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PROCESS SELECTION AND INVESTMENT ANALYSIS, METHANATION FACILITY FOR PUROX PYROLYSIS SYSTEM OFF-GAS

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INTRODUCTION AND TECHNICAL SUMMARY

The Sassi Corporation of Indianapolis, Indiana, is investigating the commercial viability of converting refuse (trash and garbage) to synthetic natural gas. This conversion is accomplished by:

A. Shredding and preparing the refuse for conversion.

B. Producing a gas of low calorific value from the refuse using the Union Carbide Purox Process.

C. Methanating the Purox off-gas to a quality suitable for sale in the existing gas distribution system.

The last step of this conversion process, the Purox off-gas methanation, has been studied by The Pritchard Corporation, whose technical expertise in this field was utilized to develop a process design and an estimate of its capital investment.

The Pritchard Corporation has submitted this Process Study and Investment Analysis to Sassi: The analysis is being published as part of The Sassi Corporation's contract reports to the U.S. Department of Energy's Office of Energy from Municipal Waste.

Pritchard has had previous experience with the Purox Process. In 1977, it supplied a small pilot unit to Union Carbide Corporation at South Charleston, West Virginia, to test the effects of Purox off-gas on various catalysts. Operation of the plant was conducted by Pritchard personnel, and the insight gained has been incorporated into the present effort. Similarly, Pritchard was retained by the Coyne Chemical Company, Philadelphia, Pennsylvania, to perform a study of the viability of refuse conversion to ammonia in the City of Seattle, Washington. The process was developed but the economics did not warrant construction.

Pritchard designed and engineered the first U.S. plant using the British Gas Corporation's Catalytic Rich Gas (CRG) Process for Commonwealth Natural Gas Company at Chesapeake, Virginia. This plant operates successfully on either the propane or butane feedstock. A similar plant was fully designed and engineered for Coastal States Natural Gas Company by Pritchard to utilize naphtha as a feedstock. Construction of this plant was curtailed by the unavailability of the naphtha feedstock caused by the Middle East oil embargo in 1974.

For Sassi's facility, the design developed by Pritchard upgrades low-BTU Purox off-gas, with a heating value of 590 BTU per cubic foot, to Synthetic Natural Gas (SNG), which is comprised mostly of methane and which has a heating value of 879 BTU per cubic foot. Upgrading is accomplished by a series of clean up and catalytic conversion steps. The clean-up steps encompass a benzol wash for removal of residual hydrocarbon liquids from the Purox off-gas, sulfur and chloride removal, carbon dioxide removal, and dehydration. The catalytic conversion steps consist of hydrogenation and methanation.

Well-proven processes have been selected for each processing step, although the sequence of the processing steps is unique to treating Purox off-gas. The process steps selected are the result of comparing viable methods for each processing application. The selection is discussed in detail in Section 1, Process Selection.

Based on the scheme envisioned, Pritchard has prepared a process design for a facility which processes 46.87 MMSCFD* of Purox off-gas, resulting in 26.4 MMSCFD of SNG. A detailed process description and process flow diagram may be found in Section 3, Process Description. A more detailed description of the mechanical aspects of the plant is also included in this report in the form of equipment specifications, layout, and operating requirements.

Our investment analysis reveals that capital requirements for the facility described here are approximately $47,320,000, resulting in a payout, not including taxes or interest, of 8.3 years. Details substantiating the investment analysis which defines how the costs were determined may be found in Section 6, Investment Analysis.

*MMSCFD = million standard cubic feet per day.

1. PROCESS SELECTION

Overview

Before reporting on the details and justification of process selection, it is deemed appropriate and important to review the overall intent of this facility and the Purox Process concept, so that a meaningful understanding of the processing steps which Pritchard has studied can be achieved.

The concept of converting refuse to synthetic gas was conceived for the disposal of municipal and industrial refuse as an environmentally acceptable alternative to the conventional methods of refuse disposal currently adopted by cities, specifically burying or incineration with air.

Burying the waste material has long been an accepted practice; and provided there is sufficient overfill, such landfill sites when filled to capacity can provide areas for municipal recreation, etc. A spinoff from such buried refuse results when, following natural anaerobic digestion, methane can be withdrawn and usefully employed. However, disposal by such methods requires large land areas. As such landfills can be unsightly, the selection is very often limited to such areas as flood plains, quarries, etc.; i.e., land which is unfit for other use. In the selection of such sites the long-term effect of the leaching of non-degradable toxins into natural aquifers was often given little more than a cursury overview. Today, the picture is vastly different and such considerations severely limit the number of available sites.

The lack of suitable land may well have forced an upsurge in incineration plants. However, such plants emit gaseous pollutants and still require disposal of the ash by other means, normally burial. Such incineration plants, using air as an oxidant, do not produce high enough temperatures to completely render toxic metals into an innocuous state. The ash is still leachable, and thus requires as careful a disposal by burial as the raw refuse.

The Purox process is in itself an incineration process. However, the oxidant chosen is pure oxygen. This simple change in the oxidant for the combustion process, combined with the furnace design, makes the environmental impact of this incineration totally acceptable. The shaft furnace is not unlike a blast furnace. Shredded raw refuse is fed by lock hopper into the top, and oxygen is fed into the bottom. The oxygen ignites the cindered refuse which has traveled down the furnace and has been totally charred by the rising hot gases. Because oxygen is used, an intense flame develops, such that the incombustibles fuse and blend into a siliceous lava which issues from the bottom of the furnace into a quench pit. This intense burning is called pyrolysis.

The resulting ash is a glassy friable material with very low leachate content. It has properties which favor it as a fill or aggregate.

The gases rising from the flame counter-currently react with the falling refuse and are in turn reduced to the pyrolysis off-gas which leaves the top of the incinerator. These gasses are valuable since they contain very little nitrogen. Had air been used as the oxidizing agent, as one finds in regular incinerators, this off-gas would have contained so much nitrogen as to render it useless as either a chemical feedstock or fuel. But since oxygen has been used, the off-gas from the Purox unit contains only as much nitrogen as was an impurity in the oxygen plus any molecular nitrogen that may have been formed by the cracking of nitrogenous compounds present in the refuse. The gas contains oils and tars which are removed by water scrubbing and electrostatic precipitation. The resulting gas has a low calorific value at the Purox plant outlet.

Reasons for Upgrading Gas

The gases obtained from the Purox unit have low calorific value but contain all the necessary constituents to produce a synthesis gas which may be used to produce various chemicals, including methane (or synthetic natural gas), which may be blended into an existing natural gas network. The gas from the Purox unit has intrinsic heat value, and arguments may be made for marketing this gas directly or burning it directly. Unfortunately the gas does not lend itself to either of these alternatives readily. The composition of the gas will vary with the "quality" of the refuse, which varies not only on a daily basis but also on a seasonal basis. Thus, burners will need to cope with varying calorific value gas. More importantly, the flue gas effluents from such burners may contain environmentally unacceptable amounts of sulfur oxides, chlorides, and nitrogen oxides, related to the "quality" of the refuse. To render the gas free of such impurities will require the same clean-up equipment and processing as required for the synthetic natural gas plant, and the problem of varying caloric value would still not be solved.

By conversion of the gas to methane, the resulting product will be of constant calorific value, suitable for use with burners presently using natural gas (without modification to the burners) and suitable for transmission and use by all users whether commercial, industrial or residential without any modifications to existing equipment. The synthetic natural gas produced would be indistinguishable from the gas currently used.

Methanation Process

Although a detailed description of the proposed process is given in the Process Description section, a general overview is presented to acquaint the reader with the reasons and alternate solutions available to render an overall processing scheme which is commercially proven and viable.

The gas leaving the Purox unit is not unlike a coke oven gas in composition as it contains essentially the same constituents. However, they are present in the Purox gas in different proportions than in the coke oven gas. For instance, if all of the elemental carbon and hydrogen with the addition of water were converted to methane from coke oven gas, an excess of hydrogen would result. Similarly, if the same transformation was conducted on Purox off-gas, an excess of carbon (as carbon dioxide) would result. This similarity of component parts between Purox off-gas and coke oven gas, however, is a guide to the necessary pretreatments required by the process.

Such treatments should be well proven, since the overall concept of converting refuse to synthetic natural gas is novel. Therefore, it is most important that each individual unit operation must be proven, possibly in other overall processing schemes, such that each of these proven steps may be combined producing the overall concept.

The first step involves compression of the gas. The Purox unit operates at essentially atmospheric pressure. Since it is undesirable to operate any portion of the methanation process at sub-atmospheric pressure to avoid ingress of air, the gas must be compressed. However, the gas, although free of particulates, contains unsaturated hydrocarbons. Compression of this raw gas could result in polymer formation in the compressor since the propagation of these polymers is initiated by the heat of compression. To prevent this, experience was drawn from low caloric content gas plants using coke oven feed gas. Following such practice, the gas is increased to sufficient pressure by a fan to allow it to be scrubbed with a hydrocarbon liquid. The scrubbing operation removes any heavy hydrocarbons and polymers, which are subsequently returned to the Purox unit for total incineration. The gases are then compressed in screw-type compressors with water injection. The water not only serves to cool the compressor, but also washes the machines continuously to prevent buildup of materials. Such compressors are operating today in coke oven gas service.

The second step involves the hydrogenation of the unsaturated hydrocarbons in the gas. It is these hydrocarbons, particularly the acetylinic compounds, which are the polymer forming agents. Hydrogenation involves using the molecular hydrogen inherent in the gas to react with these unsaturated compounds, converting them to paraffins. A choice of proven processes introduced itself for this step and the gum-forming compounds could either be removed or converted. Had removal been the choice using, for example, the Rectisol process, then simultaneous removal of the carbon dioxide and hydrogen sulfide would have occurred. However, it was necessary to retain the carbon dioxide for reasons which are discussed later. The hydrogen sulfide, following its removal after regeneration of the Rectisol solution, would still need to be converted to elemental sulfur to render it environmentally acceptable. Since not all the sulfur present in the gas is as hydrogen sulfide, further clean-up would be required as the catalysts used in subsequent processing will be sensitive to sulfur poisoning. Therefore, conversion of the gum formers by hydrogenation was decided upon.

Hydrogenation is a relatively simple and well-proven process. It is normally carried out over a nickel-based catalyst. However, the presence of the carbon oxides in the feed gas poses a problem, since the methanation reaction is also promoted by certain nickel catalysts. British Gas Corporation has devised and operated a process for many years which will hydrogenate unsaturated hydrocarbons in the presence of the oxides of carbon. This process was successfully applied to coke oven gas at the Shotton Steel Works in Wales, U.K., during 1971-72 for some six to eight months. The tests were completed and no further work was done since natural gas from the North Sea deposits were being exploited, and no need was present for synthetic natural gas. Because of the similarity between Purox off-gas and coke oven gas, the proposed methanation plant is based on this process for the hydrogenation step.

The process is called the "NIMOX" process, and relies upon a sulfided nickel molybdate catalyst. Sulfur in the gas is necessary to keep the catalyst sulfided. This processing step provides the necessary conversions to render the gas suitable for further treatment by conventional means. The "NIMOX" process provides a bonus in that all sulfur compounds are hydrogenated to hydrogen sulfide and all organic chlorides to hydrogen chloride, allowing for easy removal of these substances.

Following hydrogenation the third processing step involves the removal of the sulfur and chlorides from the gas. Again, a well-proven process has been selected, the Stretford process. This was chosen over others because it is the only practical process available; many plants are operating in the U.S.A.; and the sulfur is recovered as elemental sulfur which may be marketed, and not as H_2S or SO_2 which are atmospheric pollutants. To guard against any sulfur slippage, two absorbent beds follow the Stretford unit containing promoted zinc oxide. This is standard practice in most synthetic gas plants where catalysts involved are particularly sensitive to sulfur.

The gas has now been fully treated to make it suitable for the fourth process step, the Catalytic Rich Gas and methanation process. The process adopted is the British Gas S.N.G. (Synthetic Natural Gas) process. Similar processes are offered by Japan Gas Company and by Lurgi in Germany. Selection of the British Gas process over the other available processes was based on the large number of successfully operating plants they have, coupled with their work and familiarity with coke oven gas at Shotten Steel Works, as previously explained. The process is fully explained in the Process Description section, but in essence it consists of the conversion of the saturated hydrocarbons formed in the hydrogenation step to methane using steam and hydrogen (the latter being present in the feed gas). This is followed by wet methanation in which the bulk of the carbon oxides are combined with hydrogen to form methane. The last step is dry methanation, wherein residual hydrogen combines with the carbon oxides to maximize the production of the methane gas. All reactions are extremely exothermic, and the reactions are moderated by the excess carbon dioxide which was allowed to pass through the second processing step. The heat generated is used for making steam, which is used within the process and to drive the feed gas compressor turbines.

The excess carbon dioxide is then removed from the synthetic natural gas with a recirculating amine solution. The Union Carbide Amine Guard process was selected. This is well-proven, mainly in ammonia synthesis plants where it serves the same function. Many carbon dioxide removal systems are available commercially. Selection of Amine Guard was established by economics and it is noteworthy that many commercial plants using other systems have changed over to this process.

Finally, the methane product is dried using glycol and is available for marketing as synthetic natural gas.

2 BASIS FOR DESIGN

Introduction

This section deals with the selection of the design basis for the plant detailed in this report. The plant will convert pyrolysis gas, generated by burning refuse in a Purox refuse incinerator, to synthetic natural gas (SNG).

To establish the design basis requires the selection of the three design variables identified below:

Amount of refuse pyrolyzed and its heating value,
Heating value of pyrolysis gas, and
Thermal efficiency of the pyrolysis process.

The selection of these three design variables fixes the pyrolysis gas production rate, which in turn leads to the complete definition of the parameters defining plant size.

SASSI requested a basis for design of 2100 short tons per day of garbage be processed. This required a large variation in plant size based on the heating value of the garbage and the performance of the Purox Process. In order to avoid major plant size changes, Pritchard selected a single pyrolysis gas flow rate to design the plant and has evaluated the variation in the amount of garbage which can be processed based on the processing efficiencies.

Units

Throughout this document the English system of units is used. The Standard Cubic Foot (SCF) conditions are defined as an ideal, dry gas at 14.73 PSIA and 60 ^{o}F.

Specifications to Establish the Basis for Design

Pyrolysis Gas Production Rate

To efficiently study this plant design, a pyrolysis gas production rate was selected and fixed. The

Pyrolysis Gas Production Rate (Cont.)

pyrolysis gas production rate selected is 46.87 MMSCFD (million standard cubic feet per day). The range of the three design variables identified above which will give this fixed gas production rate is discussed with each variable in the following section.

Heating Value of the Pyrolysis Gas

The heating value of the pyrolysis gas generated by the Purox Process is derived from the gas composition. Two pyrolysis gas compositions were studied. The first was obtained during tests conducted by Pritchard in September 1977 at the South Charleston Purox Pilot Plant. The second was provided by Union Carbide Corporation as reported in Bechtel's report to the City of Seattle. The former pyrolysis gas composition has been chosen as the design basis upon which the equipment has been sized. Pritchard performed a material balance on the alternate case to develop a product gas (SNG) composition.

Table 1 gives the pyrolysis gas composition and higher heating value (HHV) for the two gas compositions studied.

TABLE 1. Pyrolysis Gas Average Composition and Higher Heating Value

Component	Composition, Vol. %	
	Source: Pritchard (Design Basis)	Source: Union Carbide Corp. (Alternate Basis)
H_2	17.3	28.9
CO	24.0	35.8
CO_2	19.6	23.4
CH_4	21.0	5.5
C_2	4.7	2.7
C_3	1.2	0.37
C_4	1.3	0.33
C5+	3.0	1.0
Sulfide	0.02	0.06
O_2	0.03	0.10
Inert Gases	7.2	1.7
H_2O	0.7	0.15
Higher Heating Value (HHV) (BTU/SCF)	590	376

Thermal Efficiency of the Pyrolysis Process

When refuse is processed in a Purox refuse incinerator, only a portion of the heating value of the refuse is recovered in the pyrolysis gas. The amount of heat recovered is defined as the efficiency of the pyrolysis process.

