COPY NO. 43

SRC-II DEMONSTRATION PROJECT
PHASE ZERO
TASK NUMBER 3

DELIVERABLE NUMBER 7

FIRST COMMERCIAL PLANT DESCRIPTION AND COST ESTIMATES

JULY 31, 1979

THE PITTSBURG & MIDWAY COAL MINING CO.
DENVER, COLORADO

PREPARED FOR

UNITED STATES DEPARTMENT OF ENERGY
UNDER CONTRACT
DE-AC05-780R03055

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SECTION 1

INTRODUCTION

1.1 PURPOSE

The SRC-II process is an advanced coal liquefaction process which is being developed to produce clean, nonpolluting liquid fuel from high sulfur bituminous coals. The goal of this development work is full commercialization. A step in the developmental process is operation of a Demonstration Plant which is described in detail in "Demonstration Plant Description," Phase Zero Deliverable No. 1. This volume documents preliminary studies and costs for expanding that Demonstration Plant, which processes 6700 tons per stream day (tpsd) of coal, to a commercial size plant processing 33,500 tpsd. This commercial size plant is referred to as the First Commercial Plant. The 26,800 tpsd expansion necessary for the First Commercial Plant is variously referred to as "expansion," "26,800 tpsd expansion" or "commercial increment". Deliverable No. 8 discusses preliminary studies and costs for a Conceptual Commercial Plant which will utilize state-of-the-art technology available in the 1990's.

The design and cost estimates of the First Commercial Plant are predicated upon satisfactory operation of the Demonstration Plant wherein:

(1) The yield structure is demonstrated for large scale operation.

(2) Operating problems are economically resolved.

(3) Adequate data are obtained or developed concurrently to confirm the scale-up economies used in developing the cost estimate.

The philosophy used in developing the 26,800 tpsd expansion consisted of adding a train or multiple trains where needed in parallel with the Demonstration Plant. The size and number of trains are based on both the SRC-II technology and the equipment fabrication capability anticipated at the

time of the expansion. Where train capacity is different from that in the Demonstration Plant, equipment was re-sized for cost estimating. Increases in equipment sizes have been checked with vendors to make certain that they can be built at the time of plant construction. The expanded plant described in this document is not intended to be a final design. It does, however, provide representative costs for expanding the plant to commercial size.

This volume describes the First Commercial Plant, presents the product slate, shows estimated utility requirements, and indicates thermal efficiency. Differences from the Demonstration Plant are reviewed, and operability and technical risk are discussed. Capital and operating costs are presented in Section 8.

1.2 BACKGROUND INFORMATION

The Solvent Refined Coal Process is a result of considerable research and development work on coal liquefaction technology. Early investigations included bench scale work which expanded to a small pilot plant, and then operation of a 50 tpd pilot plant. This work enabled definition of the SRC-II process.

In 1975 and 1976, under the direction of The Pittsburg and Midway Coal Mining Co., Stearns-Roger prepared a conceptual design and cost estimate for a 6700 tpsd Demonstration Plant utilizing the SRC-II process. The plant was located at a hypothetical site in southern Illinois.

In August 1977, The Pittsburg and Midway Coal Mining Co. authorized Stearns-Roger to prepare a similar conceptual design for a 6700 tpsd Demonstration Plant which would process Pittsburgh Seam Coal and would be located at a site north of Morgantown, West Virginia. Several changes to the 1975 process scheme were incorporated, and that plant was designed bearing in mind the eventual expansion to a commercial plant with a capacity of 33,500 tpsd. Minor changes were made in those designs and the result is the First Commercial Plant described in this report.

1.3 SCOPE OF WORK

The work performed on the design of the expansion facilities has been limited to preparation of unit block diagrams, definition of supporting facilities, estimates for utility consumption, site related definitions, and preliminary selections for process equipment. This work is preliminary in nature and should not be considered a firm basis for construction of the plant. In particular, the designs described in this report should not be considered the sole means for configuration. Although alternatives exist for some process steps or equipment items, selections were made and the capital costs reported for the 26,800 tpsd expansion representative of the SRC-II technology as visualized after the demonstration plant has been successfully operated.

The philosophy followed in design of the expansion facilities was to scale up by employing additional processing trains or by using processing technologies similar to those installed in the Demonstration Plant. Areas similar in process configuration to the Demonstration Plant were scaled up directly without extensive re-evaluation.

Discussions were held with some of the process licensors of proprietary systems to define criteria for the First Commercial Plant. This information was then used by Stearns-Roger to prepare the designs and performance estimates for those proprietary processes. These include the mineral residue slurry gasification, shift conversion and methanation, SUPERSCOT gas treating, and cryogenic hydrogen purification. Details of proprietary processes have been omitted from this report due to restrictions by the process licensor on release of information.

Process changes to the Demonstration Plant systems have been made to present more representative designs and costs for this First Commercial Plant. These changes anticipate that the Demonstration Plant operation will prove technical processes and allow a more optimistic commercial design. A revised plant fuel use basis has been applied and measures have been taken to reduce the plant water consumption.

The commercial design includes several equipment services that are currently classified as prototype. For example, the dissolvers are large, thick walled vessels which would today present some design and fabrication problems. Some compressor and pump services are also beyond the present state of the art. These prototype items are discussed in Section 4 of Phase Zero Deliverable 3 and have been included in the design because their successful development can be reasonably expected by the time the expansion construction commences.

The direct capital costs for the commercial expansion have been estimated using the Stearns-Roger CAPES computer cost estimating program. This program uses basic design information to develop purchased equipment costs and volumetric modeling to generate installed equipment costs. Volumetric models are typical installation piping and instrument arrangements. These models are used to produce appropriate takeoffs for bulk materials. Piping, foundations, and structures are determined as well as labor requirements for installation. Costs for the 26,800 tpsd expansion to produce the First Commercial Plant are presented in Section 8 of this deliverable.

SECTION 2

GENERAL DESCRIPTION

2.1 DESCRIPTION OF PLANT, PROCESS, FUEL AND PRODUCTS

A commercial-scale facility for liquefaction of coal using the Gulf SRC-II Process is discussed in the following sections. This discussion projects the expansion of a proposed Demonstration Plant capable of handling a coal feed rate of 6700 tons per stream day (tpsd) of dry coal into a commercial-size plant designed to handle 33,500 tpsd. During the time of commercial operation, the onstream factor is expected to be 90 percent for both the Demonstration and First Commercial Plants. The proposed site for the plant is located in West Virginia.

The Primary Process Plants of the SRC-II process consist of the Dissolver Plant, and the Hydrogen Treating and Recovery. Other plants include Hydrogen Production Plants, Gas Plants and Secondary Recovery and Oxygen Plants. Coal and Slag Systems and Utility Systems to support the process also are included.

The design of the plant is based on the dissolver yields shown in Table 2-1, which corresponds to operation of the plant with Pittsburg Seam Coal. Inasmuch as operating data obtained from the Demonstration Plant will be evaluated to provide a firm design for the First Commercial Plant, the dissolver yields are preliminary and eventually will be updated to include Demonstration Plant data.

Products that are obtained from the First Commercial Plant include Pipeline Gas, LPG, Butanes, Low Sulfur Light Fuel Oil, Low Sulfur Fuel Oil Mix and Naphtha. Byproducts include Sulfur, Tar Acids, and Ammonia.

Unit and area designations for the First Commercial Plant are listed in Table 2-2:

TABLE 2-1

DISSOLVER YIELDS FOR
4.0 PERCENT HYDROGEN CONSUMPTION
WITH PITTSBURGH SEAM COAL (1)
(Blacksville Type)

Component	Wt.%
Methane	6.56
Ethane	4.16
Propane	3.36
Butane	1.92
Pentane to 350°F	6.00
350°F to 600°F	17.60
600°F to 900°F	10.00
900°F +	26.90
Undissolved Coal (IOM) (2)	7.00
Mineral Matter (3)	12.00
H_2S	1.60
NH_3	0.50
H_2O	5.20
CO	0.30
CO_2	0.90
Total	104.00%

(1) Yields are expressed as the weight percent of dry coal feed to the dissolver.

(2) IOM - Insoluble Organic Matter

(3) After Hydrogenation

TABLE 2-2

UNIT AND AREA DESIGNATIONS FOR THE FIRST COMMERCIAL PLANT

Unit 10 - Primary Process Plants

Area 11 - Dissolver Plant - Including slurry mixing, slurry charge preheaters, dissolvers, raw product separation, water wash, and cooling.

Area 12 - Hydrogen Treating and Recovery Plant - Including oil wash, acid gas removal via DEA (including regeneration), cryogenic separation, and recycle compression.

Unit 20 - Hydrogen Production Plants

Area 21 - Syngas Production Plant - Including synthesis gas production (via gasification) and slag handling to the area battery limit.

Area 22 - Syngas Shift Conversion Plant - Including high pressure shift and COS conversion based on Haldor Topsoe data.

Area 23 - Hydrogen Purification and Compression Plant - Including H_2S, and CO_2 removal with a Benfield hot potassium carbonate unit and hydrogen compression.

Area 25 - Methanation Plant - Including the methanation unit (Haldor Topsoe) and glycol dehydration.

Area 26 - Syngas Purification Plant - Including H_2S and CO_2 removal with Benfield Hi-Pure unit.

Area 27 - H_2/CO Separation Plant - Including pretreatment for removal of contaminants and water and a cryogenic unit for separation of H_2 and CO.

Unit 30 - Gas Plants

Area 31 - Low Pressure Gas Compression and Treating Plant - Including vapor recovery compression and DEA absorption and regeneration.

Area 32 - Product Gas Plant - Including glycol dehydration, deethanizer, depropanizer, refrigeration and compression.

Table 2-2 - continued

Unit 30 - Gas Plants - continued

Area 33 - Sulfur Recovery Plant - Including Claus and SUPERSCOT units, and vent gas incineration.

Area 34 - Refining Plant - Including main product fractionator, debutanizer, vacuum columns and slurry transfer pumps.

Area 35 - Hydrodesulfurization Plant - Including a Gulf HDS Unit capable of hydrotreating naphtha or light fuel oil.

Unit 40 - Secondary Recovery and Oxygen Plants

Area 41 - Ammonia Recovery Plant - U. S. Steel Phosam-W Process.

Area 42 - Tar Acids Recovery Plant - ChemPro Equipment Corporation recovery process.

Area 43 - Waste Water Reclamation Plant - Including evaporators and API separator.

Area 44 - Oxygen Plant - Including process air compressors, oxygen plant and oxygen compressors.

Unit 50 - Utility Systems and General Facilities

Area 51 - Steam Generation System - Including boilers, boiler feedwater systems, and condensate return system.

Area 52 - Raw Water System - Including boiler feedwater and potable water treating.

Area 53 - Cooling Water System - Including cooling towers, pumps and distribution system.

Area 54 - Miscellaneous Distribution Systems - Including fuel system, flare and drain system, fire water system, sanitary sewage system, plant air, instrument air, inert gas, electrical distribution, product storage and shipping and overall control and instrumentation.

Area 55 - General Plant Facilities - Site Improvements - Including site preparation, plant roads, onsite railroads, surface drainage,

Table 2-2 - continued

parking lots, fencing, materials storage, etc.; General Plant Buildings - Including administration, maintenance, control rooms, fire protection, laboratory, change room, etc.

Unit 60 - Coal and Slag Systems

Area 61 - Coal Supply System - Including delivery of coal by unit trains and barges to the unloading stations, unloading, conveying, primary crushing, sampling and stockpiling

Area 62 - Coal Crushing System - Including coal reclaiming, conveying, secondary crushing and screening.

Area 63 - Fine Coal Handling System - Including fine coal conveying, storage and metering to mix tanks in Area 11.

Area 64 - Plant Slag Handling System - Including slag dewatering storage and transportation of slag to disposal in Area 65.

Area 65 - Slag Disposal System - Including slag disposal and reclaim of leachate.

2.2 PRODUCT SLATE

2.2.1 Changes from Demonstration Plant

Table 2-3 presents a comparative tabulation of net product slates for the 6700 tpsd Demonstration Plant and the 33,500 tpsd First Commercial Plant.

Table 2-4 lists the product streams which contribute to the plant fuel system for the Demonstration and the First Commercial Plant.

TABLE 2-3
NET PRODUCT SLATES
(STREAM DAY BASIS)

Net Products	6700 tpd Demonstration Plant	33,500 tpd First Commercial Plant
Pipeline Gas, MMScfd	46.7	143
LPG, bpd	2311	6870
Mixed Butanes, bpd	1632	3510
Naphtha, bpd	*	13,200
Fuel Oil, bpd (contains 57 vol% 350°F-600°F 43 vol% 600°F+)	11,486	61,366
Sulfur, stpd	166	830
Ammonia, stpd	33	165
Tar Acids, bpd	48	240

* The 2640 bpd produced may be consumed as Demonstration Plant fuel.

TABLE 2-4

GROSS PRODUCTS CONSUMED AS PLANT FUEL (LHV)

(STREAM DAY BASIS)

Plant Fuels	6700 tpd Demonstration Plant	33,500 tpd First Commercial Plant
Naphtha from Area 35 MMBtu/hr	576	-
Excess Syngas from Area 26, MMBtu/hr	430	365
CO-Rich Gas from Area 27, MMBtu/hr	-	1203
H.C. Fuel Gas from Area 32, MMBtu/hr	-	4147
Total	1006	5715

As shown in Table 2-3 and 2-4, the Demonstration Plant as presently designed uses the entire naphtha stream and a portion of the excess syngas stream as required to satisfy the approximately 1006 MMBtu/hr (LHV) average plant fuel requirement of an optimized plant. In the First Commercial Plant, all of the naphtha is a saleable product and none is used for fuel as in the Demonstration Plant. However, additional process gas is burned resulting in less available gas for methanation. The relative amount of pipeline gas is reduced.

Due to the major contribution of propane and mixed butane products in the plant fuel gas, the gross production rate of these products is proportionally less than in the Demonstration Plant.

In the tables above, the First Commercial Plant products and fuels have been adjusted to reflect calculated fuel requirements rather than the lower fuel requirement assumed for the first iteration of the plant material balance.

This fuel consumption is proportionately higher than the "optimized" Demonstration Plant. However, process improvements, as discussed in Section 4.3 Plant Fuel System, could effect a substantial reduction in the fuel requirement.

2.3 PLANT SITE

This design for the First Commercial Plant is slated for location in West Virginia, and will be built by expanding the Demonstration Plant at that site. When complete, the facility will include all support facilities such as offices, maintenance shops, utility systems, roads, railyards and barge facilities required for independent operation. Electric power required for the plant planned to be purchased from a local utility company. Raw water requirements will be met through supply from a nearby river. Coal supply to the plant will be by rail and barge. Transportation of products will be accomplished by a combination of rail, truck and pipeline shipment.

Drawing 00-16-103 located at the end of this section shows an aerial view of the proposed site. The plant consists of four main areas; the Process Areas, the Coal Preparation Area, Coal Storage Area and River Storage and Shipping Area. The site also includes areas set aside for slag disposal and containment.

The initial facilities for unloading of coal for the Demonstration Plant will be supplemented by barge unloading facilities in the expansion to the First Commercial Plant. Coal conveying facilities and electrical transmission lines will be expanded to meet the requirements of the First Commercial Plant. The Coal Storage, Crushing and Handling Systems of the Demonstration Plant will be arranged to allow for the necessary expansion to accomodate the increased quantity of coal for the First Commercial Plant. The area for the Process Units will be expanded as shown to accommodate equipment installation commensurate with the additional capacity required. Added rail loading facilities will be installed for shipment of light oil, naphtha, propane, ammonia and sulfur products from the plant.

The general arrangement of process units in the main process area of the Commercial Plant is shown on Drawing 00-16-202 located at the end of this section. The dark lines of this drawing show locations of equipment areas in the Demonstration Plant, while the dashed lines represent the areas that are allocated for the expansion. Essentially, the expansion to the First Commercial Plant has been predicated on installation of additional units

generally along the northerly direction. A minimum distance of 100 feet has been allowed between the Demonstration Plant and it's First Commercial Plant counterpart to enable the Demonstration Plant to continue operation during construction of the additional units. The number of process units and the philosophy envisioned for the expansion area are discussed in later sections of this document.

2.4 PLANT ARRANGEMENT

2.4.1 Process Areas

The additional process units required to increase the capacity of the Demonstration Plant to the commercial size are expected to occupy approximately 83 acres. The General Arrangement, Drawing 00-16-202, shows the layout of the additional equipment in this area. Four additional Dissolver Plants, Area 11, will be constructed adjacent to the Demonstration Plant Dissolver Area. Other process units, namely the Refining Plant, Area 34, and the Hydrogen Treating and Recovery Plants, Area 12, will be located immediately west of these dissolver plants. The four additional gasifiers, Area 21, will also be located in the immediate vicinity of the Dissolver and Refining Plants and in line with the gasifiers for the Demonstration Plant. Space will be allowed for a road running alongside the gasifiers to facilitate removal of slag using heavy duty slag handling trucks. Alternative means of transporting the slag to disposal area via slag-slurry pipeline or conveyors have been considered and a more intensive investigation will be made during definitive design. Due to incomplete data on the slag a decision was made to transport the slag by truck for purposes of this report.

The other process plants comprising Unit 20, i.e,, Syngas Shift Conversion Plant, Area 22; Hydrogen Purification and Compression Plant, Area 23; Syngas Purification Plant, Area 26; H_2/CO Separation Plant, Area 27; and Methanation Plant, Area 25, will be located on the other side of this road. The Hydrodesulfurization Plant, Area 35, will also be located in this vicinity. Pipe racks will be placed in a symmetrical arrangement in such a manner as to minimize high pressure piping runs.

The other process plants included in Unit 30 such as the Low Pressure Gas Compression and Treating Plant, Area 31; the Product Gas Plant, Area 32; and the Sulfur Recovery Plant, Area 33 will be located at one end of the plant. The additional intermediate storage facilities for mineral residue slurry (used for storing diluted slurry in the event of shutdown of the dissolver/refining area) are located near these plants.

The location of the expansion facilities for Unit 40 will be based on consolidating the Ammonia Recovery Plant and Tar Acid Recovery Plant and Waste Water Reclamation Plants alongside their Demonstration Plant counterparts.

Included in the expansion would be additional site improvements, extensions of fences, roads, buildings and miscellaneous utilities.

2.4.2 Coal Handling

The coal barge unloading facilities will be added to the existing rail unloading system and will permit coal to be delivered to the site and unloaded at the rate of 55,000 tons per day.

Additional conveying facilities together with primary crushing and sampling of the coal as unloaded will provide blended coal feed to the dissolvers and reduce the oxidation of coal in the active stockpile.

Coal storage for 30 days (1,175,000 tons) is provided in six long piles. Coal is placed into the stockpiles using twin-boom stackers and reclaimed with a bucket-wheel reclaimer to provide plant feed.

The secondary crushing, sizing and fine coal feed systems have been enlarged to provide minus 1/8" undried feed to the First Commercial Plant.

Dual conveying systems together with spare equipment and stacker bypass capability will provide the reliability required in the coal handling system.

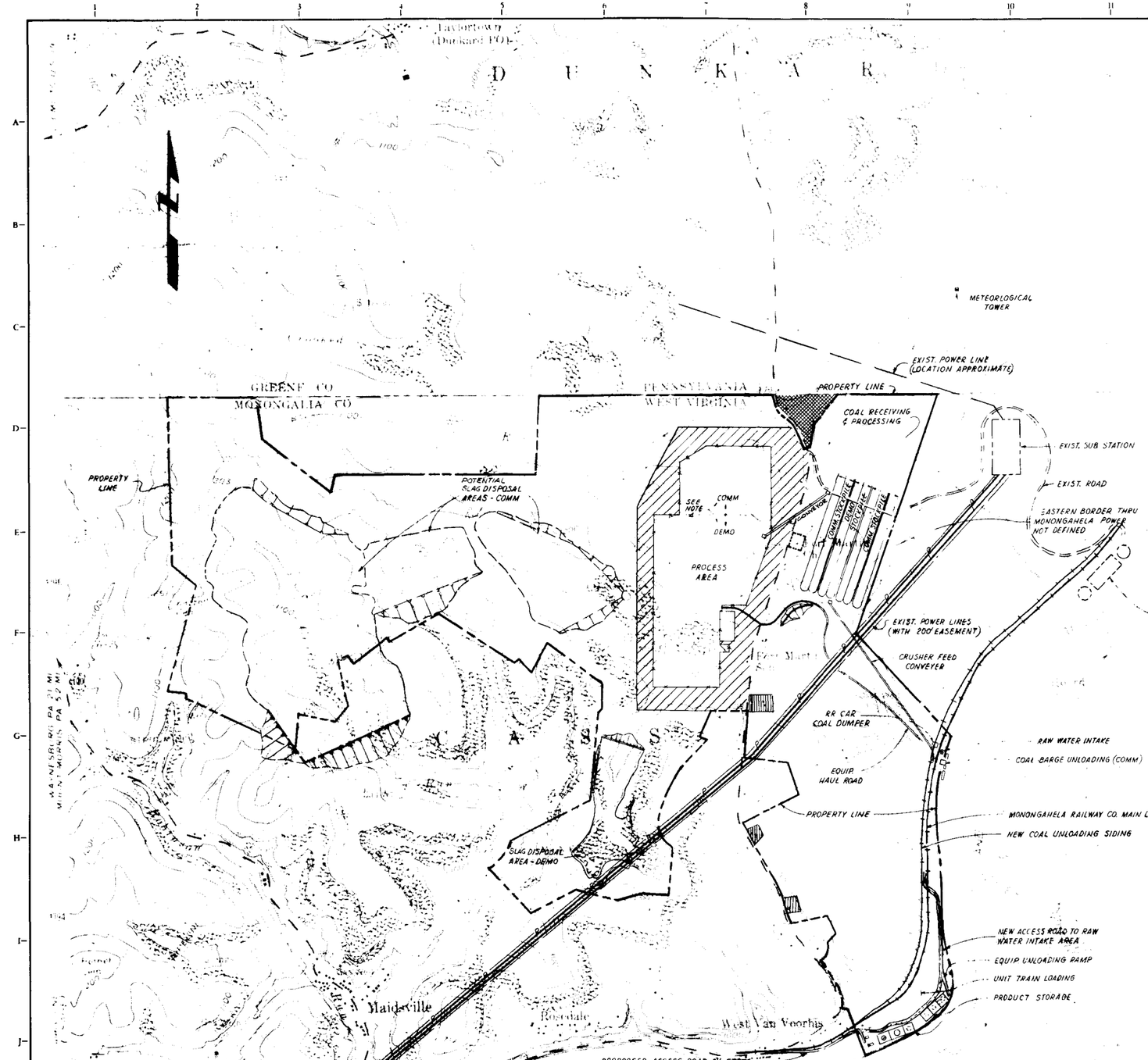
2.4.3 Slag Disposal

Slag disposal areas for the commercial expansion are indicated on Site Plan 00-16-103. These areas are contained in existing ravines south and west of the main process area, and will be extensions to the existing Demonstration Plant. Included in the construction will be dams at the lower ends to contain the slag and water, surface preparation of the inside area, a ditch around the outside perimeter to bypass rainwater runoff to natural drainage and an extension of the road for truck hauling of slag from the process area.

A preliminary geotechnical evaluation has subsequently shown the selected Slag Disposal Area to be potentially unsuitable (see Deliverable No. 16). An alternate site arrangement looks promising however, it has not been considered in the cost estimate Section 8 of this deliverable.

2.4.4 Product Storage and Shipping

Plant products are stored in these areas. The main process area contains the storage and truck loading facilities for the Demonstration Plant. These facilities are used in the commerical expansion with the additions of tanks to store Naphtha and Fuel Oil. Additional storage tanks and rail loading facilities in the River Storage and Shipping Area are required for the commercial facility.



GENERAL NOTES

1. TOTAL PLANT AREA = 2600 ACRES (APPROX)
2. DEMO - DEMONSTRATION PLANT
3. COMM - COMMERCIAL PLANT - FUTURE EXPANSION
4. PART OF THE COMMERCIAL EXPANSION IS WITHIN THE AREA SHOWN AS DEMO. REFER TO PLOT PLAN 00-16-202 FOR LOCATION OF SPECIFIC UNITS

LEGEND

- PROPERTY OUTLINE
- MAY BE OBTAINED IF REQUIRED
- GULF OWN & LEASES TO PREVIOUS OWNER FOR LIFE
- POWER LINE & TOWERS
- RESERVE FOR PROCESS AREA UNTIL SPACE REQUIREMENTS FIRM

NO.	REVISIONS	DATE	BY	CHG	APP'D
1	RENAME DISPOSAL AREA	7/19/79			

NO.	REFERENCE DRAWINGS
00-16-202	PLOT PLAN NO. 2

PRINT RECORD: DATE, FOR, REVISED, CUSTOMER, FIELD, INTRA CO.

ENG. RECORD: DRAWN VVC 7-23-79; CHECKED; MECH. CK; STRUCT. CK; ELECT. CK; PIPING CK; INSTR. CK; CIVIL CK

DRAWING STATUS: ISSUED — DATE; PRELIMINARY, "IN HOUSE REVIEW" FOR COMMENTS AND/OR APPROVAL; APPROVED FOR PHASE 0; REVISED & APPROVED FOR PHASE 0 — REV. △; NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MORGANTOWN SITE PLAN NO 2
FORT MARTIN, WEST VA.
SRC II DEMONSTRATION PLANT - MORGANTOWN, W.VA

The Pittsburg & Midway Coal Mining Co. — A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

SCALE 1" = 1000'

Stearns-Roger INCORPORATED

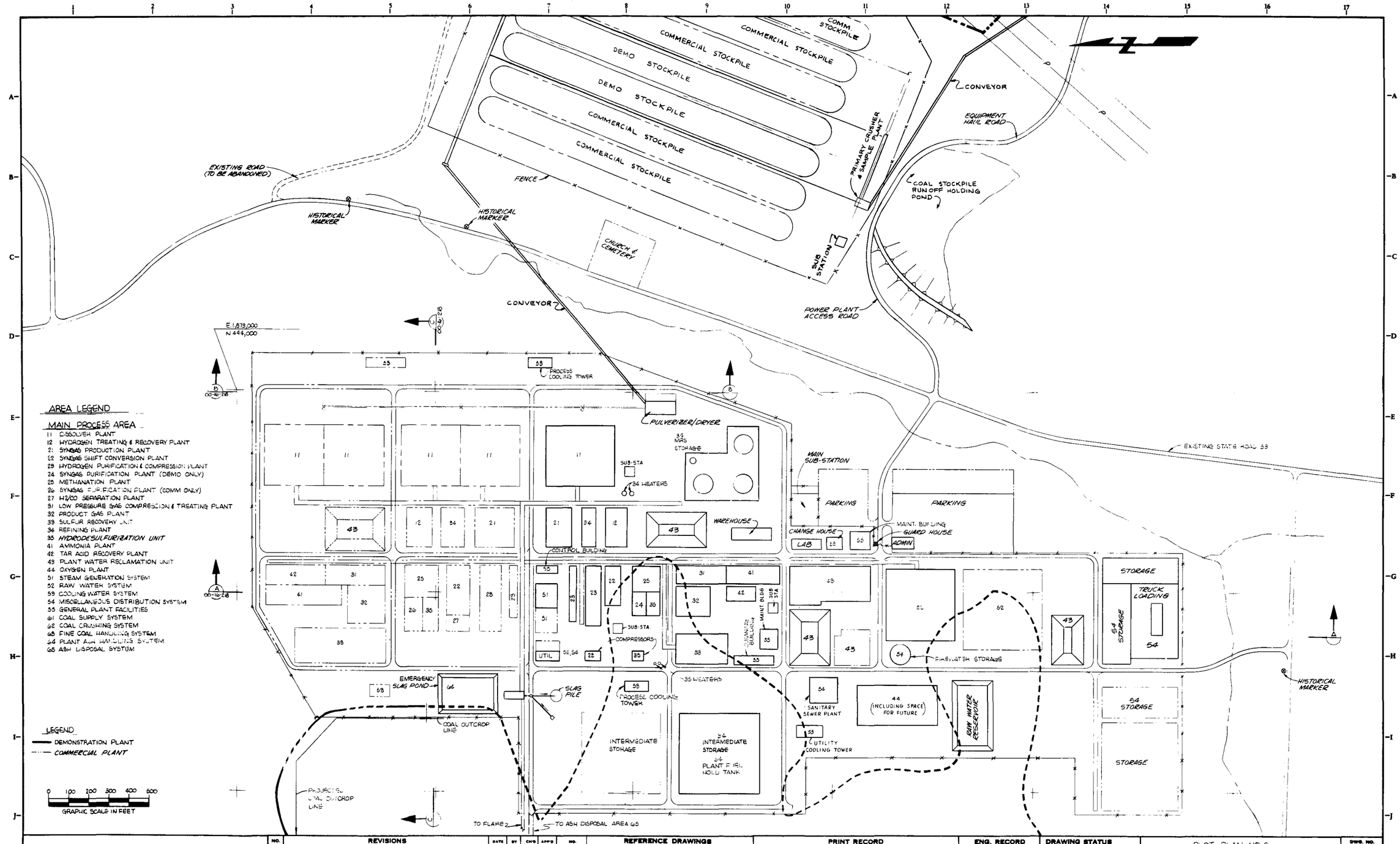
ORDER NO. C-21500

DWG. NO. 22927

SHEET NO. 00-16-103

REV. 1

Form 2778051



NO.	REVISIONS	DATE	BY	CH'D	APP'D

NO.	REFERENCE DRAWINGS
00-16-101	SITE PLAN
00-16-218	CROSS SECTIONS

PRINT RECORD			
DATE	1/14/77	1/30/79	
FOR	SA	FOR INFO	
REVISED	0	–	
CUSTOMER	2	8	
FIELD	–	–	
INTRA CO.	17	29	
TOTAL		37	

ENG. RECORD		
DRAWN	HC	11-15-78
CHECKED	JHJ	1-8-79
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
INSTR. CK.		
CIVIL CK.		

DRAWING STATUS	
ISSUED	DATE
IN HOUSE PRELIMINARY REVIEW	11-21-78
FOR COMMENTS AND/OR APPROVAL	1-12-79
APPROVED FOR PHASE 0	
REVISED & APPROVED FOR PHASE 0 — REV.	

NOT APPROVED FOR CONSTRUCTING UNLESS SIGNED & DATED. EXCEPT ALL PRINTS BEARING EARLIER DATE 8/08 REVISION NO.

PLOT PLAN NO 2
COAL PREP & PROCESS AREA
SRC II DEMONSTRATION PLANT
MOUNTAINTOWN, WEST VIRGINIA

P&M The Pittsburg & Midway Coal Mining Co. — A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

SCALE 1"=200'

Stearns-Roger INCORPORATED

ORDER NO. C-21500

DWG. NO. 22927

SHEET NO. 00-16-222

REV. 0

Form 22000-A1

SECTION 3

PROCESS DESCRIPTION

3.1 UNIT DESCRIPTION

The First Commercial Plant, like the Demonstration Plant, is divided into units and further subdivided into areas. The unit and area designations correspond to the Demonstration Plant with a few exceptions. These exceptions and other process and equipment differences are explained in detail in Section 6. The unit and area designation for the First Commercial Plant have been summarized in Section 2, Table 2-2.

3.2 OVERALL BLOCK FLOW DIAGRAMS

The overall process flow for the Commercial Plant is illustrated by the Overall Plant Block Flow Diagram, Sheet No. OOGO6-111A along with the Overall Plant Material Balance, Sheet No. OOGO6-111B. The plant water systems are represented by the Overall Water Block Flow Diagrams, Sheet Nos. OO-06-112A and OO-06-112B. These drawings are located at the end of this section.

3.3 MULTIPLE TRAIN BASIS

The 26,800 tpsd expansion is achieved by addition of processing trains in parallel to the Demonstration Plant Train. The philosophy and design limitation which went into establishing the number of parallel systems or parallel items of equipment are discussed in detail in Section 6.

The block type Plant Train Diagrams, Sheet Nos. OO-06-113 through OO-06-116 illustrate the arrangement and number of multiple parallel process trains utilized in expanding the Demonstration Plant to full commercial size. The diagrams differentiate between those units and areas existing in the Demonstration Plant (indicated by "Demo" in the block) and the number of new units and areas to be installed during the expansion. These drawings are located at the back of this section.

3.4 ENVIRONMENTAL CONSIDERATIONS

To comply with various Federal, state and local government regulations pertaining to ambient air quality and liquid and solid waste disposal, the First Commercial Plant incorporates various processing means for control of emissions and effluents. These measures are discussed in Phase Zero Deliverable No. 18. Specific measures employed are briefly discussed in the following sections.

3.4.1 Gaseous Exhausts

Acid gas produced in treating the dissolver recycle gas is fed to the Sulfur Recovery Plant, Area 33, for treatment. The Claus process employs two-stage design followed by a selective hydrogen sulfide removal step utilizing the Shell SUPERSCOT Process which reduces the SO_2 content in the incinerator offgas to 500 ppmv. This SO_2 concentration is within the environmental standard for the plant site.

Most of the plant fuel requirement is met by burning hydrocarbon-rich fuel gas produced within the Low Pressure Gas Compression and Treating Gas Plant, Area 31. The DEA absorption process within this plant produces a sweet dehydrated fuel source with only trace amounts of hydrogen sulfide or other sulfur bearing gas compounds.

The demand for plant fuel is partially met by the combustion of synthesis gas produced by the Area 21 mineral residue slurry gasifiers. Within Area 26, the Benfield Hi-Pure system reduces the hydrogen sulfide content of the plant fuel gas to less than 50 ppmv (design). Part of the gas treated for hydrogen sulfide removal within Area 26 is split off to provide the feed stream for the H_2/CO Separation Plant which, in turn, produces CO-rich plant fuel gases. The CO-rich fuel gases are low in sulfur content and comprise an environmentally acceptable plant fuel source.

The design of the highly efficient combustion units within the plant will eliminate hydrocarbon and carbon monoxide emissions from plant combustion stacks. Presently there are no regulations limiting the quantity and concentrations of nitrous oxides and carbon dioxide emissions. Estimated emissions of these compounds will be made and reported in the environmental reports.

The storage and shipping facilities within the plant incorporate closed-system designs. The API cone roof tanks used for storage of naphtha and light fuel oil are connected to a vapor recovery system which prevents hydrocarbons from reaching the atmosphere.

The coal preparation and handling facilities are equipped with dust collection and suppression equipment to prevent the release of fugitive coal dusts to the atmosphere.

3.4.2 Liquid Wastes

The First Commercial Plant is designed for zero discharge of waste aqueous liquids. All liquid effluents are either recycled or incinerated with no effluent discharged to the river. The Secondary Recovery Plants are employed to recover ammonia and tar acids for product sales.

A waste water holding pond is provided for contingency storage of plant liquids in the event of process upsets or emergencies.

Process waste waters, including cooling tower and boiler blowdown waters, are not discharged but reused and ultimately evaporated, reacted or used as dust suppressant. Storm runoff water will contain suspended and dissolved components. Contaminated surface water will be impounded and held for subsequent treatment. The treated water will be reused in the plant, which ultimately reduces the amount of raw water intake from the river.

3.4.3 Solid Wastes

The gasifier slag is fed into the Gasifier Slag Bin. Any water containing slag particles is filtered and the filtered coke sent to the Gasifier Slag Bin. The gasifier slag is transported by trucks to the slag disposal site which consists of a sealed disposal basin designed to contain all runoff. The basin capacity is approximately 33.3 MM cubic yards which will contain 25 years of slag production plus allowing for 5 feet of freeboard.

The sanitary sewage will be given primary, secondary and tertiary treatment with any remaining solids being incinerated. Solids that remain following evaporation of process waters are oxidized in an incinerator.

3.5 EQUIPMENT LIST

The following section contains the equipment lists for the 26,800 tpsd Expansion Increment to the 6700 tpsd Demonstration Plant to make a 33,500 tpsd First Commercial Plant. Included are the assigned equipment numbers, descriptions and operating conditions. Descriptions and operating conditions for proprietary processes are not included.

