

SECTION 3
DESIGN PARAMETERS

This section describes the raw materials used in the processes; the products; and the basic design parameters/criteria used.

3.1 GENERAL CHARACTERISTICS

- The products produced have sulfur contents ranging from nil to less than 0.1%.
- The design is based on the use of typical coal mined in the Eastern Region of the U.S. Interior Coal Province.
- Process waste water is reused to minimize water consumption.
- The plant is designed to meet environmental standards.

3.2 DESIGN BASIS

Preliminary Design Criteria were developed as the prime product of Phase 1 of a three-phase design development program. Specifically, the work statement for the program included the following descriptions of the separate phases.

- (1) The contractor shall perform and submit preliminary analyses of existing processes and make recommendations from which the Government shall select the better combinations.
- (2) Complete conceptual design of the processes selected under Phase 1.
- (3) Optimize concept design.

The results of item (1) above (Phase 1) were summarized in an ERDA R&D report.⁸ The Preliminary Design Criteria that appeared as Section 6 of this reference is contained in Appendix A of this report. It summarizes design parameters and guidelines established at the start of the POGO conceptual design effort. It also recognizes that "changes will be made during the actual design development as appropriate to achieve the stated objectives."

Appendix A design criteria were used in a manner consistent with the objectives, which were:

- (1) To tell the client the characteristics of the design to be achieved.
- (2) To present to designers the general characteristics of what they were to design.

The following pages of this section summarize key characteristics of the POGO design. Where changes were made to the Appendix A Preliminary Design Criteria, these changes are stated.

5.3 PLANT LOCATION

The plant for the base case was considered to be located in the Eastern Region of the U.S. Interior Coal Province, which includes portions of Illinois, Indiana, and Kentucky. The site conditions used for equipment design are summarized in the Basic Design Criteria document presented as Appendix B of this report. The plant complex was to be close to the coal mine and to a river.

5.4 SCOPE

The coal conversion complex is a grassroots coal refinery facility with a captive coal mine to supply the necessary feed coal. The product slate consists of marketable fuels and byproducts.

5.5 RAW MATERIALS

The raw materials consist of:

(1) Coal

- (a) ROM coal will be produced in a captive mine.
- (b) Two separate low ash coal products will be produced in the coal preparation unit for the process plants:
 - Pyrolyzer and SRC reactor feed coal having approximately 6-1/2% ash content
 - Fuel gas gasifier feed coal having approximately 8% ash content

Except for ash content, the coals are similar as shown below.

(c) The proximate and ultimate analyses of the two coal feeds are:

Proximate Analyses (composition weight %) are:

<u>Item</u>	<u>Pyrolyzer and SRC Feed Coal</u> %	<u>Fuel Gas Gasifier Feed Coal</u> %
Moisture	2.7	2.7
Ash	6.3	8.0
Volatile Matter	38.8	38.1
Fixed Carbon	<u>52.2</u>	<u>51.2</u>
	<u>100.0</u>	<u>100.0</u>

Higher Heating Value 12,633 Btu/lb 12,425 Btu/lb

Ultimate Analyses (composition weight %) are:

Carbon	71.5	70.1
Hydrogen	4.9	4.8
Nitrogen	1.4	1.4
Sulfur	3.9	3.9
Oxygen	9.3	9.1
Moisture	2.7	2.7
Ash	6.3	8.0
	<u>100.0</u>	<u>100.0</u>

(2) Oxygen - 98% purity, produced captively by air separation

(3) Water

(a) Process water from the river

(b) Potable water from wells

3.6 PRODUCTS

The principal products are:

<u>Product</u>	<u>Characteristics</u>	<u>Approximate Production Rate per Stream Day</u>
SNG	1,031 Btu/SCF HHV	150,000,000 SCFD
C ₃ -LPG	88% Propane	13,000 BPD
C ₄ -LPG	77% Butane	2,000 BPD
Gasoline	RON 93.4	35,000 BPD
Fuel Oil	No. 4, 0.04% S, 0.1% Ash	27,000 BPD
Coke	Electrode grade crystalline carbon	1,600 STPD
Power	230 kilovolt (kV)	970 MW

Elemental sulfur and ammonia are coproduced.

More detailed characteristics and comments regarding marketability are presented in Section 7 of this report.

