second and third quarterly reports of 1980.

Data for the demonstration plant design were obtained during Runs 218, 219, and 220. The operating data are shown in Table 7.

V. PROCESS ANALYSES

This section provides material balance (MB) data and analyses for the SRC unit, for the CSD unit, and for the integrated SRC and CSD units. The MB data consist of input and yield quantities for each unit and for the overall plant. A flow diagram showing the input and output streams for each unit and a description of the MB method for each is included in Appendix B.

A. SRC UNIT MATERIAL BALANCE

1. Input and Output Data

The SRC unit input and output data for the fourth quarter are as follows:

<u>MB Run</u>	<u>217CD</u>	<u>219AB</u>	<u>220AB</u>
<u>Input, lb/hr (% MAF coal)</u>			
Coal (MAF)	277.5(100)	487.7(100)	497.3(100)
Ash in coal	26.4(9.5)	46.7(9.6)	46.3(9.3)
Net hydrogen consumed	8.0(2.9)	12.1(2.5)	12.2(2.5)
Makeup process solvent	0 (0)	0 (0)	0 (0)
LSRC(a)	182.9(65.9)	45.6(9.4)	57.9(11.6)
Sodium carbonate	2.1(0.8)	3.8(0.8)	3.8(0.8)
Total	496.9(179.1)	595.9(122.3)	617.5(124.2)
<u>Output, lb/hr (% MAF coal)</u>			
Gases	16.6(6.0)	37.9(7.8)	36.2(7.3)
Liquids	126.3(45.5)	163.7(33.6)	201.7(40.6)
T102 bottoms(b)	353.9(127.5)	394.3(80.8)	379.6(76.3)
Total	496.8(179.0)	595.9(122.2)	617.5(124.2)
<u>MB Run</u>	<u>220DE</u>	<u>221B</u>	<u>221G</u>
<u>Input, lb/hr (% MAF coal)</u>			
Coal (MAF)	494.0(100)	284.5(100)	304.5(100)
Ash in coal	45.7(9.3)	26.8(9.4)	28.5(9.4)
Net hydrogen consumed	11.3(2.3)	5.4(1.9)	6.1(2.0)
Makeup process solvent	0 (0)	0 (0)	0 (0)
LSRC(a)	58.5(11.8)	184.0(64.7)	201.0(66.0)
Sodium carbonate	3.8(0.8)	2.2(0.8)	2.3(0.8)
Total	613.3(124.2)	502.9(176.8)	542.4(178.2)
<u>Output, lb/hr (% MAF coal)</u>			
Gases	39.9(8.1)	12.5(4.4)	19.2(6.3)
Liquids	185.7(37.6)	114.6(40.3)	128.6(42.2)
T102 bottoms(b)	387.6(78.5)	375.7(132.1)	394.7(129.6)
Total	613.2(124.2)	502.8(176.8)	542.5(178.1)

(a) LSRC containing distillable solvent.

(b) Uncorrected for residual LSRC added in the feed.

2. Yield Data

The yield data for the SRC unit are presented in the following table. All quantities are based on moisture and ash free (MAF) coal.

<u>MB Run</u>	<u>217CD</u>	<u>219AB</u>	<u>220AB</u>	<u>220DE</u>	<u>221B</u>	<u>221G</u>
<u>Yield, % MAF coal</u>						
<u>Gases</u>	6.0	7.8	7.3	8.1	4.4	6.3
CO	0.0	0.1	0.1	0.2	0.0	0.1
CO ₂	0.8	1.5	1.4	1.1	1.0	1.6
NH ₃	0.3	0.3	0.2	0.2	0.2	0.2
H ₂ S	2.4	1.8	1.0	2.0	1.2	2.1
C ₁ -C ₅	2.4	4.1	4.5	4.6	2.0	2.3
<u>Liquids</u>	45.5	33.6	40.6	37.6	40.3	42.2
H ₂ O	4.7	2.5	4.3	5.0	3.3	4.9
Naphtha	3.8	4.8	4.7	4.1	2.5	3.0
Middle distillate	4.4	6.0	5.3	4.8	2.5	5.5
Process solvent	32.7	20.3	26.2	23.8	32.0	28.7
<u>T102 bottoms^(a)</u>	126.8	80.1	75.5	77.8	131.3	128.9
SRC	111.8	65.0	61.8	63.2	115.7	113.9
Oils	26.2	16.7	18.1	19.2	24.0	40.1
Asphaltenes	63.7	37.0	33.2	32.0	65.3	52.3
Preasphaltenes	21.9	11.2	10.5	11.9	26.5	21.5
UC	6.9	6.4	5.6	6.4	6.6	6.3
Ash ^(b)	8.1	8.7	8.1	8.2	9.0	8.7
Total	178.3	121.5	123.4	123.5	176.0	177.4
Total less % ash and net H ₂ consumed	167.3	110.3	112.8	113.0	165.1	166.7

(a) Uncorrected for residual LSRC added in the feed.

(b) Excluding the amount of Na₂CO₃ added in the feed.

B. CSD UNIT MATERIAL BALANCE

1. Input Data

The input data for the CSD unit are provided below.

<u>MB Run</u>	<u>217AB</u>	<u>217CD</u>	<u>219AB</u>	<u>220AB</u>	<u>220DE</u>	<u>221B</u>	<u>221G</u>
<u>Input, % T102 bottoms</u>							
Process solvent	13.3	10.7	8.9	10.7	12.9	10.5	10.2
SRC							
Oil	19.1	18.3	18.8	21.2	12.3	16.2	27.8
Asphaltene	37.6	44.6	41.7	38.8	42.1	44.2	36.2
Preasphaltene	19.0	15.4	12.7	12.3	15.7	18.0	14.9
UC	4.6	4.8	7.2	6.6	7.1	4.5	4.4
Ash	6.4	6.2	10.7	10.4	9.9	6.6	6.5

2. Yield Data

The yield data for the CSD unit are provided on the following page.

MB Run	217AB	217CD	219AB	220AB	220DE	221B	221G
Yield, % T102 bottoms							
<u>Ash concentrate</u>	21.4	20.7	30.4	29.5	28.6	19.7	19.2
Process solvent	0.4	0.5	0.4	0.6	1.7	0.6	0.5
Oil	0.8	0.4	1.3	1.6	0	0.5	1.8
Asphaltene	1.4	2.1	1.9	3.5	3.4	1.7	1.8
Preasphaltene	4.1	3.1	5.8	3.3	3.4	3.6	2.7
Unreacted coal	7.9	8.1	10.2	10.2	10.0	6.2	6.0
Ash	6.8	6.5	10.8	10.3	10.0	6.2	6.0
<u>SRC</u>	35.4	33.4	56.4	55.1	59.0	32.8	31.9
Process solvent	3.0	1.8	2.7	6.8	5.3	2.0	1.6
Oil	4.5	5.8	16.5	9.7	10.6	4.7	5.8
Asphaltene	18.0	16.9	31.3	32.0	34.0	15.1	13.5
Preasphaltene	9.9	8.8	5.9	6.4	9.0	10.7	10.9
Unreacted coal	0.0	0.0	0.0	0.1	0	0.3	0.1
Ash	0.0	0.1	0.0	0.1	0.1	0.0	0.0
<u>LSRC</u>	43.2	45.9	13.2	15.4	12.4	47.5	48.9
Process solvent	8.6	10.0	4.2	4.5	3.2	6.3	11.9
Oil							
Asphaltene	34.6	35.9	9.0	10.9	9.2	41.2	36.8
Preasphaltene							
Unreacted coal	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Ash	0.0	0.0	0.0	0.0	0.0	0.0	0.0

3. SRC Recovery Data

The CSD-deashed SRC recovery data for the fourth quarter are provided below. See Appendix B for an explanation of recovery methods A, B, and C. The data are for the combined second and third stage streams of the CSD unit.

Recovery, % CS T102 bottoms	Run No.					
	217AB MB		217CD MB		219AB MB	
	Solv with SRC	Solv-free SRC	Solv with SRC	Solv-free SRC	Solv with SRC	Solv-free SRC
Method A (Forced ash balance)	89.7	-	90.2	-	85.1	-
Method B (Normalized material balance with LSRC)	88.2	88.4	89.0	86.1	84.8	85.7
Method C (Normalized material balance, no LSRC)	76.5	78.1	85.0	80.9	86.8	88.4

Recovery, % CS T102 bottoms	Run No.							
	220AB MB		220DE MB		221B MB		221G MB	
	Solv with SRC	Solv-free SRC	Solv with SRC	Solv-free SRC	Solv with SRC	Solv-free SRC	Solv with SRC	Solv-free SRC
Method A (Forced ash balance)	84.4	-	86.4	-	88.8	-	88.9	-
Method B (Normalized material balance with LSRC)	84.6	81.5	85.9	89.7	89.9	91.3	90.3	84.8
Method C (Normalized material balance, no LSRC)	84.3	81.2	83.7	88.5	80.1	83.3	80.2	73.0

C. OVERALL MATERIAL BALANCE

Presented in the following are material balance data for the combined SRC and CSD units. A description of the MB calculations is provided in Appendix B.

1. Input Data

The input data for the fourth quarter runs are:

Run	217AB	217CD	219AB	220AB	220DE	221B	221B
<u>Coal feed rate, lb/hr</u>							
As-is	315	306	540	551	547	318	336
MF	313	304	534	544	540	311	333
MAF	285	277	488	497	494	284	305
<u>Net input, % MAF coal</u>							
Hydrogen consumption(a)	2.6	2.9	2.5	2.4	2.3	1.9	2.0
Sodium carbonate	0.8	0.8	0.8	0.8	0.8	0.8	0.8
LSRC(b)(c)	1.9	0	0	0	0.7	0	0
Naphtha (IBP-350°F)	0	0	0	0	0	0	0
Middle distillate (350-450°F)	0	0	0	0	0	0	0
Process solvent (450°F-EP)(c)	0	0	0	0	0	0	0
Makeup deashing solvent(d)	4.3	4.9	1.8	2.2	4.0	6.4	2.6

- (a) Calculated using gas disappearance method. Number is not corrected for hydrogen leakages to the flare and atmosphere.
- (b) Includes distillable solvent.
- (c) When net yield is positive or zero, makeup requirement is zero.
- (d) Requirement, in addition to recovered DAS, due to DAS losses in the CSD unit product streams and leakages in the CSD plant.

2. Yield Data

The yield data for the overall MB follow:

Run	217AB	217CD	219AB	220AB	220DE	221B	221G
<u>Gases</u>							
CO	0.1	0.0	0.1	0.1	0.2	0.0	0.1
CO ₂	1.4	0.8	1.5	1.4	1.1	1.0	1.6
NH ₃	0.3	0.3	0.3	0.2	0.2	0.2	0.2
H ₂ S	2.3	2.4	1.8	1.0	2.0	1.2	2.1
C ₁ - C ₅	2.8	2.4	4.1	4.5	4.6	2.0	2.3
<u>Liquids</u>							
H ₂ O	4.6	4.6	2.4	4.3	4.9	3.3	4.9
Total recovered distillate	22.6	25.6	23.2	27.1	21.0	21.5	22.6
Naphtha	2.8	3.8	4.8	4.7	4.0	2.5	3.0
Middle distillate	1.8	4.5	6.0	5.3	4.7	2.4	5.7
Recovered process solvent	18.0	17.3	12.4	17.0	12.2	16.5	13.9
Non-product DAS	2.7	3.8	1.5	1.6	2.8	5.0	1.2
CSD ash concentrate	30.8	29.8	26.9	25.5	26.9	29.7	27.9
Deashing solvent	0.2	0.2	0.0	0.2	1.1	0.6	0.3
Process solvent	0.6	0.7	0.4	0.5	1.5	0.9	0.8
Non-distillable oil	1.2	0.6	1.2	1.4	0.	0.8	2.6
Asphaltenes	2.0	3.0	1.7	3.0	3.1	2.5	2.6
Preasphaltenes	5.8	4.4	5.1	2.9	3.1	5.3	3.9
UC	11.3	11.6	9.0	8.7	9.1	10.4	9.1
Ash	9.7	9.3	9.6	8.8	9.0	9.2	8.7
CSD 11/111 stage net SRC-LSRC	50.0	48.3	52.7	48.9	52.6	54.7	51.8
Deashing solvent	1.0	0.5	0.2	0.3	0.1	0.7	0.8
Process solvent	3.9	2.6	3.1	6.3	4.6	3.7	3.5
Non-distillable oil	5.9	8.3	15.1	8.8	9.4	8.6	9.5
Asphaltenes	24.9	24.1	29.0	28.0	30.4	25.3	21.8
Preasphaltenes	14.1	12.6	5.2	5.4	8.1	15.9	15.8
UC	0.1	0.1	0.0	0.1	-0.0	0.5	0.2
Ash	0.1	0.1	0.0	0.1	0.0	0.0	0.1
<u>Elemental balance error, % (SRC unit)</u>							
Carbon	-0.2	-1.6	-2.8	-2.2	-1.0	-0.4	0.20
Hydrogen	2.1	4.4	0.1	1.9	0.1	1.5	1.0
Nitrogen	-16.1	-4.9	-65.4	-23.4	-8.9	-4.4	-6.1
Sulfur	-15.3	-12.1	7.0	29.7	3.1	10.8	8.8
Oxygen	1.1	12.7	35.9	31.8	14.2	0.0	-3.3

D. DISCUSSION

Summary results for the material balance periods (Runs 217CD, 219AB, 220AB, 220DE, 221B, and 221G) are shown in Tables 5 and 6. Gas analyses of V104 High Pressure Vent Separator, V105 Decanter vent, V132 Degas vent and K110 Flare are summarized in Tables 16 through 19. A summary of selected operating conditions and results for the demonstration plant simulation MB runs is given below:

<u>Operating Conditions</u>	<u>219AB MB</u>	<u>220AB MB</u>	<u>220DE MB</u>
LSRC feed rate, lb/hr	45.6	57.9	58.5
<u>Results</u>			
Coal conversion, % of MAF coal	92.5	93.6	93.5
Yield, % of MAF coal			
SRC	58.6	53.6	54.3
Process solvent (450 °F-EP)	17.4	22.8	20.8
Naphtha and middle distillate (IBP-450 °F)	10.8	10.0	8.9
Sulfur content of V110-SRC, wt %	0.83	0.86	0.90
Hydrogen consumption, % of MAF coal	2.5	2.5	2.3
Solvent quality ^(a) , % THF conversion			
Short test	76.0	78.1	81.1
Long test	67.6	-	66.6

(a) With V131B samples.

A summary of different operating conditions and results for the low severity MB runs is given below:

<u>Operating Conditions</u>	<u>217CD MB</u>	<u>221B MB</u>	<u>221G MB</u>
R101 temperature, °F	784	765	770
volume used, %	50	100	100
Gas rate, Mscf/ton coal	34.8	20.6	18.0
Separator mode	normal	hot	hot
Coal space rate, MF lb/hr-ft ³	33.1	16.9	18.1
<u>Results</u>			
Hydrogen consumption, % of MAF coal	2.9	1.9	2.0
Sulfur content of V110-SRC, wt %	1.05	1.25	1.17
Yield, % of MAF coal			
SRC	60.2	59.6	64.0
Process solvent (450°F-EP)	18.4	23.4	12.6
Solvent quality, % THF conversion			
Short test	82.6(a)	85.8(a)	85.8(b)
Long test	65.3(a)	66.8(a)	
(a) With V131B process solvent mixed with LSRC.			
(b) With V101B laboratory filtered solvent.			

In comparison to Runs 221B MB and 221G MB, Run 217CD MB (at a higher R101 Dissolver temperature) indicated more hydrogen consumption and more sulfur removal.

Oxygen, nitrogen, and sulfur removal can be estimated from elemental analyses of feed coal and SRC as follows:

$$\text{Heteroatom removal, \%} = 100 (A - B)/A \quad \text{Equation (1)}$$

where:

A = heteroatom-to-carbon ratio in feed coal

B = heteroatom-to-carbon ratio in SRC

Heteroatom removal calculations for the fourth quarter runs are summarized in Table 15.

Total sulfur removal (TSR) can be calculated by the following equation based on the heating value of coal and SRC:

$$\text{TSR, \%} = \left[(A/C - B/D) \div A/C \right] 100 \quad \text{Equation (2)}$$

where:

A = Total sulfur in feed coal, wt %

B = Total sulfur in SRC, wt %

C = Heating value of coal, Btu/lb

D = Heating value of SRC, Btu/lb

Sulfur forms in feed coals for the fourth quarter runs were:

<u>Run</u>	<u>Pyritic</u>	<u>Sulfate</u>	<u>Sulfide</u>	<u>Organic</u>
217CD MB	1.32	0.10	<0.01	1.86
219AB MB	1.37	0.06	0.01	1.94
220AB MB	1.59	0.04	<0.01	2.06
220DE MB	1.15	0.04	0.21	2.02
221B MB	1.07	0.08	<0.01	1.72
221G MB	1.36	0.04	<0.01	1.85

Desulfurization and deoxygenation results for the fourth quarter were as follows:

<u>MB Run</u>	<u>217CD</u>	<u>219AB</u>	<u>220AB</u>	<u>220DE</u>	<u>221B</u>	<u>221G</u>
Total sulfur removal, %						
By Equation 1						
V110 SRC	73.9	78.7	81.1	79.2	62.5	68.9
CSD-deashed SRC	73.9	76.6	79.2	77.1	70.0	66.7
By Equation 2						
V110 SRC	73.3	79.6	80.4	77.9	63.6	69.4
CSD-deashed SRC	74.1	77.3	78.3	76.2	70.7	67.1
Deoxygenation, %						
By Equation 1						
V110 SRC	66.0	58.9	65.5	67.1	51.1	51.5
CSD-deashed SRC	-	57.6	72.4	65.8	59.6	53.7

Demonstration plant simulation MB Runs 219AB, 220AB and 220DE indicated 78 to 81% sulfur removal with V110 SRC and 76 to 79% sulfur removal with CSD-deashed SRC. These values are similar to the results for previous demonstration plant simulation MB Runs 209AB and 210AB (80% and 70%, respectively). (Ref. 8)

Low severity run MB data show that the higher the R101 Dissolver operating temperature, the more sulfur removal and deoxygenation:

<u>Run</u>	<u>217CD MB</u>	<u>221B MB</u>	<u>221G MB</u>
R101 temperature, °F	784	765	770
Sulfur removal, %			
V110 SRC	73-74	63-64	69
Deoxygenation, %			
V110 SRC	66	51	52

VI. OPERATIONS AND PROCESS TOPICS

This section addresses and further develops specific areas of plant operations and process performance that were of importance during 1980.

A. OPERATIONS SUMMARY

During 1980, the SRC plant on-stream factor was 67.7%. Runs 195 through 221 were completed during the year, and Run 222 was in progress on 31 December. A daily operating log for the fourth quarter is presented in Appendix A.

Runs 195 through 200 produced feed for the United States Filter Corporation (USF) pressure-leaf filter. Runs 201 through 222, each at different operating conditions, produced feed for the Kerr-McGee Critical Solvent Deashing (CSD) unit. Runs 213 and 214 produced data to complete a chlorine balance with high-chlorine coal from the Dotiki mine. The planned operating conditions for all runs made in 1980 are shown below and on the following page.

Run No.	195	196	197	198	199	200	201
Start date, 1980	1 Jan	2 Jan	5 Jan	8 Jan	14 Jan	28 Jan	11 Feb
End date	2 Jan	4 Jan	8 Jan	14 Jan	23 Jan	5 Feb	26 Feb
Coal type	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9
Mine	Lafayette	Lafayette	Lafayette	Lafayette	Lafayette	Lafayette	Lafayette
Slurry conc, % MF	38.5	38.5	38.5	38.5	38.5	38.5	38.5
Coal feed rate, MF lb/hr	515	515	515	515	515	515	515
Space velocity, lb/hr-ft ³	38	38	38	38	38	38	38
Gas feed rate, scfh	11,500	11,500	11,500	11,500	10,000	10,000	10,000
Hydrogen purity, mol %	85	85	85	85	85	85	85
Dissolver volume in use, %	75	75	75	75	75	75	75
Dissolver pressure, psig	1,700	1,700	1,700	1,700	1,700	1,700	1,700
Dissolver temperature, °F	825	825	825	825	825	825	825
HP separator mode	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Solids withdrawal, wt %	6	6	6	6	6	6	6
Na ₂ CO ₃ , lb/hr	5.8	5.8	5.8	0	5.8	5.8	5.8
LSRC, lb/hr	-	0	0	0	0	0	26
Solvent in CSD feed, %	CSD down	CSD down	CSD down	CSD down	CSD down	CSD down	6-10

Run No.	202	203	204	205	206	207	208
Start date, 1980	26 Feb	7 Mar	16 Mar	3 Apr	17 Apr	27 Apr	4 May
End date	7 Mar	16 Mar	2 Apr	17 Apr	27 Apr	1 May	9 May
Coal type	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9
Mine	Dotiki	Dotiki	Dotiki	Dotiki	Dotiki	Dotiki	Dotiki
Slurry conc, % MF	38.5	38.5	38.5	38.5	38.5	38.5	38.5
Coal feed rate, MF lb/hr	515	515	515	515	515	515	515
Space velocity, lb/hr-ft ³	38	38	38	38	38	38	38
Gas feed rate, scfh	10,000	10,000	10,000	10,500	10,500	10,500	10,500
Hydrogen purity, mol %	85	85	85	85	85	85	85
Dissolver volume in use, %	75	75	75	75	75	75	75
Dissolver pressure, psig	1,700	1,700	1,800	1,800	1,800	1,800	1,800
Dissolver temperature, °F	825	825	840	840	840	840	840
HP separator mode	Normal	Normal	Normal	Hot	Hot	Hot	Hot
Solids withdrawal, wt %	6	6	6	6	6	6	6
Na ₂ CO ₃ , lb/hr	0	5.8	5.8	5.8	5.8	5.8	5.8
LSRC, lb/hr	26	26	26	26	0	44	44
Solvent in CSD feed, %	6-10	6-10	6-8	6-8	6-8	6-8	6-8

Run No.	209	210	211	212	213	214	215
Start date, 1980	25 May	7 June	20 June	14 July	3 Aug	9 Aug	23 Aug
End date	6 June	15 June	14 July	29 July	9 Aug	21 Aug	24 Aug
Coal type	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9
Mine	Fies	Fies	Fies	Fies	Dotiki	Dotiki	Fies
Slurry conc, % MF	38.5	38.5	38.5	38.5	38.5	38.5	38.5
Coal feed rate, MF lb/hr	515	515	520	520	515	515	519
Space velocity, lb/hr-ft ³	38	38	37	37	37	37	37
Gas feed rate, scfh	10,000	10,000	9,000	9,000	10,000	10,000	7,800
Hydrogen purity, mol %	85	85	85	85	85	85	85
Dissolver volume in use, %	75	75	75	75	75	75	75
Dissolver pressure, psig	2,100	2,100	1,700	1,700	2,100	2,100	2,100
Dissolver temperature, °F	840	840	825	825	840	840	840
HP separator mode	Normal	Hot	Normal	Normal	Normal	Normal	Hot
Solids withdrawal, wt %	6	6	6	6	6	6	6
Na ₂ CO ₃ , lb/hr	0	0	0	0	0	0	0
LSRC, lb/hr	44	44	44	44	44	44	44
Solvent in CSD feed, %	6-8	6-8	6-8	6-8	6-8	6-8	6-8

Run No.	216	217	218	219	220	221	222
Start date, 1980	4 Sept	17 Sept	1 Oct	11 Oct	23 Oct	9 Dec	29 Dec
End date	17 Sept	28 Sept	10 Oct	23 Oct	9 Nov	28 Dec	-
Coal type	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9	Ky 9
Mine	Fies	Fies	Fies	Fies	Fies	Fies	Fies
Slurry conc, % MF	33.5	33.3	38.5	38.5	38.5	33.3	33.3
Coal feed rate, MF lb/hr	320	320	570	570	570	320	320
Space velocity, lb/hr-ft ³	35	35	42	42	42	18	18
Gas feed rate, scfh	3,200	5,700	8,000	8,000	8,000	3,200	3,200
Hydrogen purity, mol %	85	94	85	85	85	85	85
Dissolver volume in use, %	50	50	75	75	75	100	100
Dissolver pressure, psig	2,000	2,000	2,100	2,100	2,100	2,000	2,000
Dissolver temperature, °F	785	785	840	840	840	765 ^(a)	755 ^(a)
HP separator mode	Normal	Normal	Hot	Hot	Hot	Hot	Hot
Solids withdrawal, wt %	6	6	6	6	6	6	6
Na ₂ CO ₃ , lb/hr	0	2.3	4.0	4.0	4.0	2.3	1.4
LSRC, lb/hr	190	190	36	48	60	190	190
Solvent in CSD feed, %	10-14	10-14	6-8	9-11	9-11	9-11	9-11

(a) The thermocouple on the dissolver 100% level did not follow the previously observed temperature profile. Therefore, the dissolver temperature was controlled with the thermocouple readings at the 75% dissolver level.

B. SOLVENT INVENTORY AND PROPERTIES

1. Solvent Inventory

The naphtha (light organics) inventory was greater on 31 December than on 1 October, even though 49,300 lb was used as fuel. There was an overall gain in process solvent of 8,500 lb during the same period, but since 10,700 lb was transferred to the hydrotreater, there was a net decrease of 2,200 lb available to the front end.

The solvent inventory levels during the fourth quarter were as follows:

<u>Date, 1980</u>	<u>Inventory, M lb</u>			<u>Average compositions, wt %</u>		
	<u>1 Oct</u>	<u>31 Dec</u>	<u>Change</u>	<u>IBP-350°F</u>	<u>350-450°F</u>	<u>450°F-EP</u>
<u>Naphtha(a)</u>						
Tanks	100.7	102.1	1.4			
Drums	0.5	1.7	1.2	19.3	54.4	26.3
Total	101.2	103.8	2.6			
Tanks to fuel oil		49.3	49.3			
Adjusted total	101.2	153.1	51.9			
Shipped		1.1				
<u>Process solvent, SRC unit</u>						
In process	9.8	20.5	10.7			
Tanks	28.4	17.8	-10.6			
Drums	1.9	4.5	2.6	0.1	3.8	96.1
Makeup	58.8	53.9	-4.9			
Total	98.9	96.7	-2.2			
To hydrotreater		10.7	10.7			
Adjusted total	98.9	107.4	8.5			
Shipped		0.5				

- (a) Since the filter will not be used in the future, the naphtha and middle distillate fractions have been combined and represent all fractions boiling at less than 450°F. Naphtha will be stored in both V124A and V124B tanks and used as fuel.

The net change in process solvent inventory for each run during the quarter was as follows:

<u>Run</u>	<u>Gain (loss), lb/hr</u>
217	6.6
218	4.9
219	(3.3)
220	(18.2)
221	6.8

The process solvent loss during Run 220 was due to a slightly open ball valve on V138 bypass line that allowed process solvent to go directly to V124B Naphtha Storage Tank. The contents of this tank were later reprocessed through the T104 Recovery Column and the process solvent was recovered.

The reaction conditions and solvent yields for the MB runs with Kentucky 9 coal from the Fies mine are presented below:

<u>Run</u>	<u>217A</u>	<u>217CD</u>	<u>219AB</u>	<u>220AB</u>
Date, 1980	19-20 Sept	26-27 Sept	20-21 Oct	28-29 Oct
<u>Reaction section conditions (a)</u>				
Dissolver pressure, psig	2,000	2,000	2,100	2,100
Dissolver temperature, °F	786	784	840	840
Dissolver volume, %	50	50	75	75
Space rate, lb/hr-ft ³	34.3	33.4	39.8	40.6
LSRC addition, lb/hr	183.7	182.9	45.6	57.9
Separator mode	Normal	Normal	Hot	Hot
Solids withdrawal, wt % of slurry feed	6-7	6-7	6	6
<u>Solvent yields, % MAF coal</u>				
Process solvent (b)	24.19 (5.10)	18.39 (3.11)	17.35 (9.45)	22.82 (13.87)
Middle distillate (350-450°F)	1.91	4.37	5.99	5.29
Naphtha (IBP-350°F)	2.80	3.81	4.83	4.74
<u>Run</u>	<u>220DE</u>	<u>221B</u>	<u>221G</u>	
Date, 1980	7-9 Nov	20 Dec	27 Dec	
<u>Reaction section conditions (a)</u>				
Dissolver pressure, psig	2,100	2,000	2,000	
Dissolver temperature, °F	839	741	749	
Dissolver volume, %	75	100	100	
Space rate, lb/hr-ft ³	40.3	17.3	18.3	
LSRC addition, lb/hr	58.5	184.0	201.0	
Separator mode	Hot	Hot	Hot	
Solids withdrawal, wt % of slurry feed	6	6-7	6-7	
<u>Solvent yields, % MAF coal</u>				
Process solvent (b)	20.78 (9.16)	23.40 (7.91)	12.63 (-2.09)	
Middle distillate (350-450°F)	4.79	2.48	5.54	
Naphtha (IBP-350°F)	4.05	2.53	3.03	

(a) Ky 9 coal from the Fies mine.

(b) Yields in parentheses were calculated with solvent in the SRC.

2. Solvent Composition

Typical process solvent boiling ranges and compositions for Ky 9 Fies coal during the fourth quarter were:

Solvent Source	V131B	V131B	V131B	V131B
Run	217AB	217CD	219AB	220AB
Date, 1980	19-20 Sept	26-27 Sept	20-21 Oct	28-29 Oct
<u>Boiling fractions, wt %</u>				
IBP, °F	(350)	(358)	(384)	(398)
IBP-450°F	5.0	4.6	3.8	3.9
450-550°F	21.6	18.4	32.4	29.1
550-650°F	19.3	17.6	27.6	26.6
650°F-EP	38.0	38.3	31.8	35.3
Residual, EP	16.1(a)	21.1(a)	4.4(a)	5.1(a)
EP, °F	(975)	(960)	(937)	(951)
Carbon	86.98	85.74	85.83	86.98
Hydrogen	8.14	8.24	8.46	8.63
H/C atomic ratio	1.11	1.14	1.17	1.18
Specific gravity	1.066	1.068	1.029	1.035
Microautoclave test, %				
THF conversion,				
short test	81.7	82.3	76.0	78.1
long test	61.5	65.3	67.6	65.9
T102 bottoms temp, °F	547	546	597	594
T102 pressure, psia	0.40	0.40	0.36	0.40

Solvent Source	V131B	V131A	V131A
Run	220DE	221B	221G
Date, 1980	7-9 Nov	20 Dec	27 Dec
<u>Boiling fractions, wt %</u>			
IBP, °F	(398)	(424)	(405)
IBP-450°F	3.2	1.2	1.4
450-550°F	21.3	28.1	25.7
550-650°F	23.3	26.2	24.7
650°F-EP	48.2	41.5	45.2
Residual, EP	4.0(a)	3.0(b)	3.0(b)
EP, °F	(947)	(959)	(1000)
Carbon	87.10	86.27	87.84
Hydrogen	8.59	9.14	8.97
H/C atomic ratio	1.174	1.261	1.216
Specific gravity	1.096	1.020	1.021
Microautoclave test, %			
THF conversion,			
short test	81.1	80.4	75.1
long test	66.6	69.1	68.4
T102 bottoms temp, °F	597	594	593
T102 pressure, psia	0.40	0.33	0.30

- (a) V131B distillate samples are analyzed by determining the IBP to EP fractions. Distillation is done in a flask at 600°F and 0.1 mm Hg. The residue is reported as the material boiling above EP(°F).
- (b) As-is sample. Residual material boiling over the EP(°F) is assumed to be 3 wt %.

