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The BRECKINRIDGE PROJECT

Initial Effort

REPORT I

EXECUTIVE SUMMARY

MASTER

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.

PREPARED FOR
UNITED STATES DEPARTMENT OF ENERGY
UNDER COOPERATIVE AGREEMENT
NO. DE-FC05-800R20717

DISCLAIMER

The information and data contained in this report are the result of an economic evaluation and a preliminary design effort and because of the nature of this work no guarantees or warranties of performance, workmanship, or otherwise are made, either expressed or by implication.

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REPORT I
EXECUTIVE SUMMARY

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INTRODUCTION AND BACKGROUND

Introduction

This report presents an overview of the Breckinridge Project and summarizes the results achieved during the development phase of the project that was performed under a Cooperative Agreement with the United States Department of Energy. The rather substantial product produced to fulfill this agreement is available for the reader who is interested in pursuing particular aspects of the work in greater detail.

The Breckinridge Project provides for the design, construction and operation of a 50,000 barrel per day coal liquefaction facility in Breckinridge County, Kentucky. The Breckinridge Energy Company, a partnership of major industrial firms, is being formed to own and operate the facility. A Management Committee, consisting of a representative from each of the partners, will arrange financing and provide overall direction to the project. Ashland Synthetic Fuels, Inc. (ASFI), as "Operator" for the venture, will be responsible for the design, construction and operation of the facility.

Background

The development of the basic technology used in the Breckinridge Project dates back to the late 1950's and the invention by Hydrocarbon Research, Inc., (HRI) of the ebullated-bed reactor and the H-Oil® process. This process was originally designed to convert heavy oil extracted from tar sands to lighter, more valuable products. The H-Oil® process is currently being used commercially for the hydrocracking of residual material from crude oil.

The H-Coal® process is based on the H-Oil® technology. This coal liquefaction process produces clean low-sulfur petroleum substitutes

suitable for most types of hydrocarbon-based fuel and chemical uses regardless of the sulfur content of the coal. Significant amounts of H-Coal® process data have been accumulated over a 15-year period from bench-scale and process development units. However since this data was not readily transferable to a commercial-scale facility, a pilot plant operation was clearly indicated as the logical intermediate step.

Pilot Plant

A large H-Coal® Pilot Plant was funded in 1976 by contributions from the U.S. Department of Energy, ASFI, the Commonwealth of Kentucky, Electric Power Research Institute, and several domestic and foreign firms. Construction of the Pilot Plant was completed in January 1980 and coal was introduced into the reactor in May 1980 after initial runs on oil. It is now in operation at Catlettsburg, Kentucky, converting 220 tons of coal per day into 600 barrels of distillate products by catalytic hydrogenation.

Commercial Facility

The results obtained from operation of the Catlettsburg Pilot Plant have confirmed the logic of the Cooperative Agreement negotiated with the DOE, in 1980, which provided for the preliminary design and financial analysis of a 50,000 barrel per day H-Coal® plant. A commercially attractive site in Breckinridge County, Kentucky, has been secured for the project. Environmental monitoring and permitting activities have shown that both the site and the preliminary design are in compliance with all existing control and attainment legislation.

The estimated capital cost of the commercial facility is $3.17 billion, and the associated out-of-pocket operating cost is $18 per barrel, both in January 1981 dollars. Financial anlaysis shows the project to be an attractive investment under certain leveraged conditions which are possible through the assistance of the Synthetic Fuels Corporation.

ASFI is currently working with the Synthetic Fuels Corporation and potential partners to develop project financing for the commercial venture. Critical permits are being obtained and an Environmental Impact Statement is being prepared pursuant to initiating site preparation in early 1983. Commercial operations are expected to start up in early 1988.

INITIAL EFFORT

Overview

On April 1, 1980, the United States Department of Energy, Ashland Synthetic Fuels, Inc., and Airco Energy Company, Inc., executed a Cooperative Agreement for an "Initial Effort" to design a commercial-scale coal liquefaction plant using the H-Coal® process. This effort is now complete and the following primary objectives have all been achieved.

- Prepare a preliminary design of a commercial-scale plant
- Estimate the associated capital and operating costs
- Prepare an economic analysis of the commercial-scale plant
- Prepare a preliminary plan for the detailed engineering, procurement, construction and operation of the commercial-scale plant
- Collect certain baseline environmental data

The participants engaged Hydrocarbon Research, Inc. (HRI), Bechtel, Inc., and Dames & Moore as subcontractors to perform the work. HRI developed the design for the six plants involved in the reaction and primary separation processes. Dames & Moore collected the necessary baseline environmental data for the site and conducted preliminary soils investigations. Bechtel was assigned the primary responsibility for designing the remaining plants, preparing the capital cost estimate, preparing the project schedule, and developing the plan for the engineering, procurement and construction of the commercial-scale plant.

An ASFI project team directed and monitored the work of the three principal subcontractors. The team was responsible for the operating

cost estimate, the economic analysis, the financial plan, the technical audit, the management and operating plans for the project as well as the environmental, socioeconomic, safety and health aspects of the work.

Bechtel engaged five major subcontractors to execute highly specialized portions of the work. Roberts & Schaefer prepared the design for the Coal Washing and Secondary Crushing Plants. Airco provided the design for the Oxygen and Cryogenic Hydrogen Purification Plants. Davy McKee designed the Stack Gas Scrubbing Plant. U.O.P. provided a preliminary process design for the Naphtha Hydrotreating and Reforming Plant as well as feedstock characterization data for naphtha hydrotreating and reforming. Texaco provided the process information for the Texaco partial oxidation gasifiers in the Gasification and Purification Plant.

Concurrent with the Initial Effort, Ashland Synthetic Fuels, Inc., implemented the following activities:

- Selected a specific site for the commercial facility that has been dedicated to the Breckinridge Project by the State of Kentucky
- Investigated coal supply sources and initiated negotiations with suppliers
- Conducted socioeconomic studies and held impact mitigation discussions with officials and leading citizens of communities near the plant site
- Submitted a preliminary application to the Synthetic Fuels Corporation for a government loan guarantee
- Initiated applications for the major construction and environmental permits
- Reviewed financial and technical aspects of the project with potential partners
- Developed a draft partnership agreement

These critical and other ongoing activities were all selected to support the primary objective of initiating the Engineering and Procurement Phase of the Breckinridge Project in early 1982.