3.7 PRIMARY PROCESS UNITS

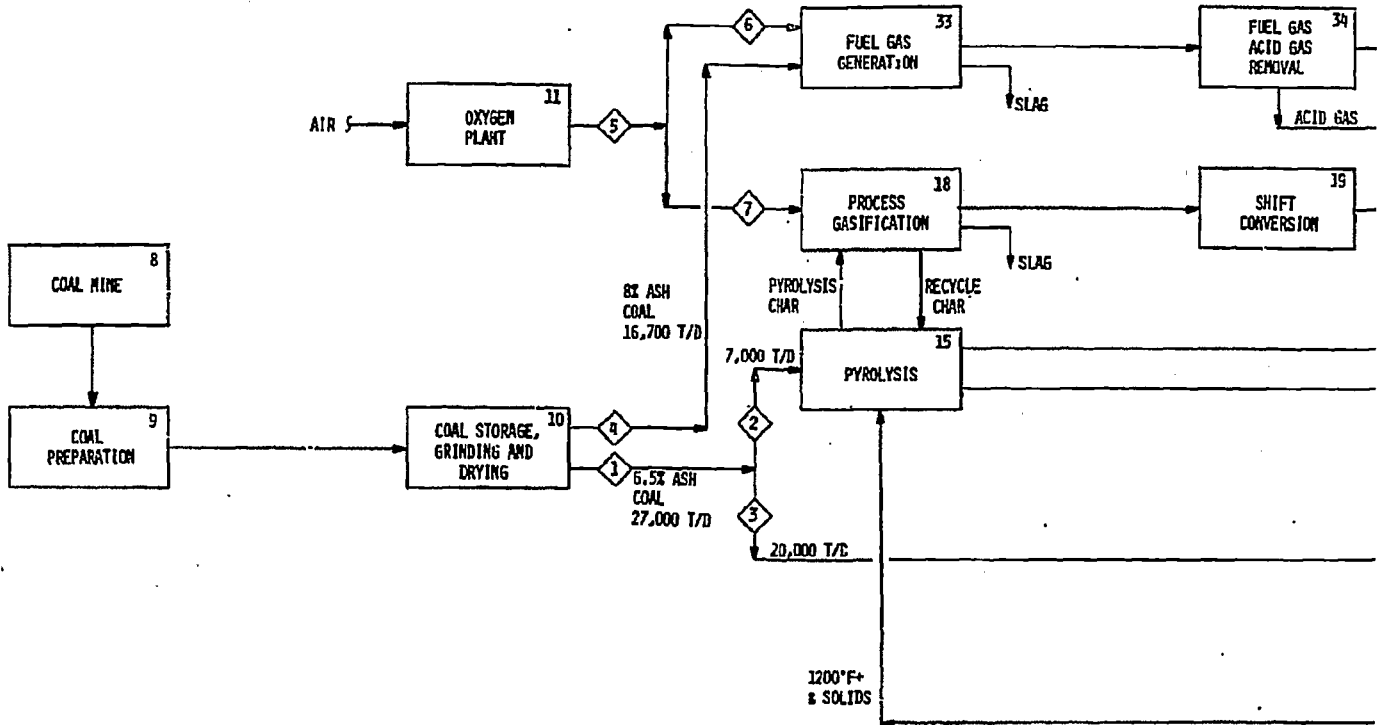
The complex contains the following major primary operating units:

- (1) A unit to crush, wash, and prepare feed coal for the process units. Facilities are provided to produce two separate coal feed streams, each with differing ash contents.