AREA 11 - DISSOLVER PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Air Cooled Equipment				
A.11.201, .401	Slurry Tank Vapor Cooler	191.19 MMBtu/hr, header and tubes carbon steel.	PROPRIETARY	1
A.11.204, .404	2nd High Pressure Flash Quench Cooler	15.84 MMBtu/hr, header and tubes carbon steel.	PROPRIETARY	1,950
A.11.205, .405	2nd Low Pressure Flash Air Cooler	20.63 MMBtu/hr, header and tubes carbon steel.	110/213	50
A.11.206, .406	3rd High Pressure Air Cooler	6.68 MMBtu/hr, header and tubes carbon steel.	PROPRIETARY	1,950
Boilers				
B.11.201, .301,.401, .501	HP 1500 psig Steam Generator	63.70 MMBtu/hr, shell 2-1/4 Cr-1Mo forged, tubes 9 Cr-1Mo.	PROPRIETARY	1,560/2,000
B.11.202, .302,.402 .502	650 psig Steam Generator	11.80 MMBtu/hr, shell carbon steel, tubes 321 SS.	PROPRIETARY	700/75

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

DISSOLVER PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Boilers - continued				
B.11.203, .303,.403, .503.	LP 1550 psig Steam Generator	49.50 MMBtu/hr, shell carbon steel, tubes 321 SS.	PROPRIETARY	1,560/80
B.11.204, .404	HP 50 psig Steam Generator	11.46 MMBtu/hr, shell and tubes carbon steel.	PROPRIETARY	50/1,950
B.11.205, .405	2nd HP 50 psig Steam Generator	27.18 MMBtu/hr, shell and tubes carbon steel	PROPRIETARY	50/1,950
Heat Exchangers				
E.11.202, .302,.402, .502	Recycle Hydrogen Preheater	72.36 MMBtu/hr, shell 2-1/4 Cr-1Mo forged, tubes 9 Cr-1Mo.	PROPRIETARY	2,120/1,990
E.11.203, .403	2nd High Pressure Flash Trim Cooler	18.66 MMBtu/hr, shell and tubes carbon steel.	100/133	50/1,970
E.11.205, .405	2nd Low Pressure Flash Trim Cooler	5.78 MMBtu/hr, shell and tubes carbon steel.	100/133	50/50
E.11.206, .306,.406 .506	LP 1500 psig Boiler Feed Water Preheater	99.31 MMBtu/hr, shell carbon steel, tubes 321 SS.	PROPRIETARY	2,200/70

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

DISSOLVER PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - continued				
E.11.208, .408	4th High Pressure Flash Reflux Cooler	218.00 MMBtu/hr, shell and tubes carbon steel.	100/133	50/1,950
E.11.210, .410	1st Low Pressure Boiler Feed Water Preheater	28.86 MMBtu/hr, shell carbon steel, tubes 321 SS.	PROPRIETARY	2,200/65
E.11.212, .312,.412, .512	Turbine Surface Condenser	45.63 MMBtu/hr, shell and tube carbon steel.	126/100	4" Hg/50
E11.213, .413	HP 700 psig Boiler Feedwater Preheater	28.00 MMBtu/hr, shell and tubes carbon steel.	PROPRIETARY	700/1,980
E.11.214 .414	300 psig Boiler Feedwater Preheater	88.40 MMBtu/hr, shell and tubes carbon steel.	PROPRIETARY	350/1,980
E.11.215 .415	HP 1500 psig Boiler Feedwater Preheater	106.20 MMBtu/hr, shell and tubes carbon steel.	PROPRIETARY	2,200/1,980
Fired Heaters				
H.11.201A/B .301A/B .401/A/B .501/A/B	Dissolver Charge Heater	PROPRIETARY	PROPRIETARY	PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

DISSOLVER PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Jet Equipment				
J.11.201	Turbine Steam Ejector	PROPRIETARY	---	---
Mixers				
M.11.201 A/B	In-line Mixer to Dissolver Dump Tank	20 bhp	880	150
M.11.202 A/B/C/D	Side Entry Mixer Into Dissolver Dump Tank	30 bhp	880	10
Pumps				
P.11.201A/B .401A/B	Slurry Feed Pump	7100 gpm, 46 psiΔP, 450 hp, carbon steel with 28% Cr-Fe wear parts, turbine drive, B spare.	PROPRIETARY	50
P.11.202A/B .302,.402 .502	Dissolver Charge Pump	3550 gpm, 2350 psiΔP, 6500 hp, carbon steel with chrome wetted parts, steam turbine driven, B spare.	PROPRIETARY	2,400
P.11.203A/B, .403A/B	Slurry Overhead Hydrocarbon Pump	40 gpm, 50 psiΔP, 5 hp, carbon steel. B spare.	250	50

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

DISSOLVER PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Pumps - Continued				
P.11.204A/B, .404A/B	Slurry Overhead Sour Water Pump	368 gpm, 20 psi△P, 10 hp, carbon steel, B spare.	150	25
P.11.205A/B, .305A/B, .405A/B, .505A/B	2nd High Pressure Flash Recycle Pump	400 gpm, 50 psi△P, 25 hp, 13-4 Cr casing and impeller, B spare.	PROPRIETARY	2,050
P.11.206A/B, .406A/B	Slurry Circulation Pump	20,000 gpm, 25 psi△P, 450 hp, 28% Cr-Fe wetted parts, carbon steel case, B spare.	PROPRIETARY	25
P.11.207A/B, .407A/B	4th High Pressure Flash Recycle Pump	25,600 gpm, 50 psi△P, 1,000 hp, carbon steel, B spare.	150	2,030
P.11.208A/B, .408A/B	3rd High Pressure Flash Recycle Pump	100 gpm, 100 psi△P, 15 hp, carbon steel.	115	2,100
P.11.209 A/B	Ammonia Metering Pump	8 gpm, 1,900 psi△P, 30 hp, 321 SS.	100	2,150
P.11.210A/B, .410A/B	Wash Water Booster Pump	200 gpm, 200 psi△P, 400 hp, carbon steel.	100	2,000

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

DISSOLVER PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Pumps - Continued				
P.11.211A/B .411A/B	Quench Booster Pump	1200 gpm, 100 psiΔP, 100 hp, carbon steel.	PROPRIETARY	2,000
P.11.212 A/B	Steam Condensate Pump	8 gpm, 34 psiΔP, 4 hp, carbon steel.	120	20
P.11.213 A/B	Hotwell Condensate Pump	425 gpm, 57 psiΔP, 25 hp, carbon steel.	120	45
P.11.214A/B .414A/B	150^{o}F Water Recycle Pump	550 gpm, 100 psiΔP, 60 hp, carbon steel.	150	2,050
P.11.221 A/B	Dissolver Dump Tank Pump	500 gpm, 50 psiΔP, 20 hp, carbon steel.	300	50
Vessels				
V.11.201, .401	Slurry Tank Overhead Receiver	11'-0" ID x 22'-0" TT, with 3'-0" ID x 6'-0" Boot, carbon steel.	150	1
V.11.202, .402	Slurry Charge Tank	PROPRIETARY	PROPRIETARY	5
V.11.203, .303,.403, .503	Dissolver	PROPRIETARY	860	2,000

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

DISSOLVER PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Vessels - Continued				
V.11.204, .304,.404, .504	Dissolver Effluent Separator	15'-6" ID x 18'-0" TT, 60° conical bottom, SA-387-22-2 with 347 SS weld overlay.	PROPRIETARY	2,000
V.11.205, .305,.405, .505	1st High Pressure Flash Drum	10'-6" ID x 17'-0" TT, SA-387-11-2 with 1/8" SA-240-321 clad.	PROPRIETARY	2,000
V.11.206, .306,.406, .506	2nd High Pressure Flash Drum	8'-0" ID x 20'-0" TT, SA-516-70.	PROPRIETARY	1,970
V.11.207, .407	3rd High Pressure Flash Drum	9'-0" ID x 17'-0" TT, 2'-0" ID x 3'-0" boot, SA-516-70.	115	1,970
V.11.208, .308,.408, .508	1st Low Pressure Flash Drum	9'-0" ID x 30'-0" TT, 60° conical bottom 1-1/4 Cr-1Mo/w 1/8" 321 SS clad.	PROPRIETARY	100
V.11.209, .409	2nd Low Pressure Flash Drum	12'-0" ID x 30'-0" TT, with 3'-0" ID x 6'-0" boot, carbon steel.	PROPRIETARY	60
V.11.210, .410	3rd Low Pressure Flash Drum	5'-4" ID x 24'-0" TT, with 2'-3" ID x 4'-0" boot, carbon steel.	115	35

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

DISSOLVER PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.11.212, .312,.412, .512	HP 1500 psig Saturated Steam Drum	6'-0" ID x 29'-0" TT, SA-516-70.	601	1,500
V.11.213, .313,.413 .513	LP 1500 psig Saturated Steam Drum	4'-6" ID x 12'-0" TT, carbon steel.	601	1,500
V.11.214, .314,.414, .514	600 psig Saturated Steam Drum	3'-0" ID x 9'-0" TT, carbon steel.	497	600
V.11.215, .315,.415, .515	1st Effluent Separator Letdown Vessel	17'-0" ID x 25'-0" TT, SA-387-11 C1.1 with 1/8" 321 clad, 60° conical bottom.	PROPRIETARY	445
V.11.216, .316,.416, .516	2nd Effluent Separator Letdown Vessel	17'-0" ID x 25'-0" TT, SA-387-11 C1.1 with 1/8" 321 clad, 60° conical bottom.	PROPRIETARY	160
V.11.217, .317,.417, .517	3rd Effluent Separator Letdown Vessel	17'-0" ID x 25'-0" TT, SA-387-11 C1.1 with 1/8" 321 clad, 60° conical bottom.	PROPRIETARY	85
V.11.218, .418	4th High Pressure Flash Drum	15'-6" ID x 70'-0" TT, carbon steel.	150	1,970

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

DISSOLVER PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.11.219, .419	1st High Pressure Chlorides Separator Drum	8'-6" ID x 28'-0" TT, 2'-11" ID x 3'-0" boot, carbon steel.	PROPRIETARY	1,970
V.11.220, .420	2nd High Pressure Chlorides Separator Drum	8'-6" ID x 18'-0" TT, 3'-0" ID x 3'-0" boot, carbon steel.	150	1,970
V.11.221	Dissolver Dump Tank	25'-0" ID x 51'-0" TT, carbon steel.	880	10
V.11.222	Steam/Air Decoking Drum	5'-0" ID x 15'-0" TT, carbon steel.	650	15
V.11.223	Hotwell	5'-5" ID x 11'-0" TT, carbon steel.	126	3" Hg
V.11.224, .424	HP 50 psig Saturated Steam Drum	3'-0" ID x 7'-6" TT, carbon steel.	298	115
V.11.225, .425	2nd HP 50 psig Saturated Steam Drum	3'-6" ID x 10'-6" TT, carbon steel.	298	115

AREA 12 -

HYDROGEN TREATING AND RECOVERY PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Air Cooled Equipment				
A.12.201	DEA Stripper Overhead Air Cooler	124.00 MMBtu/hr, header and tubes carbon steel.	110/193	13
A.12.202, .402	2nd Stage Air Intercooler	7.16 MMBtu/hr, header and tubes carbon steel.	110/156	138
A.12.203, .403	3rd Stage Air Intercooler	7.16 MMBtu/hr, header and tubes carbon steel.	110/156	361
Compressors				
C.12.201, .401	H_2 Recycle Compressor	PROPRIETARY	150	2,165
C.12.202, .402	Methane Off Gas Compressor	36,400 scfm, 895 psiΔP, 15,840 bhp, turbine drive.	150	472
Heat Exchangers				
E.12.201	Lean/Rich DEA Exchanger	98.25 MMBtu/hr, SS tubes.	214/194	16/76
E.12.202	Lean DEA Cooler	60.42 MMBtu/hr, carbon steel.	100/148	40/1,110
E.12.203, .403	DEA Stripper Overhead Trim Cooler	1.40 MMBtu/hr, carbon steel.	140/100	8/40

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN TREATING AND RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued				
E.12.204	DEA Stripper Reboiler	181.60 MMBtu/hr, SS tubes.	255/320	15/75
E.12.205, .405	Recycle Compressor Discharge Trim Cooler	10.68 MMBtu/hr, carbon steel.	100/136	60/2,115
E.12.211	Molecular Sieve Bed Regenerator Cooler	12.00 MMBtu/hr, carbon steel.	450/100	40/100
E.12.212	Molecular Sieve Bed Regenerator Heater	12.00 MMBtu/hr, carbon steel.	450/950	40/1,550
E.12.213, .413	1st Stage Intercooler	6.80 MMBtu/hr, carbon steel.	100/137	40/48
E.12.214	2nd Stage Intercooler	17.20 MMBtu/hr, carbon steel.	100/191	40/138
E.12.215	3rd Stage Intercooler	17.20 MMBtu/hr, carbon steel.	100/192	40/361
E.12.216, .416	Turbine Surface Condenser	93.75 MMBtu/hr, carbon steel.	126/100	4 " Hg/50

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN TREATING AND RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Jet Equipment				
J.12.201	Turbine Steam Ejector	2-stage twin element steam ejector with surface type inter and after coolers.	---	---
Filter Equipment				
S.12.201 A/B	DEA Filter	260 gpm, 5 microns, carbon steel.	175	1,115
S.12.202 A/B	Molecular Sieve Dust Filter	288,000 scfm, 3 micron, carbon steel.	125	2,120
Packaged Process Units				
U.12.201	High Pressure Cold Box	288,000 scfm, 91% H_2 recovery, Cu and SS wetted parts.	---	2,110
U.12.202	High Level Refrigerant Unit	Freon refrigeration unit, 1460 ton refrigeration, 1520 bhp, 2500 hp (drives both U.12.202 and U.12.203).	---	---
U.12.203	Low Level Refrigerant Unit	Freon refrigeration unit, 160 ton refrigeration, 500 bhp.	---	---

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN TREATING AND RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Power Recovery Turbines				
HTB.12.201	Rich DEA Power Recovery Turbine	2800 gpm, 1872 psi △P, 1920 bhp, 304SS turbine blades, drives P.12.203B.	153	76
HTB.12.202	Rich Oil Power Recovery Turbine	2520 gpm, 1900 psi △P, 1800 bhp, 304SS turbine blades, drives P.12.201B	140	60
Pumps				
P.12.201 A/B	High Pressure Lean Oil Pump	2520 gpm, 1885 psi △P, 3800 bhp, "A" motor drive, "B" power recovery turbine and steam turbine drive.	160	1,995
P.12.202 A/B	Lean DEA Pump	2800 gpm, 1116 psi △P, 2600 bhp, "A" motor drive, "B" steam turbine drive.	175	1,116
P.12.203 A/B	DEA Booster Pump	2800 gpm, 860 psi △P, 1800 bhp, "A" motor drive, "B" power recovery turbine drive.	122	1,961
P.12.204 A/B	DEA Stripper Reflux Pump	240 gpm, 17 psi △P, 5 hp.	130	25
P.12.205 A/B	Sump Pump	180 gpm, 18 psi △P, 10 hp.	80	18

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN TREATING AND RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.12.206 A/B	Steam Condensate Pump	5 gpm, 34 psiΔP, 1.5 hp, "B" spare.	120	3" Hg
P.12.207 A/B	Hotwell Condensate Pump	220 gpm, 57 psiΔP, 15 hp, "B" spare.	120	3" Hg
Storage Tanks				
T.12.201	DEA Surge Tank	23'-0" diameter x 25'-0" height, carbon steel.	175	atmos.
Vessels				
V.12.202	Oil Wash Absorber	13'-0" ID x 41'-0" TT, carbon steel. 12-304 SS trays.	130	1,960
V.12.203	Lean Oil Surge Drum	10'-0" ID x 15'-0" TT, carbon steel.	110	140
V.12.205 A/B	DEA Contactor	12'-0" ID x 60'-0" TT, carbon steel, 24-304 SS trays.	160	1,950
V.12.206	DEA Stripper	17'-0" ID x 62'-6" TT, carbon steel, 24 trays.	260	15
V.12.207	DEA Stripper Overhead Accumulator	8'-0" ID x 16'-0" TT, carbon steel.	130	8

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN TREATING AND RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Vessels - Continued				
V.12.208	DEA Flash Drum	10'-0" ID x 21'-0" TT, carbon steel.	155	76
V.12.209, .409	H_2 Recycle Compressor Suction Knockout Drum	6'-0" ID x 20'-0" TT, carbon steel.	140	1,945
V.12.210, .410	H_2 Recycle Compressor Discharge Knockout Drum	4'-0" ID x 11'-0" TT, carbon steel.	120	2,120
V.12.211	Sump	12'-0" wide x 12'-0" long x 12'-0" deep, concrete.	---	---
V.12.215	Water Knockout Drum	8'-0" ID x 16'-0" TT, carbon steel.	70	2,120
V.12.216A/B, .316A/B .416A/B .516A/B	Molecular Sieve Bed	9'-0" ID x 26'-0" TT, 1390 cu ft volume, shell and head SA-516-70, 316 SS liner.	200/(-22 to 550)	2,130
V.12.217	Off Gas Surge Drum	11'-0" ID x 22'-0" TT, carbon steel.	23	11
V.12.218	1st Stage Knockout Drum	6'-6" ID x 18'-0" TT, carbon steel.	120	65

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN TREATING AND RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.12.219	2nd Stage Knockout Drum	5-0" ID x 14'-0" TT, carbon steel.	120	255
V.12.220	3rd Stage Knockout Drum	4'-6" ID x 12'-0' TT, carbon steel.	100	355
V.12.221	Hotwell	4'-6" ID x 9'-0" TT, carbon steel.	126	3" Hg

AREA 21 - SYNGAS PRODUCTION PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

Equipment items, names and descriptions omitted because they contain proprietary Texaco Development Corporation synthesis gas production information.

AREA 22 - SYNGAS SHIFT CONVERSION PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

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FOR THE PITTSBURG & MIDWAY COAL MINING CO.& STEARNS-ROGER USE ONLY

Descriptive information available only to signers
of Haldor Topsoe shift secrecy agreement.

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers				
E.22.201	1500 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.22.202	1st Stage Shift Feed/Effluent Exchanger	PROPRIETARY		PROPRIETARY
E.22.203	2nd Stage Inlet 600 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.22.204	2nd Stage Outlet 600 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.22.205	700 psig Boiler Feedwater Heater	PROPRIETARY		PROPRIETARY
E.22.206	250 psig Steam Generator	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SYNGAS SHIFT CONVERSION - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.22.201 A/B	Shift Condensate Return Pump	PROPRIETARY	PROPRIETARY	
Vessels				
V.22.201	1st Stage Shift Converter	PROPRIETARY	PROPRIETARY	
V.22.202	2nd Stage Shift Converter	PROPRIETARY	PROPRIETARY	
V.22.203	COS Hydrolysis Converter	PROPRIETARY	PROPRIETARY	
V.22.204	1500 psig Steam Drum	PROPRIETARY	PROPRIETARY	
V.22.205	600 psig Steam Drum	PROPRIETARY	PROPRIETARY	
V.22.206	250 psig Steam Drum	PROPRIETARY	PROPRIETARY	
V.22.207	Shift Condensate Separator	PROPRIETARY	PROPRIETARY	
V.22.208	Shift Condensate Surge Drum	PROPRIETARY	PROPRIETARY	
V.22.209	600 psig Steam Drum	PROPRIETARY	PROPRIETARY	

AREA 23 - HYDROGEN PURIFICATION AND COMPRESSION PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Air Cooled Equipment				
A.23.201 A/B	Lean Solvent Cooler	PROPRIETARY		PROPRIETARY
A.23.202 A/B/C	Overhead Condenser	PROPRIETARY		PROPRIETARY
Compressors				
C.23.201 A/B	Makeup Hydrogen Compressor	223,900 scfm, 1,320 psiΔP, 24,000 hp, steam turbine drive.	177	2,435
Heat Exchangers			SS/TS	SS/TS
E.23.202 A/B/C	Carbonate Reboiler	PROPRIETARY		PROPRIETARY
E.23.203 A/B	50 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.23.204 A/B	70 psig Boiler Feedwater Heater	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN PURIFICATION AND COMPRESSION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued			SS/TS	SS/TS
E.23.205 A/B	Absorber Precooler	PROPRIETARY	PROPRIETARY	
E.23.206 A/B	Lean Solvent Booster Pump Turbine Surface Condenser	PROPRIETARY	PROPRIETARY	
E.23.206 C	Lean Solvent Booster Pump Turbine Surface Condenser	PROPRIETARY	PROPRIETARY	
E.23.207 A/B	Absorber Overhead Cooler	PROPRIETARY	PROPRIETARY	
E.23.208	Hydrogen Compressor Recirculation Cooler	15.3 MMBtu/hr, carbon steel.	100/152	100/1,120
E.23.210 A	Hydrogen Compressor 2nd Stage Intercooler	17.6 MMBtu/hr, carbon steel.	100/177	100/1,880
E.23.210 B	Hydrogen Compressor 2nd Stage Intercooler	28.8 MMBtu/hr, carbon steel.	100/177	100/1,880
E.23.211 A	Hydrogen Compressor Turbine Surface Condenser	87.2 MMBtu/hr, shell carbon steel, tubes Admiralty.	119/100	4" Hg/100

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN PURIFICATION AND COMPRESSION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued			SS/TS	SS/TS
E.23.211 B	Hydrogen Compressor Turbine Surface Condenser	190.2 MMBtu/hr, shell carbon steel, tubes Admiralty.	119/100	4" Hg/100
E.23.212 A/B	Shift Gas Steam Generator	70.4 MMBtu/hr ea., CS shell, 316 L SS tubes.	308/436	60/1,140
Power Recovery Turbines				
HTB.23.201 A/B	Power Recovery Turbine	PROPRIETARY	PROPRIETARY	
Jet Equipment				
J.23.201 A/B/C	Steam Ejector	PROPRIETARY	PROPRIETARY	
J.23.202	Lean Solvent Booster Pump Turbine Steam Ejector	PROPRIETARY	PROPRIETARY	
J.23.203 A/B	Hydrogen Compressor Steam Ejector	3 in. Hg absolute with jets and condensers.	112	3" Hg abs.
Pumps				
P.23.201 A/B/C/D	Lean Solvent Pump	PROPRIETARY	PROPRIETARY	

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN PURIFICATION AND COMPRESSION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Pumps - Continued				
P.23.202 A/B/C/D	Lean Solvent Booster Pump	PROPRIETARY		PROPRIETARY
P.23.203 A-F	Overhead Pump	PROPRIETARY		PROPRIETARY
P.23.206 A-C	Lean Solvent Booster Pump Steam Condensate Pump	PROPRIETARY		PROPRIETARY
P.23.206 D/E	Lean Solvent Booster Pump Steam Condensate Pump	PROPRIETARY		PROPRIETARY
P.23.207 A/B	Lean Solvent Booster Pump Hotwell Condensate Pump	PROPRIETARY		PROPRIETARY
P.23.208 A/B	Hydrogen Compressor Steam Condensate Pump	325 gpm, 57 psi$\triangle$P, 20 hp, carbon steel.	112	50
P.23.208 C/D	Hydrogen Compressor Steam Condensate Pump	165 gpm, 57 psi$\triangle$P, 10 hp, carbon steel.	112	50
P.23.209 A/B	Hydrogen Compressor Hotwell Condensate Pump	10 gpm, 34 psi$\triangle$P, 1 hp, carbon steel.	150	35

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN PURIFICATION AND COMPRESSION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels				
V.23.202 A/B	Carbonate Absorber	PROPRIETARY		PROPRIETARY
V.23.203 A/B/C	Carbonate Regenerator	PROPRIETARY		PROPRIETARY
V.23.204 A/B/C	Overhead Condenser Knockout Drum	PROPRIETARY		PROPRIETARY
V.23.205 A/B	Precooler Knockout Drum	PROPRIETARY		PROPRIETARY
V.23.206 A/B	50 psig Steam Generator Knockout Drum	PROPRIETARY		PROPRIETARY
V.23.207 A/B/C	Lean Solvent Flash Drum	PROPRIETARY		PROPRIETARY
V.23.208 A/B	70 psig Boiler Feedwater Knockout Drum	PROPRIETARY		PROPRIETARY
V.23.209 A/B	Absorber Overhead Cooler Knockout Drum	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDROGEN PURIFICATION AND COMPRESSION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.23.210 A/B	Carbonate Flash Drum	PROPRIETARY	PROPRIETARY	
V.23.211	Lean Solvent Booster Pump Hotwell	PROPRIETARY	PROPRIETARY	
V.23.212	Hydrogen Compressor Suction Knockout Drum	6'-6" ID x 7'-0" TT, carbon steel.	100	1,115
V.23.214	Hydrogen Compressor 2nd Stage Knockout Drum	3'-6" ID x 7'-0" TT, carbon steel.	120	1,880
V.23.215	Compressor Hotwell	1'-6" ID x 3'-0" TT, carbon steel.	150	---

AREA 25 - METHANATION PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Air Coolers				
A.25.201	Methane Gas Cooler	PROPRIETARY		PROPRIETARY
Heat Exchangers				
E.25.203	1500 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.25.204	600 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.25.205	Methanator Feed Gas Final Heater	PROPRIETARY		PROPRIETARY
E.25.206	1st Stage 250 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.25.207	2nd Stage 250 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.25.208	75 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.25.210	Methanator Feed Gas Primary Heater	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

METHANATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued			SS/TS	SS/TS
E.25.211	Methane Gas Trim Cooler	PROPRIETARY	PROPRIETARY	
E.25.212	Lean Glycol Cooler	.60 MMBtu/hr, carbon steel.	180/115	10/45
E.25.213	Rich/Lean Glycol Exchanger	1.94 MMBtu/hr, carbon steel.	380/150	15/805
E.25.214	Glycol Reboiler	1.515 MMBtu/hr, carbon steel.	370/406	15/250
E.25.217	Regenerator Overhead Partial Condenser	.89 MMBtu/hr, carbon steel.	248/110	14/45
Pumps				
P.25.203 A/B	Condensate Pump	PROPRIETARY	PROPRIETARY	
P.25.205 A/B	DEG Sump Pump	1.1 gpm, 50 psi$\triangle$P, 2 hp.	100	50
P.25.206 A/B	High Pressure Lean Glycol Pump	31 gpm, 860 psi$\triangle$P, 100 hp.	100	863

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

METHANATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Filter Equipment				
S.25.201	High Pressure Glycol Filter	25.8 gpm.	140	825
Storage Tanks				
T.25.201	DEG Sump Tank	3'-0" ID x 5'-0" TT, carbon steel.	100	atmos.
T.25.202	DEG Storage Tank	5'-0" ID x 12'-6" TT, carbon steel.	80	atmos.
Vessels				
V.25.204 A/B	Sulfur Absorber	PROPRIETARY		PROPRIETARY
V.25.205	1st Stage Methanator	PROPRIETARY		PROPRIETARY
V.25.206	2nd Stage Methanator	PROPRIETARY		PROPRIETARY
V.25.207	3rd Stage Methanator	PROPRIETARY		PROPRIETARY
V.25.208	1500 psig Steam Drum	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

METHANATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.25.209	Methanator Feed Gas Primary Heater Knockout Drum	PROPRIETARY		PROPRIETARY
V.25.210	Methanator Gas Trim Cooler Knockout Drum	PROPRIETARY		PROPRIETARY
V.25.211	High Pressure Glycol Dehydrator	6'-0" ID x 20'-0" TT, 6 sieve trays, carbon steel.	98	840
V.25.212	High Pressure Dehydrator Knockout Drum	6'-6" ID x 13'-0" TT, carbon steel.	98	825
V.25.213	Lean Glycol Surge Drum	4'-0" ID x 8'-0" TT, carbon steel.	100	2
V.25.214	Glycol Regenerator	2'-6" ID x 26'-0" TT, 10 sieve trays, C.S.	450	50
V.25.216	75 psig Steam Generator Knockout Drum	4'-2" ID x 8'-4" TT, stainless steel.	347	832
V.25.217	Methane Gas Cooler Knockout Drum	4'-2" ID x 8'-4" TT, stainless steel.	150	823

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

METHANATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.25.218	Condensate Drum	4'-0" ID x 12'-0" TT, carbon steel.	326	815
V.25.219	650 psig Steam Drum	5'-0" ID x 5'-0" TT, carbon steel.	496	650
V.25.220	300 psig Steam Drum	5'-0" ID x 5'-0" TT, carbon steel.	421	300
V.25.221	75 psig Steam Drum	5'-7" ID x 8'-2" TT, carbon steel.	320	75

AREA 26 - SYNGAS PURIFICATION PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Air Cooled Equipment				
A.26.201	Syngas Cooler	PROPRIETARY		PROPRIETARY
A.26.202	Carbonate Solution Cooler	PROPRIETARY		PROPRIETARY
A.26.203	Carbonate Stripper Overhead Condenser	PROPRIETARY		PROPRIETARY
Heat Exchangers			SS/TS	SS/TS
E.26.201	300 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.26.202	75 psig Steam Generator	PROPRIETARY		PROPRIETARY
E.26.203	Carbonate Reboiler	PROPRIETARY		PROPRIETARY
E.26.204	Carbonate Solution Lean/Rich Exchanger	PROPRIETARY		PROPRIETARY
E.26.205	DEA Solution Lean/Rich Exchanger	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SYNGAS PURIFICATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued			SS/TS	SS/TS
E.26.206	DEA Reboiler	PROPRIETARY	PROPRIETARY	
E.26.207	DEA Solution Cooler	PROPRIETARY	PROPRIETARY	
Power Recovery Turbines				
HTB.26.201	Carbonate Hydraulic Turbine	PROPRIETARY	PROPRIETARY	
HTB.26.202	DEA Hydraulic Turbine	PROPRIETARY	PROPRIETARY	
Pumps				
P.26.201 A/B	Carbonate Booster Pump	PROPRIETARY	PROPRIETARY	
P.26.202 A/B	DEA Booster Pump	PROPRIETARY	PROPRIETARY	

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SYNGAS PURIFICATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.26.203 A/B	Carbonate Pump	PROPRIETARY		PROPRIETARY
P.26.204 A/B	Carbonate Stripper Overhead Condensate Pump	PROPRIETARY		PROPRIETARY
P.26.205 A/B	DEA Pump	PROPRIETARY		PROPRIETARY
P.26.206 A/B	Syngas Condensate Pump	PROPRIETARY		PROPRIETARY
P.26.207 A/B	Carbonate Sump Pump	PROPRIETARY		PROPRIETARY
P.26.208 A/B	DEA Sump Pump	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SYNGAS PURIFICATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Storage Tanks				
T.26.201	Carbonate Storage Tank	PROPRIETARY		PROPRIETARY
T.26.202	DEA Storage Tank	PROPRIETARY		PROPRIETARY
T.26.203	Carbonate Sump Tank	PROPRIETARY		PROPRIETARY
T.26.204	DEA Sump Tank	PROPRIETARY		PROPRIETARY
Vessels				
V.26.201	300 psig Steam Generator K.O. Drum	PROPRIETARY		PROPRIETARY
V.26.202	75 psig Steam Generator K.O. Drum	PROPRIETARY		PROPRIETARY
V.26.203	Carbonate Reboiler K.O. Drum	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SYNGAS PURIFICATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.26.204	Syngas Cooler K.O. Drum	PROPRIETARY		PROPRIETARY
V.26.205	Syngas Condensate Drum	PROPRIETARY		PROPRIETARY
V.26.206	Carbonate Absorber	PROPRIETARY		PROPRIETARY
V.26.207	Carbonate Solution Flash	PROPRIETARY		PROPRIETARY
V.26.208	Carbonate Stripper	PROPRIETARY		PROPRIETARY
V.26.209	Carbonate Stripper Overhead Condensate K.O. Drum	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SYNGAS PURIFICATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.26.210	DEA Absorber	PROPRIETARY	PROPRIETARY	
V.26.211	DEA Solution Flash Drum	PROPRIETARY	PROPRIETARY	
V.26.212	DEA Stripper	PROPRIETARY	PROPRIETARY	

AREA 27 - H2/CO SEPARATION PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Package Equipment				
U.27.201	H_2/CO Separation (Cold Box)	10' wide x 10' long x 50' high cold box, refrigeration unit, dust filter, gas cooler, salt bath heater, molecular sieve unit, 160.4 MMSCFD.		1,171
Air Cooled Equipment				
A.27.201	M.P. CO Booster Compressor 1st Intercooler	0.233 MMBtu/hr, header & tubes C.S.	364	160
Compressors				
C.27.201 A/B	M.P. CO Booster Compressor	7958 scfm, two stage, 352 psiΔP, 200 bhp, motor drive.	364	390
C.27.202 A/B	Medium Pressure H_2 Compressor	902 scfm, 515 psiΔP, 710 bhp, steam turbine drive.	247	905

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

H2/CO SEPARATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Compressors - Continued				
C.27.203 A/B	Purification Unit Reactivation Gas Compressor	37,235 scfm, 16 psiΔP, 900 bhp, steam turbine drive for A&B.	160	58
C.27.204 A/B	Low Pressure CO Compressor	13,759 scfm, 31 psiΔP, 1300 bhp, steam turbine drive for A&B.	246	35
Heat Exchangers			SS/TS	SS/TS
E.27.201	Medium Pressure CO Booster Compressor Intercooler	0.0545 MMBtu/hr, shell & tubes C.S	150/115	142/45

AREA 31 - LP GAS COMPRESSION AND TREATING PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Air Cooled Equipment				
A.31.201	LP Gas Compressor Discharge Precooler	26.52 MMBtu/hr,carbon steel.	237	67
A.31.202	LP Amine Regenerator Overhead Precooler	92.85 MMBtu/hr, carbon steel.	194	29
A.31.203	LP Lean Amine Precooler	56.26 MMBtu/hr, carbon steel.	169	82
Compressors				
C.31.201	Vapor Recovery Compressor	5254 scfm, 60 psiΔP, 850 bhp, turbine driven, carbon steel case with Ni-resist cylinder liners.	305	61
C.31.202	LP Gas Compressor	66,923 scfm, 60 psiΔP, 13,500 bhp, turbine driven, carbon steel.	325	61
Heat Exchangers			SS/TS	SS/TS
E.31.202	Vapor Recovery Compressor Aftercooler	1.07 MMBtu/hr, carbon steel.	210/100	57/45
E.31.204	LP Gas Compressor Aftercooler	4.11 MMBtu/hr, carbon steel.	132/100	57/45

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

LP GAS COMPRESSION & TREATING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued			SS/TS	SS/TS
E.31.205	LP Lean Amine Cooler	40.39 MMBtu/hr, carbon steel.	136/100	63/45
E.31.206	LP Rich/Lean Amine Exchanger	116.48 MMBtu/hr, carbon steel.	228/187	20/50
E.31.207	LP Amine Regenerator Reboiler	198.47 MMBtu/hr, carbon steel.	268/280	22/33
E.31.208	LP Amine Regenerator Overhead Condenser	6.25 MMBtu/hr, carbon steel.	132/100	29/45
E.31.209	LP Sweet Gas Cooler	6.05 MMBtu/hr, carbon steel.	108/97	47/45
E.31.210	LP Gas Compressor Turbine Surface Condenser	10.26 MMBtu/hr, carbon steel.	125/100	4" Hg/45
Pumps				
P.31.202 A/B	LP Lean Amine Pump	3080 gpm, 106 psi$\triangle$P, 250 hp, carbon steel.	180	110
P.31.203 A/B	LP Amine Regenerator Reflux Pump	180 gpm, 47 psi$\triangle$P, 10 hp, carbon steel.	115	65

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

LP GAS COMPRESSION & TREATING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.31.204 A/B	LP Gas Compressor Hydrocarbon Condensate Pump	5 gpm, 50 psiΔP, 0.5 hp, carbon steel.	115	50
P.31.205 A/B	LP Gas Compressor Turbine Condensate Pump	205 gpm, 40 psiΔP, 10 hp, carbon steel.	125	30
Filter Equipment				
S.31.201 A/B	LP Amine Filter	10 microns, 300 gpm, carbon steel.	189	105
Packaged Process Equipment				
U.31.201	LP Gas Compressor Turbine Steam Ejector System	3" Hg absolute, includes the following:		
U.31.201(J1)*	Steam Jets	Cast iron		
U.31.201(E1)*	Intercondenser	Carbon steel shell, Admiralty tubes.		
U.31.201(E2)*	Aftercondenser	Carbon steel shell, Admiralty tubes.		
Vessels				
V.31.201	Vapor Recovery Compressor Suction Knockout Drum	3'-6" ID x 7'-0" TT, carbon steel.	146	1

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

LP GAS COMPRESSION & TREATING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.31.203	LP Gas Compressor Suction Knockout Drum	11'-0" ID x 13'-0" TT, carbon steel.	115	1
V.31.205	LP Sour Gas Knockout Drum	8'-6" ID x 12'-0" TT, carbon steel.	115	55
V.31.209	LP Sweet Gas Knockout Drum	7'-6" ID x 11'-0" TT, carbon steel.	95	45
V.31.210	LP Amine Absorber	11'-0" ID x 64'-0" TT, carbon steel, with 20 SS trays.	150	55
V.31.211	LP Amine Regenerator	11'-6" ID x 62'-0" TT, carbon steel, with 20 SS trays.	268	23
V.31.212	LP Lean Amine Surge Drum	13'-0" ID x 29'-0" TT, carbon steel.	189	18
V.31.213	LP Amine Regenerator Reflux Accumulator	4'-6" ID x 10'-0" TT, carbon steel.	115	23
V.31.214	LP Gas Compressor Steam Jet Hotwell	2'-0" ID x 2'-0" TT, carbon steel.	125	0

AREA 32 - PRODUCT GAS PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Air Cooled Equipment				
A.32.201	Deethanizer Feed Compressor Discharge Precooler	15.86 MMBtu/hr, carbon steel.	230	450
A.32.202	Deethanizer Feed Compressor Interstage Cooler	4.15 MMBtu/hr, carbon steel.	193	103
A.32.203	Depropanizer Bottoms Product Cooler	1.98 MMBtu/hr, carbon steel.	193	248
Compressors				
C.32.201	Deethanizer Feed Compressor	24,731 scfm inlet suction, 44,724 scfm side suction, 415 psiΔP, 9,090 hp, carbon steel.	310	456
C.32.204	Deethanizer Refrigerant Compressor	13,234 scfm inlet suction, 36,763 scfm side suction, 160 psiΔP, 7350 hp, carbon steel.	130	166
C.32.205	Deethanizer Offgas Compressor	35,698 scfm, 570 psiΔP, 2074 hp, carbon steel.	97	1,000

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

PRODUCT GAS PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers			SS/TS	SS/TS
E.32.201	LP Lean Glycol Cooler	3.83 MMBtu/hr, carbon steel.	116/100	62/45
E.32.202	LP Rich/Lean Glycol Exchanger	28.48 MMBtu/hr, carbon steel.	268/250	67/43
E.32.203	LP Glycol Regenerator Reboiler	6.40 MMBtu/hr, carbon steel.	400/497	4/650
E.32.205	LP Glycol Regenerator Overhead Condenser	4.35 MMBtu/hr, carbon steel.	149/100	2/45
E.32.208	Deethanizer Feed Compressor Aftercooler	3.47 MMBtu/hr, carbon steel.	132/100	452/45
E.32.209	Deethanizer Feed Cooler	17.50 MMBtu/hr, carbon steel.	18/71	39/448
E.32.210	Deethanizer Reboiler	14.33 MMBtu/hr, carbon steel.	279/200	32/445
E.32.211	Deethanizer Condenser	12.41 MMBtu/hr, carbon steel.	-29/-2	6/438
E.32.212	Depropanizer Condenser	12.83 MMBtu/hr, carbon steel.	120/100	238/45

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

PRODUCT GAS PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued			SS/TS	SS/TS
E.32.213	Depropanizer Reboiler	10.90 MMBtu/hr, carbon steel.	279/237	32/250
E.32.215	Deethanizer Refrigerant Condenser	39.63 MMBtu/hr, carbon steel.	112/100	163/45
E.32.217	Deethanizer Feed Compressor Turbine Surface Condenser	67.44 MMBtu/hr, carbon steel shell, Admiralty tubes.	125/100	4" Hg/45
Pumps				
P.32.201 A/B	LP Lean Glycol Pump	350 gpm, 81 psiΔP, 20 hp, carbon steel.	400	90
P.32.202 A/B	LP Glycol Regenerator Reflux Pump	8 gpm, 40 psiΔP, 0.5 hp, carbon steel.	115	46
P.32.203 A/B	Deethanizer Reflux Pump	240 gpm, 28 psiΔP, 7.5 hp, carbon steel.	-20	466
P.32.204 A/B	Depropanizer Reflux Pump	430 gpm, 46 psiΔP, 20 hp, carbon steel.	115	286
P.32.205 A/B	Deethanizer Feed Compressor Turbine Condensate Pump	135 gpm, 40 psiΔP, 7.5 hp, carbon steel.	125	30

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

PRODUCT GAS PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Filter Equipment				
S.32.201 A/B	LP Glycol Filter	5 microns, 305 gpm, carbon steel, 5 psiΔP, clean.	117	45
Packaged Process Equipment				
U.32.201	Deethanizer Feed Compressor Steam Ejector System	3 in. Hg absolute, includes the following:		
U.32.201(J1)*	Two-Stage Jets	Cast iron.		
U.32.201(E1)*	Intercondenser	Carbon steel shell, Admiralty tubes.		
U.32.201(E2)*	Aftercondenser	Carbon steel shell, Admiralty tubes.		
Vessels				
V.32.201	LP Glycol Dehydrator	10'-0" ID x 29'-6" TT, carbon steel, 12 SS trays.	120	46
V.32.202	LP Dehydrator Knockout Drum	9'-0" ID x 11'-0" TT, carbon steel.	103	41

*Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

PRODUCT GAS PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.32.204	LP Glycol Regenerator	4'-6" ID x 28'-6" TT, carbon steel, 2 SS wash trays, 8 ft of 2" SS Pall ring packing.	400	4
V.32.205	LP Glycol Regenerator Reflux Accumulator	2'-0" ID x 6'-0" TT, carbon steel.	115	1
V.32.206	Glycol Surge Tank	6'-0" ID x 12'-0" TT, carbon steel.	140	10
V.32.207	Deethanizer Feed Compressor 2nd Stage Suction Knockout Drum	7'-6" ID x 9'-0" TT, carbon steel.	115	100
V.32.209	Deethanizer	6'-6" ID x 52'-6" TT, carbon steel, 20 C.S. trays.	100	450
V.32.210	Deethanizer Reflux Drum	5'-6" ID x 12'-0" TT, carbon steel.	-20	431
V.32.211	Depropanizer	4'-6" ID x 82'-6" TT, carbon steel, 35 C.S. trays.	175	250
V.32.212	Depropanizer Reflux Drum	5'-0" ID x 15'-0" TT, carbon steel.	115	236

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

PRODUCT GAS PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.32.213	Deethanizer Refrigerant Knockout Drum	6'-0" ID x 12'-0" TT, carbon steel.	-42	1
V.32.214	Deethanizer Economizer	6'-0" ID x 16'-0" TT, carbon steel.	50	77
V.32.215	Deethanizer Refrigerant Surge Drum	8'-0" ID x 23'-0" TT, carbon steel.	95	160
V.32.216	Deethanizer Refrigerant Interstage Knockout Drum	5'-6" ID x 11'-0" TT, carbon steel.	16	38
V.32.217	Deethanizer Feed Compressor Turbine Steam Ejector Hotwell	2'-0" ID x 2'-0" TT, carbon steel.	125	0

AREA 33 - SULFUR RECOVERY PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Air Cooled Equipment				
A.33.201	Stripper Overhead Air Cooler	PROPRIETARY	PROPRIETARY	
Boilers			SS/TS	SS/TS
B.33.201	Claus Waste Heat Boiler	110.56 MMBtu/hr, carbon steel.	459/1,200	650/10
B.33.202	SCOT Waste Heat Boiler	PROPRIETARY	PROPRIETARY	
Compressors				
C.33.201	Combustion Air Blower	33,033 scfm, 14.8 psiΔP, 2420 hp, carbon steel.	225	15
C.33.202 A/B	Incinerator Air Blower	30,384 scfm, 3.3 psiΔP, 610 hp, carbon steel.	100	3.3
Heat Exchangers			SS/TS	SS/TS
E.33.201	No. 1 Sulfur Condenser	33.98 MMBtu/hr, carbon steel.	297/ 505	50/11
E.33.202	No. 2 Sulfur Condenser	15.6 MMBtu/hr, carbon steel.	297/408	50/9

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SULFUR RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued			SS/TS	SS/TS
E.33.203	No. 3 Sulfur Condenser	3.06 MMBtu/hr, carbon steel.	277/294	65/9
E.33.205	Quench Cooler	PROPRIETARY	PROPRIETARY	
E.33.206	H_2S Absorber Feed Cooler	PROPRIETARY	PROPRIETARY	
E.33.207 A/B	Lean Solution Chiller	PROPRIETARY	PROPRIETARY	
E.33.208 A/B	Lean Solution Cooler	PROPRIETARY	PROPRIETARY	
E.33.209 A/B	Lean/Rich Solution Exchanger	PROPRIETARY	PROPRIETARY	
E.33.210 A/B	Stripper Reflux Condenser	PROPRIETARY	PROPRIETARY	

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SULFUR RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued			SS/TS	SS/TS
E.33.211 A/B	Stripper Reboiler	PROPRIETARY		PROPRIETARY
E.33.212 A/B	Turbine Surface Condenser	PROPRIETARY		PROPRIETARY
E.33.214	Waste Heat Recovery Exchanger	336.43 MMBtu/hr, 300,000 scfm, 304 SS corrugated plate.	476/850	3/2.5
Furnaces and Stacks				
H.33.201	Claus Reaction Furnace	138.43 MMBtu/hr, heat release, 2100 cu ft volume, refractory lined carbon steel.	2,515	12
H.33.203	SCOT Inline Burner/Mixer	PROPRIETARY		PROPRIETARY
H.33.205	Incinerator	130 MMBtu/hr, 15'-0" ID x 45'-0" long, refractory lined carbon steel.	1,200	3
H.33.206	Incinerator Stack	18'-6" ID base, 11'-0" ID top x 150'-0" high, refractory lined carbon steel.	500	0

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SULFUR RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps				
P.33.201 A/B	Sulfur Product Pump	700 gpm, 60 psiΔP, 50 hp, cast iron.	300	60
P.33.202 A/B	Quench Circulation Pump	PROPRIETARY		PROPRIETARY
P.33.203 A/B/C	Rich Solution Pump	PROPRIETARY		PROPRIETARY
P.33.204 A/B/C	Lean Solution Pump	PROPRIETARY		PROPRIETARY
P.33.205 A/B/C	Stripper Reflux Pump	PROPRIETARY		PROPRIETARY
P.33.206 A/B/C	Chilled Brine Pump	PROPRIETARY		PROPRIETARY
P.33.207 A/B	Solvent Transfer Pump	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SULFUR RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.33.208 A/B	Solvent Sump Pump	PROPRIETARY		PROPRIETARY
P.33.209 A/B/C	Steam Condensate Pump	PROPRIETARY		PROPRIETARY
P.33.210 A/B/C	Hotwell Condensate Pump	PROPRIETARY		PROPRIETARY
Filter Equipment				
S.33.201 A/B	Quench Water Filter	PROPRIETARY		PROPRIETARY
S.33.202 A/B/C	Lean Solution Filter	PROPRIETARY		PROPRIETARY
Storage Tanks				
T.33.201	Solvent Storage Tank	PROPRIETARY		PROPRIETARY
Packaged Process Units				
U.33.201 A/B	Refrigeration Package	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SULFUR RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Packaged Process Units - Continued				
U.33.202 A/B	Turbine Steam Ejector System	PROPRIETARY		PROPRIETARY
Vessels				
V.33.201	Acid Gas Knockout Drum	8'-6" ID x 11'-0" TT, carbon steel.	110	12
V.33.202	No. 1 Sulfur Converter	22'-0" ID x 85'-6" TT, carbon steel with internal refractory, 5170 cu ft alumina catalyst.	655	10
V.33.203	No. 2 Sulfur Converter	22'-0" ID x 88'-0" TT, carbon steel with internal refractory, 5320 cu ft alumina catalyst.	475	9
V.33.204	Tail Gas Separator	8'-0" ID x 18'-0" TT, carbon steel.	276	8
V.33.205	Hydrogenation Reactor	PROPRIETARY		PROPRIETARY
V.33.206	Quench Tower	PROPRIETARY		PROPRIETARY
V.33.207 A/B	H_2S Absorber Inlet Scrubber	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SULFUR RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.33.208 A/B	H_2S Absorber	PROPRIETARY		PROPRIETARY
V.33.209 A/B	Solution Stripper	PROPRIETARY		PROPRIETARY
V.33.210 A/B	Stripper Reflux Accumulator	PROPRIETARY		PROPRIETARY
V.33.212 A/B	Chilled Brine Surge Drum	PROPRIETARY		PROPRIETARY
V.33.213	LP Steam Separator	7'-0" ID x 14'-6" TT, carbon steel.	297	50
V.33.214	Solvent Sump	PROPRIETARY		PROPRIETARY
V.33.215 A/B	Hotwell	PROPRIETARY		PROPRIETARY