Deliverables

Prior to execution of the Cooperative Agreement, ASFI developed a very comprehensive definition of the scope of work for the Initial Effort that included an itemized list of the engineering drawings, narratives and other descriptive materials or "deliverables" that were considered necessary to document the effort. This definition was included in the Cooperative Agreement.

The deliverables produced under the Initial Effort of the Cooperative Agreement are presented in eleven reports consisting of twenty-eight volumes. A detailed index of reports and volumes can be found in the Appendix of this Report I, The Executive Summary. The contents of the other ten reports are briefly summarized below.

Report II, Breckinridge Project Design Basis, presents an overview of the project and includes a history of the project, a generalized process description, and a description of the facilities.

Report III, Specifications, contains the design, engineered equipment and material specifications prepared for the Initial Effort.

Report IV, Process Units, and Report V, Utility and Offsite Units, contain detailed process descriptions, process flow diagrams, heat and material balances, major equipment lists, equipment data sheets, piping and instrument diagrams, electrical single-line drawings, plot plans, and equipment arrangement drawings for each of the 36 plants.

Report VI, Management Plan, presents the management plan for execution of the engineering, procurement, construction and operation of the commercial facilities. It includes an overview of management objectives and responsibilities. Organization charts, craft and nonmanual staffing charts, master schedules and a discussion of the managerial techniques that will be employed to control the work are also presented in Report VI.

Report VII, Environmental, Socioeconomic, Safety and Health, presents the baseline environmental data collected by Dames & Moore for the site and the Socioeconmic Report prepared by Watkins and Associates. The report also contains the air management, the water management and the solid waste disposal plans. Detailed discussions of the safety and health plans developed for implementation during subsequent phases of the project are also presented and reflect the major attention given to these aspects during this initial period.

Report VIII, Capital Cost Estimate, presents the factored estimate prepared by Bechtel to determine the capital cost of the project. The costs of bulk materials, labor and other related costs were established for each plant using factors based on Bechtel's historical cost data for similar plants. The accuracy of this estimate is considered to be within the ±20% specified in the Cooperative Agreement.

Report IX, Operating Cost Estimate, presents the costs of operating the facility. This estimate is based on a detailed staffing table prepared after extensive consultation with operating personnel of Ashland Oil, Inc., the H-Coal® pilot plant, and other operating companies in the area. Catalyst and chemical costs were obtained from suppliers. The confidence level in this estimate is high.

Report X, Economic Analysis and Financial Plan, presents various economic analyses and the financial plan for the project. These are also summarized in this executive summary.

Report XI, Technical Audit, presents reports and other material used during the Initial Effort in making engineering comparisons, process tradeoffs and decisions in areas of technical uncertainty. It identifies critical design areas that require further study and development in later phases of the project and lists supplementary design data needed.

Facility

FACILITY

Location

The commercial facility will be located in Breckinridge County, Kentucky, immediately adjacent to the Ohio River, approximately midway between Louisville, Kentucky, and Evansville, Indiana. It will be served by a branch of the Louisville and Nashville Railroad and by Kentucky State Highway 144. The 1,600-acre site is currently under purchase option by the State of Kentucky from ASARCO, and title will be transferred to ASFI when the project is initiated.

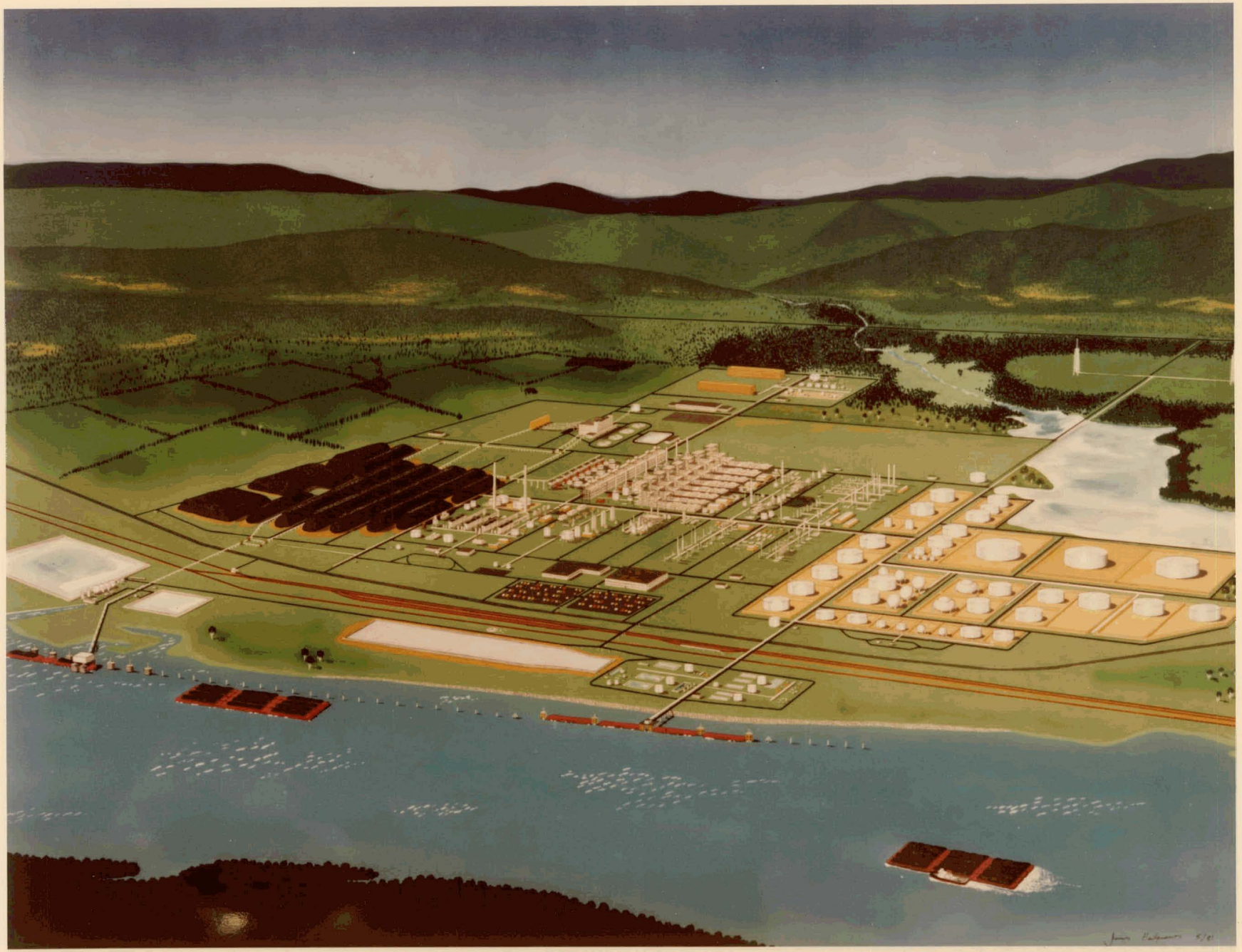
This site has been studied from both the environmental and socioeconomic standpoints. No major concerns that will unduly affect the construction or operation of the facility have been identified.