3. Solvent Quality

Solvent quality is determined by a laboratory procedure as follows:

Standard coal (Indiana V) and recycle process solvent are charged to a 30-cc microautoclave unit. The slurry is mixed and heated to a specified temperature ($\pm 5^{\circ}\text{F}$) within a two (2) minute period and the resulting reaction is maintained for a specific period of time. At the end of the reaction, the microautoclave is quenched in water and the reaction products are washed and extracted with tetrahydrofuran (THF).

The ratio of the amount of reacted coal to the original sample weight is expressed as a percentage conversion which is referred to as "quality".

The conditions generally used for microautoclave tests are:

<u>Test type</u>	<u>Temp, °F</u>	<u>Solvent-to-coal ratio</u>	<u>Reaction time, minutes</u>
short	750	8:1	10
long	750	2:1	30

The quality variations of process solvent samples obtained during the quarter, with and without LSRC, are shown on Figure 7. The data indicate that the solvent quality increases as the LSRC content increases.

C. REACTION

1. Dissolver Solids Accumulation

Solids accumulation in the dissolver is controlled by making periodic withdrawals from a point ten inches above the distributor plate in the dissolver bottom. The solids withdrawal system is shown in Figure 6, which also shows how the average density in the dissolver is monitored by a DP cell and nuclear density meters.

During the fourth quarter, solids were withdrawn from the dissolver at a target rate of 6 wt % of the total slurry feed. Table 7 presents an analysis of typical dissolver samples with corresponding operating data at the time of withdrawal. Analyses of blowdown solids extracted from the dissolver on 10 November 1980 (AWS basis) are presented below. About 33 lb of solids were extracted.

wt % carbon	24.54
hydrogen	1.67
nitrogen	0.47
sulfur	10.86
ash	62.46

Data for typical blowdown solids samples extracted from the dissolver during the year are summarized below:

Date, 1980	AWS recovered, lb	% wt in AWS		Ash in AWS, lb	LSRC addition, lb/hr	Operation Conditions		
		Ash	Sulfur			Ash conc. in slurry, %	Dissolver volume, ft ³	Ideal ash in dissolver, lb (a)
5 Feb	19	42.80	5.31	8.1	-	3.64	13.58	26.2
1 May	109	33.23	4.33	36.2	47	3.78	13.58	32.0
9 May	15	63.00	8.03	9.5	44	3.64	13.58	26.2
16 June	15	-	-	-	43	3.23	13.58	23.3
29 July	13	49.50	-	6.4	44	3.13	13.58	22.5
24 Aug	14	-	-	-	41	3.15	13.58	22.7
29 Sept	11	38.80	8.42	4.3	167	2.84	9.20	13.8
10 Nov	33	64.40	11.20	21.3	59	3.08	13.58	22.2

(a) Assumed that average specific gravity = 0.85. No consideration of gas holdup in the liquid phase of the R101 Dissolver.

The "expected" ash content in the R101 Dissolver was calculated using an assumed average specific gravity of 0.85. No consideration was given to gas holdup in the liquid phase of the dissolver. Analysis of samples taken on 5 February, 9 May, 29 July, and 29 December indicated that the amount of solids actually recovered was only about one-third of the "expected" value. It appears that, due to the complex flow patterns and a large volume of vapor in the dissolver, the calculations of the "expected" ash content are not accurate.

The large quantity of solids extracted on 10 November indicated a significant accumulation of solids in the dissolver. This was confirmed by nuclear density gauge and DP cell readings.

2. Hot and Normal Separator Modes of Operation

An evaluation of the hot separator mode of operation was completed during 1980. Initial results confirmed expectations that substantial energy savings can be obtained by bypassing the E102 Dissolver Product Cooler and the B103 Vacuum Column Preheater. This eliminates the cooling and subsequent reheating of the reaction stream. Additional data will be collected in 1981 after a new, reduced volume separator is installed.

A summary of Soxhlet extraction results of the V110 laboratory filtered SRC and the T102 Vacuum Column bottoms for the hot and normal separator modes of operation is provided on the following page.

Run	204C MB		206A MB		206B MB		208AB MB		209AB MB	
Coal mine	Dotiki		Dotiki		Dotiki		Dotiki		Fies	
Separator mode	normal		hot		hot		hot		normal	
LSRC addition, lb/hr	26.3		0		0		44.7		44.9	
Temperature, °F										
R101 dissolver	841		839		840		841		840	
V103 HP flash	645		800+		800+		800		710	
V110 LP flash	591		697		697		685		633	
T102 bottoms	553		593		595		600		559	
	V110	T102	V110	T102	V110	T102	V110	T102	V110	T102
	SRC	btms	SRC	btms	SRC	btms	SRC	btms	SRC	btms
Ratio of benzene-solubles to benzene insolubles	4.3	3.1	1.8	1.5	1.6	1.8	2.1	2.3	2.0	3.2

Run	210AB MB		217AB MB		217CD MB		221B MB		221G MB	
Coal mine	Fies		Fies		Fies		Fies		Fies	
Separator mode	hot		normal		normal		hot (a)		hot (a)	
LSRC addition, lb/hr	44.0		183.7		182.9		184.0		201.0	
Temperature, °F										
R101 dissolver	834		786		784		765		770	
V103 HP flash	740		600		550(\$20)		642		654	
V110 LP flash	675		515		502		582		597	
T102 bottoms	588		547		546		591		595	
	V110	T102	V110	T102	V110	T102	V110	T102	V110	T102
	SRC	btms	SRC	btms	SRC	btms	SRC	btms	SRC	btms
Ratio of benzene-solubles to benzene-insolubles	2.1	1.7	3.2	3.7	3.1	4.8	2.9	3.9	2.3	5.0

(a) R101 effluent flowing through heavily insulated E102.

The ratios of benzene-solubles to benzene-insolubles in the V110 laboratory filtered SRC and the T102 Vacuum Column bottoms from MB runs made during the year are plotted against operating temperatures of the V103 High Pressure Separator and the V110 Flash Tank in Figures 8 and 9. Runs such as 219AB, 220AB, and 220DE showed large deviations from the general trends observed. It appears that the composition of the SRC varies directly with the operating temperatures of the V103 High Pressure Separator and at the T102 Vacuum Column bottoms. The benzene-soluble to benzene-insoluble ratios decreased significantly when the operating temperatures increased. The thermal history of the SRC products seems to have a significant effect on the quality of SRC. To calibrate and control the V103 High Pressure Separator temperature more precisely, several heating and cooling tests in the R101 Dissolver were conducted on 6-7 December 1980. The results are plotted in Figures 10 and 11. The E102 Product Cooler was heavily insulated and only solvent and hydrogen gas were fed without coal. The plots are described by the following equations:

R101 temp (y) vs V103 temp (x) Equation (3)

$$y = 0.69(x) + 490$$

E102 outlet process temp (y) vs V103 temp (x) Equation (4)

$$y = 0.80(x) + 360$$

E102 inlet skin temp (y) vs V103 temp (x) Equation (5)

$$y = 0.69(x) + 270$$

D. FILTRATION

The United States Filter Corporation (USF) filter processed reaction product from Kentucky 9 coal (Lafayette mine) in January and February. The Industrial Filter and Pump Manufacturing Company (IF) skid-mounted candle filter was tested with the reaction product from Kentucky 9 coal (Dotiki mine) during April and August.

The most significant accomplishment during the USF filtration program was the development of leaves that could withstand processing conditions, that could be cleaned in place, and that required precoat only every fifth cycle. Solution annealing of the leaves in January solved a major corrosion problem. These leaves were in service until the filter program ended 43 days later.

Analysis of filtrates from both filters showed small amounts (0.01 to 0.04 wt %) of cresol-insoluble material; however, the ash in the filtrate usually ranged between 0.04 and 0.12 wt %, which is equivalent to 0.14 to 0.43 wt % ash in the SRC. This discrepancy indicates the presence of cresol-soluble ash in the filtrate.

For Run 198, during the USF filtration program, an attempt was made to determine the effects of sodium carbonate on ash solubility. Mechanical problems made the test inconclusive. August tests with the IF filter were made without adding sodium carbonate. The ash levels in the filtrate and SRC were similar to the April runs when sodium carbonate was added.

During 17-23 February 1980, the USF filter cycle was improved by reducing the amount of middle distillate (wash solvent) used for cake washing and by reducing the filter aid input. The middle distillate required for cake washing was reduced from 737 lb per cycle to 344 lb per cycle, which is equivalent to 1.4 pounds of wash solvent per pound of discharged cake. The fraction of SRC in the filter cake did not increase significantly. Precoat consumption was reduced from 0.35 to 0.07 lb/ft². The downtime during Run 201 averaged 65 minutes with a 90 minute filtration cycle time. The cycle average filtration rate was 1.9 gallons of filter feed per hour per square foot of filter screen area. The USF and IF filter cycles are detailed in the following table which also indicates the duration of each step in the cycle.

Filtration Cycle

<u>Operation</u>	<u>Time, minutes</u>	
	<u>IF with body feed</u>	<u>USF without body feed</u>
Fill with precoat	-	3
Precoat	-	10
Remove excess precoat solvent	-	1
Precoat drain	-	2
Fill with filter feed	3	4
Drain filter feed	2	2
Blow cake	3	-
Fill with wash solvent	3	3
Wash cake	17	20
Drain wash solvent	3	2
Cake blow	5	1
Depressure	4	1
Dry and break vacuum	-	9
Discharge	1	4
Repressue to 120 psig	1	3
Sluice at 1,200 psig and 3 rpm	-	0.2
Downtime, min.	42	65
Filtration time, min.	50	90
Total cycle time, min.	92	155
Draw down volume, gal/ft ²	3.9	4.4
Filter feed volume, gal/ft ²	5.2	5.0
Cycle feed rate, gal/hr-ft ²	3.4	1.9
Run	205	201

The candle filter element in the IF filter is made with sturdy wedge wire and seems to be less susceptible to corrosion and erosion than filter leaves. The IF filter tubes did not show signs of degradation after two months. Since the filter elements are tubular, ash discharge was by vibration. This means of ash discharge removed most of the ash, but some ash residue remained on the tubes and reduced the filtration rates in later cycles.

With the IF filter, peripheral equipment problems complicated filter testing. The air-cylinder-driven, reciprocating agitator drive broke twice and agitation in the body feed slurry tank was reduced each time to prevent recurrences. The vibrator on the tubes was repaired or replaced four times. The level taps for the differential pressure cell, installed in the bottoms of the tanks, gave inaccurate level readings when solids settled into the orifices. Purging the differential pressure cell impulse lines helped, but the feed tank lines continued to plug because the operating mode required pressurization of the feed tank during each cycle. The body feed addition pot plugged frequently. This could probably be corrected if a mixer were added to the body feed pot.

During Run 214 the IF filter was operated for 33 consecutive cycles, filtering reaction product containing no LSRC or sodium carbonate. Carbonaceous body feed, Nerofil, was added to the reaction product at a rate of 4 wt %. Filtration times varied from 45 minutes to 145 minutes. Cycle times varied from 85 minutes to 235 minutes. (Ref. 1)

E. CRITICAL SOLVENT DEASHING UNIT

Modifications to the Kerr-McGee CSD unit were completed between October 1979 and February 1980. These included the installation of a steel support structure, an enlarged first stage vessel, a new heat exchanger, a high pressure solvent system, equipment relocation, and instrumentation. The primary purpose of the modifications was to match the capacity of the CSD unit with the production capability of the SRC unit. Other considerations were to improve operability and heat recovery, and to reduce DAS losses. (Ref. 2)

The Dowtherm heater in the CSD unit was modified to use LPG instead of fuel oil. This reduced the cost of operation and the frequency of burner cleaning.

Deashing solvent (DAS) containing solids was initially injected into the CSD first stage letdown line at a rate of 40 lb/hr. On 11 June, the injection point was relocated between the solvent heat exchanger and the first stage. (The temperature in the CSD first stage was maintained at the previous operating level by adjusting the heat exchanger.) The injection of the solids-containing DAS ahead of the first stage did not cause ash carry-over to the second stage.

During April, tests were conducted to identify and quantify DAS losses, particularly at the continuous and batch ash concentrate vessels. A test was also conducted to determine total gas flow and the rate of DAS losses through the flare header. These tests have been discussed previously. (Ref. 3)

Several improvements were made during May, June, and July to convert the continuous ash receiver into a closed system. (Ref. 4, 5, 6) These resulted in increased ash separation that improved the system operability and contributed to a reduction in DAS losses. They included:

- Heat controls in the top, middle and bottom sections of the ash receiver.
- Installation of a venturi scrubber to handle the upflow of DAS vapors in the vent header connected to the ash receiver.
- Timer-control of the valve actuators to provide more control of first stage letdown and, therefore, a more uniform operation.
- Connection of the ash receiver drum vent to the venturi scrubber and the addition of heat tracing to the drum vent header.

Before the CSD unit first stage was modified, DAS losses ranged from 20 to 30 lb/hr. After initial modifications, DAS losses were reduced to approximately 15 lb/hr. After final modifications, the lowest DAS losses were observed. They averaged 13.1 lb/hr, or 3.4% of feed in September. (Ref. 7)

The use of a different deashing solvent, designated DAS "B", increased the ash content and reduced the SRC content in the ash concentrate (Run 212 vs Run 211). The addition of LSRC accomplishes the same effect, as noted from Run 217. (Ref. 1)

Comparison of MB data for Runs 204, 206, 208, 209, and 210 suggests that the CSD recovery is related to the benzene-soluble content of the feed. Consequently, it appears that the hot separator mode of operation, combined with a high T102 bottoms temperature, results in reducing the benzene-solubles in the feed with a corresponding reduction in CSD recovery. (Ref. 8)

During Runs 221 and 222, the CSD unit maintained LSRC production at a rate equal to 30 wt % of the recycled process solvent stream without any apparent effect on unit operability, and with the dissolver operating at 100% volume. (Ref. 9)

F. SOLVENT RECOVERY

During the first, second, and third quarters of 1980, the solvent recovery system utilized T102 Vacuum Column, T105 Solvent Fractionation Column, and T104 Recovery Column (see Figure 12, Mode 1 Operation). During the fourth quarter, the T105 Column was eliminated in the solvent recovery system (see Figure 13, Mode 2 Operation).

When operating in Mode 1, the feed from V110 Flash Tank and from T104 bottoms enter T102 slightly below tray 8. Refluxes were maintained on both tray 1 (overhead) and tray 3. Draw-offs from trays 3 and 8 are combined and sent to T105 Fractionation Column where the process solvent (as bottom product) and naphtha and middle distillate (as overhead product) are recovered. The T102 overhead product is sent to T104 via P171 (hot well) where the naphtha product is separated as overhead while the T104 bottoms are either sent to T102 or to T105. The bottom product of T102 is sent either to the CSD unit or to K125 Product Solidifier.

When operating in Mode 2, the drawoffs from trays 3 and 8 are combined and used as process solvent, thus eliminating T105 Fractionation Column. The T104 column operation is adjusted by increasing the boiling range and throughput of the overhead to produce a T104 bottoms stream with a lower concentration of fractions boiling at less than 450°F. By adding this stream to T102, the combined drawoffs of trays 3 and 8 yield an acceptable process solvent (95% boiling at temperatures higher than 450°F).

1. T102 Vacuum Column

Operating data for the column during the fourth quarter material balance periods are given in Table 20. A summary is presented below:

Run	217CD	219AB	220AB	220DE	221B	221G
T102 pressure, psia	0.40	0.36	0.40	0.40	0.33	0.30
T102 bottom temperature, °F	546	597	594	597	594	593
Overhead temperature, °F	230	241	240	246	233	234
Overhead rate, lb/hr	10	215	212	188	39	20
Distillate, wt % in T102 bottoms						
at 500°F, 0.1 mm Hg	3.5	2.5	1.4	4.7	2.5	1.4
at 600°F, 0.1 mm Hg	10.7	8.9	10.7	12.9	10.5	10.2
Melting point, T102 bottoms	242	319	288	275	277	251
Composition of T102 bottoms(a), %						
Oil	32.6	33.7	38.4	30.4	30.0	42.7
Asphaltene	50.1	50.8	46.8	50.7	49.7	40.6
Preasphaltene	17.3	15.5	14.8	18.9	20.3	16.7

(a) Cresol-soluble basis.

Tables 21, 22, 23, and 24 show the analyses and compositions of the streams obtained from T102 while Figures 14 through 25 show the distillation curves of process solvent. In the past, B103 Vacuum Column Preheater supplied the additional heat to compensate the latent heat of vaporization lost in T102 Vacuum Column. This is in accordance with the demon-

stration plant design, which calls for shorter residence time in the flash and distillation systems.

Bypassing B103 requires a higher feed inlet temperature to T102 and a higher recirculation rate of T102 bottoms in the existing, Dowtherm jacketed, short recycle loop.

To achieve a higher feed temperature, the E102 Dissolver Product Cooler was completely insulated. This kept the V103 temperature at around 750°F (hot mode of operation), and resulted in a higher V110 temperature (feed inlet temperature to T102 column). With the faster recycle of T102 bottoms, the stream becomes, for comparative purposes, a backmix reactor in which the residence time has an exponential distribution. With B103 in use, the average residence time was about two hours in T102; however, 37 vol % of the feed had a residence time greater than two hours while about 5 vol % had a residence time of greater than six hours. When bypassing B103, the average residence time was reduced to 80 minutes in the T102 column.

Table 20 (T102 Vacuum Column Operating Data) presents the weight fractions by boiling range of the combined tray 3 and 8 streams. The data indicate that an acceptable process solvent was obtained without using the T105 Fractionation Column.

2. T105 Fractionation Column

Process solvent was produced via T105 Fractionation Column during the first, second, and third quarter of 1980 (see Ref. 1, 2, and 8). During the fourth quarter, T105 was eliminated from the process solvent recovery system because it is no longer necessary to isolate the 350 to 450°F fraction. In the future, it will be used in conjunction with the hydrotreater unit to fractionate hydrogenated solvent.

3. T104 Recovery Column

To obtain an acceptable process solvent from T102 without the use of T105, it was necessary to make adjustments in the T104 column operation. High temperature feed (above 500°F by the use of E112 Dowtherm Heat Exchanger) was fed to the column to increase the boiling range and throughput of the overhead. Tables 25 and 26 summarize the T104 column operating data, the naphtha (organic liquid) analyses, and the compositions during material balance periods. (The T104 overhead rates were calculated by V170 level changes.) Figures 26 through 32 show distillation curves for the naphtha products.

The T104 operating data indicate that the 30% LSRC addition to the process solvent and the reduced coal rate (Runs 217 and 221) yielded a lower feed rate to the T104 Column.

G. CORROSION

During 1980, tests were performed to evaluate the effects of adding sodium carbonate to the coal slurry stream. Initial tests demonstrated that sodium carbonate is an effective corrosion inhibitor. Additional tests are being conducted to more fully assess the impact of its addition on SRC and CSD unit operations.

In the first quarter, sodium carbonate was added during each run except for Run 198 and Run 202. Run 198 filtration data were compared to that for Runs 196 and 197 when sodium carbonate was added. Run 202 was made without sodium carbonate in order to obtain a chlorine balance while processing Dotiki mine coal.

During the second quarter of 1980, Runs 205 through 208 were made with sodium carbonate addition at a rate of 40 lb per batch of feed coal. No sodium carbonate was added during Runs 209 and 211. The probes that were most sensitive to corrosion were located in the T102 packing area and at T105 tray 15. (Ref. 8)

During the third quarter of 1980, on 22 August, three carbon steel corrosion test probes were installed in the T104 Recovery Column. The carbon steel test probe used in the packing area of T102 Vacuum Column was also replaced. Both columns indicated corrosion rates of more than 100 mpy until 17 September when 25 lb of sodium carbonate was added to each batch of coal slurry. Three days later, the corrosion rate decreased to nearly zero.

Corrosion tests were made on 21 August with Kentucky 9 Fies mine coal (Runs 211 and 212) and Dotiki mine coal (Runs 213 and 214) without sodium carbonate. The corrosion rates in T102 Vacuum Column (packing area) and T105 Fractionation Column (tray 15) were more than twice as high while processing the Dotiki mine coal than the Fies mine coal.

During Run 214, T104 Recovery Column bottoms were shifted from T102 to T105 to determine if corrosion would decrease in T102 and increase in T105. Corrosion in T102 did increase measurably at first, although the effect seemed short-lived. Because the corrosion measuring probe was nearing the end of its useful life, the indicated corrosion increase at the end of Run 214 must be interpreted with caution. The corresponding increase in the T105 corrosion rate appeared after seven days.

T105 Fractionation Column was down for the month of September. The trays were removed and inspections indicated that trays 10 through 19 needed to be replaced. (Ref. 1)

There was no appreciable corrosion in any of the columns during the fourth quarter. The installation of the new T105B column was completed. Specimens were removed from the shell of the original T105 and sent to the International Coal Refining Company (ICRC) and to the Oak Ridge National Laboratory (ORNL) for study.

H. WASTEWATER TREATMENT

A flow diagram of the wastewater treatment system is shown in Figure 33.

The system operated within all National Pollutant Discharge Elimination System (NPDES) and Alabama Water Improvement Commission (AWIC) standards established for the Wilsonville facility. A complete review of the 1980 discharge parameters is provided in Figures 34 through 39.

The following NPDES regulatory limits apply:

<u>Component</u>	<u>Allowable Daily Average</u>	<u>Allowable Daily Maximum</u>
BOD, mg/l	30.0	60.0
Phenol, mg/l	0.25	0.5
Oil and grease, mg/l	10.0	15.0
Total suspended solids, mg/l	30.0	60.0
Settleable solids, mg/l	1.0	1.0
pH	6.0-9.0	6.0-9.0
Temperature, °F	95	100

Removal of Biological Oxygen Demand (BOD) was consistently above 98% and removal of phenolics exceeded 99.5%. The addition of activated carbon was not necessary under normal operating conditions, but it was useful during periods of shock loading by organic components in the influent. A total of 950 lb of activated carbon was added to bio-reactor "A", and 575 lb to bio-reactor "B" in 1980.

I. LABORATORY PROGRAMS

The laboratory programs currently being performed at the Wilsonville pilot plant are listed on the following page. Additional tests such as mineral, proximate, and ultimate analyses as well as heat content and sulfur forms are performed by an outside laboratory.

- DAS Determination in CSD Samples

A regular laboratory vacuum distillation is performed to determine the percent solvent in CSD samples. The distillate is recovered in a cold trap of methanol and dry ice or in a cryogenic bath. The solvent is extracted (with or without THF), weighed, and dried. The percent DAS is computed with a Varian 3700 gas chromatograph (GC) using an SP2100 packed column.

- SP2100 Packed Column for GC Tests

Comparisons were made during the year to evaluate the performance of the Dexsil 300 and Supelco SP2100 packed columns for GC analysis tests. The results showed greater resolution of the light end fractions, including Dowtherm, with the SP2100 and without loss of the heavy end fractions resolution. The SP2100 packing column is now used in conjunction with the GC for most determinations.

- H₂S Determination by GC

A new method to determine the percent H₂S has been instituted using the Fisher Model 1200 gas partitioner. Using the GC in conjunction with this partitioner results in a more precise analysis than was previously obtained with the volumetric titration procedure.

- Replacement DAS (Special Program)

In an effort to prepare a process-derived deashing solvent (DAS) for use in the Kerr-McGee CSD unit, the Catalytic laboratory distilled naphtha from the SRC unit. After two distillations, the sample was analyzed and the Catalytic results indicated that its characteristics were generally similar to the currently used DAS. A sample was forwarded to Kerr-McGee for further evaluation and their tests showed that, in respect to solvency, there was a considerable difference between the two. Additional testing is being considered.

VII. MECHANICAL PERFORMANCE

During 1980, improvements were made in the durability of the packing for the P180 CSD Feed Pumps. The P119 Tower Bottoms Pumps operated with less trouble. T105 Fractionation Column was replaced with a new column. The K110 Flare was relocated for the hydrotreater construction. There was a great overall improvement in the operation of the CSD letdown system after modifications were completed.

An analysis of plant component problems during the fourth quarter is provided in Table 27.

A. AGITATORS AND MIXERS

The A101A Mixer in the V101A Slurry Mix Tank was rebuilt when a low speed worm gear was replaced in the unit on 24 August.

B. COMPRESSORS

C102 Hydrogen Recycle Compressor packing was replaced on four occasions. The cooling water filter plugged on two occasions, allowing the packing to overheat. This happened on 31 March and 4 April. On 30 August, an O-ring failed on the packing box water jacket, causing the packing to fail. Bronze packing was installed, but it did not give good results and the compressor was repacked with carbon-filled Teflon on 23 September. After several failures of the O-rings, a new packing box was installed on 12 November. The cause of the O-ring failures was due to corroded O-ring seats between the packing cups.

The annual inspection of the C104 Fresh Hydrogen Compressor, in May, showed that it was in good condition. The only damage was found in the third stage piston rings. The compressor failed three times during the third quarter after discs broke in the second stage valves. The broken valve discs were tested and found to be too brittle. A new set of valves was installed in September. The compressor was again inspected on 13 November, and no serious problems were found. New valves were installed.

The valves in C202 Instrument Air Compressor were replaced in August.

A used Worthington 500 cfm oil-free instrument air compressor (C208) was placed in service on 25 September.

During October, the C203 Air Compressor began using an excessive amount of oil. It was dismantled and the worn piston rings were replaced.

C. DRYERS

The Kahn D201A Instrument Air Dryer failed on two occasions to give a -40°F dew point. In the first instance, an adjustment to the purge was required. In the second instance, a microswitch failed, which caused a regeneration failure in one side of the dryer. This necessitated the replacement of the desiccant bed. On several occasions during the year, the purge solenoids stuck and the dryer did not regenerate. Daily maintenance inspections were initiated.

D. EXCHANGERS

A leaking tube in E171 Overhead Product Cooler (for T105 Fractionation Column) caused a plant shutdown on 21 June when solvent leaked into the cooling water system. The failure was caused when the hot process liquid impinged on the relatively cold exchanger tube. The exchanger tubes were replaced and an impingement baffle was installed. Several of the CSD unit heat exchangers plugged and were cleaned. There were no mechanical failures.

E. FIRED HEATERS

B102 Slurry Preheater was decoked on 7 February. Coal feed was stopped three times due to preheater problems. Two outages were due to wet atomizing steam. To eliminate this problem, the heater was modified to atomize with air. The third outage resulted from a clinker in the heater burner. During the June shutdown, the preheater was decoked. After decoking, the 316 SS heater coil was tested ultrasonically. No wear was found. A process leak in a thermowell on the preheater coil resulted in a plant outage on 15 June after a pinhole had appeared in the Stellite tip of the Incoloy 800 thermowell. Four thermowells were replaced in the heater and a fifth thermowell broke and could not be replaced. This well was plugged. The burner was converted to use both propane gas and No. 2 fuel oil on 29 July. On 4 August, the fuel regulator failed because light solvent mixed with No. 2 fuel oil and destroyed the regulator diaphragm. The heater was switched to propane and ran without problems. The heater was decoked on 5 September. Problems with low LPG gas pressure caused two heater outages during 4-9 October. An additional LPG vaporizer was installed to eliminate the problem. The broken thermowell was removed from turn 37 along with a 6 inch section of the coil during the 12 November shutdown. This was sent to Oak Ridge National Laboratory (ORNL) for a metallurgical examination. All thermowells on the heater were replaced and new thermocouples installed. The thermowells that were installed last June were badly eroded. On 15 December, the heater was checked. The elastomer parts used in the oil train were swollen and required replacement. On 23 December, the heater shut down for no apparent reason. The heater was relit; it again shut

down. After several shutdowns for no apparent reason, the flame detector, amplifier, and the Flame Safeguard Programmer were replaced. All three components were returned to the manufacturer for analyses.

B103 Vacuum Column Preheater malfunctioned at the beginning of the first quarter due to a faulty spring in a control regulator. On 7 February when the plant was shut down, B103 was decoked, and the regulator was repaired.

B102 Slurry Preheater and B103 Vacuum Column Preheater plugged during a power failure on 1 July and again on 7 July. In both cases, the heaters were cleared with nitrogen.

B201 Steam Boiler was given an annual inspection in May. A buildup of ash was noted on the fire side of the tubes. This ash was removed with a hydroblaster. The burner was modified to burn both propane and No. 2 fuel oil. The boiler failed on 25 December due to low water. A new feed water pump was installed. The boiler continued to cause problems. A study is underway to determine the source of the boiler problems. The new B202 Steam Boiler was placed in service on 16 December.

There was an ignition flash-back while lighting the main burner of B203 Dowtherm Heater on 14 July. The problem was traced to a very low pilot flame. The heater was not damaged and no one was injured. A procedure for checking the pilots on all heaters was written to prevent this from recurring. This heater was shut down for the installation of the new T105 column.

F. MINERAL RESIDUE SEPARATORS

The United States Filter Corporation (USF) filter operated until 23 February with only three shutdowns required to correct mechanical problems. On 12 January, the XV654 recycle control valve began leaking. This allowed precoat to leak into the filter feed tank. This valve was replaced with a rebuilt valve. The filter was inspected on 24 January. Two pinholes were found in one screen and a cutoff blade had broken. The broken blade, however, did not damage the screen. A new screen was installed to replace the screen with pinholes. On 2 February, the filter was again inspected because of high ash in the product. A spacer gasket had failed. On 23 February, the filter was again inspected. The screens were in good condition. The filter was prepared for an extended shutdown.

Tests of the Industrial Filter Corporation (IF) candle filter were conducted during April and May. A major problem with the IF filter is cake removal from the screens. A new vibrator was installed in May in an effort to improve cake removal. There was no improvement. In December, preparations were made to return the filter to the manufacturer.

The Kerr-McGee Critical Solvent Deashing (CSD) unit was restarted in the latter part of February on remelted SRC. The unit has operated well with the only problems attributed to plugging of the letdown system. In November, the letdown system was modified and this reduced the frequency of plugging. The high pressure DAS system was not operated because the pulsation dampener was inadequate for the pump discharge. The Hydro-Bellows dampeners failed on startup of the pumps. Pulsation dampeners are being designed for this service.