Two different values of the thermal efficiency of the pyrolysis process have been considered. The first, suggested by the SASSI Corporation, is a thermal efficiency of 61%. The second value, recommended by Union Carbide Corporation, is a thermal efficiency of 75%.

The effect of the Purox thermal efficiency on the amount of refuse processed is shown in Table 2.

Amount of Refuse Pyrolyzed

To calculate the amount of refuse pyrolyzed, the following design basis has been used:

Heating value of the refuse - 5000 BTU/lb*

Table 2 shows the amount of refuse which can be pyrolyzed in a plant of the selected size based on the thermal efficiency of the pyrolysis process and the heating value of the pyrolysis gas.

Product Gas (SNG) Specification

The product gas (SNG) composition depends on the feed gas composition. The product gas composition which results from the design basis feed and the alternate basis feed is shown in Table 3.

*Union Carbide Corporation

Table 2. Refuse Pyrolyzed at Two Plant Designs

	Pyrolysis Gas Production Rate (MMSCFD)	Pyrolysis Gas HHV (BTU/SCF)	Product Gas Rate (MMSCFD)	Product Gas HHV (BTU/SCF)	Refuse Pyrolyzed @ 61% Eff. (T/D)	Refuse Pyrolyzed @ 75% Eff. (T/D)
Design Basis	46.87	590[1]	26.4	879	4530	3690
Alternate Basis	46.87	376[2]	14.1	956	2890	2350

Note 1. Pritchard; test at South Charleston

Note 2. Bechtel's Seattle Report

Note 3. T/D - short ton/day

Table 3. Product Gas (SNG) Specification

Composition	Design Basis	Alternate Basis
H_2	0.2	0.3
CO	0.1	0.2
Inerts	12.7	5.5
CH_4	87.0	94.0
Total	100.0	100.0
HHV (BTU/SCF)	879	956
Temp. (^oF)	100	100
Pressure (psig)	30	30
Water Dewpoint (^oF)	0	0

Ambient Conditions

Process Design Temperatures

Maximum	94^oF
Minimum	-20^oF

Mechanical Design Temperatures

Maximum	110^oF
Minimum	-20^oF

3 PROCESS DESCRIPTION

Introduction

The raw gas from the Purox furnace is cooled and passed through an electrostatic precipitator for removal of dust and heavy oil particles as part of the Union Carbide Purox Process Package. This gas then flows to the Methanation Plant for final clean-up, treatment, and upgrading to produce a pipeline-quality synthetic gas. The design consists of several process steps used in the following order:

(a) Benzol wash system for removal of residual hydrocarbon liquids.
(b) Feed gas compression.
(c) Hydrogenation of olefinic compounds.
(d) Sulfur and chloride removal.
(e) Methanation to upgrade the heating value of the gas.
(f) Carbon Dioxide (CO_2) removal by monoethanolamine (MEA).
(g) Glycol Dehydration.

The synthetic gas produced by these steps is a pipeline quality gas having a heating value of 879 BTU/SCF. Further upgrading of the gas to an even higher heating value is possible by hydrocarbon liquid injection.

Benzol Wash*

The pyrolysis gas from the Purox unit is compressed by Exhauster C-3A or B to a pressure of 15.8 psia to assure the operation of the Benzol system above-atmospheric pressure. From the Exhauster, the pyrolysis gas flows to the Benzol Absorber, T-1, where it is scrubbed by the circulating lean oil. The lean oil serves to remove residual benzenes and other hydrocarbon liquids which have remained in the pyrolysis gas. The absorber overhead gas flows to the feed gas compression system.

A rich oil from the bottom of the absorber is pumped via Rich Oil Pump P-4A or B, through Lean/Rich Exchanger E-7, and Rich Oil Heater E-6, both of which add heat to the Benzol Stripper, T-2. The rich oil is stripped of benzenes and aromatics by live steam injected into the base of the stripper. The regenerated lean oil is returned via Lean Oil Pump P-5A or B, through Exchangers E-7 and E-5, both of which cool the oil which is fed to the top of the Benzol Absorber.

The stripper overhead stream is cooled in Benzol Condenser E-8 before flowing to the Benzol Separator D-5. Three streams are sent from the separator as follows:

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*Refer to Figures 1 and 2.

EQUIPMENT LIST

GENERAL

ACC. #2 - BUILDINGS

CONTROL BUILDING

BENZOL WASH UNIT

ACC. #5 - VESSELS & TANKS

D-5	BENZOL SEPARATOR
T-1	BENZOL ABSORBER
T-2	BENZOL STRIPPER
TK-2	BENZOL STORAGE TANK
TK-3	LEAN OIL STORAGE TANK

ACC. #7 - HEAT EXCHANGERS

E-5A&B	LEAN OIL COOLER
E-6	RICH OIL HEATER
E-7A&B	LEAN/RICH EXCHANGER
E-8	BENZOL CONDENSER

ACC. #9 - MECHANICAL & PACKAGED EQUIPMENT

C-3A&B	EXHAUSTER
P-4A&B	RICH OIL PUMP
P-5A&B	LEAN OIL PUMP
P-6A&B	LEAN OIL MAKE-UP PUMP
P-7	BENZOL CONDENSATE PUMP

FEED GAS COMPRESSION UNIT

ACC. #9 - MECHANICAL & PACKAGED EQUIPMENT

PG-1A&B	FEED GAS COMPRESSOR PACKAGES
D-1A&B	INTERSTAGE SEPARATORS
D-2A&B	INTERSTAGE SEPARATORS
D-3A&B	DISCHARGE SEPARATORS
D-4A&B	DISCHARGE SEPARATORS
TK-1A&B	COOLANT SURGE TANKS
E-1A&B	INTERSTAGE COOLERS
E-2A&B	INTERSTAGE COOLERS
E-3A&B	DISCHARGE COOLERS
E-4A&B	COMPRESSOR COOLANT COOLERS
C-1A&B	FEED GAS COMPRESSORS
P-1A,B,C&D	COOLANT PUMPS
P-2A,B,C&D	COOLANT BOOSTER PUMPS
P-3A&B	OIL SKIMMER PUMPS
ST-1A&B	COMPRESSOR STAEM TURBINE DRIVER

PURIFICATION UNIT

ACC. #5 - VESSELS & TANKS

D-6	RECYCLE GAS SEPARATOR
R-1A&B	HYDROGENATOR
R-2A	CHLORIDE/SULFUR GUARD BEDS

ACC. #6 - DIRECT FIRED HEATERS & POWER BOILERS

F-1	START-UP FEED GAS FURNACE

ACC. #7 - HEAT EXCHANGERS

E-[illegible]A,B&C	FEED GAS HEATER
E-[illegible]	COLD RECYCLE COOLER

ACC. #9 - MECHANICAL & PACKAGED EQUIPMENT

C-2A&B	RECYCLE COMPRESSOR
PG-2	CARBON DISULFIDE INJECTION UNIT
PG-3	PACKAGE HYDROGEN PLANT

STRETFORD UNIT

ACC. #5 - VESSELS & TANKS

FIL-1A&B	SECONDARY SEPARATOR
D-7	PRIMARY SEPARATOR
D-8A&B	FLASH DRUM
TK-4	PUMP TANK
TK-5	OXIDIZER
TK-6	SLURRY TANK
TK-7	SUMP TANK

ACC. #7 - HEAT EXCHANGERS

E-9	GAS/GAS EXCHANGER
E-10A&B	GAS COOLER

ACC. #9 - MECHANICAL & PACKAGED EQUIPMENT

B-2A&B	AIR BLOWER
M-1	CONTACTOR (MIXER)
M-2	SLURRY TANK MIXER
P-9A&B	LEAN SOLUTION CIRCULATION PUMP
P-10A&B	SLURRY PUMP
P-11	SUMP PUMP

CONVERSION UNIT

ACC. #5 - VESSELS & TANKS

R-3A&B	CRG REACTORS
R-4	METHANATOR NO. 1
R-5	METHANATOR NO. 2
D-9	METHANATOR EFFLUENT SEPARATOR
D-14	CRG EFFLUENT SEPARATOR

ACC. #6 - DIRECT FIRED HEATERS & POWER BOILERS

WHB-1	NO. 1 WASTE HEAT BOILER STEAM DRUM
WHB-2	NO. 2 WASTE HEAT BOILER STEAM DRUM

ACC. #7 - HEAT EXCHANGERS

E-11	CRG FEED COOLER
E-12	CRG EFFLUENT COOLER
E-13	METHANATOR EFFLUENT COOLER NO. 1
E-14A,B&C	METHANATOR EXCHANGER
E-15A,B&C	METHANATOR EFFLUENT COOLER NO. 2
E-16	METHANATOR EFFLUENT COOLER NO. 3
E-25A&B	GAS/GAS EXCHANGER
E-26	CRG EFFLUENT STEAM CONDENSER

CO_2 REMOVAL & GLYCOL DEHYDRATION UNIT

ACC. #5 - VESSELS & TANKS

D-10	K.O. DRUM
D-11	REFLUX DRUM
D-12	SOLUTION MIX TANK
D-13	MEA CARBON FILTER
FIL-[illegible]	SUMP FILTER
T-3	CO_2 STRIPPER
T-4	CO_2 ABSORBER
TK-8	MEA STORAGE TANK
TK-9	MEA SUMP
D-15	HOT CONDENSATE SEPARATOR

ACC. #7 HEAT EXCHANGERS

E-17	MEA REBOILER
E-18	MEA STEAM REBOILER
E-19	MEA RE[illegible]
E-20	STRIPPER OVERHEAD CONDENSER
E-21	LEAN MEA/RICH MEA EXCHANGER
E-22	GAS COOLER
E-23	MEA COOLER

ACC. #9 - MECHANICAL & PACKAGED EQUIPMENT

P-12A&B	STRIPPER REFLUX P[illegible]
P-13A&B	MEA CHARGE PUMP
P-14	MEA MAKE-UP PUMP
P-15	MEA SUMP PUMP
PG-4	GLYCOL DEHYDRATION PA[illegible]GE
P-18A&B	CONDENSATE PUMP

T-5	GLYCOL CONTACTOR
T-6	GLYCOL REGENERATOR
P-16A&B	GLYCOL PUMP
[illegible]-17	GLYCOL MAKE-UP PUMP

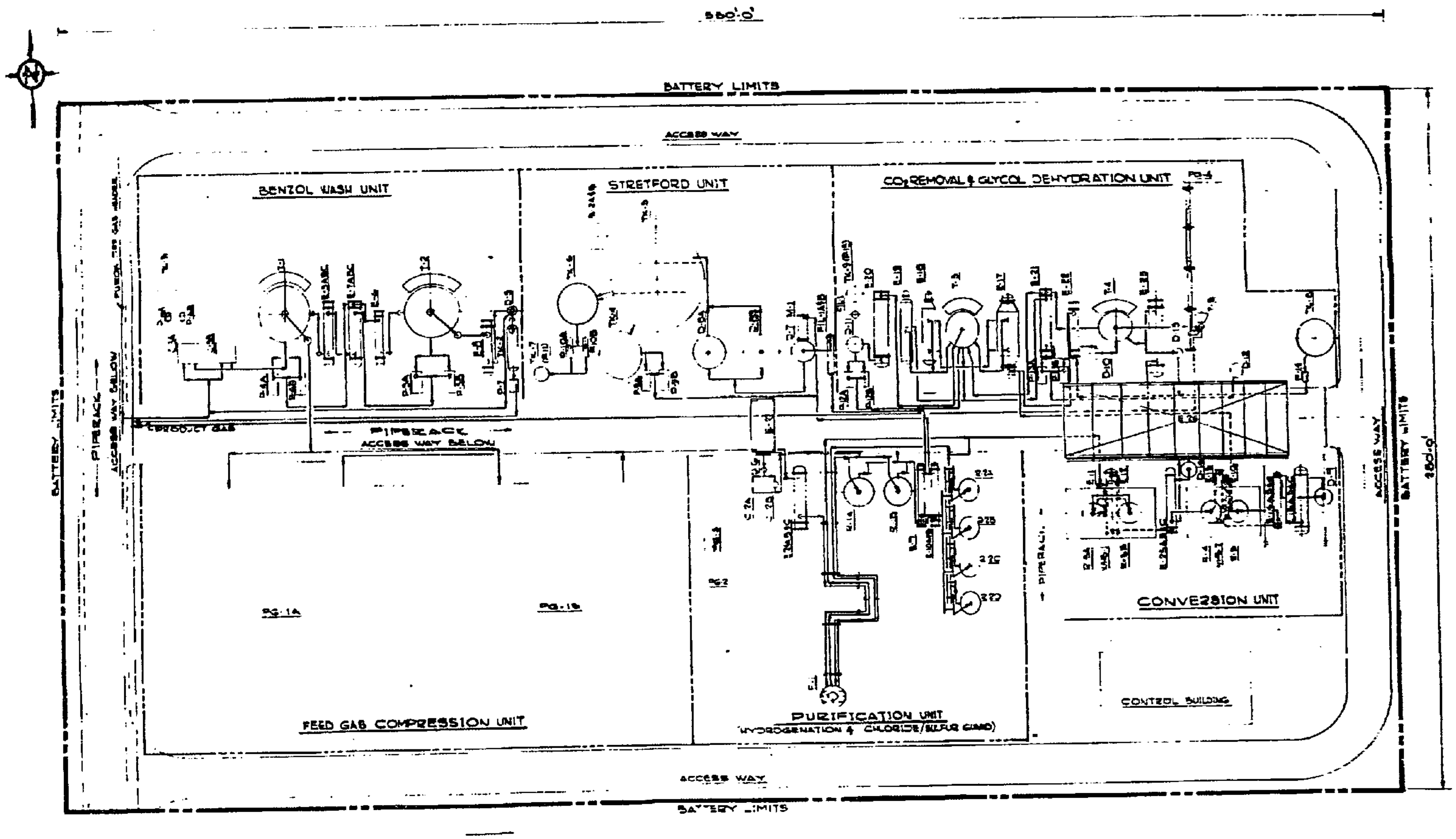


Fig. 1. Equipment Layout - Methanation of Purox Off-Gas. (Detailed equipment descriptions can be found in subsequent Figures and in App. A - D.)