Plants

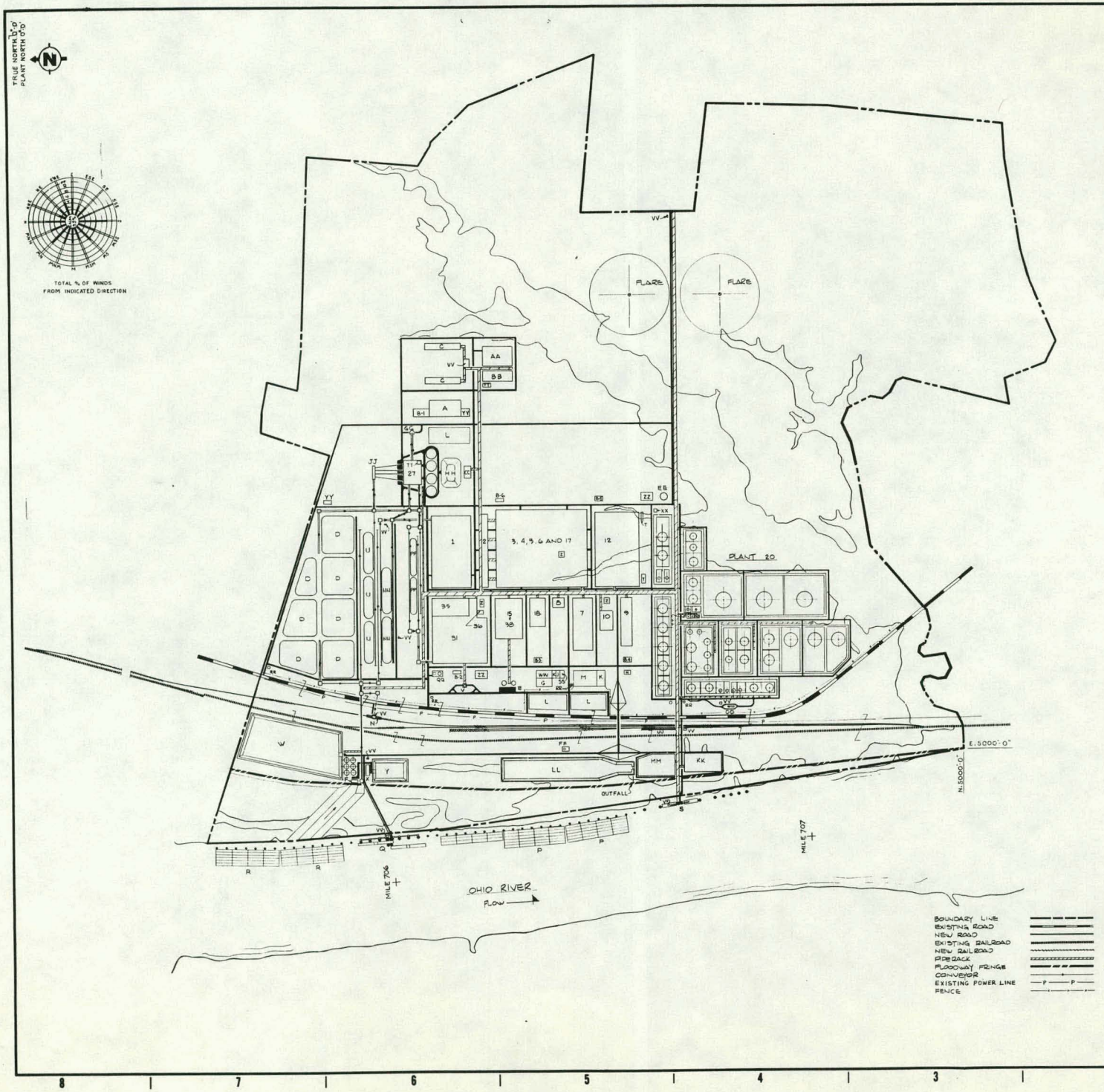
The facility contains thirty-six plants, thirteen of which are process units directly involved in processing the coal and its liquid hydrocarbon products. The remaining plants are ancilliary or "offsite" units such as tankage, waste water treatment, cooling towers, and riverfront docks. Most of the process plants and some of the offsites involve multiple trains of identical units. The main reaction and separation plants, for instance, have eight duplicate trains. Several of the plants contain a series of processing steps, such as the Gasification and Purification Plant, which has separate sections for generating the synthesis gas, shifting the gas, removing the hydrogen sulfide, and compressing the gases. All in all, more than eighty operating entities are involved.

Both the Artist's Rendering, Figure 1, and The Overall Site Plan, Figure 2, are included in this section; they depict the Breckinridge Project Facility. The river water intake and coal unloading dock are

located upriver near the northwest corner of the property. The product barge loading dock is approximately 4,000 feet downstream. Wastewater storage ponds, treatment and pumping equipment are located between the river and the railroad. The primary preparation, reaction and separation plants are on the east side of the main pipeway and the product separation plants are on the west side. The truck and rail product loading facilities are located adjacent to the highway and railroad west of the tank farm. The facilities for unloading coal received by rail are located near the coal storage area. The cooling towers and flares are located considerably east of the process plants.