G. PUMPS

The P111B Filter Feed Pump (Lawrence Pump) had a Kalrez O-ring, and a bearing failure. The failures were approximately 250 operating hours apart. The pump was shut down in February after a total of 2,426 operating hours.

The Rocketdyne test pump has operated for a total of 467 hours. During the third quarter, the pump was plagued with seal failures and cavitation problems caused from unmixed LSRC solids being drawn into the pump suction. The test ring was damaged and was returned to Rocketdyne. A new test ring was installed and the pump was operated for approximately 600 hours. This ring was removed in November and returned to Rocketdyne for inspection.

P180A and B CSD Feed Pumps failed on 9 March. Repair parts were fabricated and the pumps were returned to service on 14 March. An automatic grease feeder was added to lubricate the pump packing. The new parts and the addition of approximately one-half pint of grease (Lubriplate 930-AA, PP09635) per 24 hours of operation have eliminated most pumping problems. The pumps caused problems during startup on 13-14 August. The problems were traced to the temperatures of the pumps being too low. An orifice was removed from the heat transfer media return and the increased flow raised the operating temperature. The pumps operated for the period with only two packing failures. The automatic packing lubrication system and the new-style packing have increased the reliability of these pumps. P180A and B were repacked twice during December; both pumps on 21 December, P180A on 25 December, and P180B on 28 December. The installation of an automatic grease feeder to the CSD feed pumps has increased the packing life threefold.

The P119C and D T102 bottoms pumps failed on several occasions. On 11 July, the P119C pump failed when a seal oil circulator relief valve malfunctioned. On 16 July, a faulty inboard shaft bearing on P119D failed. T102 experienced frequent upsets from 17 to 20 July, resulting in failures of both P119 pumps. On 14 August, a snap-ring retainer on P119D failed, allowing the impeller to rub against the pump casing.

The addition of 30% crushed LSRC to the slurry in the V101A and B Slurry Mix Tanks caused more than normal problems with the P102A and B Slurry Circulation Pumps. When LSRC was added in a melted form from V130, the pump problems were eliminated.

H. DISSOLVER (REACTOR) AND COLUMNS

The R101 Dissolver was opened and inspected on 7 February during a plant shutdown and on 17 February because of a leak on the bottom head flange gasket.

During a plant outage on 27 March, the bottom head was removed for an inspection and the flange gasket was replaced. The bottom head was pulled three times during the second quarter for inspection. In May, a team of metallurgists from Oak Ridge National Laboratory inspected the dissolver. No problems were found. Both dissolver blowdown valves were replaced. During June, the nuclear meters which had been rebuilt were installed. Their performance appears to be acceptable. On 29 July, the bottom head was removed for an inspection of the distribution plate. The dissolver was clean and the orifices in the distribution plate were clear. The dissolver was again opened during the week of 12 November and very little solids buildup was noted. Oak Ridge National Laboratory performed a metallurgical examination of the bottom. A report will be issued at a later date by ORNL. Test coupons were installed in the bottom for future corrosion rate determination. The dissolver was re-assembled and piped for 100% volume operation. Actual operation for the dissolver was at 75% volume for Runs 195 to 215 and for Runs 218, 219, and 220. It was at the 50% level for Runs 216 and 217. It was at the 100% level for Runs 221 and 222.

TR401 Doric Temperature Recorder for B102 Slurry Preheater and R101 Dissolver was tested and found to be out of calibration on 28 August. Using a signal transferred from a calibration meter, the points 1 through 20 of B102 were found to be reading 30°F higher. The Conax, Inc. 16-point thermocouple used in R101 was removed on 5 September and checked for accuracy. The unit was found to be giving a false reading and was not reinstalled. A new thermocouple has been ordered and is scheduled for delivery in mid-January. Thermowells were installed in the reactor at the 50% and 75% points. On 27 September, the dissolver outlet was changed from the 50% point to the 75% point.

The V103 High Pressure Separator degas tank was cleaned three times during the second quarter to remove coke. This coke formed when E102 Dissolver Product Cooler was bypassed in the hot separator mode of operation.

T102 Vacuum Column was shut down for inspection on 7 February. The gasket under tray 8 had deteriorated and was allowing solvent to leak into the bottom of the column. Tray 8 was replaced with a new 321 SS tray and the tray floor was welded to the tray support to eliminate the gasket. A jacketed section of liquid coal piping on the T102 circulation loop failed after the inner pipe eroded and collapsed from the Dowtherm pressure in the outer pipe. This piping was replaced. During the May shutdown, the column was inspected. No deterioration was evident since the February 1980 inspection. A splash plate was installed inside the column for the short circulation line that is used when the B103 Vacuum Preheater is bypassed. On 23 June, the bottom was removed from T102 and several pieces of tray parts were removed. These parts had been in the column bottom for several years.

I. VALVES

XV4078 Solids Withdrawal Valve plugged on 22 July. The tungsten carbide tip had broken and plugged the seat. A new trim was installed. The valve was checked for a plug on 9 October. The valve and the trim were in good condition.

A new fluteless trim was tested in LV415B High Pressure Letdown Valve in April and operated for 1,251 hours. It was expected that the lack of flutes would make the trim wear more evenly. Inspection revealed that the flow continued to channel over only one area. The single fluted trim sets used earlier had operated for more than 3,000 hours.

Block valves to the LV415B High Pressure Letdown Valve were replaced during the May plant shutdown. The valves had been used for throttling when a letdown valve failed. The trim in the LV415B Letdown Valve was replaced after 1,200 hours of operation. The trim in LV415A was changed on 20 August. This trim had approximately 2,200 hours of operating time. On 15 December, LV415A High Pressure Letdown Valve failed after a trim broke. This valve had operated for 103 hours.

New trim was installed in October and November in the PV999 Back Pressure Control Valve for the T102 Vacuum Column feed.

Several control valves in the T104 Recovery Column required trim changes because of the very low flow rates during Runs 216 and 217.

The high pressure letdown valve from Consolidated Controls was installed for testing in April. During startup, the plug seized in the 35% open position and would not operate. The valve trim has been returned to the manufacturer.

A leaking blowdown valve on B102 Slurry Preheater was replaced on 29 July.

Both R101 Dissolver blowdown valves were replaced on 29 July.

J. HYDROTREATER

Startup work for the hydrotreater is underway. The compressors and heaters have been tested and are ready for operation. There was a problem assembling the thermocouple for the R1235 Reactor, but installation was completed on 15 December.

K. OTHER

During the final phase of the shutdown for hydrotreater tie-ins and maintenance work, during the week of 12 November, the nitrogen storage tank fell on the pipe rack. The pipe rack was damaged severely and required total replacement. While this work was underway, maintenance efforts were directed toward the hydrotreater startup.

VIII. PROJECTS

A. ACTIVE

1. Project 4151 - Replacement of T105 Fractionation Column

This project provides for the replacement of the T105 Fractionation Column with one of identical size and configuration, but fabricated from 316L clad carbon steel. The present fractionation column has experienced severe corrosion.

Installation will be complete in mid-January 1981.

2. Project 4154 - Ash Concentrate Dryer Bottom Seal

This project provides for the installation of a heated screw conveyor and a peripheral seal rotary feeder on the outlet of the ash concentrator in the Critical Solvent Deashing unit. This system is designed to improve the integrity of the bottom seal and thereby to improve recovery of deashing solvent.

Installation is scheduled for January 1981.

3. Project 4156 - New V103 High Pressure Separator

This project provides for the installation of a reduced volume high pressure separator. The residence time of reaction product at high temperatures in the absence of hydrogen will be reduced to approximately two minutes for the hot separator mode of operation. The shorter residence time should reduce coke-like solids formations in this vessel.

Installation is scheduled for January 1981.

4. Project 4159 - Catalyst Addition and Withdrawal

This project provides for the installation of a system to add and withdraw catalyst at the R1235 Hydrotreater Reactor with the unit in operation.

Installation will be complete by mid-1981.

5. Project 4161 - CSD Ash Concentrator Modification

This project provides for the installation of a new CSD ash concentrator with a 4-inch cyclone. With this unit, the Wilsonville facility will more closely parallel the demonstration plant design.

The target date for installation is April 1981.

6. Project 4162 - R101 Product Cooler

This project provides for the installation of a heat exchanger using Dowtherm as the cooling medium to control the reaction product temperature in the V103 High Pressure Separator.

The project schedule has not been established.

B. COMPLETE

1. Project 4143 - Hydrotreater Installation

This project provides for the installation of a hydrogenation unit at the Wilsonville pilot plant. It will permit exploration of various modes of short residence time operation while maintaining process solvent quality at minimal hydrogen consumption rates. It will also yield experimental data on the production of liquid fuels from SRC-I using conventional hydroprocessing catalysts.

Project 4142 - New V204 Flush Solvent Tank and Project 4152 - HRI Bench Scale Test were combined with and completed under Project 4143.

Installation of the equipment was completed in December.

2. Project 4144 - Critical Solvent Deashing Unit Modifications

This project provides for the following:

- Recovery of deashing solvent in a high-pressure, high-temperature recycle system.
- A new first stage to provide increased capacity for future process conditions.
- Increased plant operating area to accommodate new equipment.

This project was completed in February.

3. Project 4146 - Laboratory, Warehouse and Locker Room

This project provides for the following:

- A controlled-atmosphere laboratory to house the highly sensitive electronic equipment.
- An enlarged warehouse and maintenance shop area.
- Enlarged and improved locker room facilities.

This project was completed in June.

4. Project 4150 - Rocketdyne Pump Test Loop

This project provides for the reinstallation of the Rocketdyne pump test loop. This loop will be used to evaluate materials for possible use in a high speed slurry pump application.

This project was completed in March.

5. Project 4153 - New Steam Boiler

This project provides for the purchase and installation of a new 150 horsepower steam boiler. Plant modifications and expansion will impose a steam demand exceeding the capacity of the existing boiler.

The project was completed in November.

6. Project 4158 - Ash Concentrate Briquetter

This project provides for the installation of a roll briquetter/compactor. It will be used to test the briquetting of the ash concentrate to provide better handling and storage characteristics. The increased bulk density will also reduce the expense of ash disposal.

This project was completed in December.

7. Project 4160 - Slops Recovery System

This project provides for the installation of a piping system to utilize Vlll vessel in the filter system as a slops receptacle until the slops can be reprocessed to recover the process solvent.

This project was completed in December.

C. CANCELLED

1. Project 4147 - Administrative Building

2. Project 4149 - Replacement of Filter System Equipment

3. Project 4155 - Improved Hygiene Facilities

4. Project 4157 - Industrial Filter and Pump Manufacturing Co. Filter System Modifications

IX. FUTURE PLANS

The proposed 1981 operating schedule for the Wilsonville SRC pilot plant is presented below:

Task 1: SRC-I Demonstration Plant Support Runs

<u>Approximate Date</u>	<u>Objectives</u>
Jan-Feb 1981	Demonstration plant simulation run A "low quality" startup solvent (anthracene oil, Allied 24-CB) will be used. The conditions for the run will be the same as those for Run 220. A material balance will be made using the conditioned startup solvent and hot separator mode. Remove insulation on V103 High Pressure Separator. With normal separator temperature, 14,000 lb of filter feed will be collected for filtration tests during the later stages of the run.
Feb 1981	Installation of new V103 High Pressure Separator.
Feb-Mar 1981	Demonstration plant simulation run. The temperature at the new high pressure separator will be 740°F maximum.
Mar-Apr 1981	Dissolver temperature and/or pressure variation studies.
Mar 1981	Studies of different solids withdrawal rates from R101 Dissolver.
May-June 1981	Mild SRC plant conditions for hydro-treater run.
July-Aug 1981	Demonstration plant simulation run. The new high pressure separator will be tested.
Sept-Oct 1981	Demonstration plant simulation run. Severe SRC plant conditions will be used for the hydrotreater run.
Oct-Nov 1981	Demonstration plant simulation run using alternate coal. ICRC will provide bench scale data on the alternate coal before testing in the pilot plant.
Nov-Dec 1981	Product solidification tests. Equipment such as a paddle dryer will be tested.

Task 2: Kerr-McGee Critical Solvent Deashing Unit Test Runs

<u>Approximate Date</u>	<u>Objectives</u>
Jan-Feb 1981	Stripping tests.
Feb 1981	Installation of ash concentrate dryer bottom seal.
Feb-Mar 1981	Tests with ash concentrate dryer bottom seal and high pressure DAS recycle.
June 1981	Installation of the cyclone for the CSD unit.
July-Aug 1981	Tests with cyclone system and alternate DAS.

Task 3: Hydrotreater Unit Test Runs

<u>Approximate Date</u>	<u>Objectives</u>
Jan-Feb 1981	Off-line hydrogenation of anthracene oil.
Feb-Mar 1981	Off-line hydrogenation of solvent and remelted SRC.
Mar-Apr 1981	Hydrotreat SRC at demonstration plant conditions.
May-June 1981	Hydrotreater run at mild plant conditions.
July 1981	Integrated SRC upgrading and low sulfur SRC recycle.
July-Aug 1981	Installation of catalyst addition and withdrawal system.
Sept-Oct 1981	Hydrotreater run at severe SRC plant conditions.
Oct-Nov 1981	Hydrotreater run with an approved alternate coal.
Dec 1981	Catalyst addition and withdrawal runs.

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APPENDIX A
OPERATING LOG

October

1. Run 218 began at 0400 hr. The purpose of this run was to bring the process solvent to demonstration plant design conditions.
2. Coal feed was stopped at 1420 hr. Pressure in the SRC plant was reduced to 1,600 psig so a valve in the C102 Recycle Gas Compressor could be repaired. A floating obstruction (plug) developed in the first stage on startup of the CSD unit.
3. Run 218 resumed at 1315 hr. Coal feed was stopped again at 2330 hr because of B102 Slurry Preheater problems. The CSD unit first stage and letdown lines were cleaned by hydroblasting.
4. Run 218 resumed at 0606 hr.
5. Run 218 was in progress.
6. Recycle gas flow was reduced from 10,500 scfh to 10,000 scfh.
7. An increase in LSRC addition from 225 lb/batch to 300 lb/batch of coal slurry was made.
8. Recycle gas flow was reduced from 10,000 scfh to 8,000 scfh to yield a hydrogen partial pressure of 1,250 psia in the dissolver.
9. Coal feed was stopped at 0805 hr due to B102 Slurry Preheater problems. Run 218 resumed at 1030 hr. The solids withdrawal system on the dissolver plugged. The mixer in the first stage feed line at the CSD unit began to plug. The CSD unit was taken off feed to flush the mixer with SRC.
10. The line to the XV4078 valve was plugged. A spool piece was installed and the plug was blown into V102 withdrawal sample pot. The dissolver solids withdrawal system was returned to service at 1535 hr.
11. Run 218 ended at 0001 hr and Run 219 began.
- 12-19. Run 219 was in progress.
20. Run 219A MB was completed on schedule.
21. Run 219B MB was completed on schedule.
22. Run 219 was in progress.

23. Run 220 began at 2020 hr. The only change in run conditions was an increase in LSRC addition from 300 lb/batch to 375 lb/batch of coal slurry.
- 24-27. Run 220 was in progress.
28. Run 220A MB was completed on schedule.
29. Run 220B MB was completed on schedule.
30. Run 220 was in progress. Steam stripping of SRC was attempted, but the deashing solvent exchanger fouled.
31. The CSD production of LSRC decreased and crushed LSRC was added from storage to maintain proper slurry mixtures. A high water level was discovered in the DAS feed tank and drained.

November

- 1-2-3. Run 220 was in progress.
4. Low voltage on the electrical power supply caused the C102 Recycle Gas Compressor, the B102 Slurry Preheater, the B203 Dowtherm Heater, and other support equipment to stop. Because of the upset in the SRC plant, the CSD unit was off feed from 1100 hr to 1430 hr.
5. The C102 Recycle Gas Compressor began to leak gas into the cooling water.
6. Run 220C MB began at 0200 hr after equilibrating T102 Vacuum Column following a boiler upset. Coal feed was stopped at 0530 hr due to problems with B203 Dowtherm Heater. An electrical short circuit in the Maxon safety valve prevented the heater from controlling properly. Run 220 resumed at 0815 hr. The CSD unit began to receive feed at 1130 hr.
7. Run 220D MB began at 1200 hr. An additional steam preheater was installed on the T104 Recovery Column feed line.
8. Run 220D MB was completed at 1200 hr and Run 220E MB began.
9. Run 220E MB was completed at 1200 hr. Run 220 ended at 1315 hr for final hydrotreater tie-in work.
- 10-18. During this period, all units were down for repair and hydrotreater tie-in work. The dissolver was changed to 100%. The B102 Slurry Preheater was decoked. The V103 High Pressure Separator was checked for coke formation with water. The vessel held 97 gallons of water; a clean vessel holds 99 gallons of water.

19. While replacing a small nitrogen tank with a larger tank at 1900 hr, the smaller tank fell and damaged a pipe rack. Pressure testing of the CSD unit began.
- 20-22. The new nitrogen storage tank was installed and put into service. Temporary fuel oil and propane lines were put into service. Calibration tests on de-ashing solvent and pumps at the CSD unit were started.
23. The SRC plant was pressure-tested and a few small leaks were discovered.
24. The leaks were repaired and the SRC plant was pressure-tested again. There were no major leaks. The T104 column began to distill the 8,745 pounds of liquid collected during Runs 219 and 220. In the hot separator mode of operation, more liquid was flashed to the T104 column than could be processed so this extra material was stored in drums.
- 25-26. Following the completion of the distillation of the material collected during Runs 219 and 220, the T104 column began processing the light organic oil in V124B. During Run 220, a ball valve on V138 bypass line was discovered slightly opened. This slightly opened ball valve allowed process solvent to mix with the light organic oils in V124B. As a result, the analysis of V124B showed an increase of process solvent from 28.3% to 40%.
27. Following repairs to the CSD unit, preliminary steam stripping tests resumed.
- 28-29. T104 column continued to operate. The CSD unit continued to complete preliminary steam stripping tests.
30. Following preliminary steam stripping tests, remelted SRC was fed to the CSD unit.

December

1. Steam stripping of remelted SRC began.
2. Steam stripping of remelted SRC continued.
3. The T104 column operation ended when the material in V124B was distilled. Steam stripping of remelted SRC continued.
4. The Dowtherm exchanger E112 was inspected. All tubes were fouled. The exchanger was cleaned and reassembled. Steam stripping of remelted SRC continued at the CSD unit.

5. The SRC plant was pressure-tested again. No new leaks were discovered. The steam stripping tests at the CSD unit ended.
- 6-8. The startup of the SRC plant began. As test conditions were obtained, a B102 Slurry Preheater clean coil test was completed and the top nuclear density instrument was calibrated. The E102 Dissolver Product Cooler was insulated.
9. Run 221 began at 1151 hr.
10. Coal feed was stopped at 0830 hr because of C102 Recycle Gas Compressor problems. A compressor valve was replaced and coal feed resumed at 1300 hr.
11. The CSD unit began receiving feed from the SRC plant at 0025 hr.
12. Run 221 was in progress.
13. Coal feed was stopped at 1530 hr because of B102 Slurry Preheater problems. Coal feed was resumed at 1956 hr.
14. Run 221 was in progress.
15. While cycling the B102 Slurry Preheater for adjustments, the dissolver temperature became too low. Coal feed was stopped at 1435 hr. Coal feed resumed at 1520 hr.
- 16-17. Run 221 was in progress.
18. Coal feed was stopped at 1200 hr because of B102 Slurry Preheater problems. Coal feed resumed at 1222 hr.
19. Run 221A MB was started at 0001 hr. The 24-hr material balance was prematurely terminated at 0845 hr because light SRC (LSRC) production at the CSD unit became erratic for unknown reasons.
20. Run 221B MB began at 0001 hr and was completed on schedule. The CSD unit was not on feed continuously because of feed pump problems. The CSD unit was on-stream for 23.3 of 24 hours.
21. Run 221C MB began at 0001 hr and was completed on schedule. The CSD unit was not on feed continuously because of feed problems. The CSD unit was on-stream for 18.6 of 24 hours.

- 22. Run 221 was in progress.
- 23. Run 221D MB began at 0001 hr, but was prematurely terminated at 0342 hr because of B102 Slurry Pre-heater problems. Coal feed was stopped at 0352 hr and resumed at 0450 hr. Coal feed was again stopped at 0529 hr. Coal feed resumed at 0900 hr.
- 24. Run 221 was in progress.
- 25. Run 221E MB was started at 0001 hr and completed on schedule.
- 26. Run 221F MB was started at 0001 hr, but was prematurely terminated at 0800 hr because of process solvent problems. Due to an operational error, LSRC was added to a blend tank without process solvent. As a result, the blend tank circulation system solidified with LSRC.
- 27. Run 221G MB was started at 0001 hr and was completed on schedule.
- 28. Run 221H MB was started at 0001 hr and was completed on schedule.
- 29. Run 222 was started at 0001 hr. The only changes in run conditions were the lowering of the dissolver temperature 10°F and a reduction of sodium carbonate from 25 lb to 15 lb/batch of coal slurry.
- 30-31. Run 222 was in progress.

APPENDIX B
MATERIAL BALANCE DIAGRAMS AND CALCULATIONS

1. SRC Unit

The diagram below indicates the input and output streams that are considered in developing the SRC unit material balance (MB). The mass flow rate for each stream is the basis for the MB calculations.

Raw coal, solvent, LSRC, and Na_2CO_3 inputs are weighed directly.

CO , CO_2 , H_2S , and $\text{C}_1\text{-C}_5$ mass flow rates for the gas streams are determined using integral orifice meters and gas chromatographic analyses of these streams. NH_3 in V104 and V105 vent gases is calculated from vapor-liquid equilibria data.

Flow rates for V105 organic liquid and V105 water streams are measured directly. Distillate components are determined from GC analyses. NH_3 in V105 decanter water is determined from analyses.

The mass balance around the reaction section is "closed" by calculating V110 Flash Tank outlet stream as the net difference between the mass flow rates of the other input and output streams.

SRC, UC, and ash component flow rates are determined from the mass flow rate of the T102 Vacuum Column bottoms and laboratory analyses of this stream.

The distillate component of the V110 stream is calculated from the difference between the mass flow rate of the V110 stream and the SRC, UC, and ash flows. The naphtha, middle

distillate, and process solvent cuts are calculated from gas chromatograph analyses of this distillate.

The SRC yield is determined from the net amount of SRC produced, i.e., the SRC in the V110 stream. Oil, asphaltene, and preasphaltene components of the SRC are determined by Soxhlet extraction analyses.

Distillate yields are calculated from the net amount of distillate produced.

The hydrogen consumed by the process is calculated as the difference between the hydrogen makeup and the sum of the hydrogen vented.

2. CSD Unit

The flow diagram below indicates the input and output streams that are considered in developing the CSD unit MB. The flow rate for each stream is the basis for the calculations.

The SRC recovery can be calculated by forced ash balance (Method A) as follows:

METHOD A

$$\text{SRC recovery} = 100 - \frac{(\% \text{ ash in feed})(100) \div 100 - \% \text{ CI in feed}}{\% \text{ ash in ash con.} \div 100}$$

SRC recovery can also be calculated by normalized material balance (Method B) on an LSRC-containing basis^(a), as follows:

METHOD B

$$\text{SRC recovery} = \frac{(\text{SRC in lb/hr} + \text{LSRC in lb/hr})(100)}{(\text{feed in lb/hr}) [(100 - \% \text{ CI in feed}) \div 100]}$$

(a) SRC and LSRC rates are given on a DAS-free and CI-free basis.

SRC recovery can also be calculated by normalized material balance (Method C) on an LSRC-free basis^{(a) (b)}, as follows:

METHOD C

$$\text{Percent SRC recovery} = \frac{(\text{SRC output in lb/hr} + \text{LSRC output in lb/hr} - \text{LSRC input in lb/hr})(100)}{(\text{feed in lb/hr})(100 - \% \text{ CI in feed} \div 100) - \text{LSRC input in lb/hr}}$$

- (a) SRC and LSRC rates are given on a DAS-free and CI-free basis.
- (b) Assuming LSRC input is unchanged during the process.

3. Overall MB

The input and output streams for the overall MB calculations are as shown on the diagram below.

Note: When the net yield of distillates and LSRC is positive or zero, the makeup requirement is also zero.

The requirement for CSD deashing solvent (DAS) makeup is due to DAS losses in the CSD product streams and other leakages in the CSD unit.

The CSD product streams contain distillable process solvent. This is experimentally determined by distilling the sample in a flask at 600°F and 0.1 mm Hg for 1 hour.

Figure B1 shows the routing of selected input and output streams of the SRC and CSD units in detail. It also identifies each piping run with a number.

It should be noted that the material balance is not "closed". This is due to the difficulty in obtaining accurate measurements for the following streams and vessels:

- The recycle solvent flow from T102 at trays 3 and 8 is not measured accurately. The V131A tank (about 39,300 lb capacity when full) level changes are used to measure the rate.
- The steady-state rate from the T104 overhead stream is not determined accurately because (1) there is no water/oil interface controller in V164 and it is not certain if level changes in that vessel are due to water or oil accumulation and (2) the discharge from P171 to V164 is not measured directly.

Therefore, in the overall MB method, the rate of the total recovered product distillate, which comprises naphtha (IBP to 350°F boiling range), middle distillate (350 to 450°F), plus process solvent (450°F to EP) is estimated by a balance around the T102, V164, and T104 units.

The following paragraphs describe how the calculations are made in more detail. The numbers in brackets (< >) correspond to the piping run identification numbers shown on Figure B1.

a. Distillate Yields

$$D_{V110} = \text{the total distillate rate at } 12 - \text{the SRC+CI rate at } <13> \quad \text{Equation (B1)}$$

The SRC plus CI rate at <13> is calculated from the CSD product streams at <26>, <27>, and <29> (which are corrected to reflect the K125 rate) and by deashing solvent (DAS) and process solvent analyses of the streams. Then the stream <12> distillate analysis is used to allocate the D_{V110} rate among naphtha (IBP-350°F boiling range), middle distillate (350 to 450°F), and process solvent (450°F to EP).

Next, the following relationship is applied:

$$(PS)_T = \text{Combined process solvent rates in } <10> + <11> + <12> \quad \text{Equation (B2)}$$

where

$$(PS)_T = \text{Total flow rate of the process solvent from the reaction section.}$$

Then,

$$(PS)_R = (PS)_T - (PS)_{<13>} \quad \text{Equation (B3)}$$

where

$(PS)_R$ Total rate of recovered process solvent

and

$$(PS)_{<13>} = (PS)_{<26>} + <27> + <29> \quad \text{Equation (B4)}$$

where

$(PS)_{<26>} + <27> + <29>$ represents total residual process solvent in streams <26>, <27>, and <29> corrected for the K125 rate in <14>.

The yield of recovered process solvent

$$= (PS)_R - (PS) \text{ in stream } <2> \quad \text{Equation (B5)}$$

The yields of recovered naphtha and middle distillate are calculated in a similar way. It is assumed that there are no losses of naphtha and middle distillate to the T105 bottoms stream.

b. Yields of C_1 - C_5 , H_2S , and CO , CO_2 , NH_3 , and Water

C_1 - C_5 yields are obtained from C_1 - C_5 in streams <7>, <8>, <9>, and <23>.

The yields of H_2S , CO and CO_2 are estimated from their respective levels in streams <7>, <8>, <9>, and <23> and from the quantity of each that is scrubbed out into streams <32> and <33>.

The NH_3 yield is calculated from the NH_3 levels in streams <10> and <11> by direct determination and from the NH_3 levels in streams <7> and <31> by indirect determination based on the vapor-liquid equilibria.

The yield of water is calculated from the amount of water in streams <10> and <11> less the water in stream <1>.

c. Hydrogen Consumption

Hydrogen consumption is estimated as the H_2 in streams <7>, <8>, <9>, and <23> less the H_2 in <6>.

d. Yields of CSD Ash Concentrate and Net SRC and LSRC

The CSD ash concentrate yield is based on stream <26>, corrected for the K125 rate in <14>.

The net SRC and LSRC yield is based on streams <27> and <28>, corrected for the K125 rate.

e. Deashing Solvent (DAS) Makeup Requirement

The CSD DAS makeup requirement, calculated as a percentage of the MAF coal feed, is based on the non-product DAS losses (stream <32>) and the DAS losses to streams <26>, <27>, and <29>. The DAS makeup rate, stream <25>, is based on the actual CSD feed rate, stream <15>. The non-product DAS losses, stream <32>, are estimated as:

$$<32> = <25> - \text{DAS in } <26> + <27> + <29> \quad \text{Equation (B6)}$$

Net DAS makeup (% MAF coal) =

$$\frac{\text{DAS in } <26> + <27> + <29> \text{ corrected for K125 rate} + <32>}{\text{Coal feed rate, MAF}} \text{ lb/hr} \times 100$$

Equation (B7)

It is assumed that the non-product DAS losses, stream <32>, remain the same even if the CSD feed rate, <15>, is increased to account for the K125 rate, stream <14>.

FIGURE B1. OVERALL MATERIAL BALANCE - SRC AND CSD UNITS

APPENDIX C
RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) COMPLIANCE:
HAZARDOUS WASTE DISPOSAL

Subtitle C of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, directs the Environmental Protection Agency (EPA) to promulgate regulations to protect human health and the environment by proper management of hazardous waste. This gave EPA authority to develop a nationwide program to regulate hazardous waste handling procedures from "cradle to grave" - i.e., from the time the waste is generated to its final disposal.

Most of the hazardous waste regulations were promulgated on May 19, 1980 (Phase I). These regulations become effective on November 19, 1980. Existing hazardous waste management facilities could continue to operate after November 19, 1980, if they met certain notification and permit filing requirements. Such facilities are said to be operating under "Interim Status" until action is taken by EPA to issue final permits. To ensure protection of human health and the environment during the "Interim Status" period, minimum national standards were established to define acceptable hazardous waste management for existing facilities.

An intensive effort was begun to assure that the Wilsonville SRC pilot plant would be in compliance with the lengthy and complex regulations soon after they were promulgated on 19 May. A waste audit was conducted to characterize the chemical and physical compositions of each waste, to determine waste handling practices, and to assess the hazardous nature of each waste as required by RCRA regulations. The form used in this survey is shown in Exhibit C1.

Waste materials are characterized by RCRA as hazardous in two basic ways:

- (1) They may be present on any of several hazardous waste lists or
- (2) They may exhibit one or more hazardous characteristics; specifically, ignitability, corrosivity, reactivity, and/or extraction procedure toxicity.

Catalytic, Inc. filed the "Notification of Hazardous Waste Activity" (Exhibit C2) with EPA Region IV on August 18, 1980. This report contained the general results of the pilot plant waste study which included testing for certain hazardous characteristics.