- (2) Facilities to store, dry, and grind the coal for the pyrolyzer, SRC reactor, and fuel gas gasifier feed.
- (3) A pressurized flash pyrolyzer to pyrolyze the coal and produce a gas, a tar, and a char; also facilities to separate the gaseous and liquid constituents.
- (4) An entrainment type, two-stage, slagging process gasifier to produce synthesis gas plus hot char for pyrolysis heat transfer and a slag stream containing the ash constituents of the coal.
- (5) A unit to slurry coal with solvent. A dissolver to heat it in the presence of hydrogen and react it at high temperature and pressure.
- (6) Atmospheric fractionation equipment to separate pyrolysis and dissolver liquids into gas and appropriate liquid cuts.
- (7) A sour shift conversion unit to substantially increase the hydrogen-to-carbon monoxide ratio in the gasifier product.
- (8) Physical solvent selective acid gas removal units for separating hydrogen sulfide and carbon dioxide from process gasifier and fuel gas gasifier streams.
- (9) Chemical absorbent acid gas removal units to separate hydrogen sulfide and carbon dioxide streams produced in the pyrolysis/fractionation and SRC dissolving/fractionation units.
- (10) A facility to separate cryogenically hydrogen-rich, methane-rich gases and heavier fractions; also, facilities to convert the methane-rich stream to produce pipeline SNG.
- (11) A unit to methanate residual carbon monoxide in the hydrogen-rich stream to produce high purity hydrogen for use in hydrotreating operations.
- (12) Units to hydrotreat naphthas and heavy liquids.
- (13) A unit to reform naphtha into commercial grade gasoline.
- (14) A unit for olefin recovery and polymerization to produce commercial gasoline blending stock.
- (15) A unit for fractionation of LPGs into salable products.
- (16) A unit treating all hydrogen sulfide streams generated in the separate process steps to produce salable elemental sulfur and an ecologically acceptable tail gas.
- (17) A large, combined cycle mode, power plant operating on intermediate Btu gas to produce electric power; approximately one-third of the power is used for the operation of the mine and plant and two-thirds is produced for sale.

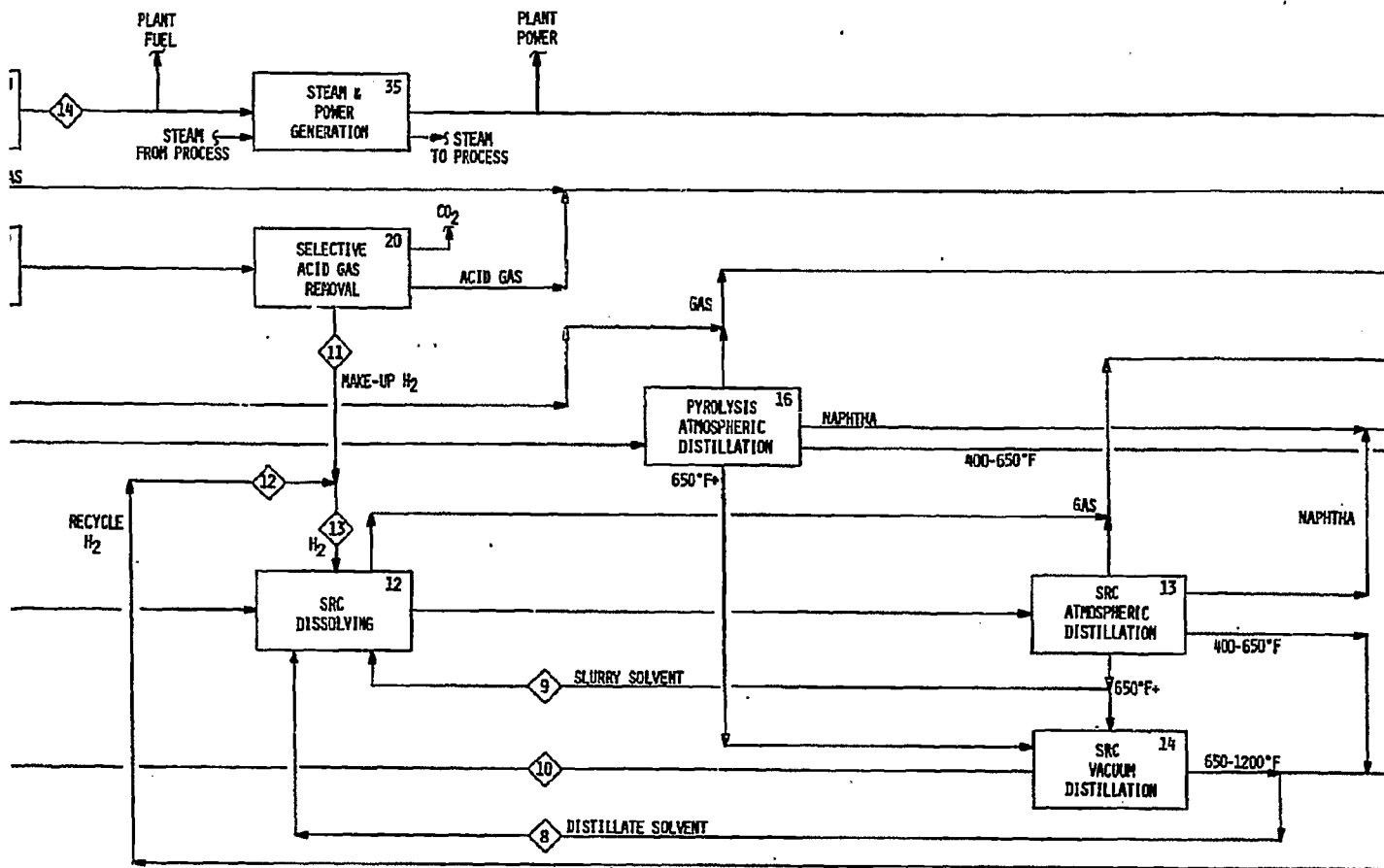
- (18) A unit for thermal cracking of the heavy oil fraction remaining after heavy liquids hydrotreating/fractionation to produce additional lighter hydrocarbons and a thermal tar.
- (19) A delayed coking unit to process the thermal tar into salable needle coke.
- (20) A unit to separate ammonia and hydrogen sulfide from the sour water streams generated in the process. Salable anhydrous ammonia is produced.