ARTIST'S RENDERING OF PLANT



LEGEND

1. COAL DRYING AND PULVERIZING
2 COAL SLURRY PREPARATION
3 H-COAL PREHEATING AND REACTION
4 H-COAL PRIMARY SEPARATION
5 H-COAL RECYCLE SLURRY PREPARATION
6 H-COAL RECYCLE HYDROGEN CONCENTRATION AND COMPRESSION
7 GAS PLANT
8 CRYOGENIC HYDROGEN PURIFICATION
9 SOUR WATER TREATING
10 SULFUR PLANT
12 GASIFICATION AND PURIFICATION
15 OXYGEN PLANT
17 DISTILLATE SEPARATION
18 NAPHTHA TREATING AND REFORMING
20 TANKAGE
21 INTERCONNECTING PIPING (PIPERACKS)
22 RIVER LOADING FACILITIES
25 RAIL AND TRUCK LOADING
26 COAL RECEIVING AND STORAGE
27 COAL WASHING AND SECONDARY CRUSHING
31 STEAM GENERATION AND B.F.W. TREATING
32 WATER SYSTEM
33 FIRE SYSTEM
34 WASTE WATER TREATMENT PLANTS
35 STACK GAS SCRUBBING
36 INSTRUMENT AIR AND PLANT AIR SYSTEM
38 INERT GAS SYSTEM
39 PURGE AND FLUSH OIL SYSTEM
42 WASTE SLUDGE INCINERATOR

A WAREHOUSE
B-1 THRU B-6 MAINTENANCE BUILDINGS
C COOLING TOWERS (PLT 32)
D DEAD COAL (PLT 26)
E LIQUID OXYGEN AND NITROGEN UNLOADING
F WATER INTAKE
G CHANGE HOUSE
H FIRE STATION
J FIRST AID STATION
K CAFETERIA
L PARKING
M ADMINISTRATION
N RAILROAD COAL UNLOADING (PLT 26)
P PULL BARGES, 24 BARGE TOW (PLT 22)
Q COAL UNLOADING DOCK (PLT 22)
R EMPTY BARGES, 24 BARGE TOW (PLT 22)
S LIQUID LOADING DOCK (PLT 22)
T SWITCH GEAR
U RAW COAL (PLT 26)
V FLY ASH UNLOADING AREA (PLT 31)
W RAW WATER POND
X CSP RUNOFF TREATING AREA (PLT 34)
Y COAL STORAGE PILES (CSP) RUNOFF POND (PLT 34)
Z CONTROL ROOM
AA COOLING TOWER SOFTENING AND FILTRATION (PLT 32)
BB WASTE WATER CONCENTRATION AND EVAPORATION SYSTEM (PLT 34)
CC ASH HANDLING (PLT 31)
DD TANK TRUCK LOADING (PLT 23)
EE FIRE WATER TANK (PLT 33)
FF SANITARY SEWAGE TREATMENT PLANT (PLT 34)
GG REFUSE BUNKER (PLT 27)
HH EMERGENCY POND (PLT 27)
JJ PLANT FEED BUNKER (PLT 26)
KK POST TREATMENT OF STRIPPED SOUR WATER (PLT 34)
LL OILY WATER SURGE POND (PLT 34)
MM OILY WATER TREATMENT (PLT 34)
NN CLEAN COAL STORAGE (PLT 26)
PP BOILER FUEL STORAGE (PLT 26)
QQ SUMP AND TANK FOR INCINERATOR (PLT 42)
RR GATE HOUSE
SS GUARD/SECURITY HOUSE
TT OPERATING EQUIPMENT ROOM
UU RAIL LOADING (PLT. 23)
VV OPERATOR SHELTER
WW LABORATORY
XX SPECIAL CLEANING
YY GARAGE

NOTES

1. SITE COORDINATES N.5000'-0" E.5000'-0" ARE ESTABLISHED AT THE MOUTH OF TOWN CREEK AT THE INTERSECTION OF THE WATER LINE OF THE OHIO RIVER. REFERENCE: COMMONWEALTH LAND TITLE INSURANCE COMPANY PHILADELPHIA, PENNSYLVANIA FILE No. L-052282.
2. HIGH POINT OF FINISHED GRADE ELEVATION 100'-0" EQUALS ELEVATION 415'-0" ABOVE M.S.L.
3. NORMAL WATER ELEVATION OF OHIO RIVER IS EL. 382.3 AT RIVER MILE 706.
4. MEAN HIGHWAY ELEVATION IS EL. 415'-0"
5. TOP OF RAILROAD BALLAST EL. IS 415'-0"

REFERENCE DRAWINGS

50E-A-4 INDEX DRAWING
50E-A-6 CONSTRUCTION REQUIREMENT STUDY

0 200 400 600 800 1000
1"=400'-0"
GRAPHIC SCALE

NO.	DATE	REVISIONS	BY	CHK'D	APP'D
1	10/29/81	ISSUED FOR PHASE ZERO	P.P	J.K	J.S
0	9/4/81	ISSUED FOR REVIEW AND APPROVAL	P	J.K	J.K

SCALE 1"=400' DESIGNED J. KUTLIK DRAWN T. BOWERSOX

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.

U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-80ER20717

BRECKINRIDGE PROJECT

BRECKINRIDGE COUNTY — PHASE ZERO — KENTUCKY

OVERALL SITE PLAN

HOUSTON

JOB NO.	DRAWING NO.	REV.
14222	50E-A-1	1

34 X 44 "E" SIZE

PROCESS DESCRIPTION

Introduction

This section describes the coal liquefaction process and offsite plants of the Breckinridge facility. Detailed descriptions can be found in Reports IV and V, Process Units and Utility and Offsite Units.

Process

The ebullated-bed reactor of the H-Coal® liquefaction process is the heart of the Breckinridge Project. In support of this proprietary process, a large number of process facilities are required both upstream and downstream of the reactor. This process section presents an overview of the process more or less in the order of flow through the facility. Figure 3, Overall Block Flow Diagram, on page 17, may aid the reader in following the narrative description.

Run-of-mine Illinois basin bituminous coal is received, stored, reclaimed and fed to the Coal Washing Plant where it is processed by screens, heavy media separators, cyclones, and hydroclones that materially lower its ash and sulfur content. The middlings are used as boiler fuel for steam generation, and the tailings are transported to an offsite landfill.

The clean coal product from the Washing Plant is dried and pulverized in bowl mills. It is then slurried with recycled oil, preheated, and pumped into the base of the reactor. There it is reacted with hydrogen in presence of a catalyst at 3000 psi and 859°F. Liquid is

continuously withdrawn near the top of the reactor and recycled to the bottom thereby creating an ebullating effect. This ebullation controls the temperature of the reactor within close limits and permits a portion of the catalyst to be routinely withdrawn and replaced with fresh catalyst, thus maintaining a high and constant level of catalytic activity.