AREA 34 - REFINING PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Air Cooled Equipment				
A.34.201	Fractionator Overhead Condenser	109.12 .MMBtu/hr, carbon steel tubes.	218	13
A.34.202	Gas Oil Air Cooler	65.76 MMBtu/hr, carbon steel tubes.	249	51
A.34.203	Debutanizer Product Precooler	12.0 MMBtu/hr, carbon steel.	232	33
A.34.204	Lean Oil Air Cooler	38.8 MMBtu/hr, carbon steel.	179	120
A.34.205	1st Stage Vacuum Overhead Air Cooler	14.0 MMBtu/hr, carbon steel.	212	1.7 psia
Compressors				
C.34.231	Vapor Recovery Compressor	1000 scfm, 5 psiΔP, 75 hp, carbon steel.	100	6
Heat Exchangers			SS/TS	SS/TS
E.34.201	Fractionator Overhead Trim Cooler	14.96 MMBtu/hr, 12-Cr tubes.	135/100	11/45
E.34.202	Gas Oil Trim Cooler	2.70 MMBtu/hr, carbon steel tubes.	135/100	41/45

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

REFINING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued			SS/TS	SS/TS
E.34.203	Gas Oil/Low Pressure Cold Feed Exchanger	32.0 MMBtu/hr, carbon steel tubes.	270/488	35/71
E.34.204	Gas Oil/High Pressure Cold Feed Exchanger	34.84 MMBtu/hr, carbon steel tubes.	396/220	75/60
E.34.205	Lean Oil Cooler	26.3 MMBtu/hr, Admiralty tubes.	130/100	118/45
E.34.206	Rich Oil/Lean Oil Exchanger	68.0 MMBtu/hr, carbon steel tubes.	340/435	18/150
E.34.207	Gas Oil/Low Pressure Hot Feed Exchanger	32.53 MMBtu/hr, carbon steel tubes.	490/570	21/81
E.34.208	Lean Oil Precooler	124.1 MMBtu/hr, carbon steel tubes.	300/130	141/45
E.34.211	Debutanizer Overhead Condenser	6.63 MMBtu/hr, carbon steel tubes.	137/100	100/45
E.34.212	Debutanizer Feed Bottoms Exchanger	6.37 MMBtu/hr, carbon steel tubes.	356/155	92/98

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

REFINING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued			SS/TS	SS/TS
E.34.213	Debutanizer Reboiler	19.80 MMBtu/hr, carbon steel tubes.	384/488	105/600
E.34.214	Debutanizer Naphtha Cooler	2.20 MMBtu/hr, carbon steel tubes.	135/100	42/45
E.34.221	1st Stage Vacuum Flash Overhead Precooler	91.3 MMBtu/hr, carbon steel tubes.	496/188	2.7 psia/23
E.34.222	1st Stage Vacuum Flash Overhead Cooler	2.1 MMBtu/hr, carbon steel.	135/100	1.7 psia/45
E.34.223	2nd Stage Vacuum Flash Overhead Precooler	19.2 MMBtu/hr, carbon steel.	497/287	0.12 psia/32
Fired Heaters				
H.34.201	Fractionator Reboiler	326.5 MMBtu/hr, carbon steel tubes.	595	31
H.34.231	Mineral Residue Slurry Heater	11.8 MMBtu/hr, 123,000 lbs/hr, carbon steel tubes, refractory lined carbon steel shell.	275	100
H.34.232	Heating Oil Heater	2.55 MMBtu/hr, carbon steel.	550	60

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

REFINING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Mixers				
M.34.231 A/B/C/D	Mineral Residue Slurry Tank Mixer	304 SS, 1 rpm (approx. 1 fps tip speed), 10 hp	300	75
Pumps				
P.34.201 A/B	Fractionator Reflux Pump	708 gpm, 112 psiΔP, 75 hp, carbon steel.	120	130
P.34.202 A/B	Lean Oil Pump	3276 gpm, 135 psiΔP, 308 bhp, carbon steel, one turbine driven, one motor driven (350 hp).	480	156
P.34.203 A/B	Gas Oil Pump	1720 gpm, 85 psiΔP, 125 hp, carbon steel.	609	106
P.34.204 A/B	Fractionator Reboiler Pump	6624 gpm, 60 psiΔP, 273 bhp, carbon steel, one turbine driven, one motor driven (300 hp).	580	81
P.34.205 A/B	Fractionator Sour Water Pump	84 gpm, 35 psiΔP, 5 hp, carbon steel.	120	51
P.34.211 A/B	Debutanizer Reflux Pump	180 gpm, 35 psiΔP, 7.5 hp, carbon steel.	120	125
P.34.221 A/B	Light Vacuum Gas Oil Pump	800 gpm, 49 psiΔP, 40 hp, carbon steel.	120	46

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

REFINING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.34.222 A/B	Vacuum Bottoms Pump	1680 gpm, 57 psiΔP, 100 hp, 28% Cr-iron liners and impeller.	700	61
P.34.223 A/B	Vacuum Hotwell Oil Pump	20 gpm, 35 psiΔP, 1 hp, carbon steel.	120	41
P.34.224 A/B	Vacuum Hotwell Water Pump	30 gpm, 44 psiΔP, 2 hp, carbon steel.	120	51
P.34.225 A/B	Heavy Vacuum Gas Oil Pump	100 gpm, 50 psiΔP, 7.5 hp, carbon steel.	120	50
P.34.231 A/B	Naphtha Pump	695 gpm, 150 psiΔP, 100 hp, carbon steel. (is common spare with P.34.232.)	120	152
P.34.232	Light Fuel Oil Pump	695 gpm, 150 psiΔP, 100 hp, carbon steel.	120	152
P.34.233 A/B	Solvent Makeup Pump	200 gpm, 150 psiΔP, 30 hp, carbon steel.	110	152
P.34.234 A/B	Solvent Dilution Pump	500 gpm, 50 psiΔP, 200 hp, carbon steel.	110	152
P.34.235 A/B	Slops/Heavy Oil Pump	250 gpm, 150 psiΔP, 50 hp, carbon steel.	120	152

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

REFINING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.34.236 A thru H	Mineral Residue Slurry Transfer Pump	1050 gpm, 50 psi△P, 50 hp, carbon steel.	300	152
P.34.237 A/B	MRS Tank Jet-Mix Pump	50,000 gpm, 10 psi△P, 400 hp, carbon steel.	300	12
P.34.238 A/B	Heating Oil Circulating Pump	50 gpm, 60 psi△P, 5 hp, carbon steel.	450	65
Storage Tanks				
T.34.231	Untreated Naphtha Tank	120'-0" diameter x 40'-0" high, 80,580 bbl, carbon steel.	120	0
T.34.232	Untreated Light Fuel Oil Tank	120'-0" diameter x 40'-0" high, 80,580 bbl, carbon steel.	110	0
T.34.233	Solvent Tank	80'-0" diameter x 40'-0" high, 35,000 bbl, carbon steel.	110	0
T.34.234 A/B/C/D	Mineral Residue Dilution Tank	10'-0" ID x 30'-0" TT, carbon steel.	300	20
T.34.235 A/B	Slops Tank	70'-0" diameter x 40'-0" high, 27,000 bbl, carbon steel.	120	0

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

REFINING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Storage Tanks - Continued				
T.34.236 A/B	Dilute Mineral Residue Slurry Hold Tank	75'-0" diameter x 40'-0" high, 30,000 bbl, carbon steel.	300	0
Packaged Process Equipment				
U.34.221	First Stage Vacuum Ejector System	1.0 psia includes:		
U.34.221(E1)*	1st Stage Vacuum Condenser	Carbon steel.		
U.34.221(E2)*	2nd Stage Vacuum Condenser	Carbon steel.		
U.34.221(J1)*	Dirty Vacuum Flash Ejector	Carbon steel,2 stage 1.0 psia.		
U.34.222	Second Stage Vacuum Ejector System	3 mm Hg absolute, includes the following:		
U.34.222(E1)*	2nd Stage Vacuum Condenser	Carbon steel tubes.		
U.34.222(E2)*	3rd Stage Vacuum Condenser	Carbon steel tubes.		
U.34.222(E3)*	4th Stage Vacuum Condenser	Carbon steel tubes.		
U.34.222(J1)*	Dirty Vacuum Flash Ejector	4 stage, 3 mm Hg, #1 & #2 carbon steel,#3 & #4 cast iron.		

* Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

REFINING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels				
V.34.201	High Pressure Cold Feed Surge Drum	12'-0" ID x 25'-0" TT, carbon steel.	93	50
V.34.202	Atmospheric Fractionating Tower	14'-0" and 25'-0" ID x 69'-6" TT, (overall) carbon steel clad with 1/8" 316 SS 24-304 SS valve trays.	610	16
V.34.203	Fractionator Overhead Accumulator	8'-0" ID x 20'-0" TT, with water boot 2'-6" ID x 4'-0" long, carbon steel.	120	12
V.34.204	Fractionator Side Stream Stripper	10'-0" ID x 17'-0" TT, carbon steel clad with 1/8" 316 SS, 4-304 SS valve trays.	495	14
V.34.211	Debutanizer	5'-6" ID x 75'-6" TT, carbon steel, 30-304 SS valve trays.	398	100
V.34.212	Debutanizer Overhead Accumulator	5'-0" ID x 12'-6" TT, with water boot, 1'-6" ID x 3'-0" long, carbon steel.	120	94
V.34.221	1st Stage Vacuum Flash Tower	14'-0" ID x 10'-0" TT, and 5'-6" ID x 20'-0" TT, carbon steel, 37'-4" overall TT.	718	3 psia
V.34.222	1st Stage Vacuum Flash Overhead Accumulator	6'-0" ID x 15'-0" TT, carbon steel.	120	2.5 psia

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

REFINING PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.34.223	Vacuum Hotwell	2'-6" ID x 7'-0" TT, carbon steel with internal weir.	150	0
V.34.224	2nd Stage Vacuum Flash Tower	19'-0" ID x 10'-0" TT, and 5'-6" ID x 20'-0" TT, carbon steel, 41'-8" overall TT.	695	0.2 psia
V.34.225	2nd Stage Vacuum Overhead Accumulator	4'-0" ID x 10'-0" TT, carbon steel.	300	0.1 psia
V.34.226	Heating Oil Surge Drum	4'-6" ID x 9'-0" TT, carbon steel.	450	5

AREA 35 - HYDRODESULFURIZATION PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

Descriptive equipment information omitted because it contains proprietary Gulf Oil Corporation hydrodesulfurization information.

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Air Cooled Equipment				
A.35.201	HDS Product Precooler	PROPRIETARY		PROPRIETARY
A.35.202	HDS Stripper Overhead Precooler	PROPRIETARY		PROPRIETARY
A.35.203	HDS Reactor Effluent Precooler	PROPRIETARY		PROPRIETARY
Compressors				
C.35.201	Hydrodesulfurization Recycle Compressor	PROPRIETARY		PROPRIETARY
Heat Exchangers				
E.35.201	Hydrodesulfurization Reactor Feed/Effluent Exchanger	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDRODESULFURIZATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued				
E.35.202	Hydrodesulfurization Stripper Feed/Product Exchanger	PROPRIETARY		PROPRIETARY
E.35.203	Hydrodesulfurization Product Cooler	PROPRIETARY		PROPRIETARY
E.35.204	Hydrodesulfurization Stripper Condenser	PROPRIETARY		PROPRIETARY
E.35.205	Hydrodesulfurization Reactor Effluent Cooler	PROPRIETARY		PROPRIETARY
Fired Heaters				
H.35.201	Hydrodesulfurization Feed Heater	PROPRIETARY		PROPRIETARY
H.35.202	Hydrodesulfurization Stripper Reboiler	PROPRIETARY		PROPRIETARY
Pumps				
P.35.201 A/B	Hydrodesulfurization Feed Pump	PROPRIETARY		PROPRIETARY

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

HYDRODESULFURIZATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.35.202 A/B	Hydrodesulfurization Stripper Bottoms Pump	PROPRIETARY		PROPRIETARY
P.35.203 A/B	Hydrodesulfurization Stripper Reflux Pump	PROPRIETARY		PROPRIETARY
Vessels				
V.35.201	Hydrodesulfurization Feed Surge Drum	PROPRIETARY		PROPRIETARY
V.35.202	Hydrodesulfurization Reactor	PROPRIETARY		PROPRIETARY
V.35.203	Hydrodesulfurization High Pressure Separator	PROPRIETARY		PROPRIETARY
V.35.204	Hydrodesulfurization Stripper	PROPRIETARY		PROPRIETARY
V.35.205	Hydrodesulfurization Stripper Overhead Accumulator	PROPRIETARY		PROPRIETARY
V.35.206	Hydrodesulfurization Compressor Suction Knockout Drum	PROPRIETARY		PROPRIETARY

AREA 41 - AMMONIA RECOVERY PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

Exchanger duties and equipment descriptions omitted because they contain proprietary USS E&C Phosam-W Process information.

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers				
E.41.201	Lean Solution Cooler	PROPRIETARY	PROPRIETARY	
E.41.202	Feed Preheater	PROPRIETARY	PROPRIETARY	
E.41.203	After Condenser Cooler	PROPRIETARY	PROPRIETARY	
E.41.204	Solution Exchanger	PROPRIETARY	PROPRIETARY	
E.41.205	Reflux Condenser	PROPRIETARY	PROPRIETARY	
E.41.206	Superstill Reboiler	PROPRIETARY	PROPRIETARY	
E.41.207	Stripper Reboiler	PROPRIETARY	PROPRIETARY	
E.41.208	Stripper Condenser	PROPRIETARY	PROPRIETARY	

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

AMMONIA RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Heat Exchangers - Continued				
E.41.209	Fractionator Condenser	PROPRIETARY	PROPRIETARY	
E.41.210	Fractionator Reboiler	PROPRIETARY	PROPRIETARY	
Pumps				
P.41.201 A/B	Ammonia Recovery Feed	1200 gpm, 30 psi $\triangle$P, 30 hp motor, horiz. centrifugal carbon steel case, carbon steel imp.	115	30
P.41.202 A/B	After Condenser Pump	PROPRIETARY	PROPRIETARY	
P.41.203 A/B	Absorber Circulation Pump	PROPRIETARY	PROPRIETARY	
P.41.204 A/B	Rich Solution Pump	PROPRIETARY	PROPRIETARY	
P.41.205 A/B	Reflux Condenser Pump	PROPRIETARY	PROPRIETARY	
P.41.206 A/B	Fractionator Feed Pump	PROPRIETARY	PROPRIETARY	

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

AMMONIA RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Pumps - Continued				
P.41.207 A/B	Fractionator Reflux Pump	PROPRIETARY	PROPRIETARY	
P.41.208 A/B	Phosphoric Acid Pump	PROPRIETARY	PROPRIETARY	
P.41.209 A/B	Caustic Metering Pump	PROPRIETARY	PROPRIETARY	
Storage Tanks				
T.41.201	Ammonia Recovery Feed Tank	50'-0" diameter x 48'-0" height, API 650 tank, carbon steel.	200	4" H_2O
Vessels				
V.41.201	Superstill	PROPRIETARY	PROPRIETARY	
V.41.202	Stripper	PROPRIETARY	PROPRIETARY	
V.41.203	Fractionator	PROPRIETARY	PROPRIETARY	
V.41.204	Fractionator Feed Tank	PROPRIETARY	PROPRIETARY	

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

AMMONIA RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.41.205	HP Steam Flash Drum	PROPRIETARY	PROPRIETARY	
V.41.206	LP Steam Flash Drum	PROPRIETARY	PROPRIETARY	
V.41.207	Phosphoric Acid Tank	PROPRIETARY	PROPRIETARY	
V.41.208	Caustic Tank	PROPRIETARY	PROPRIETARY	

AREA 42 - TAR ACIDS RECOVERY PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

Exchanger duties and equipment descriptions omitted because they contain proprietary Jones & Laughlin Extraction process information.

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers				
E.42.201 A/B	Stripping Column Overhead	PROPRIETARY	PROPRIETARY	
E.42.202 A/B	Solvent Recovery Column Overhead Condenser	PROPRIETARY	PROPRIETARY	
E.42.203 A/B	Solvent Recovery Column Reboiler	PROPRIETARY	PROPRIETARY	
E.42.204 A/B	Tar Acid Still Overhead Condenser	PROPRIETARY	PROPRIETARY	
E.42.205 A/B	Tar Acid Still Reboiler	PROPRIETARY	PROPRIETARY	

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

TAR ACIDS RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Jet Equipment				
J.42.201	Tar Acid Ejector	PROPRIETARY	PROPRIETARY	
J.42.202	Tar Acid Barometric Condenser	PROPRIETARY	PROPRIETARY	
Pumps				
P.42.201 A/B	Tar Acid Feed Pump	PROPRIETARY	PROPRIETARY	
P.42.202 A/B	Devil Liquor Pump	PROPRIETARY	PROPRIETARY	
P.42.203 A/B	Solvent Pump	PROPRIETARY	PROPRIETARY	
P.42.204 A/B	Stripping Colum Reflux Pump	PROPRIETARY	PROPRIETARY	
P.42.205 A/B	Solvent Makeup Pump	PROPRIETARY	PROPRIETARY	

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

TAR ACIDS RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.42.206 A/B	Solvent Recovery Column Bottoms Pump	PROPRIETARY	PROPRIETARY	
P.42.207 A/B	Tar Acid Still Reflux Pump	PROPRIETARY	PROPRIETARY	
P.42.208 A/B	Tar Acid Still Bottoms Pump	PROPRIETARY	PROPRIETARY	
P.42.209 A/B	Tar Acid Product Pump	PROPRIETARY	PROPRIETARY	
Tanks				
T.42.201 A/B	Solvent Makeup Tank	PROPRIETARY	PROPRIETARY	
Vessels				
V.42.201 .301,.401	Extraction Column	PROPRIETARY	PROPRIETARY	
V.42.202	Solvent Stripping Column	PROPRIETARY	PROPRIETARY	

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

TAR ACIDS RECOVERY PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.42.203	Solvent Recovery Column	PROPRIETARY	PROPRIETARY	
V.42.204	Tar Acid Still	PROPRIETARY	PROPRIETARY	
V.42.205	Tar Acid Feed Surge Tank	PROPRIETARY	PROPRIETARY	
V.42.206	Solvent Drum	PROPRIETARY	PROPRIETARY	
V.42.207	Tar Acid Overhead Accumulator	PROPRIETARY	PROPRIETARY	
V.42.208	Tar Acid Product Tank	PROPRIETARY	PROPRIETARY	

AREA 43 - WASTE WATER RECLAMATION PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Mixers				
M.43.201 A/B/C/D	Sump Mixer	30 rpm, 5 feet diameter flat blade paddle, 20 hp, carbon steel.	ambient	atmos.
Pumps				
P.43.201 A/B	Rain Water Pump	116 gpm, 30 psiΔP, 5 hp, carbon steel.	ambient	32
P.43.202 A/B	Blowdown Transfer Pump	3000 gpm, 35 psi ΔP, 75 hp, carbon steel.	115	37
P.43.203 A/B	Flotation Inlet Pump	730 gpm, 24 psi ΔP, 15 hp, carbon steel.	ambient	22
P.43.204 A/B	Flotation Water Pump	714 gpm, 24 psi ΔP, 15 hp, carbon steel.	ambient	26
P.43.205 A/B	Flotation Oil Pump	16 gpm, 22 psi ΔP, 3 hp, carbon steel.	ambient	24
P.43.206 A/B	Low Quality Brine Conc Inlet Pump	2100 gpm, 24 psi ΔP, 40 hp, carbon steel.	ambient	26

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

WASTE WATER RECLAMATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.43.207 A/B	Filter Press Filtrate Pump (clarifier blowdown)	415 gpm, 22 psi ΔP, 10 hp, carbon steel.	ambient	25
P.43.208 A/B	Filter Press Filtrate Pump (concentrator concentrate)	85 gpm, 26 psi ΔP, 5 hp, stainless steel.	ambient	28
P.43.209 A/B	Filter Press Inlet Pump (clarifier blowdown)	480 gpm, 22 psi ΔP, 10 hp, carbon steel.	ambient	24
P.43.210 A/B	Filter Press Inlet Pump (concentrator concentrate)	128 gpm, 21 psi ΔP, 5 hp, stainless steel.	ambient	23
P.43.213 A/B/C	Reclaimed Water Pump	2625 gpm, 24 psi ΔP, 50 hp, carbon steel.	ambient	26
Separation and Thickening Equipment				
S.43.201	Oil Flotation System	800 gpm, 30'-0" ID x 9'-0" Flotation tank.	ambient	atmos.
S.43.202	Belt Filter Press	800 gpm, 4 units, includes chemical feed equipment.	ambient	atmos.
Storage Basins				
T.43.201	Rainwater Retention Basin	210'-0" x 210'-0" x 25'-0" deep, 8 MM gallons, lined earth.	ambient	atmos.

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

WASTE WATER RECLAMATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Storage Basins - Continued				
T.43.202	Process Water Basin	20'-0" x 20-0"' x 8'-0" deep, 22,000 gallons, lined earth.	ambient	atmos.
T.43.203	Belt Filtrate Pump Sump (clarifier blowdown)	10'-0" x 10'-0" x 8'-0" deep, 5,000 gallons, concrete.	ambient	atmos.
T.43.204	Belt Filter Filtrate Pump Sump (concentrator concentrate)	6'-0" x 6'-0" x 4'-0" deep, 1,000 gallons, concrete.	ambient	atmos.
Packaged Process UNits				
U.43.201	Brine Concentrator	3,000 gpm.	---	---
U.43.202	Brine Concentrator	2,400 gpm.	---	---
Vessels				
V.43.201	High Quality Brine Conc. Inlet Water Tank	140'-0" ID x 40'-0" high, carbon steel, coated.	ambient	atmos.
V.43.202	Low Quality Brine Conc. Inlet Water Tank	140'-0" ID x 40'-0" high, carbon steel, coated.	ambient	atmos.
V.43.203	Reclaimed Water Tank	40'-0" ID x 40'-0" high, carbon steel, coated.	ambient	atmos.

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

WASTE WATER RECLAMATION PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.43.204	Filter Press Inlet Tank (clarifier)	110'-0" ID x 48'-0" high, carbon steel.	ambient	atmos.
V.43.205	Filter Press Inlet Tank (cooling tower)	60'-0" ID x 40'-0" high, carbon steel.	ambient	atmos.
V.43.210	Acid Storage Tank	5'-6" ID x 12'-0" long, carbon steel.	ambient	80
V.43.211	Caustic Storage Tank	5'-6" ID x 12'-0" long, carbon steel.	ambient	80

AREA 44 - OXYGEN PLANT

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Compressors				
C.44.201 .301,.401, .501	Oxygen Plant Air Compressor	143,250 scfm, 94.8 psi ΔP, 28,000 hp, with interstage coolers, gas turbine driven.	250	95
C.44.203 .303,.403	Oxygen Compressor	41,500 scfm, 1460 psi ΔP, 22,100 hp, 3-case compressor with 7 interstage coolers.	220	1,461
CGT.44.201, .301, .401, .501	Air Compressor Gas Turbine	28,000 hp, with steam injection.	---	---
CT.44.203, .303, .403	Oxygen Compressor Steam Turbine Drive	22,100 bhp, condensing turbine, 1500 psi, 950°F steam to 4" Hg.	---	---
Heat Exchangers				
E.44.201, .301, .401, .501	Air Compressor Aftercooler	27.9 MMBtu/hr, 13,332 ft^2, carbon steel.	SS/TS 96/169	SS/TS 60/92
E.44.203, .303,.403, .503	Gas Turbine Waste Heat Boiler	109.4 MMBtu/hr, generating 112,275 lbs/hr of 600 psi saturated steam.	610/379	4" WG/600
E.44.205, .305	Liquid Oxygen Vaporizer	36.9 MMBtu/hr, carbon steel, 304SS tubes.	-100/320	25/75

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

OXYGEN PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Heat Exchangers - Continued				
E.44.206, .306,.406	Oxygen Bypass Cooler	2.0 MMBtu/hr, 2870 ft^2, carbon steel.	96/145	66/10
E.44.207, .307,.407	Oxygen Compressor Turbine Surface Condenser	141.8 MMBtu/hr, 12,900 ft^2, carbon steel.	126/96	4" Hg/60
Jet Equipment				
J.44.203, 303,.403	Oxygen Compressor Steam Ejector	Two stage, 930 lb/hr, 50 psi steam with inter and after condensers.	---	---
Pumps				
P.44.203, .303	Liquid Oxygen Pump	370 gpm, 25 psi $\triangle$P, 10 hp, motor horiz. centrifugal, 304 SS case, 304SS impeller.	-295	25
P.44.204, .304	Liquid Nitrogen Pump	30 gpm, 275 psi $\triangle$P, 15 hp, motor, horiz. centrifugal.	-300	315
P.44.205A/B, .305A/B, .405A/B	Oxygen Compressor Turbine Condensate Pump	300 gpm, 41 psi $\triangle$P, 15 hp, motor, vertical turbine, carbon steel case, cast iron impeller.	126	29

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

OXYGEN PLANT - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Filters				
S.44.201, .301,.401	Air Compressor Suction Filter	143,250 scfm, removes 98% particles 5 microns 2" W.G. P.	90	atmos.
Storage Tanks				
T.44.201, .301	Liquid Oxygen Storage Tank	53'-0" diameter x 45'-0" high, 2500 ton storage	-295	atmos.
T.44.202, .302	Liquid Nitrogen Storage Tank	20'-0" diameter x 55'-0" high, 400 ton storage	-300	40
Packaged Process Units				
U.44.201, .301	Oxygen Plant	3550 tpd gaseous O_2, 99.5% purity, 1500 KW, net export.	---	---
Vessels				
V.44.201, .301, .401, .501	Air Compressor K.O. Drum	11'-0" ID x 2'-0" TT, carbon steel.	87	92
V.44.205, .305,.405	Oxygen Compressor Steam Ejector Hotwell	24'-0" OD x 4'-0" TT, carbon steel.	140	atmos.

AREA 51 - STEAM GENERATION SYSTEM

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Boilers				
B.51.201	Power Boiler	1500 psig, 887.7 MMBtu/hr heat absorbed, 800,000 lbs/hr peak evaporation rate.	950 outlet	1550 drum press.
Fired Heaters				
H.51.201	600 psig Superheater	65.2 MMBtu/hr heat absorbed, 368,800 lbs/hr.	750 outlet	650 inlet
H.51.202	1500 psig Superheater	223.2 MMBtu/hr heat absorbed, 755,090 lbs/hr.	950 outlet	1550 inlet
H.51.203	250 psig Superheater	31.9 MMBtu/hr heat absorbed, 1,468,600 lbs/hr.	440 outlet	300 inlet
Pumps				
P.51.201 A/B	115 psig Boiler Feedwater Pump	605 gpm, 95 psi ΔP, 48 bhp, carbon steel, "A" motor driven, "B" steam turbine driven spare, motor nameplate 60 hp.	258	115 disch.
P.51.202 A/B	370 psig Boiler Feedwater Pump	2326 gpm, 350 psi ΔP, 621 bhp, carbon steel, "B" motor driven spare, "A" steam turbine driven, motor nameplate 700 hp.	258	370 disch.

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

STEAM GENERATION SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.51.203 A/B	750 psig Boiler Feedwater Pump	1953 gpm, 730 psi ΔP, , 1100 bhp, carbon steel, "B" motor driven spare, "A" steam turbine driven, motor nameplate 1250 hp.	258	750 disch.
P.51.204 A/B/C	2200 psig Boiler Feedwater Pump	2908 gpm, 2,180 psi ΔP, 2896 bhp, carbon steel, "A/B" steam turbine driven, "C" motor driven spare, motor nameplate 3,500 hp	258	2200 disch.
P.51.205	Hydrazine Feed Pump	1 gal/hr, 30 psi ΔP, 0.1 bhp, carbon steel, motor nameplate 0.5 hp.	70	30 disch.
P.51.206	Amine Feed Pump	1 gal/hr, 30 psi ΔP, 0.1 bhp, carbon steel, motor nameplate 0.5 hp.	70	30 disch.
Vessels				
V.51.201 A/B	Deaerator with two Storage Drums	16'-0" ID x 91'-0" TT, 4,400,000 lbs/hr, carbon steel with SS trays.	258	20
V.51.202	High Pressure Flash Tank	4'-0" ID x 12'-0" TT, carbon steel.	420	300

AREA 52 - RAW WATER SYSTEM

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Compressors				
C.52.201	Pressure Tank Air Compressor	3 scfm, 65 psi △P, 0.5 hp	60	65
Mixers				
M.52.201	Lime Mixer	1,200 rpm, 3 blade propeller, 15 hp, carbon steel.	60	---
M.52.202	Alum Mixer	1,200 rpm, 3 blade propeller, 15 hp, stainless steel.	60	---
Pumps				
P.52.201 A/B/C	River Water Pump	5,500 gpm, 210 psi △P, 1750 hp, carbon steel.	60	210
P.52.202 A/B/C	Raw Water Pump	5,500 gpm, 20 psi △P, 125 hp, carbon steel.	60	20
P.52.203 A/B	Lime Feed Pump	10 gpm, 20 psi △P, 0.5 hp, carbon steel.	60	20
P.52.204 A thru F	Alum Feed Pump	3 gpm, 20 psi △P, 0.25 hp, stainless steel.	60	20

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

RAW WATER SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.52.205 A/B/C/D	Clarifier Sludge Pump	150 gpm, 45 psi ΔP, 7.5 hp, rubber-lined carbon steel.	60	45
P.52.206 A/B/C	Clear Water Transfer Pump	5,500 gpm, 45 psi ΔP, 250 hp, carbon steel, "A" and "B" turbine driven, "C" motor driven spare.	60	45
P.52.207	Potable Water Filter Backwash Pump	50 gpm, 70 psi ΔP, 3 hp, carbon steel.	60	70
P.52.208 A/B	Potable Water Supply Pump	120 gpm, 70 psi ΔP, 7.5 hp, carbon steel.	60	70
P.52.209 A/B	Clear Water Supply Pump	11,000 gpm, 60 psi ΔP, 600 hp, carbon steel, "A" turbine driven, "B" motor driven spare.	60	60
P.52.210	Caustic Transfer Pump	50 gpm, 30 psi ΔP, 2 hp, carbon steel.	120	30
P.52.211	Acid Transfer Pump	50 gpm, 40 psi ΔP, 3 hp, carbon steel.	60	40
P.52.212 A/B	Demineralized Water Supply Pump	1,750 gpm, 40 psi ΔP, 60 hp, 304 stainless steel, "A" turbine driven spare, "B" motor driven.	60	40

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

RAW WATER SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Storage Tanks				
T.52.201	Alum Silo	12'-0" diameter, 25'-0" height (5'-0" bottom cone) 200,000 lb Alum, stainless steel.	60	---
T.52.202	Alum Hopper	6'-0" x 6'-0" x 10'-0" height, 42,000 lb Alum, stainless steel.	60	---
T.52.203 A/B/C	Clear Water Suction Drum	12'-0" diameter x 14'-0" height, 10,000 gal, carbon steel.	60	---
T.52.204	Potable Water Storage Tank	15'-0" diameter x 18'-0" height, 20,000 gal, carbon steel.	60	---
T.52.205	Clear Water Storage Tank	75'-0" diameter x 44'-0" height, 590,000 gal, carbon steel.	60	---
T.52.206	Caustic Storage Tank	24'-0" diameter x 25'-0" height, 78,000 gal, 300 sq ft heating coil, carbon steel.	120	---
T.52.207	Caustic Day Tank	7'-0" ID x 11'-0" TT, 2,600 gal, with dimple jacket, carbon steel.	120	---
T.52.208	Acid Storage Tank	24'-0" diameter x 25'-0" height, 78,000 gal, carbon steel.	60	---

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

RAW WATER SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Storage Tanks - Continued				
T.52.209	Acid Day Tank	7'-0" ID x 11'-0" TT, 2,600 gal, carbon steel.	60	---
T.52.210	Demineralized Water Storage Tank	90'-0" diameter x 40'-0" height, 1,800,000 gal, epoxy-lined carbon steel.	60	---
Vessels				
V.52.201	Lime Solution Tank	3'-0" ID x 4'0" Ht, 200 gal, carbon steel.	60	---
V.52.202	Alum Solution Tank	3'-0" ID x 4'-0" Ht, 200 gal, stainless steel.	60	---
V.52.203	Potable Water Pressure Tank	7'-0" ID x 10'-0" TT, 3,000 gal, carbon steel.	60	60
Water Treating Equipment				
W.52.201	Raw Water Chlorinator	5.4 scfm Cl_2 (60 lbs/hr)	60	20
W.52.202	Polymer Additive Unit	1 gpm, 0.5% polymer solution	60	20
W.52.203 A/B/C	Clarifier	75'-0" diameter x 15'-6" height, 4,400 gpm, 7.5 hp mixer, 0.75 hp scraper.	60	---

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

RAW WATER SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Water Treating Equipment - Continued				
W.52.204 A/B	Potable Water Filter	2'-6" ID x 3'-0" TT, 15 gpm, 10 psi ΔP,	60	45
W.52.205	Potable Water Chlorinator	0.13 scfm Cl_2 (1.5 lbs/hr.)	60	45
W.52.206 A thru I	Clear Water Polishing Filter	10'-0" ID x 3'-0" TT, graded sand filter, 235 gpm, carbon steel, 10 psi ΔP,	60	60
W.52.207	Demineralizer Unit	760 gpm, three-train package unit which includes:		
W.52.207 (C.1A/B/C/D)*	Degasser Air Blower	2,700 scfm, 4" H_2O ΔP, 1.5 hp, carbon steel.	60	4" H_2O
W.52.207 (P.1A/B)*	Caustic Metering Pump	15 gpm, 40 psi ΔP, 1.0 hp, carbon steel.	120	40
W.52.207 (P.2A/B)*	Acid Metering Pump	15 gpm, 40 psi ΔP, 1.0 hp, Hastelloy.	60	40
W.52.207 (P.2A/B/C/D)*	Booster Pump	870 gpm, 40 psi Δ P, 30hp, stainless steel.	60	40

*Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

RAW WATER SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Water Treating Equipment - Continued				
W.52.207 (V.1A/B/C)*	Cation Vessel	12'-0" ID x 12'-0" TT, resin depth 4'-5" 5 psi ΔP, epoxy-lined carbon steel.	60	50
W.52.207 (V.2A/B/C)*	Degasser	7'-6" ID x 18'-0" TT, 1-1/2" Raschig rings, 12'-0" deep, epoxy-lined carbon steel.	60	40
W.52.207 (V.3A/B/C)*	Anion Vessel	12'-0" ID x 12'-0" TT, resin depth 4'-1" 5 psi ΔP, epoxy-lined carbon steel.	60	40
Miscellaneous Equipment				
X.52.201	Raw Water Reservoir	300'-0" x 300'-0" x 20'-0" deep, 13,000,000 gal, plastic lined earth.	60	---
Feeding Equipment				
Y.52.201	Alum Truck Unloading Conveyor	Screw conveyor, 25,000 lbs/hr, 1'-0" diameter 50'-0" length, 7.5 hp, stainless steel.	60	---
Y.52.202	Alum Silo Feeder	"Z" belt conveyor, 25,000 lbs/hr, 100' length 2'-0" wide, 10 hp, neoprene belt.	60	---

*Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

RAW WATER SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Feeding Equipment - Continued				
Y.52.203	Alum Hopper Feeder	Screw conveyor, 400 lbs/hr, 1'-0" diameter 12'-0" length, 0.25 hp, stainless steel.	60	---
Y.52.204	Alum Solution Tank Feeder	Screw conveyor, 400 lbs/hr, 1'-0" diameter 12'-0" length, 0.25 hp, stainless steel.	60	---

AREA 53 - COOLING WATER SYSTEM

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Air Cooled Equipment				
A.53.201	Process Cooling Tower	213,000 gpm, 3,139 MMBtu/hr, 19 bays, 200 hp/bay, carbon steel and corrugated asbestos.	85/115	atmos.
A.53.202	Utility Cooling Tower	95,100 gpm, 1,076 MMBtu/hr, 8 bays, 250 hp/bay, carbon steel and corrugated asbestos.	81/111	atmos.
Heat Exchangers			SS/TS	SS/TS
E.53.201 A/B/C	Process Turbine Surface Condenser	14.38 MMBtu/hr, 1100 sq ft, carbon steel.	125/85-115	4" Hg/65
E.53.202 A/B/C/D	Utility Turbine Surface Condenser	7.94 MMBtu/hr, 500 sq ft, carbon steel.	125/81-111	4"Hg/65
Jet Equipment				
J.53.201 A/B/C	Process Turbine Steam Ejector	4 in. Hg absolute with jets and condensers.		
J.53.202 A/B/C/D	Utility Turbine Steam Ejector	4 in. Hg absolute with jets and condensers.		

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COOLING WATER SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps				
P.53.201 A thru F	Process Cooling Tower Cooling Water Pump	42,600 gpm, 65 psi ΔP, 1990 hp, "A/B/C" turbine driven, "D/E/F" motor driven, carbon steel, nameplate hp 2,250.	85	65
P.53.202 A thru E	Utility Cooling Tower Cooling Water Pump	24,000 gpm, 65 psi ΔP, 1,099 hp. "A/B/C/D" turbine driven, "E" motor driven, carbon steel, nameplate hp 1,250.	81	65
P.53.204 A thru F	Process Turbine Steam, Condensate Pump	33 gpm, 57 psi ΔP, 2 hp, carbon steel. "A/B/C" motor driven, "D/E/F" turbine driven spares, nameplate hp 2.	125	42
P.53.205 A thru H	Utility Turbine Steam, Condensate Pump	18 gpm, 57 psi ΔP, carbon steel. "A/B/C/D" motor driven, "E/F/G/H" turbine driven spares, nameplate hp 1.0.	125	42
P.53.206 A/B	Process Hotwell Condensate Pump	4 gpm, 42 psi ΔP, 0.50 hp, carbon steel, nameplate hp 0.5	200	34
P.53.207 A/B	Utility Hotwell Condensate Pump	5 gpm, 42 psi ΔP, 0.50 hp, carbon steel, nameplate hp 0.5	200	34

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COOLING WATER SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Storage Tanks				
T.53.201	Process Cooling Tower Sulfuric Acid Day Tank	6'-0" ID x 10'-0" TT, 1,800 gal, carbon steel.	ambient	5
T.53.202	Utility Cooling Tower Sulfuric Acid Day Tank	6'-0" ID x 10'-0" TT, 1,800 gal, carbon steel.	ambient	5
Vessels				
V.53.201	Process Hotwell	1'-6" ID x 6'-0" TT, carbon steel.	200	atmos.
V.53.202	Utility Hotwell	1'-6" ID x 6'-0" TT, carbon steel.	200	atmos.
Water Treating Equipment				
W.53.201	Process Cooling Tower Chromate Treating System	9'-0" ID x 14'-0" TT, 5,800 gal, carbon steel.	ambient	atmos.
W.53.202	Process Cooling Tower Chlorinator	Add 318 lbs/hr Cl_2 to cooling water (one hour/day).	85	atmos.

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COOLING WATER SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Water Treating Equipment - Continued				
W.53.203	Utility Cooling Tower Chromate Treating System	9'-0" ID x 14'-0" TT, 5,800 gal,carbon steel.	ambient	atmos.
W.53.204	Utility Cooling Tower Chlorinator	Add 144 lbs/hr Cl_2 to cooling water (one hour/day).	81	atmos.
Miscellaneous Equipment				
X.53.201	Process Cooling Tower Pump Well	120'-0" long x 40'-0" wide x 12'-0" deep, reinforced concrete.	85	atmos.
X.53.202	Utility Cooling Tower Pump Well	100'-0" long x 40'-0" wide x 12'-0" deep, reinforced concrete.	81	atmos.