In addition, offsites and ancillaries adequate to provide efficient operation for the industrial complex and its population are included.



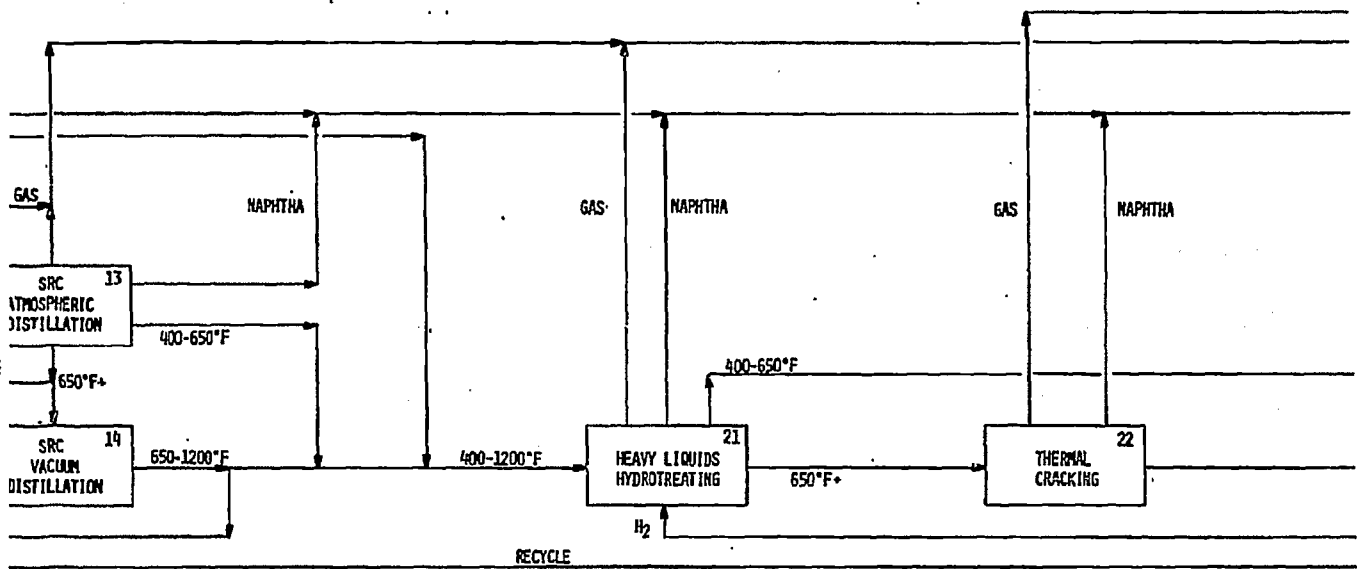
STREAM NO.	DESCRIPTION
	COMPONENT
	O ₂ T/D
	H ₂
	N ₂
	CO
	CO ₂
	H ₂ S
	H ₂ O
	CH ₄
	C ₂ H ₆
	C ₃ H ₈
	C ₄ H ₁₀
	C ₅ H ₁₂
	C ₆ H ₁₄
	C ₇ H ₁₆
	C ₈ H ₁₈
	C ₉ H ₂₀
	C ₁₀ H ₂₂
	187-400
	400-650
	650-950
	950-1200
	1200+ RESIDUE
	ASH
	COAL (NAF)
	COKE
	SULFUR
	TOTAL, T/D
	MMSCFD
	BPD
	HEATING VAL
	BILLION BTU