To fulfill the final requirement for obtaining "Interim Status", Part A of the permit application was submitted to EPA on November 18, 1980 (Exhibit C3). The pilot plant facility is considered to have a "permit" until EPA requests and subsequently acts upon Part B of the permit application.

Part A of the application only requested authorization to store and treat hazardous wastes. No disposal activities have been or will be performed at the plant site.

The transportation of all solid hazardous waste, such as sludges and spill residues, will be conducted under Department of Transportation and EPA-approved procedures. Disposal will be in an EPA-approved chemical waste landfill. Furthermore, all other process-derived solid wastes, which are technically non-hazardous at the present time, will be discarded in the same landfill. Liquid hazardous wastes, such as spent solvents and waste oils, will be transported to an off-site reclamation facility. Hazardous wastewaters are currently treated and discharged using an on-site treatment system permitted by the National Pollution Discharge Elimination System (NPDES).

On November 19, 1980, the effective date of the regulations, the pilot plant began complying with "Interim Status" standards promulgated pursuant to RCRA Section 3004. In preparation for compliance, specific plans and procedures were developed. These included a waste analysis plan, security measures, general inspection requirement, personnel training, preparedness and prevention procedures, a contingency plan and emergency procedures, a closure plan, and a cost estimate for closure. Exhibits C4 and C5 are the forms for daily and weekly inspection reports.

During 1980, Southern Company Services, Inc., provided most of the support to interpret Phase I RCRA regulations and amendments. Catalytic, Inc. will assume primary responsibility for staying abreast of the Phase II regulations that are anticipated in early 1981. Major areas to be addressed in the coming year are:

- (1) Preparation of a cost impact study.
- (2) Implementation of secondary containment standards for the container storage area.
- (3) Assessment of "Financial Responsibility" requirements.

Date _____

WILSONVILLE SRC PILOT PLANT
WASTE CHARACTERIZATION

(Attach available documentation such as analyses, laboratory test results, inventories, manifests, etc. Enter NA when not available.)

1. Waste Name: _____

2. Process (or Event) Generating the Waste: _____

_____3. Amount Generated (kg or gal per month): _____

4. Description of Waste Handling:

A. Storage (include temporary) ☐

(1) Total Amount (kg or gal): _____

(2) Type: vessel ☐ amount (kg or gal): _____sump ☐ amount (kg or gal): _____drum ☐ amount (kg or gal): _____

other: _____ amount (kg or gal): _____

(3) Drums Stored Longer Than 90 Days ☐(4) Sludge Formed or Solids Settled ☐B. Treatment ☐

(1) Amount (kg or gal per month): _____

(2) Brief Description: _____

_____(3) Sludge Formed or Solids Settled ☐(4) Oils Separated ☐

C. Disposal ☐

(1) Amount (containers per month): _____

(2) Disposal Site(s): _____

_____(3) EPA Approved Chemical Waste Landfill Facility ☐(4) Sanitary Landfill Facility ☐(5) Transporter(s): _____

_____(6) DOT "Hazardous Material" Pursuant To Hazardous Materials
Transportation Act (see 49CFR 172.101 and 173) ☐Describe: _____

5. General Waste Composition and Properties:

A. Contains Organic Component(s) ☐B. Contains Inorganic Component(s) ☐C. Contains Polynuclear Aromatic Hydrocarbons (PNAs), Tar Acids, Tar
Bases, and/or Coal Tar Distillates ☐Describe and/or Quantify: _____

_____D. Wastewater ☐E. Phases: One ☐ Multiple ☐

F. Physical State At 70°F and 760 mmHg:

Solid ☐ Powder ☐ Semi-Solid or Sludge ☐Liquid ☐ Gas ☐

G. pH: _____

H. Specific Gravity [or Specific Weight (lb per unit)]: _____

I. Flash Point: _____ °F closed cup ☐ open cup ☐

J. Vapor Pressure (mmHg at 70°F): _____

K. Sulfide Content as: _____ %

L. Ash Content: _____ %

M. Energy Content (Btu per lb or gal): _____

N. Solids Content (Total): _____ %

6. Description of Hazardous Properties of Waste As Required By the Resource Conservation and Recovery Act (RCRA):

A. Hazardous Waste From Non-Specific Source ☐

Describe (Enter Four-Digit Number(s) From 40CFR Part 261.31):

B. Hazardous Waste From Specific Source ☐

Describe (Enter Four-Digit Number(s) From 40CFR Part 261.32):

C. Commercial Chemical Product Hazardous Waste ☐

Describe (Enter Four-Digit Number(s) From 40CFR Part 261.33):

D. Characteristics of Non-Listed Hazardous Waste (From 40CFR Subpart C):

Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic ☐

Describe (Laboratory Test Results, Analyses, Observations, etc.):

Please print or type with ELITE type (12 characters/inch) in the unshaded areas only.

Form Approved OMB No. 158-S79016
GSA No. 0246-EPA-OT

U.S. ENVIRONMENTAL PROTECTION AGENCY NOTIFICATION OF HAZARDOUS WASTE ACTIVITY		INSTRUCTIONS: If you received a preprinted label, affix it in the space at left. If any of the information on the label is incorrect, draw a line through it and supply the correct information in the appropriate section below. If the label is complete and correct, leave Items I, II, and III below blank. If you did not receive a preprinted label, complete all items. "Installation" means a single site where hazardous waste is generated, treated, stored and/or disposed of, or a transporter's principal place of business. Please refer to the INSTRUCTIONS FOR FILING NOTIFICATION before completing this form. The information requested herein is required by law (Section 3010 of the Resource Conservation and Recovery Act).																
INSTALLATION'S EPA I.D. NO. I. NAME OF INSTALLATION II. INSTALLATION MAILING ADDRESS III. LOCATION OF INSTALLATION	ALD063687016 CATALYTIC INC PO BOX 239 WILSONVILLE, AL 35186 HWY 25 N WILSONVILLE, AL 35186																	
FOR OFFICIAL USE ONLY																		
COMMENTS <div style="border: 1px solid black; height: 20px; width: 100%;"></div>																		
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 40%;">INSTALLATION'S EPA I.D. NUMBER</th> <th style="width: 10%;">APPROVED</th> <th style="width: 50%;">DATE RECEIVED (yr., mo., & day)</th> </tr> <tr> <td style="text-align: center;"> <div style="border: 1px solid black; display: inline-block; padding: 2px;"> 1 1 </div> </td> <td></td> <td></td> </tr> </table>			INSTALLATION'S EPA I.D. NUMBER	APPROVED	DATE RECEIVED (yr., mo., & day)	<div style="border: 1px solid black; display: inline-block; padding: 2px;"> 1 1 </div>												
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I. NAME OF INSTALLATION CATALYTIC INC - SRC PILOT PLANT																		
II. INSTALLATION MAILING ADDRESS <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2" style="text-align: left;">STREET OR P.O. BOX</th> <th style="width: 10%;">ST.</th> <th style="width: 20%;">ZIP CODE</th> </tr> <tr> <td colspan="2">PO DRAWER 239</td> <td></td> <td>35186</td> </tr> <tr> <th colspan="2" style="text-align: left;">CITY OR TOWN</th> <th>ST.</th> <th>ZIP CODE</th> </tr> <tr> <td colspan="2">WILSONVILLE ALABAMA</td> <td></td> <td>35186</td> </tr> </table>			STREET OR P.O. BOX		ST.	ZIP CODE	PO DRAWER 239			35186	CITY OR TOWN		ST.	ZIP CODE	WILSONVILLE ALABAMA			35186
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VI. TYPE OF HAZARDOUS WASTE ACTIVITY (enter "X" in the appropriate box(es)) <table style="width: 100%;"> <tr> <td>☒ A. GENERATION</td> <td>☐ B. TRANSPORTATION (complete item VII)</td> </tr> <tr> <td>☒ C. TREAT/STORE/DISPOSE</td> <td>☐ D. UNDERGROUND INJECTION</td> </tr> </table>			☒ A. GENERATION	☐ B. TRANSPORTATION (complete item VII)	☒ C. TREAT/STORE/DISPOSE	☐ D. UNDERGROUND INJECTION												
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VII. MODE OF TRANSPORTATION (transporters only - enter "X" in the appropriate box(es)) <table style="width: 100%;"> <tr> <td>☐ A. AIR</td> <td>☐ B. RAIL</td> <td>☐ C. HIGHWAY</td> <td>☐ D. WATER</td> <td>☐ E. OTHER (specify):</td> </tr> </table>			☐ A. AIR	☐ B. RAIL	☐ C. HIGHWAY	☐ D. WATER	☐ E. OTHER (specify):											
☐ A. AIR	☐ B. RAIL	☐ C. HIGHWAY	☐ D. WATER	☐ E. OTHER (specify):														
VIII. FIRST OR SUBSEQUENT NOTIFICATION Mark "X" in the appropriate box to indicate whether this is your installation's first notification of hazardous waste activity or a subsequent notification. If this is not your first notification, enter your installation's EPA I.D. Number in the space provided below. <table style="width: 100%;"> <tr> <td>☒ A. FIRST NOTIFICATION</td> <td>☐ B. SUBSEQUENT NOTIFICATION (complete item C)</td> </tr> </table>			☒ A. FIRST NOTIFICATION	☐ B. SUBSEQUENT NOTIFICATION (complete item C)														
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IX. DESCRIPTION OF HAZARDOUS WASTES Please go to the reverse of this form and provide the requested information.																		
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I.D. - FOR OFFICIAL USE ONLY									
1	2	3	4	5	6	7	8	9	10
W									

IX. DESCRIPTION OF HAZARDOUS WASTES (continued from front)

A. HAZARDOUS WASTES FROM NON-SPECIFIC SOURCES. Enter the four-digit number from 40 CFR Part 261.31 for each listed hazardous waste from non-specific sources your installation handles. Use additional sheets if necessary.

1 F 0 0 1 23 - 26	2 F 0 0 3 23 - 26	3 F 0 0 4 23 - 26	4 F 0 0 5 23 - 26	5 23 - 26	6 23 - 26
7 23 - 26	8 23 - 26	9 23 - 26	10 23 - 26	11 23 - 26	12 23 - 26

B. HAZARDOUS WASTES FROM SPECIFIC SOURCES. Enter the four-digit number from 40 CFR Part 261.32 for each listed hazardous waste from specific industrial sources your installation handles. Use additional sheets if necessary.

13 23 - 26	14 23 - 26	15 23 - 26	16 23 - 26	17 23 - 26	18 23 - 26
19 23 - 26	20 23 - 26	21 23 - 26	22 23 - 26	23 23 - 26	24 23 - 26
25 23 - 26	26 23 - 26	27 23 - 26	28 23 - 26	29 23 - 26	30 23 - 26

C. COMMERCIAL CHEMICAL PRODUCT HAZARDOUS WASTES. Enter the four-digit number from 40 CFR Part 261.33 for each chemical substance your installation handles which may be a hazardous waste. Use additional sheets if necessary.

31 23 - 26	32 23 - 26	33 23 - 26	34 23 - 26	35 23 - 26	36 23 - 26
37 23 - 26	38 23 - 26	39 23 - 26	40 23 - 26	41 23 - 26	42 23 - 26
43 23 - 26	44 23 - 26	45 23 - 26	46 23 - 26	47 23 - 26	48 23 - 26

D. LISTED INFECTIOUS WASTES. Enter the four-digit number from 40 CFR Part 261.34 for each listed hazardous waste from hospitals, veterinary hospitals, medical and research laboratories your installation handles. Use additional sheets if necessary.

49 23 - 26	50 23 - 26	51 23 - 26	52 23 - 26	53 23 - 26	54 23 - 26
---------------	---------------	---------------	---------------	---------------	---------------

E. CHARACTERISTICS OF NON-LISTED HAZARDOUS WASTES. Mark "X" in the boxes corresponding to the characteristics of non-listed hazardous wastes your installation handles. (See 40 CFR Parts 261.21 - 261.24.)

☒ 1. IGNITABLE
(D001)

☒ 2. CORROSIVE
(D002)

☒ 3. REACTIVE
(D003)

☐ 4. TOXIC
(D000)

X. CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

SIGNATURE

NAME & OFFICIAL TITLE (type or print)

H. E. LEWIS
PLANT MANAGER

DATE SIGNED

8-14-80

A T T A C H M E N T

V. OWNERSHIP

A. Name of Installation's Legal Owner

1. Kerr-McGee Corporation
2. Electric Power Research Institute
3. Southern Company Services, Inc.
4. Southern Electric Generating Company

Legal ownership of this installation is subject to property rights provisions of contracts, agreements and leases executed by the parties designated in Items I and V of this notification.

Print in the designated areas only.
Fill-in areas are spaced for elite type, i.e., 12 characters/inch.

Form Approved OMB No. 158-R0175

FORM 1 GENERAL		U.S. ENVIRONMENTAL PROTECTION AGENCY GENERAL INFORMATION Consolidated Permits Program (Read the "General Instructions" before starting.)		I. EPA I.D. NUMBER
F A L D 0 6 3 6 8 7 0 1 6 D	
II. POLLUTANT CHARACTERISTICS INSTRUCTIONS: Complete A through J to determine whether you need to submit any permit application forms to the EPA. If you answer "yes" to any questions, you must submit this form and the supplemental form listed in the parenthesis following the question. Mark "X" in the box in the third column. If the supplemental form is attached. If you answer "no" to each question, you need not submit any of these forms. You may answer "no" if your activity is excluded from permit requirements; see Section C of the instructions. See also, Section D of the instructions for definitions of bold-faced terms.		III. NAME OF FACILITY 1 SKIP SRC PILOT PLANT		IV. FACILITY CONTACT A. NAME & TITLE (last, first, & title) 2 LEWIS HARRY E. PLANT MANAGER B. PHONE (area code & no.) 205 669 6747	
V. FACILITY MAILING ADDRESS A. STREET OR P.O. BOX 3 P.O. DRAWER 239 B. CITY OR TOWN 4 WILSONVILLE C. STATE AL D. ZIP CODE 35186		VI. FACILITY LOCATION A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER 5 HIGHWAY 25 NORTH B. COUNTY NAME SHELBY C. CITY OR TOWN 6 WILSONVILLE D. STATE AL E. ZIP CODE 35186 F. COUNTY CODE (if known)		GENERAL INSTRUCTIONS If a preprinted label has been provided, affix it in the designated space. Review the information carefully; if any of it is incorrect, cross through it and enter the correct data in the appropriate fill-in area below. Also, if any of the preprinted data is absent (the area to the left of the label space lists the information that should appear), please provide it in the proper fill-in area(s) below. If the label is complete and correct, you need not complete items I, III, V, and VI (except VI-8 which must be completed regardless). Complete all items if no label has been provided. Refer to the instructions for detailed item descriptions and for the legal authorizations under which this data is collected.	

EPA Form 3510-1 (6-80)

CONTINUE ON REVER.

CONTINUED FROM THE FRONT

VII. SIC CODES (4-digit, in order of priority)									
A. FIRST					B. SECOND				
7	2	9	9	9	(specify)	7		(specify)	
Product of petroleum and coal (nec. refer to XII below)					N/A				
C. THIRD					D. FOURTH				
7					(specify)	7		(specify)	
N/A					N/A				
VIII. OPERATOR INFORMATION									
A. NAME									
8	CATALYTIC, INC.								
B. Is the name listed in Item VIII-A also the owner?									
☐ YES ☒ NO									
C. STATUS OF OPERATOR (Enter the appropriate letter into the answer box; if "Other", specify.)									
F - FEDERAL	M - PUBLIC (other than federal or state)	P	(specify)						
S - STATE	O - OTHER (specify)								
P - PRIVATE									
D. PHONE (area code & no.)									
E. STREET OR P.O. BOX									
P.O. DRAWER 239									
F. CITY OR TOWN									
WILSONVILLE									
G. STATE									
AL									
H. ZIP CODE									
35186									
IX. INDIAN LAND									
Is the facility located on Indian lands?									
☐ YES ☒ NO									
X. EXISTING ENVIRONMENTAL PERMITS									
A. NPDES (Discharges to Surface Water)					D. PSD (Air Emissions from Proposed Sources)				
9	N				9	P			
AL 0.0.2.6.0.2.6.					N/A				
B. UIC (Underground Injection of Fluids)					E. OTHER (specify)				
9	U				9				
N/A					4-1.1-0.0.2.3-2.0.0.1				
(specify)					Alabama Air Pollution Control Commission--Flare				
C. RCRA (Hazardous Wastes)					E. OTHER (specify)				
9	R				9				
N/A					N/A				
(specify)									
XI. MAP									
Attach to this application a topographic map of the area extending to at least one mile beyond property boundaries. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers and other surface water bodies in the map area. See instructions for precise requirements.									
XII. NATURE OF BUSINESS (provide a brief description)									
The SRC Pilot Plant is used to obtain research information on the conversion of coal to clean burning solids and liquids.									
XIII. CERTIFICATION (see instructions)									
I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.									
A. NAME & OFFICIAL TITLE (type or print)					B. SIGNATURE			C. DATE SIGNED	
L. C. Knox Vice President and Chief Engineer								28 October 1980	
COMMENTS FOR OFFICIAL USE ONLY									

Please print or type in the unshaded areas only
 (4 1/4-in. areas are spaced for elite type, i.e., 12 characters/inch).

Form Approved OMB No. 158-S80004

 HAZARDOUS WASTE PERMIT APPLICATION Consolidated Permits Program (This information is required under Section 3005 of RCRA.)		1. EPA I.D. NUMBER <div style="border: 1px solid black; padding: 2px; display: flex; justify-content: space-between;"> F A L D 0 6 3 6 8 7 0 1 6 1 </div>					
FOR OFFICIAL USE ONLY							
APPLICATION APPROVED <div style="border: 1px solid black; width: 100px; height: 20px; margin-top: 5px;"></div>		DATE RECEIVED (yr., mo., & day) <div style="border: 1px solid black; width: 100px; height: 20px; margin-top: 5px;"></div>					
II. FIRST OR REVISED APPLICATION							
Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA I.D. Number, or if this is a revised application, enter your facility's EPA I.D. Number in Item I above.							
A. FIRST APPLICATION (place an "X" below and provide the appropriate date) ☒ 1. EXISTING FACILITY (See instructions for definition of "existing" facility. Complete item below.) <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div style="width: 45%;"> <div style="border: 1px solid black; padding: 2px; display: flex; justify-content: space-between;"> YR. MO. DAY </div> <div style="display: flex; justify-content: space-between;"> 74 01 15 </div> </div> <div style="width: 50%;"> FOR EXISTING FACILITIES, PROVIDE THE DATE (yr., mo., & day) OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED (use the boxes to the left) </div> </div>		☐ 2. NEW FACILITY (Complete item below.) FOR NEW FACILITIES, PROVIDE THE DATE (yr., mo., & day) OPERATION BEGAN OR IS EXPECTED TO BEGIN <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div style="width: 45%;"> <div style="border: 1px solid black; padding: 2px; display: flex; justify-content: space-between;"> YR. MO. DAY </div> <div style="display: flex; justify-content: space-between;"> 73 74 75 </div> </div> <div style="width: 50%;"> </div> </div>					
☐ 1. FACILITY HAS INTERIM STATUS		☐ 2. FACILITY HAS A RCRA PERMIT					
III. PROCESSES - CODES AND DESIGN CAPACITIES							
A. PROCESS CODE - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process (including its design capacity) in the space provided on the form (Item III-C).							
B. PROCESS DESIGN CAPACITY - For each code entered in column A enter the capacity of the process.							
1. AMOUNT - Enter the amount. 2. UNIT OF MEASURE - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.							
PROCESS	PRO-CESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY	PROCESS	PRO-CESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY		
Storage:			Treatment:				
CONTAINER (barrel, drum, etc.)	S01	GALLONS OR LITERS	TANK	T01	GALLONS PER DAY OR LITERS PER DAY		
TANK	S02	GALLONS OR LITERS	SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY		
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS	INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR		
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS		T04	GALLONS PER DAY OR LITERS PER DAY		
Disposal:			OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Item III-C.)				
INJECTION WELL	D79	GALLONS OR LITERS					
LANDFILL	D80	ACRE-FEET (the volume that would cover one acre to a depth of one foot) OR HECTARE-METER					
LAND APPLICATION	D81	ACRES OR HECTARES					
OCEAN DISPOSAL	D82	GALLONS PER DAY OR LITERS PER DAY					
SURFACE IMPOUNDMENT	D83	GALLONS OR LITERS					
UNIT OF MEASURE	UNIT OF MEASURE CODE	UNIT OF MEASURE	UNIT OF MEASURE CODE	UNIT OF MEASURE	UNIT OF MEASURE CODE		
GALLONS.....	G	LITERS PER DAY.....	V	ACRE-FEET.....	A		
LITERS.....	L	TONS PER HOUR.....	D	HECTARE-METER.....	F		
CUBIC YARDS.....	Y	METRIC TONS PER HOUR.....	W	ACRES.....	B		
CUBIC METERS.....	C	GALLONS PER HOUR.....	E	HECTARES.....	Q		
GALLONS PER DAY.....	U	LITERS PER HOUR.....	H				
LINE NUMBER	A. PRO-CESS CODE (from list above)	B. PROCESS DESIGN CAPACITY	FOR OFFICIAL USE ONLY	LINE NUMBER	A. PRO-CESS CODE (from list above)	B. PROCESS DESIGN CAPACITY	FOR OFFICIAL USE ONLY
		1. AMOUNT (specify)				1. AMOUNT	
X-1	S02	600		5	T01	28,800	
X-2	T03	20		6			
1	S01	8,250		7			
2	S02	144,000		8			
3	T01	30,000		9			
4	T01	23,000		10			

Continued from the front.

III. PROCESSES (continued)**C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESSES (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.**

T04	18	U Liquid Waste Oil Skimmer
T04	24	U Sludge Dryer

IV. DESCRIPTION OF HAZARDOUS WASTES**A. EPA HAZARDOUS WASTE NUMBER** — Enter the four-digit number from 40 CFR, Subpart D for each listed hazardous waste you will handle. If you handle hazardous wastes which are not listed in 40 CFR, Subpart D, enter the four-digit number(s) from 40 CFR, Subpart C that describes the characteristics and/or the toxic contaminants of those hazardous wastes.**B. ESTIMATED ANNUAL QUANTITY** — For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.**C. UNIT OF MEASURE** — For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS.....	P	KILOGRAMS.....	K
TONS.....	T	METRIC TONS.....	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES**1. PROCESS CODES:**

For listed hazardous waste: For each listed hazardous waste entered in column A select the code(s) from the list of process codes contained in Item III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed hazardous wastes: For each characteristic or toxic contaminant entered in column A, select the code(s) from the list of process codes contained in Item III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed hazardous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.**NOTE: HAZARDOUS WASTES DESCRIBED BY MORE THAN ONE EPA HAZARDOUS WASTE NUMBER** — Hazardous wastes that can be described by more than one EPA Hazardous Waste Number shall be described on the form as follows:

1. Select one of the EPA Hazardous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other EPA Hazardous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other EPA Hazardous Waste Number that can be used to describe the hazardous waste.

EXAMPLE FOR COMPLETING ITEM IV (shown in line numbers X-1, X-2, X-3, and X-4 below) — A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

W Z O JZ	A. EPA HAZARD. WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEA- SURE (enter code)	D. PROCESSES	
				1. PROCESS CODES (enter)	2. PROCESS DESCRIPTION (if a code is not entered in D(1))
X-1	K 0 5 4	900	P	T 0 3 D 8 0	
X-2	D 0 0 2	400	P	T 0 3 D 8 0	
X-3	D 0 0 1	100	P	T 0 3 D 8 0	
X-4	D 0 0 2				included with above

EXHIBIT C3 (continued).

(continued from page 2.)

NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

Form Approved OMB No. 159-S90004

EPA I.D. NUMBER (enter from page 1)										FOR OFFICIAL USE ONLY									
W A L D 0 6 3 6 8 7 0 1 6 1										W DUP 2 DUP									
IV. DESCRIPTION OF HAZARDOUS WASTES (continued)										D. PROCESSES									
LINE NO.	A. EPA HAZARD. WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	1. PROCESS CODES (enter)								2. PROCESS DESCRIPTION (if a code is not entered in D(1))							
				27	28	29	30	31	32	33	34	35	36	37	38				
1	F 0 0 1	62	T	S	0	2													
2	F 0 0 3																included with above		
3	F 0 0 4																included with above		
4	F 0 0 5																included with above		
5	F 0 0 1	22,000	T	S	0	2	T	0	1	T	0	4							
6	F 0 0 3																included with above		
7	F 0 0 4																included with above		
8	F 0 0 5																included with above		
9	F 0 0 1	20,000	P	S	0	1	S	0	2										
10	F 0 0 3																included with above		
11	F 0 0 4																included with above		
12	F 0 0 5																included with above		
13	D 0 0 2	17,000	T	S	0	2	T	0	1										
14	D 0 0 3																included with above		
15	D 0 0 2	14,000	P	S	0	1	S	0	2										
16	D 0 0 3																included with above		
17	F 0 0 1	6,000	P	S	0	1	S	0	2										
18	F 0 0 3																included with above		
19	F 0 0 4																included with above		
20	F 0 0 5																included with above		
21	F 0 0 1	95,000	P	S	0	1	T	0	4										
22	F 0 0 3																included with above		
23	F 0 0 4																included with above		
24	F 0 0 5																included with above		
25	F 0 0 1	13,000	P	S	0	1													
26	F 0 0 3																included with above		

EPA Form 3510-3 (6-80)

CONTINUE ON REVERSE

PAGE 3 A OF 5

(enter "A", "B", "C", etc. behind the "3" to identify photocopied pages)

IV. DESCRIPTION OF HAZARDOUS WASTES (continued)																																					
E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM ITEM D(1) ON PAGE 3.																																					
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="10" style="text-align: center;">EPA I.D. NO. (enter from page 1)</td> </tr> <tr> <td style="width: 20px;">F</td> <td style="width: 20px;">A</td> <td style="width: 20px;">L</td> <td style="width: 20px;">D</td> <td style="width: 20px;">0</td> <td style="width: 20px;">6</td> <td style="width: 20px;">3</td> <td style="width: 20px;">6</td> <td style="width: 20px;">8</td> <td style="width: 20px;">7</td> <td style="width: 20px;">0</td> <td style="width: 20px;">1</td> <td style="width: 20px;">6</td> <td style="width: 20px;">6</td> </tr> </table>										EPA I.D. NO. (enter from page 1)										F	A	L	D	0	6	3	6	8	7	0	1	6	6				
EPA I.D. NO. (enter from page 1)																																					
F	A	L	D	0	6	3	6	8	7	0	1	6	6																								
V. FACILITY DRAWING																																					
All existing facilities must include in the space provided on page 5 a scale drawing of the facility (see instructions for more detail).																																					
VI. PHOTOGRAPHS																																					
All existing facilities must include photographs (aerial or ground-level) that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas (see instructions for more detail).																																					
VII. FACILITY GEOGRAPHIC LOCATION																																					
LATITUDE (degrees, minutes, & seconds)					LONGITUDE (degrees, minutes, & seconds)																																
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20px;">3</td> <td style="width: 20px;">3</td> <td style="width: 20px;">1</td> <td style="width: 20px;">4</td> <td style="width: 20px;">0</td> <td style="width: 20px;">4</td> <td style="width: 20px;">1</td> </tr> </table>					3	3	1	4	0	4	1	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20px;">8</td> <td style="width: 20px;">6</td> <td style="width: 20px;">2</td> <td style="width: 20px;">8</td> <td style="width: 20px;">0</td> <td style="width: 20px;">0</td> <td style="width: 20px;">0</td> </tr> </table>					8	6	2	8	0	0	0														
3	3	1	4	0	4	1																															
8	6	2	8	0	0	0																															
VIII. FACILITY OWNER																																					
☐ A. If the facility owner is also the facility operator as listed in Section VIII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.																																					
☐ B. If the facility owner is not the facility operator as listed in Section VIII on Form 1, complete the following items:																																					
1. NAME OF FACILITY'S LEGAL OWNER					2. PHONE NO. (area code & no.)																																
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20px;">E</td> <td style="width: 20px;">F</td> <td colspan="8">Attached.</td> </tr> </table>					E	F	Attached.								<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20px;">99</td> <td style="width: 20px;">98</td> <td style="width: 20px;">97</td> <td style="width: 20px;">96</td> <td style="width: 20px;">95</td> <td style="width: 20px;">94</td> <td style="width: 20px;">93</td> <td style="width: 20px;">92</td> <td style="width: 20px;">91</td> <td style="width: 20px;">90</td> </tr> </table>					99	98	97	96	95	94	93	92	91	90								
E	F	Attached.																																			
99	98	97	96	95	94	93	92	91	90																												
3. STREET OR P.O. BOX					4. CITY OR TOWN		5. ST.		6. ZIP CODE																												
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20px;">C</td> <td style="width: 20px;">F</td> <td colspan="8"></td> </tr> </table>					C	F									<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20px;">G</td> <td colspan="8"></td> </tr> </table>		G									<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20px;">99</td> <td style="width: 20px;">98</td> <td style="width: 20px;">97</td> <td style="width: 20px;">96</td> <td style="width: 20px;">95</td> <td style="width: 20px;">94</td> <td style="width: 20px;">93</td> <td style="width: 20px;">92</td> <td style="width: 20px;">91</td> <td style="width: 20px;">90</td> </tr> </table>		99	98	97	96	95	94	93	92	91	90
C	F																																				
G																																					
99	98	97	96	95	94	93	92	91	90																												
IX. OWNER CERTIFICATION																																					
I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.																																					
A. NAME (print or type)					B. SIGNATURE			C. DATE SIGNED																													
X. OPERATOR CERTIFICATION																																					
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A. NAME (print or type)					B. SIGNATURE			C. DATE SIGNED																													
L. C. Knox Vice President and Chief Engineer								28 October 1980																													

Continued from the front.

IV. DESCRIPTION OF HAZARDOUS WASTES (continued)**E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM ITEM D(1) ON PAGE 3.**

EPA I.D. NO. (enter from page 1)

F A L D 0 6 3 6 8 7 0 1 6 6

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility (see instructions for more detail).

VI. PHOTOGRAPHS

All existing facilities must include photographs (aerial or ground-level) that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas (see instructions for more detail).

VII. FACILITY GEOGRAPHIC LOCATION

LATITUDE (degrees, minutes, & seconds)

LONGITUDE (degrees, minutes, & seconds)

33 14 04 1

86 28 00 0

VIII. FACILITY OWNER
☐ A. If the facility owner is also the facility operator as listed in Section VIII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VIII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER

2. PHONE NO. (area code & no.)

E Attached.

3. STREET OR P.O. BOX

4. CITY OR TOWN

5. ST.

6. ZIP CODE

F

G

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME (print or type)

F. L. Clayton, Jr.
Senior Vice President - SEGC

B. SIGNATURE

F. L. Clayton Jr.

C. DATE SIGNED

11-5-80

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME (print or type)

B. SIGNATURE

C. DATE SIGNED

Continued from the front.