AREA 54 - MISCELLANEOUS DISTRIBUTION SYSTEMS

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	PRESSURE (PSIG)
Compressors				
C.54.201	Heavy Oil Vapor Recovery Compressor	200 scfm, 5 psi ΔP, 5 hp, carbon steel.	100	5
C.54.221 A/B	Fuel Gas Compressor	13,900 scfm, 140 psi ΔP, 1,990 hp "A" steam turbine driven, "B" steam turbine driven (spare), carbon steel.	312	175
C.54.271 A/B	Air Compressor	3,000 scfm, 100 psi ΔP, 1,000 hp, intercoolers, "A" steam turbine driven, "B" motor driven (spare), carbon steel	315	310
C.54.272	Nitrogen Compressor	3,776 scfm, 245 psi ΔP, 600 hp, carbon steel.	360	310
Heat Exchangers			SS/TS	SS/TS
E.54.271	Nitrogen Vaporizer	3,776 scfm 1.49 MMBtu/hr, 130 sq ft, stainless steel.	320/-95	75/300
E.54.272	Compressed Air Cooler	0.74 MMBtu/hr, 520 sq ft., carbon steel.	210/100	100/60
E.54.273	Compressed Nitrogen Cooler	1.03 MMBtu/hr, 400 sq ft, carbon steel.	230/100	310/60

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

MISCELLANEOUS DISTRIBUTION SYSTEMS - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Fired Heaters				
H.54.232	Heavy Hydrocarbon Flare Stack	6'-6" ID x 240'-0" height, carbon steel with ceramic lining, 1.0 MMBtu/hr, pilot gas.	---	---
Pumps				
P.54.201 A/B	Fuel Oil Pipeline Transfer Pumps	2,000 gpm, 120 psi ΔP, 200 hp, carbon steel.	120	120
P.54.203	K.O. Drum Pump	50 gpm, 40 psi ΔP, 5 hp, carbon steel.	100	40
P.54.211 A/B	Naphtha Pipeline Transfer Pumps	3,000 gpm, 75 psi ΔP, 200 hp, carbon steel.	100	75
P.54.212/ 213	Light Fuel Oil Loading Pumps	3,000 gpm, 75 psi ΔP, 200 hp, carbon steel.	100	75

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

MISCELLANEOUS DISTRIBUTION SYSTEMS - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.54.214 A/B	Propane Loading Pumps	1,000 gpm, 150 psi ΔP, 100 hp, carbon steel.	35	210
P.54.215 A/B	Butane Loading Pumps	500 gpm, 150 psi ΔP, 75 hp, carbon steel.	100	210
P.54.216 A/B	Ammonia Loading Pumps	250 gpm, 150 psi ΔP, 50 hp, carbon steel.	40	210
P.54.217	Tar Acid Loading Pump	250 gpm, 150 psi ΔP, 50 hp, carbon steel.	100	150
P.54.218 A/B	Sulfur Loading Pumps	1,000 gpm, 75 psi ΔP, 100 hp, motor driven, carbon steel.	300	75
P.54.219	Condensate Pump	30 gpm, 235 psi ΔP, 7.5 hp, motor driven, carbon steel.	200	250
P.54.232	Heavy HC Flare Recirculation Pump	150 gpm, 40 psi ΔP, 10 hp, rubber lined carbon steel.	150	40
P.54.234	Heavy HC Flare Liquids Transfer Pump	60 gpm, 30 psi ΔP, rubber lined carbon steel.	100	30
P.54.248	River Firewater Jockey Pump	250 gpm, 170 psi ΔP, 50 hp, carbon steel.	60	170

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

MISCELLANEOUS DISTRIBUTION SYSTEMS - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps - Continued				
P.54.249	River Firewater Main Pump	2,000 gpm, 170 psi △P, 300 hp, motor driven, carbon steel.	60	170
P.54.250	River Firewater Main Pump	2,000 gpm, 170 psi △P, 300 hp, diesel driven with 600 gal fuel tank, carbon steel.	60	170
P.54.251	Process Firewater Main Pump	2,000 gpm, 170 psi△P, 300 hp, motor driven, carbon steel.	60	170
P.54.252	Process Firewater Main Pump	2,000 gpm, 170 psi△P, 300 hp, motor driven carbon steel.	60	170
Storage Tanks				
T.54.201 A/B	Fuel Oil Storage Tanks	190'-0" diameter x 40'-0" height, 200,000 BBL, carbon steel.	120	atmos.
T.54.211 A/B	Naphtha Storage Tanks	154'-0" diameter x 40'-0" height, 120,000 BBL, carbon steel.	100	atmos.
T.54.213 A/B	Propane Storage and Loadout Spheres	56'-0" diameter, 15,000 BBL, carbon steel.	35	60

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

MISCELLANEOUS DISTRIBUTION SYSTEMS - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Storage Tanks - Continued				
T.54.214	Butane Storage and Loadout Sphere	56'-0" diameter, 15,000 BBL, carbon steel.	100	60
T.54.215	Ammonia Storage and Loadout Sphere	56'-0" diameter, 15,000 BBL, carbon steel.	40	60
T.54.216	Tar Acid Storage Tank	26'-0" diameter x 16'-0" height, 1,500 BBL carbon steel.	100	atmos.
T.54.218	Sulfur Storage Tank with Heater	70'-0" diameter x 40'-0" height, 26,000 BBL carbon steel, 50,000 Btu/hr (max.) heater.	300	atmos.
T.54.232	Heavy Hydrocarbon Flare Knockout Tank	20'-0" ID x 50'-0"TT, 117,500 gal, carbon steel.	150	---
T.54.234	Heavy HC Flare Liquids Storage Tank	16'-0" ID x 28'-0" height, 42,000 gal, epoxy-lined carbon steel.	100	---
T.54.244	River Firewater Storage	85'-0" diameter x 40'-0" height, 1.7 mm gal, carbon steel.	60	atmos.

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

MISCELLANEOUS DISTRIBUTION SYSTEMS - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Packaged Process Units				
U.54.211	Propane Storage Refrig. Package	80 tons, two-250 hp comp. 1 oper. - 1 spare.	125	250
U.54.212	Ammonia Storage Refrig. Package	40 tons, 2-125 hp compressors, 1 operator, 1 spare.	125	250
U.54.242	Process Foam System	3,000 gpm, proportioning system, 2,000 gal tank, carbon steel.	60	100
U.54.243	Railroad Foam System	3,000 gpm, proportioning system, 2,000 gal tank, carbon steel.	60	100
U.54.271	Air Dryer	-40°F dew point, 1,800 scfm, with electric heater, carbon steel.	110	100
Vessels				
V.54.201	Heavy Oil Vent K.O. Drum	6'-0" diameter x 18'-0" TT, carbon steel.	100	5
V.54.219	Condensate Return Drum	5'-0" diameter x 10'-0" TT, carbon steel.	240	10
V.54.222	Boiler Fuel Surge Drum	12'-0" ID x 54'-0" TT, carbon steel.	110	35

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

MISCELLANEOUS DSITRIBUTION SYSTEMS - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Vessels - Continued				
V.54.223	Fuel Compressor Suction Drum	4'-0" ID x 12'-0" TT, carbon steel.	103	35
V.54.224	Fuel Compressor Discharge Drum	3'-6" ID x 14'-0" TT, carbon steel.	312	175
V.54.271	Compressed Air Receiver Tank	12'-0" ID x 36'-0" TT, carbon steel.	110	100
V.54.272	Instrument Air Receiver Tank	12'-0" ID x 28'-0" TT, carbon steel.	110	95
V.54.273	Plant Air Receiver Tank	8'-6" ID x 18'-0" TT, carbon steel.	110	85
V.54.274	Nitrogen Receiver Tank	12'-0" ID x 26'-0" TT, carbon steel.	110	300
V.54.275 A thru Z	Area Surge Bottles	3'-0" ID x 26'-0" TT, carbon steel (26 required).	100	90
Water Treating Equipment				
W.54.261	Sanitary Sewage Treatment Package	25,000 gpd with tertiary treatment and sludge incineration.	80	---

AREA 61 - COAL SUPPLY SYSTEM

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Separation Equipment				
S.61.201	Dust Collector (1)	Modifications to Demonstration Plant	Ambient	
S.61.201 (X1)	Ductwork (1)	Modifications to Demonstration Plant	Ambient	
S.61.201 (C1)	Fan (1)	Carbon Steel, 60 hp	Ambient	
S.61.202	Dust Collector	Bag type, 22,000 acfm capacity, carbon steel)	Ambient	
S.61.202	Ductwork	Carbon steel	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL SUPPLY SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Storage Bins				
T.61.201	Barge Unloading Surge Bin	300 ton capacity	Ambient	
T.61.202	Primary Crusher Surge Bin	100 ton capacity	Ambient	
Miscellaneous Equipment				
X.61.201	Barge Unloader (1)	Continuous bucket ladder type system, 330 hp	Ambient	
X.61.201 (X1)	Barge Haul System (1)	Barge positioning system, 50 hp	Ambient	
X.61.201 (X2)	Discharge Chute (1)	Carbon Steel	Ambient	
X.61.201 (Z1)	60" Discharge Belt Conveyor (1)	3,500 tph, 60' x 220' long, 100 hp	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL SUPPLY SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Miscellaneous Equipment - Continued				
X.61.201(S1)	Tramp Iron Magnet, Trolley, Hoist & Rectifier (1)	3 kW	Ambient	
X.61.201(X3)	Tote Box (1)	Carbon steel	Ambient	
X.61.202	Dust Suppression System - Barge Unloader (1)	Package system utilizing wetting agents with distribution system, 5 hp	Ambient	
X.61.203	Work Boat (1)	Primary barge mover to and from barge unloading area, diesel powered	Ambient	
X.61.204	Primary Coal Crushers (3)	1750 tph, roll crusher, minus 2" discharge, carbon steel, AR liners, 200 hp	Ambient	
X.61.204(X1)	Skirts & Chutes (3)	Carbon steel	Ambient	
X.61.205	Sampling Tower - Barge Coal	Package System, 13-1/2 hp	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL SUPPLY SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Miscellaneous Equipment - Continued				
X.61.207	Portable Reclaim Hoppers (3)	Carbon Steel	Ambient	
X.61.209	Stacker/Reclaimer Transport Carriage	Rail mounted, carbon steel, 15 hp	Ambient	
Weighing & Feeding Equipment				
Y.61.201	Vibrating Feeder - Barge Coal (1)	2400 tph, 84" wide, 30 hp	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL SUPPLY SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Weighing & Feeding Equipment - Continued				
Y.61.201(X1)	Feed & Discharge Chutes (1)	Carbon steel	Ambient	
Y.61.202 A/B	Vibrating Grizzly Feeders (2)	1750 tph, 84" wide, 2" grizzly, 15 hp	Ambient	
Y.61.202(X1)	Skirts & Chutes (2)	Carbon steel	Ambient	
Y.61.203	Virbrating Grizzly Feeders (2)	1750 tph, 84" wide, 2" grizzly, 15 hp	Ambient	
Y.61.203(X1)	Oversize Chutes & Crusher Hoods (2)	Carbon steel	Ambient	
Y.61.203(X2)	Fines Chutes (2)	Carbon steel	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL SUPPLY SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Solids Transfer Equipment				
Z.61.201	60" Barge Coal Transfer Belt Conveyor (1)	2400 tph, 60" x 240' long, 30 hp	Ambient	
Z.61.201(X1)	Discharge Chute (1)	Carbon steel	Ambient	
Z.61.202	60" Speed Up Belt Conveyor(1)	3529 tph, 60" x 29' long, 25 hp	Ambient	
Z.61.202(X1)	Transfer Chute & Skirts (1)	Carbon steel	Ambient	
Z.61.202(Y1)	Belt Scale (1)	Electronic with test chain	Ambient	
Z.61.203	60" Belt Conveyor to Primary Crushing Plant (1)	3529 tph, 60" x 3550' long, 2500 hp	Ambient	
Z.61.203(X1)	Discharge Chute (1)	Carbon steel	Ambient	
Z.61.204	60" Crushed Coal Belt Conveyor #1 (1)	3529 tph, 60" x 60' long, 15 hp	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL SUPPLY SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Solids Transfer Equipment - Continued				
Z.61.204(X1)	Discharge Chute & Skirts (1)	Carbon steel	Ambient	
Z.61.205	60" Crushed Coal Belt Conveyor #2 (1)	3329 tph, 60" x 60' long, 15 hp	Ambient	
Z.61.205(X1)	Skirts & Chutes (1)	Carbon steel	Ambient	
Z.61.206	60" Stacker/Reclaim Belt Conveyor "B"(1)	3529 tph, 60' x 60" long, 650 hp	Ambient	
Z.61.206(X1)	Skirts & Chutes (1)	Carbon steel	Ambient	
Z.61.207	Twin Boom Stackers (2)	Twin boom, rail mounted, 700 hp	Ambient	
Z.61.207(X1) A/B	Stacker Tripper Trailers (2)	Carbon steel	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL SUPPLY SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Solids Transfer Equipment - Continued				
Z.61.208	60" Distribution Belt Conveyors (2) #1A/B,	3529 tph, 60" x 390' long, 125 hp	Ambient	
Z.61.208(X1)	Diverter Chutes (2)	Carbon steel	Ambient	
Z.61.209	60" Distribution Belt Conveyor #2A/B	3529 tph, 60" x 390' long, 125 hp	Ambient	
Z.61.209(X1)	Discharge Chutes (2)	Carbon steel	Ambient	

AREA 62 - COAL CRUSHING SYSTEM

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Separation Equipment				
S.62.201	Dust Collector (1)	Bag type, 7500 cfm capacity, carbon steel	Ambient	
S.62.201(X1)	Ductwork (1)	Carbon steel	Ambient	
S.62.201(X2)	Dust Transfer Screw Conveyor	Carbon steel, 5 hp	Ambient	
S.62.201(C1)	Fan & Motor	Cabon steel, 30 hp	Ambient	
S.62.202	Scalping Screens (23)	8' x 20' with 1/8" sq. opening screens, 20 hp	Ambient	
S.62.202(X1)	Oversize Chutes (23)	Carbon steel	Ambient	
S.62.202(X2)	Undersize Chutes (23)	Carbon steel	Ambient	
S.62.203	Dust Collector (1)	Bag type, 22,000 cfm capacity, carbon steel, 60 hp	Ambient	
S.62.203(X1)	Ductwork (1)	Carbon steel	Ambient	
S.62.203(Z1)	Dust Transfer Screw Conveyor (1)	Carbon steel, 5 hp	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL CRUSHING SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Storage Bins				
T.62.201	Screens Feed Bin #B (1)	Carbon steel	Ambient	
T.62.201(X1)	Discharge Gates and Chutes (23)	Carbon steel	Ambient	
Miscellaneous Equipment				
X.62.202 A/B	Secondary Crushers (2)	500 tph, cage mills minus 1/8" discharge carbon steel with AR liners, 1200 hp	Ambient	
X.62.202(X1)	Discharge Chutes (2)	Carbon steel	Ambient	
Solids Transfer Equipment				
Z.62.201	Reclaimer (1)	1600 tph, rail mounted, twin bucket wheels, 350 hp	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL CRUSHING SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Solids Transfer Equipment - Continued				
Z.62.202	Reclaim Belt Conveyors (Extend Conveyor A - 750 ft Add Conveyor B - 980 ft)	1600 tph, 48" width, 60 hp	Ambient	
Z.62.202(X1)	Skirts & Chutes (2)	Carbon steel	Ambient	
Z.62.202(Y1)	Belt Scale on Reclaim Collection Belt Conveyor (1)	Electronic with test chain	Ambient	
Z.62.202(S1)	Tramp Iron Magnet with Rectifier (1)	3 kW	Ambient	
Z.62.202(X2)	Tote Box (1)	Carbon steel	Ambient	
Z.62.203	48" Crusher Feed Belt Conveyor (2)	1600 tph, 48" x 285' long, 125 hp	Ambient	
Z.62.203(X1)	Discharge Chute (2)	Carbon steel	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL CRUSHING SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Solids Transfer Equipment - Continued				
Z.62.204	48" Screen Feed Belt Conveyor (1)	1600 tph, 48" x 150' long, 40 hp	Ambient	
Z.62.204(X1)	Transfer Chute (1)	Carbon steel	Ambient	
Z.62.204(X2)	Splitter Chute (1)	Carbon steel	Ambient	
Z.62.205 A/B	48" Screen Feed Belt Conveyors #2(1)	1600 tph, 48" x 55' long, 10 hp	Ambient	
Z.62.205(X1)	Transfer Chutes (1)	Carbon steel	Ambient	
Z.62.205(X2)	Conversion to Diverter on Conveyor #A	Carbon steel	Ambient	
Z.62.205(Z1)	Extend Belt Conveyor A	Add 25' section to Demonstration Plant Conveyor	Ambient	
Z.62.206	48" Screen Feed Belt Conveyor #2 (1)	1600 tph, 48" x 100' long, 10 hp	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

COAL CRUSHING SYSTEM - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Solids Transfer Equipment - Continued				
Z.62.206(X1)	Tripper for Belt Conveyor (1)	Self Propelled	Ambient	
Z.62.206(X2)	Dribble Chute (1)	Carbon steel	Ambient	
Z.62.206	48" Screen Feed Belt #3 (2)	Existing from Demonstration Plant	Ambient	
Z.62.206(Z1)	Extension for Belt Conveyor #A (1)	Add 42' section to existing conveyor	Ambient	
Z.62.207	48" Fine Coal Belt Conveyor #1 (2)	1600 tph, 48" x 100" long, 10 hp	Ambient	
Z.62.207(X1)	Skirts & Chutes (2)	Carbon steel	Ambient	
Z.62.208	48" Fine Coal Belt Conveyor B (1)	Add 42' section to existing conveyor	Ambient	
Z.62.208(X1)	Diverter Chute (1)	Carbon steel	Ambient	

(1) Subsystem

AREA 63 - FINE COAL HANDLING

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Separation Equipment				
S.63.201 A/B	Dust Collector (1)	Bag type, 30,000 acfm capacity, carbon steel	Ambient	
S.63.201(X1)	Ductwork (1)	Carbon steel	Ambient	
Storage Bins				
T.63.201/301 A/B	1120 Ton Fine Coal Storage Bins #2 (4)	Carbon steel	Ambient	
Weighing and Feeding Equipment				
Y.63.202 A/B	Fine Coal Weigh Belt Feeders (2)	Package units, 350 tph, 7.5 hp	Ambient	
Y.63.302 A/B	Fine Coal Weigh Belt Feeders (2)	Package units, 350 tph, 7.5 hp	Ambient	
Y.63.202(X1)	Transfer Chutes (2)	Carbon steel	Ambient	
Y.63.302(X1)	Transfer Chutes (2)	Carbon steel	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

FINE COAL HANDLING - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Solids Transfer Equipment				
Z.63.201	48" Cross Belt Conveyor #2 (1)	1600 tph, 48" x 50' long, 15 hp	Ambient	
Z.63.202 A/D	Mix Tank Feed Conveyors (4)	350 tph, 23" Redler conveyors, 100 hp	Ambient	
Z.63.202(X1)	Discharge Chutes (2)	Carbon steel	Ambient	
Z.63.203 A/B	48" Fine Coal Belt Conveyors #4 (2)	1600 tph, 48" x 250' long, 30 hp	Ambient	

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

FINE COAL HANDLING - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Solids Transfer Equipment - Continued				
Z.63.203(X1)	Diverter Chutes (2)	Carbon steel	Ambient	
Z.63.204 A/B	48" Fine Coal Belt Conveyors (2)	1600 tph, 48" x 300' long, 30 hp	Ambient	
Z.63.204(X1) A/B	Discharge Chutes (2)	Carbon steel	Ambient	

(1) Subsystem

AREA 64 - SLAG HANDLING FACILITIES

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps				
P.64.201	Sump Pump (1)	300 gpm, 70' tdh, carbon steel, 30 hp	Ambient	
P.64.202 A/B	Slag Basin Sump Pumps (2)	300 gpm, 70' tdh, carbon steel, 30 hp	Ambient	
Separation Equipment				
S.64.201	Drum Filter (1)	10' diameter x 16' face, 3 hp	Ambient	
S.64.201(V1)	Filtrate Receiver (1)	Carbon steel	Ambient	
S.64.201(V2)	Moisture Trap (1)	Carbon steel	Ambient	
S.64.201(P1)	Vacuum Pump (1)	Package Unit, 75 hp	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SLAG HANDLING FACILITIES - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Separator Equipment - Continued				
S.64.201(P2)	Silencer (1)	Carbon steel	Ambient	
S.64.202	Seal Tank #B	Carbon steel	Ambient	
Storage Bins				
T.64.201	Gasifier Slag Bin (1)	200 ton capacity, carbon steel	Ambient	
Miscellaneous Equipment				
X.64.201	Diverter Chute (1)	Carbon Steel	Ambient	
X.64.202	Dust Suppression System (1)	Package system utilizing wetting agents with distribution system	Ambient	

(1) Subsystem

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

SLAG HANDLING FACILITIES - Continued

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Weighing and Feeding Equipment				
Z.64.201	Slag Belt Conveyor (1)	200 tph, 24" x 1500' long, 30 hp	Ambient	
Z.64.201(X1)	Transfer Chute (1)	Carbon steel	Ambient	
Z.64.201(Z1)	Modify Demo Conveyor (1)	Increase speed and modify chute, 10 hp	Ambient	
Z.64.205	Slag Disposal Trucks (4)	40 ton capacity, diesel powered	Ambient	

(1) Subsystem

AREA 65 - SLAG DISPOSAL

EQUIPMENT LIST - 26,800 TPSD EXPANSION INCREMENT

EQUIPMENT NUMBER	SERVICE	DESCRIPTION	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS PRESSURE (PSIG)
Pumps				
P.65.201	Sump Pumps (2)	Carbon steel, 10 hp	Ambient	

3.6 UTILITY SUMMARIES

The utility summaries for the First Commercial Plant are included within the following section. In addition to the totals for the First Commercial Plant, these summaries show the utilities required for the commercial expansion increment as well as for the initial Demonstration Plant when modified to operate in parallel with the expansion facilities, and are presented for each area of the plant.

UTILITIES, FUEL & CHEMICAL SUMMARY

TOTAL PLANT

	MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
Electric Power			
Connected Nameplate hp	55,143	116,214	171,357
Operating hp	25,674	48,186	73,860
Generate KW(1)	500	1,500	2,000
Lighting KW	1,474	1,919	3,393
Steam Generation LB/HR			
1500 Psig Power Boiler	590,000	690,000	1,280,000
1500 Psig Waste Heat Boilers	304,540	1,208,700	1,513,240
600 Psig Waste Heat Boilers	169,304	789,814	959,118
250 Psig Waste Heat Boilers	202,020	1,043,505	1,245,525
50 Psig Waste Heat Boilers	47,650	51,720	99,370
75 Psig Waste Heat Boilers	151,510	741,020	892,530
35 Psig Waste Heat Boilers	19,200	156,104	175,304
TOTAL:	1,484,224	4,680,863	6,165,087
Cooling Water - gpm			
Process Cooling Tower	80,730	192,260	272,990
Utility Cooling Tower	33,433	86,450	119,883
TOTAL:	114,163	278,710	392,873
Fuel - MMBTU/HR(2)	1,451	4,264	5,715
Catalysts and Chemicals			
Initial; Charge -	Refer to Section 8 Table 8.3-2		
Annual Requirements -	Refer to Section 8 Table 8.4-5		

(1) Supplied by power recovery unit in Area 44.
(2) Calculated fuel requirements do not include effects of fuel economy improvement modifications of optimized plant; see Section 4.3.

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 11
DISSOLVER PLANT

	MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER			
Connected Nameplate hp	3,619	6,020	9,639
Operating hp	1,758	1,774	3,532
STEAM - lb/hr			
CONSUME:			
600/4" psig	34,660	192,130	226,790
250/35 psig	-	38,360	138,230
75/COND psig	800	2,830	3,630
GENERATE:			
1550 psig	103,600	678,360	781,960
650 psig	78,070	60,160	38,360
50 psig	---	84,744	84,744
COOLING WATER - gpm			
30 °F RISE, gpm	11,540	44,732	56,272
FUEL - MMBtu/hr	453	2,020	2,473
CHEMICALS	NONE	NONE	NONE

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 12
HYDROGEN TREATING & RECOVERY PLANT

		MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER				
Connected Nameplate hp		2,809	9,712	12,521
Operating hp		542	654	1,196
STEAM - lb/hr				
CONSUME:				
1500/600	psig	---	926,320	926,320
1500/35	psig	58,920	---	58,920
1500/COND	psig	3,300	13,200	16,500
600/35	psig	PROPRIETARY	---	PROPRIETARY
600/4"	psig	---	PROPRIETARY	PROPRIETARY
250/35	psig	38,391	117,350	155,741
75/COND	psig	---	860	860
35/COND	psig	51,000	204,000	255,000
GENERATE:		NONE	NONE	NONE
COOLING WATER - gpm				
30°F RISE, gpm		5,680	26,813	32,493
FUEL - MMBtu/hr			(GAS BLANKETING ONLY)	
CHEMICALS				
DIETHANOLAMINE (98%w), lb/sd		50	200	250
ANTIFOAMER (100%), gal/mo		5	20	25
FREON (REFRIGERANT)		NIL	NIL	NIL
MISCELLANEOUS				
NITROGEN			(GAS BLANKETING ONLY)	

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 21
SYNGAS PRODUCTION PLANT

Utility summary information has been omitted because it contains proprietary Texaco Development Corporation synthesis gas production information.

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 22
SYNGAS SHIFT CONVERSION PLANT

			MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER					
Connected Nameplate hp			500	1,000	1,500
Operating hp			205	---	205
STEAM - lb/hr					
CONSUME:					
	250/35	psig	---	22,960	22,960
GENERATE:					
	1550	psig	103,980	372,200	276,180
	650	psig	49,505	133,060	182,565
	300	psig	184,530	509,920	694,450
COOLING WATER - gpm					
30 ^{o}F Rise, gpm			NONE	NONE	NONE
FUEL - MMBtu/hr			NONE	NONE	NONE
CHEMICALS & CATALYST					
H.T. Shift Cat.			PROPRIETARY	PROPRIETARY	PROPRIETARY
H.T. COS Conversion Cat.			PROPRIETARY	PROPRIETARY	PROPRIETARY

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 23
HYDROGEN PURIFICATION & COMPRESSION PLANT

			MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER					
Connected Nameplate hp			11,274	22,025	33,299
Operating hp			1,715	4,633	6,348
STEAM - lb/hr					
CONSUME:					
	1500/4"	psig	---	PROPRIETARY	PROPRIETARY
	600/4"	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
	600/250	psig	PROPRIETARY	---	PROPRIETARY
	250/35	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
	75/-	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
	50/COND	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
	35/COND	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
GENERATE:					
	50	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
COOLING WATER - gpm					
30 °F RISE, gpm			11,900	25,473	37,373
FUEL - MMBtu/hr			NONE	NONE	NONE
CHEMICALS					
Potassium Carbonate, lb/sd			PROPRIETARY	PROPRIETARY	PROPRIETARY
Antifoam, gal/mo			PROPRIETARY	PROPRIETARY	PROPRIETARY

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 25
METHANATION PLANT

		MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER				
Connected Nameplate hp		342	802	1,144
Operating hp		171	443	614
STEAM - lb/hr				
CONSUME:				
1500/-	psig	44,335	140,625	184,960
250/COND.	psig	430	1,450	1,880
35/COND.	psig	1,960	---	1,960
GENERATE:				
1550	psig	96,960	154,340	251,300
650	psig	7,570	22,220	29,790
300	psig	17,490	27,010	44,500
75	psig	47,650	51,720	99,370
COOLING WATER - gpm				
30°F RISE, gpm		180	699	879
FUEL - MMBtu/hr		NONE	NONE	NONE
CHEMICALS & CATALYST				
Diethylene Glycol 100%, lb/sd		72	263	335
Antifoamer, gal/mo		5	15	20
Sulfur Absorber Catalyst		PROPRIETARY	PROPRIETARY	PROPRIETARY
H.T. Methanation Catalyst		PROPRIETARY	PROPRIETARY	PROPRIETARY
MISCELLANEOUS				
Nitrogen			(Gas Blanketing)	

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 26
SYNGAS PURIFICATION PLANT

			FIRST COMMERCIAL/ EXPANSION INCREMENT
ELECTRIC POWER			
Connected Nameplate hp			2,600
Operating hp			1,553
STEAM - lb/hr			
CONSUME:			
250/35	psig		PROPRIETARY
35/COND	psig		PROPRIETARY
GENERATE:			NONE
COOLING WATER - gpm			
30 °F RISE, gpm			1,083
FUEL - MMBtu/hr			NONE
CHEMICALS			
Diethanolamine, lb/yr		---	PROPRIETARY
Potassium Carbonate, lb/yr			PROPRIETARY
Antifoam Agent, gal/yr			PROPRIETARY

This plant (Benfield High Pure) does not exist in demonstration plant.

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 27
H_2/CO SEPARATION PLANT (COLD BOX)

	FIRST COMMERCIAL/ EXPANSION INCREMENT
ELECTRIC POWER	
Connected Nameplate hp	1,750
Operating hp	1,395
STEAM - lb/hr	
CONSUME:	
600/4" psig	28,060
250/35 psig	17,420
GENERATE:	NONE
COOLING WATER - gpm	
30 °F RISE, gpm	4,109
FUEL - MMBtu/hr	11.1

This plant does not exist in demonstration plant.

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 31
L.P. GAS COMPRESSION & TREATING PLANT

			MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER					
Connected Nameplate hp			407	981	1,388
Operating hp			267.3	608	875.3
STEAM - lb/hr					
CONSUME:					
	600/4"	psig	---	91,200	91,200
	600/35	psig	41,070	---	41,070
	250/35	psig	---	10,790	10,790
	35/COND	psig	57,200	195,059	252,259
GENERATE:			NONE	NONE	NONE
COOLING WATER - gpm					
30 °F RISE, gpm			4,260	3,586	7,846
FUEL - MMBtu/hr			NONE	NONE	NONE
CHEMICALS					
Diethanolamine 100%wt, lb/sd			200	7	207
Antifoam Agent, gal/mo			5	5	10

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 32
PRODUCT GAS PLANT

		MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER				
Connected Nameplate hp		60.5	201.0	261.5
Operating hp		22.1	115.7	137.8
STEAM - lb/hr				
CONSUME:				
600/4"	psig	38,250	59,934	98,184
600/COND	psig	2,423	8,106	10,529
250/35	psig	83,925	130,580	214,505
75/COND	psig	450	550	1,000
35/COND	psig	13,470	25,870	39,340
GENERATE:		NONE	NONE	NONE
COOLING WATER - gpm				
30 °F RISE, gpm		5,989	8,068	14,057
FUEL - MMBtu/hr		NONE	NONE	NONE
CHEMICALS				
Triethylene Glycol 100%w, lb/sd		110	54	164
Propane (Refrigerant)		nil	nil	nil

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 33
SULFUR RECOVERY PLANT

		MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER				
Connected Nameplate hp		1,474	2,616.5	4,090.5
Operating hp		589.6	1,178.7	1,768.3
STEAM - lb/hr				
CONSUME:				
600/4"	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
250/35	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
75/COND	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
35/COND	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
GENERATE:				
650	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
35	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
COOLING WATER - gpm				
30 ^{o}F RISE, gpm		14,777	40,843	55,620
FUEL - MMBtu/hr		PROPRIETARY	PROPRIETARY	PROPRIETARY
CHEMICALS & CATALYST				
Alumina, lbs/yr		41,600	167,900	209,500
Solvent, gal/sd		80	70	150
Hydrogenation Catalyst		PROPRIETARY	PROPRIETARY	PROPRIETARY
Freon 12 (Refrigerant)		Nil	Nil	Nil

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 34
REFINING PLANT

		MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER				
Connected Nameplate hp		2,168	4,801	6,969
Operating hp		916.9	2,575	3,491.9
STEAM - lb/hr				
CONSUME:				
600/COND	psig	6,800	27,068	33,868
250/35	psig	---	14,820	14,820
75/-	psig	10,000	37,750	47,750
GENERATE:		NONE	NONE	NONE
COOLING WATER - gpm				
30 °F RISE, gpm		2,410	4,663	7,073
FUEL - MMBtu/hr		90.4	296.8	387.2
CHEMICALS				
Corrosion Inhibitor, gal/mo		150	150	300
MISCELLANEOUS				
Nitrogen			(Gas Blanketing)	

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 35
HYDRODESULFURIZATION PLANT

			MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER					
Connected Nameplate hp			1,180	930	2,110
Operating hp			540	600	1,140
STEAM - lb/hr					
CONSUME:					
	1500/ -	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
	250/35	psig	PROPRIETARY	PROPRIETARY	PROPRIETARY
GENERATE:			NONE	NONE	NONE
COOLING WATER - gpm					
30 ^{o}F RISE, gpm			2,472	1,856	4,328
FUEL - MMBtu/hr			25.0	100.0 (Plus Gas Blanketing)	125
CHEMICALS & CATALYST					
HDS Catalyst			PROPRIETARY	PROPRIETARY	PROPRIETARY

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 41
AMMONIA RECOVERY PLANT

	MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER			
Connected Nameplate hp	288.5	1,038	1,326.5
Operating hp	110.5	398.5	509.0
STEAM - lb/hr			
CONSUME:			
600/COND psig	21,600	86,300	107,900
35/COND psig	25,000	92,100	117,100
GENERATE:	NONE	NONE	NONE
COOLING WATER - gpm			
20°F RISE, gpm	1,640	6,560	8,200
FUEL - MMBtu/hr	NONE	NONE	NONE
CHEMICALS			
Phosphoric Acid 100% Equivalent, lb/sd	100	400	500
Sodium Hydroxide 100% Equivalent, lb/sd	660	2,640	3,300

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 42
TAR ACID RECOVERY PLANT

		MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER				
Connected Nameplate hp		114	376	490
Operating hp		38.4	132.9	171.3
STEAM - lb/hr				
CONSUME:				
250/COND	psig	1,400	5,600	7,000
75/COND	psig	4,800	19,200	24,000
GENERATE:		NONE	NONE	NONE
COOLING WATER - gpm				
30 ^{o}F RISE, gpm		135	540	675
FUEL - MMBtu/hr		NONE	NONE	NONE
CHEMICALS				
Solvent 100%, gal/sd		PROPRIETARY	PROPRIETARY	PROPRIETARY

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 43
WASTE WATER RECLAMATION PLANT

		MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER				
Connected Nameplate hp		2,500	5,280	7,780
Operating hp		1,518	1,860	3,378
STEAM - lb/hr				
CONSUME:				
600/4"	psig	55,180	188,230	243,410
250/35	psig	---	105,025	105,025
75/-	psig	2,850	1,350	4,200
35/COND	psig	137,000	---	137,000
GENERATE:		NONE	NONE	NONE
COOLING WATER - gpm				
30 ^{o}F RISE, gpm		11,800	12,089	23,889
FUEL - MMBtu/hr		29.8	---	29.8
CHEMICALS				
Sulfuric Acid 66^{o} Be', lbs/sd		375	1,500	1,875
Sodium Hydroxide 50%, lbs/sd		900	3,600	4,500

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 44
OXYGEN PLANT

			MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER					
Connected Nameplate hp			95.0	45.0	140.0
Operating hp			17.8	27.3	45.1
Generate kw			500	1,500	2,000
STEAM - lb/hr					
CONSUME:					
	1500/600	psig	214,302	---	214,302
	1500/4"	psig	316,935	398,100	715,035
	250/LOSS	psig	---	50,000	50,000
	75/COND	psig	2,307	2,790	5,097
GENERATE:					
	650	psig	NONE	449,100	449,100
COOLING WATER - gpm					
30 °F RISE, gpm			28,063	47,675	75,738
10 °F RISE, gpm			10,360	31,080	41,440
FUEL - MMBtu/hr			31.6	919.0	950.6
CHEMICALS			NONE	NONE	NONE

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 51
STEAM GENERATION SYSTEM

			MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER					
Connected Nameplate hp			5,572	8,511	14,083
Operating hp			19	61	80
STEAM - lb/hr					
CONSUME:					
	600/35	psig	16,840	105,400	122,240
	250/35	"	128,700	25,510	154,210
GENERATE:					
	1550	psig	590,000	690,000	1,280,000
	650	psig	557,000	320,000	877,000
	300	psig	---	1,277,000	1,277,000
COOLING WATER - gpm					
30 °F RISE, gpm			NONE	NONE	NONE
FUEL - MMBtu/hr			782	944	1,726
CHEMICALS					
Amine, lb/sd			7.2	18.0	25.2
Hydrazine (35% Solution), lb/sd			1.4	3.8	5.2

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 52
RAW WATER SYSTEM

		MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER				
Connected Nameplate hp		2,462	9,434	11,896
Operating hp		1,187	4,645	5,832
STEAM - lb/hr				
CONSUME:				
35/COND	psig	315	450	765
GENERATE:		NONE	NONE	NONE
COOLING WATER - gpm				
30 °F RISE, gpm		NONE	NONE	NONE
FUEL - MMBtu/hr		NONE	NONE	NONE
CHEMICALS				
Quicklime	100%, lb/sd	120	180	300
Alum	100%, lb/sd	2,400	8,450	10,850
Polymer	100%, lb/sd	60	240	300
Chlorine	100%, lb/sd	681	1,500	2,181
Sulfuric Acid	66°Be', gal/sd	500	1,000	1,500
Sodium Hydroxide	50%w, gal/sd	1,000	2,600	3,600

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 53
COOLING WATER SYSTEM

	MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER			
Connected Nameplate hp	6,322	13,814	20,136
Operating hp	4,350	9,012	13,362
STEAM - lb/hr			
CONSUME:			
600/4" psig	28,818	78,752	107,570
75/COND psig	1,800	4,200	6,000
GENERATE:	NONE	NONE	NONE
COOLING WATER - gpm			
30°F RISE, gpm	1,941	5,329	7,270
FUEL - MMBtu/hr	NONE	NONE	NONE
CHEMICALS			
Chromate, Zinc Phosphonate, Polymer 10%, lb/sd	2,160	12,513	14,673
Sulfuric Acid 66° Be', lb/sd	1,200	2,936	4,136
Chlorine 100%, lb/sd	220	462	682

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 54*
MISCELLANEOUS (1) DISTRIBUTION SYSTEMS

	MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER			
Connected Nameplate hp	2,886	4,148	7,034
Operating hp	1,210	2,019	3,229
For Air Dryers kw	10	30	40
STEAM - lb/hr			
CONSUME:			
600 psig	--	28,000	28,000
250 psig	--	18,900	18,900
75 psig	3,100	1,000	4,100
GENERATE:	NONE	NONE	NONE
COOLING WATER - gpm			
30 °F RISE, gpm	132	334	466
FUEL - MMBtu/hr			
Naphtha	2.0	--	2.0
Pilot gas	2.0	1.0	3.0
Fuel gas	0.2	3.4	3.6
Diesel fuel, gal/tank	1,600	1,200	2,800
CHEMICALS			
Chlorine 100%, lb/sd	60	60	120
Foam agent, gal/year	40	40	80
MISCELLANEOUS			
Nitrogen		(Blanket & unloading gas)	

(1) Product storage and shipping, fuel system, flare and drain, firewater, sanitary sewage, compressed air.

* Note: Total does not include systems for electrical supply & distribution and for communications and process control.

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 61
COAL SUPPLY SYSTEM

	MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER			
Connected Nameplate hp	5,460	10,953.5	16,413.5
Operating hp	5,256	9,203.5	14,459.5
Intermittent hp	150	---	150
Magnet kw	3	---	3
CHEMICALS			
Dust Suppression Wetting Agent, gal/d	1.15	4.6	5.75
MISCELLANEOUS			
Utility Water - gpm			
Dust Suppression	4	16	20
STEAM, FUEL, AND COOLING WATER			
Car Thawing Shed, MMBtu/hr	33	---	33

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 62
COAL CRUSHING SYSTEM

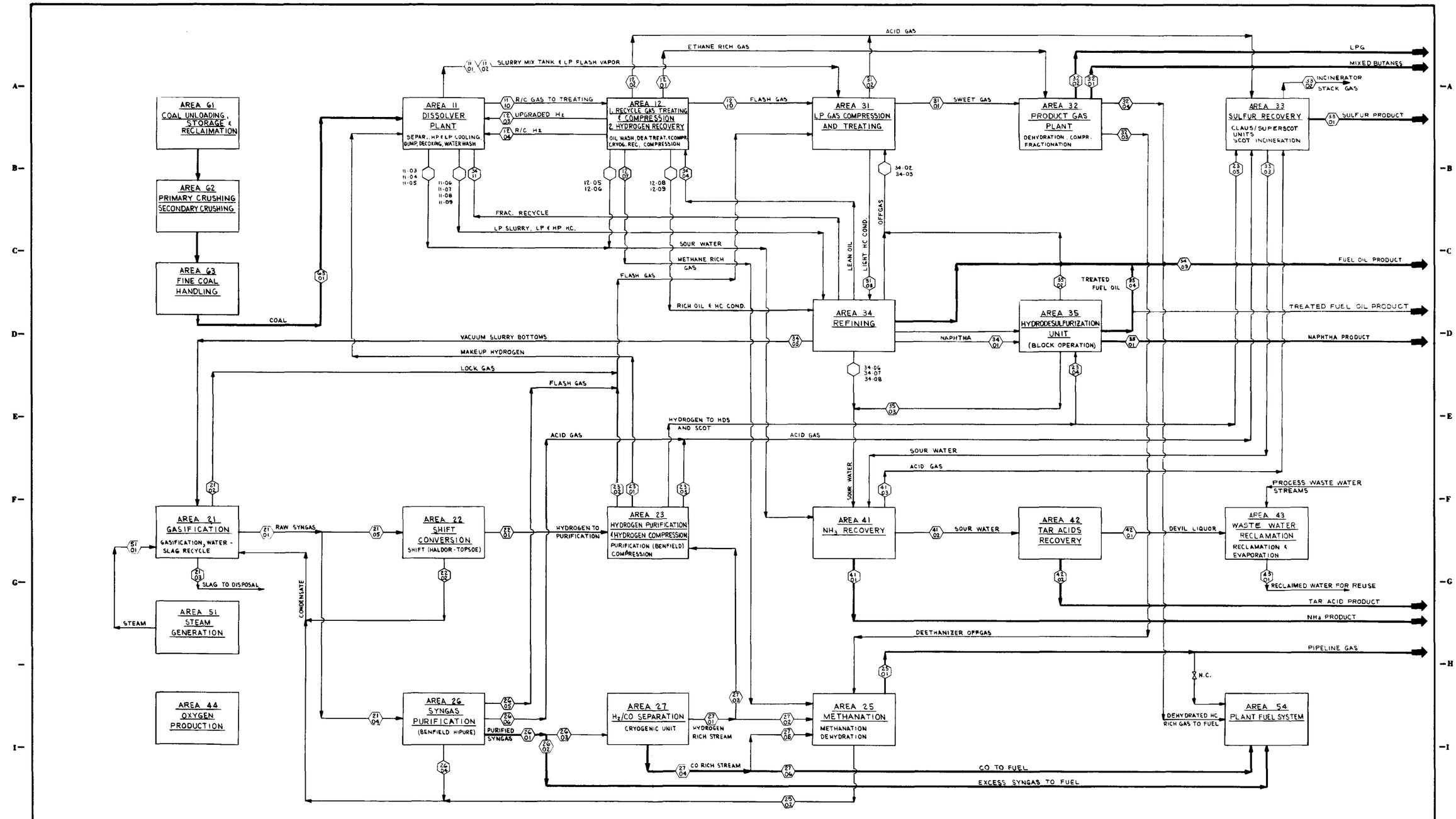
	MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER			
Connected Nameplate hp	3,267.5	3,380	6,647.5
Operating hp	3,267	3,320	6,587
Magnets kw	6	---	6
CHEMICALS			
Dust Suppression Wetting Agent, gal/d	1.15	4.6	5.75
MISCELLANEOUS			
Utility Water - gpm			
Dust Suppression	4	16	20
STEAM, FUEL, AND COOLING WATER	NONE	NONE	NONE

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 63
FINE COAL HANDLING SYSTEM

	MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER			
Connected Nameplate hp	149	902	1,051
Operating hp	149	902	1,051
MISCELLANEOUS			
Nitrogen: To purge air from fine coal feed	---	---	---
STEAM, FUEL, COOLING WATER, CHEMICALS	NONE	NONE	NONE

UTILITIES, FUEL & CHEMICAL SUMMARY
AREA 64/65
PLANT SLAG HANDLING AND DISPOSAL SYSTEM

	MODIFIED DEMO	EXPANSION INCREMENT	FIRST COMMERCIAL
ELECTRIC POWER			
Connected Nameplate hp	194	263	457
Operating hp	194	263	457
CHEMICALS			
Johnson March Compound MR Wetting Agent, gal/d	1.15	4.6	5.75
Miscellaneous			
Utility Water (Dust Suppression) - gpm	4	16	20
STEAM, FUEL, COOLING WATER, CHEMICALS	NONE	NONE	NONE



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Form 60575

NO.	REVISIONS	DATE	BY	CH'D	APP'D
1	DELETION OF PROPRIETARY DATA	3/7/79			

PRINT RECORD

ENGINEERING REVIEW	APP'D BY
DATE	
AUTOMATION	
ELECTRICAL	
EQUIPMENT	
INSTRUMENTATION	
PIPING	
PROJ. DES. SUPR.	
PROCESS ENGINEER	11/6/78

AUTHORIZED FOR RELEASE	APP'D BY	DATE
PROCESS ENGINEER		11/6/78
PROJECT ENGINEER		11/6/78

ANY PROCESS CONDITIONS OF SERVICE, SUCH AS TEMPERATURES, PRESSURES, FLOW QUANTITIES, STREAM COMPOSITIONS, AND EQUIPMENT DUTIES, SHOWN ON THIS FLOW DIAGRAM ARE CALCULATED AND ARE FOR DESIGN PURPOSES ONLY. WHILE THEY MAY BE USEFUL AS GUIDES IN OPERATION, THEY DO NOT REPRESENT EXACT OR GUARANTEED OPERATING CONDITIONS.
GUARANTEES ARE CONTAINED ONLY IN THE CONTRACT (OR PROPOSAL) DOCUMENTS.