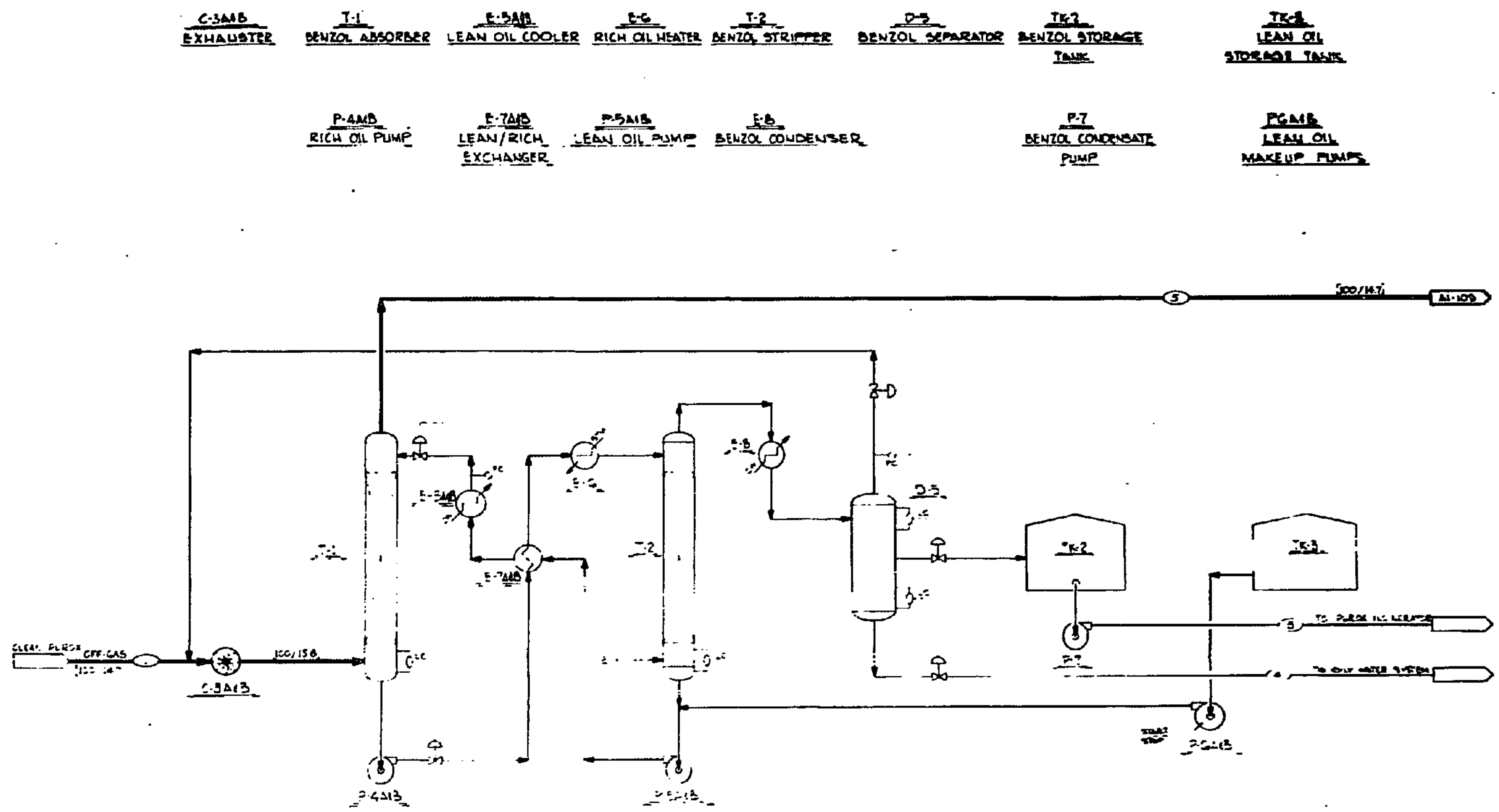


Fig. 2. Process Flow Diagram: Benzol Wash

(a) Gas previously dissolved in the lean oil is sent from the top of D-5 to the suction of the exhauster under pressure control.

(b) Benzene and other hydrocarbon liquids form a separate liquid phase which is sent from the mid height of D-5 to the Benzol Storage Tank, TK-2. It is intermittently pumped by Benzol Condensate Pump, P-7, to the Purox furnace for incineration.

(c) The water phase is sent from the bottom of D-5 to the oily water drain system for disposal.

Make-up lean oil is stored in Lean Oil Storage Tank TK-3, and pumped to the system on surge level control by Lean Oil Makeup Pump P-6A or B.

Fig. 2. Process Flow Diagram: Benzol Wash

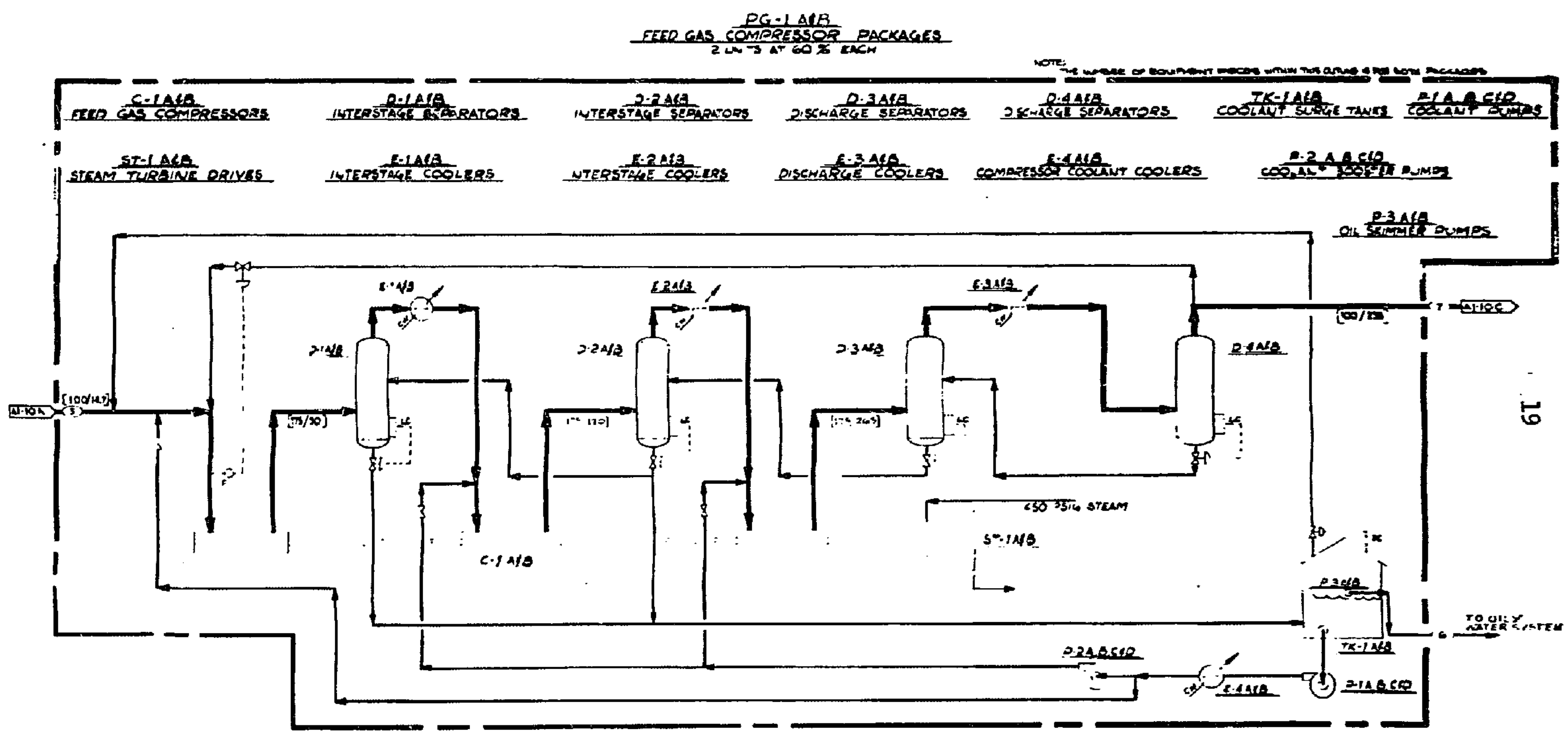
Feed Gas Compression*

Each Feed Gas Compressor Package, PG-1A or B, is capable of compressing 60 percent of the normal design gas flow from atmospheric pressure to 258 psia. Each compressor is provided with recycle capabilities such that in normal operation one unit will be operating fully loaded and one unit on partial recycle.

Each compressor package consists of a three-stage screw-type compressor with coolant injected into the suction of each stage. The cylinders operate flooded to maintain a maximum gas temperature of 200°F. This temperature must be controlled to prevent polymerization and coking of the gum formers in the gas.

Coolant is injected into the gas stream flowing to the compressor's first stage where the two-phase mixture is compressed from 14.7 psia to 50 psia. The gas/coolant mixture flows to the Interstage Separator, D-1A or B, from which the coolant is separated and sent to the Coolant Surge Tank, TK-1A or B, under level control. The gas from D-1A or B is cooled in Interstage Cooler, E-1A or B. Coolant is again injected into the gas, and the two-phase mixture is sent to the second stage for compression from 45 psia to 120 psia. The gas/coolant mixture is again separated, this time in Interstage Separator D-2A or B, and the coolant is sent back to the Coolant Surge Tank, TK-1A or B, under level control. The gas is cooled in Interstage Cooler E-2A or B. For a third time coolant is injected into the gas stream before the third stage of compression. In the final compression step, the two-phase mixture is compressed from 115 psia to 265 psia before being sent to Discharge Separator D-3A or B. The gas phase is cooled in Discharge Cooler E-3A or B, and flows to Discharge Separator D-4A or B for final coolant separation with the coolant being sent to Discharge Separator D-2A and B, under level control.

*Refer to Figure 3.



NOMENCLATURE - [°F / PSIA]

Fig. 3. Process Flow Diagram: Feed Gas Compressor Packages

Fig. 3. Process Flow Diagram: Feed Gas Compressor Packages

Each compressor package has a separate coolant circulation system. The coolant is pumped from the Coolant Surge Tank, TK-1A or B, by Coolant Pump, P1A, B, C or D, through Compressor Coolant Cooler E-4A or B, where it is cooled by cooling water. From E-4A or B the coolant either flows to the first-stage compression coolant injection point or to Coolant Booster Pump P-2A or B, to be pumped to higher pressure for injection into the second or third stage compressor suction injection points. The compressors are steam turbine driven and also have lube oil and seal oil systems.

Oily water is skimmed from the top of TK-1A or B by Oil Skimmer Pumps, P-3A, B, C and D and sent to the oily water system.

Hydrogenation*

Using the "NIMOX" process, the compressed feed gas is heated by steam in Feed Gas Heater, E-24A, B, & C, and fired Startup Feed Gas Furnace, F-1.

The 550^{o}F feed gas flows to the Hydrogenator, R-1A and B, where the unsaturated hydrocarbons are saturated and sulfur is converted to hydrogen sulfide in the presence of a nickel molybdate catalyst. The temperature rise across the reactor bed is limited to 150^{o}F. As the temperature rise increases across the bed due to higher unsaturates in the gas, the ΔT controller will allow gas cooled by Cold Recycle Cooler #1, E-27, and Cold Recycle Cooler #2, E-28, to be circulated from Recycle Compressor C-2A or B, to the reactor inlet. When no gas is required for the reactor temperature rise control, the compressor operates through the minimum flow bypass.

A Carbon Disulfide Injection Unit, PG-2, and Package Hydrogen Plant, PG-3, are included for presulfiding the catalyst and startup. The Carbon Disulfide Injection Unit is also used if H_2S concentration to the hydrogenator drops below 100 ppm. This would desulfide the catalyst and could result in localized high-temperature areas where coking would likely occur.

Sulfur and Chloride Removal

Purification of the gas is accomplished by two methods in the facility:

1. Stretford plant
2. Chloride/Sulfur Guard beds

The gas flows to the Stretford plant first where the sulfur is removed to a level of 4 ppm in the gas. The gas returns from the Stretford

*Refer to Figure 4.

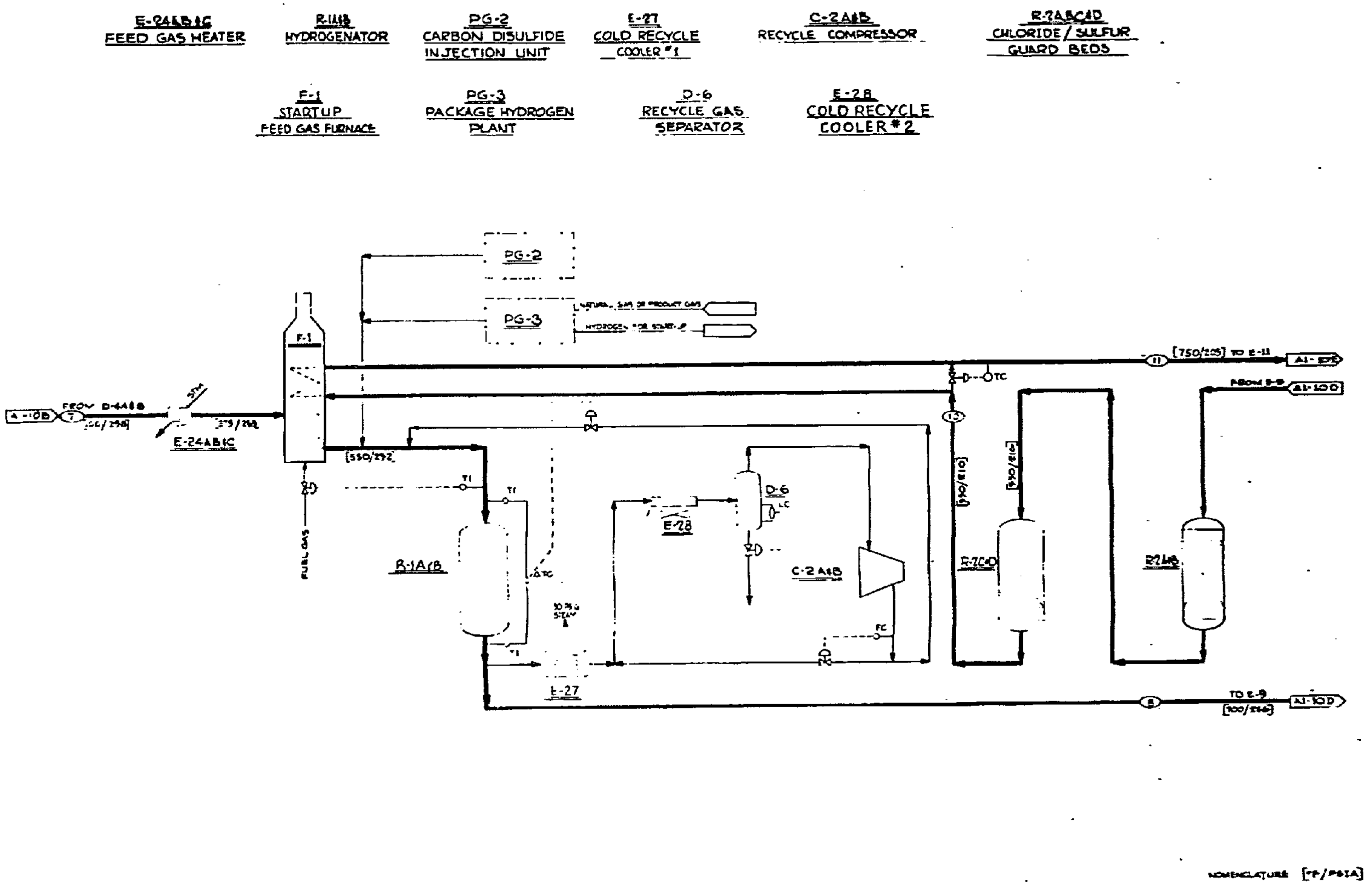


Fig. 4. Process Flow Diagram: Purification Section

plant and flows through the Chloride/Sulfur Guard Beds, R-2 A and B, and R-2C and D, where the final trace sulfur and chlorides in the gas are removed by absorption using promoted zinc oxide before the gas flows to the catalytic upgrading system. Only one bed is actually needed but with two guard beds piped and valved for both series (with either bed first) and parallel operation, one bed may be removed from service for replacement of the zinc oxide while the other one remains in operation.

Stretford Plant*

General

The Stretford process removes hydrogen sulfide from sulfur-bearing gas streams by converting it to elemental sulfur. The process is essentially a regenerative oxidation-reduction system which utilizes atmospheric oxygen as a regenerative agent.

The system can be divided into four parts; Absorption, Oxidation-Reduction, Regeneration, and Sulfur Separation/Recovery.

1. Absorption

   The Stretford solution is an aqueous solution containing sodium carbonate, sodium metavanadate, Anthraquinone Disulfonic Acid (ADA), and Rochelle salt. Hydrogen sulfide is absorbed into the solution forming sodium hydrosulfide (reaction 1).** The sodium carbonate also reacts with carbon dioxide in the gas stream, hydrolyzing and forming a carbonate, bicarbonate buffer system. This protects the system against rapid pH changes.

2. Oxidation-Reduction

   The penta-valent vanadium, in solution, oxidizes the hydrosulfide, forming elemental sulfur (reaction 2), vanadium being present in a stoichiometric quantity with the hydrosulfide concentration. This reaction takes place in an oxygen-free environment since oxygen preferentially reacts with hydrosulfide forming thiosulfate. Next, ADA oxidizes the reduced vanadium back to the penta-valent stage (reaction 3).