IV. DESCRIPTION OF HAZARDOUS WASTES (continued)**E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM ITEM D(1) ON PAGE 3.**

EPA I.D. NO. (enter from page 1)

F	A	L	D	0	6	3	6	8	7	0	1	6	6
---	---	---	---	---	---	---	---	---	---	---	---	---	---

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility (see instructions for more detail).

VI. PHOTOGRAPHS

All existing facilities must include photographs (aerial or ground-level) that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas (see instructions for more detail).

VII. FACILITY GEOGRAPHIC LOCATION

LATITUDE (degrees, minutes, & seconds)

LONGITUDE (degrees, minutes, & seconds)

3	3	1	4	0	4	1
---	---	---	---	---	---	---

8	6	2	8	0	0	0
---	---	---	---	---	---	---

VIII. FACILITY OWNER
☐ A. If the facility owner is also the facility operator as listed in Section VIII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VIII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER

2. PHONE NO. (area code & no.)

E

 Attached.

3. STREET OR P.O. BOX

4. CITY OR TOWN

5. ST.

6. ZIP CODE

C

G

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME (print or type)

S. R. Hart, Jr.
Vice President-Research & Dev.

B. SIGNATURE

C. DATE SIGNED

11-13-80

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME (print or type)

B. SIGNATURE

C. DATE SIGNED

IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM ITEM D(1) ON PAGE 3.

EPA I.D. NO. (enter from page 1)

F A L D 0 6 3 6 8 7 0 1 6

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility (see instructions for more detail).

VI. PHOTOGRAPHS

All existing facilities must include photographs (aerial or ground-level) that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas (see instructions for more detail).

VII. FACILITY GEOGRAPHIC LOCATION

LATITUDE (degrees, minutes, & seconds)

33 14 04 1

LONGITUDE (degrees, minutes, & seconds)

86 28 00 0

VIII. FACILITY OWNER

☐ A. If the facility owner is also the facility operator as listed in Section VIII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VIII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER

2. PHONE NO. (area code & no.)

E Attached.

3. STREET OR P.O. BOX

4. CITY OR TOWN

5. ST.

6. ZIP CODE

F

G

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME (print or type)

DAVID SAXE, Vice Pres.

B. SIGNATURE

 DAVID SAXE
 Vice President
 Finance & Operations

C. DATE SIGNED

10/31/80

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME (print or type)

B. SIGNATURE

C. DATE SIGNED

Continued from page 4.

Form Approved OMB No. 158-S80004

V. FACILITY DRAWING (see page 4)

VIII. FACILITY OWNERS

Electric Power Research Institute
3412 Hillview Avenue
P. O. Box 10412
Palo Alto, California 94303

Telephone No. AC 415-855-2000

Southern Company Services, Inc.
P. O. Box 2625
Birmingham, Alabama 35202

Telephone No. AC 205-870-6011

Southern Electric Generating Company (Land Owner)
P. O. Box 2641
Birmingham, Alabama 35291

Telephone No. AC 205-250-1000

FORM 3

III. PROCESSES-CODES AND DESIGN CAPACITIES

- LINE 1: FUTURE 150 DRUM STORAGE AREA (ON CURBED, CONCRETE PAD). WILL CONTAIN SLUDGES AND SPILL RESIDUES. SCHEDULED FOR COMPLETION BY DECEMBER 19, 1980.
- LINE 2: COMBINED TANK STORAGE CAPACITY: LIQUID WASTE SUMP (WITH OIL SKIMMER)^a, WASTE CAUSTIC SUMP^a, HOLDING TANK FOR WASTE CAUSTIC^a, EQUALIZATION BASIN^a, EMERGENCY HOLDING BASIN^a, AND SLOPS TANKS (2). CONTAIN WASTE WATERS, SLUDGES, SPENT SOLVENTS, AND WASTE OILS.
- LINE 3: PRETREATMENT TANKS (2)^a IN PROCESS WASTE WATER TREATMENT SYSTEM. SULFIDES IN WASTE CAUSTIC ARE OXIDIZED; pH IS LOWERED.
- LINE 4: BIOLOGICAL REACTORS (2)^a IN PROCESS WASTE WATER TREATMENT SYSTEM. BOD AND PHENOLICS ARE REMOVED BY BIOLOGICAL OXIDATION IN AN ACTIVATED SLUDGE TREATMENT SYSTEM.
- LINE 5: VERTICAL TUBE COALESCER^a IN PROCESS WASTE WATER TREATMENT SYSTEM. OILS ARE SEPARATED FROM WASTE CAUSTIC.

IV. DESCRIPTION OF HAZARDOUS WASTES

- LINES 1-4: SLOPS TANKS MATERIALS. CONTAINS SPENT SOLVENTS FROM LABORATORY AND SEPARATED OILS FROM PROCESS WASTE WATER TREATMENT SYSTEM (HAZARDOUS WASTE MIXTURE).
- LINES 5-8: LIQUID WASTE SUMP WATER. CONTAINS SPILLS OF SPENT SOLVENTS AND A DECANTED WATER LAYER FROM SLOPS TANKS (HAZARDOUS WASTE MIXTURE).

EXHIBIT C3 (continued).

LINES 9-12: SLUDGE IN LIQUID WASTE SUMP.

LINES 13-14: WASTE CAUSTIC WATER. CONTAINS SULFIDES. HAS HIGH pH.

LINES 15-16: SLUDGES FROM STORAGE OF WASTE CAUSTIC WATER.

LINES 17-20: SLUDGE IN SLOPS TANKS.

LINES 21-24: BIOLOGICAL SLUDGE FROM PROCESS WASTE WATER TREATMENT SYSTEM.

LINES 25-28: SPILL AND CLEANUP RESIDUES.

LINES 29-32: SLUDGE FROM EQUALIZATION BASIN IN PROCESS WASTE WATER TREATMENT SYSTEM.

^a TREATMENT AND/OR STORAGE OF WASTE WATER AND/OR SLUDGE IN PROCESS WASTE WATER TREATMENT SYSTEM (NPDES PERMIT NO. AL0026026).

Date _____

Daily Inspection Report
Hazardous Waste Facilities

Inspect facilities for equipment malfunctions, pumps, meters, blowers, etc. Vessel deterioration, leaks, operator error or any type of problem that may release hazardous wastes into the environment or become a threat to human health. Check working order of waste feed cut off valves to tanks. Check for abnormal temperatures, pressure, level or other abnormal operating conditions.

CAUSTIC WASTE SUMP.

Level _____

Comments: _____

SKIMMER IN SERVICE

Yes _____ No _____

LIQUID WASTE SUMP.

Levels No. 1 _____

No. 2 _____

No. 3 _____

No. 4 _____

Comments: _____

Slop Tanks

Levels A _____ B _____

Comments: _____

CAUSTIC HEAD TANK

Level _____

Comments: _____

WASTE WATER TREATMENT

A Premix Tank _____ B Premix Tank _____

Equilization Storage Tank _____

A Aeration Basin _____ B Aeration Basin _____

Emergency Holding Basin _____

Biosludge Drying Beds _____

Vertical Tube Coalescer _____

Comments: _____

WASTE DRUM STORAGE AREA

Total No. of Drums _____

No. of Drums Stored Longer Than 90 Days _____

Comments: _____

Remedial Action: _____

Operator's Name _____

Date _____

FIRE PROTECTION**Weekly Inspection Report (Every Friday)**
For Hazardous Waste Facilities**Fire Water Storage Tank Contains 240,000 Gallons****No 1 Station:** **Ready For Use?** **If Not-Why Not?****HYDRANT:****FOAM:****WATER GUN:****HOSE:****No 2 Station:** **Ready For Use?** **If Not-Why Not?****HYDRANT:****FOAM:****WATER GUN:****HOSE:****No 3 Station:** **Ready For Use?** **If Not-Why Not?****HYDRANT:****FOAM:****WATER GUN:****HOSE:****No 4 Station:** **Ready For Use?** **If Not-Why Not?****HYDRANT:****FOAM:****WATER GUN:****HOSE:****No 5 Station:** **Ready For Use?** **If Not-Why Not?****EXTINGUISHER:****COMMENTS:** _____

_____**OPERATOR'S NAME:** _____

Table 1
SRC Unit and CSD Unit Operating Hours

<u>Run</u>	<u>With solvent and H₂, hr(a)</u>	<u>Reaction Section(c), hr</u>					<u>Vacuum column section, hr</u>	<u>Filtration section, cycles</u>	<u>CSD unit, hr</u>
		<u>5-20%(b)</u>	<u>25%(b)</u>	<u>27-35%(b)</u>	<u>38.5%(b)</u>	<u>40%(b)</u>			
218	225				204		204		134
219	312				307		309		294
220	413				399		403		389
221	500			453			464		408
222(d)	72			72			72		72
<u>Report period</u>	1,522			525	910		1,452	0	1,297
<u>Prior 1980</u>	4,760			532	3,956		4,657	325	2,972
<u>Total 1980</u>	6,282			1,057	4,866		6,109	325	4,269
<u>Total 1979</u>	6,837	26	37	71	6,188	0	6,530	605	2,882
<u>Total 1978</u>	7,207	0	0	0	6,697	0	7,002	1,102	1,495
<u>Total 1974-1977</u>	21,446	1,389	6,732	3,222	6,672	300	22,001	7,995	0
<u>Overall total to date</u>	41,772	1,415	6,769	4,350	24,423	300	41,642	10,027	8,646

(a) On-stream hours with solvent and hydrogen through B102 Slurry Preheater and R101 Dissolver.

(b) Coal slurry concentration, MF basis.

(c) On-stream hours with coal slurry and hydrogen through B102 Slurry Preheater and R101 Dissolver.

(d) December portion of run.

Table 2
Operating Data Summary for October 1980
Kentucky 9 Coal

Date, Oct 1980	Coal feed, MF lb/hr	Coal feed, hr	Slurry conc, MF coal, %	LSRC added, lb/hr	Feed Gas			Process solv, (a) % conv	B102 Preheater				outlet temp, °F	R101 Dissolver				DP Cell, %
					H ₂ %	B102 scfh	total scfh		inlet press, psig	ΔP btm, psi	ΔP mid, psi	ΔP top, psi		Temperature		Density		
													btm, °F	outlet, °F	btm, %	mid, %		
- Run 218 - Fies Coal -																		
										(b)(c)	(d)	(e)						
1	536	19	36.7	35.1	86	10,090	10,090	77.7	2,147	22(50)	14	NA	802	806	840	53	67	61
2	456	15.3	38.1	32.5	86	11,160	11,160	71.8	2,180	21(63)	17	19	794	803	841	42	60	NA
3	521	10.6	37.2	33.6	86	10,050	10,050	74.3	2,170	17(65)	NA	17	786	807	842	50	65	67
4	533	17	37.6	34.0	86	10,780	10,780	77.2	2,179	22(63)	16	16	787	809	839	41	59	58
5	534	24	37.5	34.2	85	10,940	10,940	73.0 (g)	2,196	23(62)	15	17	785	811	840	40	58	60
6	545	24	37.5	34.9	85	10,630	10,630	71.9/68.6	2,190	22(71)	16	16	788	809	841	43	56	60
7	549	24	37.3	36.5	85	10,060	10,060	77.2	2,186	25(60)	17	15	791	806	839	44	57	64
8	539	24	36.7	45.5	85	9,590	9,590	78.9	2,169	25(59)	13	15	790	805	840	47	59	67
9	536	21.7	37.2	44.7	87	7,990	7,990	77.1 (g)	2,190	23(45)	11	10	792	809	841	53(h)	64(h)	73(h)
10	536	24	36.8	45.1	86	7,860	7,860	73.0/66.3	2,150	23(47)	12	13	785	807	840	67(h)	64(h)	81(h)
- Run 219 - Fies Coal - Demo Run -																		
11	537	22.2	36.2	45.9	86	7,950	7,950	75.2	2,190	22(53)	9	14	790	807	841	54	63	71
12	491	23.6	37.1	41.1	85	7,880	7,880	78.1	2,190	21(57)	NA	14	789	807	841	65	64	71
13	518	24	36.8	43.6	86	7,990	7,990	77.3 (g)	2,190	24(48)	11	12	787	806	840	63	64	71
14	524	24	36.2	44.8	85	7,870	7,870	76.1/67.7	2,190	23(59)	13	15	786	807	841	60	65	71
15	569	24	36.4	48.5	85	7,840	7,840	76.7 (g)	2,187	24(59)	14	18	785	808	840	52	64	71
16	524	24	35.9	45.3	86	7,890	7,890	78.5/69.0	2,185	21(57)	12	19	782	805	840	52	63	72
17	541	24	37.0	45.4	85	7,740	7,740	75.5	2,187	22(60)	13	17	778	803	839	53	64	73
18	544	24	37.0	45.4	85	7,808	7,808	79.7	2,182	21(58)	11	10	787	807	842	53	64	72
19	532	24	36.7	45.0	85	7,830	7,830	76.1 (g)	2,190	22(63)	12	11	786	805	841	53	54	74
20	521	24	36.2	44.6	85	7,950	7,950	73.1/68.3	2,190	24(69)	11	22	791	808	841	55	49	73
21	548	24	36.4	46.6	84	7,640	7,640	78.5	2,200	26(71)	13	17	785	804	840	55	52	71
22	555	24	37.0	46.6	85	7,790	7,790	75.8	2,200	22(75)	15	23	782	803	840	50	50	71
23	556	21.3	36.6	47.1	85	7,840	7,840	75.3	2,200	22(78)	12	22	788	897	840	51	50	71
- Run 220 - Fies Coal - Demo Run -																		
23	579	2.7	36.4	62.0	85	7,840	7,840	75.3	2,200	22(78)	12	22	788	807	840	51	50	71
24	550	24	36.4	58.9	86	7,930	7,930	79.4	2,200	25(83)	14	21	785	806	840	50	57	72
25	550	24	36.8	58.4	86	8,020	8,020	NA	2,207	26(84)	11	23	790	805	840	53	81	70
26	562	25(*)	36.5	59.9	85	7,870	7,870	79.0	2,213	23(81)	13	27	788	806	841	53	84	71
27	536	24	36.4	57.6	85	7,400	7,400	79.1	2,210	21(83)	14	26	785	804	840	52	85	71
28	547	24	36.5	58.5	85	7,900	7,900	82.7 (g)	2,210	26(90)	13	24	789	804	841	52	66	71
29	538	24	36.7	57.3	86	7,990	7,990	75.5/66.9	2,220	26(100)	13	28	785	803	840	51	60	70
30	555	24	36.5	59.2	85	7,870	7,870	79.5	2,225	26(105)	14	29	787	805	840	54	62	68
31	540	24	36.3	58.0	84	7,630	7,630	79.1	2,230	24(107)	13	29	784	804	841	54	61	68

* Change from Daylight Saving Time to Central Standard Time.

(Table continued)

Table 2 (continued)
Operating Data Summary for October 1980
Kentucky 9 Coal

Date, Oct 1980	Performance					Sulfur in V110-SRC(j), %	H ₂ con- sumed,(i) % MAF	T102 Vacuum Column		T104(k) 1t org +350°F, wt %	T102 Vacuum Column(k)			(1)	
	Coal conv, % MAF	Yield, % MAF Coal(i)		SFC	Temperature btm, top, °F °F			Press, top, psia	Tray 8, -450°F, wt %		Tray 3		Process solvent +650°F wt %	Sp Gr	
		Naphtha and middle dist.	Process solvent								Tray 3 -350°F wt %	Tray 3 +450°F wt %			
- Run 218 Fies Coal -															
1	93.0	← Coal feed 19 hrs only →			0.90	2.4	581	220	0.5	-	-	-	-	54.2	1.03
2	-	← Coal outage →			-	3.0	593	224	0.4	-	-	-	-	NA	1.02
3	92.8	← Coal outage →			0.73	2.7	574	225	0.4	-	-	-	-	45.1	1.04
4	93.6	← Coal feed 17 hrs only →			0.87	2.4	600	225	0.4	-	1.9	0.1	88.8	NA	NA
5	93.7	10.5	23.2	53.9	0.82	2.5	600	226	0.4	-	1.2	0.2	87.9	36.8	1.04
6	93.8				0.83	2.4	600	225	0.4	54.5	1.2	0.2	86.5	32.0	1.04
7	93.7				0.90	2.0	612	226	0.4	36.2	-	0.2	89.2	30.6	1.05
8	93.6	11.6	22.1	53.6	-	2.3	606	228	0.4	41.1	3.4	0.2	85.8	41.3	1.05
9	93.6				0.78	2.2	591	245	0.4	59.0	0.8	0.2	87.7	29.8	1.03
10	94.0				0.84	2.5	596	243	0.4	64.2	3.1	0.1	90.6	31.3	1.03
- Run 219 - Fies Coal -															
11	94.2	← Coal outage →			0.79	2.4	587	242	0.4	56.6	0.3	0.1	90.4	31.9	1.04
12	94.3	-	-	-	0.85	2.3	590	241	0.3	66.1	2.1	0.1	92.6	33.2	1.04
13	94.0	11.8	20.1	55.8	0.91	2.4	588	241	0.4	58.1	1.2	0.1	90.3	32.4	1.04
14	93.6				0.82	2.6	589	241	0.4	59.5	0.5	-	91.9	36.6	1.03
15	93.7				0.89	2.3	587	240	0.4	63.8	0.3	0.05	92.3	31.5	1.03
16	94.1	11.5	21.1	56.1	0.87	2.5	593	241	0.4	59.8	0.5	0.1	91.5	26.5	1.03
17	93.9				0.83	2.4	591	241	0.4	61.9	0.25	0.05	92.1	23.9	1.03
18	93.1				0.80	2.5	594	241	0.4	54.9	0.2	0.1	92.2	32.9	1.02
19	93.7	11.7	21.3	52.0	0.89	2.5	596	241	0.4	79.7	0.3	0.1	92.0	29.9	1.04
20	93.5				0.73	2.5	598	241	0.3	25.9	0.4	-	92.9	31.6	1.04
21	93.0				0.94	2.5	597	240	0.4	41.1	0.5	0.09	91.5	30.7	1.03
22	93.8	10.6	28.3	49.7	0.87	2.4	596	242	0.4	48.4	-	0.01	91.0	31.0	1.02
23	93.2				0.71	2.4	598	241	0.4	67.0	0.3	0.03	94.3	32.7	1.03
- Run 220 - Fies Coal -															
23	93.2	-	-	-	0.71	2.4	597	241	0.4	67.0	0.3	0.03	94.3	32.7	1.03
24	93.2	9.6	18.9	59.7	0.79	2.4	595	242	0.4	45.8	0.5	0.04	93.0	24.4	1.03
25	93.8				0.97	2.4	592	241	0.4	36.7	0.7	0.1	90.3	32.5	1.03
26	93.2				1.09	2.2	596	240	0.4	20.9	0.5	0.1	90.3	31.6	1.03
27	93.7	11.0	14.2	60.5	0.94	2.4	596	240	0.4	26.7	1.7	0.1	90.4	32.3	1.03
28	94.0				0.75	2.3	591	240	0.4	61.1	0.7	0.1	88.9	28.0	1.03
29	94.0				0.80	2.4	598	240	0.4	49.5	0.5	0.1	89.8	33.4	1.04
30	93.4	5.4	23.6	57.9	0.87	2.3	599	238	0.4	41.3	0.6	0.1	90.3	17.6	1.02
31	94.0				0.90	2.4	601	238	0.4	37.6	0.5	0.1	90.4	28.8	1.03

(Table continued)

Table 2 (continued)
Operating Data Summary for October 1980
Kentucky 9 Coal

- (a) From V131B, microautoclave conversion, short method.
- (b) DPR-368; data questionable. Damaged internals (bent flexure) were noted during maintenance check on 5 November 1980. Necessary repairs were made.
- (c) DPR-369. Total pressure drop, psi. Readings were 5% higher during calibration check on 7 November 1980. Necessary corrections were made.
- (d) DPR-370; data questionable. Coke/ash buildup around capsule was noted during maintenance check on 5 November 1980. Necessary repairs were made.
- (e) DPR-371; data okay as per maintenance check on 5 November 1980.
- (f) DPR-402-4; the high pressure tap near the distributor and the low pressure tap at the top of the dissolver (near the 100% outlet). Transmitter ranges set to read 0.5 average specific gravity at 0% reading and 0.9 specific gravity at 100% reading. Sp. gr. at X% reading = $0.5 + 0.004X$.
- (g) From V131B, microautoclave conversion, long method.
- (h) The solids withdrawal system on the dissolver plugged at 1710 hr on 9 October and was returned to service at 1535 hr on 10 October. The bottom density gauge reading increased from 56% @ 1600 hr on 9 October to about 79% @ 1500 hr on 10 October; the reading dropped to 54% @ 1800 hr on 10 October after the solids withdrawal system became operational. The middle density gauge readings did not change appreciably over this period.

The DP cell reading similarly increased from about 64% to 88% for the period when the solids withdrawal system was not in service. The reading dropped to 73% @ 1800 hr on 10 October.
- (i) Process material balance method. Product ash, unreacted coal, and solvent-free SRC (distillation @ 600°F and 0.1 mm Hg) based upon T102 bottoms rate and analyses. Product distillate is estimated from the V110 Flash Tank rate. Gas flow rates are based upon on-line H₂ analyzers and total acid gases estimated from empirical correlations.
- (j) SRC obtained from lab-workup of V110 Flash Tank sample; SRC and distillate separated by vacuum distillation in a flask @ 600°F and 0.1 mm Hg.
- (k) Analysis by GC.
- (l) From V131B.

Table 3
Operating Data Summary for November 1980
Kentucky 9 Coal

Date, Nov 1980	Coal feed, MF lb/hr	Coal feed, hr	Slurry conc, MF coal, %	LSRC added, lb/hr	Feed Gas			Process solv, (a) % conv	B102 Preheater					Temperature		Density		DP Cell, (f) %
					H ₂ %	to B102 scfh	total scfh		inlet press, psig	ΔP btm, psi	ΔP mid, psi	ΔP top, psi	outlet temp, °F	btm, °F	outlet, °F	btm, %	mid, %	
Run 220 - Fies Coal																		
										(b)	(c)	(d)	(e)					
1	553	24	36.8	58.5	85	7,880	7,880	NA	2,240	21(107)	17	>30	783	805	841	48	65	69
2	559	24	36.5	59.8	84	7,600	7,600	NA	(g) 2,240	23(107)	14	29	779	803	841	51	66	73
3	549	24	36.6	58.5	84	7,720	7,720	77.8(67.6)	2,236	28(107)	14	>30	782	805	841	53	67	75
4	550	24	36.5	58.8	85	7,780	7,780	79.4	2,236	29(109)	15	0	783	805	840	51	65	82(h)
5	552	24	36.5	59.0	84	7,770	7,770	78.4	2,240	23(113)	14	29	782	804	841	54	66	93(h)
6	540	21.2	36.3	58.0	85	7,700	7,770	79.0	2,213	23(95)	15	24	781	803	840	52	66	100(h)
7	542	24	36.5	57.9	85	7,800	7,800	81.0	(g) 2,210	28(80)	(i) 10	24	796	807	840	57	62	100(h)
8	542	24	35.9	58.9	85	7,640	7,640	70.4(66.6)	2,200	25(83)	(i) 11	23	796	805	840	57	69	100(h)
9	535	14.3	35.5	58.7	85	7,680	7,680	77.0	2,200	29(78)	(i) 6	21	841(j)	807	838	63	69	100(h)

(Table continued)

Table 3 (continued)
Operating Data Summary for November 1980
Kentucky 9 Coal

Date, Nov 1980	Coal conv, % MAF	Performance Yield, % MAF coal(k)			Sulfur(1) V110 SRC, wt %	H ₂ con-(k) sumed, % MAF	T102 Vacuum Column		T104(m) 1t org +350°F, wt %	T102 Vacuum Column			Process solvent(n)				
		Distillate		SRC			Temperature			Press, top, psia	Tray 8 -450°F, wt %	Tray 3		+650°F wt %	Sp Gr		
		Naphtha middle dist.	Process solvent				btm, °F	top, °F				-350°F, wt %	+450°F, wt %				
1	93.2	9.5	22.7	56.6	0.72	2.4	600	239	0.4	NA	NA	0.1	90.1	39.7	1.03		
2	93.6	7.4	22.5	57.7	1.17	2.4	602	239	0.4	NA	NA	NA	NA	NA	1.03		
3	93.8	7.6	21.2	57.3	0.78	2.4	599	240	0.4	54.6	NA	NA	NA	35.2	1.03		
4	93.7	9.5	29.0	49.7	0.80	2.4	598	241	0.4	33.0	1.0	0.06	89.1	33.0	1.03		
5	93.6	7.7	23.0	55.8	0.94	2.5	598	239	0.4	19.1	0.6	0.2	90.5	38.2	1.03		
6	94.2	← coal outage →			0.91	2.5	596	242	0.4	62.1	1.3	0.3	85.0	30.4	1.03		
7	94.1	9.7(o)	17.3(o)	56.3(o)	0.87	2.5	597	247	0.4	41.4	0.9	0.1	88.9	54.8	1.03		
8	94.0				0.90	2.4	599	245	0.4	60.4	0.7	0.08	93.2	(o,p)	1.05		
9	NA				7.8(o)	17.8(o)	57.8(o)	NA	2.4	601	245	0.4	72.6	0.2	0.02	94.2	50.6 (o,p)

- (a) From V131B, microautoclave conversion, short method.
 (b) DPR-368; data questionable. Damaged internals (bent flexure) were noted during maintenance check on 5 November 1980. Necessary repairs were made.
 (c) DPR-369. Total pressure drop, psi. Readings were 5% higher during calibration check on 7 November 1980. Necessary corrections were made.
 (d) DPR-370; data questionable. Coke/ash buildup around capsule was noted during maintenance check on 5 November 1980. Necessary repairs were made.
 (e) DPR-371; data okay per maintenance check on 5 November 1980.
 (f) DPR-402-4; the high pressure tap near the distributor and the low pressure tap at the top of the dissolver (near the 100% outlet). Transmitter ranges set to read 0.5 average specific gravity at 0% reading and 0.9 specific gravity at 100% reading. Sp. gr. at X% reading = $0.5 + 0.004X$.
 (g) From V131B, microautoclave conversion, long method.
 (h) Data questionable.
 (i) Coal outage on 6 November, following which the front end was on solvent/hydrogen for some time. The overall pressure drop, as indicated by DPR-369, decreased from about 113 psi on 5 November to about 80 psi on 7-9 November. B102 inlet pressure also decreased from about 2,240 psig on 5 November to about 2,200 psig on 7-9 November.
 (j) B102 Slurry Preheater outlet temperature increased from 791°F at 2200 hr on 8 November to 822°F at 0001 hr on 9 November. The temperature steadily increased to about 850°F at 1200 hr on 9 November.
 (k) Process material balance method. Product ash, unreacted coal, and solvent-free SRC (distillation at 600°F and 0.1 mm Hg) based upon T102 bottoms rate and analyses. Product distillate is estimated from the V110 Flash Tank rate. Gas flow rates are based upon on-line H₂ analyzers and total acid gases estimated from empirical correlations.
 (l) SRC obtained from lab workup of V110 Flash Tank sample; SRC and distillate separated by vacuum distillation in a flask at 500°F and 0.1 mm Hg.
 (m) Analysis by GC.
 (n) Sample from V131B tank. The sample is distilled in a flask at 600°F and 0.1 mm Hg and the distillate is analyzed by GC. The residue is reported as a part of material + 650°F.
 (o) Run 220D MB: 1200 hr on 7 November to 1200 hr on 8 November; Run 220E MB: 1200 hr on 8 November to 1200 hr on 9 November.
 (p) On 8 November, during Run 220D MB, the bypass line from V138 tank (receives solvent from tray 3 of T102 Vacuum Column) to V124B tank (receives solvent from V170 tank, which, in turn, receives mostly naphtha and middle distillate range distillates from T104 Light Solvent Recovery Column) was found partially open. During Run 220, the solvent from V138 tank was being sent to V131B process solvent tank only. The bypass line to V124B was closed before the start of Run 220E MB. Process solvent (+450°F solvent) content of V124B material was 28.3% on 5 November and about 40% at the end of Run 220E MB. The total inventory in V124B was about 50,000 lbs on 5 November and 61,700 lbs on 9 November.