CUSTOMER APPROVAL

BY [illegible] DATE 11-7-78

DRAWING STATUS	APP'D	DATE
ISSUE NO.		
DEVELOPMENT		
PRELIMINARY ENGINEERING	5	11/6/78
FINAL ENGINEERING		
APPROVED FOR CONSTRUCTION		
REV.		

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. VERIFY ALL PRINTS BEFORE USE. ENTER DATE AND/OR REVISION NO.

PROCESS FLOW DIAGRAM
OVERALL PLANT BLOCK FLOW
AREA 00
SRC II FIRST COMMERCIAL PLANT

The Pittsburg & Midway Coal Mining Co.
A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

DRAWN LOU 5/25/79

Stearns-Roger INCORPORATED

ORDER NO. C-21500

DWG. NO. 22927

SHEET NO. 00G06

REV. -111A

MATERIAL BALANCE

Stream Number	MW	11-01	11-02	11-03	11-04	11-05	11-06	11-07	11-08	11-09	11-10
Identification / Component		SLURRY MIX TANK VAPOR	L.P. FLASH VAPOR	SLURRY MIX TANK SOUR WATER	H.P. SOUR WATER	L.P. SOUR WATER	L.P. HOT SLURRY TO VAC. FLASH	H.P. COLD H.C. TO FRAC.	L.P. COLD H.C. TO FRAC.	L.P. HOT H.C. TO FRAC.	RECYCLE GAS TO TREATING
H_2	2.016	45.0	2525.5	—		—	8.5	165.5	1.5	4.0	PROPRIETARY
C_1	16.042	25.0	1296.5	—		—	3.0	777.0	3.0	2.0	
C_2	30.068	30.0	720.0	—	—	—	4.0	209.0	0.5	3.0	
C_3	44.094	25.0	323.0	—	—	—	2.5	250.5	12.0	2.5	
C_4	58.120	15.0	226.5	—		—	1.0	53.0	14.0	2.0	
C_5	72.151	5.0	19.0	—			0.5	58.5	9.0	0.5	
150 - 350	—	3.0	17.0	—	(4) 25.0	(4) 6.0	9.0	822.5	362.5	35.0	
350 - 600	—	—	5.5	—		—	561.0	966.0	1042.0	1095.5	
600 - 900	—	—	—	—	—	—	764.0	31.0	109.5	970.5	
900 +	—	—	—	—		—	868.5		—	126.5	
N_2	28.016	15.0	24.5	—	—	—	5.0	17.0	0.5	0.5	
CO	28.010	30.0	139.5	—	—	—	8.5	32.0	0.5	0.5	
O_2	32.000	—	—	—	—	—	—	—	—	—	
CO_2	44.010	1.5	89.5	TR	452.5	2.5	0.5	16.5	0.5	0.5	
H_2S	34.076	3.5	118.5	TR	250.0	0.5	0.5	47.0	3.0	0.5	
NH_3	17.032	—	—	—	820.0	1.0	—		—	—	
COS	60.07	—	—	—	—	—	—	—	—	—	
SO_2	64.059	—	—	—	—	—	—	—	—	—	
H_2O	18.000	66.0	171.0	6157.0	18610.5	813.0	2.5	—	—	4.0	
S	32.060	—	—	—	—	—	—	—	—	—	
TOTAL (MOLES/HR)		264.0	5676.0	6157.0	20158.0	823.0	2239.0	3445.5	1564.5	2247.5	
TOTAL (LBS/HR)		6665	94750	110825	379890	15380	1054335	300725	250890	502250	
SOLIDS (LBS/HR)		—	—	—	—	—	530435	—	—	—	
TOTAL (LBS/HR)		6665	94750	110825	379890	15380	1584770	300725	250890	502250	
TOTAL (TPD)/BPSD/[MM SCFD]		[2.4]	[51.[illegible]]	7595	27135	1055	72345	25145	18305	34790	
NOTES:					(4)	(4)					

Stream Number	MW	12-01	12-02	12-03	12-04	12-05	12-06	12-07	12-08	12-09	12-10
Identification / Component		ETHANE RICH GAS	ACID GAS TO SCOT	UPGRADED HYDROGEN	RECYCLE HYDROGEN	KNOCKOUT WATER	SOUR WATER	METHANE RICH GAS	ABSORBER RICH OIL TO REFINING	H.C. COND. TO REFINING	FLASH GAS
H_2	2.016	240.0		PROPRIETARY	PROPRIETARY	—	—	2980.0	390.0	40.0	65.0
C_1	16.042	1053.0	5.0			—	—	8057.0	575.5	81.0	20.5
C_2	30.068	1408.5	1.5			—	—	883.5	472.0	126.5	5.5
C_3	44.094	721.5	0.5			—		93.5	544.0	153.0	2.0
C_4	58.120	101.5	TR			—		2.5	441.0	68.0	0.5
C_5	72.151	0.5	—			—	—	—	101.0	0.5	—
150 - 350	—	TR	—			—	—	—	116.0	2.0	—
350 - 600	—	—	—			—	—	—	6783.5	0.5	—
600 - 900	—	—	—			—	—	—	617.0	—	—
900 +	—	—	—			—	—	—	10.5	—	—
N_2	28.016	18.5	TR			—	—	321.5	16.5	2.0	1.0
CO	28.010	43.0	—			—	—	752.0	31.0	4.0	3.5
O_2	32.000	—	—			—	—	—	—	—	—
CO_2	44.010	2.5	263.0			—	TR	—	69.5	—	1.0
H_2S	34.076	TR	706.0			—	TR	< 2 PPM	191.0	—	1.0
NH_3	17.032	—	—			—	—	—	—	—	—
COS	60.07	—	—			—	—	—	—	—	—
SO_2	64.059	—	—			—	—	—	—	—	—
H_2O	18.000		114.0			17.0	24.0	—	39.0	—	1.5
S	32.060	—	—			—	—	—	—	—	—
TOTAL (MOLES/HR)		3589.0	1090.0			17.0	24.0	13090.0	10397.5	477.5	101.5
TOTAL (LBS/HR)		99315	37840			310	430	196160	1425510	16275	970
SOLIDS (LBS/HR)		—	—			—	—	—	—	—	—
TOTAL (LBS/HR)		99315	37840			310	430	196160	1425510	16275	970
TOTAL (TPD)/BPSD/[MM SCFD]		[32.7]	[9.9]			20	30	[119.2]	108615	2200	[1.0]
NOTES:											

Stream Number	MW	21-01	21-02	21-03	21-04	21-05	22-02	22-01	22-02	23-01	23-02	23-03	23-04	23-05
Identification / Component		SYNGAS FROM GASIFIER	LOCK GAS	SLAG TO DISPOSAL	SYNGAS TO PURIFICATION	SYNGAS TO SHIFT CONVERSION		HYDROGEN TO PURIFICATION	SHIFT CONDENSATE TO GASIFIER	MAKEUP HYDROGEN TO DISSOLVER	FLASH GAS	ACID GAS	HYDROGEN TO HDS UNIT	HYDROGEN TO SCOT UNIT
H_2	2.016	PROPRIETARY	PROPRIETARY	PROPRIETARY	PROPRIETARY	PROPRIETARY		60860.5	—	62185.0	725.2	165.7	1459.0	110.0
C_1	16.042							282.8	—	271.1	—	4.9	6.8	0.5
C_2	30.068							—	—	—	—	—	—	—
C_3	44.094							—	—	—		—	—	—
C_4	58.120							—	—	—	—	—		—
C_5	72.151							—	—	—	—	—	—	
150 - 350	—							—	—	—	—	—	—	
350 - 600	—							—	—	—	—	—	—	—
600 - 900	—							—	(2) 7.5	—	—	—	—	—
900 +	—							(14) 97.0	—	(14) 71.6	—	(14) 1.7	(14) 2.3	(14) 0.2
N_2	28.016							317.0	—	331.1	—	6.4	7.6	0.6
CO	28.010							1052.8	—	1296.9	4.7	11.1	25.2	1.9
O_2	32.000							—		—	—	—		—
CO_2	44.010							41577.5	—	153.8	1314.3	40105.3	3.8	0.3
H_2S	34.076							539.5	—	6.0	8.6	524.7	0.2	—
NH_3	17.032							22.5	127.5	—	—	22.5	—	
COS	60.07							1.3	—	2 PPM	—	1.3	—	—
SO_2	64.059							—	—	—	—	—	—	—
H_2O	18.000							624.2	81283.6	52.4	228.1	1918.7	1.3	0.1
S	32.060							—	—	—	—	—	—	—
TOTAL (MOLES/HR)								105375.1	81418.6	64367.9	2280.9	42760.6	1506.2	113.6
TOTAL (LBS/HR)								2028503	1465480	186152	63835	1818021	4258	323
SOLIDS (LBS/HR)								—	—	—	—	—	—	—
TOTAL (LBS/HR)		4659085	5325	376101	1164771	3494314		2028503	1465480	186152	63835	1818021	4258	323
TOTAL (TPD)/BPSD/[MM SCFD]								[958.4]	100448	[585.5]	[20.8]	[309.5]	[13.7]	[1.0]
NOTES:				(3)				(14)	(2)	(14)		(14)	(14)	(14)

Stream Number	MW	25-01	25-02	26-01	26-02	26-03	26-04	26-05	26-06	27-01	27-02	27-03	27-04	27-05	27-06
Identification / Component		PIPELINE GAS	METHANATION CONDENSATE TO GASIFIER	SYNGAS FROM PURIFICATION	SYNGAS TO PLANT FUEL	SYNGAS TO H_2/CO SEPARATOR	SYNGAS CONDENSATE TO GASIFIER	FLASH GAS	ACID GAS	HYDROGEN RICH STREAM FROM H_2/CO SEPARATOR	HYDROGEN RICH STREAM TO METHANATOR	HYDROGEN RICH STREAM TO COMPRESSION	CO-RICH STREAM FROM H_2/CO SEPARATOR	CO-RICH STREAM TO METHANATOR	CO-RICH STREAM TO PLANT FUEL
H_2	2.016	304.4	—	PROPRIETARY	PROPRIETARY	PROPRIETARY	PROPRIETARY	PROPRIETARY	3.8	PROPRIETARY	3145.7	3784.4	503.6	1.1	502.5
C_1	16.042	18147.9							0.4		0.3	0.5	78.9	1.2	77.7
C_2	30.068								—		—	—	—	—	—
C_3	44.094	—	—						—		—	—	—	—	—
C_4	58.120	—	—						—		—	—	—	—	—
C_5	72.151	—	—						—		—	—	—	—	—
150 - 350	—	—	—						—		—	—	—	—	—
350 - 600	—	—							—		—	—	—	—	—
600 - 900	—	—	—						—		—	—	—	—	—
900 +	—		—						—		(14) 1.3	(14) 1.4	(14) 24.5	(14) 0.4	(14) 24.1
N_2	28.016	(15) 382.0	—						0.5		4.2	4.4	80.1	1.1	79.0
CO	28.010	5PPMV	—						40.3		262.9	287.0	9368.3	140.0	9228.3
O_2	32.000	—	—						—		—	—	—	—	—
CO_2	44.010	78.5	—						2357.0		—	—	—	—	—
H_2S	34.076	—	—						177.6		—	—	—	—	—
NH_3	17.032	—	—						49.2		—	—	—	—	—
COS	60.07	—	—						0.6		—	—	—	—	—
SO_2	64.059	—	—						—		—	—	—	—	—
H_2O	18.000	—	11841.4						1128.0		—	—	—	—	—
S	32.060	—	—						—		—	—	—	—	—
TOTAL (MOLES/HR)		18912.8	11841.4						3757.4		3414.4	4077.7	10055.4	143.8	9911.6
TOTAL (LBS/HR)		305899	213146						132190		13881	15855	267904	3984	263920
SOLIDS (LBS/HR)		—	—						—			—	—		
TOTAL (LBS/HR)		305899	213146						132190		13881	15855	267904	3984	263920
TOTAL (TPD)/BPSD/[MM SCFD]		[172.0]	1462						[34.228]		[31.0]	[37.1]	[91.4]	[1.3]	[90.1]
NOTES:		(15)									(14)	(14)	(14)	(14)	(14)

Stream Number	MW	31-01	31-02	31-03	32-01	32-02	32-03	32-04	33-01	33-02	33-03	34-01	34-02
Identification / Component		SWEET GAS FROM TREATING	ACID GAS TO SULFUR PLANT	LIGHT H.C. CONDENSATE	MIXED BUTANES PRODUCT	LPG PRODUCT	DEETHANIZER OFF GAS	HYDROCARBON RICH GAS TO FUEL	SULFUR PRODUCT	STACK GAS TO INCINERATION	SOUR WATER	NAPHTHA TO DESULFURIZATION (7) (16)	ATM OFF GAS
H_2	2.016	4562.0	TR		—	—	1973.6	2828.4	—	—	—	—	609.5
C_1	16.042	2840.5	TR	0.5	—	—	2132.4	1761.1	—	—	—		1438.0
C_2	30.068	1601.5	—	1.0	—	27.4	1989.7	992.9	—	—	—		813.5
C_3	44.094	1364.5	—	3.0	1.0	1102.4	136.6	846.0	—	—	—	—	944.0
C_4	58.120	821.0	—	5.5	390.6	22.9		509.0	—	—	—	—	543.0
C_5	72.151	140.5	—	4.0	53.9	—	—	87.1	—	—	—	53.5	119.0
150 - 350	—	86.5	—	100.0	32.9	—	—	53.6	—	—	(4) 0.4	1221.0	166.5
350 - 600	—	—	—	7.0	—	—	—	—	—	—	—	192.0	1.5
600 - 900	—	—	—	—	—	—	—	—	—	—	—	—	—
900 +	—	—	—	—	—	—	—		—	(14) 2337.7	—	—	—
N_2	28.016	92.0	—	—	—	—	53.5	57.0	—	(13) 7600.4	—	—	30.0
CO	28.010	439.0	TR	—	—	—	209.8	272.2	—	—	—		76.0
O_2	32.000	—	—	—	—	—	—	—	—	170.1	—	—	—
CO_2	44.010	0.6	1567.1	0.5	—	—	2.7	0.4	—	45879.4	—	—	87.0
H_2S	34.076	0.1	395.3	0.5	—	—	< 2 PPM	0.1	—	—	TR	—	240.5
NH_3	17.032	—	—			—	—	—	—	—	0.5	—	—
COS	60.07	—	—	—	—	—	—	—	—	—	—	—	—
SO_2	64.059	—	—	—	—	—	—	—	—	16.9	—	—	—
H_2O	18.000	164.7	111.1	TR	—	—	—	TR	—	1717.1	4233.1	—	352.0
S	32.060	—	—	—	—	—	—	—	2160.0	—	—	—	—
TOTAL (MOLES/HR)		12112.9	2073.5	122.0	478.4	1152.7	6498.3	7407.8	2160.0	57781.6	4234.0	1456.5	5420.5
TOTAL (LBS/HR)		247988	84438	12438	30090	50764	111530	151852	69250	2364586	76249	168640	170055
SOLIDS (LBS/HR)		—	—	—	—	—	—	—	—	—	—	—	—
TOTAL (LBS/HR)		247988	84438	12438	30090	50764	111530	151852	69250	2364586	76249	168640	170055
TOTAL (TPD)/BPSD/[MM SCFD]		[110.1]	[18.8]	1029	3510	6870	[59.1]	[67.4]	(830)	[575.5]	5224	13290	[49.3]
NOTES:										(13)(14)	(4)	(7) (16)	

Stream Number	MW	34-03	34-04	34-05	34-06	34-07	34-08	34-09	34-11	35-01	35-02	35-03	35-04
Identification / Component		DEBUTANIZER OFF GAS	LEAN OIL	VAC. SLURRY BOTTOMS TO GASIFIERS	ATM. SOUR WATER	DEBUTANIZER SOUR WATER	VAC. FLASH SOUR WATER	TOTAL FUEL OIL PRODUCT	FRAC. RECYCLE	TREATED NAPHTHA PRODUCT (7) (16)	HDS UNIT SOUR GAS	HDS SOUR WATER	TREATED FUEL OIL
H_2	2.016		—	PROPRIETARY	—	—	—		PROPRIETARY	—	438.0	—	—
C_1	16.042	4.0			—	—				—	57.0	—	—
C_2	30.068	8.5			—	—	—	—		—	25.0	—	—
C_3	44.094	23.5	—		—	—	—	—		—	50.0	—	—
C_4	58.120	41.5	—		—	—	—	—		—	—	—	—
C_5	72.151	1.5	—		TR	—	—	—		53.5	—	—	—
150 - 350	—	—	46.0		—	—		[illegible]3.0		1221.0	—	—	6.5
350 - 600	—	—	6777.5		—	—	—	2651.0		114.0	—	—	907.0
600 - 900	—	—	617.0		—	—	—	1082.3		—	—	—	96.8
900 +	—	—	10.5		—	—	—	219.7		—	—	—	1.5
N_2	28.016	11.5			—	—	—	—		—	10.0	—	—
CO	28.010	0.5	—		—	—	—	—		—	25.0	—	—
O_2	32.000	—			—	—	—	—		—	—	—	—
CO_2	44.010	1.0	—		TR	TR	TR	—		—	1.5	TR	—
H_2S	34.076	2.0	—		TR	TR	TR	—		—	15.0	TR	—
NH_3	17.032	—	—		—	—	—			—	TR	—	—
COS	60.07	—			—	—	—	—		—	—	—	—
SO_2	64.059				—	—	—	—		—	—	—	—
H_2O	18.000	1.5	49.0		1604.5	30.5	826.0	7.5		—	39.5	1707.5	—
S	32.060		—			—	—	—		—	—	—	—
TOTAL (MOLES/HR)		95.5	7500.0		1604.5	30.5	826.0	4730.5		1449.5	661.0	1707.5	1011.8
TOTAL (LBS/HR)		4350	1325470	577415	28885	550	14870	956445		167375	7020	30735	192810
SOLIDS (LBS/HR)		—		(5) 530435	—	—	—	—		—	—	—	—
TOTAL (LBS/HR)		4350	1325470	1107850	28885	550	14870	956445		167375	7020	30735	192810
TOTAL (TPD)/BPSD/[MM SCFD]		[0.9]	94285		1980	40	1020			(7) 13200	[6.0]	1030	(7) 13450
NOTES:				(5)				(7) (17)		(7) (16)			(7) (17)

Stream Number	MW	41-01	41-02	41-03	42-01	42-02	43-01	44-01	51-01	63-01
Identification / Component		AMMONIA PRODUCT	WATER TO TAR ACID RECOVERY	ACID GAS	DEVIL LIQUOR	TAR ACID PRODUCT	RECLAIMED WATER	OXYGEN TO GASIFIERS	STEAM TO GASIFIERS	COAL FEED TO MIX TANK
H_2	2.016	—	—	—	—	—	—	PROPRIETARY	PROPRIETARY	—
C_1	16.042	—	—	—	—	—	—			—
C_2	30.068	—	—	—	—	—	—			—
C_3	44.094	—	—	—	—	—	—			—
C_4	58.120	—	—	—	—	—	—			—
C_5	72.151	—	—	—	—	—	—			—
150 - 350	—	—	(4) 31.0	(4) 2.0	—	(4) 31.0	—			—
350 - 600	—	—	—	—	—	—	—			—
600 - 900	—	—	—	—	—	—	—			—
900 +	—	—	—	—	(12) 0.5	(12) 0.5	—			—
N_2	28.016	—	—	—	—	—	—			—
CO	28.010	—		—	—	—	—			—
O_2	32.000	—	—	—	—	—	—			—
CO_2	44.010	—	<0.5	455.0	< 0.5	—	—			—
H_2S	34.076	—	1.5	249.5	1.5	—	—			—
NH_3	17.032	811.0	10.0	0.5	10.0	—	—			—
COS	60.07	—	—	—	—	—	—			—
SO_2	64.059	—	—	—	—	—	—			—
H_2O	18.000	—	7306.0	127.0	38639.0	—	186826			7775
S	32.060	—	—	—	—	—	—			—
TOTAL (MOLES/HR)		811.0	37349.0	834.0	38651.5	31.5	186826			7775
TOTAL (LBS/HR)		13815	674825	31020	695754	3145	3362868			139950
SOLIDS (LBS/HR)		—	—	—	—	—	—			(1) 2790000
TOTAL (LBS/HR)		13815	674825	31020	695754	3145	3362868			2929950
TOTAL (TPD)/BPSD/[MM SCFD]		(165)	46290	[7.6]	47726	240	9599			(35160)
NOTES:			(4)	(4)	(12)	(4) (12)				(1)

NOTES:
(1) DRY COAL
(2) HCN
(3) INCLUDES 3200 LBS/HR CHAR
(4) PHENOLS AND CRESYLICS
(5) UNCONVERTED COAL, ASH, ETC.
(6) 2 x PRODUCTION RATE, 50% OF THE TIME
(7) ANNUAL AVERAGE
(8) 1 x PRODUCTION RATE, 50% OF THE TIME
(9) 50% PRODUCTION RATE OF LIGHT FUEL OIL
(10) PRODUCTION RATE SHOWN IS 2 x AVERAGE PER DAY
(11) 1 x PRODUCTION RATE SHOWN
(12) SOLVENT
(13) INCLUDES NO_2
(14) ARGON
(15) INCLUDES ARGON
(16) ALL NAPHTHA IS PROCESSED IN HDS UNIT. NAPHTHA FLOW THROUGH HDS UNIT (50% OF TIME) IS 2 x STREAM DAY PRODUCTION RATE.
(17) ONLY 50% OF TOTAL LIGHT FUEL OIL PRODUCT IS PROCESSED IN HDS UNIT. LIGHT FUEL OIL FLOW THROUGH HDS UNIT (50% OF TIME) IS 1 x STREAM DAY PRODUCTION RATE.

Nº	REVISIONS	DATE	BY	CH'D	APP'VD
1	MISC. MINOR REV'S	7/3/79			
2	MISC. MINOR REV'S	7/19/79			

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PROCESS ENGINEER	JJB 11/16/78

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FINAL ENGINEERING		
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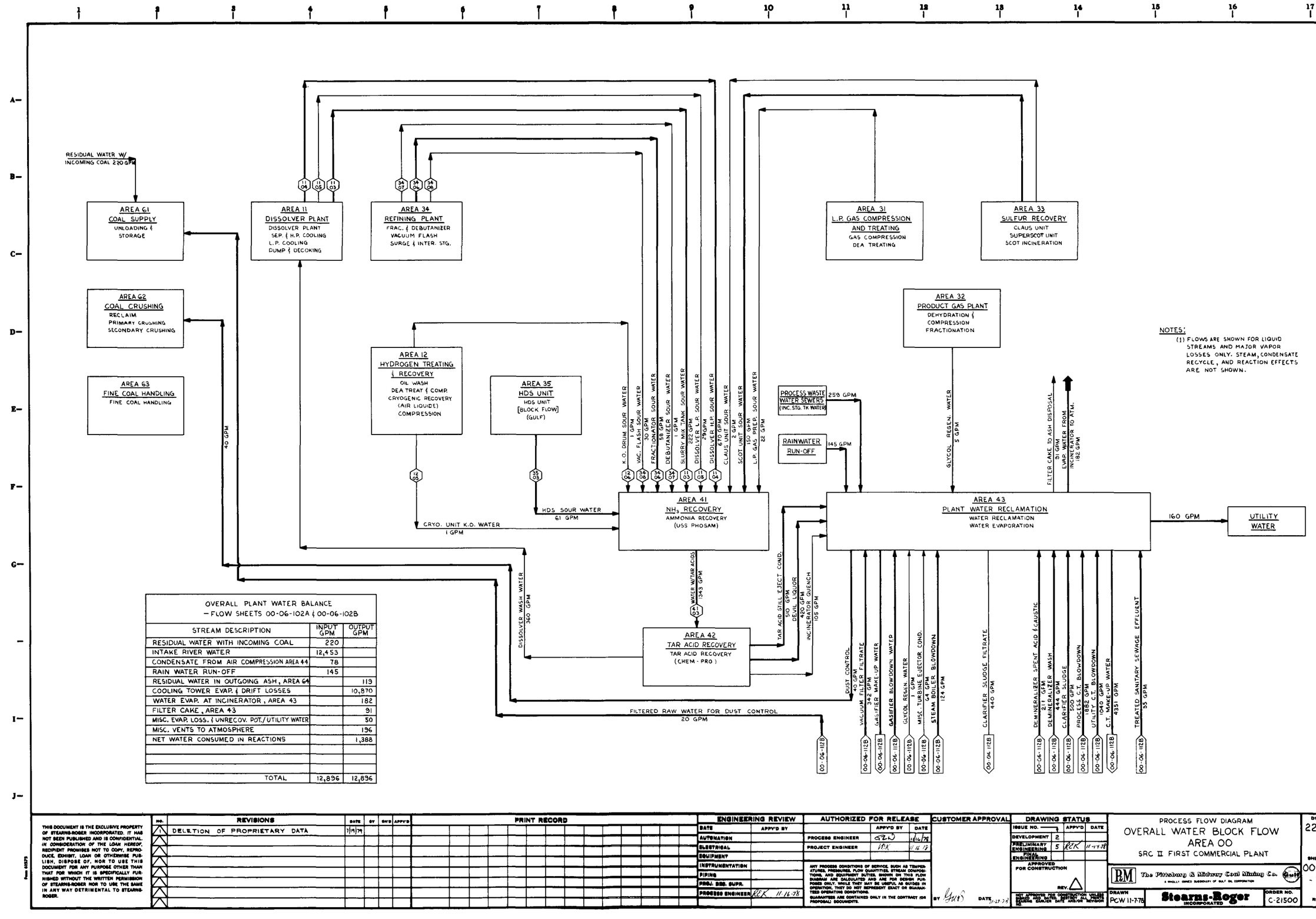
PROCESS FLOW DIAGRAM
OVERALL PLANT MATERIAL BALANCE
AREA 00
SRC II FIRST COMMERCIAL PLANT

P&M The Pittsburg & Midway Coal Mining Co. — A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION — Gulf

DRAWN LOU 5/25/79

Stearns-Roger INCORPORATED

DWG. NO. 22927
SHEET NO. 00G-06-111B
ORDER NO. C-21500
REV. 2



OVERALL PLANT WATER BALANCE
— FLOW SHEETS 00-06-102A & 00-06-102B

STREAM DESCRIPTION	INPUT GPM	OUTPUT GPM
RESIDUAL WATER WITH INCOMING COAL	220	
INTAKE RIVER WATER	12,453	
CONDENSATE FROM AIR COMPRESSION AREA 44	78	
RAIN WATER RUN-OFF	145	
RESIDUAL WATER IN OUTGOING ASH, AREA 64		119
COOLING TOWER EVAP. & DRIFT LOSSES		10,870
WATER EVAP. AT INCINERATOR, AREA 43		182
FILTER CAKE, AREA 43		91
MISC. EVAP. LOSS. & UNRECOV. POT./UTILITY WATER		50
MISC. VENTS TO ATMOSPHERE		196
NET WATER CONSUMED IN REACTIONS		1,388
TOTAL	12,896	12,896

NO.	REVISIONS	DATE	BY	CH'D	APP'D
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PROJ. ENGR. SUPR.		
PROCESS ENGINEER	REK	11-16-78

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PROJECT ENGINEER	WK	11/16/78

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BY _____ DATE 11-27-78

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DEVELOPMENT	2		
PRELIMINARY ENGINEERING	5	REK	11-9-78
FINAL ENGINEERING			
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PROCESS FLOW DIAGRAM
OVERALL WATER BLOCK FLOW
AREA 00
SRC II FIRST COMMERCIAL PLANT

The Pittsburg & Midway Coal Mining Co. — A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

DRAWN PCW 11-7-78
Stearns-Roger INCORPORATED
ORDER NO. C-21500

DWG. NO. 22927
SHEET NO. 00-06-112A
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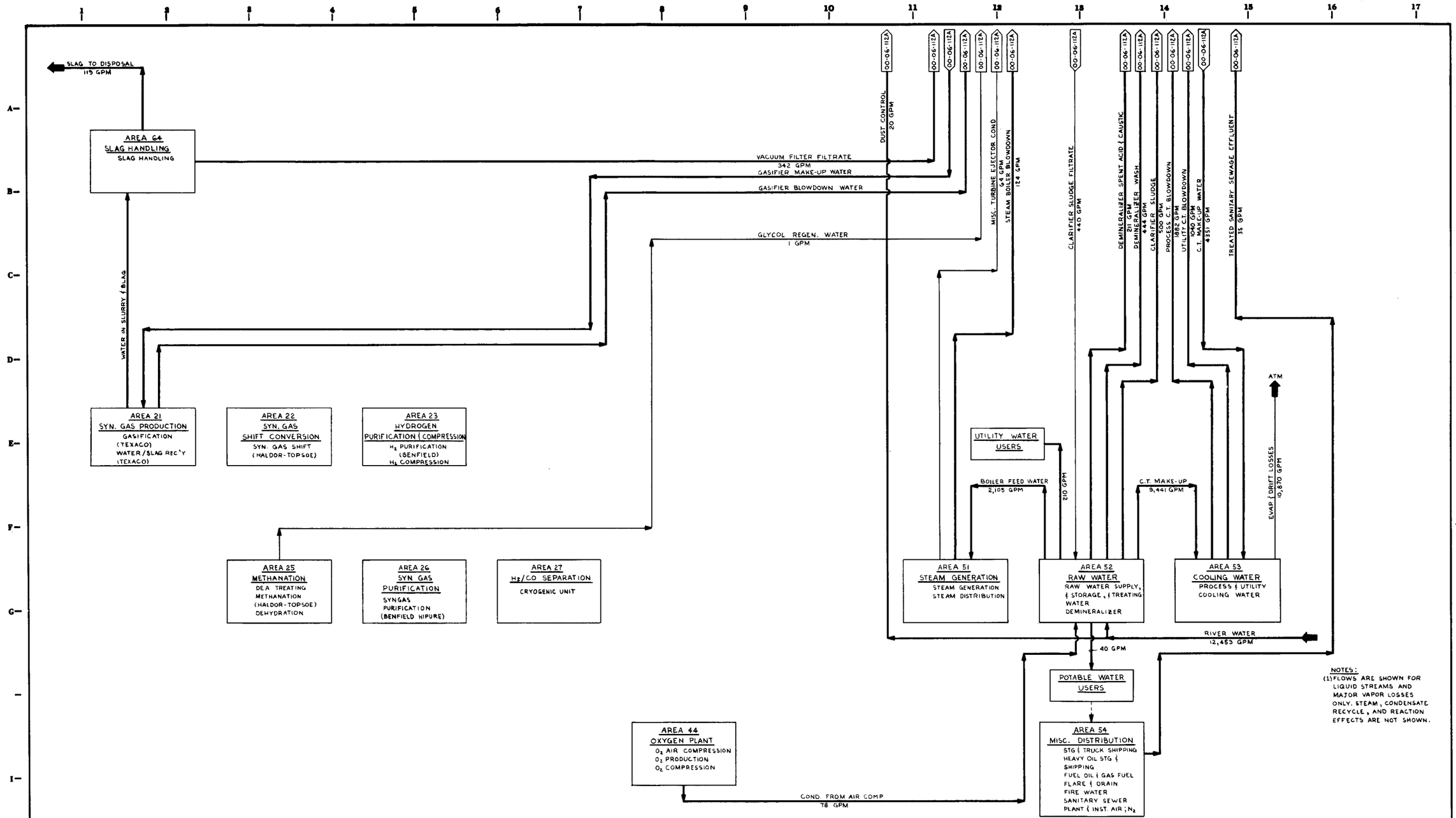

NO.	REVISIONS	DATE	BY	CH'D	APP'D
1	DELETION OF PROPRIETARY DATA	7/19/79			

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PROCESS ENGINEER	REK 11-16-78

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DRAWING STATUS	ISSUE NO.	APP'D	DATE
DEVELOPMENT	2		
PRELIMINARY ENGINEERING	5	REK	11-17-78
FINAL ENGINEERING			

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PROCESS FLOW DIAGRAM
OVERALL WATER BLOCK FLOW
AREA 00
SRC II FIRST COMMERCIAL PLANT

The Pittsburg & Midway Coal Mining Co. — A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

DRAWN PCW 11-7-78

Stearns-Roger INCORPORATED

ORDER NO. C-21500

DWG. NO. 22927

SHEET NO. 00-06-112B

REV. 1

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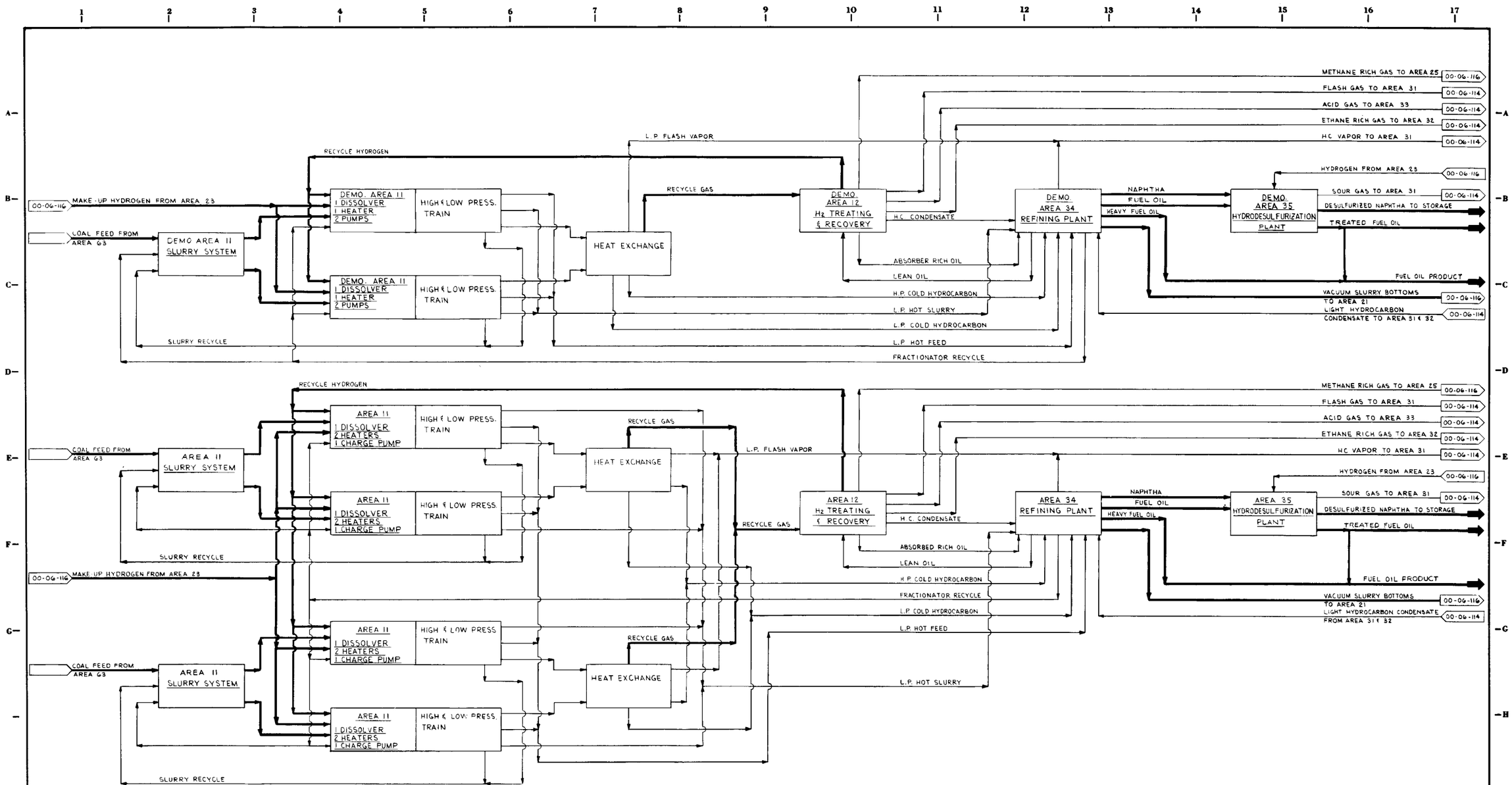

NO.	REVISIONS	DATE	BY	CH'D	APP'D
1	PROP. BLENDING REVSD.	5/25/79	LPR		
2	AREA DESIGNATION/PROD. BLENDING	7/3/79			
3	DELETION OF PROPRIETARY DATA	7/19/79			

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PROCESS ENGINEER	

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PROJECT ENGINEER		11/16/78

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DEVELOPMENT	2	RKP	11/9/78
PRELIMINARY ENGINEERING	5	RKP	11/16/78
FINAL ENGINEERING			

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BLOCK FLOW DIAGRAM
PLANT TRAIN DIAGRAM AREA 00
SRC II FIRST COMMERCIAL PLANT

The Pittsburg & Midway Coal Mining Co. — A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

DRAWN LOU 6/22/79

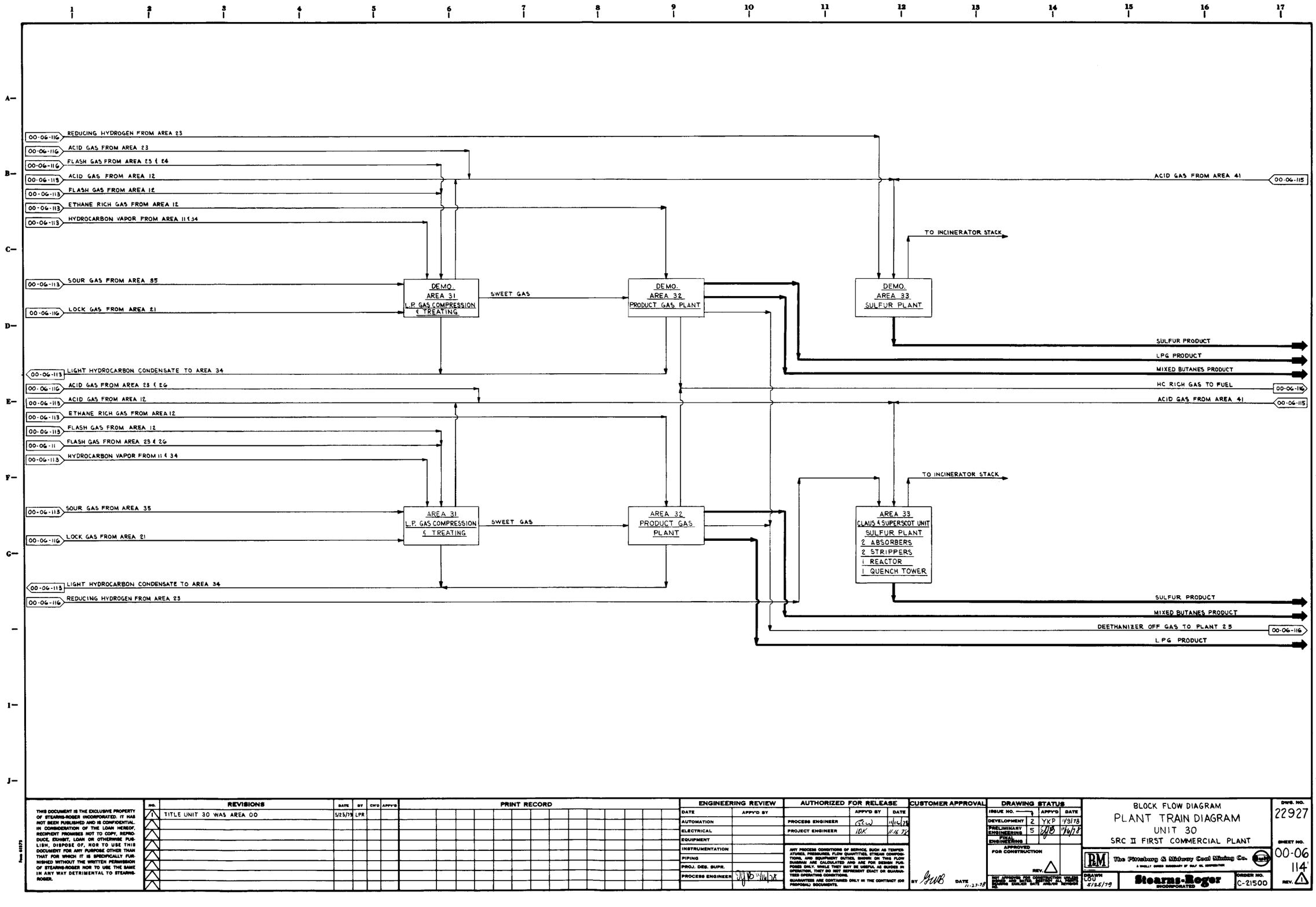
Stearns-Roger INCORPORATED

ORDER NO. C-21500

DWG. NO. 22927

SHEET NO. 00-06-113

REV. 3



NO.	REVISIONS	DATE	BY	CH'D	APP'D
1	TITLE UNIT 30 WAS AREA 00	5/25/79	LPR		

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PROCESS ENGINEER	11/16/78

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PROJECT ENGINEER	JDK	11-16-78