A

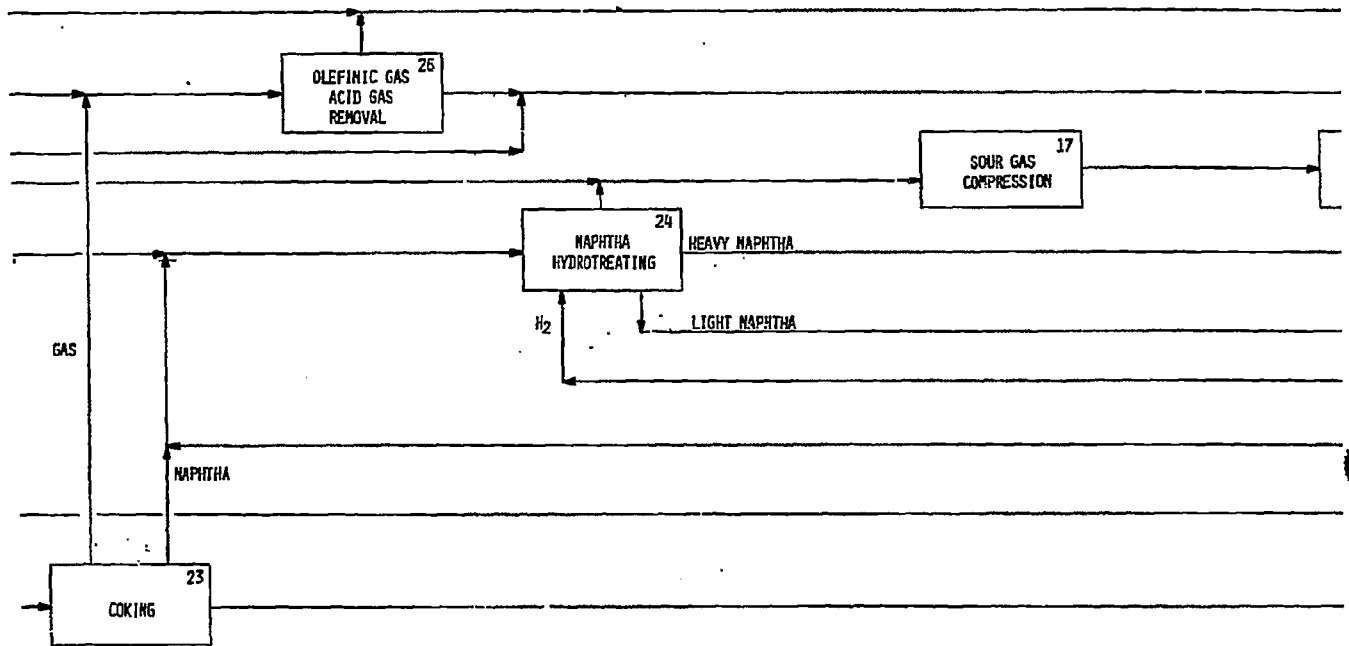


NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
FROM	COAL TO PROCESS	COAL TO PYROLYSIS	COAL TO SRC	COAL TO FUEL GAS GENERATION	TOTAL OXYGEN	O ₂ TO FUEL GAS GENERATION	O ₂ TO PROCESS	DISTILLATE SOLVENT	SLURRY SOLVENT	SRC VACUUM BOTTOMS	MAKEUP HYDROGEN	RECYCLE HYDROGEN	TOTAL HYDROGEN	TOTAL FUEL I
MT/D	...	...	...	...	18428.3	11865.6	6762.7	...	...	...	1264.1	675.9	1944.0	1393.0
	...	...	...	...	329.2	208.4	120.8	...	...	...	241.9	241.1	356.0	427.0
	...	...	...	...	...	...	...	...	...	...	34.9	...	1210.1	2193.0
	...	...	...	...	...	...	...	...	...	...	13.5	...	34.9	823.0
	727.0	189.0	540.0	450.9	...	...	...	...	...	...	12.3	...	13.5	0.0
	...	...	...	...	...	...	...	...	...	...	125.2	43.8	12.3	62.0
	...	...	...	...	...	...	...	...	...	...	...	...	169.0	190.0