The reactor products, along with the unreacted coal and ash, are removed at a point above the catalyst bed and separated into gaseous and liquid effluent streams. The gases are cooled in successive steps and separated from condensible material. A portion of the hydrogen-rich gas stream is recompressed and returned to the reactor as a part of the hydrogen feed. Another portion is sent to the Gas Plant as a purge stream to prevent the accumulation of methane and inerts in the system. The condensed liquids flow to a fractionation section for recovery of products and recycle streams. Gas streams fed to the Gas Plant contain C_4 and lighter hydrocarbons and gases; the liquid streams to the fractionator contain mostly C_5 and heavier hydrocarbons.

The liquid effluent pressure is let down in two stages. The slurry remaining after the second flash is separated in hydroclones. The ash lean hydroclone overflow is recirculated to the reactor in the slurry feed. The ash-rich hydroclone underflow is distilled in atmospheric and vacuum towers. The distilled material is sent to the fractionator, and the distillation residue is fed to the Texaco gasifiers to produce make-up hydrogen.

Overhead gases and light naphtha from the fractionator are sent to the Gas Plant. The heavy naphtha sidecut is hydrotreated and reformed to produce 105 RONC gasoline blending stock. Recovered flush oil and distillate oil sidecuts are sent to storage. The flush oil is used

for various recycle operations and the distillate oil is marketed as utility fuel oil. The heavy distillate bottoms stream is primarily used for recycling; a small fraction flows to product tankage.

In the Gas Plant, lighter hydrocarbons are washed with diethanolamine to remove hydrogen sulfide and carbon dioxide, which are sent to the Sulfur Plant. The hydrocarbon gases are then cooled, dried, filtered, washed with liquid butane and liquid propane, and sent to the Cryogenic Hydrogen Purification Plant, where the gases are further cooled to cryogenic temperatures. Recovered hydrogen is compressed and recycled to the reactor. Condensed, light hydrocarbons are vaporized and used as fuel gas for the plant-fired heaters or marketed as a pipeline gas product.

The propane and butane streams are separated by distillation and sent to storage as marketable products. The light naphtha is treated by caustic washing, Merox sweetening, and filtration and sent to storage as light straight-run gasoline product.

The hydrogen consumed in the reaction is generated in the Gasification and Purification Plant. Synthesis gas is produced by gasification of the vacuum bottoms with oxygen and superheated high-pressure steam in the Texaco partial-oxidation gasifiers. The resulting synthesis gas is catalytically shifted in three stages to convert the carbon monoxide and water vapor to hydrogen and carbon dioxide. The water is condensed, and hydrogen sulfide and carbon dioxide are removed by scrubbing with Selexol solution in successive stages. The 98% pure hydrogen stream is combined with hydrogen from the Cryogenic Hydrogen Purification Plant and the Naphtha Hydrotreating and Reforming Plant. The combined gases are then compressed and fed to the reactors. A Cryogenic Air Separation Plant is provided to supply the oxygen

required for the Texaco gasifiers. This plant also produces nitrogen for purging and blanketing as well as some marketable liquid argon by-products.

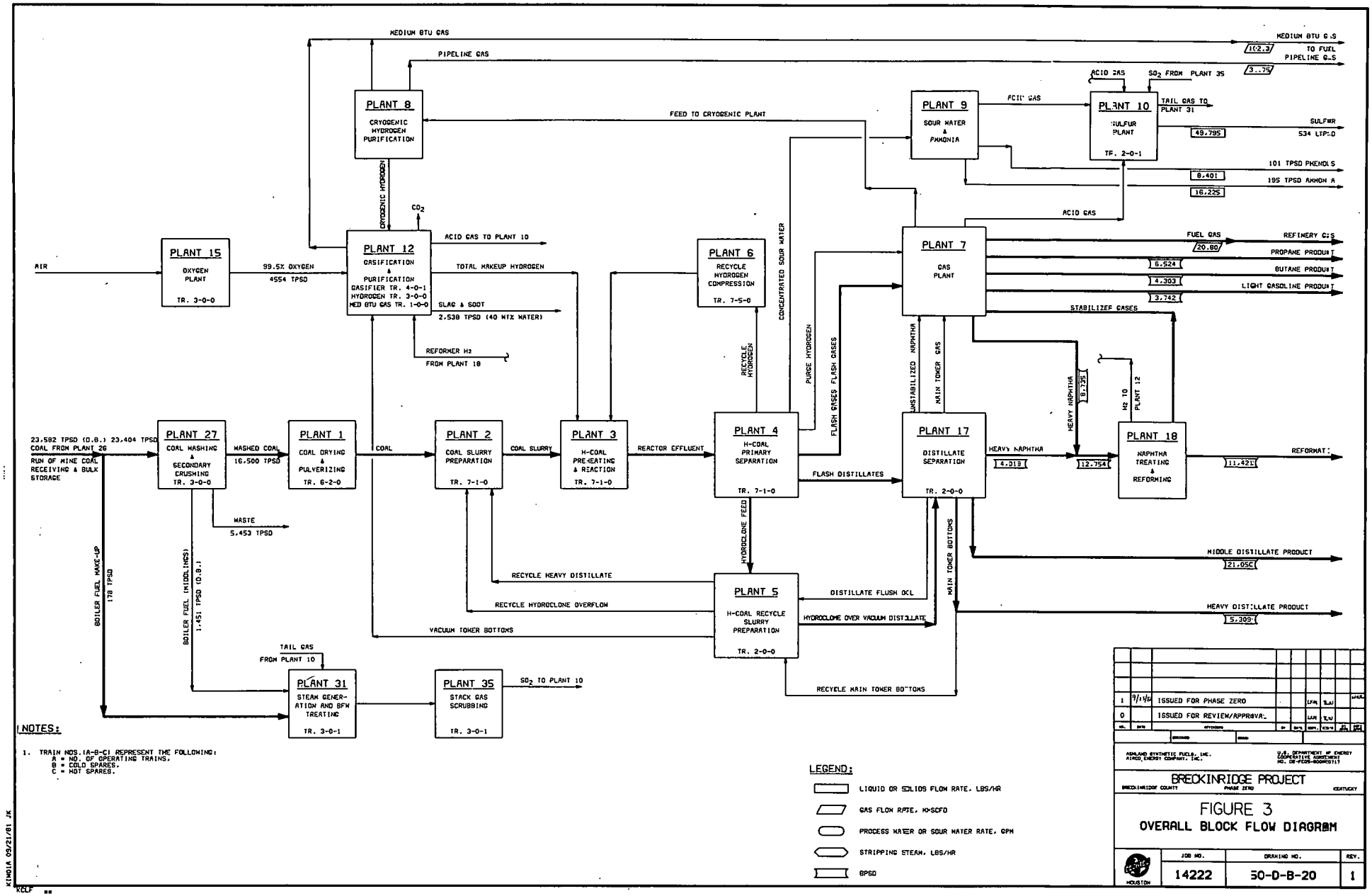
Sour water from all sources is stripped of its acid gas content. Ammonia is removed from the stripped gases by the PHOSAM® process and recovered as a marketable by-product. The remaining gases are sent to the Sulfur Plant. The phenolic compounds in the stripped water are removed by solvent extraction using Jones & Laughlin's proprietary dephenolization process. The phenol-free water is sent to the Waste Water Treatment Plant for further purification and reuse.