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DEVELOPMENT	2	YKP	1/9/78
PRELIMINARY ENGINEERING	5	JDK	11/16/78
FINAL ENGINEERING			
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BLOCK FLOW DIAGRAM
PLANT TRAIN DIAGRAM
UNIT 30
SRC II FIRST COMMERCIAL PLANT

The Pittsburg & Midway Coal Mining Co. — A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

DRAWN LBO 5/25/79

Stearns-Roger INCORPORATED

ORDER NO. C-21500

DWG. NO. 22927

SHEET NO. 00-06 114

REV. △

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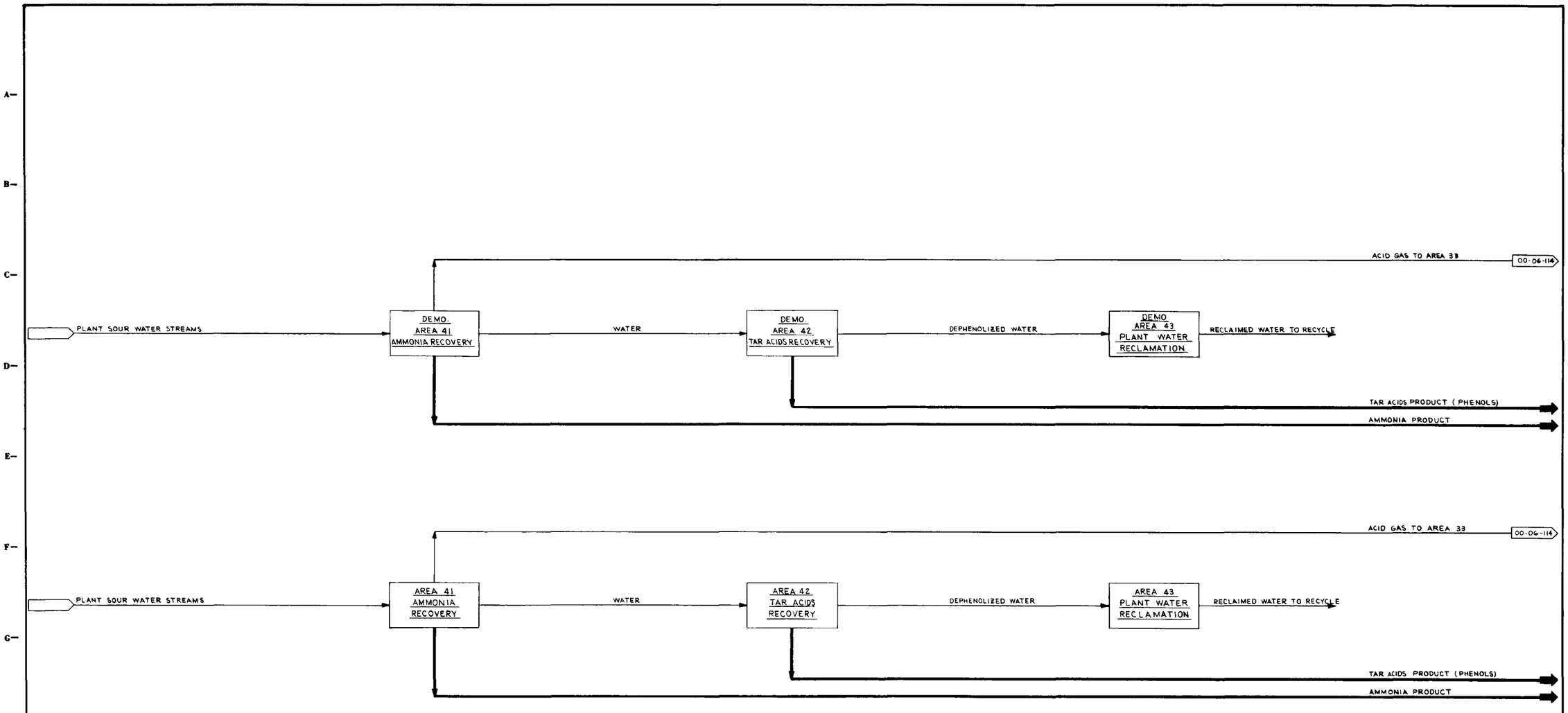

Form 61373

NO.	REVISIONS	DATE	BY	CH'D	APP'D
1	TITLE UNIT 40 WAS AREA 00	5/25/79	LPR		

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PROJ. DES. SUPR.		
PROCESS ENGINEER	11/14/78	

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PROCESS ENGINEER		11/14/78
PROJECT ENGINEER		11-14-78

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ISSUE NO.	2	YKP	11/9/78
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PRELIMINARY ENGINEERING			
FINAL ENGINEERING			
APPROVED FOR CONSTRUCTION			
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BLOCK FLOW DIAGRAM
PLANT TRAIN DIAGRAM
UNIT 40
SRC II FIRST COMMERCIAL PLANT

R&M The Pittsburg & Midway Coal Mining Co. (Gulf)
A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

DRAWN LOU 5/25/79

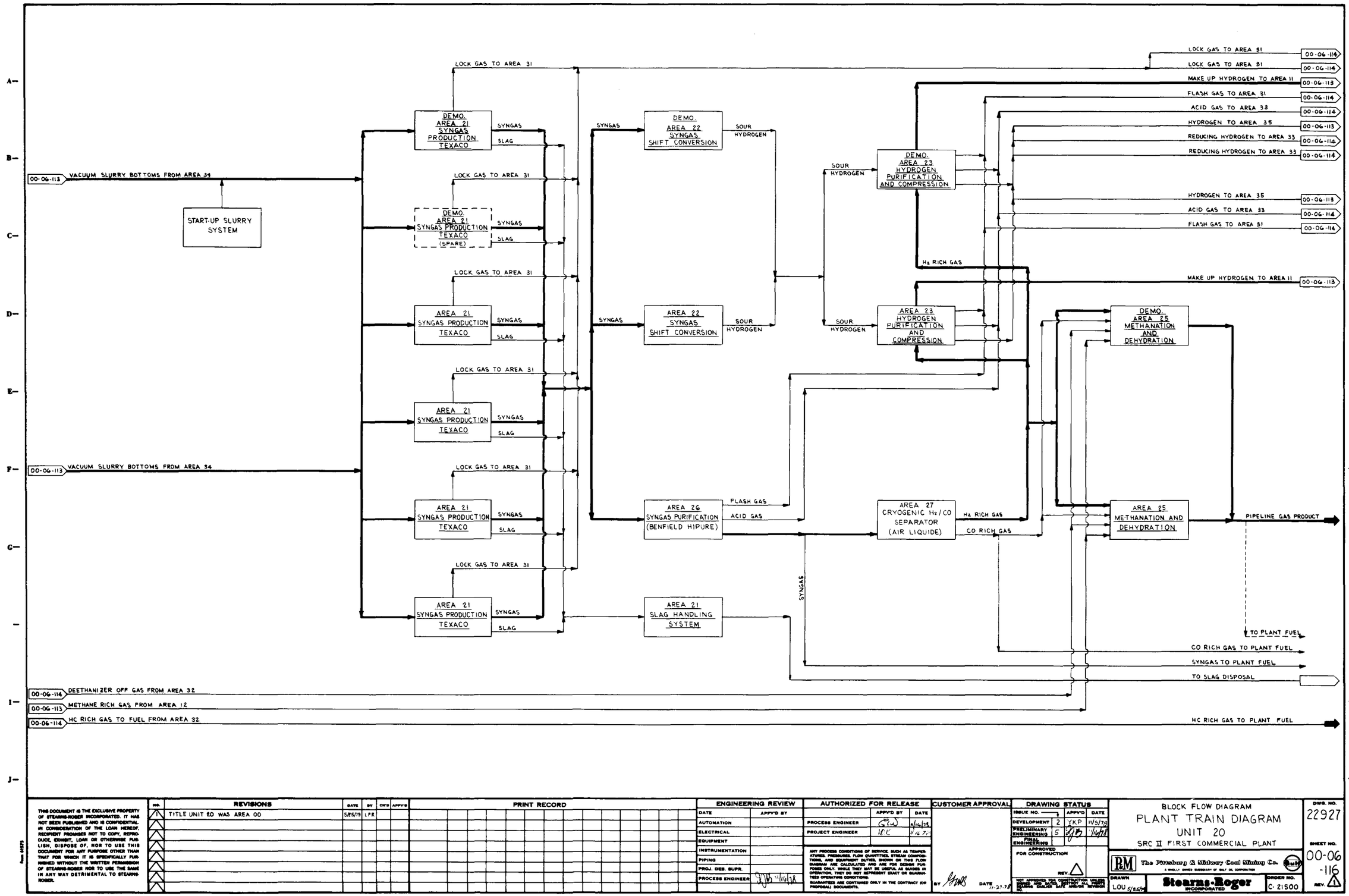
Stearns-Roger INCORPORATED

ORDER NO. C-21500

DWG. NO. 22927

SHEET NO. 00-06-115

REV. △



NO.	REVISIONS	DATE	BY	CH'D	APP'D
1	TITLE UNIT 20 WAS AREA 00	5/25/79	LPR		

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PROCESS ENGINEER	11/16/78

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PROCESS ENGINEER		11/16/78
PROJECT ENGINEER		11-21-78

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BY _____ DATE 11-21-78

DRAWING STATUS	ISSUE NO.	APP'D	DATE
DEVELOPMENT	2	YKP	11/5/79
PRELIMINARY ENGINEERING	5		11/16/78
FINAL ENGINEERING			
APPROVED FOR CONSTRUCTION			
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BLOCK FLOW DIAGRAM
PLANT TRAIN DIAGRAM
UNIT 20
SRC II FIRST COMMERCIAL PLANT

The Pittsburg & Midway Coal Mining Co. (RM)
A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

DRAWN LOU 5/25/79

Stearns-Roger INCORPORATED

ORDER NO. C-21500

DWG. NO. 22927

SHEET NO. 00-06-116

REV. 1

SECTION 4

UTILITIES

4.1 GENERAL

The utility systems have been expanded to meet the First Commercial Plant requirements in the most efficient manner. Because of the interdependence of the process and utility systems, considerable effort has been expended in making the designs both economical and operable. The designs also incorporate techniques for achieving high thermal efficiencies and minimizing raw water usage.

Steam generation facilities are provided onsite. Electric power is supplied by a nearby utility. Raw water treating is included for boiler feedwater and cooling tower makeup. Facilities have been provided for recovery of all process water. With these designs, a water balance was obtained with zero aqueous waste discharge. Conventional systems for instrumentation and plant air, nitrogen/inert gas, fire water, cooling water and sanitary sewers are included.

4.2 PLANT STEAM SYSTEM

The overall plant steam system is shown on three process flow diagrams. Drawing 51G06-111 shows the steam generation equipment and the steam generating process areas. Drawings 51G06-112A and 51G06-112B show the steam distribution network. These drawings are included at the end of this section.

The description following applies to the overall steam system, including both the Demonstration Plant facilities and the additions required for expansion. The process flow diagrams show total production and consumption, as well as indicating the quantities attributed to the demonstration and expansion portions of the plant.

The four major steam pressure levels in operating the plant are 1500, 600, 250, and 35 psig.

A total of 2,793,040 lbs/hr of 1500 psig steam is required at design stream day conditions with 1,513,240 lbs/hr generated from process waste heat and 1,279,800 lbs/hr produced in the two fired power boilers.

The 600 psig steam design demand is 2,099,740 lbs/hr with 1,140,600 lbs/hr obtained by topping and extraction from the large 1500 psig steam turbines driving the methane rich gas compressors and the oxygen plant air compressor (Demonstration). The remainder is derived from waste heat recovered from process streams and from the exhaust of the gas turbines driving the oxygen plant air compressors (First Commercial).

All 250 psig and 35 psig steam production comes from process waste heat and from topping and extraction turbines. There are two small low pressure steam subsystems that produce steam at 75 psig and 50 psig for use in numerous steam jet ejectors.

The steam and power system design is based on minimizing the number of electric motor drivers larger than 250 hp, and starting up the plant using steam supplied by the power boilers fired with pipeline gas. At the time of definitive design an investigation will be made to determine the best economical means of supplying motive power.

Although most of the process waste heat is utilized, there is still potential for improvement in the steam balance. Some design changes which could significantly reduce the power boiler steam requirement include changing the Demonstration Plant wastewater reclamation system from steam-heated double effect evaporation to vapor compression evaporation as was done for the expansion; utilizing a portion of the O_2 containing gas turbine exhaust as preheated combustion air for the power boilers; replacing other large steam turbines with gas turbines with heat recovery; recovering flash steam and heat from boiler blowdowns; and utilizing selective physical absorption of H_2S and CO_2 as part of hydrogen purification processing.

4.3 PLANT FUEL SYSTEM

Table 4-1 summarizes the estimated fuel requirement for each area of the total First Commercial Plant. Three columns are shown in this table, one for the design fuel requirement and two for normal operation. The design fuel requirement reflects the maximum rate of fuel usage for which the equipment in each area is designed. The "present design" operating fuel requirement assumes that all units in the Commercial Plant are operating in accord with normal material balance conditions as required by the current plant configuration. The "optimized" operating fuel requirements is an estimate for a plant configuration changed to provide improved fuel economy.

All fuel consumption figures are in MMBtu/hr, and are based on the lower heating value of the fuel used.

The sources of fuel for the commercial plant are hydrocarbon-rich gas (LHV=1,100 Btu/scf), CO-rich gas (LHV-320 Btu/scf) and purified syngas (LHV=300 Btu/scf).

The development of the plant fuel requirement is an iterative process in which processing steps, product yields and fuel availability are all interrelated. The overall plant material balance was made on the assumption that 4,670 MMBtu/hr of plant fuel was required. However, the first iteration produced a calculated requirement of 5,715 MMBtu/hr. The time available did not permit further iterations to bring the two numbers together. An estimate of fuel savings was made for changes in plant configuration to achieve improved fuel economy. The changes included selective physical absorption of H_2S and CO_2 and vapor recompression evaporation for waste water reclamation. The fuel consumption for the "optimized" plant is estimated at 4,692 MMBtu/hr, essentially the same as the fuel provided in the material balance, indicating that the original fuel assumption can be attained.

TABLE 4-1

COMMERCIAL PLANT FUEL SUMMARY

STREAM DAY BASIS:MMBtu/Hr - LHV

		OPERATING	
	DESIGN	PRESENT DESIGN	OPTIMIZED DESIGN
1. Area 11 - Preheaters(1)	2,525	2,301	2,301
2. Area 27 - Salt Bath Heater	12	11	11
3. Area 33 - SCOT Unit	PROPRIETARY	PROPRIETARY	PROPRIETARY
4. Area 33 - Incinerator	PROPRIETARY	PROPRIETARY	PROPRIETARY
5. Area 34 - Refining	412	382	382
6. Area 35 - HDS	PROPRIETARY	PROPRIETARY	PROPRIETARY
7. Area 43 - Incinerator	53	30	30
8. Area 44 - Gas Turbines(2)	1,110	919	919
9. Area 44 - Fuel Expander Heater(3)	41	32	32
60. Area 51 - Power Boilers	1,875	1,600	590
11. Area 51 - Superheaters	147	127	130
12. Area 54 - Flares	3	3	3
TOTAL (MMBtu/hr)		5,715	4,692

(1) Operating fuel requirement does not include 15% safety allowance in radiant duty.

(2) Gas turbines planned for expansion only.

(3) Fuel expander heater planned for Demonstration Plant only.

4.4 PLANT COOLING WATER SYSTEM

The total First Commercial Plant Cooling Water System includes four cooling towers. Two towers are added to the Demonstration Plant. One for the cooling water used in the process and the other for cooling water used for the utilities.

The First Commercial Plant utilizes proportionately more aerial cooling and improved heat recovery in the process areas than the Demonstration Plant. Consequently, the water cooling has been reduced in these areas. Based on these criteria, the total process cooling tower duty is 4,050 MMBtu/hr, including 1,200 MMBtu/hr at the Demonstration Plant tower and 2,850 MMBtu/hr at the new tower.

The use of combined cycle drivers for the oxygen plant air compressors, Area 44, results in a reduction in the cooling water requirements for this area when compared to the Demonstration Plant. Therefore, there is a significant reduction in the utility cooling tower duty when compared with the Demonstration Plant. The total utility area cooling tower load is 1,390 MMBtu/hr including 410 MMBtu/hr at the Demonstration Plant tower and 980 MMBtu/hr at the new tower.

4.5 OVERALL WATER BLOCK FLOW

The overall water block flow for the total First Commercial Plant is shown on Drawing 00-06-112 A&B located at the end of Section 3. These drawings show the sources of incoming water, water flows between process and water reclamation, and a water balance around the cooling tower. Steam flows, condensate recycles between process units and chemical reaction waters are not shown.

The river water consumption did not go up in proportion to the plant capacity increase because the cooling water system did not increase in proportion to the added plant capacity. Also, the water balance calculation procedure was revised for the commercial design to better account for the reuse of the reclaimed water. As a result, the estimated river water

consumption of 12,453 gpm is well below the 20,000 gpm available. The other sources of incoming water are relatively small, and include 220 gpm residual water in the coal feed, 789 gpm condensed from the compressed air feed to the oxygen plant, and 145 gpm average rain water run-off.

4.6 PLANT ELECTRICAL SYSTEM

4.6.1 Basis for Design

The fully integrated First Commercial Plant is a complex facility requiring simultaneous operation of several interdependent processes. In order to maintain an excellent on-stream capability, reliability of the plant electrical system has been stressed.

4.6.2 Purchased Power and 138KV Station Equipment

Purchased power for the plant is available at a main substation located south of the warehouse. This substation serves both the Demonstration Plant and the First Commercial Plant. It is planned that the local power company will construct two separate 138KV transmission lines into the plant and terminate at the main substation dead-end structures. In order to attain highest power-supply reliability, each circuit is to be sized for the total plant load, including the Demonstration Plant and the First Commercial Plant, and each circuit is to originate from a separate source. Normally, the two circuits are to be used simultaneously and are not to be connected in parallel by plant equipment. Initially the 138KV station bus, line switching and transformer switching at the main substation was designed for both the Demonstration Plant and the First Commercial Plant. Physical size of the main substation accomodates the additional transformers and switchgear required for the First Commercial Plant expansion without need to rebuild the main substation or shutdown the Demonstration Plant during First Commercial Plant construction.

4.6.3 Operating Demands

Normal operating power demands have been estimated to be 28,684 KVA for the Demonstration Plant and 47,860 KVA for the First Commercial Plant. The power demands for the First Commercial Plant are additive to the demands of the Demonstration Plant, thus the total Plant normal operating demand is approximately 76,544 KVA. A contingency operating demand for a spare 7500 HP Lean Solvent Booster Pump located in the Demonstration Plant (5,895 KVA) and a 15,000 HP Lean Solvent Booster Pump located in the First Commercial Plant (11,656 KVA) must be added to the total plant normal operating demand. Thus total plant demand, with contingency load, will be approximately 94,095 KVA.

4.6.4 Main Transformer Sizing

The First Commercial Plant requires two 20 MVA transformers provided with automatic cooling fans and oil pumps. In sizing the main transformers for the Demonstration Plant (20 MVA each) spare transformer capability was provided for the First Commercial Plant. Each transformer will provide 37,300 KVA contingency load capability with both fans and pumps in operation. These features, with a special 13.8 KVA primary bus arrangement which provides load transfer to adjoining transformers, should allow normal operation of the plant in the event of transformer failure or during maintenance operations and should also allow normal operation during large motor contingency load demands.

4.6.5 Main Switchgear (SG-1 Extended)

The switchgear will be 13.8 KV nominal voltage class, 750 MVA interrupting rating, with 2000 ampere continuous rated main breakers, 3750 ampere tie breakers and 5000 ampere main bus. In the event of main transformer failure or maintenance operations, the affected main breaker would open, and the tie breakers on each side of the affected bus would close, either automatically or manually, allowing all loads to be fed from the adjoining two transformers. Main breakers and tie breakers will be electrically operated and feeder breakers will be manually operated.

4.6.6 Primary Distribution System

A 13.8 KV primary distribution voltage will be utilized which provides good voltage regulation, limits line losses and conductor sizes to load-center substations and allows an underground installation of the primary cabling system. A primary-selective radial system is being used in that two circuits each originating from a separate power source are provided for each process load-center substation. Normally the two circuits share the total load demands of each substation, however if a feeder fails, the remaining feeder is sized for the total substation load. This 13.8 KV primary-selective arrangement assures excellent reliability for the critical processes by providing quick restoration of service if a primary feeder fails, offers acceptable economics, safety and flexibility to the system and allows the purchase of standard primary distribution equipment and 15 KV cabling.

The primary distribution system for the Demonstration Plant has been designed to facilitate expansion to the First Commercial Plant. Where required, Demonstration Plant feeders have been oversized to accomodate the First Commercial Plant expansion. Conduit duct banks originating at the main substation, and located in the Demonstration Plant, are installed with additional interfacing conduits in order to accomodate the future needs of the First Commercial Plant.

4.6.7 Load Center Substations

At the process load-center substations, two 13.8 KV primary source feeders are connected to the line-side of two interrupter switches which are connected to a bus divided into two sections by a bus-tie switch. Automatic or manual operation is provided by switch operators and an automatic control device. Under normal operating conditions, the bus-tie switch is open, and each bus section receives power from its normal source. Should one of the source circuits fail, the interrupter switch associated with that source is automatically opened and the bus-tie switch closed, permitting the remaining source to serve the entire load.

Secondary-selectivity is provided with double-ended 480 volt and 4160 volt transformers and switchgear employing manual or automatic bus selectivity in the event of single load center transformer operations. Motor Control Centers will be fed from this switchgear and will provide circuit protection and motor start capability for all 480 volt and 4160 volt loads.

Transformer rating is limited where possible, or standard current-limiting techniques will be employed, in order to limit the interrupting ratings of the switchgear and motor control centers to 13.8 MVA at 4160 volts and 22,000 symmetrical amperes at 480 volts. All 13.8 KV - 4.16 KV and 480 volt transformers are sized to operate in the $55^{o}C$ or $65^{o}C$ self-cooled range for the anticipated normal operating load. For all double-ended transformer arrangements, the transformers will be provided with $65^{o}C$ fan-cooling equipment so that maximum capability can be realized from a given transformer in the event of contingent single transformer operation. Minimum load shedding is required in most of these operations.

A standby emergency power system is required for safe shutdown of the plant in the event of purchased power failure. On-site emergency generators will be required and location/number of these generators will be determined by critical process and emergency power requirements.

4.6.8 General Electrical Design

The following voltage breakdowns are typical of current standard design practice:

Motors smaller than 1/2 HP	120V, 1-Phase
Motors 1/2HP through 200 HP	480V, 3-Phase
Motors 250 HP and larger	4160V, 3-Phase
Outdoor Lighting, mercury	208/480V, 3-Phase
Indoor Lighting, Fluorescent	120, 1-Phase
Misc. Lighting and Outlets	120V, 1-Phase
Welding Receptacles	480V, 3-Phase

All major electrical control equipment is located a minimum of 25 feet outside the hazardous area boundaries. Load-center substations are located throughout the site to allow for equipment grouping, provide central control locations, and allow the use of general purpose equipment enclosures.

Miscellaneous power and lighting transformers, panel boards, and welding receptacles will be located near the loads they serve and will be indoors or outdoors as required.

Certain areas of the plant have been classified as electrically hazardous in accordance with Article 500 of the National Electric Code (NFPA). The American Petroleum Institute Standard RP500A was used as a guide for atmospheres containing flammable liquids, gases or vapors.

Effort was made to locate all major electrical equipment outside of the hazardous areas. Any electrical equipment within a hazardous area shall be approved for use in that area.

The location of a piece of equipment determines the type of enclosure. The following criteria was established:

Indoors	General Purpose, NEMA 1
Outdoors	Weatherproof, NEMA 4
Hazardous	As required by the hazardous area and if indoors or outdooors

4.7 PRODUCT STORAGE AND SHIPPING

This system includes tankage for storage of the various liquid products prior to loading and shipping on designated schedules. Also the system includes pumping equipment for transfer and for loading products into trucks and rail cars and shipment by pipeline. Auxiliary equipment includes vapor recovery facilities.

The product storage basis for the total First Commercial Plant is summarized in the following table.

TABLE 4-2
COMMERCIAL PLANT PRODUCT STORAGE SUMMARY

Product	Rate B/D	Total Storage Bbls.	Days of Storage
Propane	6,870	40,000	6
Butane	3,510	20,000	6
Ammonia	1,520	18,000	12
Sulfur	2,633	28,100	10
Tar Acids	240	2,500	10
Naphtha	13,200	270,000.*	20.*
Fuel Oil **	61,366	570,000	9
		948,600	

* Extra storage is required to ship naphtha in 100,000 Bbl. tenders.

** Includes 140,000 Bbls. tankage segregated for Treated Fuel Oil. The remaining 430,000 Bbls. is available for Mixed Fuel Oil. Days of storage depends upon production rate of each product.

The total daily loading basis for the First Commercial Plant averages 2 tank trucks and 61 rail cars. The operation is based on one eight-hour shift per day, five days per week.

The equipment is located within two areas on the plant site. These areas are within the main process area and on a low site close to the river. The river storage is located about 10,000 feet from the main process area. The facilities at each of these areas are described below.

4.7.1 Main Process Area

The storage and shipping facilities for naphtha, mixed fuel oil and tar acids are located adjacent to the main process area.

The total naphtha storage, 270,000 barrels, is equivalent to approximately twenty days production. This relatively large storage volume is provided to allow pipeline shipment of naphtha in 100,000 barrel tenders.

The total mixed fuel oil storage, 430,000 barrels, is equivalent to seven to ten days production, depending upon the quantity of treated fuel oil segregated for separate shipment. The mixed fuel oil is shipped by pipeline on an essentially continuous basis. The storage volume is set to conform to pipeline company recommendations. The tar acids total storage, 2,500 barrels, accommodates about ten days of production. The tar acids are loaded into tank trucks at a rate of about two trucks per day.

Storage is also provided in the main process area for propane, butane and ammonia. These three products are then transferred to the river area storage for loading into tank cars. Liquid sulfur is stored in a heated pit at the sulfur plant, and transferred via a steam heated line to the river storage site for shipping via tank cars.

4.7.2 River Storage and Shipping

Shipping facilities are provided for loading treated fuel oil, propane, butane, ammonia and sulfur into rail cars.

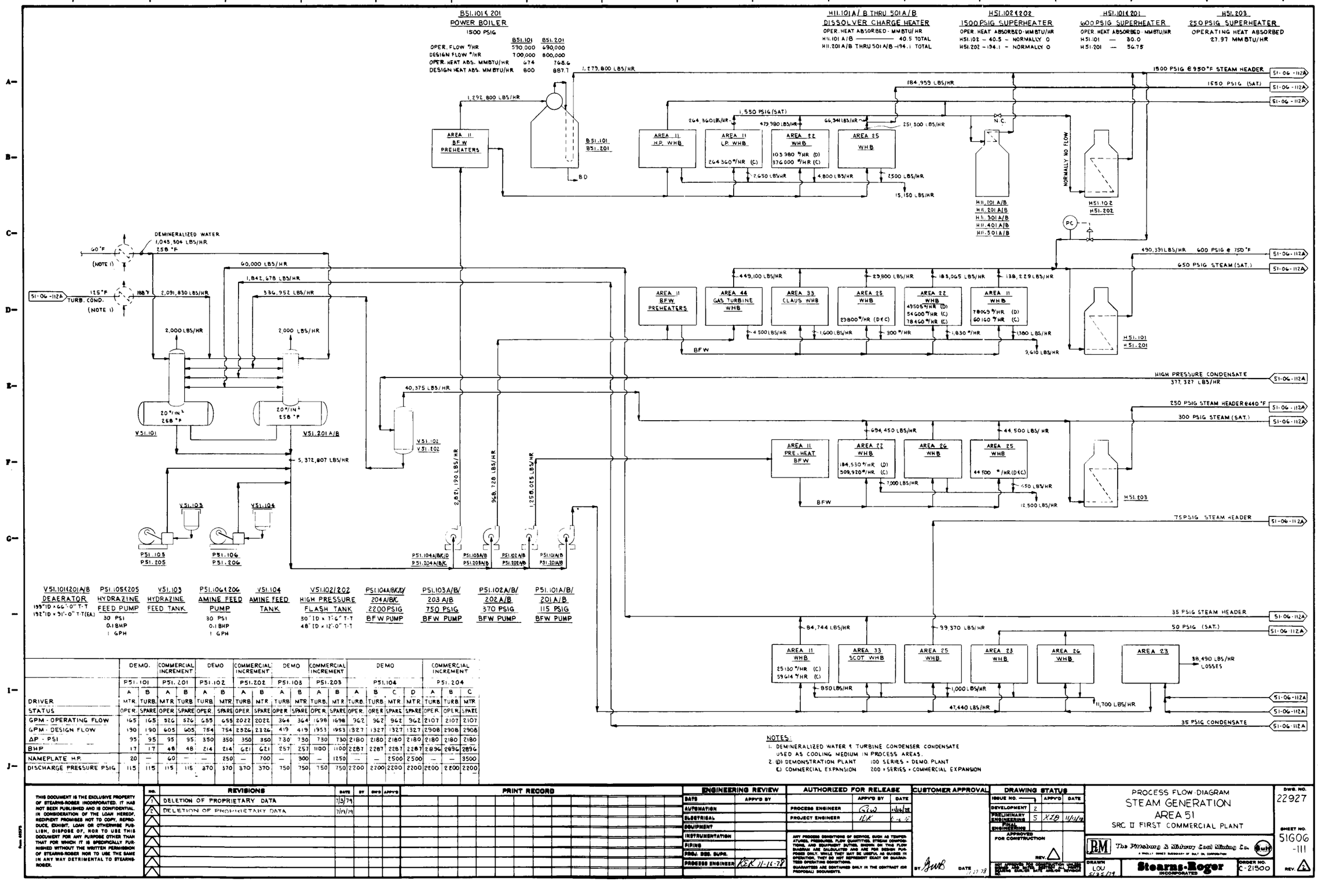
Treated fuel oil is stored in the 140,000 barrels of tankage that was used for mixed fuel oil in the Demonstration Plant. The storage is equivalent to about seventeen days production, on the basis that thirty percent of the treated fuel oil is segregated for separate shipment. Loading of the treated fuel oil is into rail cars at an average rate of 20 cars per day.

Propane is stored in two additional 15,000 barrel pressure spheres. Loading of the propane is into rail cars at an average rate of about 18 cars per day. Total commercial storage for propane is 40,000 barrels or about six days of production.

Butane is stored in one additional 15,000 barrel pressure sphere. Loading of butane is into rail cars at an average rate of 9 cars per day. Total commercial storage for butane is 20,000 barrels, or about six days of production.

Ammonia is stored in one additional 15,000 barrel pressure sphere. Loading of ammonia is into rail cars at an average rate of 4 cars per day. Total commercial storage for ammonia is 18,000 barrels, or about twelve days of production.

Liquid sulfur is stored in one additional 26,000 barrel insulated tank with an internal steam heater to keep the sulfur molten. Tank capacity represents about ten days of production. Loading of the sulfur is into rail cars at an average rate of about ten cars per day.



	DEMO.		COMMERCIAL INCREMENT		DEMO		COMMERCIAL INCREMENT		DEMO		COMMERCIAL INCREMENT		DEMO				COMMERCIAL INCREMENT		
	P51.101		P51.201		P51.102		P51.202		P51.103		P51.203		P51.104				P51.204		
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	C	D	A	B	C
DRIVER	MTR	TURB.	MTR	TURB	TURB.	MTR	TURB	MTR	TURB	MTR	TURB.	MTR	TURB.	TURB.	MTR	MTR	TURB	TURB	MTR
STATUS	OPER.	SPARE	OPER	SPARE	OPER.	SPARE	OPER.	SPARE	OPER	SPARE	OPER	SPARE	OPER.	ORER	SPARE	SPARE	OPER.	OPER.	SPARE
GPM - OPERATING FLOW	165	165	526	526	655	655	2022	2022	364	364	1698	1698	962	962	962	962	2107	2107	2107
GPM - DESIGN FLOW	190	190	605	605	754	754	2326	2326	419	419	1953	1953	1327	1327	1327	1327	2908	2908	2908
ΔP - PSI	95	95	95	95	350	350	350	350	730	730	730	730	2180	2180	2180	2180	2180	2180	2180
BHP	17	17	48	48	214	214	621	621	257	257	1100	1100	2287	2287	2287	2287	2896	2896	2896
NAMEPLATE H.P.	20	—	60	—	—	—	700	—	—	300	—	1250	—	—	2500	2500	—	—	3500
DISCHARGE PRESSURE PSIG	115	115	115	115	370	370	370	370	750	750	750	750	2200	2200	2200	2200	2200	2200	2200

NOTES:
1. DEMINERALIZED WATER & TURBINE CONDENSER CONDENSATE USED AS COOLING MEDIUM IN PROCESS AREAS.
2. (D) DEMONSTRATION PLANT 100 SERIES = DEMO. PLANT
(C) COMMERCIAL EXPANSION 200 + SERIES = COMMERCIAL EXPANSION

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2	DELETION OF PROPRIETARY DATA	7/19/79			

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INSTRUMENTATION	
PIPING	
PROJ. ENG. SUPR.	
PROCESS ENGINEER	KER 11-16-78

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PROCESS ENGINEER	[illegible]	11/16/78
PROJECT ENGINEER	[illegible]	11-16-78

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ISSUE NO.	APP'D	DATE
DEVELOPMENT	2	
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FINAL ENGINEERING		
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PROCESS FLOW DIAGRAM
STEAM GENERATION
AREA 51
SRC II FIRST COMMERCIAL PLANT

P&M The Pittsburg & Midway Coal Mining Co. Gulf
A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

DRAWN LOU 5/25/79

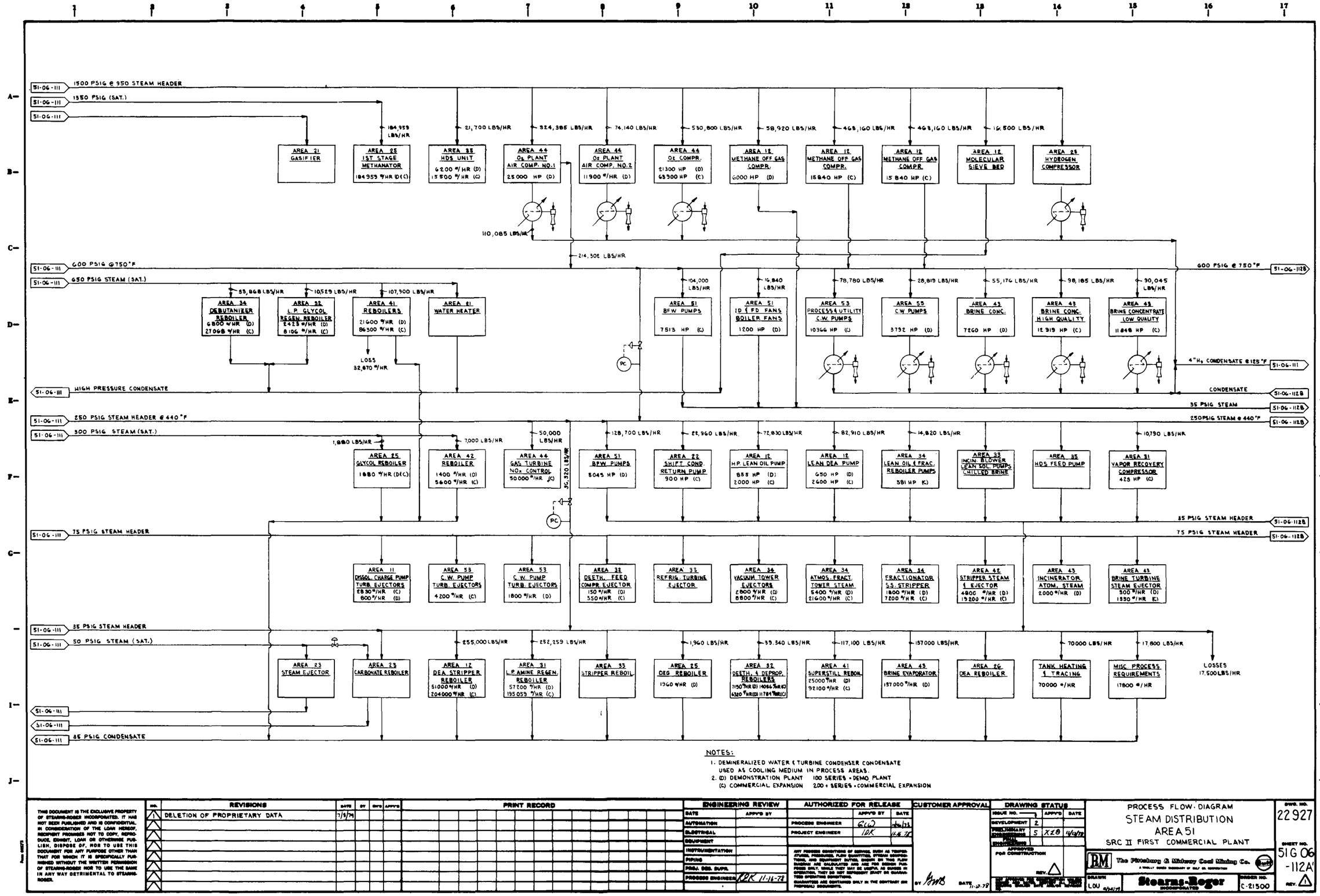
Stearns-Roger INCORPORATED

ORDER NO. C-21500

DWG. NO. 22927

SHEET NO. 51G06 -111

REV. 1



NOTES:

1. DEMINERALIZED WATER & TURBINE CONDENSER CONDENSATE USED AS COOLING MEDIUM IN PROCESS AREAS.
2. (D) DEMONSTRATION PLANT 100 SERIES - DEMO. PLANT
   (C) COMMERCIAL EXPANSION 200 + SERIES - COMMERCIAL EXPANSION

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INSTRUMENTATION	
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PROJ. DES. SUPV.	
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PROJECT ENGINEER	DDR	11/16/78

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PROCESS FLOW DIAGRAM
STEAM DISTRIBUTION
AREA 51
SRC II FIRST COMMERCIAL PLANT

The Pittsburg & Midway Coal Mining Co. — A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

DRAWN LOU 4/4/79 | Stearns-Roger INCORPORATED | ORDER NO. C-21500

DWG. NO. 22927
SHEET NO. 51G06-112A
REV.

51-06-112A 600 PSIG @ 750°F STEAM HEADER

98,162 LBS/HR | 41,070 LBS/HR | 27,920 LBS/HR | 54,660 LBS/HR | 192,130 LBS/HR | 88,060 LBS/HR | 91,200 LBS/HR

AREA 33 REFRIGERATOR PACKAGE

AREA 32 DEETHANIZER FEED COMPR. 5030 HP (D) 7886 HP (C)

AREA 31 LP GAS COMPRESSOR 2927 HP (D)

AREA 54 GAS TURBINE FUEL GAS COMP 1990 HP (C)

AREA 12 H₂ RECYCLE COMPRESSOR

AREA 11 DISSOLVER CHARGE PUMP 4560 HP (D)

AREA 11 DISSOLVER CHARGE PUMP 25,280 HP (C)

AREA 23 HYDROGEN COMPR.