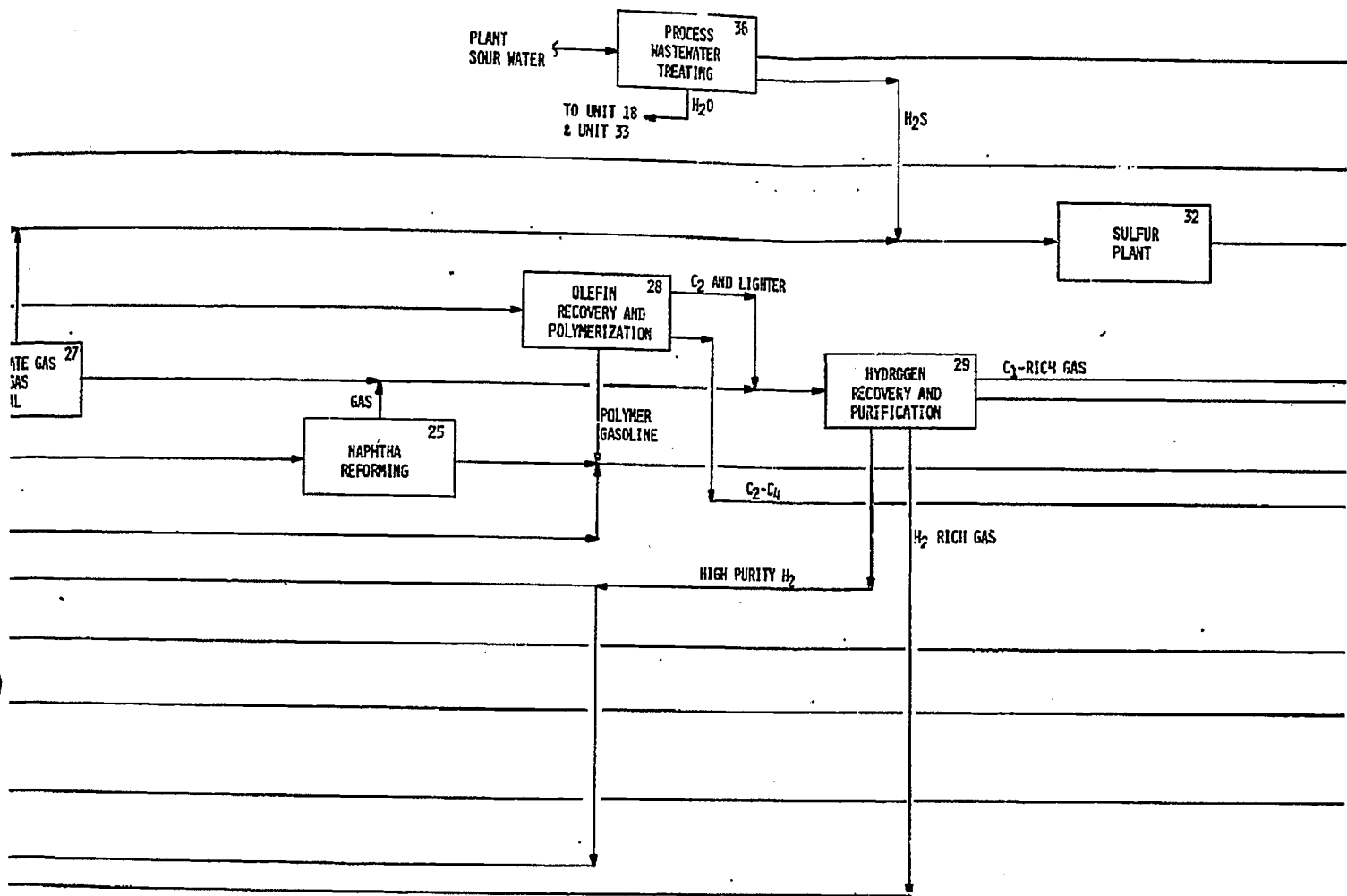
	...	...	...	...	...	...	...	567.4	916.5	0.3	...	...	...	...
	...	...	...	...	...	...	...	11264.1	78229.7	182.5	...	...	...	...
	...	...	...	...	...	...	...	8150.6	14104.2	668.1	...	...	...	...
	...	...	...	...	...	...	...	17.9	3389.8	2670.4	...	...	...	...
MF)	1706.4	442.4	1264.0	1416.8	...	...	...	...	1768.8	1484.0	...	...	...	...
	24564.6	6350.6	18195.0	14832.3	...	...	...	...	1591.4	1272.8	...	...	...	...
T/D	27000.0	7000.0	20000.0	16700.0	18757.5	11874.0	6803.8	20000.0	40000.0	6286.1	2685.1	1054.9	3740.0	24610.0
VALUE, 1 BTU/D	...	...	...	...	444.00	282.33	163.67	...	...	...	519.30	265.62	784.92	1132.0
	684.11	177.36	586.75	412.76	...	...	...	...	...	...	...	...	...	360.0