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*Refer to Figure 5.

**Reactions are shown on page 24.

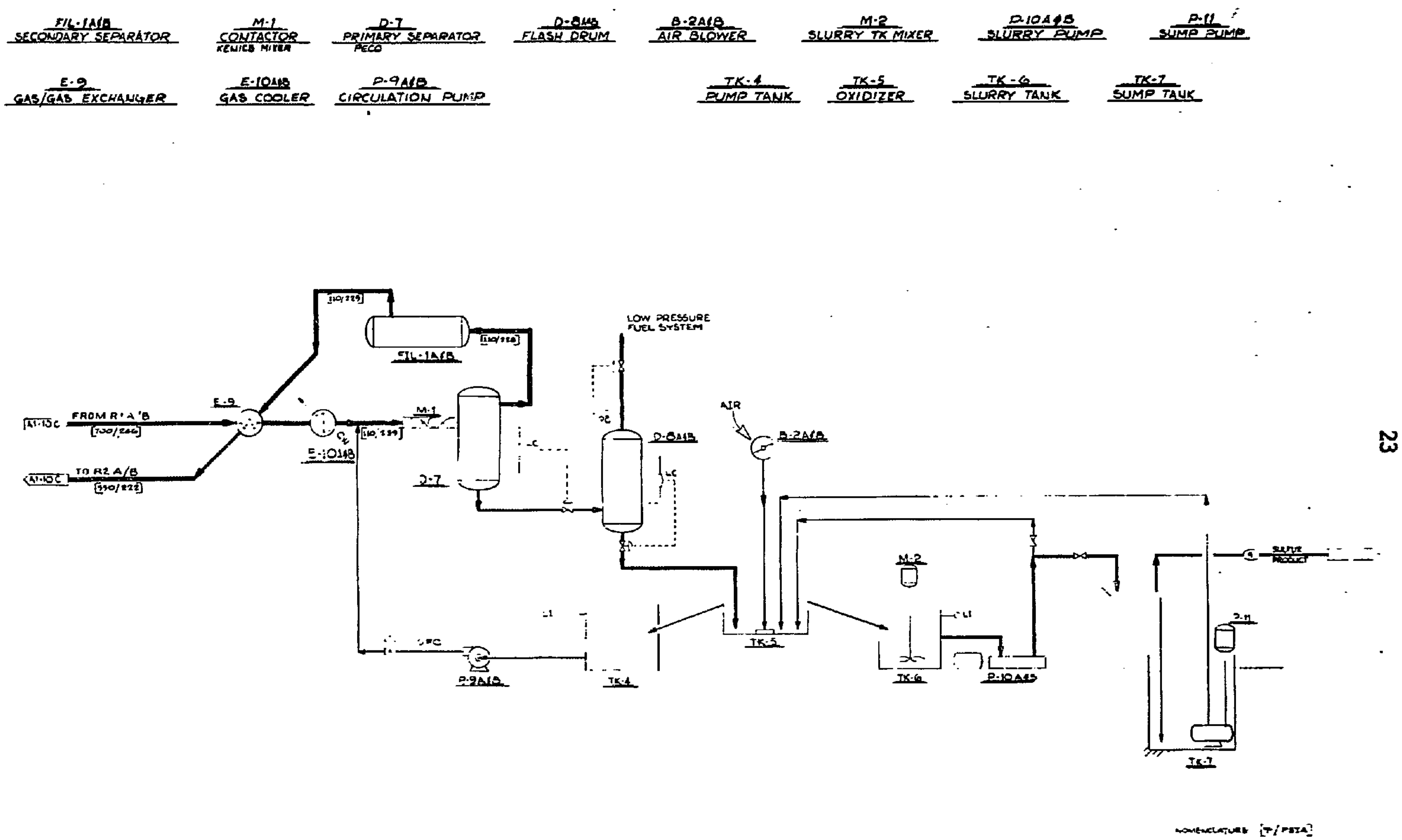

Fig. 5. Process Flow Diagram: Stretford Plant

3. Regeneration

Although part of the regeneration cycle (reaction 3) is described in the oxidation-reduction section, the regeneration step is completed as indicated by equation 4. Atmospheric oxygen is continuously used to oxidize the reduced ADA. Oxygen is introduced by sparging air through the solution.

4. Sulfur Separation and Recovery

When air is sparged through the solution, only part of the oxygen is consumed in the chemical reaction and none of the nitrogen is used. The nitrogen and excess oxygen pass upwards through the solution and exhaust to the atmosphere. As the gas bubbles rise, they adhere to the sulfur particles forming a froth which floats on the solution surface. This is the first sulfur separation stage. The second stage of sulfur separation is accomplished by mechanical means and described later.

The overall chemistry of the process can be summarized as follows:

(1) $H_2S + Na_2CO_3 \longrightarrow NaHS + NaHCO_3$

(2) $HS^- + V^{+5} \longrightarrow S + V^{+4}$

(3) $V^{+4} + ADA \longrightarrow \text{Reduced ADA} + V^{+5}$

(4) $\text{Reduced ADA} + O_2 \longrightarrow ADA + H_2O$

(5) $2H_2S + O_2 \longrightarrow 2S + 2H_2O$*

Details

The hydrogen sulfide Contactor, M-1, is a static mixer. The sour pyrolysis gas enters the mixer section, and flows co-current with the Stretford solution. The gas and liquid are intimately mixed throughout the mixer. During this process, hydrogen sulfide is removed from the gas stream. Other gases are also removed as a function of their solubility, or reactivity with the Stretford

*Summary of reactions 1 through 4.

solution. The clean H_2S-free gas leaving the contactor is called sweet gas, which is separated from the Stretford solution in the Primary Separator, D-7.

The sweet gas is filtered prior to leaving the battery limits of the Stretford process system. The Secondary Separator, FIL-1, removes solid and liquid droplets entrained in the gas stream. The liquid from the secondary separator flows to the Flash Drum, D-8.

Liquid from the primary separator also flows to the Flash Drum, D-8, where dissolved gases are flashed from the solution and vented to the low-pressure fuel system. The liquid is retained in the Flash Drum for 10 minutes to allow the vanadium to react with the hydrosulfide in an oxygen-free environment. The solution then flows to the Oxidizer, TK-5.

The Oxidizer, TK-5, serves to accomplish three functions: one, oxidation of reduced ADA; two, flotation of elemental sulfur; and three, stripping dissolved gases from solution. These functions are accomplished by bubbling air through the liquid using spargers located near the bottom of the tank. The spargers are open bottom cylinders with a perforated plate top. This design causes many small air bubbles to form, promoting oxygenation and flotation. Baffles in the oxidizer tank require the liquid to make three passes in the oxidizer, preventing back mixing and insuring that all liquid remains in the oxidizer approximately 46 minutes. A two-weir combination allows the sulfur froth to overflow into the Slurry Tank, TK-6, and the oxidized Stretford solution to underflow back to the Pump Tank, TK-4.

Oxidized Stretford solution is pumped from the Pump Tank to the Contactor by Circulation Pump P-9A or B, completing the absorption circuit. The operating temperature of the Stretford solution is controlled by adjusting the feed gas temperature thru Gas/Gas Exchanger E-9 and Gas Cooler E-10. The solution temperature is maintained for two reasons: one, water balance adjustment; and two, control sulfur fixation.

The sulfur recovery system is comprised of the Slurry Tank, TK-6, Slurry Tank Mixer, M-2, and Slurry Pump, P-10A or B. The Slurry Tank receives sulfur froth from the Oxidixer overflow.

A mixer located in the Slurry Tank homogenizes the slurry. The slurry is pumped to a draining receiver where the sulfur is collected for disposal. The excess liquid is collected in the Sump Tank, TK-7, and returned to the Oxidizer by Sump Pump P-11. The Slurry Tank also serves to "level" froth surges in the system.

Catalytic Upgrading*

Catalytic Rich Gas (CRG) Reactor

The gas from the purification sections flows to the CRG Feed Cooler, E-11, where steam is generated from the excess heat in the gas. Saturated 450-psig process steam is mixed with the hot feed gas stream before entering the CRG Reactor, R-3A and B. This steam provides the water necessary for the reaction as defined in equations 1 and 2 below. The steam-to-gas ratio is closely controlled to protect the CRG catalyst from "carbon laydown" and to moderate the temperature rise across the bed. The CRG catalyst (modified nickel) causes the steam to react adiabatically with the feed to form methane, carbon dioxide, carbon monoxide, and hydrogen via the following reactions:

(1) $C_AH_B + A\ H_2O$ ____ $(A + \frac{1}{2}B)\ H_2 + A\ CO$ (reforming)

(2) $CO + H_2O$ ____ $H_2 + CO_2$ (water gas)

(3) $CO + 3H_2$ ____ $CH_4 + H_2O$ (methanation)

(4) $CO_2 + 4H_2$ ____ $CH_4 + 2H_2O$ (methanation)

The first reaction will go to completion such that no higher hydrocarbons other than methane will exit the CRG reactor. Reactions 2, 3 and 4 reach an equilibrium state dependent upon the outlet conditions of the reactor. The reactor effluent consists of methane, carbon dioxide, hydrogen, and carbon monoxide, and unreacted steam at near chemical equilibrium according to the latter three reactions.

Methanator

The gas from the CRG reactor passes through the CRG Effluent Cooler, E-12, for removal of the heat of reaction before entering the first of two stages of methanation. The gas is further cooled in the Gas/Gas Exchanger, E-25A and B, and in the CRG Effluent Steam Condenser, E-26. Steam condensed is separated from the gas in D-14, the CRG Effluent Separator. From there the gas is reheated to 482^{o}F in the shell side of E-25 and is ready to be fed to Methanator #1, R-4. In the methanation steps, hydrogen

*Refer to Figure 6.

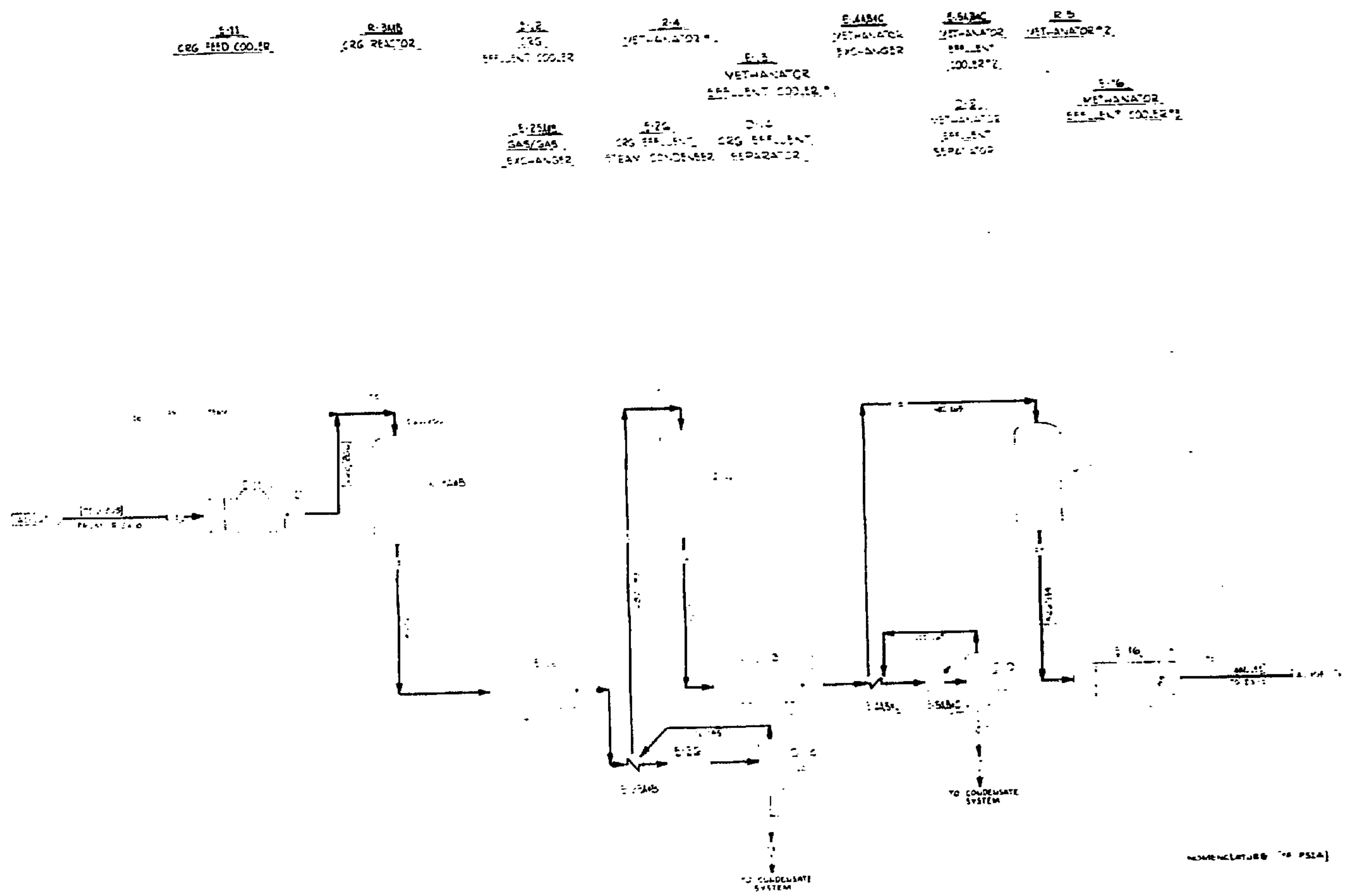

Fig. 6. Process Flow Diagram: Conversion Section

reacts with carbon monoxide according to reactions 3 and 4 above, over CRG catalyst, to form methane. The methanation reaction is exothermic, resulting in a temperature rise across the reactor bed.

The gas enters Methanator No. 1, R-4, at 482°F. Methanator No. 1 reduces the carbon monoxide concentration to 0.6 mole percent. The first methanator is called the "wet" methanator, and the steam remains in the gas to moderate both the reaction rate and temperature rise. This methanator's effluent gas enters the Methanator Effluent Cooler No. 1, E-13, for removal of the heat of reaction, and then passes through Methanator Exchanger E-14A, B and C, and Methanator Effluent Cooler No. 2, E-15A, B and C where the steam in the gas is condensed. The condensed steam is separated from the gas in Methanator Effluent Separator, D-9.

The hydrocarbon gas portion of the stream flows overhead from the separator to the shell side of the Methanator Exchanger, where the gas is reheated to 482°F before entering Methanator No. 2, R-5, the "dry" methanator. The removal of the steam from the stream and reduction of the gas temperature both tend to promote the furthering of the reactions, which convert the carbon oxides to methane. The carbon monoxide in the gas is reduced to 0.07 mole percent when exiting this methanator, and the gas has now completed its conversion to SNG. The SNG is cooled in Methanator Effluent Cooler No. 3, E-16.

The four coolers in the methanation process step comprise a waste heat boiler which is used to generate 450 psig steam, for driving other process operations.

CO_2 Removal*

Synthetic Gas Flow

The SNG from the Methanation Effluent Cooler is desuperheated to 350°F by Desuperheater, DS-1, and is then cooled and condensed in the tubes of the MEA Reboiler, E-17, which is a kettle-type reboiler providing the heat for stripping the MEA used in the CO_2 removal process.

The SNG is again cooled and condensed, this time to 150°F in the tubeside of the Gas Cooler, E-22. The Gas Cooler is operated with co-current flow of reformed gas and cooling water to prevent overcooling the gas.

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*Refer to Figure 7.