AREA 23 LEAN SOLVENT BOOSTER PUMP

AREA 27 LP CO COMPRESSOR 2000 HP (C)

AREA 12 H₂ RECYCLE COMPRESSOR

AREA 31 LP GAS COMPR. 12000 HP (C)

AREA 23 LEAN SOLVENT BOOSTER PUMPS

51-06-112A CONDENSATE

51-06-112A 35 PSIG STEAM

51-06-112A 250 PSIG STEAM HEADER @ 440°F

17,860 LBS/HR | 38,370 LBS/HR | 43,880 LBS/HR | 75,250 LBS/HR | 86,060 LBS/HR | 128,445 LBS/HR

AREA 35 HDS RECYCLE COMPRESSOR 700 HP (C)

AREA 11 SLURRY FEED & CIRCULATION 1504 HP (C)

AREA 11 H.P. FLASH RECYCLE 1720 HP (C)

AREA 35 COMBUSTION AIR BLOWER 750 HP (D) 2200 HP (C)

AREA 32 DEETHANIZER OFF-GAS COMPRESSOR 1500 HP (D) 2074 HP (C)

AREA 32 DEETHANIZER REPRK. COMPRESSOR 1930 HP (D) 3045 HP (C)

AREA 23 LEAN SOLVENT PUMPS

AREA 21 H.P. GRAY WATER PUMP

AREA 21 GASIFIER CHARGE PUMP

AREA 21 SCRUBBER CIRC. PUMP

51-06-112A 35 PSIG STEAM HEADER

51-06-112A 75 PSIG STEAM HEADER

20,400 LBS/HR | 17,420 LBS/HR | 18,880 LBS/HR | 25,510 LBS/HR | 105,025 LBS/HR

AREA 52 CLEAR WATER SUPPLY PUMP 800 HP (C)

AREA 27 M.P. H₂ COMP. 683 HP (C)

AREA 54 AIR COMPRESSOR 740 HP (C)

AREA 26 CARBONATE PUMP

AREA 26 CARBONATE BOOSTER PUMP

AREA 51 ID & FD FAN 1000 HP (C)

AREA 43 AUXILIARIES BRINE CONC. 10 PUMPS 4117 HP

AREA 44 MISC. STM EJECTORS 2,307 #/HR (D) 2,790 #/HR (C)

AREA 34 2ND STAGE VACUUM FLASH STM EJECTOR 100 #/HR (C)

AREA 43 EVAP. STM. EJECTOR 850 #/HR (D)

AREA 12 STEAM EJECTOR 860 #/HR

AREA 23 LEAN SOLV. PUMP TURB. STM. EJECTOR

AREA 23 HYDROGEN COMP. STEAM EJECTOR

AREA 54 CLEAN FLARE VAPORIZER 2100 #/HR (D)

AREA 54 CLEAN H.C. FLARE 500 #/HR (D)

AREA 54 HEAVY H.C. FLARE 500 #/HR (D) 1000 #/HR (C)

AREA 27 L.P. COMP. TURB. EJECTOR

AREA 31 L.P. GAS COMP. TURB. EJECTOR 725 #/HR

NOTES:

1. DEMINERALIZED WATER & TURBINE CONDENSER CONDENSATE USED AS COOLING MEDIUM IN PROCESS AREAS.
2. (D) DEMONSTRATION PLANT — 100 SERIES = DEMO PLANT
   (C) COMMERCIAL EXPANSION — 200 + SERIES = COMMERCIAL EXPANSION
3. # INTERMITTENT FLOW

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1	DELETION OF PROPRIETARY DATA	3/7/79			
2	DELETION OF PROPRIETARY DATA	7/19/79			

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EQUIPMENT		
INSTRUMENTATION		
PIPING		
PROJ. DES. SUPR.		
PROCESS ENGINEER	REK 11-16-78	

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PROJECT ENGINEER	[illegible]	11/16/78

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FINAL ENGINEERING		

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PROCESS FLOW DIAGRAM
STEAM DISTRIBUTION
AREA 51
SRC II FIRST COMMERCIAL PLANT

The Pittsburg & Midway Coal Mining Co. — A WHOLLY OWNED SUBSIDIARY OF GULF OIL CORPORATION

DRAWN LDU 4/26/79

Stearns-Roger INCORPORATED

ORDER NO. C-21500

DWG. NO. 22927

SHEET NO. 51606-112B

REV. △

SECTION 5

THERMAL EFFICIENCY

5.1 GENERAL

One method of determining the overall thermal efficiency of a plant is to determine the total thermal energy (in Btu's) available in the aggregate product and express it as a percentage of total energy equivalent (again in Btu's) supplied to the plant as raw material and electric power. Application of this method arrives at an overall energy loss; however, it does not trace the individual components of the total energy loss.

For the First Commercial Plant, the total energy input is computed by summing the total heat of combustion of the coal charged into the plant and the equivalent Btu total of electric power supplied under operation per average stream day. The energy output is computed in a similar fashion by summing up the total Btu's available in all the products produced in an average stream day.

5.2 DISCUSSION

Using product rates and heating values shown in Table 5.1, the overall plant thermal efficiency for the First commercial plant is 72% (71% if byproducts are not included). These efficiency values allow for a calculated plant fuel requirement of 5715 MMBtu/hr. As discussed in Section 4.3, Plant Fuel System, the fuel consumption could be reduced by making certain changes in the plant configuration.

TABLE 5-1

FIRST COMMERCIAL PLANT THERMAL EFFICIENCY(6)

	Flow,Lbs/Hr	HHV,Btu/Lb(1)	Total,MMBtu/Hr
Energy Input			
Coal(2)	2,790,000	13,392	37,360
Electricity;Motor (4,5,7)	71,180 HP Operating	7,600 Btu/HpHr	540
Electricity; Lighting(5)	3393 KW	9,500 Btu/kwh	30
		TOTAL ENERGY INPUT	37,930
Energy Output			
A. Main Products			
Pipeline Gas(3)	255,047	22,810	5,820
Propane (3)	50,764	21,630	1,100
Butanes(3)	30,090	21,310	640
Naphtha(2)	167,375	18,280	3,060
Fuel Oil(2)	956,445	17,000	16,260
		TOTAL (MAIN PRODUCTS)	26,880
B. By-Products			
Sulfur			275
Anhydrous Ammonia			135
Tar Acids			65
		TOTAL (MAIN PRODUCTS & BYPRODUCTS)	27,335

3. Thermal Efficiency

With Main Products only = 71%

With Main Products & Byproducts = 72%

NOTES

(1) HHV = Higher Heating Value
(2) Heating values taken or estimated from Gulf Memo dated 11/16/78.
(3) Heating values taken from American Gas Association data.
(4) Average motor at 93% efficiency.
(5) Electricity heat content reflects thermal efficiency of typical coal-fired power station.
(6) Plant fuel requirement on product slate basis is 5,715 MMBtu/hr - LHV (calculated value).
(7) Net motor horsepower adjusted for horsepower generated in Area 44.

SECTION 6

DIFFERENCES FROM DEMONSTRATION PLANT

6.1 GENERAL

The design philosophy in expanding the 6700 tpsd Demonstration Plant into a 33,500 tpsd First Commercial Plant has taken into account economies of scale, existing pre-investment in the Demonstration Plant and process changes aimed toward improving the overall efficiency of operation. Consequently, the First Commercial Plant is not a direct train by train addition to the Demonstration Plant. Differences between the Demonstration and First Commercial Plants include changes dictated by layout considerations and use of common process units wherever operability has been previously proven. Whereas the Demonstration Plant incorporates designs for operation over a wide range, the First Commercial Plant is designed to operate within narrower limits, determined by analysis of information gathered from the operation of the Demonstration Plant.

The number of trains for the First Commercial Plant is summarized in Table 6-1. This table compares the number of trains in each of the Demonstration Plant areas with those required for expansion to the First Commercial Plant. The multiple train basis envisioned for the First Commercial Plant is described in Section 3.3.

6.2 PROCESS SYSTEMS

Process differences from the First Commercial Plant and the Demonstration Plant are detailed in the following sections.

6.2.1 Area 11 - Dissolver Plant

Each of the two expansion Area 11 trains consist of a single slurry mixing system, four dissolver charge heaters, two dissolvers, and two high and two low pressure heat exchange and letdown lines whose flows combine into a single line after cooling. Mechanical design limitations established the

TABLE 6-1

TRAIN BASIS - FIRST COMMERCIAL PLANT

AREA NO.	FIRST COMMERCIAL PLANT AREA	------NUMBER OF TRAINS/AREA----- DEMO PLANT	EXPANSION	FIRST COMMERCIAL TOTAL
11	Dissolver Plant	1	2	3
12	Hydrogen Treating and Recovery Plant	1	1	2
21	Syngas Production Plant	1+1 spare	4	5+1 spare
22	Syngas Shift Conversion Plant	1	1	2
23	Hydrogen Purification & Compression Plant	1	1	2
25	Methanation Plant	1	1	2
26	Syngas Purification Plant	-	1	1
27	H_2/CO Separation Plant	-	1	1
31	Low Pressure Gas Compression & Treating Plant	1	1	2
32	Product Gas Plant	1	1	2
33	Sulfur Recovery Plant	1	1	2
34	Refining Plant	1	1	2
35	Hydrodesulfurization Unit	1	1	2
41	Ammonia Recovery Plant	1	1	2
42	Tar Acids Recovery Plant	1	1	2
43	Waste Water Reclamation Plant	1	1	2
44	Oxygen Plant:			
	Air Compression	2	4	6
	O_2 Production	1	2	3
	O_2 Compression	1	3	4
51	Steam Generation System	1	1	2
52	Raw Water System	1	1	2
53	Cooling Water System	1	1	2
54	Misc. Distribution Systems	1	1	2
55	General Plant Facilities	-	-	-

NOTE: The process train concepts for the First Commercial Plant differ from those of the Demonstration Plant in several areas. Refer to the descriptions in the following sections for specific configurations.

number of parallel dissolvers required for the expanded plant and, thus, influenced the entire Area 11 train concept. The number of dissolvers determined the number of required parallel equipment trains with consideration of maximum-size fabrication limitations for selected equipment items.

The additions to the plant include only two slurry charge tanks, i.e., one tank for each pair of commercial size dissolvers. The capacity of a single commercial charge tank is twice that of the Demonstration Plant tank. Two charge tanks for the expanded plant were selected in order to minimize the number of tanks. The larger vessels will still allow adequate mixing of the coal slurry, preventing solids settling and plugging. Each commercial slurry charge tank is independent with its own vapor recovery system and circulation pump.

The charge pump system configuration for the First Commercial Plant is based on the low pressure slurry feed pump from each charge tank supplying a common suction header feeding four operating Rocketdyne multi-stage centrifugal dissolver charge pumps. Centrifugal pumps were chosen over reciprocating type pumps (used in the Demonstration Plant design) to reduce pump cost for the First Commercial Plant since fewer charge pumps are required with centrifugal type units. There is also a potential reduction in maintenance with centrifugal pumps. The expanded plant pump system is a proprietary Rocketdyne design with each pump designed to provide 3550 gpm at 2350 psi differential pressure. One common spare charge pump is provided and is connected to the manifolded suction and discharge headers of the operating pumps.

Each dissolver charge heater in the First Commercial Plant can accept coal slurry fed from either commercial slurry charge tank via the charge pump manifolding system. The expanded plant design incorporates two demonstration size charge heaters per dissolver as two units were considered equivalent to the cost of a single large heater for each dissolver. The expanded plant heater design is based on proprietary information from Kinetics Technology International with each commercial charge heater designed to burn fuel gas. The radiant section heats the slurry and the convective section heats hydrogen-rich gas, superheats high pressure steam, and preheats combustion air.

The plant expansion is designed with two trains of two dissolvers each with each commercial vessel having twice the capacity of a single Demonstration Plant dissolver. Determination of the number and size of the commercial dissolvers resulted from mechanical design considerations.

There are two high and two low pressure heat exchange and pressure letdown lines in the commercial expansion. The high pressure and low pressure heat exchange and letdown flows combine into a single line per train. The line concept was dictated by the selected number of dissolvers. The dissolver downstream equipment is sized for twice the demonstration plant service capacity, which is within present fabrication capability.

The emergency dump system for the plant expansion has the capability of receiving the vapor and liquid contents of one commercial dissolver based on one hour of normal operating flow. The received gas is sent to flare while the received liquid is sent to the Mineral Residue Slurry (MRS) holding tank.

6.2.2 Area 12 - Hydrogen Treating and Recovery Plant

With the exception of the DEA contactors, the Hydrogen Treating and Recovery Plant consists essentially of a single train of equipment. As a point of preference, two 12' ID DEA contactors which can be shop fabricated are selected over a larger single vessel which would require field fabrication.

Two 50 percent capacity hydrogen recycle compressors have been included in the First Commercial Plant design. Since Area 12 has only a single train of equipment and it is required that a continuous supply of hydrogen be made available to each of the four commercial dissolvers, two operating hydrogen compressors have been used to provide greater reliability and turndown.

A single high pressure cold box containing both single and parallel equipment is provided for the First Commercial Plant. The increased commercial gas flows can still be handled in a single field erected unit of Air Liquide proprietary design. The commercial cryogenic unit will normally process 413 MMscfd with about 91 percent hydrogen recovery.

Methane rich gas from Area 12 is compressed via the Methane Offgas Compressor to approximately 920 psia before flowing as feed to the methanation unit. In order to provide turndown and service reliability and to assure continuous methanator feed flow, two 50 percent capacity compressors are used.

6.2.3 Area 21 - Syngas Production Plant

The First Commercial Plant expansion requires four additional gasifiers for a total of six (five operating with one spare). Each new gasifier unit includes feed, lockhopper and gas scrubbing equipment identical in design to those employed in the Demonstration Plant.

Common heat exchange, liquid degassing and solids handling trains serve each pair of gasifiers. The operation of the gasifier solids handling systems is sequenced to allow each train to serve two gasifiers. Transfer of solids is done intermittently.

The heat exchange systems as well as the degassing equipment are sized at twice the duties of the Demonstration Plant.

The Commercial Syngas Production Plant produces 4.31 times as much synthesis gas as was produced in the Demonstration Plant. This reduced yield per ton of coal throughput is due to a change in processing basis wherein a more concentrated mineral residue slurry is fed to the gasifiers.

The relative amount of slag produced per ton of coal feed by the Syngas Production Plant remains unchanged from the Demonstration Plant.

6.2.4 Area 22 - Syngas Shift Conversion Plant

The expansion facilities incorporate the addition of a single processing train. The new train is identical in process sequence to that of the Demonstration Plant but larger in size to meet the new plant hydrogen demand. The new reactors are spherical to reduce the vessel cost for these larger units.

The overall unit produces only 4.22 times as much hydrogen as the Demonstration Plant. The additional hydrogen required is produced by the H_2/CO Separation Plant, Area 27. As with the Demonstration Plant, process designs are based upon information supplied by Haldor Topsoe.

6.2.5 Area 23 - Hydrogen Purification and Compression Plant

Within the Purification Plant, an additional Benfield train is added to meet the increased capacity of the First Commercial Plant. Overall, the process utilizes a single train concept. Due to the large vessel sizes required, the new Benfield Unit includes two parallel absorbers and three regeneration columns.

Two absorbers are required because a single unit sized for commercial throughput would not be practical due to the high weight resulting from a heavy wall thickness. Three regenerators are required to keep the vessels to a practical size.

Each absorber is preceded by a single train of shift gas coolers and liquid knockout vessels.

Within the Compression Plant, the most significant revision is to the original Demonstration Plant hydrogen compressor. To meet the increased capacity of the expanded plant, the compressor has been mechanically modified using the original frame with replacement of the original rotor. An additional turbine driver is added. To pick up the remaining 50 percent gas load, a second new three-stage machine has been added.

6.2.6 Area 25 - Methanation Plant

One additional methanation train is added that is identical in overall process configuration to the original unit, but increased in size. The commercial system has an overall reduced gas production (per ton of feed coal) as there is less feed gas for methanation. (Refer to previous discussion in Section 6.2.3.) A higher percentage of unshifted synthesis gas is used as plant fuel gas in the commercial design resulting in reduced relative pipeline gas production. The total production rate of pipeline gas is 143 MMscfd for the commercial design and 46.7 MMscfd for the demonstration design.

6.2.7 Area 26 - Syngas Purification Plant

The Syngas Purification Unit for the Demonstration Plant (Area 24) is replaced with a complete new single train Benfield Hi-Pure Unit. The new Benfield system provides high purity hydrogen to the Dissolver and Methanation Plants.

Due to the higher feed gas purity required by the Area 27 H_2/CO Separation Plant, the Hi-Pure System has been designed to treat gas to a more severe specification. The design basis calls for concentrations of 2 ppmv total hydrogen sulfide and 200 ppmv carbon dioxide in the treated gas.

6.2.8 Area 27 - H_2/CO Separation Plant

Area 27 is a complete new processing area. There is no counterpart within the Demonstration Plant. A single cryogenic processing train is provided. The inclusion of this unit is based on requirements for providing flexiblity in handling variations in coal feed.

6.2.9 Area 31 - LP Gas Compression and Treating Plant

Item C.31.201, the Vapor Recovery Compressor, is changed to a steam turbine driver instead of an electric motor driver as its size is over 250 hp in the First Commercial Plant.

Noncondensing steam turbines discharge to a pressure of 35 psig instead of 75 psig since the low pressure steam header pressure in the First Commercial Plant has been established at 35 psig. In addition, Item E.31.107, the LP Amine Regenerator Reboiler, has been changed from 75 psig steam pressure to 35 psig for the same reason.

Air coolers are used in some services to cool process streams to 150°F prior to water cooling in order to reduce the overall cooling water demand. Air cooled services include:

(1) A.31.201 LP Gas Compressor Discharge Precooler
(2) A.31.202 LP Regenerator Overhead Precooler
(3) A.31.203 LP Lean Amine Precooler

6.2.10 Area 32 - Product Gas Plant

Naphtha is now planned for use as the main plant fuel in the Demonstration Plant, with all of the Area 32 sweet gas (after dehydration) processed in the deethanizer and depropanizer facilities.

Fuel gas is the main plant fuel in the First Commercial Unit. Two-thirds of the plant fuel demand is provided by dehydrated sweet gas. This amount is about 62 percent of the total sweet gas produced within the Commercial Plant. The remaining 38 percent is processed in the deethanizer and depropanizer sections in Area 32.

The feed to the deethanizers consists of sweet gas from the Area 32 dehydration facilities and an ethane-rich stream from the cold box in Area 12, Hydrogen Treating and Recovery Plant. The ethane-rich stream in the First Commercial Plant is approximately four times that of the Demonstration Plant. However, the commercial sweet gas stream has had 62 percent of its flow removed as plant fuel gas with the remaining portion sent to the Demonstration Plant deethanizer. Due to the fuel gas demand, the remaining portion (feed to the First Commercial Plant deethanizer) does not amount to four times the

Demonstration Plant deethanizer feed. Consequently, combining this stream with the ethane-rich stream results in a different deethanizer feed composition relative to the Demonstration Plant. This has caused process design changes within the plant relative to the Demonstration unit.

Overhead condensing temperature in the deethanizer is -20°F in the First Commercial Plant instead of -33°F because of the change in feed composition. In addition, the refrigeration temperature is -30°F in the First Commercial Plant instead of -42°F for the same reason.

The steam turbine drivers on C.32.204, Deethanizer Refrigerant Compressor, and C.32.205, Deethanizer Offgas Compressor, discharge to 35 psig instead of 75 psig since the low pressure steam header in the First Commercial Plant operates at a lower pressure. Reboiler steam for the deethanizer and depropanizer is 35 psig instead of 75 psig for the same reason.

Aerial cooler A.32.201, Deethanizer Feed Compressor Discharge Precooler, has been added to cool the process stream to 150°F prior to water cooling in order to reduce cooling water requirements.

Heat exchangers E.32.206, Deethanizer Feed Compressor Interstage Cooler and E.32.114, Depropanizer Bottoms Product Cooler, have been deleted and have been replaced by aerial coolers A.32.202 and A.32.203 in the same process service in order to reduce cooling water requirements.

6.2.11 Area 33 - Sulfur Recovery Plant

The absorber-stripper section of the SUPERSCOT Unit uses two trains as information provided by the process licensor (Shell Development) indicates the absorber diameter should be limited. To accomplish this, two trains are employed. Two strippers are also used to limit the size of the stripper reboilers.

The First Commercial SUPERSCOT Unit incinerator offgas contains 230 ppmv total sulfur dioxide to limit total sulfur emissions. The performance is dependent on the number of absorber stages and the solution circulation rates. The Demonstration Plant unit required fewer absorption stages and lower circulation rates to control total sulfur emissions for a smaller throughput capacity.

The sulfur condensers in the new Claus Unit and the SCOT waste heat boiler produce 50 psig rather than 75 psig steam due to a change in steam header pressure in the commercial design.

The lean solution pumps, the chilled brine pumps and the combustion air blower in the SUPERSCOT Unit are steam turbine driven since they are all over 250 hp. The common spare pumps for each service are electric motor driven. The steam turbine driver for the combustion air blower in the Claus Unit discharges to 35 psig instead of 75 psig due to the steam header revised pressure.

An aerial cooler has been used for the SCOT Unit solution stripper overhead to reduce the temperature to 150^{o}F prior to water cooling in order to reduce water demand.

6.2.12 Area 34 - Refining Plant

Three air coolers have been added to the First Commercial Plant process services to cool the lean oil product, the first stage vacuum flash overhead and the untreated naphtha product. These changes were made to comply with the overall commercial design basis of precooling to 150^{o}F to reduce cooling water demand. These changes result in a reduced cooling water requirement of 4,320 gpm.

A two-stage vacuum flash unit is planned for the First Commercial Plant. The first stage flash runs at approximately 3.5 psia, and the second stage at 0.2 psia. The advantages of the two-stage flash are as follows:

(1) A reduction in the overhead vapor line sizes (approximately 70 inches in the Demonstration Plant).

(2) More available pressure drop in the first stage for solids de-entrainment.

(3) Eliminating the need for a solids de-entrainment device in the second stage vessel (the majority of the flash vapors are removed in the first stage).

(4) To allow condensing the second stage overhead at a higher temperature to facilitate pumping and handling.

The final cooling water exchanger in the second stage overhead vapor line has been eliminated because of the higher condensing temperature achieved in the two-stage flash design. The higher temperature is advantageous as noted in Item 4 above.

It is assumed that the Demonstration Plant will define the solids carry-over problem, if any, and if needed, design changes can be made to the First Commercial Plant to produce the solids-free oil. If special designs are needed to produce a solids free flushing oil these can be added later to the First Commercial Plant design and are expected to have a minimal cost impact on total plant cost.

The solids wash column in the Demonstration Plant is also used to rerun diluted mineral residue slurry (MRS) prior to feeding the MRS to the Texaco Gasifier. If more rerun capability is required in the First Commercial Plant and if the solids wash design is not required, a separate rerun system can be added later. This additional equipment will have a minimum effect on the First Commercial Plant cost.

A mineral residue slurry (MRS) dilution tank and pump is provided for each dissolver in the First Commercial Plant. This is done to facilitate pumping and handling of the slurry to the dilute MRS holding tanks during normal shutdown operations. The design provides a system to mix dissolver system liquid and solids with dilution solvent to dilute and cool the dump material.

The MRS Heater is sized on the basis of the Texaco Gasifier startup requirement. The startup heater in Area 21 is eliminated in the First Commercial Plant design.

The Lean Oil Pump and the Fractionator Reboiler Pump are steam turbine driven. Spares for these services are electric motor driven.

6.2.13 Area 35 - Hydrodesulfurization Plant

Two air coolers are added to the First Commercial Plant for HDS product and HDS stripper overhead cooling. These changes were made to maximize the use of air coolers to reduce cooling water requirements.

The HDS Feed Pump and HDS Recycle Compressor are steam-turbine driven in the First Commercial Plant. The spare HDS Feed Pump is electric-motor driven.

6.2.14 Area 41 - Ammonia Recovery Plant

A second train is added as part of the commercial expansion facilities with no change to the overall process basis. The new train is larger; sized for the increased flows.

6.2.15 Area 42 - Tar Acid Recovery Plant

The process used in the expanded plant is identical to that used in the Demonstration Plant. A single train of larger equipment is utilized except three extractors operating in parallel are required. Based on information from Chem-Pro Equipment Corporation (Process Licensor) the extractors available at the present time are limited in size.

6.2.16 Area 43 - Waste Water Reclamation Plant

A Resources Conservation Company brine concentrator has been substituted for the evaporator used in the Demonstration Plant. The brine concentrator consumes less steam than the evaporator, and is more adaptable due to the inclusion of proprietary chemical scaling and corrosion inhibiting measures in the system.

The brine concentrator concentrates a waste stream composed of miscellaneous process wastes plus rainwater runoff, devil liquor, vacuum filter filtrate, belt filter filtrate and Texaco gasifier blowdown. It is felt that the size and cost of this brine concentrator system can be reduced when more chemical analysis information on the component streams is available. Demonstration Plant experience will provide significant input to the design of this system for the First Commercial Plant.

A flotation unit has been substituted for the oil skimmer used in the Demonstration Plant. The flotation process offers additional flexibility in removing differing types of oil and in breaking oily emulsions.

A belt filter press has been incorporated into the First Commercial Plant design, replacing the incinerator used in the Demonstration Plant. A belt filter press system will be used to dewater the high and low quality brine concentrator concentrate and the raw water clarifier blowdown. Sludge dewatered by the filter press will be transferred directly to a disposal site, thus eliminating the incinerator.

Another associated difference is in the handling of the raw water clarifier blowdown. In the Demonstration Plant, this blowdown was concentrated by evaporation and the dry sludge disposed. In the First Commercial Plant, the clarifier blowdown is fed to the belt filter press for dewatering with the filtrate returned to the raw water reservoir and the cake transferred to the slag disposal area.

Utilization of the belt filter press as opposed to evaporation results in substantial energy and capital cost savings.

6.2.17 Area 44 - Oxygen Plant

An additional 7100 ton per day (tpd) of oxygen is required for the expansion making a total of 9600 tpsd total oxygen requirement for the First Commercial Plant. An additional 7100 tpd of oxygen is required for the expansion. The Demonstration Plant air compressors and oxygen cold box are rated at 2500 tpd oxygen production. During Demonstration Plant operation, they normally operate at about 2200 tpd output, but during commercial operation, the air compressors and cold box operate at 2500 tpd capacity. Two 3550 tpd cold boxes are included in the expansion. Four gas turbine air compressors supply air for 7100 tpd oxygen production. Three additional oxygen compressors are utilized for compressing the oxygen for use in the gasifiers.

Two air compressors are provided for the Demonstration Plant; one rated at 60 percent capacity and the other rated at 40 percent capacity. The 60 percent capacity compressor allows operation of the cold box at its minimum turndown of approximately 60 percent. This allows operation of a single dissolver with minimum reduction in compression efficiency. The 60 percent capacity compressor is steam-turbine driven. The 40 percent capacity air

compressor is driven by a hot gas expander and a helper steam turbine. Power is recovered from high pressure syngas prior to being burned as fuel. In the First Commercial Plant operation, less syngas is available as fuel than in Demonstration Plant operation. The existing expander is retained and operated at about 85 percent load during First Commercial Plant operation.

Four 28,000 horsepower air compressors, each gas-turbine (operating on syngas fuel) driven, are provided in the expansion. Waste heat boilers generating 650 psig saturated steam from gas turbine exhaust gas are included. The system of gas turbines plus waste heat boilers is utilized in the expansion to give a higher plant thermal efficiency than would be achieved by generating additional steam in the power boiler.

Air compressors larger than 28,000 horsepower are available; however, the 28,000 horsepower compressors were selected as they fit well with available gas turbines. Larger gas turbines in the 80,000 horsepower range are available, but do not match up with the 112,000 horsepower air compression requirement. The four compressors provide flexibility in the event of reduced plant capacity. Also, in the event a gas turbine or air compressor is down for a prolonged period, only about 18 percent oxygen production is lost from the First Commercial Plant operation.

Two 3550 tpd oxygen cold boxes are provided in the expansion. (The Demonstration Plant cold box is 2500 tpd). The 3550 tpd cold boxes are larger than presently available, but should be available by the time the plant is expanded. The two 3550 tpd oxygen cold boxes were selected based on lower capital and maintenance costs compared to three smaller units.

The Demonstration Plant contains 2500 tons of liquid oxygen storage (approximately one day) to allow for minor expected cold box outages and minor compressor maintenance time. In the expansion, 5000 tons of additional storage is provided as back-up oxygen to gasification. The liquid oxygen

storage for First Commercial Plant operation was determined after review of gas turbine inspection and maintenance requirements. As gas turbines normally require scheduled down time for routine inspections and maintenance, the additional 5000 tons of storage (7500 tons total) allows approximately four days down time for one gas turbine air compressor unit.

Three additional oxygen compressors identical to the Demonstration Plant compressor are provided in the expansion. The Demonstration Plant oxygen compressor is a prototype machine that will be proven during Demonstration Plant operation. The compressors are identical to enable a proven design to be installed in the expanded plant. Larger oxygen compressors could possibly be provided in the expanded plant but would probably have to be demonstrated in First Commercial Plant operation.

6.2.18 Unit 60 - Coal and Slag Systems

Significant Differences

(1) The coal handling system has been enlarged by the addition of facilities to receive and unload coal delivered by barge.

(2) Additional conveying, crushing, sampling and stockpile facilities are provided in the expansion.

(3) The First Commercial Plant expansion provides for 30 days of active coal storage and requires an enlargement of the Coal Storage Area to store an additional 944,000 tons of coal for a total of 1,180,000 tons of storage including the Demonstration Plant.

(4) A bucket-wheel reclaimer has been added to reclaim coal from the stockpile at a rate of 1600 tph for plant feed.

6.3 UTILITIES

In general, the utilities for the First Commercial Plant are the same in concept as those for the Demonstration Plant. The few differences are due to the larger sizes required, or to changes in the process areas affecting utility consumption. The major exception is the fuel system where the type of fuel has been changed. Utility differences are discussed by area in the following paragraphs.

6.3.1 Area 51 - Steam

Steam production and distribution for the First Commercial Plant is similar to that of the Demonstration Plant except for the following items:

(1) The required capacity of the 1500 psig power boiler has not increased in proportion to plant capacity. A major reason for this is the substitution of gas turbines with heat recovery (combined cycle) for the steam turbines driving the Oxygen Plant air compressors. This change has a twofold effect, in that it decreases the requirement for 1500 psig steam while increasing the supply to 600 psig steam. Other major contributors include the change in product yields, the change to vapor compression evaporation instead of steam-heated double effect evaporation for waste water reclamation, and improved waste heat recovery in the process areas which is made practical by the larger sizes of the commercial equipment and by reduction of the lowest steam level to 35 psig. The expanded plant requires one additional power boiler which is about 15 percent larger than the Demonstration Plant boiler.

(2) In the Demonstration Plant, the bulk of the low pressure steam was produced at 75 psig, and a smaller amount at 50 psig. These pressures were established to be compatible with the numerous steam jet ejectors used in the plant. In the First Commercial Plant, the 50 psig system and a small 75 psig system are retained for the ejectors, but the main header pressure is dropped to 35 psig. This change provides improved low level heat recovery, and also increased horsepower recovery from the extraction and topping turbines. Design modifications will be made later to isolate or eliminate dirty condensate from the clean condensate system.

6.3.2 Area 52 - Raw Water

The raw water requirement does not increase in proportion to plant capacity primarily because the major water consumer, the cooling water system, does not increase in proportion (as discussed below for Area 53). Also, the water balance calculation procedure was revised to better account for reuse of reclaimed water. The calculated raw water requirement is only 12,453 gpm, which is substantially below the 20,000 gpm available at the site.

The only significant change for the boiler feedwater demineralizer is in the sparing philosophy. The Demonstration Plant demineralizer has one spare train, equivalent to 100 percent spare. The First Commercial Plant demineralizer also has one spare train, but it is equivalent to only 25 percent of the required load.

6.3.3 Area 53 - Cooling Water

The process cooling tower has not increased in proportion to the plant capacity because process heat recovery is improved and because additional air cooling is utilized. A single new mechanical draft cooling tower is added, approximately two and one-half times the duty of the process cooling tower in the Demonstration Plant. A natural draft, hyperbolic tower was considered, but rejected because the lowest practical cooling water temperature was somewhat higher than had been assumed in sizing the process area water coolers. Also, preliminary economics showed only a marginal payout for the higher initial cost of the hyperbolic tower.

The utility cooling tower has not increased in proportion to plant capacity because of the change in oxygen consumption and because the drivers for the Oxygen Plant air compressors are changed to gas turbines, thus eliminating the need for several large surface condensers on the steam turbine exhausts. A single new mechanical draft cooling tower is added of a size approximately two and one-half times the duty of the utility cooling tower in the Demonstration Plant.

6.3.4 Area 54 - Miscellaneous

The naphtha fuel system is deleted from the First Commercial Plant. This change comes about because the much larger volume of naphtha makes it practical to market this somewhat unusual material. The deficit in the plant fuel supply created by the elimination of the naphtha fuel is filled by two new gaseous fuels, CO-rich gas from Area 27 and hydrocarbon-rich gas from Area 32.

The clean hydrocarbon flare is not expanded because the stack included in the Demonstration Plant design was found to be oversized and adequate for the First Commercial Plant.

A new firewater storage tank is provided for the expanded storage area near the river. New firewater pumps are also provided.

New firewater pumps and a foam system are added to the process area to accomodate the large tanks added for pipeline shipment of mixed fuel oil and naphtha.

No new firewater storage tanks or pumps are required for the expanded coal handling area. However, the firewater grid system is expanded.

6.4 STORAGE AND SHIPPING

There are three changes in Product Storage and Shipping in converting from the Demonstration Plant to the First Commercial Plant.

First, additional storage facilities are added. Second, the method of shipping the liquid products is changed. The volume of liquids to be shipped in the First Commercial Plant is over five times that of the Demonstration Plant. This volume increase required using not only tank trucks and rail cars, but also pipeline. The Demonstration Plant shipped mixed fuel oil and some treated fuel oil by rail car and all other products by tank truck. The

First Commercial Plant ships mixed fuel oil and naphtha by pipeline, while treated fuel oil, propane, butanes and ammonia are shipped by rail car. The tar acids) are shipped by tank trucks. Third, sulfur will be stored in a heated storage tank (70' dia. 40' height). A heated line is provided to transfer molten sulfur from the plant area to the storage tank, for tank car shipment.

SECTION 7

OPERABILITY AND TECHNICAL RISK

7.1 INTRODUCTION

Because the First Commercial Plant will include to a large extent the same processing units as the Demonstration Plant, many operability and technical risk aspects of SRC-II technology will have been resolved prior to the First Commercial Plant operation. In other words, with a successful demonstration the operability and risk of the First Commercial Plant will be measurable and known. However, due primarily to the increased scale of operation for the First Commercial Plant and selected process changes, there are some technical features that may present some risk or operational uncertainties for the First Commercial Facility. This section of the report presents a review of selected operability/risk topics.

In general, no detailed engineering evaluations have been undertaken on risk and operability with the exception of questions pertaining to the design and fabrication of the Area 11 dissolvers. A somewhat detailed discussion is included for the dissolver to answer to specific technical questions.

Several qualifications exist. First, because the designs for the First Commercial Plant are not definitive, they generally are not of sufficient depth to enable precise or detailed evaluations to be undertaken on many process features such as operational ranges, upset or contingency operation, overall system control, details relative to startup and shutdown, etc. Second, features of the plant that are considered to be proven technology have not been covered with respect to operation or risk. Third, although many major process system alternatives to those of the Demonstration Plant have been explored as part of the design effort, alternatives to minor systems have not been reviewed.

7.2 AREA 11 - DISSOLVER PLANT

In the First Commercial Plant, the Area 11 Dissolver Plant design involves several risks as discussed in this section. The magnitudes of the risks associated with Area 11 equipment design and operation will be related directly to test experience in the operation of the SRC-II Demonstration Plant. Using extensive instrumentation for Area 11 in the Demonstration Plant will significantly reduce risks associated with this area and will provide a detailed data base of physical property information at SRC-II flow conditions. Knowledge of process transients will be obtained. This data base can be used to provide scale-up design factors for the expanded plant serving to minimize design and operating risks.

7.2.1 Dissolver Design and Fabrication

Specific areas pertaining to the dissolver design and fabrication are listed below.

7.2.1.1 Materials of Construction

The dissolver vessels are to be fabricated from 2-1/4 Chrome - 1 Moly material with an internal weld overlay of Type 347 stainless steel. The base material was selected using the Nelson Curves which establish operating limits for steels in hydrogen service at elevated temperatures and pressures. No allowance was made for any reduction in hydrogen concentration at the inside surface of the base metal due to the presence of the stainless steel weld overlay. Preliminary results of current research indicate that this is a conservative approach.

7.2.1.2 Wall Thickness

The maximum thickness 2-1/4 Chrome - 1 Moly material which can be produced by the steel mills is determined by the required minimum cooling rate at the center of the material necessary to obtain the required physical properties.

Tests indicate that this minimum cooling rate limits the material thickness to approximately 18 inches. If a vessel fabrication forming allowance of 1/2-inch is maintained, the maximum design thickness for the dissolvers is limited to approximately 17-1/2 inches.

7.2.1.3 Maximum Diameter

The ASME Code allowables for normalized and tempered material, Class 2, are too high for thick material since these allowables are based on average values rather than minimums. Multiple, long post weld heat treatments cause the mechanical properties to drop toward the properties for annealed material, Class 1. For the Demonstration Plant, the ASME Pressure Vessel Code, Section VIII, Division 1 stress allowables for annealed material have been conservatively used. The vessel thickness can be reduced and/or the inside diameter can be increased if better properties can be guaranteed based on testing which is currently underway.

7.2.1.4 Internal Insulation

Larger diameter vessels and/or vessels with thinner walls are possible also if internally insulated vessels are used. However, an insulation must be found which is impervious enough to prevent coke build-up behind the insulation. This coke build-up could cause spalling of the lining. Lowering the vessel wall temperature below the creep range would result in significantly improved material allowables. Also, the Nelson Curves would permit the use of lower alloy materials at lower temperatures, which could result in a significant cost saving for these items.

7.2.1.5 Material Availability

Lukens Steel Company is the only domestic steel mill which produces 2-1/4 Chrome - 1 Moly material in heavy plate thicknesses. Lukens can produce a plate which has a maximum thickness of 15 inches. Heavy 2-1/4 Chrome - 1 Moly material is produced by two steel mills overseas with Japan Steel Works producing plate and forgings and Marrell of France producing plate only. Both foreign mills have the current capability for producing material 18 inches thick.

7.2.1.6 Fabrication

There are three domestic vessel fabricators which have significant experience in the fabrication of large heavy-walled vessels. They are Combustion Engineering, Chicago Bridge & Iron and Babcock & Wilcox. All of these fabricators have fabricated and welded plates with thicknesses greater than 20 inches. The procedures for welding this material will vary from fabricator to fabricator since there are several weld procedures which can be qualified in accordance with the ASME Code. These procedures will vary depending on whether the final assembly is made in the shop or in the field. Experience has shown that a high quality vessel can be produced in either the shop or the field. Nuclear reactors which require the very highest level of quality have been assembled in the field with no reduction in level of quality compared to shop fabrication. In addition, to the companies mentioned above there are foreign fabricators such as Japan Steel Works experienced in heavy-walled vessel fabrication.

7.2.1.7 Fatigue Analysis

It is intended that the dissolver vessels will be designed, fabricated, inspected, tested and stamped in accordance with Section VIII, Division 2 of the ASME Pressure Vessel Code. This Division of the Code requires that vessels with a design temperature greater than 700^{o}F be exempted from a fatigue analysis in order to qualify for stamping to Section VIII, Division 2. It appears that all requirements for exemption from a fatigue analysis can be met. However, if it is later found that the vessel cannot be exempted from a fatigue analysis due to a loading condition not foreseen, the vessel can be stamped Section VIII, Division 1. In this case, all design fabrication, inspection, and testing would be in accordance with Section VIII, Division 2. The required fatigue analyses would be performed in accordance with Code Case N-47 which is permitted by Division 1. All mandatory requirements of Division 1, such as allowable stresses, would be met.

7.2.1.8 Shipping

The feasibility of barge shipping a totally shop fabricated dissolver vessel to the jobsite is dependent on the maximum barge size which can navigate the river and the minimum channel depth and the minimum height clearances for obstructions crossing the river. Preliminary investigations would indicate that the maximum size barge which can pass through the locks on the Ohio and Monongahela Rivers would displace a depth of water too close to the minimum depth of the channel to be acceptable when loaded with a commercial plant size dissolver. Thus, it appears that the larger dissolver would have to be shipped in a minimum of two pieces with at least some field fabrication required.

Heavy rigging Contractors such as Neil F. Lampson, Inc., have indicated that it would be feasible to transport overland and to lift the completed commercial size dissolver. This gives some flexibility in performing the required field fabrication. The vessel can be completed in the horizontal position on the ground and then lifted into place, or else it can be completed in the vertical position on the foundation. As stated previously, a high quality vessel can be obtained with either method of final fabrication.

7.2.1.9 Post Weld Heat Treating

The technology currently exists for performing the necessary post weld heat treatment required by the ASME Code in either the shop or the field. Vessels larger in size have been post weld heat treated in the field with complete success. This post weld heat treatment can be performed on the whole vessel at one time or on individual welds depending on specific job requirements.

7.2.1.10 Radiographing

Equipment for radiographing material in the 18 inch thickness range is currently owned by all fabricators capable of performing the fabrication required for the dissolver. Linear accelerators have been used on thicknesses up to approximately 26 inches. Methods of shielding have been developed which

will safely protect the workers and residents in the surrounding area and the environment. The methods have been used safely for several years in all fabrication shops involved in heavy-walled vessel fabrication.

7.2.2 Dissolver Charge Pumps

The design basis for the First Commercial Plant specifies the use of Rocketdyne centrifugal dissolver charge pumps. Currently this pump is not commercially available, but is under development as part of an Electric Power Research Institute and United States Department of Energy research and development program. Rocketdyne's design criteria calls for a pump system slurry delivery rate of 5000 gpm at a discharge pressure of 3000 psig. To meet this requirement Rocketdyne utilizes two pumps.

The Rocketdyne pump was selected for the First Commercial Plant as the total dissolver charge requirement is 17,750 gpm for the four new dissolvers. Using the Demonstration Plant plunger pumps would require 20 pumps with an appropriate number of spares. Plunger pumps were not considered a good selection for the First Commercial Plant due to the large number of pumps required and potential problems associated with reliability and high maintenance. The plunger pump system would prove extremely awkward for commercial operation.

The Rocketdyne pump is a prototype design and is beyond the commercially tested state of the art. However, if development tests with the pump are successful, it would give good potential for commercial success of the design. Rocketdyne maintains that their 2500 gpm unit can be upgraded in the future to 3550 gpm with a discharge pressure of 2400 psig. The pump selection for the First Commercial Plant assumes that Rocketdyne will be able to successfully develop their pump to meet the SRC-II duty requirements.

7.2.3 Slurry Charge Tanks

The First Commercial Plant charge tanks are 1.4 times larger in diameter than the Demonstration Plant tanks. It is probable that little technical risk will exist for the commercial charge tanks if the demonstration tank design

operability is proven. A risk does indirectly exist in regard to the commercial slurry charge tanks in that much longer slurry lines are required to convey coal from the two commerical charge tanks to the four large dissolvers. Manifolding the slurry lines is required so that coal slurry feed to the four dissolvers can come from either of the two available slurry tanks. The manifolding and longer slurry line transfers may involve an increased degree of operations risk due to possible momentary decreases in flows or increases in solids concentrations. This could result in line pluggage. An evaluation should be made to consider a separate slurry charge tank for each commercial dissolver. Thus, the commercial charge tanks would be the same size as the demonstration charge tank. Greater operating flexibility and less risk may be provided by adding two more charge tanks in the First Commercial Plant design.