The Sulfur Plant uses a conventional Claus process to convert sulfur compounds in all sour gas streams to molten sulfur which is sent to storage as a marketable by-product. The tail gas from the Sulfur Plant is vented to boilers in the Steam Generation Plant. Flue gas from the boilers is treated by the Wellman-Lord process to recover sulfide dioxide.

Product Slate

The marketable products from the facility at the design clean coal feed rate of 16,500 TPSD include:

Pipeline gas	31.7 MMSCFD
Propane	6500 BPSD
Mixed butane	4300 BPSD
Light naphtha	3700 BPSD
Reformate gasoline	11,400 BPSD
Distillate oil	26,300 BPSD
Anhydrous ammonia	190 TPSD
Sulfur	530 LTPSD
Phenols	101 TPSD


MEDIUM BTU GAS
PIPELINE GAS
MEDIUM BTU GAS TO FUEL
102.3
PIPELINE GAS
3.75
ACID GAS
SO2 FROM PLANT 35
PLANT 8
CRYOGENIC HYDROGEN PURIFICATION
FEED TO CRYOGENIC PLANT
PLANT 9
SOUR WATER & AMMONIA
FOUL GAS
PLANT 10
SULFUR PLANT
TR. 2-0-1
TAIL GAS TO PLANT 31
SULFUR
49.795
534 LTPD
101 TPSD PHENOLS
8.401
195 TPSD AMMON A
16.225
ACID GAS
CRYOGENIC HYDROGEN
CO2
PLANT 15
OXYGEN PLANT
TR. 3-0-0
AIR
99.5% OXYGEN
4554 TPSD
PLANT 12
GASIFICATION & PURIFICATION
GASIFIER TR. 4-0-1
HYDROGEN TR. 3-0-0
MED BTU GAS TR. 1-0-0
ACID GAS TO PLANT 10
TOTAL MAKEUP HYDROGEN
SLAG & SOOT
2.538 TPSD (40 WTX WATER)
REFORMER H2
FROM PLANT 18
PLANT 6
RECYCLE HYDROGEN COMPRESSION
TR. 7-5-0
CONCENTRATED SOUR WATER
PLANT 7
GAS PLANT
FUEL GAS
20.80
REFINERY GAS
PROPANE PRODUCT
6.524
BUTANE PRODUCT
4.303
LIGHT GASOLINE PRODUCT
3.742
STABILIZER GASES
RECYCLE HYDROGEN
PURGE HYDROGEN
FLASH GASES
FLASH GASES
UNSTABILIZED NAPHTHA
MAIN TOWER GAS
HEAVY NAPHTHA
6.735
H2 TO PLANT 12
23,582 TPSD (D.B.) 23,404 TPSD
COAL FROM PLANT 26
RUN OF MINE COAL RECEIVING & BULK STORAGE
PLANT 27
COAL WASHING & SECONDARY CRUSHING
TR. 3-0-0
WASHED COAL
16,500 TPSD
WASTE
5,453 TPSD
PLANT 1
COAL DRYING & PULVERIZING
TR. 6-2-0
COAL
PLANT 2
COAL SLURRY PREPARATION
TR. 7-1-0
COAL SLURRY
PLANT 3
H-COAL PREHEATING & REACTION
TR. 7-1-0
REACTOR EFFLUENT
PLANT 4
H-COAL PRIMARY SEPARATION
TR. 7-1-0
FLASH DISTILLATES
PLANT 17
DISTILLATE SEPARATION
TR. 2-0-0
HEAVY NAPHTHA
4,018
12,754
PLANT 18
NAPHTHA TREATING & REFORMING
REFORMATE
11,421
HYDROCLONE FEED
MIDDLE DISTILLATE PRODUCT
21,050
BOILER FUEL MAKE-UP
178 TPSD
BOILER FUEL (MIDDLINGS)
1,451 TPSD (D.B.)
RECYCLE HEAVY DISTILLATE
RECYCLE HYDROCLONE OVERFLOW
VACUUM TOWER BOTTOMS
PLANT 5
H-COAL RECYCLE SLURRY PREPARATION
TR. 2-0-0
DISTILLATE FLUSH OIL
HYDROCLONE OVER VACUUM DISTILLATE
MAIN TOWER BOTTOMS
HEAVY DISTILLATE PRODUCT
5,309
TAIL GAS FROM PLANT 10
PLANT 31
STEAM GENERATION AND BFW TREATING
TR. 3-0-1
PLANT 35
STACK GAS SCRUBBING
TR. 3-0-1
SO2 TO PLANT 10
RECYCLE MAIN TOWER BOTTOMS
NOTES:
1. TRAIN NOS.(A-B-C) REPRESENT THE FOLLOWING:
A = NO. OF OPERATING TRAINS.
B = COLD SPARES.
C = HOT SPARES.
LEGEND:
LIQUID OR SOLIDS FLOW RATE, LBS/HR
GAS FLOW RATE, MSCFD
PROCESS WATER OR SOUR WATER RATE, GPM
STRIPPING STEAM, LBS/HR
GPSD
1 9/11/81 ISSUED FOR PHASE ZERO
0 ISSUED FOR REVIEW/APPROVAL
ASHLAND SYNTHETIC FUELS, INC.
AMOCO ENERGY COMPANY, INC.
U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-80ORO10713
BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY
PHASE ZERO
KENTUCKY
FIGURE 3
OVERALL BLOCK FLOW DIAGRAM
HOUSTON
JOB NO. 14222
DRAWING NO. 30-D-B-20
REV. 1

ECONOMIC ANALYSIS

The economic analysis of the Breckinridge Project is based on Bechtel's capital cost estimate, ASFI's operating cost estimate and a market demand and pricing forecast prepared by the Pace Company.