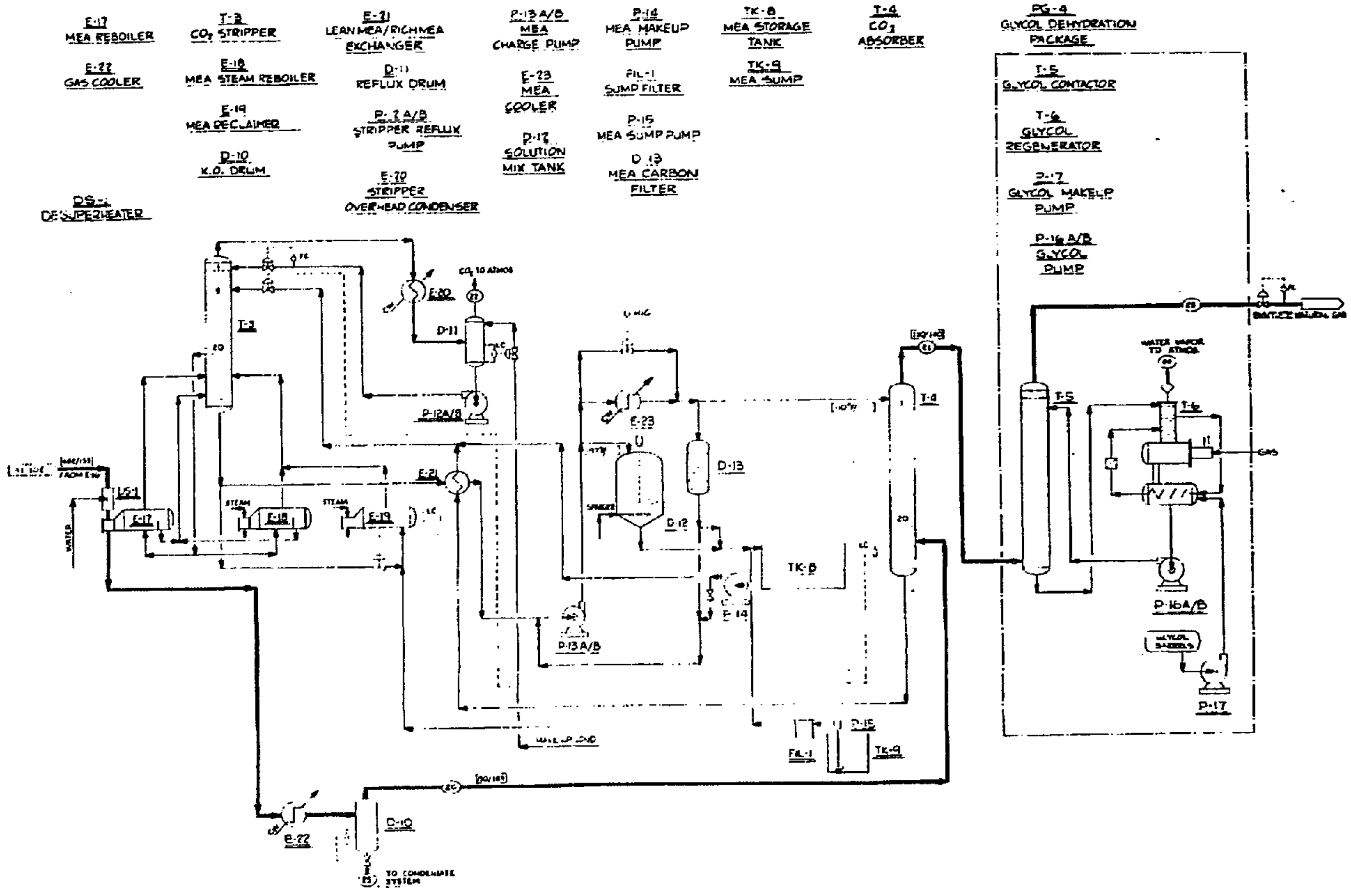

Fig. 7. Process Flow Diagram: CO_2 Removal and Glycol Dehydration

The K.O. Drum, D-10, separates the liquid and vapor from E-22. The liquid goes to the process condensate header via level control.

The SNG from D-10 enters the bottom of the CO_2 Absorber, T-4, and is sparged into momoethanolamine (MEA) below the liquid level. The SNG flows upward through the column where it is contacted with the liquid MEA coming down the column which removes the CO_2 from the SNG. The column contains 20 two-pass valve trays and a mist pad covering the gas outlet to remove any entrained MEA. The overhead from the column at 110°F flows to the glycol contactor, T-5, for dehydration.

MEA Circulation

Rich MEA

Rich MEA (loaded with CO_2) exits the bottom of the CO_2 Absorber at 150°F and flows to the Lean MEA/Rich MEA Exchanger, E-21, where the rich MEA is heated to 215°F against the cooling of the lean MEA. The rich solution then flows through a level control valve into the CO_2 Stripper, T-3. The level control valve controls the flow rate of MEA from the bottom of the absorber in order to keep an adequate level in the absorber. The liquid flows down over 17 two-pass valve trays against a reboiled steam flow. The CO_2 is removed from the MEA by steam stripping. At the bottom of the column, the liquid collects in a chimney tray and flows to two reboilers.

The largest reboiler, E-17, is heated by cooling reformed gas. The MEA Steam Reboiler, E-18, is heated with low-pressure saturated steam. The steam flow rate to E-18 is automatically controlled by a flow controller. The flow of steam is regulated to permit adequate stripping to prevent CO_2 breakthrough at the absorber. The flow of liquid MEA to the two reboilers is distributed by two manual butterfly valves. The vapor from each reboiler flows back to the stripper underneath the chimney tray. The liquid overflows a weir in each reboiler and flows to the bottom of the stripper where, having been stripped of the CO_2, it accumulates as lean MEA. The bottom of the stripper functions as the surge tank and pumping tank of the MEA system. The level in the tank fluctuates freely with the water balance and distribution of MEA throughout the rest of the system.

The CO_2 overhead from the MEA stripper flows to the tube side of the Stripper Overhead Condenser, E-20. Here water is condensed from the CO_2. The resulting liquid/vapor stream is separated in D-11, the Reflux Drum. The CO_2 vapor at 110°F flows through a mist pad in the top of D-11. The liquid condensate in D-11 is pumped by Stripper Reflux Pump, P-12 A or B to the top of the CO_2 Stripper. The condensate enters the top of the stripper and flows down over 3 one-pass, bubble cap trays. The purpose of these trays is to wash entrained and vaporized amine from the CO_2 overhead thus reducing amine losses.

Lean MEA

The lean MEA flows from the bottom of the stripper at 240°F to the Lean MEA/Rich MEA Exchanger, E-21, where the lean solution is cooled to 197°F. The solution goes to the MEA Charge Pump, P-13 A or B to be pumped to the MEA Cooler, E-23, which reduces the temperature to 110°F. There is a manual slipstream bypass on E-23 to prevent the MEA from getting too cold in the winter. The MEA flow is then metered through an automatic flow controller to the top of the CO_2 Absorber at the rate required to prevent CO_2 slippage to the glycol dehydration package.

CO_2 Removal System Auxiliaries

The MEA Carbon Filter, D-13, is a fixed carbon bed absorber which treats a 2% slipstream of cold, lean MEA. The vessel contains an inlet deflector plate followed by a layer of tabular alumina balls which sit on top of a 2-layer screen. The screen rests on the activated carbon, which is supported by tabular alumina balls. The flow through the filter goes back to the suction of P-13 and is controlled manually. The carbon is not regenerated.

The MEA Reclaimer, E-19, separates amine from degradation products by vaporizing the amine in a batch-type distillation. The kettle-type reclaimer is fed with hot, lean MEA from the bottom of the CO_2 Stripper. The flow of MEA is controlled by a level controller in E-19, which keeps the tubes covered. There is no liquid overflow from the reclaimer. The amine is vaporized and flows back to the bottom of the stripper. The high pressure steam is supplied to the reclaimer under automatic pressure control. The liquid in the reclaimer is concentrated and the amine boils off until the temperature reaches 290°F. The contents of the reclaimer are then dumped manually for disposal. The reclaimer does not stay in continuous operation.

The normal operating concentration of the MEA solution is 35% by weight. This is highly corrosive and requires special corrosion inhibitors to prevent corrosion. A Solution Mix Tank, D-12, is used to prepare these inhibitors. D-12 is also provided with an air sparger using utility air. This air sparger keeps the corrosion inhibitors in an oxidized condition.

The MEA Storage Tank, TK-8, provides storage capacity adequate to empty any single piece of equipment in the MEA system. The MEA Make-up Pump, P-14, places solution into the circulating system. The tank can be fed from either D-12; cold, lean solution from E-23; or from the MEA Sump, TK-9.

A 750 gallon MEA Sump, TK-9, is provided to collect any spills or drains in the MEA system. The contents of the sump are removed by the MEA Sump Pump, P-15, which will pump 50 gpm of solution through the Sump Filter, FIL-1 (a cartridge filter), to the MEA Reclaimer, E-19. The contents of the sump can also be pumped to the Storage Tank, TK-8.

Water Balance

The MEA System will constantly need a small amount of make-up water. This is due to the fact that more water is carried out with the vapor streams leaving the stripper, the flash drum, and the absorber than is carried in with the reformed gas to the absorber. To make up this loss, a small stream of demineralized water flows to the Reflux Drum, D-11. The flow rate of this water is controlled automatically by a control valve. The flow rate is set to maintain a constant level in the bottom of the CO_2 Stripper, T-3.

Glycol Dehydration Package*

The Glycol Dehydration Package, PG-4, employs triethylene glycol to remove water vapor from the SNG, and consists of the following items of equipment:

Glycol Contactor,
Glycol Regenerator with Integral Flash Drum, and
Glycol Circulatiom Pump.

The SNG from the CO_2 Absorber flows to the bottom of the Glycol Contactor, T-5. The SNG flows upward through the column, contacting the triethylene glycol, which absorbs the water vapor from the gas stream. The dried SNG exits the top of the contactor with a water dewpoint of less than 0°F, and after a final pressure reduction to achieve pipeline pressure, it is exported to the existing distribution system. The dilute glycol solution containing the absorbed water flows out the bottom of the contactor to the glycol regeneration system. The system operates at a much lower pressure than that in the contactor, so that most of the dissolved gas in the solution separates from the glycol and is used for fuel. The dilute glycol solution flows to the Glycol Regenerator, T-6, after being preheated by exchange with the hot lean glycol. In the regenerator, a direct-fired reboiler strips the water from the glycol solution and exits to the atmosphere. The regenerated triethylene glycol solution from the bottom of the regenerator is heat-exchanged with the incoming dilute solution. The concentrated solution then flows to a glycol accumulator, from which it is then pumped through the glycol cooler before entering the top tray of the contactor. The cooler assumes that the glycol entering the contactor is at a low contacting temperature to obtain a low water dew point.

Reflux requirements for the regenerator are low due to the wide boiling point range between water and triethylene glycol. The incoming glycol feed flows through a coil in the top of the regenerator to furnish cooling for the internal reflux.

The glycol reboiler is fired with natural gas to maintain a temperature of 400°F in the reboiler. The immersion firetube is equipped with burner, burner controls, flame arrestor and stack. A glycol filter is located on the incoming glycol feed line, after the preheat.

*Refer to Figure 7.

Material Balance

The Material Balance found on the process flow diagrams designates the composition for each of the main process streams throughout the facility. The stream numbers form the key between the Material Balance and flow sheets.

Total Water Balance

The water, steam and condensate balance of the system are depicted on Figure 8, showing the connections between and quantities for all users and generators.

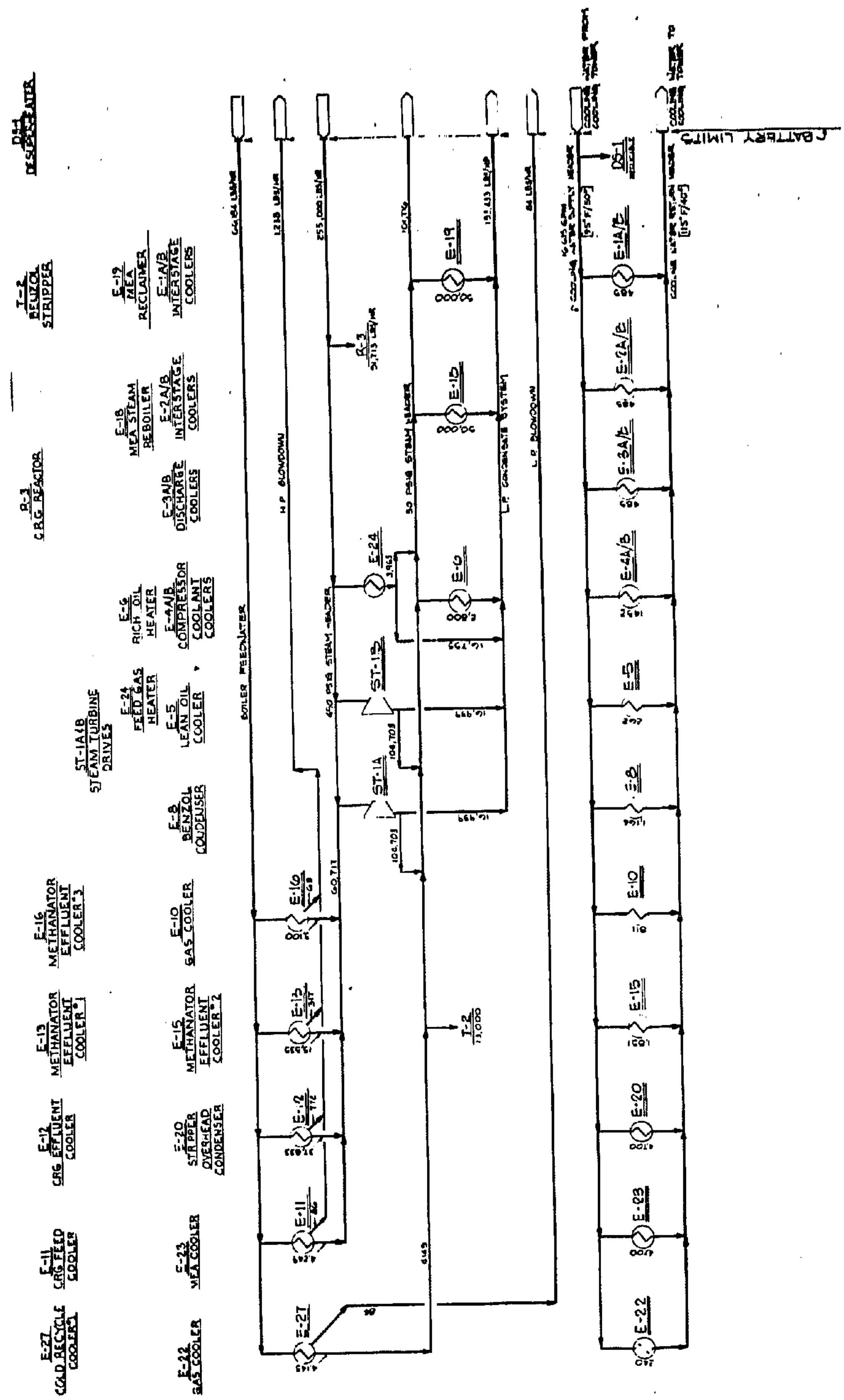

Fig. 8. Process Flow Diagram: Utility System

Base Case

4. UTILITIES, PRODUCTS, ENERGY BALANCE AND AN ANALYSIS OF THE NET REVENUE

Introduction

This section summarizes the utilities consumed or generated by the plant. Also summarized are the plant's products and by-products. Included in this section is an energy balance for the plant and an analysis leading to the net revenue generated by the plant.

Utilities

Boiler Feedwater (import)

Temperature	$100^{o}F$
Pressure	520 psig
Rate	66184 lb/hr / 132 GPM*

*GPM based on $65^{o}F$ base temperature.

High-Pressure Steam (import)

Temperature	$460^{o}F$
Pressure	450 psig
Rate	265,980 lb/hr

Low-Pressure Steam (export)

Temperature	$298^{o}F$
Pressure	50 psig
Rate	101,716 lb/hr

Condensate (export)

Temperature	$270^{o}F$
Pressure	50 psig
Rate	202,503 lb/hr / 405 GPM*

*GPM based on $65^{o}F$ base temperature.