11	12	13	14	STREAM NO.	15	16	17	18	19	20	21	22
MAKEUP HYDROGEN	RECYCLE HYDROGEN	TOTAL HYDROGEN	TOTAL FUEL GAS	DESCRIPTION	AMMONIA	SULFUR	SHG	C ₂ -LPG	C ₃ -LPG	POOL GASOLINE	FUEL OIL	COKE
1268.1	675.9	1944.0	1393.9	COMPONENT	-	-	-	-	-	-	-	-
281.5	94.1	355.0	422.0	O ₂ , T/D	-	-	28.9	-	-	-	-	-
969.2	241.1	1210.3	2115.7	H ₂	-	-	248.8	-	-	-	-	-
34.9	-	34.9	823.7	N ₂	-	-	-	-	-	-	-	-
13.5	-	13.5	0.1	CO	183.2	-	276.9	-	-	-	-	-
12.3	-	12.3	62.6	CO ₂	-	-	-	-	-	-	-	-
125.2	43.8	169.0	150.1	NH ₃	-	-	-	-	-	-	-	29.7
-	-	-	-	H ₂ S	-	-	0.2	-	-	-	-	-
-	-	-	-	H ₂ O	-	-	2097.9	-	-	-	-	-
-	-	-	-	CH ₄	-	-	115.0	0.4	-	-	-	-
-	-	-	-	C ₂ H ₆	-	-	921.4	29.6	7R	7R	-	-
-	-	-	-	C ₃ H ₈	-	-	7.9	74.5	0.1	0.3	-	-
-	-	-	-	C ₄ H ₁₀	-	-	63.0	1023.9	25.0	53.7	-	-
-	-	-	-	C ₅ H ₁₂	-	-	-	3.9	14.2	30.7	-	-
-	-	-	-	C ₆ H ₁₄	-	-	-	19.6	169.0	674.0	-	-
-	-	-	-	C ₇ H ₁₆	-	-	-	-	4.0	3712.4	-	-
-	-	-	-	160-400	-	-	-	-	-	-	343.0	-
-	-	-	-	400-650	-	-	-	-	-	-	3843.8	-
-	-	-	-	650-950	-	-	-	-	-	-	276.9	-
-	-	-	-	950-1200	-	-	-	-	-	-	-	-
-	-	-	-	1200+	-	-	-	-	-	-	-	-
-	-	-	-	RESIDUE	-	-	-	-	-	-	-	-
-	-	-	-	ASH	-	-	-	-	-	-	-	-
-	-	-	-	COAL (M/F)	-	-	-	-	-	-	-	-
-	-	-	-	COKE	-	-	-	-	-	-	-	1596.4
-	-	-	-	SULFUR	-	1709.9	-	-	-	-	-	-
2685.1	1054.9	3740.0	24010.5	TOTAL, T/D	183.2	1709.9	3760.0	1151.9	212.3	4471.1	4429.7	1525.1
519.30	265.62	784.92	1133.47	HHSCFD	-	-	149.0	13040	2114	34822	27020	-
-	-	-	360.72	BPD	-	-	-	49.83	9.06	181.24	172.01	46.91
-	-	-	-	HEATING VALUE, BILLION BTU/D	3.54	13.66	153.87	-	-	-	-	-