Capital Cost Estimate

Bechtel estimates that the capital cost of the facility, in January 1981 dollars, is $3.17 billion with a 50/50 probability of underrun or overrun. A summary of these costs is presented in Table 1 below.

TABLE 1
CAPITAL COST SUMMARY
($MM)

	Major Equipment	Bulk Materials	Labor	Sub-Contracts	Total
Processing Plants	481.6	313.2	281.8	66.0	1,142.6
Offsite Plants	109.5	207.9	247.1	282.7	847.2
Subtotal	591.1	521.1	528.9	348.7	1,989.8
Initial Catalyst and Chemicals, Commercial Equipment, Sales Tax and Spare Parts					79.3
Field Indirects and Home Office					629.4
Contingency					406.6
Fee					62.4
Total					3,167.5

Operating Cost Estimate

The initial plant startup scheduled for early 1988 will result in only limited production. Full-rated capacity is expected to be achieved during 1990. At full production the operating cost, less by-product revenue, is $18.29 per barrel in 1981 dollars. The most important aspects of the operating cost estimate are summarized in Table 2 below.

TABLE 2
BASE OPERATING COST*
(1981 dollars)

	Cost ($M/YR)	Cost ($/Barrel)
Coal	$242,300	14.42
Electrical Power, and Catalysts and Chemicals, Rolling Stock	84,400	5.02
Direct Labor and Supervision	13,300	0.79
Maintenance Labor, Supervision and Material	43,900	2.62
Overhead, Operating Supplies, Indirects and General Administration	19,500	1.16
Local Taxes and Insurance	47,500	2.83
Byproduct Revenue	143,700	8.55
Operating Cost less Byproduct Revenue	307,200	18.29

*Costs for life of project from start of full production in 1990 at 86.4 percent onstream factor.

Market Demand and Pricing Forecast

In developing the market demand and pricing forecast, Pace employed a comprehensive forecasting system that simultaneously estimates the interactive effects of numerous economic and energy variables, such as GNP, energy supplies, energy product prices, the number of automobiles and miles driven, the number of households, efficiencies of household appliances, petrochemical production, and many other factors. The product pricing forecast assumes that:

- Natural gas will be decontrolled, thereby stimulating significant new additions to reserves and supply.
- There will be no long-term disruptions in the supply of foreign crude oil.

If either of these assumptions proves incorrect, the products will command higher prices.

Sensitivity Analysis

The analysis provided in Report X, Economic Analysis and Financial Plan, includes a base case with sensitivities to product pricing, on stream factor, capital cost and coal cost. The sensitivity analyses indicated that, within the limits of the variables tested, only product prices have a major impact on the profitability of the project. Since the base case forecast is judged to be conservative, any error in the forecast is expected to result in increased project profitability.

The economic analysis is based on 100 percent equity funding, since no other form of financing is presently available to the project. However, in anticipation of securing project debt through the Synthetic Fuels Corporation, the project sponsors have also evaluated the economics on the basis of leveraging. The analysis is based on tax law

existing prior to passage of the Economic Recovery Act of 1981. The results of this comparison for the base case are summarized in Table 3, below.

TABLE 3
ECONOMIC SUMMARY
(as spent dollars)

	DCF ROE Percent	Net Present Value Discounted @ 15 Percent
100 Percent Equity Funding	12.1	$ - 456MM
Debt Funding with $3 Billion Loan Guarantee	20.8	+ 337MM

The product prices required to provide a 15 percent return on equity for either the 100 percent equity funded or the debt-leveraged cases are presented in Figure 4. Forecast product prices have been included for comparison. The figure illustrates the improved economic viability of the project under the leveraged case.

REQUIRED AVERAGE PRODUCT PRICE
(15% DCF ROE)