7.2.4 Dissolver Charge Heaters

The First Commercial Plant design employs two Demonstration Plant-size charge heaters per commercial dissolver. Thus, proven operation of the Demonstration Plant charge heaters should minimize technical risk and operability problems associated with the commercial service. However, utilizing eight heaters in the First Commercial Plant poses some design risk and potential operating problems in regard to maintaining proper flow distribution of the coal slurry in long lines and headers to the eight charge heaters and from the heaters to the four dissolvers. A risk of line pluggage may be present in this type of design. Also, the number of slurry feedline penetrations into the dissolver should be held to a minimum to reduce fabrication problems for the dissolver vessels. Thus, for Phase I it is recommended that a further review with KTI be made to see if the charge heaters could be so designed that only one is needed for each commercial dissolver. A commercial charge heater would be twice the size of a Demonstration Plant heater. This significant scale-up in size may involve a change in design concept of the heater. However the potential problems and scale-up risks can be minimized through proper instrumentation of the Demonstration Plant charge heaters to develop sound scale-up design factors for the commercial size heaters, even if the design concept is revised for the larger units.

7.2.5 Dissolver Operation

The technical design risk and operability questions for the dissolver from a process standpoint are limited to concerns about achieving proper slurry and hydrogen mixing and flow distribution in the larger diameter vessels. It is recognized that the demonstration size dissolver will be subjected to a wide range of operating conditions because of varying coal feeds which the commercial dissolver will not experience. This will serve to produce valuable data for commercial dissolver design. Thus, the commercial dissolver should be a somewhat easier service compared to the previous operation.

7.2.6 Dissolver Effluent Separator

The large diameter, 15'-6" I.D., of the commercial effluent separator may create unpredictable flow distributions. It may be impossible during the design to predict the degree of separation possible in the large vessel. The design of the effluent separator is made difficult because the separation involves (1) a three-phase mixture, (2) large liquid volume, and (3) a need to achieve discrete liquid and gas phases from the separation. The inability to accurately predict the operating characteristics of this separator impacts on the design of all downstream equipment. Performance data from the 11'-0" I.D. demonstration separator will serve to reduce the risk for the commercial separator; however the larger vessel size will produce some design uncertainties.

7.2.7 Larger Vessels and Lines - General

The First Commercial Plant will utilize longer slurry transfer lines and large diameter vessels which must be designed with detailed attention given to maintaining proper flow rates for good flow distribution, separation, mixing, etc. It is expected that for the First Commercial Plant, the turndown capability of large equipment and line flows will be limited to keep coal slurry in suspension or solution to avoid pluggages, to keep proper flow distributions of slurry and hydrogen in the charge heaters and dissolvers (reactors), and to keep desirable flow rates of liquid and gases for proper

phase separations. Thus, there may be less flexibility in the turndown capacity of the First Commercial Plant as compared to the Demonstration Plant which should be noted when designing the commercial equipment.

7.3 AREA 12 - HYDROGEN TREATING AND RECOVERY PLANT

7.3.1 Recycle Compressor

The recycle compressors compress recovered hydrogen to 2400 psig for discharge to the dissolver. Even though these centrifugal compressors are large-scale, operation of the units in the Demonstration Plant should solve potential problems including shaft-end oil sealing with the high inlet and discharge pressures, throttling the machines to 50 percent capacity while maintaining discharge pressure and handling large amounts of hydrogen sulfide during process upset conditions.

Although compressors for the First Commercial Plant will handle twice as much volume as the Demonstration Plant, operation of the Demonstration units will serve to minimize operational risks for the commercial compressors.

7.3.2 Cold Box

The Demonstration Plant design includes a cold box sized to provide hydrogen for two dissolvers. However, the First Commercial Plant cold box is designed to provide hydrogen feed for four dissolvers, each of which has twice the capacity of a single demonstration dissolver. If a major component failure occurs within the cold box package unit, the cold box must be bypassed, producing an operability problem. The bypass operation can only be tolerated for a finite and, as yet, undetermined period. Purging of light gas impurities from the high pressure loop will help. However, the bypass operation will produce a steady deterioration in hydrogen purity. When the purity is no longer acceptable, all four commercial dissolver systems will need to be shut down. Depending upon the rate of shutdown, this may exceed the current commercial one-hour single dissolver system dump design capability.

An alternative to this design would be a multiple cold box design which may give a more reliable purification unit and a less severe dissolver pump service. It is recommended that this alternative be investigated prior to finalizing the commercial design basis.

7.4 AREA 21 - SYNGAS PRODUCTION PLANT

7.4.1 Gasifier Charge Pumps

The gasifier charge pumps are utilized to feed mineral residue slurry into the gasifiers. They operate at 700°F pumping slurry containing 48 percent solids. Due to the abrasiveness of the slurry (caused by the mineral content) combined with the high discharge pressure requirement, mechanical problems may be encountered in operating these pumps. To minimize charge pump problems with First Commercial Plant operation, identical units to those proven in the Demonstration Plant will be installed.

7.4.2 Slag Handling

The Gasification Area for the First Commercial Plant must transfer approximately 170 tons of slag per hour. The lock hoppers fill and discharge batchwise. Because of the severe service, some mechanical problems including erosion, plugging and wear and tear may be expected within the slag system. To minimize operational problems, the slag solids handling equipment for the First Commercial Plant will be identical to that proven in the Demonstration Unit.

7.4.3 Refractory Life

The gasifier refractory lining is exposed to a hostile environment of high temperature and pressure.

Preliminary information indicates that through certain design modifications, the refractory problems reported for these units have been solved. These results, plus the advantages to the commercial gasifier design of the operation of identical Demonstration Plant units, should yield a successful refractory system design for the expanded plant. It should be noted that as with typical refractory system operation in severe environments, routine maintenance of the refractory system within the gasifiers is to be expected.

7.5 AREA 22 - SYNGAS SHIFT CONVERSION PLANT

7.5.1 Catalyst Life and Catalyst Poisoning

The shift conversion process proposed for the First Commercial Plant is a so-called "dirty shift." That is, the syngas from the gasifier scrubber is shifted prior to acid gas cleanup in order to achieve heat recovery economies. The shift catalyst must therefore be tolerant to sulfur or trace element poisoning or shift catalyst life will be shortened, resulting in excessive down time and large operating expenses.

The Haldor Topsoe catalyst proposed for this application has undergone extensive pilot plant testing and has been further tested in a commercial size ammonia plant in Sweden. The catalyst has been found highly resistant to poisoning from any source and is reported to be similar to a type used successfully by BASF for "dirty shift" in a large facility utilizing heavy oil gasification producing ammonia feedstock. Because of these experiences and the Demonstration Plant test results, the shift conversion process for the First Commercial Plant should not encounter abnormal catalyst problems.

7.6 AREA 23 - HYDROGEN PURIFICATION AND COMPRESSION PLANT

7.6.1 Benfield Regenerators

Three additional Benfield regenerator towers are proposed for the First Commercial Plant additions that are identical in overall design and size to the Demonstration Plant tower. No particular operability or large performance

problems are foreseen for these large diameter units as the Demonstration Plant operation will have proven the adequacy of the design. Additionally, reviews with the Norton Company (manufacturers of column packing and internals) have indicated the large towers can be designed for effective operation without adverse effects brought about by poor liquid distribution.

7.6.2 Power Recovery Turbines

The turbine recovers hydraulic power by reducing the pressure of 15,874 gpm of acid-gas rich Benfield solution from 1,135 psig to 235 psig. This recovered power is used to drive the Lean Solvent Booster Pump in conjunction with a steam turbine driver.

Even though the horsepower for the new commercial turbine is greater than the one for the Demonstration Plant rating, the previous operation should resolve control and operational problems for this service. Thus, there should be no major technical risks associated with the larger commercial unit. The Demonstration Plant operation should have proven the suitability of corrosion resistant material exposed to Benfield solution, the control system using the steam turbine acting as a governor for speed regulation with a clutch, problems with flashing of solution, available horsepower, and coupling performance. The above problems should be solved in the Demonstration operation; however, there would still be some risk expected associated with the larger unit as a power recovery turbine of this size usually will have operational problems. The commercial unit will be an existing-design recovery turbine with slight modifications undertaken for the specified application.

7.7 AREA 25 - METHANATION PLANT

7.7.1 Methanators

There will be no unusual operability or technical risks associated with the commercial methanators as the commerical reaction system will be equivalent to the demonstration process. The change in reactor configuration from cylindrical vessels to spherical will present no significant problem in commercial operation. The methanation catalyst overall process control

including the means of limiting reactor outlet temperatures and heat rejection performance will have all been explored and resolved in Demonstration Plant testing.

7.8 AREA 26 - SYNGAS PURIFICATION PLANT

7.8.1 Benfield Hi-Pure Unit

The Syngas Benfield Purification Unit in the Demonstration Plant will be replaced with a Benfield Hi-Pure Unit for First Commercial Plant. As the Benfield Hi-Pure process represents proven technology, no unusual technical risk will be presented by this change.

7.9 AREA 27 - H2/CO SEPARATION PLANT

7.9.1 Cryogenic Unit

The Air Liquide France cryogenic separation unit is a complete new processing section for the First Commercial Plant. Even though this plant area has no direct counterpart within the Demonstration Plant, the technical risk to commercial operation is diminished for several reasons. First, as part of the engineering work associated with the Area 12 of the First Commercial Plant, Air Liquide conducted extensive laboratory experiments to develop vapor-liquid equilibrium data at 2000 psi over a broad range of temperatures. This work was specific to the SRC-II process conditions, and can be used for design of the commercial process. Second, operation of the Area 12 in the Demonstration Plant will produce actual low temperature vapor-liquid equilibrium data for the gas system that will be used for design of the new H_2/CO Separation Plant. This will improve the overall design confidence for the First Commercial Plant. Third, the upstream processing units, including Benfield and the mole sieve sections represent proven technologies and as such will yield reliably treated feed to the cryogenic unit.

To improve the operability of the H_2/CO cold box, there is a 4:1 turndown capability in the unit to meet fluctuations in plant hydrogen demand.

7.10 AREA 32 - PRODUCT GAS PLANT

7.10.1 Deethanizer Feed, Refrigerant and Offgas Compressors

The Demonstration Plant operation of these three compressors should solve potential problems with leakage of gas at the shaft end seals and with throttling the units to 50 percent gas flow. Although the expansion compressors are larger than those of the Demonstration Plant, the previous operation of the similar smaller units will serve to minimize mechanical risks associated with the new units.

7.11 AREA 33 - SULFUR RECOVERY PLANT

7.11.1 Claus Unit

The Claus Unit will be a split-flow design. This type of design was selected because of the relatively low H_2S/CO_2 ratio in the feed to the Claus Unit. The split-flow design is sensitive to changes in H_2S content of the feed gas and is more difficult to operate than a straight-through design. To ensure good operability of the unit, instrumentation will be provided to adjust the process for hydrogen sulfide variations in the feed. Analyzers on the feed gas and tail gas streams will be provided.

Possibly a straight-through design can be used depending upon the final selection of the type of coal (sulfur content) for the commercial unit and if selective absorption (enriching H_2S content of Claus feed) is incorporated into the designs of upstream process areas.

7.11.2 SUPERSCOT Unit

The SUPERSCOT Unit will be larger than any SCOT Unit presently in operation or in design. The First Commercial Plant requires multiple trains with towers having diameters at the maximum size limit as dictated by the process licensor, Shell Development Company. Large diameter towers can have

operating problems due to non-level trays and channeling. Careful design and tray selection (possibly special trays) will avoid operating problems associated with the large diameter towers. These aspects will be resolved in final engineering.

7.12 AREA 34 - REFINING PLANT

7.12.1 Mineral Residue Slurry Storage System

The design includes equipment to allow for rundown and storage of mineral residue slurry (MRS) during upset conditions in the vacuum system and to store MRS dumped from the dissolvers. This system will handle a large quantity of material that freezes at a high temperature. To prevent freezing, the MRS will be diluted with solvent and kept hot. The storage tanks provided for storage of the diluted MRS will be located outside the process area because of their large size. The MRS will be diluted with solvent in the process area then pumped through heat-jacketed lines to the storage area. The combination of dilution with solvent and heat-jacketed lines should prevent the MRS from freezing as it is transferred to the MRS storage tanks. Diluted MRS stored in the tanks will be kept hot by recirculation through fired heaters.

7.13 AREA 44 - OXYGEN PLANT

7.13.1 Oxygen Cold Boxes

The design of the First Commercial Plant calls for the installation of two 3550 tpd oxygen cold boxes. Each unit's capacity is larger than what is currently commercially available, as the largest current cold boxes are 2500 tpd presently being erected in South Africa.

The 3550 tpd units have been included in the design anticipating that design development for large capacity cold boxes will continue. It has been assumed that 3550 tpd units will be commercially available at the time the First Commercial Plant is constructed. Assuming that the large cold boxes are available by the process licensors, the technical risk to the First Commercial Plant should be no greater than for the smaller units currently in operation.

An alternative to the two 3550 tpd cold boxes would be three nominal 2500 tpd units. This alternative was rejected for the commercial expansion due to the higher capital outlay for three units.

7.13.2 Oxygen Plant Air Compressors

The First Commercial Plant design basis calls for four 28,000 horsepower gas turbine driven air compressors. The gas turbines will be fired with sweet fuel gas having a lower heating value of 1105 Btu/Scf. The compressors, although larger than the previous demonstration units, will be standard proven-technology machines well under the maximum pressure and capacity limits for commercial units. As such, they present no significant technical risks to the First Commercial Plant.

The gas turbine units are of a size currently commercially available and are a proven design. As gas turbines do require periodic down times for inspection and maintenance, to maintain full oxygen supply; four days of liquid oxygen storage (based upon one air compressor) will be provided in the First Commercial Plant to allow for a scheduled turbine outage. With this inventory, the oxygen supply for the gasification units will be very reliable.

With good operating procedures and maintenance program, the turbine-air compressor units should not present any nontypical or significant operating problems relative to the Demonstration Plant operation.

7.13.3 Oxygen Compressors

The First Commercial Plant design basis calls for the addition of three compressors identical to the prototype three-case centrifugal machine tested in the Demonstration Plant. As such, there will be no unusual risks presented to the First Commercial Plant.

As will be required for the Demonstration Plant, effective compressor operation combined with a good maintenance program will be required to prevent compressor oxygen fires.

7.14 UNIT 50 - UTILITY SYSTEMS

All of the utility systems are conventional and utilize proven technology. As such, the utility systems for the First Commercial Plant present no unusual operating or technical risks.

7.14.1 Water Supply

The raw water availability at the site is limited to 20,000 gpm. As the calculated raw water requirement for the First Commercial Plant is only 12,453 gpm, no supply problem is anticipated.

In order to avoid a potential water supply problem, it was necessary to change several design features such that the Demonstration Plant water requirement did not increase in proportion to plant capacity. The most significant changes included the addition of air coolers to cool to 150^{o}F; substitution of gas turbines for steam turbines with surface condensers; and, process changes in the refining vacuum flash area and in the waste water reclamation area. All of these measures reduced the water evaporation loss from the cooling towers.

7.15 UNIT 60 - COAL AND SLAG SYSTEMS

7.15.1 Coal Drying and Pulverizing

The First Commercial Plant, as presently scoped, does not have a coal drying and pulverizing circuit. This exclusion limits the plant's ability to handle a variety of coals. The design coal, with a received moisture of up to 15 percent, cannot be continuously pulverized, dry-sized, handled or stored when its moisture is in excess of three to five percent. This is the typical limit for reliable handling.

The obvious solution is to add coal drying with pulverizing capability. Test work should be carried out with air swept ball or rod mills that will perform both the drying and size reduction (grinding) steps with fewer pieces of equipment than conventional pulverizer/dryer systems. This difference could amount to three or four circuits for grinding versus twelve to sixteen for pulverizing plus standby circuits in both cases.

7.15.2 Slag Handling

The First Commercial Plant as presently estimated and designed does not include standby conveyors or filters to assure 100 percent operating capability. Additional conveyors and a standby filter could be added to improve the process reliability.

Alternate methods of transporting the slag from the First Commercial Plant to the disposal area should be investigated after slag test data are received. The estimated cost of slag disposal for the First Commercial Plant is $500,000 per year (mostly labor) for trucking the slag to the disposal area. There are several alternatives depending on the quality of the slag that can be used to reduce this estimated operating cost. More work is required to resolve this item.

SECTION 8
COST ESTIMATES

8.1 INTRODUCTION

This report contains the various cost estimates prepared by Stearns-Roger for the SRC-II 33,500 tpsd First Commercial Plant at Morgantown, West Virginia, with descriptions of the methods used to prepare these estimates and the qualifications for them. The following estimates are included:

(1) Direct Capital Costs

(2) Elements of Indirect Capital Costs

(3) Elements of Annual Operating Costs

Each of these estimates is presented in November 1978 dollars.

8.2 DIRECT CAPITAL COSTS

Direct Capital Costs are those costs which would normally be incurred by the engineering/construction contractor for engineering, procurement, and construction. The Direct Capital Costs estimated by Stearns-Roger for the SRC-II 26,800 tpsd expansion of the Demonstration Plant to produce the First Commercial Plant at Morgantown, West Virginia, are presented in Table 8.2-1, broken down by areas. Table 8.2-2 presents a breakdown of this same estimate into various cost elements. The estimate was developed in November 1978 dollars. This estimate is additive to that for the 6700 tpsd Demonstration Plant estimate, to determine total Direct Capital Costs for the SRC-II 33,500 tpsd First Commercial Plant.

8.2.1 Direct Field Costs

The Direct Field Costs were developed using the Stearns-Roger Computer-Aided Preliminary Estimating System (CAPES). CAPES uses basic equipment design information and preliminary conditions of service to develop the complete installed cost for each piece of equipment, through simulation based on a volumetric model technique. The volumetric models are typical mechanical flow diagrams (P & ID's) for specific types of equipment. These models are used in conjunction with size and service data to generate material takeoffs and labor requirements for all direct field accounts. Direct field accounts include process equipment, foundations, structures and structural supports, piping, electrical, instrumentation, insulation, and painting; and they are stated in terms of direct labor, direct material, and direct subcontract costs, based on user definition. These are then priced based on user-specified material costs, labor rates and productivities, and subcontractor unit costs to determine Direct Field Costs. CAPES has the capacity to develop prices on common types of process equipment; prototype or specialized equipment items for this plant were priced using in-house information or formal vendor phone quotations. There are approximately 1,400 pieces of equipment in the plant; of these, about 1,000 pieces were priced by CAPES (40 percent of the total equipment dollars). Current union contracts (fourth quarter, 1978) for the Morgantown area were used to develop craft wage rates. Informal unit price quotations from various subcontractors in Morgantown and Pittsburgh were used. Prices for bulk materials were based on currently prevailing levels.

Preliminary quantity takeoffs were made for several items, primarily the civil, structural, and equipment accounts in Unit 60. Other preliminary quantity takeoffs made include site preparation requirements, structures, and interconnecting piping. Spread footings were assumed for all foundations. Because the actual soil conditions are unknown, no piling costs were included. Site preparation excavation costs were based on 50/50 rock/earth ratio, and foundation excavation costs were based on common earth conditions. Other than for grass seeding around the administrative offices, no landscaping costs were included. It was assumed that the costs for construction or improvement of the main access roads to the site would be borne by others. No

costs for infrastructures have been included, such as for schools, hospitals, and recreational facilities which would be required to support construction, operation, maintenance, and administrative work forces. Incoming power to the main plant substation was assumed to be provided by others.

Several areas include battery-limits unit estimates supplied by others, in lieu of estimates built up from equipment requirements. The areas and the suppliers of the estimates, which have been assumed to be all-inclusive lump-sum subcontracts, are as follows:

(1) Area 21 - Texaco Development Corp.
(2) Area 43 - Resources Conservation Co.
(3) Area 44 - Air Liquide

The total construction labor effort is estimated to require about 18,700,000 craft hours; this includes all equipment and material installation, as well as supporting craft requirements such as warehousing, temporary facility construction, and construction equipment operation and maintenance.

8.2.2 Indirect Field Costs

Indirect Field Costs include field staff costs, field office expenses, payroll taxes, insurance, performance bonds, consumable supplies, temporary facilities, construction equipment rental, and small tools. There is a direct relationship between Direct Field Labor Costs and Indirect Field Costs; for this estimate, Indirect Field Costs were estimated at 130 percent of Direct Field Labor Cost. No precommissioning, commissioning, or start-up costs have been included.

8.2.3 Engineering Costs

Engineering Costs were estimated as a percentage of Total Field Cost (the sum of Direct and Indirect Field Costs). Markups appropriate to government projects were used. The total estimate includes approximately 4,200,000 engineering hours for the engineering/construction contractor. Various engineering subcontractors will be required during the design and engineering effort. Quotations for the Demonstration Plant were received from several

subcontractors early in 1978; others were estimated by Stearns-Roger. These costs were adjusted by Stearns-Roger for the 26,800 tpsd expansion increment, escalated to November 1978 dollars, and are assumed to be lump sum. The areas and subcontractors are as follows:

(1)	Areas 12, 32, 44	-	Air Liquide
(2)	Areas 22, 23, 25, 26, 27	-	Haldor Topsoe A/S
(3)	Area 33	-	Shell Development Corporation (Goar, Arrington & Associates, Inc.)
(4)	Area 41	-	U. S. Steel
(5)	Area 42	-	Chem-Pro
(6)	Area 55	-	Soils Test and Mapping Subcontractor

8.2.4 Other Costs

The cost estimate is based on a single-shift, 40-hour construction work week. An allowance has been made for casual overtime only (for pouring concrete, etc.). A General and Administrative Expense (per government requirements) and engineering/construction contractor fees are included. The West Virginia Business and Occupation Tax of 2.2 percent of gross receipts (total fixed capital investment) has also been included in the estimate.

SRC-II FIRST COMMERCIAL PLANT

(26,800 TPSD EXPANSION INCREMENT ONLY)

TABLE 8.2-1: DIRECT CAPITAL COSTS

(Breakdown by Areas)

	$11/78	
Unit 10 - Primary Process Plants		
Area 11 - Dissolver Plant	$ 353.100	M2
Area 12 - Hydrogen Treating & Recovery Plant	66.900	
Subtotals, Unit 10:	$ 420.000	M2
Unit 20 - Hydrogen Purification Plants		
Area 21 - Syngas Production Plant	$ 67.300	M2
Area 22 - Syngas Shift Conversion Plant	28.200	
Area 23 - H_2 Purification & Compression Plant	99.800	
Area 25 - Methanation Plant	17.200	
Area 26 - Syngas Purification Plant*	21.900	
Area 27 - H_2/CO Separation Plant	27.800	
Subtotals, Unit 20:	$ 262.200	M2
Unit 30 - Refining & Gas Plants		
Area 31 - LP Gas Compression & Treating Plant	$ 18.900	M2
Area 32 - Product Gas Plant	19.600	
Area 33 - Sulfur Recovery Plant	74.000	
Area 34 - Refining Plant	44.300	
Area 35 - Hydrodesulfurization Plant	20.800	
Subtotals, Unit 30:	$ 177.600	M2
Unit 40 - Secondary Recovery & Oxygen Plants		
Area 41 - Ammonia Recovery Plant	$ 11.500	M2
Area 42 - Tar Acid Recovery Plant	10.700	
Area 43 - Waste Water Reclamation Plant	58.600	
Area 44 - Oxygen Plant	138.100	
Subtotals, Unit 40:	$ 218.900	M2
Unit 50 - Utility Systems & General Facilities		
Area 51 - Steam Generation System	$ 29.300	M2
Area 52 - Raw Water System	23.000	
Area 53 - Cooling Water System	45.300	
Area 54 - Miscellaneous Distribution Systems	104.400	
Area 55 - General Plant Facilities	20.600	
Subtotals, Unit 50:	$ 222.600	M2
204.747 M2		
Unit 60 - Coal & Slag Systems		
Area 61 - Coal Supply System	$ 61.200	M2
Area 62 - Coal Crushing System	18.300	
Area 63 - Fine Coal Handling System	8.100	
Area 64 - Plant Slag Handling System	3.000	
Area 65 - Slag Disposal System	3.100	
Subtotals, Unit 60:	$ 93.700	M2
TOTAL DIRECT CAPITAL COSTS:	$1,395.000	M2

* Area 24 of the 6700 tpsd Demonstration Plant is replaced totally by Area 26 of the First Commercial Plant.

SRC-II FIRST COMMERCIAL PLANT
(26,800 TPSD EXPANSION INCREMENT ONLY)
TABLE 8.2-2: DIRECT CAPITAL COSTS
(Breakdown by Cost Elements)

	$11/78
I. Engineering Costs	
A. Prime Contractor	$ 85.000 M^2
B. Subcontractors	5.000
Subtotals, Engineering Costs:	$ 90.000 M^2
II. Equipment and Materials Costs	
A. Shop-Fabricated Equipment	$ 360.000 M^2
B. Field-Erected Equipment	210.000
C. Construction Materials	190.000
D. Battery Limits Units	115.000
Subtotals, Equipment and Materials Costs:	$ 875.000 M^2
III. Construction Costs	
A. Direct Field Labor	$ 145.000 M^2
B. Indirect Field Costs	180.000
C. Installation Subcontracts	75.000
D. Battery Limits Units	30.000
Subtotals, Construction Costs:	$ 430.000 M^2
TOTAL DIRECT CAPITAL COSTS:	$ 1,395.000 M^2

NOTE: All of the costs above include a pro rata share of G & A Expenses, Fees, Indeterminate, and B & O Taxes.

8.3 ELEMENTS OF INDIRECT CAPITAL COSTS

Indirect Capital Costs are those costs which are typically incurred by the owner, rather than by the engineering/procurement contractor, and which must be committed sometime during the period prior to commencement of plant operation. These elements were calculated using recognized engineering practices and are in fourth quarter 1978 dollars. Appropriate indeterminates have been included. Note that these costs include those for the Demonstration Plant, with the exception of land cost.

8.3.1 Catalysts and Chemicals

The initial charge requirements, unit costs used, and net initial costs for all catalysts and chemicals are shown in Table 8.3-2.

8.3.2 License Fees

No recent quotations were received on license fees. Prior quotes and estimates for the Demonstration Plant were escalated and adjusted as required. Table 8.3-3 presents these estimates by area and licensor.

8.3.3 Land

It was assumed that all required land would be purchased when the Demonstration Plant is constructed.

8.3.4 Working Capital

The following items of working capital have been included:

(1) Raw Coal Inventory: A 30-day supply of raw coal was assumed to be required at $25 per ton.

(2) Finished Product Inventory: A 10-day inventory of finished product was included, valued at cost (daily operating cost, without plant overhead plus the cost of raw coal at $25 per ton, based on 365 days per year).

(3) Catalysts and Chemicals Inventory: A 30-day supply of catalysts and chemicals was included, based on the annual replacement cost.

(4) Spare Parts and Maintenance Materials Inventory: This inventory cost was calculated at 3 percent of total capital equipment cost.

(5) Cash

(6) Work in Progress

(7) Accounts Receivable

(8) Accounts Payable

SRC-II FIRST COMMERCIAL PLANT

(TOTAL PLANT)

TABLE 8.3-1: ELEMENTS OF INDIRECT CAPITAL COSTS

		$11/78
1.	Catalysts and Chemicals	$20.295 M2
2.	License Fees	13.175
3.	Land	--
4.	Working Capital	
	A. Raw Coal Inventory	$22.813 M2
	B. Finished Products Inventory	12.285
	C. Catalysts and Chemicals Inventory	1.050
	D. Spare Parts and Maintenance Materials Inventory	32.800
	E. Cash	3.607
	F. Work in Progress	1.000
	G. Accounts Receivable	75.580
	H. Accounts Payable	27.455
	Subtotals, Working Capital:	$121.680M2
TOTAL INDIRECT CAPITAL COST ELEMENTS: (Omissions as noted)		$155.150 M2

SRC-II FIRST COMMERCIAL PLANT

(TOTAL PLANT)

TABLE 8.3-2: INITIAL CATALYST AND CHEMICAL COSTS

Area	Description	Initial Quantity	Unit Cost ($11/78)	Net Cost ($11/78)
	Catalysts			
12	Molecular Sieve	570,000 lb	$ 1.44/lb	$ 820,800
22	SSK-1, SSK-2, CKA	--	--	5,970,000
25	HTZ-3, MCR-2X, RKL	--	--	3,850,000
33	S-201 Alumina	628,400 lb	.28/lb	176,000
33	Support Balls	203,900 lb	1.10/lb	224,300
33	SCOT Hydrogenation	PROPRIETARY	PROPRIETARY	220,500
35	Reactor Catalyst	PROPRIETARY	PROPRIETARY	1,628,800
52	Cation Resin	2,500 cf	48.60/cf	121,500
52	Anion Resin	2,200 cf	135.00/cf	297,000
	Subtotal, Catalysts:			$ 13,308,900
	Chemicals			
12	Lean Oil	1,100 bbl	$ 25.00/bbl	$ 27,500
12	Diethanol Amine	303,000 lb	.49/lb	148,500
12	Antifoaming Agent	1,000 gal	43.00/gal	43,000
12	Freon	4,500 lb	.90/lb	4,100
23	Potassium Carbonate	PROPRIETARY	PROPRIETARY	409,400
23	Antifoaming Agent	PROPRIETARY	PROPRIETARY	41,300
25	Diethylene Glycol	30,600 lb	.28/lb	8,600
26	Diethanol Amine	11,000 lb	.49/lb	5,400
26	Potassium Carbonate	PROPRIETARY	PROPRIETARY	105,400
26	Antifoaming Agent	PROPRIETARY	PROPRIETARY	12,900
31	Diethanol Amine	216,000 lb	.49/lb	105,800
31	Antifoaming Agent	300 gal	43.00/gal	12,900
32	Triethylene Glycol	205,700 lb	.28/lb	57,600
32	Propane	17,224 gal	.54/gal	9,300
33	SCOT Solvent	PROPRIETARY	PROPRIETARY	2,155,300
33	Freon	55,000 lb	.90/lb	49,500
41	Phosphoric Acid	210,000 lb	.29/lb	60,900
41	Caustic (50%)	170,000 lb	.075/lb	12,800
42	Solvent	PROPRIETARY	PROPRIETARY	11,900
43	Sulfuric Acid	45,000 lb	.0225/lb	1,000
43	Caustic (50%)	37,000 lb	.075/lb	2,800
51	Neutralizing Amine	1,100 lb	.50/lb	600
51	Hydrazine	1,100 lb	3.85/lb	4,200
52	Quicklime	9,000 lb	.03/lb	300
52	Alum	272,000 lb	.075/lb	20,400

SRC-II FIRST COMMERCIAL PLANT

(TOTAL PLANT)

TABLE 8.3-2: INITIAL CATALYST AND CHEMICAL COSTS (Continued)

Area	Description	Initial Quantity	Unit Cost ($11/78)	Net Cost ($11/78)
	Chemicals (Continued)			
52	Polymer	9,200 lb	$ 1.00/lb	$ 9,200
52	Chlorine	64,000 lb	.08/lb	5,100
52	Sulfuric Acid	664,000 lb	.0225/lb	14,900
52	Caustic (50%)	1,173,900 lb	.075/lb	88,000
53	Chlorine	18,000 lb	.08/lb	1,400
53	Sulfuric Acid	310,500 lb	.0225/lb	7,000
53	Chromate Phosphate	145,100 lb	.30/lb	43,500
54	Diesel Fuel	2,800 gal	.50/gal	1,400
54	Chlorine	4,000 lb	.08/lb	300
54	Foam Agent	4,000 gal	30.00/gal	120,000
	Subtotal, Chemicals:			$ 3,602,200
Total without allowance for indeterminates				$16,911,100
Allowance for indeterminates				$ 3,383,900
TOTAL INITITAL CATALYST AND CHEMICAL COSTS:				$20,295,000

SRC-II FIRST COMMERCIAL PLANT
(TOTAL PLANT)
TABLE 8.3-3: LICENSE FEES

Area	Licensor	Net Cost
21	Texaco Development Corp.	PROPRIETARY
22	Haldor Topsoe A/S	PROPRIETARY
23	Benfield Corporation	PROPRIETARY
25	Haldor Topsoe A/S	PROPRIETARY
33	Shell Development Corp.	PROPRIETARY
41	U. S. Steel	PROPRIETARY
42	Chem-Pro	PROPRIETARY
Total without allowance for indeterminates		PROPRIETARY
Allowance for indeterminates		PROPRIETARY
	TOTAL LICENSE FEES:	$13.175 M^2

8.4 ELEMENTS OF ANNUAL OPERATING COSTS

Certain elements of Annual Operating Costs were estimated by Stearns-Roger; these costs are shown in Table 8.4-1. These costs were estimated, as described below, in fourth quarter 1978 dollars. Appropriate allowances for indeterminates have been included. Note that these costs include those for the Demonstration Plant. Cost of coal feed to the plant is not included in these operating costs.

8.4.1 Operating Labor and Supplies

Table 8.4-2 shows the estimated number of operators required for plant operation. The average operator rate was estimated to be $21,225 per year. This rate is based on those currently in effect in Homer City, Pennsylvania (fourth quarter, 1978), and includes shift differentials and allowances for overtime, vacations, and holidays. Operating supplies were calculated at 10 percent of operating labor.

8.4.2 Maintenance Labor

Table 8.4-3 shows the estimated direct-hire plant maintenance work force requirements. The average annual rate for the maintenance work force, based on the craft rates used for the estimation of Direct Capital Cost, is $26,200.

8.4.3 Maintenance Materials

The annual costs for maintenance materials were calculated as a percentage of Direct Capital Cost. These costs are shown in Table 8.4-4.

8.4.4 Contract Maintenance

Contract Maintenance was estimated to require the same number of workers as the direct-hire plant maintenance work force. The annual rate, covering wages, overheads and fees, was estimated as $63,000 per worker.

8.4.5 Catalysts and Chemicals

The annual replacement quantities, unit costs, and net annual replacement costs for catalysts and chemicals are shown in Table 8.4-5.

8.4.6 Electricity

The annual purchased power requirement, based on an annual demand of 87,500 KVA and a power factor of 0.9, is 78.75 MW; this was priced at $0.02 per KWH.

8.4.7 Labor Benefits and Idle Time

The costs of labor benefits and idle time for craft workers were calculated at 40 percent of operating and maintenance labor costs.

8.4.8 Property Taxes and Insurance

These costs were estimated as 1.5 percent of fixed capital investment (Direct Capital Cost). This would be a reasonable rate for a normal commercial venture.

8.4.9 Plant Overhead

Table 8.4-6 summarizes the estimated noncraft plant personnel requirements.

SRC-II FIRST COMMERCIAL PLANT

(TOTAL PLANT)

TABLE 8.4-1: ELEMENTS OF ANNUAL OPERATING COSTS

		$11/78	
1.	Direct Expense Elements		
	A. Operating Labor	$ 7.580	M^2
	B. Operating Supplies	0.760	
	C. Maintenance Labor	5.500	
	D. Maintenance Materials	36.200	
	E. Contract Maintenance	13.230	
	F. Catalysts and Chemicals	12.600	
	G. Electricity	16.555	
	Subtotals, Direct Expense Elements:	$ 92.425	M^2
2.	Indirect Expense Elements		
	A. Labor Benefits and Idle Time	$ 5.230	M^2
	B. Property Taxes and Insurance*	29.475	
	C. Plant Overhead	10.500	
	Subtotals, Indirect Expense Elements:	$ 45.205	M^2
	TOTAL ANNUAL OPERATING COST ELEMENTS:	$137.630	M^2

* This would be a reasonable rate for a normal commercial venture.

SRC-II FIRST COMMERCIAL PLANT

(TOTAL PLANT)

TABLE 8.4-2: PLANT OPERATIONS WORK FORCE

	Operator Positions x Shift Coverage*			
	Grade A	Grade B	Grade C	Total Requirements
Utility Areas	2x4.2 = 8.4	6x4.2 = 25.2	4x4.2 = 16.8	50.4
Process Areas	2x4.2 = 8.4	8x4.2 = 33.6	6x4.2 = 25.2	67.2
Gas Production and Treating Areas	2x4.2 = 8.4	8x4.2 = 33.6	10x4.2 = 42.0	84.0
Materials Handling and Offsite Areas	---	8x4.2 = 33.6 4x2.0 = 8.0	12x4.2 = 50.4 2x2.0 = 4.0	96.0
TOTAL REQUIREMENTS:	25.2	134.0	138.4	297.6

*Around-the-clock operation requires 3 shifts per day, 7 days per week, or 21 shifts per week. Since each operator works 5 shifts per week (40 hours), 4.2 operators are required for each around-the-clock position. Several positions require only 2-shift, 5 day-per-week coverage.

SRC-II FIRST COMMERCIAL PLANT
(TOTAL PLANT)
TABLE 8.4-3: PLANT MAINTENANCE WORK FORCE

Craft	Number Required
Boilermakers	16
Carpenters	6
Electricians	21
Finishers/Insulators	3
Ironworkers	4
Laborers	11
Millwrights	30
Operators	6
Pipefitters	70
Teamsters	8
TOTAL REQUIREMENTS:	175

SRC-II FIRST COMMERCIAL PLANT
(TOTAL PLANT)
TABLE 8.4-4: ANNUAL COSTS FOR MAINTENANCE MATERIALS

Unit	Description	Net Cost ($11/78)
10	Primary Process Plants	$10.13 M^2
20	Hydrogen Production Plants	8.00
30	Refining and Gas Plants	4.63
40	Secondary Recovery and Oxygen Plants	5.73
50	Utility Systems and General Facilites	3.43
60	Coal and Slag Systems	4.28
TOTAL MAINTENACE MATERIALS:		$36.20 M^2

SRC-II FIRST COMMERCIAL PLANT
(TOTAL PLANT)
TABLE 8.4-5: ANNUAL CATALYST AND CHEMICAL COSTS

Area	Description	Annual Quantity	Unit Cost ($11/78)	Net Cost ($11/78)
	Catalysts			
12	Molecular Sieve	142,500 lb	$ 1.44/lb	$ 205,200
22	SSK-1, SSK-2, CKA	--	--	1,990,000
25	HTZ-3, MCR-2X, RKL	--	--	1,925,000
33	S-201 Alumina	209,500 lb	.28/lb	58,700
33	SCOT Hydrogenation	PROPRIETARY	PROPRIETARY	73,500
35	Reactor Catalyst	PROPRIETARY	PROPRIETARY	1,091,200
52	Cation Resin	500 cf	48.60/cf	24,300
52	Anion Resin	460 cf	135.00/cf	62,100
	Subtotal, Catalysts:			$ 5,430,000
	Chemicals			
12	Diethanol Amine	91,250 lb	$ .49/lb	$ 44,700
12	Antifoam Agent	290 gal	43.00/gal	12,500
23	Potassium Carbonate	PROPRIETARY	PROPRIETARY	122,400
23	Antifoaming Agent	PROPRIETARY	PROPRIETARY	15,500
25	Diethylene Glycol	108,000 lb	.28/lb	30,200
26	Diethanol Amine	15,000 lb	.49/lb	7,400
26	Potassium Carbonate	PROPRIETARY	PROPRIETARY	35,300
26	Antifoaming Agent	PROPRIETARY	PROPRIETARY	3,900
31	Diethanol Amine	328,500 lb	.49/lb	161,000
31	Antifoaming Agent	300 gal	43.00/gal	12,900
32	Triethylene Glycol	186,150 lb	.28/lb	52,100
33	SCOT Solvent	PROPRIETARY	PROPRIETARY	593,800
34	Corrosion Inhibitor	9,000 gal	11.80/gal	106,200
41	Phosphoric Acid	182,500 lb	.29/lb	52,900
41	Caustic (50%)	2,401,700 lb	.075/lb	180,100
42	Solvent	PROPRIETARY	PROPRIETARY	291,000

SRC-II FIRST COMMERCIAL PLANT

(TOTAL PLANT)

TABLE 8.4-5: ANNUAL CATALYST AND CHEMICAL COSTS (Continued)

Area	Description	Annual Quantity	Unit Cost ($11/78)	Net Cost ($11/78)
	Chemicals (Continued)			
43	Sulfuric Acid	684,375 lb	$ .0225/lb	$ 15,400
43	Caustic (50%)	1,642,500 lb	.075/lb	123,200
51	Neutralizing Amine	8,265 lb	.50/lb	4,100
51	Hydrazine	1,660 lb	3.85/lb	6,400
52	Quicklime	102,900 lb	.03/lb	3,100
52	Alum	3,651,600 lb	.075/lb	273,900
52	Polymer	100,700 lb	1.00/lb	100,700
52	Chlorine	733,400 lb	.08/lb	58,700
52	Sulfuric Acid	7,424,500 lb	.0225/lb	167,000
52	Caustic (50%)	14,565,500 lb	.075/lb	1,092,000
53	Chlorine	224,100 lb	.08/lb	17,900
53	Sulfuric Acid	1,358,500 lb	.0225/lb	30,600
53	Chromate Phosphonate	4,820,500 lb	.30/lb	1,446,200
54	Diesel Fuel	800 gal	.50/gal	400
54	Chlorine	43,800 lb	.08/lb	3,500
54	Foam Agent	100 gal	34.00/gal	3,400
	Subtotal Chemicals:			$ 5,068,400
Total without allowance for indeterminates				$ 10,498,400
Allowance for indeterminates				$ 2,101,200
TOTAL INITITAL CATALYST AND CHEMICAL COST:				$ 12,599,600

SRC-II FIRST COMMERCIAL PLANT
(TOTAL PLANT)
TABLE 8.4-6: NONCRAFT PLANT PERSONNEL

Function	Number Required
Plant Management	
Manager	1
Secretary	1
Subtotal, Plant Management:	2
Plant Administration	
Manager	1
Administrative Services Personnel	19
Purchasing Personnel	7
Material Control Personnel	7
Secretary	1
Subtotal, Plant Administration:	35
Human Resources	
Manager	1
Human Resources Personnel	5
Safety and Security Personnel	24
Health Protection Personnel	6
Public Relations Personnel	2
Secretary	1
Subtotal, Human Resources:	39
Plant Operations	
Manager	1
Plant and Shift Supervisors	22
Technical Personnel	5
Secretary	1
Subtotal, Plant Operations:	29
Plant Maintenance	
Manager	1
Technical Personnel	14
Craft Supervisors	5
Secretary	1
Subtotal, Plant Maintenance:	21
Technical Services	
Manager	1
Plant Laboratory Personnel	28
Plant Engineering Personnel	19
Process Evaluation Personnel	8
Environmental Personnel	5
Secretary	1
Subtotal, Technical Services:	62
TOTAL REQUIREMENTS:	188