A



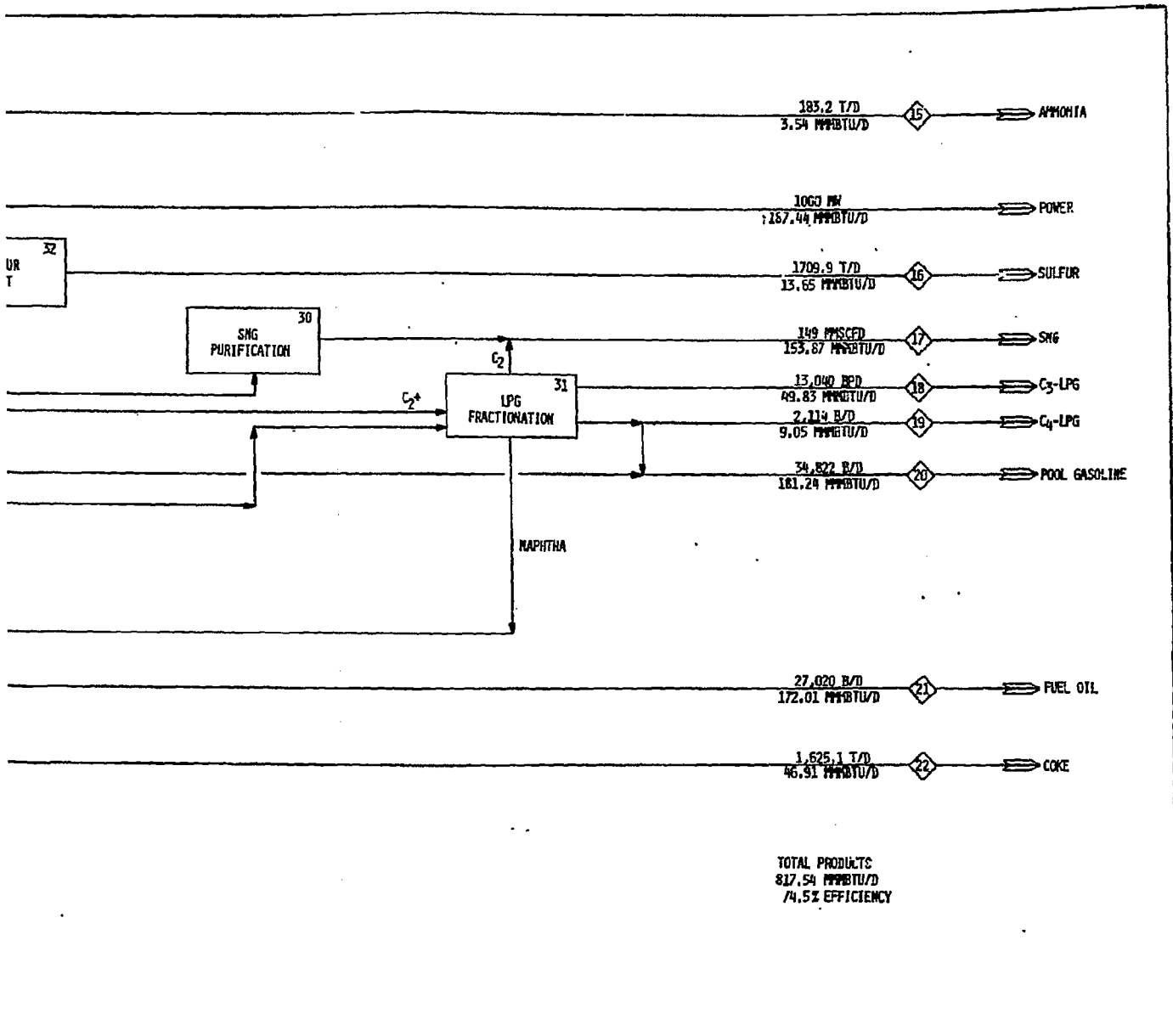


FIGURE 4-1

REV.	DATE	BY	DESCRIPTION	APP.	DATE	BY	DESCRIPTION	APP.	DATE
0			ISSUED FOR REPORT						

DEPARTMENT OF ENERGY - DIVISION OF COAL CONVERSION
POCO PLANT
BLOCK FLOW DIAGRAM
BASE CASE

THE RALPH W. PARSONS CORPORATION PARSONS, BOSTON, MA	NO. 5435-4	REV. NO. R-01-FS-1	0
---	------------	--------------------	---