Table 4
Operating Data Summary for December 1980
Kentucky 9 Coal

Date, Dec 1980	Coal feed, MF lb/hr	Coal feed, hr	Slurry conc, MF coal, %	LSRC added, lb/hr	Process Solvent														
					Feed Gas			% conv.		B102 Preheater					R101 Dissolver				
					H ₂	to	total	V101B(a)	V131A(b)	inlet press, psig	ΔP btm, psi	ΔP mid, psi	ΔP top, psi	outlet temp, °F	Temperature		Density		DP Cell(e) %
					%	B102 scfh	scfh								btm, °F	outlet, °F	btm, %	mid, %	
-Run 221 - Fies Coal																			
9	384	11.2	32.9	230	88	8,270	8,270	-	72.6	2,020	16	2	1.6	798	773	797	84	96	92(f)
10	321	19.6	33.4	192	93	3,820	3,820	-	77.4	2,041	14	3	1.9	770	746	773	67	51	96(f)
11	333	24	32.6	200	91	3,770	3,770	-	79.2/67.2(d)	2,045	20	2	1.5	799	750	773	63	52	96(f)
12	302	24	30.8	184	91	3,630	3,630	85.4	82.3	2,037	14	2	1.5	793	754	773	62	53	93(f)
13	324	19.6	30.8	192	91	4,000	4,000	84.2	81.7	2,041	14	3	1.5	788	750	769	61	48	89(f)
14	320	24	31.3	189	91	3,620	3,620	77.6	70.8	2,048	13	2	1.6	792	754	774	61	49	92(f)
15	341	23.2	33.3	204	91	3,680	3,680	-	76.4	2,050	14	4	1.4	779	751	772	65	55	97(f)
16	345	24	32.3	207	91	3,700	3,700	85.9	72.8	2,050	16	5	1.5	775	751	771	65	49	100(f)
17	322	24	32.3	192	92	3,720	3,720	84.8	(c) 74.2	2,050	18	5	1.5	776	748	770	65	51	100(f)
18	331	23.7	31.9	196	90	3,650	3,650	93.4/55.1	75.3/69.5(d)	2,045	19	4	1.5	776	747	770	65	50	100(f)
19	315	24	30.5	188	91	3,660	3,660	85.6	78.1	2,044	18	3	1.5	777	746	765	64	51	100(f)
20	311	24	30.6	184	89	3,510	3,510	82.5	73.7	2,043	17	3	1.5	781	745	765	63	57	100(f)
21	314	24	30.6	187	89	3,470	3,470	-	-	2,043	17	4	1.5	776	746	768	66	66	100(f)
22	306	24	30.2	192	87	3,350	3,350	86.4	82.2	2,037	17	4	1.5	778	744	767	67	64	73
23	325	19.5	30.1	196	87	3,370	3,370	84.6	(c) 78.9	2,034	13	4	1.6	775	745	767	64	55	57
24	325	24	30.4	195	89	3,450	3,450	- /59.1	- /69.5(d)	2,050	15	4	1.6	774	744	766	66	58	51
25	326	24	31.6	197	90	3,600	3,600	-	-	2,042	16	3	1.5	782	749	770	66	56	46
26	334	24	30.6	201	87	3,350	3,350	-	-	2,030	16	3	1.5	748	749	763	66	55	47
27	333	24	30.0	201	89	3,490	3,490	85.8	75.1/68.4(d)	2,032	17	4	1.5	760	745	770	67	57	52
28	322	24	30.0	193	89	3,490	3,490	81.3	73.3/68.1(d)	2,047	18	4	1.5	760	744	767	67	57	52
-Run 222 - Fies Coal																			
29	341	24	29.0	206	88	3,380	3,380	- /63.1(c)	- /69.8(d)	2,037	13	3	1.6	758	738	759	66	57	52
30	322	24	28.8	195	90	3,500	3,500	-	-	2,034	14	3	1.6	761	736	753	65	56	50
31	332	24	29.9	196	87	3,270	3,270	-	-	2,043	15	3	1.5	744	736	754	67	57	51

(Table continued)

Table 4 (continued)
Operating Data Summary for December 1980
Kentucky 9 Coal

Performance																
Date, Dec 1980	Yield, % MAF coal ^(g)					Sulfur in V110-SRC ^(h) %	H ₂ Con- sumed, (g) % MAF	T102 Vacuum Column		T104(j) 1t org +350°F, wt %	T102 Vacuum Column ^(j)				Process solvent ^(k)	
	Coal conv, % MAF	Distillate		SRC	Temperature btm, top, °F			Press, top psia	Tray 8, -450°F, wt %		Tray 3		+650°F wt %	Sp	Gr	
		Naphtha and middle dist.	Process solvent								-350°F wt %	+450°F, wt %				
-Run 221 - Fies Coal																
9	93.4	-	-	-	N/A	2.3	609	220	0.4	-	N/A	N/A	N/A	-	-	
10	93.0	-	-	-	1.04	2.0	603	227	0.4	75.5	0.9	1.5	85.9	-	-	
11	92.9	12.0	20.0	54.6	1.00	2.0	587	214	0.4	79.5	1.0	ND	94.1	-	-	
12	93.3	8.8	17.7	59.5	0.87	2.4	595	232	0.3	83.4	0.4	ND	94.7	39.3	1.03	
13	92.0	-	-	-	0.86	2.1	594	233	0.4	73.5	0.5	0.04	94.1	42.2	1.02	
14	92.9	6.8	21.6	56.8	1.04	2.2	594	236	0.4	79.9	0.4	ND	98.3	44.1	1.02	
15	93.7	7.0	17.3	57.0	0.98	2.2	581	233	0.3	74.5	0.2	ND	95.4	-	1.02	
16	92.7	4.8	30.9	50.3	1.11	2.1	588	234	0.3	71.1	0.5	ND	94.7	43.6	1.02	
17	92.9	5.8	11.4	65.6	1.02	2.2	591	235	0.3	69.5	2.2	ND	95.5	-	-	
18	92.8	5.9	22.8	57.9	1.15	2.1/1.8 ⁽ⁱ⁾	594	235	0.3	67.5	0.3	0.03	95.2	45.8	1.04	
19	92.7	6.8	8.9	68.1	1.01	1.9/1.8 ⁽ⁱ⁾	594	234	0.3	65.0	0.5	ND	95.2	44.7	1.02	
20	92.8	4.9	22.1	60.8	1.25	1.8	594	233	0.3	59.9	0.5	ND	95.4	45.9	1.02	
21	92.9	5.9	21.3	57.9	1.10	1.8	603	234	0.3	65.3	0.2	ND	95.7	45.3	1.02	
22	93.4	6.4	13.9	62.6	0.99	1.7	598	235	0.3	60.7	0.2	ND	95.1	46.5	-	
23	92.4	-	-	-	1.13	-	598	237	0.3	-	0.4	ND	95.6	43.1	1.02	
24	92.1	5.7	11.5	67.1	1.13	1.6/1.4 ⁽ⁱ⁾	594	234	0.3	63.8	0.3	ND	95.0	46.8	1.02	
25	92.9	-	-	-	1.16	2.1	594	233	0.3	-	0.1	ND	96.1	46.2	1.02	
26	92.8	} 7.9	} 16.1	} 60.8	1.07	-	600	232	0.3	63.0	0.1	ND	96.1	47.8	1.02	
27	92.9				N/A	1.9	593	234	0.3	70.2	0.4	ND	95.4	48.2	1.02	
28	93.2				1.14	2.2	540	233	0.3	66.8	0.1	ND	95.7	50.4	1.02	
-Run 222 - Fies Coal																
29	92.7	5.3	16.5	62.1	1.12	1.9	596	233	0.3	61.4	0.1	ND	96.3	47.7	-	
30	92.3	5.2	12.7	64.5	1.18	1.4	596	234	0.3	60.5	0.1	0.6	96.6	48.1	1.02	
31	92.5	5.5	13.0	64.2	1.30	1.5	598	233	0.3	64.2	ND	ND	96.8	50.2	1.02	

(a) From V101B lab-filtered samples, microautoclave conversion, short method.

(b) From V131A, microautoclave conversion, short method.

(c) From V101B, lab-filtered samples, microautoclave conversion, long method.

(d) From V131A, microautoclave conversion, long method.

(e) DPR-402-4; Transmitter ranges set to read 0.5 to 0.9. Specific gravity at X% reading = $0.5 + 0.004X$. Since 22 December the transmitter ranges were reset to read 0.5 to 1.1. Specific gravity at X% reading = $0.5 + 0.006X$.

(f) Questionable data.

(g) Process material balance method. Product ash, unreacted coal, and solvent-free SRC (distillation at 600°F and 0.1 mm Hg) based upon T102 bottoms rate and analyses. Product distillate is estimated from the V110 Flash Tank rate. Gas flow rates are based upon on-line H₂ analyzers and total acid gases estimated from empirical correlations.

(h) SRC obtained from lab workup of V110 Flash Tank sample; SRC and distillate separated by vacuum distillation in a flask at 600°F and 0.1 mm Hg.

(i) By the ethylene injection method.

(j) Analysis by GC.

(k) Sample from V131A tank. The sample is analyzed by GC. The residue is reported as a part of material + 650°F.

Table 5
Conditions and Results Summary
Kentucky 9 Coal

Date, 1980 Run Mine	26-27 Sept 217CD MB Fies	20-21 Oct 219AB MB Fies	28-29 Oct 220AB MB Fies
<u>Coal</u>			
Volatile matter (dry basis, %)	35.24	28.22	36.36
H/C atomic ratio	0.85	0.78	0.83
Microautoclave conversion, % long test(a)	78.0	82.4	76.2
<u>Solvent</u>			
IBP, °F	358(b)	360(c)	384(b)
EP, °F	960	959	951
Fractions, < 450 °F/>650 °F/residue, %	4.6/38.3/21.1	6.4/43.4/3.0	3.9/35.4/5.1
Specific gravity	1.068	-	1.035
H/C atomic ratio	1.15	1.27	1.19
Microautoclave conversion, %			
Short test	82.6	73.4	76.0
Long test	65.3	-	67.6
<u>Operating conditions.</u>			
<u>Feed</u>			
Dissolver volume, %	50	75	75
Coal feed rate, MF lb/hr	304	535	544
Moisture content of feed coal, wt % as-is coal	0.84	1.03	1.35
Concentration, % MF coal	32.7	36.5	36.6
Feed gas, Mscf/ton coal to B102	34.8	28.2	27.6
Hydrogen purity, mol %	91.8	82.3	82.3
LSRC (from CSD) recycle, lb/hr	182.9	45.6	57.9
El02 Dissolver-Product Cooler bypass	No	Yes	Yes
Dissolver solids withdrawal, % of slurry feed	6	6	6
Sodium carbonate addition, lb/hr	2.1	3.8	3.8
<u>Reaction</u>			
Coal space rate, MF lb/hr-ft ³			
Cumulative(f)	24.7	32.1	32.6
Dissolver(g)	33.1	39.4	40.1
Temperature, °F			
Preheater outlet	793	788	787
Dissolver			
Bottom (10%)	780	812	804
Middle (50%)	784	840	839
Outlet (75%)	-	840	840
Dissolver pressure, psig	2,000	2,100	2,100
Hydrogen partial pressure, psig			
Preheater inlet	1,900	1,820	1,820
Dissolver outlet(h)	1,320	1,150	1,150

(Table continued)

Table 5 (continued)
Conditions and Results Summary
Kentucky 9 Coal

Date, 1980	26-27 Sept	20-21 Oct	28-29 Oct
Run	217CD MB	219AB MB	220AB MB
Mine	Fies	Fies	Fies
<u>Results</u>			
Coal conversion to cresol-solubles,			
wt % MAF coal	93.2	92.5	93.6
Hydrogen consumption(i), % MF coal	2.62	2.27	2.24
Sulfur, % of SRC product(j)	1.05	0.83	0.86
Yields, % MF coal(i)			
SRC	55.0	53.4	49.0
Organic liquid	24.3	25.7	30.0
Gases			
C ₁ -C ₅	2.2	3.7	4.1
CO-CO ₂	0.8	1.5	1.4
H ₂ S	2.2	1.6	1.0
NH ₃	0.3	0.3	0.2
Water	4.3	2.2	3.9
Unreacted coal	6.3	5.8	5.2
Ash	7.4	8.0	7.4

(Table continued)

Table 5 (continued)
Conditions and Results Summary
Kentucky 9 Coal

Date, 1980	7-9 Nov	20 Dec	27 Dec
Run	220DE MB	221B MB	221G MB
Mine	Fies	Fies	Fies
<u>Coal</u>			
Volatile matter (dry basis, %)	32.75	34.43	35.31
H/C atomic ratio	0.86	0.79	0.80
Microautoclave conversion, % long test(a)	77.9	79.0	82.4
<u>Solvent</u>			
IBP, °F	398(b)	405(d)	405(d)
EP, °F	947	1,000	960
Fractions, < 450 °F/>650 °F/residue, %	3.2/48.3/4.0	1.4/34.7/24.6	0.9/37.0/18.8
Specific gravity	1.046	1.070	1.064
H/C atomic ratio	1.18	1.18	1.17
Microautoclave conversion, % short test	81.1	82.5/85.8(b)	85.8
long test	66.6	-/66.8(b)	-
<u>Operating conditions</u>			
<u>Feed</u>			
Dissolver volume, %	75	100	100
Coal feed rate, MF lb/hr	540	311	333
Moisture content of feed coal, wt % as-is coal	1.33	2.11	0.90
Concentration, % MF coal	36.2	30.8	30.1
Feed gas, Mscf/ton coal to B102	27.7	20.6	18.0
Hydrogen purity, mol %	84.5	86.2	82.8
LSRC (from CSD) recycle, lb/hr	58.5	184.0	201.0
E102 Dissolver Product Cooler bypass	Yes	No(k)	No(k)
Dissolver solids withdrawal, % of slurry feed	6	6	6
Sodium carbonate addition, lb/hr	3.8	2.2	2.3
<u>Reaction</u>			
Coal space rate, MF lb/hr-ft ³			
Cumulative(f)	32.4	14.5	15.5
Dissolver(g)	39.8	16.9	18.1
Temperature, °F			
Preheater outlet	796(e)	781	760
<u>Dissolver</u>			
Bottom (10%)	806	745	745
Middle (50%)	837	759	763
Outlet (75%)	840	765(1)	770(1)
Dissolver pressure, psig	2,100	2,000	2,000
<u>Hydrogen partial pressure, psig</u>			
Preheater inlet	1,870	1,770	1,700
Dissolver outlet(h)	1,250	1,130	930

(Table continued)

Table 5 (continued)
Conditions and Results Summary
Kentucky 9 Coal

Date, 1980 Run Mine	7-9 Nov 220DE MB Fies	20 Dec 221B MB Fies	27 Dec 221G MB Fies
Results			
Coal conversion to cresol-solubles, wt % MAF coal	93.5	92.8	93.7
Hydrogen consumption ⁽ⁱ⁾ , % MF coal	2.09	1.73	1.80
Sulfur, % of SRC product ^(j)	0.90	1.25	1.17
Yields, % MF coal ⁽ⁱ⁾			
SRC	49.7	54.5	58.5
Organic liquid	27.1	26.0	19.4
Gases			
C ₁ -C ₃	4.2	1.8	2.1
CO-CO ₂	1.2	1.0	1.5
H ₂ S	1.8	1.1	1.9
NH ₃	0.2	0.2	0.2
Water	4.5	3.0	4.5
Unreacted coal	5.9	6.0	5.8
Ash	7.5	8.2	7.9

- (a) Thirty minutes at 750°F, 2:1 solvent/coal ratio. Solvent: 25% tetralin and 75% 1-methylnaphthalene.
- (b) V131B process solvent mixed with LSRC.
- (c) Solvent from V131A Tank containing tray 3 and 8 streams from T102 Vacuum Tower Column.
- (d) V101B laboratory filtered solvent.
- (e) On 9 November 1980, B102 Slurry Preheater outlet temperature was 822-850°F.
- (f) Using 1.6 ft³ as preheater volume, plus 1.5 ft³ for full-dissolver transfer plus dissolver volume.
- (g) Using 13.58 ft³ as three-quarter dissolver volume, 9.197 ft³ for half-dissolver volume, and 18.394 ft³ for full-dissolver volume.
- (h) Dissolver outlet hydrogen partial pressure (psia) = $\left[P \text{ at B102 inlet} \right] \times \frac{\% \text{ H}_2 \text{ in B102 feed gas}}{100} \times \left[100 - \frac{\text{H}_2 \text{ consumed, lb/hr}}{\text{H}_2 \text{ in B102 feed, lb/hr}} \times 100 \right] \times \frac{1}{100}$
- (i) Process material balance method, unadjusted yields. Product ash, unreacted coal and solvent-free SRC (distillation at 600°F and 0.1 mm Hg) based upon T102 bottoms rate and analyses. Product distillate is estimated from the V110 Flash Tank rate.
- (j) From laboratory workup of V110 Flash Tank sample, distilled at 600°F, 0.1 mm Hg.
- (k) R101 effluent flowing through heavily insulated E102.
- (l) Thermocouple reading was not reliable for 100% position of R101 Dissolver. These data were from 75% position.

Table 6
Results Summary - Unadjusted Yields (Process Method) (a)
Kentucky 9. Coal

Date, 1980 Run Mine	26-27 Sept 217CD MB Fies	20-21 Oct 219AB MB Fies	28-29 Oct 220AB MB Fies	7-9 Nov 220DE MB Fies	20 Dec 221B MB Fies	27 Dec 221G MB Fies
<u>Yields, % MF coal</u>						
Gases						
H ₂ S	2.21	1.62	0.95	1.81	1.08	1.90
CO ₂	0.75	1.35	1.25	1.02	0.93	1.47
CO	0.03	0.13	0.11	0.16	0.04	0.05
C ₁	0.57	1.53	1.66	1.64	0.50	0.72
C ₂	0.58	1.05	1.08	1.06	0.46	0.55
C ₃	0.52	0.74	0.81	0.85	0.42	0.46
C ₄ -C ₅	0.48	0.40	0.59	0.64	0.42	0.37
NH ₃	0.31	0.27	0.21	0.21	0.17	0.21
Water	4.25	2.24	3.94	4.53	3.00	4.49
<u>Distillates</u>						
C ₃ -350°F	3.48	4.40	4.33	3.71	2.31	2.78
350-450°F	3.99	5.47	4.84	4.39	2.27	5.07
450°F-EP	16.80	15.83	20.87	19.02	21.39	11.55
<u>SRC(b)</u>						
Oil	8.61	13.54	13.20	14.80	4.09	21.93
Asphaltene	27.46	29.66	26.19	24.17	28.42	18.58
Benzene insoluble(c)	18.93	10.25	9.61	10.77	21.97	17.99
Ash	7.39	7.96	7.43	7.46	8.23	7.92
Unreacted coal	6.26	5.83	5.16	5.85	6.03	5.77
Hydrogen consumption, % MF coal	2.62	2.27	2.24	2.09	1.73	1.80
<u>Organic liquid yield, % of total liquid product(d)</u>						
IBP-350°F	14.28	17.13	14.40	13.67	8.85	14.31
350-450°F	13.05	20.93	15.72	15.85	8.25	25.30
450-550°F	20.87	19.89	5.48	8.87	21.79	5.62
550-650°F	13.36	14.89	11.07	15.93	18.90	20.97
650°F-EP	38.43	27.16	53.33	45.67	42.21	33.80

(a) Product ash, unreacted coal and solvent-free SRC (distillation at 600°F and 0.1 mm Hg) based upon T102 bottoms rate and analyses. Product distillate is estimated from the V110 rate.

(b) Solvent-free basis (distilled at 600°F and 0.1 mm Hg).

(c) Benzene-insoluble, cresol-soluble.

(d) Liquid fractions by GC determination. A negative value indicates that the amount of that fraction decreased because part of that fraction was consumed in the process.

Table 7
Critical Solvent Deashing Unit
Three-Stage Operating Data

Date Oct 1980	Feed Rate, T102 btms lb/hr	Feed Time, hr	Run No. (a)	Feed from T102 btms				Softening- Fusion Points, °F	Ash conc (DAS free basis)				SRC								Softening- Fusion, Points, °F	Recovery ^(c)	
				Ash, %	UC, %	Solv, %	Sulfur, %		Ash, %	UC, %	SRC, %(b)	Solv, %(b)	DAS, %	Ash, %	Sulfur, %	Solv, %(b)	DAS, %	%(d)	%(e)				
1																							
2																							
3		2.9	218-2																				
4	325.8	13.7	218-2	11.8	7.1	9.1	2.22	239-279	30.5	28.8	39.4	1.3	2.50	0.07	0.95	5.5	1.2	257-296	75.6	76.4			
5	396.4	23.4	218-2	11.6	8.1	9.0	1.99	298-329	33.6	30.5	33.2	2.7	0.20	0.10	0.83	10.6	1.3	246-277	81.5	85.7			
6	403.3	20.3	218-2	11.7	7.9	10.4	1.80	293-315	32.5	31.1	34.8	1.6	0.2	0.07	0.76	7.7	0.01	230-275	79.6	78.5			
7	398.7	20.8	218-2	10.6	7.8	7.5	1.84	309-324	31.0	32.6	35.2	1.2	1.60	0.03	0.97	8.1	1.3	248-284	80.6	79.1			
8	350.9	24.0	218-2	10.7	7.7	7.6	1.71	311-338	33.2	27.7	38.3	0.8	0.80	0.14	0.90	3.0	1.3	248-275	83.1	75.8			
9	410.2	14.4	218-2	9.5	7.2	11.7	1.54	280-300	34.0	33.8	30.9	1.3	1.15	0.03	0.73	5.5	1.4	248-266	86.5	76.0			
10	414.3	14.9	218-2	11.3	6.9	9.0	1.89	239-275	37.7	30.2	30.4	1.7	2.00	0.24	0.91	5.1	1.6	230-266	85.6	84.6			
11	416.7	19.0	219-2	10.5	6.6	10.4	1.7	255-280	35.7	34.4	28.6	1.3	0.90	0.12	0.82	10.5	1.06	275-293	85.1	85.6			
12	370.9	20.8	219-2	10.7	7.0	9.4	1.82	253-289	36.0	32.3	29.9	1.8	1.07	0.08	0.86	6.1	NA	255-273	85.4	83.8			
13	390.4	24.0	219-2	10.6	6.6	8.9	1.87	252-293	34.7	31.9	30.9	2.5	0.90	0.09	0.91	3.6	0.3	244-262	83.9	83.4			
14	402.6	24.0	219-2	10.6	6.9	8.6	1.85	257-284	34.4	32.6	31.4	1.6	1.40	0.05	0.87	5.4	0.4	246-264	83.9	81.0			
15	443.0	20.6	219-2	10.1	6.9	10.3	1.74	244-284	35.7	35.0	28.2	1.1	1.75	0.09	0.87	3.7	1.3	264-298	86.4	82.9			
16	419.0	24.0	219-2	10.5	6.5	10.1	1.73	244-284	35.7	37.3	25.6	1.4	1.20	0.01	0.71	9.8	0.45	240-266	85.0	83.6			
17	407.0	24.0	219-2	10.9	7.1	8.0	1.89	284-306	37.3	35.1	24.8	2.8	0.62	0.02	0.84	4.9	0.15	257-275	86.3	86.7			
18	413.4	23.6	219-2	10.9	7.1	5.9	1.75	284-306	34.7	34.9	29.2	1.2	0.90	0.09	0.80	6.3	0.41	266-284	83.6	87.6			
19	377.8	23.6	219-2	10.7	8.3	8.0	1.78	266-288	35.0	33.0	30.3	1.7	0.13	0.11	0.82	7.6	0.75	252-266	85.7	85.7			
20	397.4	24.0	219-2	10.8	7.7	7.2	1.88	311-329	34.9	34.1	29.5	1.5	0.12	0.06	0.86	6.4	0.3	266-280	84.7	85.5			
			A MB																				
21	436.6	23.8	219-2	10.6	6.6	10.6	1.83	309-327	36.0	33.0	30.0	1.0	0.10	0.10	0.86	3.2	0.3	253-271	85.2	84.2			
			B MB																				
22	419.0	22.8	219-2	10.5	8.0	13.1	1.81	306-324	36.4	35.3	26.8	1.5	0.85	0.07	0.87	7.5	1.4	257-279	87.3	85.8			
23	415.8	19.7	219-2	10.3	6.2	11.5	1.34	297-315	34.9	33.9	30.1	1.1	1.20	0.08	0.66	16.1	2.7	262-293	84.4	84.0			
23	415.8	3.6	220-2	10.3	6.2	11.5	1.34	297-315	24.9	33.9	30.1	1.1	1.20	0.08	0.66	16.1	2.7	262-293	84.4	84.0			
24	458.2	23.4	220-2	9.9	6.4	12.9	1.70	244-253	34.2	31.2	33.2	1.4	0.5	0.09	0.84	5.5	2.2	273-291	84.8	82.7			
25	421.2	24.0	220-2	9.9	4.8	10.4	1.85	246-261	35.3	33.3	30.5	0.9	0.74	0.01	0.96	10.8	1.5	278-293	84.4	82.2			
26	469.7	25.0	220-2	10.0	6.4	9.4	2.01	262-293	33.7	37.5	25.4	3.4	0.20	0.03	0.84	9.9	1.2	255-261	84.1	84.1			
27	445.6	24.0	220-2	10.1	7.1	11.5	1.85	270-288	34.8	30.3	29.6	5.3	1.00	0.01	0.89	13.7	0.2	252-268	85.7	85.1			
28	428.3	24.0	220-2	10.2	6.8	10.2	1.75	268-289	34.5	36.2	28.1	1.2	0.70	0.07	0.86	9.2	ND	259-268	84.9	85.4			
			A MB																				
29	404.9	24.0	220-2	10.6	6.5	11.2	1.84	288-306	35.4	33.3	29.9	1.4	0.80	0.16	0.87	15.5	1.2	221-266	84.5	84.2			
			B MB																				
30	459.2	23.2	220-2	10.3	6.4	12.0	1.52	291-307	35.0	32.1	31.8	1.1	0.65	0.13	0.86	15.6	1.7	244-275	87.7	83.5			
31	437.4	24.0	220-2	10.2	7.2	8.7	1.93	305-318	35.1	35.3	27.1	2.5	2.22	0.01	0.91	13.3	1.5	262-266	85.9	84.4			

(a) Run No. -1 (mode 1 operation, by the use of high pressure recycle solvent system).

Run No. -2 (mode 2 operation, bypassing high pressure recycle solvent system).

(b) At 600°F and 0.1 mm Hg.

(c) Percent of cresol soluble feed from T102 btms.

(d) By forced ash balance.

(e) By normalized material balance.

(Table continued)

Table 7 (continued)
Critical Solvent Deashing Unit
Three-Stage Operating Data

Date, Nov 1980	Feed Rate, T102 btms, lb/hr	Feed Time, hr	Run No. (a)	Feed from T102 btms					Softening- Fusion Points, °F	Ash conc (DAS free basis)					SRC							Recovery(c) %(d) %(c)	
				Ash, %	UC, %	Solv, %	Sulfur, %	Ash, %		UC, %	SRC, %(b)	Solv, %(b)	DAS, %	Ash, %	Sulfur, %	Solv, %(b)	DAS, %	Softening- Fusion Points, °F					
1	431.1	24.0	220-2	10.4	7.1	8.0	1.86	307-315	34.8	33.5	29.2	2.5	1.4	0.03	0.90	7.0	0.2	275-284	85.0	83.1			
2	446.0	24.0	220-2	10.6	7.1	8.1	1.57	307-309	36.1	31.4	31.4	1.1	2.3	0.15	0.82	12.2	1.0	270-280	85.8	84.5			
3	453.8	23.9	220-2	10.2	7.3	12.0	1.58	288-293	34.7	38.1	27.0	0.2	6.3	0.10	0.81	10.6	1.4	248-275	85.6	85.6			
4	452.9	20.4	220-2	10.0	6.8	16.8	1.54	302-325	33.5	34.5	30.0	2.0	1.5	0.06	0.99	12.2	0.43	284-298	84.3	82.3			
5	453.0	23.6	220-2	10.2	7.3	13.6	1.72	291-305	34.9	35.7	28.1	1.3	4.2	0.10	0.86	11.0	2.6	268-286	85.8	83.2			
6	432.6	17.6	220-2	10.0	7.7	13.5	1.78	300-318	34.7	33.1	30.6	1.6	2.8	0.14	0.96	6.8	1.9	259-277	86.5	84.0			
7	454.1	12.0	220-2	Sample Results Not Available																			
7-8	441.4	24.0	220-2	10.1	6.2	13.2	1.60	239-270	36.6	34.3	27.4	1.7	0.9	0.13	0.88	4.64	2.6	266-284	86.5	85.4			
8-9	457.0	24.0	220-2	9.74	6.96	12.8	1.84	254-298	33.3	35.3	31.0	0.4	3.99	0.13	0.99	2.7	1.8	261-279	84.9	83.7			
10-30			EMB	Unit down for Hydrotreater tie-ins and maintenance																			

- (a) Run No.-1 (mode 1 operation, by the use of high pressure recycle solvent system).
Run No.-2 (mode 2 operation, bypassing high pressure recycle solvent system).
(b) At 600°F and 0.1 mm Hg.
(c) Percent of cresol soluble of feed from T102 btms.
(d) By forced ash balance.
(e) By normalized material balance.

(Table continued)

Table 7 (continued)
Critical Solvent Deashing Unit
Three-Stage Operating Data

Date, Dec 1980	Feed Rate, T102 btms, lb/hr	Feed Time, hr	Run No.(a)	Feed from T102 btms					Softening- Fusion Points, °F	Ash conc (DAS free basis)					SRC					Softening- Fusion Points, °F	Recovery(c)	
				Ash, %	UC, %	Solv., %	Sulfur, %	Ash, %		UC, %	SRC, %(b)	Solv., %(b)	DAS, %	Ash, %	Sulfur, %	Solv., %(b)	DAS, %	%(d)	%(c)			
1-10										Unit down												
11	400.8	21.4	221-2	6.3	4.3	12.9	1.44	237-255	29.9	32.9	35.7	1.5	1.7	0.09	0.94	6.3	1.3	280-298	88.3	90.0		
12	409.8	24.0	221-2	6.35	4.15	13.3	1.40	248-266	31.3	39.7	27.3	1.7	4.9	0.07	1.00	12.8	1.4	248-280	89.1	90.0		
13	450.5	16.3	221-2	6.1	5.4	14.3	1.44	257-275	24.9	29.4	43.6	2.1	6.1	0.12	0.94	16.9	1.5	228-246	85.3	86.4		
14	404.3	18.7	221-2	5.7	4.8	16.9	1.29	259-277	32.1	37.1	26.0	4.8	7.6	0.12	0.95	6.9	1.7	262-280	91.9	90.1		
15	437.6	24.0	221-2	6.9	4.6	14.2	1.65	259-280	29.3	37.3	29.1	4.3	3.8	0.36	1.01	13.3	1.2	243-266	86.4	91.5		
16	425.6	23.9	221-2	6.2	6.0	13.8	1.63	255-273	30.9	37.9	29.5	1.7	5.5	0.44	1.17	11.0	1.2	275-293	91.0	89.7		
17	440.4	24.0	221-2	6.3	5.2	8.3	1.65	257-275	32.5	40.7	23.4	3.4	3.0	0.11	1.24	8.8	1.5	323-343	91.1	89.9		
18	437.7	24.0	221-2	6.7	4.4	10.2	1.76	261-279	31.9	37.0	27.6	3.5	2.8	0.06	1.18	8.2	1.3	305-330	88.9	90.7		
19	426.4	24.0	221-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
			AMB																			
20	436.7	23.3	221-2	6.63	4.47	10.5	1.79	261-293	32.2	36.7	30.0	1.10	2.09	0.10	1.27	6.06	1.3	320-340	89.3	90.1		
			BMB																			
21	412.9	19.1	221-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
			CMB																			
22	439.0	21.9	221-2	6.7	4.3	12.7	1.66	284-302	32.8	34.0	32.2	1.0	2.21	0.27	1.02	5.3	1.0	352-392	89.4	91.8		
23	238.5	23.7	221-2	6.79	4.61	8.48	1.51	272-291	29.6	30.0	37.1	3.3	3.0	0.19	1.07	5.3	1.1	345-385	87.0	(104.0)		
			IMR																			
24	447.4	24.0	221-2	6.46	4.64	10.1	1.55	270-284	32.2	35.0	31.2	1.6	2.9	0.29	1.15	4.8	1.1	424-453	89.9	90.6		
25	434.4	24.0	221-2	6.58	4.42	11.5	1.71	262-280	33.1	37.1	27.9	1.9	1.3	-	1.24	4.6	1.0	290-350	90.0	91.9		
			EMB																			
26	397.9	24.0	221-2	6.46	4.34	14.4	1.54	262-287	33.9	36.2	29.0	0.9	0.6	0.14	1.12	7.5	1.2	262-287	90.7	94.7		
27	443.7	24.0	221-2	6.53	4.37	10.2	1.68	241-261	31.7	33.3	33.3	1.7	1.2	-	1.18	7.5	1.2	320-374	89.1	90.7		
			GMB																			
28	453.3	24.0	221-2	6.61	4.49	8.6	1.67	245-273	29.9	31.0	38.0	1.1	1.1	-	1.54	6.4	0.4	325-392	87.6	89.7		
			HMB																			
29	450.1	24.0	222-2	6.3	4.5	11.4	1.72	236-270	31.5	35.0	32.2	1.3	0.7	0.13	1.24	4.7	0.8	320-347	89.7	91.3		
30	443.3	24.0	222-2	6.25	4.95	11.7	1.76	280-302	30.2	36.1	32.7	1.0	1.0	0.12	1.29	11.4	0.6	329-347	89.3	90.5		
31	445.5	24.0	222-2	6.39	4.71	11.3	1.74	287-305	29.5	35.9	33.7	0.9	1.2	0.17	1.14	4.1	1.4	327-345	88.1	89.9		

- (a) Run No.-1 (mode 1 operation, by the use of high pressure recycle solvent system).
Run No.-2 (mode 2 operation, bypassing high pressure recycle solvent system).
(b) At 600°F and 0.1 mm Hg.
(c) Percent of cresol soluble feed from T102 btms.
(d) By forced ash balance.
(e) By normalized material balance.