High-Pressure Blowdown (export)

Temperature	460°F
Pressure	450 psig
Rate	1238 lb/hr

Low-Pressure Blowdown (export)

Temperature	298°F
Pressure	50 psig
Rate	84 lb/hr

Cooling Water (import)

Temperature	95°F
Pressure	50 psig
Rate	16635 GPM
Temperature Rise	25°F

Electric Power (import)

(For motor driven equipment, lights, instruments)

Voltage	440 volt
Frequency	60 Hz
Load	2100 KW

Products

Pipeline Quality Gas

Rate	26.4 MMSCFD
HHV	879 BTU/SCF

Carbon Dioxide (discharged to atmosphere)

Rate	18.0 MMSCFD

Sulfur (recovered as elemental sulfur)

Rate	0.04 Ton/day

Oily Liquids (recycled to Purox incinerator)

Rate	105 Ton/day

Energy Balance for the Plant

The energy balance for the plant is shown in Table 4.

Table 4. Energy Balance for the Plant

Stream Name	Stream Rate	Energy Flow Rate[1] MMBTU/HR
Input		
Feed Gas	1.95 $\frac{\text{MMSCF}}{\text{hr}}$	-278.5
Boiler Feed Water	66,184 lb/hr	-429.7
High-Pressure Steam	265,980 lb/hr	-1419.5
Electric Power (1 KW = 3413 BTU/hr)	2100 KW	7.2
Start-up Feed Gas Heater		16.6
TOTAL INPUT		-2103.9

continued

Table 4 . (continued)

Stream Name	Stream Rate	Energy Flow Rate[1] MMBTU/HR
Output		
Product Gas (SNG)	1.1 MMSCF/hr	-60.0
By Products		
Condensate	202,503 lb/hr	-1279.7
50-psig Steam	101,716 lb/hr	-546.7
Oily Liquids	32 bbl/hr	-3.3
SUBTOTAL PRODUCTS AND BY PRODUCTS		-1889.7
Other Streams		
Oily Water Stream		-123.2
CO_2 Stream (Vented to atmosphere)		-330.8
Blowdown Streams		-8.0
Water Vapor Stream (Vented to atmosphere)		-2.6
Air-Cooled heat exchangers		43.7
Water-Cooled heat exchanger		206.7
TOTAL OUTPUT		-2103.9

Note 1. Based on the Girdler enthalpy tables.

Economic Analysis of Feed, Products, and Utilities

Cost of the feed and utilities is shown in Table 5.

Table 5. Cost of the Feed and Utilities to the Plant

Import Stream	Stream Flow Rate	Cost/Unit	Cost of Import $/Hr
Feed Gas	1152.2 MMBTU/hr (46.87 MMSCFD)	$1.40/MMBTU[1]	1613.00
Boiler Feed Water	7935 gal/hr	$1.26/1000 gal[2]	10.00
High-Pressure Steam	265,980 lb/hr	$2.50/1000 lb[3]	665.00
Cooling Water	16635 GPM	$0.06/1000 gal	60.00
Electric Power	2100 KW	$0.03 KW/hr	63.00
TOTAL COST OF THE IMPORTS TO THE PLANT			2411.00

NOTES

1. Price of methane had been assumed to be $2.50/MMBTU. The feed gas to the plant is inferior to methane on two accounts. First, it has a low calorific value. Second, to use it directly requires the installation of special burners and polution control equipment. With these factors in mind, the feed gas has been estimated to cost $1.40/MMBTU.

2. Boiler Feed Water (BFW) has been estimated to cost $0.75/1000 gallons as treated water at ambient temperature (65°F). The plant is supplied BFW at 100°F. The additional heat in the BFW has been priced at $1.75/MMBTU. Accounting for the additional heat, the cost of the Boiler Feed Water at 100°F turns out to be $1.26/1000 gallon.

3. High-Pressure Steam has been valued roughly equal to methane and hence is assumed to cost $2.50/1000 lb.

Prices of the products from the plant are shown in Table 6.

Table 6. Prices of the Products from the Plant

Export Stream	Stream Flow Rate	Cost/Unit	Export Stream Value, $/hr
Product Gas (SNG)	968 MMBTU/hr	$2.50/MMBTU[1]	2420.00
Low-Pressure Steam	101,716 lb/hr	$2.00/1000 lb[2]	203.00
Condensate	24300 gal/hr	$4.15/1000 gal[3]	91.00
Sulfur	Negligible	$30/ton	-----
Oily Liquid (recycled to incinerator)	32 Bbl/hr	$15/Bbl[4]	480.00
Carbon Dioxide	44 ton/hr	$5/ton[5]	220.00
TOTAL VALUE OF THE EXPORTS FROM THE PLANT			3414.00

NOTES

1. Product Gas (SNG) has been assigned the same value as methane, i.e., $2.50/MMBTU.
2. Low-Pressure Steam has been assigned a value of $2.00/1000 lb.
3. Condensate price has been based on $0.75/1000 gallon as treated water at ambient temperature (65°F). Condensate is available at 270°F and the additional heat present in the condensate has been priced at $1.75/MMBTU. Thus the value of the condensate at 298°F has been established as $4.15/1000 gal.

NOTES, contd.

4. The oily liquid is recycled to the Purox incinerator. However, it does have an intrinsic value. Crude oil to which this oily liquid is equivalent has been priced at \$15/barrel and this same price has been used for the oily liquid.

5. Raw carbon dioxide produced by this plant has been assigned a value of \$5/ton.

Net Revenue from the Plant

Table 7 below shows the net revenue generated by the plant on an hourly basis.

Table 7. Net Revenue from the Plant

Item	Cost, $/Hr
Value of the Exports, Table 6	$3414.00
Cost of the Imports, Table 5	$2411.00
NET REVENUE	$1003.00

Net revenue from Table 7 is $1003.00/hr. Based on 8000 hr/year, the net revenue can be expressed on a yearly basis. Therefore,

Net Revenue = $8.02 million/yr.

5. PLANT DESCRIPTION

Introduction

In this section the physical parameters of size, shape, and arrangement shall be defined so that an understanding of what the facility will look like can be achieved.

Layout

The arrangement and the overall area required by the equipment for all of the cleanup and conversion steps necessary to convert the pyrolysis gas to SNG can best be understood by referring to Figure 1. Although the equipment comprises one contiguous facility, the individual processing units are segregated as follows:

Benzol Wash Unit,
Feed Gas Compression Unit,
Purification Unit (Hydrogenation and Chloride/Sulfur Guard),
Stretford Unit,
Conversion Unit, and
CO_2 Removal and Glycol Dehydration Unit.

The required 530 feet by 280 feet area includes a perimeter access road and sufficient space for maintenance access and is in accordance with governing codes. Also located within this area is a control building with sufficient space available for change rooms, lunch room, instrument shop, laboratory, and offices.

In developing the layout, this facility was placed behind or to the east of the refuse receiving/preparation and Purox units. Thus, a logical flow through the entire complex is achieved. A logical flow through the methanation facility was also followed, which minimizes the piping requirements and makes for a plant more easily understood and operated by the operating personnel.

Equipment Specification

The process specifications define the size and/or process requirements which are critical to the design and proper operation of the equipment. In some cases mechanical considerations govern equipment sizing; therefore, differences between the process specifications and the equipment layout do exist. The equipment layout shows how the equipment would actually be supplied while still adhering to the critical requirements of the process specifications.

Equipment specifications are shown in the Appendices to this report. The Appendices are divided into these general categories:

Vessels and Tanks (Appendix A),
Direct-Fired Equipment (Appendix B),
Heat Exchangers (Appendix C), and
Mechanical and Packaged Equipment (Appendix D).

6. INVESTMENT ANALYSIS

Base Estimate

An order of magnitude/ratio estimate for the base case (46.87 MMSCFD pyrolysis gas, which is equivalent to 4530 T/D garbage when using the design basis composition and 61% efficiency) was developed using the procedure outlined below. (See Section 2 for additional data on capacity.)

(a) Major equipment was in-house priced using current cost data. Vendor data and pricing assistance were obtained for: *

Item	Vendor
D-7 Primary Separator	Peco
FIL-1 A/B Secondary Separator	Peco
T-1 Benzol Absorber	CB&I
F-1 A/B Start-up Feed Gas Furnace	G. C. Broach
E-5 Lean Oil Cooler	Locke Equipment
E-6 Rich Oil Heater	Locke Equipment
E-7 Lean/Rich Exchanger	Locke Equipment
E-8 Benzol Condenser	Locke Equipment
E-24 Feed Gas Heaters	Western Supply
E-27 Cold Recycle Cooler	Marley Co.
E-9 Gas/Gas Exchanger	Western Supply
E-10 Gas Cooler	Western Supply
E-11 CRG Feed Cooler	Western Supply
E-12 CRG Effluent Cooler	Western Supply
E-13 Methanator Effluent Cooler No. 1	Western Supply
E-14 Methanator Exchanger	Western Supply
E-15 Methanator Effluent Cooler No. 2	Western Supply
E-16 Methanator Effluent Cooler No. 3	Western Supply
E-25 Gas/Gas Exchanger	Western Supply
E-26 CRG Effluent Steam Condenser	Marley Co.
PG-1 Feed Gas Compressor Package	Ingersoll-Rand
PG-2 Carbon Disulfide Injection Package	A.M.S. Systems Engr.
PG-3 Package Hydrogen Plant	Howe Baker
PG-4 Glycol Dehydration Package	Maloney-Crawford
PG-5 CO_2 Removal Package	Union Carbide
D-3 A/B Exhauster	Garden City
P-4 A/B Rich Oil Pump	Gould
P-5 A/B Lean Oil Pump	Gould
P-6 A/B Lean Oil Makeup Pump	Gould
P-7 Benzol Condensate Pump	Gould

*Cost data listing begins on page 50.

(b) The Total installed cost (TIC) was developed by grouping like equipment items and factoring their cost by a TIC multiplier for that group. The multiplier covers commodity materials, field labor, field indirects and home office and was based on Pritchard's general experience in the industry. All back-up data by equipment item before factoring for the base case estimate are included in this section. The investment necessary for the methanation facility as herein defined is $47,320,000

Lower Capacity Plant Estimate

In order to obtain the total installed cost of the lower capacity plant (1050 T/D refuse pyrolyzed) an exponential procedure was applied to the capacity ratio. This procedure for adjusting estimated costs for different capacity plants is common to the industrial construction industry. In this case an exponent of 0.65 was chosen based on Pritchard's experience with facilities comprised of similar units. Specifically, the ratio of the lower capacity plant to the higher capacity plant was raised to the 0.65 power ($[1050/4530^*]^{.65} = .39$) to determine a multiplier for factoring the lower capacity plant's cost from that of the higher capacity plant. From these efforts it was determined that an investment of $18,296,000 was required for the lower capacity plant. (See Section 2 for additional information on capacity.)

Accuracy

The accuracy of an estimate of this type is very difficult to predict. The engineering is only completed to the extent that a very broad brush definition of the facility can be made, which is obviously reflected in the investment analysis. On the other hand, the estimate is the result of pricing each piece of equipment, which certainly improves the accuracy. We expect that there is a 1 in 10 chance that the estimate is within plus or minus a few percent and that the estimate could be expected to be accurate to within plus 25% or minus 5%.

Items Not Included

The following items were not included in the TIC estimate:

- Spare Parts
- Land
- Site Investigation or Improvements
- Piling
- Taxes & Royalties
- Premium Payments
- Duties
- Operating & Maintenance Cost

Items Not Included (continued)

Escalation (Estimate as of third quarter 1980)
Client's Costs
Off-sites

Personnel and Maintenance Cost

Personnel Cost

The following lists the yearly personnel costs anticipated, including benefits:

1 -	Plant Manager (1/3 charged to this facility)	$14,000
1 -	Ass't. Plant Manager (" " " ")	10,000
1 -	Secretary/Clerical	10,000
1 -	Chief Operator	30,000
4 -	Operator Foreman	80,000
12 -	Operators	180,000
1 -	Chemist	25,000
3 -	Lab Technicians	45,000
2 -	Laborers	24,000
	Total	$418,000

Maintenance Cost

Maintenance costs for this type of facility are about 4% of the TIC per year or 0.04 x $47,320,000 =$1,892,800.

Investment Payout

Although the methanation facility described herein cannot stand alone without the refuse preparation and Purox units, the battery limits concept employed for determining the total installed cost, the personnel and maintenance cost, the value of all feed stocks and utilities consumed, and the revenue produced by the primary and secondary products will permit a realistic determination of the economic parameter very often considered: that is, investment payout. Not including interest on capital or taxes the yearly income is:

Revenue from Energy Balance	$8,020,000.
Personnel Cost	- 418,000.
Maintenance Cost	- 1,892,800
Net Revenue	$5,709,200.

Payout = TIC/yearly income = $47,320,000/$5,709,200 = 8.29 years.

Base Case

Est. 124 Rev. 3 12/74

THE PRITCHARD CORPORATION KANSAS CITY, MISSOURI

ESTIMATE SUMMARY SHEET

MH	ACCT. NO.	Equipment	Commodities	Subcontracts	Field Labor	Total
	1.0 PLANT SITE					
	2.0 BUILDINGS					
	3.0 STRUCTURES					
	4.0 CONCRETE WORK					
	5.0 VESSELS	2,266,000				
	6.0 FURNACES & BOILERS	213,000				
	7.0 HEAT EXCHANGERS	1,600,000				
	8.0 COOLING TOWERS	—				
	9.0 MECHANICAL EQUIPMENT	219,000		13,203,000		
	10.0 INSTRUMENTS & CONTROLS					
	11.0 PIPING					
	12.0 ELECTRICAL					
	13.0 INSULATION					
	14.0 PAINTING					
	15.0 CHEMICALS					
	16.0 START-UP ENGINEERS					
	TOTAL DIRECT COSTS	4,298,000		13,203,000 (1)		17,501,000
	23.0 PAYROLL TAXES & FRINGE BENEFITS					
	20.0 CONST. EQMT. PREP. EXP., SMALL TOOLS					
	21.0 TEMPORARY FACILITIES					
	22.0 FIELD SUPV. & EXPENSE					
	24.1 INSURANCE					
	TOTAL INDIRECT FIELD COSTS					
	CONTINGENCIES					
	ESCALATION					

24.2 SALES & OTHER TAX	
25.0 K.C. OFFICE EXPENSE MH	
(1) Partially & Totally Installed	
SUBTOTAL DIRECT & INDIRECT COST	
JOB COST Say	37,370,000
Chemicals, Packing & Catalyst - Installed	4,500,000
PROFIT (GROSS, NET)	
Subtotal	41,870,000
Escalation 4-79 To 10-80 @ 13%/a	5,450,000
TOTAL	47,320,000

TOTAL SELLING PRICE / EQMT. COSTS = ______ =

TOTAL SELLING PRICE / KC TECH. MH = ______ = $ /MH

DRAFTING MH / PIECES OF EQMT. = ______ =

TOTAL SELLING PRICE / DIRECT COST = ______ =

GROSS PROFIT + CONTINGENCY / TOTAL SELLING PRICE-(GROSS PROFIT & CONTINGENCY) = %

BID LABOR EFFICIENCY K______

TYPE OF JOB Methanation- Purox Off-Gas MADE BY JB BID DATE 10-31-80

FOR SASSI CHECKED BY ______ JOB COMPLETION DATE ______

AT Indianapolis, Ind PAGE NO. 1 OF 4 AWARD DATE ______ ESTIMATE NO. 2392

CONSTRUCTION COSTS

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No.______ JOB No. 2392
MADE By______ APPRV.______

CUSTOMER Sassi Corporation
LOCATION Indianapolis, Indiana
PROJECT Methanation of Furox Off-Gas