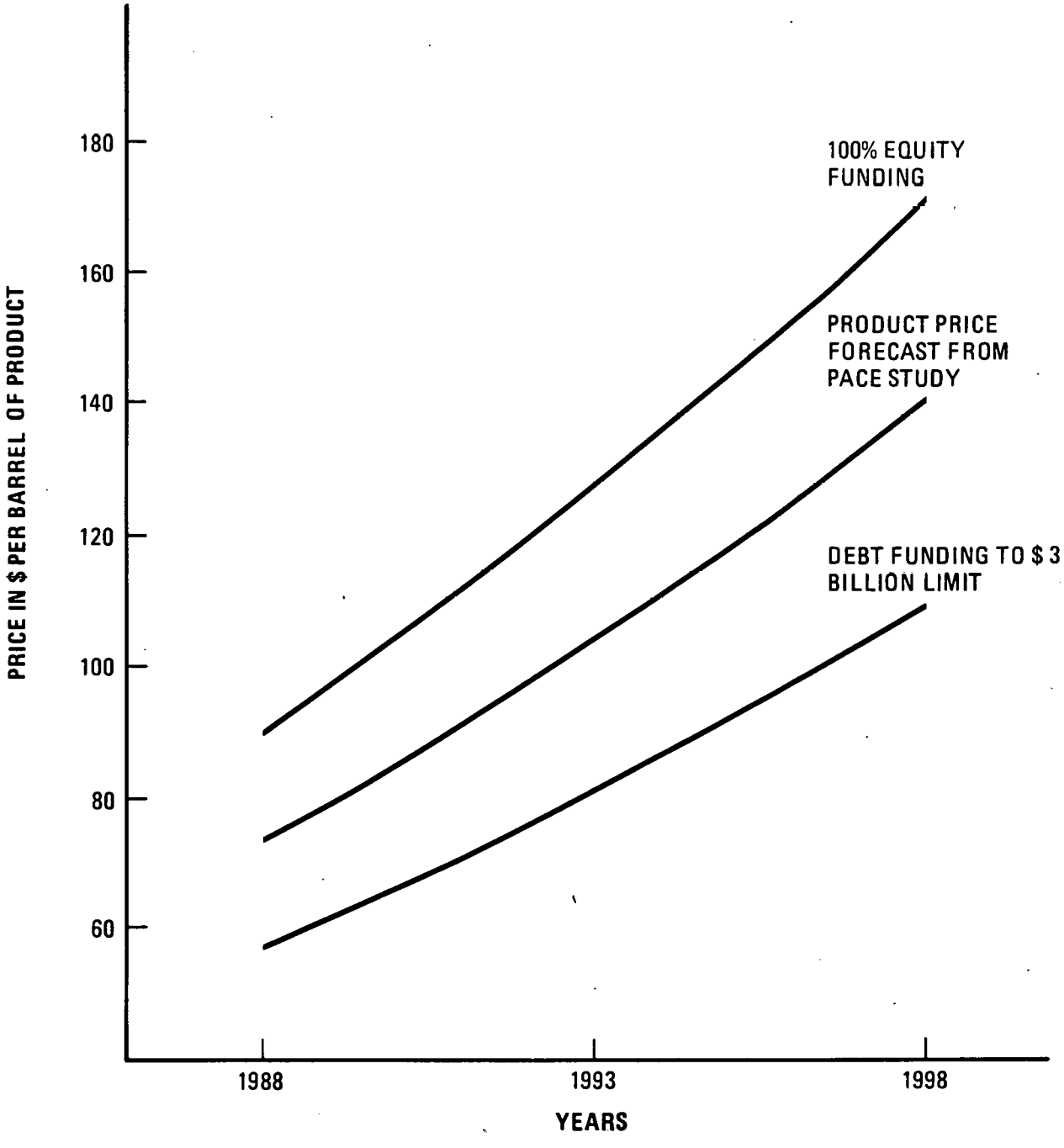


FIGURE 4

FUTURE SCHEDULE AND PLANS

Schedule

The Engineering and Procurement Phase of the project can be initiated as early as January 1982, in which case the major activities are scheduled as follows:

- Commitments for procurement of major equipment will begin in the second quarter of 1982
- Site preparation is scheduled to start in early 1983. Piling and foundation work will follow so that major equipment erection may begin in mid 1984.
- By the end of the first quarter of 1984, engineering will have progressed sufficiently to allow completion of the definitive estimate. Engineering will be essentially completed by mid-1985
- Start-up of the first pair of reactor trains is expected in early 1988, a year before completion of the construction work

Project Implementation Plans

A major engineering-construction firm, experienced in executing projects of this size and complexity, will be engaged as Managing Contractor to manage, coordinate, control and report the progress of all activities required to build the facility. The Managing Contractor will perform all portions of the work that are not subcontracted.

The home office engineering activities of the Managing Contractor and subcontractors are estimated to require a peak of 900 people in 1983. Construction manning will peak at a total of approximately six thousand in mid-1986. Maximum use will be made of preassembly shops located out of the local labor market. It is estimated that these shops may peak as high as 1,300 people, and reduce the site manpower to a maximum of 4,700 construction personnel.

As Operator for the Breckinridge Energy Company, ASFI will organize and staff a Project Team to build the facility and an Operating Department to operate and maintain the facility. The Project Team will direct, monitor and approve the Managing Contractor's work as necessary to achieve the successful and timely execution of the engineering, procurement and construction phases of the project. The Operating Department will be responsible for the successful commissioning, start-up and commercial operation of the facility. The Project Team is expected to peak at less than 100 people. The Operating Department will peak at about 1250 employees plus 300 contract maintenance personnel when full production is reached.

Beyond the Initial Effort, and pending the initiation of future phases of the Breckinridge Project, work will continue in process optimization and cost reduction activities. It is anticipated that this work will result in capital cost reductions and improved reliability of the process plants. During this period, the pilot plant at Catlettsburg, Kentucky, is expected to continue to provide valuable information for final design of the project, particularly as to equipment design, operability and metallurgy. It will produce products for testing and will also prove a valuable asset for training operation and maintenance personnel. The knowledge and operating experience being gained from this Pilot Plant operation is considered essential to the Breckinridge Project.

Many functions not directly involved in the work of actually building and operating the facility must also be performed. These include:

- Securing additional partners and establishing the venture partnership
- Securing government loan guarantees
- Purchasing the site

- Negotiating coal supply contracts
- Contracting for electric power and other utilities
- Securing all required permits
- Executing required process licenses
- Negotiating product marketing contracts
- Resolving socioeconomic matters

The successful and timely completion of the Breckinridge Project will provide the venture partnership with an opportunity to obtain a fair return on investment in a project that has a significant effect in reducing the nation's dependence on imported oil.

INITIAL EFFORT REPORTS REFERENCE

Report I - Executive Summary

Report II - Breckinridge Project Design Basis

Report III - Specifications
- Volume 1 - Specifications A through J
- Volume 2 - Specifications K through W

Report IV - Process Units
- Volume 1 - Plants 26, 27 and 1
- Volume 2 - Plants 2, 3 and 4
- Volume 3 - Plants 5, 6 and 17
- Volume 4 - Plant 7
- Volume 5 - Plants 8, 9 and 10
- Volume 6 - Plant 12
- Volume 7 - Plants 15 and 18

Report V - Utilities and Offsites Units
- Volume 1 - Plants 19, 20, 21, 22, 23 and 30
- Volume 2 - Plants 31, 32, 33 and 34
- Volume 3 - Plant 35
- Volume 4 - Plants 36, 37, 38, 39, 40, 41, 42 and 44

Report VI - Project Management Plan

Report VII - Environmental, Socioeconomic, Safety and Health
- Volume 1 - Introduction and Background
- Volume 2 - Environmental Baseline
- Volume 3 - Cultural and Socioeconomic
- Volume 4 - Health and Safety

Report VIII - Capital Cost Estimate

Report IX - Operating Cost Estimate

Report X - Economic Analysis and Financial Plan

Report XI - Technical Audit
Volume 1 - Engineering Comparisons
Volume 2 - Engineering Comparisons
Volume 3 - Critical Design Areas
Volume 4 - Critical Review of the Design Basis
Volume 5 - Critical Review of the Design Basis