Table 8
Coal Feed Summary
Kentucky 9 Coal

Run	Mine	Feed slurry concentration		Feed, lb			Weighted average, %		
		MF lb/hr	% MF Coal	As-is	MF	MAF	Moist.	Ash	Sulf.
218	Fies	559	37.7	114,875	113,795	103,840	0.94	8.75	3.10
219	Fies	533	36.6	165,741	163,818	150,014	1.16	8.43	3.30
220	Fies	547	36.6	221,273	218,092	199,387	1.44	8.58	3.30
221	Fies	334	31.1	153,071	151,064	138,252	1.31	8.48	3.24
222(a)	Fies	340	28.5	24,739	24,514	22,430	0.91	8.50	3.18
Average		463	34.1				1.15	8.55	3.22
Total				679,699	671,283	613,923			

(a) December portion of run.

Table 9
Feed Coal Analyses

Coal Mine Date, 1980 Run	Ky 9 Fies 26-27 Sept 217CD MB	Ky 9 Fies 20-21 Oct 219AB MB	Ky 9 Fies 28-29 Oct 220AB MB	Ky 9 Fies 7-9 Nov 220DE MB	Ky 9 Fies 20 Dec 221B MB	Ky 9 Fies 27 Dec 221G MB
<u>Proximate analysis, wt %</u>						
Moisture	0.86	1.53	1.44	0.86	4.68	1.53
Ash	8.56	8.60	8.40	8.59	8.26	8.44
Volatile Matter	34.94	27.79	35.84	32.47	32.82	34.77
Fixed Carbon	55.64	62.08	54.32	58.08	54.24	55.26
<u>Ultimate analysis, wt %</u>						
Carbon	71.11	71.30	69.71	70.86	72.04	72.06
Hydrogen	5.02	4.66	4.80	5.06	4.72	4.81
Nitrogen	1.47	1.18	1.12	1.48	1.51	1.40
Chlorine	0.06	0.07	0.07	0.07	0.09	0.10
Sulfur	3.23	3.38	3.69	3.42	2.87	3.25
Ash	8.63	8.73	8.52	8.66	8.65	8.57
Oxygen (by difference)	10.43	10.68	12.09	10.45	10.12	9.81
Dry heating value, Btu/lb	13,171	13,060	13,243	13,184	13,200	13,225
<u>Sulfur forms, wt %</u>						
Pyritic	1.32	1.37	1.59	1.15	1.07	1.36
Sulfate	0.10	0.06	0.04	0.04	0.08	0.04
Sulfide	<0.01	0.01	<0.01	0.21	<0.01	<0.01
Organic	1.86	1.94	2.06	2.02	1.72	1.85
<u>Mineral analysis, wt % (ignited basis)</u>						
Phos. pentoxide, P ₂ O ₅	0.12	0.08	0.64	0.05	0.09	0.13
Silica, SiO ₂	49.03	47.11	47.90	49.74	48.26	48.36
Ferric Oxide, Fe ₂ O ₃	23.20	23.90	23.51	23.17	21.15	23.61
Alumina, Al ₂ O ₃	17.03	18.26	17.29	18.07	18.10	17.65
Titania, TiO ₂	0.84	0.89	1.05	0.78	0.82	0.87
Lime, CaO	2.80	2.82	2.79	2.85	3.30	2.81
Magnesia, MgO	1.00	0.72	0.86	0.80	1.03	0.88
Sulfur Trioxide, SO ₃	3.05	2.58	2.87	2.66	3.07	3.22
Potassium Oxide, K ₂ O	1.87	2.03	1.93	1.88	2.33	2.01
Sodium Oxide, Na ₂ O	1.39	0.75	0.87	0.66	1.18	0.54
Undetermined	-	0.86	-	-	0.67	0.06
<u>Trace metal analysis, ppm</u>						
Arsenic	3.0	3.0	3.0	2.0	2.0	4.0
Vanadium	50.0	52.0	43.0	39.0	38.0	39.0

Table 10
SRC Production Summary
Kentucky 9 Coal

Run	Ky 9 Coal	MCIF, lb/hr		MCIF Yield, % MAF Coal	Analysis, wt %				MP °F	SRC, lb					
		K125	CSD		Solv	CI	Ash	S		MF		MAF		MCIF	
										K125	CSD	K125	CSD	K125	CSD
218	Fies	100	178	54.4	9.9	18.6	11.1	1.9	295	25,729 ^(a)	45,744 ^(a)	22,458 ^(a)	40,144 ^(a)	20,419 ^(a)	36,283 ^(a)
219	Fies	23	280	62.1	9.5	17.6	10.6	1.8	287	8,943 ^(a)	107,102 ^(a)	8,060 ^(a)	94,389 ^(a)	7,187 ^(a)	85,939 ^(a)
220	Fies	14	303	63.5	11.7	16.9	10.1	1.8	288	6,953 ^(a)	150,004 ^(a)	6,152 ^(a)	132,526 ^(a)	5,627 ^(a)	120,943 ^(a)
221	Fies	15	156	56.2	14.6	13.7	6.5	1.6	309	8,809 ^(a)	90,370 ^(a)	7,758 ^(a)	79,282 ^(a)	7,012 ^(a)	70,751 ^(a)
222 ^(b)	Fies	0	198	63.6	11.5	11.0	6.3	1.7	280	0	17,805 ^(a)	0	15,775 ^(a)	0	14,259 ^(a)
Average		38	223	60.0	11.4	15.6	8.9	1.8	292						
Total										50,434	411,025	44,428	362,116	40,245	328,175

(a) Reduced by proportioned amount of LSRC (solvent-free) added to coal feed.

(b) December portion of run.

Table 11

B102 Slurry Preheater Operating Data (Daily Average)

Coal Mine	Ky 9 Fies	Ky 9 Fies	Ky 9 Fies	Ky 9 Fies	Ky 9 Fies	Ky 9 Fies	Ky 9 Fies	(a)	Ky 9 Fies	Ky 9 Fies	Ky 9 Fies
Date, 1980	8 Oct	13 Oct	19 Oct	22 Oct	27 Oct	3 Nov	5 Nov	7 Dec	16 Dec	28 Dec	31 Dec
Run	218	219	219	219	220	220	220	-	221	221	222
B102 feed, lb/hr											
gas	129	107	105	105	99	104	104	49	37	37	40
solvent	884	886	873	898	879	951	960	1,260	509	554	580
coal (MAF)	539	518	532	555	536	549	552	0	345	322	332
Na ₂ CO ₃	3.8	3.7	3.9	4.1	3.7	4.0	3.9	0	2.4	2.3	1.4
LSRC	45.5	43.6	45.0	46.6	57.6	58.5	59.0	0	207	193	196
B102 fuel, gph	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B102 stack, °F	937	914	919	925	930	946	946	914	859	860	858
B102 pressure, psig											
inlet	2,169	2,190	2,190	2,200	2,210	2,236	2,240	-	2,050	2,047	2,043
outlet	2,110	2,130	2,140	2,130	2,140	2,140	2,140	2,050	2,010	2,030	2,030
Total ΔP, psi											
ΔP btm	53	47	45	60	61	-	-	4.5	22.5	23.5	19.5
ΔP mid	25	24	22	22	21	28(b)	23(b)	-	16	18	15
ΔP top	13	11	12	15	14	14(b)	14(b)	-	5	4	3
	15	12	11	23	26	>30	29	-	1.5	1.5	1.5
B102 temperature, °F											
inlet	174	159	189	172	176	179	168	151	154	172	178
turn 7, s/f(c)						-/-	-/-	468/427	454/426	476/433	475/433
Δt						-	-	41	28	43	42
turn 15, s/f	581/616	573/614	585/622	588/618	624/586	612/599	609/598	-/587	-/609	-/595	-/593
Δt	35	41	37	30	38	13	11	-	-	-	-
turn 19, s/f	665/612	666/609	669/615	672/613	683/620	685/621	694/614	659/650	662/627	650/617	647/616
Δt	53	57	54	59	63	64	80	9	35	33	31
turn 23, s/f	679/652	679/636	693/661	687/659	691/651	679/678	676/668	707/702	698/690	685/676	684/677
Δt	27	43	32	28	40	1	8	5	8	9	7
turn 27, s/f	723/700	723/698	729/705	724/700	732/708	722/698	718/693	746/742	726/711	714/699	714/700
Δt	23	25	24	24	24	24	25	4	15	15	14
turn 31, s/f	756/754	751/756	762/761	760/755	765/776	761/757	758/752	776/770	753/743	740/729	739/729
Δt	2	5	1	5	11	4	6	6	10	11	10
turn 33, s/f	-	-	-	-	-	-	-	788/780	764/753	749/737	748/736
Δt	-	-	-	-	-	-	-	8	11	12	12
turn 35, s/f	808/753	810/758	838/758	837/754	846/763	846/754	840/750	798/787	773/765	758/742	757/741
Δt	55	57	80	83	83	92	90	11	8	16	16
turn 37, s/f	823/777	817/781	859/781	861/786	873/792	876/800	870/786	806/792	781/763	768/752	767/751
Δt	46	54	78	75	81	76	84	14	13	16	16
coil outlet	790	787	786	782	785	782	782	800	775	760	744

(a) Clean coil test without coal after decoking.

(b) Data questionable.

(c) Skin/fluid temperatures.

Table 12
B102 Slurry Preheater Operating Data (Material Balance Periods)

Coal Mine Date, 1980 Run	Ky 9 Fies 26-27 Sept 217CD MB	Ky 9 Fies 20-21 Oct 219AB MB	Ky 9 Fies 28-29 Oct 220AB MB	Ky 9 Fies 7-9 Nov 220DE MB	Ky 9 Fies 20 Dec 221B MB	Ky 9 Fies 27 Dec 221G MB
<u>B102 feed, lb/hr (total)</u>	981	1,571	1,584	1,594	1,052	1,150
gas	52	106	106	100	42	44
solvent	440	880	872	891	513	570
coal (MF)	304	535	544	540	311	333
Na ₂ CO ₃	2.1	3.8	3.8	3.8	2.2	2.3
LSRC	183	46	58	59	184	201
B102 fuel, gph	NA	NA	NA	NA	NA	NA
stack, °F	858	919	933	950	868	861
B102 inlet, psig	2,057	2,195	2,215	2,203	2,043	2,032
B102 outlet, psig	2,041	2,142	2,141	2,016	2,012	2,017
Total ΔP, psi	-	66	69	59	21.5	22.5
ΔP btm	16	25	26	27	17	17
ΔP mid	4	20	16	9	3	4
ΔP top	-	21	27	23	1.5	1.5
<u>B102 coil temperatures, °F</u>						
Inlet	162	170	156	159	134	172
Turn 7, skin/fluid	-	-	-	1	461/424	476/432
Δt	-	-	-	-	37	44
Turn 15, skin/fluid	638/593	591/625	623/594	644/614	-/610	-/593
Δt	45	34	29	30	-	-
Turn 19, skin/fluid	681/633	671/618	672/614	688/645	669/632	648/616
Δt	48	53	58	43	37	32
Turn 23, skin/fluid	709/658	685/661	683/663	706/683	704/693	684/675
Δt	51	24	20	23	11	9
Turn 27, skin/fluid	744/717	732/710	728/705	760/734	730/717	713/699
Δt	27	22	23	26	13	14
Turn 31, skin/fluid	769/769	764/767	764/771	793/809	760/750	740/729
Δt	0	-	-	-	10	11
Turn 33, skin/fluid	-/-	-/-	-/-	-/-	770/758	749/737
Δt	-	-	-	-	12	12
Turn 35, skin/fluid	796/763	840/763	843/763	860/793	779/764	758/743
Δt	33	77	80	67	15	15
Turn 37, skin/fluid	807/756	864/787	871/791	881/835	787/774	768/753
Δt	51	77	80	46	13	15
Outlet	793	788	787	796(a)	781	760

(a) On 9 November 1980, B102 Slurry Preheater outlet temperature was 822 to 850 °F.

Table 13
R101 Dissolver Operating Profile
Kentucky 9 Coal

Mine	Fies	Fies	Fies	Fies	Fies	Fies
Date, 1980	26-27 Sept	20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run	217CD MB	219AB MB	220AB MB	220DE MB	221B MB	221G MB
Volume in use, %	50	75	75	75	100	100
Coal space rate, lb/hr-ft ³ (a)	33.1	39.4	40.1	39.8	16.9	18.1
<u>B102 feed, lb/hr (total)</u>	981	1,571	1,584	1,594	1,052	1,150
Coal (MF)	304	535	544	540	311	333
Solvent	440	880	872	891	513	570
Gas	52	106	106	100	42	44
Na ₂ CO ₃	2.1	3.8	3.8	3.8	2.2	2.3
LSRC	183	46	58	59	184	201
Gas hydrogen purity, mole %	91.8	82.3	82.3	84.5	86.2	82.8
R101 bottoms withdrawal rate, %(b)	6	6	6	6	6	6
<u>Withdrawal sample analysis, wt %</u>						
UC	5.2	5.3	5.4	5.0	-	-
Ash	3.9	7.4	8.1	8.0	4.2	4.6
SRC	37.6	28.8	29.2	27.3	-	-
Solvent (by difference)	53.3	58.5	57.3	59.7	-	-
<u>V110 analysis, wt %</u>						
UC	2.2	3.2	2.9	2.7	2.2	1.9
Ash	3.0	4.9	4.7	4.2	3.0	2.6
SRC	39.4	37.2	31.6	31.7	39.3	38.8
Solvent (by difference)	55.4	54.7	60.8	61.4	55.5	56.7
<u>R101 temperature profile, °F</u>						
Inlet	764	748	748	798	752	741
5% from bottom	-	-	-	-	-	-
10% from bottom	780	806	804	806	745	745
15% from bottom	-	-	-	-	-	-
20% from bottom	-	-	-	-	-	-
25% from bottom	-	-	-	-	-	-
50% from bottom	784	840	839	837	759	763
75% from bottom	-	840	840	840	765	770
100% from bottom	-	-	-	-	-(c)	-(c)
R101 outlet pressure, psig	2,000	2,100	2,100	2,100	2,000	2,000

(a) Based on no bottoms withdrawal.

(b) Nominal percent of slurry feed.

(c) Thermocouple reading was not available.

Table 14
Reaction Section Operating Data
Kentucky 9 Coal

Mine Date, 1980 Run	Fies 26-27 Sept 217CD MB	Fies 20-21 Oct 219AB MB	Fies 28-29 Oct 220AB MB	Fies 7-9 Nov 220DE MB	Fies 20 Dec 221B MB	Fies 27 Dec 221G MB
E102 Dissolver Product Cooler bypass	No	Yes	Yes	Yes	No(b)	No(b)
Dissolver volume in use, %	50	75	75	75	100	100
<u>Flow rates, lb/hr</u>						
MF coal to B102 (includes Na ₂ CO ₃)	306	539	548	544	313	335
Solvent to B102 (includes LSRC)	623	926	930	950	697	771
Light organic liquids from V105	61	309	318	225	58	75
Water from V105	16	17	19	29	16	18
<u>Gas flow rates, scfh</u>						
Feed gas to B102	5,285	7,535	7,488	7,489	3,210	3,001
Makeup hydrogen	2,046	3,103	3,182	3,221	1,213	1,318
Recycle gas from V104	7,899	8,132	8,329	8,109	4,414	3,878
HP purge gas	0	284	388	611	0	0
LP vent gas from V105	219	372	365	529	117	114
Degas vent(a)	449	538	522	354	177	205
Gas removed by caustic scrubber	76	132	100	132	50	98
<u>Temperature, °F</u>						
B102 outlet	793	788	787	796(d)	781	760
R101 bottom (10%)	780	812	804	806	745	745
R101 middle (50%)	784	840	839	837	759	763
R101 outlet (75%)	-	840	840	840	765(c)	770(c)
V104 HP vent	80	77	78	84	88	97
V103 HP flash	550(520)(e)	710	690-710	680-700	642	654
V110 LP flash	502	639	633	628	582	597
<u>Pressure, psig</u>						
B102 inlet	2,057	2,195	2,215	2,203	2,043	2,032
B102 outlet	2,041	2,142	2,141	2,016	2,012	2,017
V110 outlet gas	120	110	101	129	110	106
V105 outlet gas	12	12	12	12	12	12
<u>Hydrogen purity, vol %</u>						
Feed gas to B102	91.8	82.3	82.3	84.5	86.2	82.8
Recycle gas from V104	87.9	74.4	74.3	76.0	80.4	72.6
Recycle gas from V106	88.5	75.0	73.2	78.0	81.9	75.1
LP vent gas from V105	38.2	38.0	38.7	39.6	33.7	35.7
Degas vent	85.4	79.7	78.2	79.6	73.6	70.8

(a) Includes compressor vents, plus on-line GC.

(b) R101 effluent flowing through heavily insulated E102.

(c) Thermocouple reading was not reliable for 100% position of R101 Dissolver. These data were from 75% position.

(d) On 9 November 1980, B102 Slurry Preheater outlet temperature was 822-850°F.

(e) V103 HP flash temperatures were 520°F for about 10 hours in the morning of 26 September 1980.

Table 15
Heteroatom Removal

Run	Weight Ratio of Heteroatom to Carbon					Heteroatom Removal, %		
	Heteroatom	Feed Coal	SRC			Equation 1 SRC		
			V110	CSD Feed	CSD Product	V110	CSD Feed	CSD Product
217CD MB	Oxygen	0.147	0.050	0.057	0.092	66.0	61.2	37.4
	Nitrogen	0.021	0.020	0.021	0.021	4.8	0	0
	Sulfur	0.046	0.012	0.018	0.012	73.9	60.9	73.9
219AB MB	Oxygen	0.151	0.062	0.045	0.064	58.9	70.2	57.6
	Nitrogen	0.017	0.022	0.022	0.021	Negative	Negative	Negative
	Sulfur	0.047	0.010	0.024	0.011	78.7	48.9	76.6
220AB MB	Oxygen	0.174	0.060	0.050	0.048	65.5	71.3	72.4
	Nitrogen	0.016	0.019	0.018	0.017	Negative	Negative	Negative
	Sulfur	0.053	0.010	0.025	0.011	81.1	52.8	79.2
220DE MB	Oxygen	0.149	0.049	0.047	0.051	67.1	68.5	65.8
	Nitrogen	0.021	0.023	0.021	0.018	Negative	0	14.3
	Sulfur	0.048	0.010	0.022	0.011	79.2	54.2	77.1
221B MB	Oxygen	0.141	0.069	0.063	0.057	51.1	55.3	59.6
	Nitrogen	0.021	0.023	0.017	0.018	Negative	19.1	14.3
	Sulfur	0.040	0.015	0.020	0.012	62.5	50.0	70.0
221G MB	Oxygen	0.136	0.066	0.046	0.063	51.5	66.2	53.7
	Nitrogen	0.019	0.021	0.020	0.020	Negative	Negative	Negative
	Sulfur	0.045	0.014	0.021	0.015	68.9	53.3	66.7

Run	Heating Value, Btu/lb.			Total Sulfur, wt %			Total Sulfur Removal, %	
	Coal	SRC		Coal	SRC		Equation 2 SRC	
		V110	CSD Product		V110	CSD Product	V110	CSD Product
217CD MB	13,171	15,797	15,791	3.28	1.05	1.02	73.3	74.1
219AB MB	13,060	15,739	15,830	3.38	0.83	0.93	79.6	77.3
220AB MB	13,243	15,754	15,897	3.69	0.86	0.96	80.4	78.3
220DE MB	13,184	15,684	15,891	3.42	0.90	0.98	77.9	76.2
221B MB	13,200	15,808	15,710	2.87	1.25	1.00	63.6	70.7
221G MB	13,225	15,557	15,703	3.25	1.17	1.27	69.4	67.1

Table 16
High Pressure Vent Separator Gas Analyses (V104)
Kentucky 9 Coal

Mine		Fies	Fies	Fies	Fies	Fies	Fies
Date		26-27 Sept	20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run		217CD MB	219AB MB	220AB MB	220DE MB	221B MB	221G MB
Component	Mol wt	Component, mole %					
H ₂	2.02	87.9	74.4	74.3	76.0	80.4	72.6
N ₂	28.01	ND	0.1	0.1	0.1	0.3	0.3
CO	28.01	0.5	0.8	0.7	0.8	0.6	0.6
CO ₂	44.01	0.4	0.7	0.7	0.7	0.7	1.0
H ₂ S	34.08	0.8	0.9	0.6	1.1	0.7	1.5
CH ₄	16.04	7.1	17.6	17.9	15.6	12.3	17.4
C ₂ H ₂	26.04	ND	ND	ND	ND	ND	ND
C ₂ H ₄	28.05	ND	ND	ND	ND	ND	ND
C ₂ H ₆	30.07	2.3	4.0	4.1	3.8	3.4	4.4
C ₃ H ₆	42.08	ND	ND	0	ND	ND	ND
C ₃ H ₈	44.09	0.9	1.2	1.4	1.4	1.3	1.7
iC ₄ H ₁₀	58.12	ND	0.1	0	ND	ND	ND
nC ₄ H ₁₀	58.12	0.1	0.2	0.2	0.3	0.2	0.3
iC ₅ H ₁₂	72.15	ND	ND	ND	0.1	0.1	ND
nC ₅ H ₁₂	72.15	ND	ND	ND	0.1	ND	0.1
C ₆ H ₁₄	86.17	ND	ND	ND	ND	ND	0.1

(Note: ND means not detected).

Table 17
Decanter Vent Gas Analyses (V105)
Kentucky 9 Coal

Mine Date, 1980 Run		Fies 26-27 Sept 217CD MB	Fies 20-21 Oct 219AB MB	Fies 28-29 Oct 220AB MB	Fies 7-9 Nov 220DE MB	Fies 20 Dec 221B MB	Fies 27 Dec 221G MB
Component	Mol wt	Component, mole %					
H ₂	2.02	38.2	38.0	38.7	39.6	33.7	35.7
N ₂	28.01	45.1	23.7	25.9	26.4	43.9	33.4
CO	28.01	0.1	0.5	0.3	0.3	0.1	0.1
CO ₂	44.01	0.7	1.1	1.0	0.9	0.8	1.1
H ₂ S	34.08	3.0	5.0	2.4	4.2	3.5	4.1
CH ₄	16.04	4.4	15.0	14.3	12.0	7.7	13.1
C ₂ H ₂	26.04	ND	ND	ND	ND	ND	ND
C ₂ H ₄	28.05	ND	ND	ND	ND	ND	ND
C ₂ H ₆	30.07	3.6	9.0	8.5	7.3	4.6	6.2
C ₃ H ₆	42.08	ND	ND	ND	ND	ND	ND
C ₃ H ₈	44.09	2.7	5.4	5.5	5.3	3.2	3.9
iC ₄ H ₁₀	58.12	ND	ND	0.3	0.4	0.2	0.2
nC ₄ H ₁₀	58.12	0.9	1.3	1.5	1.7	1.2	1.2
iC ₅ H ₁₂	72.15	0.3	0.2	0.3	0.3	0.2	0.2
nC ₅ H ₁₂	72.15	0.5	0.4	0.5	0.7	0.5	0.4
C ₆ H ₁₄	86.17	0.5	0.4	0.8	0.9	0.4	0.4

(Note: ND means not detected).

Table 18
Degas Vent Gas Analyses (V132)
Kentucky 9 Coal

Mine		Fies	Fies	Fies	Fies	Fies	Fies
Date, 1980		26-27 Sept	20-21 Sept	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run		217CD MB	219AB MB	220AB MB	220DE MB	221B MB	221G MB
Component	Mol wt	Component, mole %					
H ₂	2.02	85.4	79.7	78.2	79.6	73.6	70.8
N ₂	28.01	5.9	2.3	3.9	4.8	11.1	9.0
CO	28.01	0.2	0.6	0.6	0.4	0.5	0.4
CO ₂	44.01	0.5	ND	ND	0.5	ND	ND
H ₂ S	34.08	0.3	ND	ND	ND	ND	ND
CH ₄	16.04	5.1	13.1	13.0	10.8	10.3	14.3
C ₂ H ₂	26.04	ND	ND	ND	ND	ND	ND
C ₂ H ₄	28.05	ND	ND	ND	ND	ND	ND
C ₂ H ₆	30.07	1.8	3.1	3.0	2.7	3.1	3.8
C ₃ H ₆	42.08	ND	ND	0	ND	ND	ND
C ₃ H ₈	44.09	0.7	0.9	1.0	1.0	1.1	1.3
iC ₄ H ₁₀	58.12	ND	ND	0	ND	ND	ND
nC ₄ H ₁₀	58.12	0.1	0.1	0.2	0.2	0.2	0.2
iC ₅ H ₁₂	72.15	ND	0.1	0.1	ND	0.1	ND
nC ₅ H ₁₂	72.15	ND	0.1	ND	ND	ND	0.1
C ₆ H ₁₄	86.17	ND	ND	ND	ND	ND	0.1

(Note: ND means not detected).

Table 19
Flare Gas Analyses (K110)
Kentucky 9 Coal

Mine		Fies	Fies	Fies	Fies	Fies	Fies
Date, 1980		26-27 Sept	20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run		217CD MB	219AB MB	220AB MB	220DE MB	221B MB	221G MB
Component	Mol wt	Component, mole %					
H ₂	2.02	49.9	47.8	42.9	47.5	20.1	22.9
N ₂	28.01	43.5	32.9	37.7	31.9	72.8	67.3
CO	28.01	0.1	1.0	0.3	0.4	ND	ND
CO ₂	44.01	0.2	0.3	0.3	0.3	0.2	0.3
H ₂ S	34.08	0	1.3	1.3	1.7	0.9	ND
CH ₄	16.04	3.4	9.6	9.9	10.1	2.9	4.9
C ₂ H ₂	26.04	ND	ND	ND	ND	ND	ND
C ₂ H ₄	28.05	ND	ND	ND	ND	ND	ND
C ₂ H ₆	30.07	1.5	4.0	3.9	3.8	1.5	2.0
C ₃ H ₆	42.08	ND	ND	ND	ND	ND	ND
C ₃ H ₈	44.09	0.9	2.2	2.4	2.3	1.0	1.3
iC ₄ H ₁₀	58.12	ND	ND	0.1	0.2	ND	ND
nC ₄ H ₁₀	58.12	0.3	0.5	0.7	0.8	0.3	0.5
iC ₅ H ₁₂	72.15	ND	0.1	0.1	0.1	ND	0.1
nC ₅ H ₁₂	72.15	0.1	0.2	0.2	0.4	0.2	0.3
C ₆ H ₁₄	86.17	0.1	0.1	0.2	0.5	0.1	0.4

(Note: ND means not detected).

Table 20
T102 Vacuum Column Operating Data

Date, 1980	26-67 Sept	20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run	217CD MB	219AB MB	220AB. MB	220DE MB	221B MB	221G MB
Pressure, psia	0.40	0.36	0.40	0.40	0.33	0.30
Flow rates, lb/hr						
Feed						
from V110	846	1120	1125	1219	936	1003
from T104 bottom	164	444	446	416	90	77
Overhead light solvent						
to V164	10	215	212	188	39	20
Tray 1 reflux	1743/3734 ^{L H}	3262	3153	3153	1296	1481
Process solvent (tray 3)						
to V138	308	572	289	423	166	169
Process solvent (tray 8)						
to V177	296	344	645	579	401	451
Process solvent (combined trays)						
3 and 8						
to V131A	604	916	934	1002	567	620
Bottoms (SRC)						
to K125 CSD	396	433	425	445	420	440
to B103	17,625	20,201(a)	20,201(a)	20,201(a)	19,797(a)	20,201(a)
Temperature, °F						
Tray 1 (overhead)	230	241	240	246	233	234
Tray 3	246	269	261	272	261	263
Tray 8	346	356	340	374	317	331
Packing reflux	153	195	193	189	101	104
B103 outlet	534	-	-	-	-	-
Bottom	546	597	594	597	594	593
Product pump power, amps	25	28	27	28	27	26
Compositions, wt %						
Tray 3						
IBP-350°F	0.4	0.1	0.1	0.2	0	0
350-450°F	12.6	8.1	9.9	6.8	3.8	4.5
450°F-EP	87.0	91.8	90.0	93.0	96.2	95.5
Tray 8						
IBP-350°F	0	0	0	0	0	0
350-450°F	0.1	0.3	0.6	0.5	0.2	0.2
450°F-EP	99.9	99.7	99.4	99.5	99.8	99.8
Combined trays 3 and 8						
IBP-350°F	0.1	0.1	0.1	0.1	0	0
350-450°F	6.3	3.7	3.8	3.1	1.2	1.4
450°F-EP	93.6	96.2	96.1	96.8	98.8	98.6

(a) B103 bypassed.