Vessels

A/C No.	DESCRIPTION			QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
5.0	Vessels												
	Page	5-2	D-5	1	Ea						9000		
	"	5-3	D-6	1	"						3000		
	"	5-4	D-7	1	"						71000		
	"	5-5	D-8 A/B	2	"						206000		
	"	5-6	D-9	1	"						18000		
	"	5-7	D-14	1	"						25000		
	"	5-8	FIL-1 A/B	2	"						27000		
	"	5-9	R-1 A/B	2	"						223000		
	"	5-10	R-2 A/B/C/D	4	"						296000		
	"	5-11	R-3 A/B	2	"						245000		
	"	5-12	R-4	1	"						50000		
	"	5-13	R-5	1	"						48000		
	"	5-14	T-1	1	"						368000		
	"	5-15	T-2	1	"						258000		
	"	5-16	TK-2	1	"						8000		
	"	5-17	TK-3	1	"						14000		
	"	5-18	TK-4	1	"						42000		

DATE 4/3/79
REV. NO.______
REV. DATE______

REV. DATE

EST. 906- 1 78

CONSTRUCTION COSTS

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2392
MADE By JB APPRV. ____

CUSTOMER Sassi Corporation
LOCATION Indianapolis, Indiana
PROJECT Menthanation of Purox Off-Gas — Vessels

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
5.0	Vessels (con't										
	Page 5-19 TK-5	1	Ea						164000		
	5-20 TK-6	1	"						38000		
	5-21 TK-7	1	"						5000		
	Subtotal								2118000		
	Allowance for nozzles & misc item								64000		
	" " Freight								84000		
	Total								2266000		

DATE 4/3/79
REV. NO.
REV. DATE

PAGE NO. 5-1a

PAGE NO. 5-1a

Est.-721 Rev. 1 10/74 **J. F. PRITCHARD AND COMPANY** KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # D-5					
	SERVICE: BENZOL SEPARATOR	1		8200		
	SIZE & DESCRIPTION: Horiz ___ Vert X					
	Dimensions: 3'0" ID X 18'-0" T-T					
	Shell Thk 3/8"					
	MATERIAL: S.S. C.S. A-285-c Other					
	Pressure Temperature					
	Design 50 psig 150 °F					
	Working 0.4 psig 100 °F					
	INTERNALS (Description & Material)					
	6" THK. S.S. MIST ELIMINATOR M/L } TRAY SUPPORTS: 2" X 3/8" BAR RINGS			800		
	Weight: Vessel 4100 lbs.					
	Internals ___ lbs.					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks.after P.O.					
	TERMS OF PAYMENT:					
				9000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS, INDIANA PAGE NO. 5-2 ESTIMATE NO. 2392

(place one copy in the equipment log)

DATE 4/3/79
REV. NO. ___
REV. DATE ___

Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # D-6					
	SERVICE: RECYCLE GAS SEPARATOR			2500		
	SIZE & DESCRIPTION: Horiz ___ Vert ___					
	Dimensions: 18" X 4'-6" T-T					
	HEAD: A-234 WPB C.S.					
	SHELL: A-106-B C.S. Shell Thk ___					
	MATERIAL: S.S. ___ C.S. X Other ___					
	Pressure / Temperature					
	Design 285 psig 150 °F					
	Working 231 psig 100 °F					
	INTERNALS (Description & Material)					
	6" THK. S.S. MIST ELIMATOR M/L & Supports			500		
	Weight: Vessel 1100 #/EA. lbs.					
	Internals ___ lbs.					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks.after P.O.					
	TERMS OF PAYMENT:					
				3000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS, INDIANA PAGE NO. 5-3 ESTIMATE NO. 2392

(place one copy in the equipment log)

Est.- 721 Rev. 1 10/74 **J. F. PRITCHARD AND COMPANY** KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # D-7					
	SERVICE: PRIMARY SEPARATOR			61000		
	w/CONTROLS			5000		
	SIZE & DESCRIPTION: Horiz ___ Vert ___					
	Dimensions: 96" I.D. X 24' S-S.					
	FLOW: GAS 124,000 #/HR. MOL. WT. 26.5					
	FLOW: LIQUID 4550 gpm Shell Thk ___					
	MATERIAL: S.S. C.S. X Other					
	(5300 GAL. STORAGE) Pressure Temperature					
	Design ___ psig ___ °F					
	Working 239 psig 110 °F					
	FILTER C.S. WITH EPOXY LINING			5000		
	INTERNALS (Description & Material)					
	STAINLESS STEEL (incl above)					
	Weight: Vessel 39,000 lbs.					
	Internals ___ lbs.					
	14" INLET & OUTLET FLANGE					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks. after P.O.					
	TERMS OF PAYMENT:					
				71000		

TYPE OF JOB ___ MADE BY ___ DATE ___

FOR ___ CHECKED BY ___ DATE ___

AT ___ PAGE NO. 5-4 ESTIMATE NO. ___

(... copy in the equipment log)

Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # D-8 A/B	2	91000	182000		
	SERVICE: FLASH DRUM					
	SIZE & DESCRIPTION: Horiz ___ Vert X					
	Dimensions: 13'-0" I.D. X 34'-0" T-T					
	Shell Thk ___					
	MATERIAL: S.S. C.S. A-285-C Other					
	Pressure / Temperature					
	Design 25 psig 150 °F					
	Working 10 psig 110 °F					
	INTERNALS (Description & Material)					
	COAL TAR EPOXY LINING			24000		
	Weight: Vessel 49,000 #/EA. lbs.					
	Internals ___ lbs.					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks. after P.O.					
	TERMS OF PAYMENT:			206000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS, INDIANA PAGE NO. 5-5 ESTIMATE NO. 2395

(place one copy in the equipment log)

KANSAS CITY, MISSOURI

Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # D-9					
	SERVICE: METHANATOR EFFLUENT SEPARATOR	1		16000		
	SIZE & DESCRIPTION: Horiz ___ Vert X					
	Dimensions: 5'-6" I.D. X 6'-0" T-T					
	Shell Thk 9/16"					
	MATERIAL: S.S. C.S. A-516-70 Other					
	Pressure / Temperature					
	Design 210 psig 250 °F					
	Working 154 psig 100 °F					
	INTERNALS (Description & Material)					
	6" THK. S.S. MIST ELIMINATOR m/L			2000		
	Weight: Vessel 6900 #/EA. lbs.					
	Internals ___ lbs.					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks. after P.O.					
	TERMS OF PAYMENT:					
				18000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS, INDIANA PAGE NO. 5-6 ESTIMATE NO. 2392

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ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # D-14					
	SERVICE: CRG EFFLUENT SEPARATOR	1		23000		
	SIZE & DESCRIPTION: Horiz ___ Vert X					
	Dimensions: 6'-0" I.D. X 8'-0" T-T					
	Shell Thk .625					
	MATERIAL: S.S. C.S. A-516-70 Other					
	Pressure / Temperature					
	Design 225 psig 275 °F					
	Working 169 psig 212 °F					
	INTERNALS (Description & Material)					
	6" THK. S.S. MIST ELIMINATOR M/L w/Supports			2000		
	Weight: Vessel 9900 #/EA. lbs.					
	Internals ___ lbs.					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks.after P.O.					
	TERMS OF PAYMENT:					
				25000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS, INDIANA PAGE NO. 5-7 ESTIMATE NO. 2392

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J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

Est.-721 Rev. 1 10/74 **J. F. PRITCHARD AND COMPANY** KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # FIL-1A & B					
	SERVICE: SECONDARY SEPARATOR	2		26000		
	W/CONTROLS					
	SIZE & DESCRIPTION: Horiz ___ Vert ___					
	Dimensions: 28" O.D. SHELL 10" SUMP					
	10" INLET & OUTLET FLANGE					
	FLOW: 124,000 #/HR. Shell Thk ___					
	MATERIAL: S.S. ___ C.S. X Other ___					
	MOL. WT 26.53 Pressure Temperature					
	Design ___ psig ___ °F					
	Working 228 psig 110 °F					
	FILTER - C.S. WITH EPOXY LINING			1000		
	INTERNALS (Description & Material)					
	Weight: Vessel 4600 #/EA. lbs.					
	Internals ___ lbs.					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks. after P.O.					
	TERMS OF PAYMENT:					
				27000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/79

FOR SASCI CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS, INDIANA PAGE NO. 5-8 ESTIMATE NO. 2393

(place one copy in the equipment log)

Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # R-1 A & B					
	SERVICE: HYDROGENATOR	2	104,000	208000		
	SIZE & DESCRIPTION: Horiz ____ Vert X					
	Dimensions: 11'-6" ID X 26'-0" T-T					
	MATL. A302-B UT-435					
	MANGANESE ½ MOLY Shell Thk 1 3/16"					
	MATERIAL: S.S. C.S. Other X					
	Pressure / Temperature					
	Design 285 psig 830 °F					
	Working 237 psig 800 °F					
	CATALYST VOLUME: 2200 CU FT. EA		w/chem & pack.			
	INTERNALS (Description & Material)	18 ea				
	8 MESH - 304 S. STL. WIRE MESH - 3 w/1 Hold down	6	2500	15000		
	PACKING: ⅛" x ¼" MIXED ALUMINA BALLS, ½" & 1" Ø ALUMINA BALLS.		w/chem & packing			
	Weight: Vessel 76,200 #/EA. lbs.					
	Internals ____ lbs.					
	ERECTION:					
	Field Fab ____ Shop Fab ____					
	Quote By ____					
	Date ____					
	Freight					
	Export Box					
	Painted Area ____ s.f.					
	Insulated Area ____ s.f.					
	SCHEDULED DELIVERY ____ wks. after P.O.					
	TERMS OF PAYMENT:					
				223000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ____ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ____ DATE ____

AT INDIANAPOLIS, INDIANA PAGE NO. 5-9 ESTIMATE NO. 2395

(place one copy in the equipment log)

Est.- 721 Rev. 1 10/74 **J. F. PRITCHARD AND COMPANY** KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # R-2A/B/C/D					
	SERVICE: CHLORIDE / SULFUR GUARD BEDS	4	68,000	272000		
	SIZE & DESCRIPTION: Horiz ___ Vert X					
	Dimensions: 11'-0" I.D. X 16'-0" T-T					
	MATL. MANGANESE ½ MOLY					
	A302-B UT-435 Shell Thk 1 1/16"					
	MATERIAL: S.S. ___ C.S. ___ Other X					
	Pressure / Temperature					
	Design 250 psig 850 °F					
	Working 207 psig 550 °F					
	CATALYST VOLUME: 760 CU.FT. EA			w/chem & pack.		
	INTERNALS (Description & Material)		18			
	8 MESH - 304 S. STL. WIRE MESH	12	2000	24000		
	PACKING: ALUMINA BALLS ⅛"x¼" MIXED			w/chem & pack.		
	ALSO ½" + 1" Ø					
	Weight: Vessel 50,000 #/EA. lbs.					
	Internals ___ lbs.					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks.after P.O.					
	TERMS OF PAYMENT:					
				296000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS, INDIANA PAGE NO. 5-10 ESTIMATE NO. 2392

4/2/79

2392

Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # R-3 A/B	2	118,000	236000		
	SERVICE: CRG REACTOR					
	SIZE & DESCRIPTION: Horiz ____ Vert X					
	Dimensions: 9'-6" ID x 11'-0" T-T					
	MATL. MANGANESE ½ MOLY					
	A302-B UT-425 Shell Thk 3 ¼"					
	MATERIAL: S.S. C.S. Other X					
	Pressure / Temperature					
	Design 250 psig 1000 °F					
	Working 125 psig 927 °F					
	CATALYST VOLUME: 425 CU. FT. EA			w/chem & packing		
	INTERNALS (Description & Material)		18			
	8 MESH - 304 S. STL. WIRE MESH	6	1500	9000		
	PACKING: ALUMINA BALLS ½" & 1" Ø &		20.4			
	⅛" x ¼" MIXED			w/chem & packing		
	Weight: Vessel 86,200 #/EA. lbs.					
	Internals ________ lbs.					
	ERECTION:					
	Field Fab ________ Shop Fab ________					
	Quote By ________					
	Date ________					
	Freight					
	Export Box					
	Painted Area ________ s.f.					
	Insulated Area ________ s.f.					
	SCHEDULED DELIVERY ________ wks. after P.O.					
	TERMS OF PAYMENT:					
				245000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ________ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ________ DATE ________

AT INDIANAPOLIS, INDIANA PAGE NO. 5-11 ESTIMATE NO. 2392

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Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

Est.-721 Rev. 1 10/74 **J. F. PRITCHARD AND COMPANY** KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # R-4					
	SERVICE: METHANATOR No. 1	1		46000		
	SIZE & DESCRIPTION: Horiz ___ Vert X					
	Dimensions: 8'-6" I.D. X 11'-0" T-T					
	MATL. MANGANESE ½ MOLY					
	MATL. A-302-B UT-435 Shell Thk 1 9/16"					
	MATERIAL: S.S. ___ C.S. ___ Other ___					
	Pressure / Temperature					
	Design 220 psig 925 °F					
	Working 175 psig 800 °F					
	CATALYST VOLUME: 380 CU.FT.		w/ chem & packing			
	INTERNALS (Description & Material)		18			
	8 MESH - 304 S.STL. WIRE MESH	3	1600 use	4000		
	PACKING: ⅛" x ¼" MIXED ALUMINA BALLS,		20 H w/ chem & packing			
	½" + 1" ø ALUMINA BALLS					
	Weight: Vessel 33,500 lbs.					
	Internals ___ lbs.					
	WT. INCLUDES NOZZLES + SKIRTS					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks.after P.O.					
	TERMS OF PAYMENT:					
				50000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS, INDIANA PAGE NO. 5-12 ESTIMATE NO. 2392

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J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

Est.-721 Rev. 1 10/74 **J. F. PRITCHARD AND COMPANY** **KANSAS CITY, MISSOURI**

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # R-5					
	SERVICE: METHANATOR No. 2	1		44000		
	SIZE & DESCRIPTION: Horiz ___ Vert X					
	Dimensions: 8'-6" I.D. X 11'-0" T-T					
	MATL MANGANESE ½ MOLY					
	MATL A-302B UT-435 Shell Thk 1 3/16"					
	MATERIAL: S.S. C.S. Other					
	Pressure / Temperature					
	Design 200 psig 925 °F					
	Working 150 psig 800 °F					
	CATALYST VOLUME: 350 CU.FT.			w/chem & packing		
	INTERNALS (Description & Material)					
	8 MESH-304 S.STL. WIRE MESH	3	1200	4000		
	PACKING: 1/8" x 1/4" MIXED ALUMINA BALLS,					
	½" + 1"Ø ALUMINIA BALLS			w/chem & packing		
	Weight: Vessel 32,200 lbs.					
	Internals ___ lbs.					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks.after P.O.					
	TERMS OF PAYMENT:					
				48000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/79

FOR SOSSI CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS INDIANA PAGE NO. 5-15 ESTIMATE NO ___

Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # T-1 (Field Fab)	1	EA.	360000		
	SERVICE: BENZOL ABSORBER					
	SIZE & DESCRIPTION: Horiz ___ Vert X					
	Dimensions: 22'-0" I.D. X 80'-0" T-T					
	Shell Thk 1/2"					
	MATERIAL: S.S. C.S. A-285-C Other					
	Pressure Temperature					
	Design 5 psig 150 °F					
	Working 1.1 psig 108 °F					
	INTERNALS (Description & Material)					
	2- levels of Wood Grid Packing		w/chem & packing			
	22' ID x 20' L ea. level 7600 cf/ea					
	Liq. Distributor C.S.	2	4000	8000		
	Weight: Vessel 195,000 lbs.					
	Internals ___ lbs.					
	TRAY SUPPORTS: 7 X 8 STRUCTURAL TEES					
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By CB & I By PHONE					
	Date 12/6/78					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks. after P.O.					
	TERMS OF PAYMENT:					
				368000		