Table 21
Naphtha Analyses
Kentucky 9 Coal

Date, 1980	26-27 Sept	20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run	217CD MB	219AB MB	220AB MB	220DE MB	221B MB	221G MB
<u>Naphtha from V105</u>						
<u>Boiling fractions, wt %</u>						
(IBP, °F)	(97)	(67)	(72)	(97)	(67)	(131)
IBP-200°F	4.1	3.8	3.7	3.6	4.2	3.7
200-350°F	10.7	3.9	4.3	5.1	7.1	7.0
350-450°F	21.7	13.0	13.3	14.2	9.9	11.4
450°F-EP	63.5	79.3	78.7	77.1	78.8	77.9
(EP, °F)	(838)	(838)	(867)	(907)	(866)	(811)
Specific gravity	0.942	0.961	0.965	0.966	0.945	0.944
<u>Ultimate analysis, wt %</u>						
Carbon	85.48	84.77	87.27	84.96	86.11	84.65
Hydrogen	9.92	9.64	9.61	9.81	10.17	9.81
Nitrogen	1.97	1.79	1.92	2.08	1.62	1.30
Sulfur	0.39	0.32	0.30	0.34	0.18	0.19
Ash	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Oxygen (by difference)	2.24	3.48	0.90	2.81	1.92	4.05
<u>Naphtha from T102 overhead</u>						
<u>Boiling fractions, wt %</u>						
(IBP, °F)	(194)	(165)	(176)	(283)	(306)	(246)
IBP-200°F	0.5	0.7	0.6	0.1	0	0.1
200-350°F	4.1	1.8	1.9	1.6	2.1	1.7
350-450°F	46.5	29.6	31.6	35.7	15.6	20.5
450°F-EP	48.9	67.9	65.9	62.6	82.3	77.7
(EP, °F)	(776)	(754)	(749)	(643)	(622)	(643)
Specific gravity	0.964	0.964	0.964	0.970	0.965	0.964

Table 22
Naphtha Compositions (wt %)
Kentucky 9, Fies Mine Coal

Date, 1981	26-27 Sept		20-21 Oct		28-29 Oct		7-9 Nov		20 Dec		27 Dec	
Run	217CD MB		219AB MB		220AB MB		220DE MB		221B MB		221G MB	
	V105 Oil SN 60904	(P171) SN 60898 T102 OH	V105 Oil SN 61713	(P171) SN 61714 T102 OH	V105 Oil SN 62268	(P171) SN 62269 T102 OH	V105 Oil SN 62593	(P171) SN 62612 T102 OH	V105 Oil SN 63731	(P171) SN 63729 T102 OH	V105 Oil SN 63992	(P171) SN 63990 T102 OH
Boiling range, °F, or component												
IBP - 96.9	0.3	0.0	1.0	0.2	0.6	0.1	0.4	0.	0.9	0.	0.	0.
pentane	0.7	0.0	0.6	0.1	1.0	0.1	0.8	0.	0.7	0.	0.	0.
97.1 - 156.1	0.5	0.1	0.4	0.1	0.4	0.1	0.5	0.	0.5	0.	1.6	0.
hexane	0.5	0.1	0.4	0.1	0.3	0.1	0.4	0.	0.4	0.	0.3	0.
156.3 - 175.9	0.4	0.1	0.3	0.1	0.3	0.1	0.4	0.	0.4	0.	0.4	0.1
cyclohexane	0.9	0.1	0.6	0.1	0.6	0.1	0.6	0.	0.8	0.	0.8	0.1
176.1 - 231.0	1.5	0.3	0.9	0.2	0.4	0.1	0.6	0.	0.6	0.	0.6	0.0
toluene	5.6	1.3	0.7	0.2	0.9	0.2	1.1	0.1	2.8	0.2	3.0	0.3
231.2 - 240.7	0.1	0.	0.1	0.	0.1	0.	0.	0.	0.	0.	0.1	0.
pyridine	0.	0.	0.	0.	0.5	0.1	0.5	0.	0.6	0.0	0.6	0.0
240.9 - 281.0	1.5	0.5	0.9	0.2	1.0	0.2	1.1	0.2	0.9	0.0	0.8	0.1
xylene (p-, m-)	0.5	0.2	0.3	0.2	0.3	0.1	0.4	0.1	0.1	0.0	0.5	0.1
281.2 - 290.9	0.3	0.	0.	0.1	0.	0.1	0.	0.1	0.2	0.0	0.	0.
o-xylene	0.	0.	0.	0.	0.2	0.1	0.5	0.2	0.5	0.1	0.2	0.1
291.1 - 349.9	2.1	2.0	1.5	0.9	1.5	1.0	1.4	1.0	1.9	1.7	1.7	1.1
indane	0.	0.	0.	0.	0.	0.	0.	1.3	0.	0.	0.	0.
350.1 - 359.5	5.1	12.7	2.4	4.9	2.6	5.2	2.9	4.7	2.2	3.1	2.0	3.1
phenol	1.8	3.1	1.1	1.3	1.3	1.2	1.3	1.3	0.3	0.2	0.9	1.0
359.7 - 404.9	8.4	14.0	4.6	9.8	4.4	11.0	4.8	12.5	1.6	2.3	3.6	5.8
tetralin	0.6	3.7	0.4	1.9	0.7	2.1	0.8	2.4	2.1	4.8	0.9	1.7
405.1 - 423.9	2.4	0.	0.	0.9	0.	0.	0.	0.	0.	0.	0.	0.
naphthalene	0.7	8.7	2.4	7.3	2.0	7.5	2.5	8.5	1.6	5.2	1.5	4.8
424.1 - 459.9	2.8	4.4	2.2	3.5	2.3	4.6	2.0	5.1	2.2	0.	2.5	4.2
quinoline	3.2	3.8	4.5	6.3	4.0	7.1	3.5	7.4	3.3	6.5	3.2	6.0
460.1 - 465.7	3.5	5.3	2.5	6.9	2.2	5.5	2.0	5.9	2.5	12.8	2.5	6.7
2-methylnaphthalene	6.2	8.6	7.1	13.2	6.2	12.5	5.7	13.1	6.2	16.3	6.4	15.4
465.9 - 491.9	6.3	6.7	7.4	9.8	6.7	9.4	5.9	9.6	7.9	13.3	6.1	13.0
biphenyl	2.8	2.5	3.1	3.4	2.7	3.3	2.3	2.5	3.1	4.4	4.1	4.3
492.1 - 496.2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
diphenyl ether	0.	0.	4.0	4.8	3.5	4.7	3.1	4.6	4.2	6.5	4.9	7.1
496.4 - 531.0	10.7	8.8	9.3	8.0	8.8	8.2	7.5	7.8	10.2	10.6	10.1	11.1
acenaphthene	3.6	2.2	4.4	2.8	4.3	3.0	3.8	2.8	4.8	3.7	6.9	6.5
531.2 - 642.9	1.1	0.6	1.7	1.0	1.6	1.1	1.5	1.0	1.7	0.	0.	0.

(Table continued)

Table 22 (continued)
Naphtha Compositions (wt %)
Kentucky 9, Fies Mine Coal

Date, 1980	26-27 Sept		20-21 Oct		28-29 Oct		7-9 Nov		20 Dec		27 Dec	
Run	217CD MB		219AB MB		220AB MB		220DE MB		221B MB		221G MB	
	V105 Oil	(P171) T102 OH	V105 Oil	(P171) T102 OH	V105 Oil	(P171) T102 OH	V105 Oil	(P171) T102 OH	V105 Oil	(P171) T102 OH	V105 Oil	(P171) T102 OH
Component or boiling range, °F												
dibenzofuran	2.0	1.2	2.0	1.1	2.0	1.1	1.7	1.0	2.2	1.3	1.8	1.8
548.7 - 568.3	4.0	2.2	2.9	2.5	3.0	1.5	2.6	2.1	3.0	2.2	3.1	0.
fluorene	2.5	1.0	2.2	1.6	2.6	1.0	1.9	1.6	2.0	1.2	6.3	2.7
568.5 - 642.9	6.6	2.7	13.1	2.9	13.5	4.2	13.3	2.4	14.1	3.2	9.1	2.3
phenanthrene	2.4	0.9	3.2	0.8	3.3	0.7	3.8	0.5	2.5	0.3	3.8	0.6
643.1 - 675.9	1.9	0.3	2.9	0.6	3.1	1.0	3.7	0.	2.0	0.2	2.0	0.
1-methylphenanthrene	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
676.1 - 685.3	0.7	0.3	1.3	0.4	1.4	0.	1.8	0.2	0.	0.	0.7	0.
9-methylanthracene	0.6	0.1	0.8	0.1	1.0	0.1	1.3		1.5	0.1	0.9	0.1
685.5 - 721.8	1.4	0.7	2.1	0.6	2.5	0.5	3.1		2.0	0.	2.0	0.
fluoranthene	0.8	0.2	1.1	0.3	1.1	0.3	1.5		0.7	0.	0.9	0.0
722.0 - 739.9	0.	0.	0.	0.	0.	0.	0.3		0.	0.	0.	0.
pyrene	0.3	0.1	0.5	0.1	0.0	0.1	0.7		0.7	0.	0.7	0.1
740.1 - 837.9	1.9	0.7	2.4	0.4	3.7	0.7	4.1		2.9	0.	2.1	0.1
chrysene	0.5	0.	0.4	0.2	0.6	0.1	0.9		0.6	0.	0.3	0.
838.1 - 937.3	0.4	0.	0.3	0.	0.6	0.	1.0		0.6	0.	0.2	0.
perylene	0.	0.	0.	0.	0.	0.	0.		0.	0.	0.	0.
unknowns > perylene	0.	0.	0.	0.	0.	0.	0.1		0.	0.	0.0	0.

Table 23
Naphtha Product Analyses
(Kentucky 9 Coal)

Date, 1980	26-17 Sept	20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run	217CD MB	219AB MB	220AB MB	220DE MB	221B MB	221G MB
Sample source	V131B	V131B	V131B	V131B	V131A	V131A
<u>Recycle solvent (V131 A or B)</u>						
<u>Boiling fractions, wt %</u>						
(IBP, °F)	(358)	(384)	(398)	(398)	(424)	(405)
IBP-350°F	0.3	0.1	0.1	0.1	0	0
350-450°F	4.3	3.7	3.8	3.1	1.2	1.4
450-550°F	18.4	32.4	29.2	21.3	28.1	25.7
550-650°F	17.7	27.6	26.6	23.3	26.2	24.7
650°F-EP	59.3	36.2	40.3	52.2	44.5	48.2
(EP, °F)	(960)	(937)	(951)	(947)	(959)	(1,000)
Specific gravity	1.068	1.029	1.035	1.096	1.020	1.021
<u>Ultimate analysis, wt %</u>						
Carbon	85.74	85.83	86.98	87.10	86.27	87.84
Hydrogen	8.24	8.46	8.63	8.59	9.14	8.97
Nitrogen	0.96	0.80	0.91	1.12	0.53	1.00
Sulfur	0.56	0.37	0.38	0.39	0.36	0.23
Chlorine	-	-	-	-	-	-
Ash	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Oxygen (by difference)	4.48	4.54	3.10	2.80	3.70	1.96
<u>Naphtha from T104 OH</u>						
<u>Boiling fractions, wt %</u>						
(IBP, °F)	(97)	(69)	(70)	(70)	(97)	(97)
IBP-200°F	13.9	20.8	17.5	10.9	8.8	4.8
200-350°F	58.3	30.9	26.2	17.8	23.4	23.1
350-450°F	27.5	45.3	52.1	52.2	54.4	55.2
450°F-EP	0.3	3.0	4.2	19.1	13.4	16.9
(EP, °F)	(424)	(496)	(487)	(611)	(488)	(487)
Specific gravity	0.844	0.839	0.859	0.891	0.901	0.913
<u>Ultimate analysis, wt %</u>						
Carbon	83.11	82.43	82.61	82.54	84.42	84.39
Hydrogen	11.62	11.68	11.01	10.57	10.72	10.63
Nitrogen	1.48	1.74	1.88	1.96	1.26	1.20
Sulfur	0.18	0.45	0.41	0.36	0.15	0.30
Chlorine	-	-	-	-	-	-
Ash	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Oxygen (by difference)	3.61	3.70	4.09	4.57	3.45	3.48

Table 24
Naphtha Product Compositions (wt %)
Kentucky 9, Fies Mine Coal

Date, 1980	26-27 Sept		20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run	217CD MB		219AB MB	220AB MB	220DE MB	221B MB	221G ME
Sample source	V131A SN 60786	V131B SN 61191	V131B SN 62254	V131B SN 62314	V131B SN 62613	V131A SN 63303	V131A SN 63657
Boiling range, °F, or component							
IBP - 96.9	0.	0.	0.	0.	0.	0.	0.
pentane	0.	0.	0.	0.	0.	0.	0.
97.1 - 156.1	0.	0.	0.	0.	0.	0.	0.
hexane	0.	0.	0.	0.	0.	0.	0.
156.3 - 175.9	0.	0.	0.	0.	0.	0.	0.
cyclohexane	0.	0.	0.	0.	0.1	0.	0.
176.1 - 231.0	0.	0.	0.	0.	0.	0.	0.
toluene	0.	0.2	0.1	0.1	0.	0.	0.
231.2 - 240.7	0.	0.	0.	0.	0.	0.	0.
pyridine	0.	0.	0.	0.	0.	0.	0.
240.9 - 281.0	0.	0.	0.	0.	0.	0.	0.
xylene (p-, m-)	0.	0.	0.	0.	0.	0.	0.
281.2 - 290.9	0.	0.	0.	0.	0.	0.	0.
o-xylene	0.	0.	0.	0.	0.	0.	0.
291.1 - 349.9	0.1	0.1	0.	0.	0.	0.	0.
indane	0.	0.	0.	0.	0.	0.	0.
350.1 - 359.5	0.2	0.8	0.2	0.	0.	0.	0.
phenol	0.0	0.0	0.	0.	0.	0.	0.
359.7 - 404.9	1.8	1.4	1.5	0.7	0.6	0.1	0.2
tetralin	1.7	0.3	0.9	1.2	1.0	0.1	0.3
405.1 - 423.9	0.	0.	0.	0.	0.	0.3	0.
naphthalene	1.4	1.0	0.4	0.9	0.8	0.4	0.3
424.1 - 459.9	1.2	0.8	0.7	0.9	0.7	0.3	0.5
quinoline	1.6	1.2	2.5	2.2	1.5	0.3	1.2
460.1 - 465.7	1.1	0.8	1.1	0.9	0.7	2.1	0.8
2-methylnaphthalene	3.6	2.4	4.7	4.1	3.0	3.1	2.9
465.9 - 491.9	3.6	2.3	4.1	3.7	2.7	4.2	3.7
biphenyl	1.8	1.6	2.8	2.4	1.8	1.9	1.8
492.1 - 496.2	0.	0.	3.1	0.	0.	0.	0.
diphenyl ether	2.0	0.	2.0	2.4	1.7	2.4	2.2
496.4 - 531.0	5.3	5.4	4.8	6.5	4.8	7.0	6.4
acenaphthene	2.8	2.2	3.8	3.6	2.5	3.5	3.4
531.2 - 548.5	1.0	0.	0.	1.6	1.0	1.4	1.3
dibenzofuran	2.0	2.4	3.5	1.8	1.5	2.1	2.1
548.7 - 568.3	1.9	3.1	2.5	1.8	1.9	2.7	2.5
fluorene	5.4	2.4	6.7	0.9	5.2	7.0	6.2
568.5 - 642.9	10.5	7.9	16.4	18.6	10.6	12.4	11.3

Table 24 (continued)
Naphtha Product Compositions (wt %)
Kentucky 9, Fies Mine Coal

Date, 1980	26-27 Sept		20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run	217CD MB		219AB MB	220AB MB	220DE MB	221B MB	221G MB
Sample source	V131A SN 60786	V131B SN 61191	V131B SN 62254	V131B SN 62314	V131B SN 62613	V131A SN 63303	V131A SN 63657
Component or boiling range, °F							
phenanthrene	4.7	4.3	2.0	5.3	5.6	4.1	4.7
643.1 - 675.9	4.4	3.7	3.2	5.0	5.8	4.8	4.8
1-methylphenanthrene	0.	0.	0.	0.	0.	0.	0.
676.1 - 685.3	0.	2.0	2.0	0.	3.8	0.	2.5
9-methylanthracene	2.3	1.6	2.1	2.8	2.7	4.0	1.9
685.5 - 721.8	7.0	4.5	4.9	7.3	7.0	5.0	5.2
fluoranthene	1.3	2.5	2.3	2.7	4.0	1.4	2.5
722.0 - 739.9	2.7	0.6	0.	0.	0.2	1.9	0.8
pyrene	2.5	2.0	1.8	1.7	2.4	0.2	1.7
740.1 - 837.9	10.5	10.3	8.5	8.8	12.8	11.5	11.1
chrysene	1.2	2.0	2.0	1.5	2.1	1.5	2.4
838.1 - 937.3	10.2	7.5	3.9	4.6	6.7	8.8	9.5
perylene	0.4	0.3	0.8	0.4	0.2	0.4	0.5
unknown >perylene	1.0	1.3	0.3	0.5	0.5	1.8	2.3

Table 25
T104 Recovery Column Operating Data
Kentucky 9 Coal

Date, 1980	26-27 Sept	20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run	217CD MB	219AB MB	220AB MB	220DE MB	221B MB	221G MB
Pressure, psig	8.0	8.5	8.6	8.3	10.0	9.0
<u>Flow rates, lb/hr</u>						
Feed from V164	182	494	498	503	111	98
<u>Overhead</u>						
Product	19	50	52	87	21	21
Reflux	-	-	-	-	102	141
Vent	-	-	2.0	0.6	-	-
Bottom product	164	444	446	416	90	77
<u>Temperature, °F</u>						
Top	285	342	333	342	339	339
Bottom	455	522	518	526	555	546
Feed	558	488	489	527	556	551
<u>Composition, wt %</u>						
<u>Feed</u>						
IBP-350°F	8.1	5.6	5.1	5.8	6.8	7.9
350-450°F	30.3	19.9	22.1	24.8	14.7	14.6
450°F-EP	61.6	74.5	72.8	69.4	78.5	77.5
<u>Overhead oil</u>						
IBP-350°F	72.2	51.6	43.7	28.7	32.2	27.9
350-450°F	27.5	45.3	52.1	52.2	54.4	55.2
450°F-EP	0.3	3.1	4.2	19.1	13.4	16.9
<u>Bottom</u>						
IBP-350°F	0.8	0.4	0.8	0.3	0	0.1
350-450°F	41.5	19.2	19.3	15.0	9.5	8.0
450°F-EP	57.7	80.4	79.9	84.7	90.5	91.9
<u>Specific gravity</u>						
Overhead	0.844	0.839	0.965	0.966	0.901	0.913
Bottom	0.973	0.979	0.981	0.986	0.972	0.971
Feed	0.953	0.962	0.966	0.965	0.956	0.951

Table 26
T104 Overhead Stream Compositions (wt %)
Kentucky 9, Fies Mine Coal

Date, 1980	26-27 Sept	20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run	217CD MB	219AB MB	220AB MB	220DE MB	221B MB	221G MB
	(V170) SN 60900	SN 61650	SN 62309	SN 62591	SN 63320	SN 63636
Boiling range, °F, or component						
IBP - 96.9	0.3	1.9	1.7	1.0	0.4	0.2
pentane	1.7	3.6	3.1	1.8	1.0	0.4
97.1 - 156.1	2.0	2.8	2.2	1.5	1.2	0.5
hexane	1.6	2.6	2.2	1.4	1.0	0.5
156.3 - 175.9	1.5	2.1	1.8	1.2	1.2	0.6
cyclohexane	3.9	4.2	3.0	2.2	2.2	1.5
176.1 - 231.0	6.2	6.9	3.4	2.0	1.8	1.1
toluene	27.0	5.4	5.5	3.4	7.7	9.2
231.2 - 240.7	0.6	0.	0.5	0.3	0.3	1.5
pyridine	0.	0.	2.7	1.8	2.0	2.6
240.9 - 281.0	7.5	6.2	5.8	3.9	3.9	2.0
xylene (p-, m-)	3.2	3.7	2.2	1.4	1.2	2.0
281.2 - 290.9	0.	1.4	0.	0.	0.	0.
o-xylene	0.	0.	1.3	0.8	1.6	0.8
291.1 - 349.9	16.6	11.0	8.3	6.2	6.7	6.8
indane	0.	0.	0.	0.	0.	0.
350.1 - 359.5	7.3	15.6	19.6	14.4	15.5	15.6
phenol	16.3	10.1	9.5	7.2	7.5	6.5
359.7 - 404.9	3.3	11.3	13.0	16.3	10.8	20.0
tetralin	0.3	2.8	3.4	3.3	13.0	3.6
405.1 - 423.9	0.	2.0	0.	0.	0.	0.
naphthalene	0.3	1.9	2.7	7.6	7.7	9.4
424.1 - 459.9	0.	1.7	3.9	3.3	0.	0.
quinoline	0.2	0.5	0.6	3.5	6.4	7.0
460.1 - 465.7	0.	0.8	1.9	2.8	3.7	5.7
2-methylnaphthalene	0.	0.8	1.2	3.8	1.6	2.4
465.9 - 491.9	0.	0.1	0.1	2.7	1.3	1.4
biphenyl	0.0	0.1	0.1	0.6	0.1	0.1
492.1 - 496.2	0.	0.	0.	0.	0.	0.
diphenyl ether	0.	0.2	0.2	0.9	0.3	0.3
496.4 - 531.0	0.	0.1	0.1	1.6	0.	0.
acenaphthene	0.	0.2	0.1	0.6	0.0	0.
531.2 - 548.5	0.	0.	0.	0.2	0.	0.
dibenzofuran	0.	0.1	0.	0.3	0.	0.
548.7 - 568.3	0.	0.	0.	0.5	0.	0.
fluorene	0.	0.	0.	0.4	0.0	0.
568.5 - 642.9	0.	0.	0.	0.8	0.	0.
phenanthrene	0.	0.0	0.	0.2	0.	0.
643.1 - 675.9	0.	0.	0.	0.1	0.	0.

(Table continued)

Table 26
T104 Overhead Stream Compositions (wt %) (continued)
Kentucky 9, Fies Mine Coal

Date, 1980	26-27 Sept	20-21 Oct	28-29 Oct	7-9 Nov	20 Dec	27 Dec
Run	217CD MB	219AB MB	220AB MB	220De MB	221B MB	221G MB
	(V170) <u>SN 60900</u>	<u>SN 61650</u>	<u>SN 62309</u>	<u>SN 62591</u>	<u>SN 63320</u>	<u>SN 63636</u>
Component or boiling range, °F						
1-methylphenanthrene	0.	0.	0.	0.1	0.	0.
676.1 - 685.3	0.	0.	0.	0.	0.	0.
9-methylanthracene	0.	0.0	0.	0.1	0.	0.
685.5 - 721.8	0.	0.	0.	0.	0.	0.
fluoranthene	0.	0.	0.	0.	0.	0.
722.0 - 739.9	0.	0.	0.	0.	0.	0.
pyrene	0.0	0.	0.	0.	0.	0.
740.1 - 837.9	0.1	0.	0.	0.	0.	0.
chrysene	0.	0.	0.	0.	0.	0.
838.1 - 937.3	0.	0.	0.	0.	0.	0.
perylene	0.	0.	0.	0.	0.	0.
unknowns > perylene	0.	0.	0.	0.	0.	0.

Table 27
Analysis of Plant Component Problems - October 1980

<u>Item</u>	<u>Type Failure</u>	<u>Cause</u>	<u>Process Conditions</u>	<u>Operating hours between failures</u>	<u>Priority Code(a)</u>	<u>Action</u>	<u>Future Action</u>
B102 Slurry Preheater (two failures)	Low gas pressure	Vaporizer not large enough	Do not apply	Unknown	A	Installed new vaporizer	None
First stage letdown system	Plug	Coke	Proprietary	Unknown	C	Clean	Modify valve trims
P18G-A CSD Feed Pump	Packing	Leaking from abrasion of plunger	Liquid coal with ash. 590°F	600	C	Repack pump	Install tungsten carbide coated plunger for test
P18G-B CSD Feed Pump	Packing	Leaking from abrasion of plunger	Liquid coal with ash. 590°F	450	C	Repack pump	None
C203 Instrument Air Compressor	Using excessive amount of oil	Worn compression ring	Air at 100 psi	8,000	D	Rebuild compressor	None

(a) Priority Code:

- A. Requires immediate plant shutdown to repair.
- B. Plant operation is crippled, requires immediate action.
- C. Operating spare is available. Jeopardy situation exists.
- D. Plant operation is not seriously impaired.

(Table continued)

Table 27
Analysis of Plant Component Problems - November 1980

<u>Item</u>	<u>Type Failure</u>	<u>Cause</u>	<u>Process Conditions</u>	<u>Operating hours between failures</u>	<u>Priority Code(a)</u>	<u>Action</u>	<u>Future Action</u>
C102 Hydrogen Recycle Compressor	Ruptured O-ring	Corroded O-ring seats	Cooling water at 80°F, 60 psig, 85% hydrogen at 1,100 psig suction, 2,300 psig discharge, 140°F	550	A	None at the time	Replace stuffing box
B203 SRC Dowtherm Heater	Burned electrical contacts	Low voltage on primary power supply to the pilot plant	Dowtherm A 700°F, 125 psig	Unknown	A	Replaced contacts	Install dual fuel burner
CSD Feed Pump	Leaking check valve	Wear	Proprietary	Unknown	C	Replaced valves	None

(a) Priority Code

- A. Requires immediate plant shutdown to repair.
- B. Plant operation is crippled, requires immediate action.
- C. Operating spare is available. Jeopardy situation exists.
- D. Plant operation is not seriously impaired.

(Table continued)

Table 27
Analysis of Plant Component Problems - December 1980

Item	Type Failure	Cause	Process Conditions	Operating hours between failures	Priority Code(a)	Action	Future Action
PV999 T102 Feed Valve	Worn trim	Corrosion of trim	Liquid coal and ash 650°F, 115 psi upstream, 0.7 psia downstream	Approx 1,500	B	Replace trim	Change to harder materials.
LV945-2 T102 Feed valve	Damaged seat	Damaged while removing seat to unplug valve	Liquid coal and ash 590°F, 100 psi	Unknown	C	Replace seat	None
LV415-A High Pressure Letdown Valve	Broken trim	Unknown	+650°F liquid coal and ash	103	C	Replace trim	None
C208 Instrument Air Compressor	Discharge valve	Broken disc - Teflon cushion dislodged	Instrument air 100 psi discharge	Unknown	B	Replace valve	Check valves each shutdown
TR-401 Doric Temperature Recorder for R101/B102	Electronic	Unknown	Does not apply	Approx 2,500	B	Replace electronic component	None
B102 Slurry Preheater	Shutdown (several times)	Unknown	800°F, 2,000 psi		A	Replace flame detector, amplifier and programmer	Hire outside consultant to work with pilot plant on improving reliability of all heaters
P180A and B	Packing	Nct receiving lubrication	590°F, 900 psi Liquid coal and ash	P180A - 96 P180B - 72	C	Repack pump	Increase lubrication rate
B202 Steam Boiler	Shutdown (several times)	Low water	Steam 200 psi	Unknown	A	Install new pump	Hire outside consultant to work with pilot plant on improving reliability of all heaters

(a) Priority Code

- A. Requires immediate plant shutdown to repair.
- B. Plant operation is crippled, requires immediate action.
- C. Operating spare is available. Jeopardy situation exists.
- D. Plant operation is not seriously impaired.

FIGURE 2. USF FILTER UNIT FLOWSHEET

FIGURE 3. INDUSTRIAL FILTER TEST UNIT FLOWSHEET

FIGURE 4. CRITICAL SOLVENT DEASHING UNIT FLOWSHEET

FIGURE 6. DISSOLVER DIFFERENTIAL PRESSURE AND
NUCLEAR DENSITY INSTRUMENTATION

FIGURE 7 PROCESS SOLVENT QUALITY

FIGURE 8. RATIOS OF BENZENE-SOLUBLES TO
BENZENE-INSOLUBLES IN T102
VACUUM COLUMN BOTTOMS VS T102
BOTTOMS TEMPERATURE

FIGURE 9. RATIOS OF BENZENE-SOLUBLES TO BENZENE-INSOLUBLES IN V10 SRC VS V103 HIGH PRESSURE SEPARATOR TEMPERATURE

FIGURE 10. RIOI DISSOLVER TEMPERATURE VS
VIO3 HIGH PRESSURE SEPARATOR
TEMPERATURE

FIGURE 11. E102 OUTLET PROCESS AND INLET SKIN TEMPERATURE VS V103 HIGH PRESSURE SEPARATOR TEMPERATURE

FIGURE 12. BIO3 VACUUM COLUMN PREHEATER, MODE I OPERATION

FIGURE 13. BIO3 VACUUM COLUMN PREHEATER, MODE 2 OPERATION

FIGURE 14. PROCESS SOLVENT DISTILLATION CURVES (RUN 217 CD MB BY GC AND ASTM-86)

FIGURE 15. PROCESS SOLVENT DISTILLATION CURVES (RUN 219 AB MB BY GC AND ASTM D-86)

FIGURE 16. PROCESS SOLVENT DISTILLATION CURVES(RUN 220 AB MB BY GC AND ASTM D-86)

FIGURE 17. PROCESS SOLVENT DISTILLATION CURVES (RUN 220 DE MB BY GC AND ASTM D-86)

FIGURE 18. PROCESS SOLVENT DISTILLATION CURVES (RUN 221B MB BY GC AND ASTM D-86)

FIGURE 19. PROCESS SOLVENT DISTILLATION CURVES (RUN 221 G MB BY GC AND ASTM D-86)

FIGURE 20. PROCESS SOLVENT DISTILLATION CURVES
(RUN 217 CD MB BY ASTM D-1160)

FIGURE 21. PROCESS SOLVENT DISTILLATION CURVES (RUN 219 ABMB BY ASTM D-1160)

FIGURE 22. PROCESS SOLVENT DISTILLATION CURVES(RUN 220AB MB BY ASTM D-1160)

FIGURE 23. PROCESS SOLVENT DISTILLATION CURVES (RUN 220 DE MB BY ASTM D-1160)

FIGURE 24 . PROCESS SOLVENT DISTILLATION CURVES (RUN 221 B MB BY ASTM D-1160)

FIGURE 25. PROCESS SOLVENT DISTILLATION CURVES (RUN 221 G MB BY ASTM D-1160)

FIGURE 26. NAPHTHA DISTILLATION CURVES (RUN 217 CD MB)

FIGURE 27. NAPHTHA DISTILLATION CURVES (RUN 219 AB MB)

FIGURE 28. NAPHTHA DISTILLATION CURVES (RUN219 B MB)

FIGURE 29. NAPHTHA DISTILLATION CURVES (RUN 220 AB MB)

FIGURE 30. NAPHTHA DISTILLATION CURVES (RUN 220 DE MB)

FIGURE 31. NAPHTHA DISTILLATION CURVES (RUN 221 B MB)

FIGURE 32. NAPHTHA DISTILLATION CURVES (RUN 221G MB)

FIGURE 33 . WASTEWATER TREATMENT SYSTEM

FIGURE 34. EFFLUENT TREND CHART: PHENOL, BOD, pH AND OIL & GREASE - JANUARY TO JUNE 1980

FIGURE 35. EFFLUENT TREND CHART: PHENOL, BOD, pH AND OIL & GREASE - JULY TO DECEMBER 1980

FIGURE 36. EFFLUENT TREND CHART: SOLIDS AND TEMPERATURE-JANUARY TO JUNE 1980

FIGURE 37. EFFLUENT TREND CHART: SOLIDS AND TEMPERATURE-JULY TO DECEMBER 1980

FIGURE 38. FLOW TREND CHART—JANUARY TO JUNE 1980

FIGURE 39. FLOW TREND CHART—JULY TO DECEMBER 1980