TYPE OF JOB METHENATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS, INDIANA PAGE NO. 5-14 ESTIMATE NO. 2392

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KANSAS CITY, MISSOURI

Est.-721 Rev. 1 10/74

J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	PRESSURE VESSELS					
M.H.	TAG # T-2 (Field Fab)					
	SERVICE: BENZOL STRIPPER	1		250000		
	SIZE & DESCRIPTION: Horiz ___ Vert X					
	Dimensions: 20'-0" I.D. X 56'-0" T-T					
	Shell Thk 1/2"					
	MATERIAL: S.S. C.S. A-285-C Other					
	Pressure / Temperature					
	Design 5.0 psig 250 °F					
	Working 1.0 psig 215 °F					
	INTERNALS (Description & Material)					
	2 - LEVELS OF 1 1/2" RACHIG RINGS			w/them & packing		
	22' I.D. X 15' L. EA. LEVEL 5700 C.F./EA.					
	TRAY SUPPORTS: 4"x1" BAR RINGS					
	Weight: Vessel 60,300 lbs.					
	Internals ___ lbs.					
	Liquid Distributor C.S.	2	4000	8000		
	ERECTION:					
	Field Fab ___ Shop Fab ___					
	Quote By ___					
	Date ___					
	Freight					
	Export Box					
	Painted Area ___ s.f.					
	Insulated Area ___ s.f.					
	SCHEDULED DELIVERY ___ wks. after P.O.					
	TERMS OF PAYMENT:					
				258000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ___ DATE 4/2/77

FOR SESCO CORPORATION CHECKED BY ___ DATE ___

AT INDIANAPOLIS, INDIANA PAGE NO. ___ ESTIMATE NO. ___

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Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
	Storage Tanks					
	TK-2 Benzol Storage Tank	1	Ea	8000		
	Size - 42" ø × 16'-0" T/T					
	Capacity - 1000 gals					
	Design P - 0.5 psig					
	T - 120° F					
	Thickness - 15/16"					
	Wt - 3800 #					
	Material -					
	Shop Fab					
				8000		

TYPE OF JOB Methanation of Purox Off-Gas MADE BY JB DATE 4/3/79

FOR Sassi Corp CHECKED BY DATE

AT Indianapolis, Indiana PAGE NO. 5-16 ESTIMATE NO. 2392

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Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

EST. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
	Storage Tank					
	TK-3 Lean Oil Storage	1	Ea	14000		
	Size - 13'-0" ø x 24'-0" H					
	Roof - Cone					
	Capacity - 25,000 gals					
	Design P - atmos					
	T - 120° F					
	Wt - 14000#					
	Material					
	API					
				14000		

TYPE OF JOB Methanation of Purox Off-Gas MADE BY JB DATE 4/3/79

FOR Sassi Corp CHECKED BY DATE

AT Indianapolis, Ind PAGE NO. 5-17 ESTIMATE NO. 2392

Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
5.0	FIELD FABRICATED STORAGE TANKS					
	TAG # TK- 4					
	SERVICE: Pump Tank (Field Fab)	1	Ea	30000		
	SIZE AND DESCRIPTION (complete)					
	18'-6" Ø x 26'-0" H w/Cone roof					
	Liquid level @ 21'-0" lined with					
	coal tar epoxy allow	1500	SF	12000		
	Volume ____ c.f.					
	Material: S.S. ____ C.S. A-285-C Other ____					
	S.R & spot x-ray					
	Pressure atmos psig Working					
	Temperature 110 °F "					
	Insulated Area ____ s.f.					
	Painted Area ____ s.f.					
	Weight 25,200 lbs.					
	ERECTION:	S/C				
	ACCESSORIES:					
	Hydro Test ____					
	Freight					
	Quote By ____ Export Box					
	Date ____					
	START ERECTION ____ wks.after P.O.					
	FINISH ERECTION ____ wks.after P.O.					
	TERMS OF PAYMENT:					
				42000		

TYPE OF JOB Methanation of Purox Off-Gas MADE BY JB DATE 4/3/79

FOR Sassi Corp CHECKED BY ____ DATE ____

AT Indianapolis, Ind. PAGE NO. 5-18 ESTIMATE NO. 2392

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Est.- 721 Rev. 1 10/74

J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
.0		FIELD FABRICATED STORAGE TANKS					
		TAG # TK-5					
		SERVICE: Oxidizer					
		SIZE AND DESCRIPTION (complete)			140000		
		41'-6" Ø x 26'-0" H w/ Cone Roof					
		Thicknes - Shell 1/4" - lined w/ coal	3000	SF	24000		
		tar epoxy - baffles used to divide					
		tank in 3 = parts					
		Volume ______ c.f.					
		Material: S.S. ______ C.S. A-285-C Other ______					
		Pressure Atmos psig Working					
		Temperature 110 °F "					
		Insulated Area ______ s.f.					
		Painted Area ______ s.f.					
		Tank Weight 81,000 lbs.					
		Piping & Misc Internals 27,300 #	S/C				
		ERECTION:					
		ACCESSORIES:			incl		
		134- Spargers - 304L S.S. 18"Ø x 18"					
		Air pipes 2" Ø					
		Hydro Test ______					
		Freight					
		Quote By ______ Export Box					
		Date ______					
		START ERECTION ______ wks.after P.O.					
		FINISH ERECTION ______ wks.after P.O.					
		TERMS OF PAYMENT:					
					164000		

TYPE OF JOB Methanation of Purox Off-Gas MADE BY JB DATE 4/3/79

FOR Sassi Corp CHECKED BY ______ DATE ______

AT Indianapolis, Ind PAGE NO. 5-19 ESTIMATE NO. 2392

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J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
	FIELD FABRICATED STORAGE TANKS					
	TAG # TK-6					
	SERVICE: Slurry Tank	1	Ea	28000		
	SIZE AND DESCRIPTION (complete)					
	16'-0" ø x 26'-0" w/ Cone Roof					
	lined w/ coal tar epoxy max	1300	SF	10000		
	liquid level 21'-0"					
	Volume ______ c.f.					
	Material: S.S. ______ C.S. A-285-C Other ______					
	Pressure Atmos psig Working					
	Temperature 110 °F "					
	Insulated Area ______ s.f.					
	Painted Area ______ s.f.					
	Weight 23,700 lbs.					
	ERECTION:	S/C				
	ACCESSORIES:					
	Hydro Test ______					
	Freight					
	Quote By ______ Export Box					
	Date ______					
	START ERECTION ______ wks.after P.O.					
	FINISH ERECTION ______ wks.after P.O.					
	TERMS OF PAYMENT:					
				38000		

TYPE OF JOB Methanation of Purox Off-Gas MADE BY JB DATE 4/3/79

FOR Sassi Corp CHECKED BY ______ DATE ______

AT Indianapolis, Ind PAGE NO. 5-20 ESTIMATE NO. 2392

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Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

IT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
	Storage Tanks					
	TK-7 Sump Tank	1	Ea	5000 (w/lining)		
	Size - 6'-0" Ø x 6'-0" H					
	Capacity					
	Working P - Atmos					
	T - 110 °F					
	Wt - 3400#					
	Mat'l - FRP or CS epoxy lined w/ U/G protection (3' below grade)					
				5000		

TYPE OF JOB Methanation of Purox Off-Gas MADE BY JB DATE 4/3/79

FOR Sussi Corp CHECKED BY DATE

AT Indianapolis, Ind PAGE NO. 5-21 ESTIMATE NO. 2352

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Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

MATERIAL LABOR TOTAL

EST. 905- 1 78

CUSTOMER Sassi Corporation

LOCATION Indianapolis, Indiana

PROJECT Methanation of Purox Off-Gas

CONSTRUCTION COSTS

Furnaces

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No.____ JOB No. 2392
MADE By JB APPRV.____

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
6.0	Furnaces										
	Page 6-2 F-1 A/B	2	Ea						193000		
	Allow for misc items and low allowable pressure drop								12000		
	Allow for freight								8000		
	Total								213000		

DATE 4/19/79

REV. NO.____

REV. DATE____

PAGE NO. 6-1

Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

EST. 906- 1 /P

CONSTRUCTION COSTS

6.0 Account
Furnaces

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2392
MADE By JB APPRV. ____

CUSTOMER SASSI Corporation
LOCATION Indianapolis, Indiana
PROJECT Methanation of Purox Off-Gas

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
6.0	F-1A/B Start-up Feed Gas Furnace										
	A. 7.44 MM Btu/Hr F1 Hydro. Section Heater								40000		
	B. 24.78 MM Btu/Hr Reactor Feed Heater								153000		
	F1 Heater to be vertical tube C.S. all radiant heater w/ multipasses										
	Reactor Feed Heater to be vertical radiant-convection type heater w/ alloy radiant tubes & CS convection tubes										
	Vendor quoted 2 separate furnaces as opposed to 1 furnace w/ 2 sections as stated in our req. Vendor feels that it will provide better control and the cost would be about the same										
	Price per Braach 1/10/79								193000		

DATE 4/18/79
REV. NO.
REV. DATE

PAGE NO. 6-2

DATE 1/18/79
REV. NO.
REV. DATE

PAGE NO. 6-2

EST. 905- 1/78

CONSTRUCTION COSTS

7.0 Account

Heat Exchangers

CUSTOMER Sassi Corp.
LOCATION Indianapolis, Indiana
PROJECT Methanation of Purox Off-Gas

J.F. PRITCHARD AND CO.
KANSAS CITY, MISSOURI
E.W.O. No.____ JOB No. 2392
MADE By____ APPRV.____

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
7.0	Heat Exchangers										
	Page 7-2 E-5	3	Ea						70900		
	7-3 E-6	1	"						10700		
	7-4 E-7	5	"						216100		
	7-5 E-8	1	"						7700		
	7-6 E-7	1	"						145000		
	7-7 E-8	1	"						22000		
	7-8 E-9	1	"						35000		
	7-9 E-10	1	"						85000		
	7-10 E-11	1	"						18000		
	7-11 E-12	1	"						100000		
	7-12 E-13	1	"						50000		
	7-13 E-14	1	"						68000		
	7-14 E-15	1	"						250000		
	7-15 E-16	1	"						16000		
	7-16 E-25	1	"						98000		
	7-17 E-26	1	"						200000		
	7-18 E-27	1	"						65000		
	7-19 E-28	1	"						40000		
	Subtotal								1497400		
	Design Allowance & Freight								102600		
	Total								1600000		

DATE 11/80
REV. NO.
REV. DATE

PAGE NO. 7-1 (Rev 1)

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ESTIMATING SHEET

PAGE NO. 7-1 (Rev 1)

Est.- 721 Rev. 1 10/74

J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-5					
		SERVICE: LEAN OIL COOLER	3	23,633	70900		
		S-T ____ OTHER ____					
		TYPE ____ SIZE ____					
		No. Shells/Unit ____					
		Heat Transfer Area 5,500 S.F.					
		Bare Tube Surface/Shell ____ s.f.					
		Heat Exchanged (Design) Btu/Hr. ____					
		SHELL / TUBE					
		Design Pressure 90 psig / 75 psig					
		Design Temp. 150 °F / 185 °F					
		Material C.S. SA-516 GR.70 / SA-179 (?)					
		TEMA CLASS: C					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes ____ O.D. ____					
		BWG ____ Length ____					
		FLANGES: 150# RF					
		Weight EA. 9780 lbs.					
		TOTAL WEIGHT 29,340#					
		ERECTION					
		Field ____ Shop ____ Assembled					
		Quote By LOCKE EQUIP. CO.					
		Date 12/4/78 Freight					
		Export Box					
		Painted Area ____ s.f.					
		Insulated Area ____ s.f.					
		F.O.B. BUFFALO, NEW YORK					
		SCHEDULED DELIVERY 22 TO 24 wks. after P.O.					
		TERMS OF PAYMENT:			70900		
		PRICES FIRM - 30 DAYS FROM QUOTE DATE					

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ____ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ____ DATE ____

AT INDIANAPOLIS, INDIANA PAGE NO. 7-2 ESTIMATE NO. 9392

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REV. NO. ____
REV DATE

Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-6					
		SERVICE: RICH OIL HEATER	1	EA.	10700		
		S-T ______ OTHER ______					
		TYPE ______ SIZE ______					
		No. Shells/Unit ______					
		Heat Transfer Area 641 S.F.					
		Bare Tube Surface/Shell ______ s.f.					
		Heat Exchanged (Design) Btu/Hr. ______					
		SHELL / TUBE					
		Design Pressure 75 psig / 75 psig					
		Design Temp. 350 °F / 350 °F					
		Material C.S. SA-516-GR.70 / SA-179					
		TEMA CLASS: C					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes ______ O.D. ______					
		BWG ______ Length ______					
		FLANGES: 150# RF					
		Weight EA. 3660 lbs.					
		ERECTION					
		Field ______ Shop ______ Assembled					
		Quote By LOCKE EQUIP. CO.					
		Date 12/4/78 Freight					
		Export Box					
		Painted Area ______ s.f.					
		Insulated Area ______ s.f.					
		SCHEDULED DELIVERY 22 TO 24 wks.after P.O.					
		TERMS OF PAYMENT:					
		PRICES FIRM - 30 DAYS FROM QUOTE DATE.			10700		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ______ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ______ DATE ______

AT INDIANAPOLIS, INDIANA PAGE NO. 7-3 ESTIMATE NO. 2392

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4/2/79

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TOTAL

p

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ESTIMATING SHEET

MATERIAL LABOR TOTAL

Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
.0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-7					
		SERVICE: LEAN/RICH EXCHANGER	5	43225	216100		
		S-T OTHER					
		TYPE SIZE					
		No. Shells/Unit					
		Heat Transfer Area 11,248 S.F.					
		Bare Tube Surface/Shell s.f.					
		Heat Exchanged (Design) Btu/Hr.					
		SHELL TUBE					
		Design Pressure 75 psig 90 psig					
		Design Temp. 300 °F 300 °F					
		Material C.S. SA-516-GR.70 SA-179					
		TEMA CLASS: C					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes O.D.					
		BWG Length					
		FLANGES: 150 # RF					
		Weight EA. 18,200 lbs.					
		TOTAL WT. 91,000 #					
		ERECTION					
		Field Shop Assembled					
		Quote By LOCKE EQUIP. CO.					
		Date 12/4/78 Freight					
		Export Box					
		Painted Area s.f.					
		Insulated Area s.f.					
		SCHEDULED DELIVERY 22 TO 24 wks.after P.O.					
		TERMS OF PAYMENT:					
		PRICES FIRM - 30 DAYS FROM QUOTE DATE			216100		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ______ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ______ DATE ______

AT INDIANAPOLIS, INDIANA PAGE NO. 7-4 ESTIMATE NO. 2392

(place one copy in the equipment log)

92

LABOR

...D CO. ...OURI ...OB No. 2392 ...PPRV.

Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-8					
		SERVICE: BENZOL CONDENSER	1	EA.	7700		
		S-T ____ OTHER ____					
		TYPE ____ SIZE ____					
		No. Shells/Unit ____					
		Heat Transfer Area 1,106 S.F.					
		Bare Tube Surface/Shell ____ s.f.					
		Heat Exchanged (Design) Btu/Hr. ____					
		SHELL / TUBE					
		Design Pressure 15 psig / 75 psig					
		Design Temp. 300 °F / 320 °F					
		Material C.S. SA-516-GR 70 / SA-179					
		TEMA CLASS: C					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes ____ O.D. ____					
		BWG ____ Length ____					
		FLANGES: 150# RF					
		Weight EA. 2450 lbs.					
		ERECTION					
		Field ____ Shop ____ Assembled					
		Quote By LOCKE EQUIP. CO.					
		Date 12/4/78 Freight					
		Export Box					
		Painted Area ____ s.f.					
		Insulated Area ____ s.f.					
		F.O.B. BUFFALO, NEW YORK					
		SCHEDULED DELIVERY 22 TO 24 wks. after P.O.					
		TERMS OF PAYMENT:			7700		
		PRICES FIRM - 30 DAYS FROM QUOTE DATE					

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ____ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ____ DATE ____

AT INDIANAPOLIS, INDIANA PAGE NO. 7-5 ESTIMATE NO. 2392

(place one copy in the equipment log)

Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
.0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-7					
		SERVICE: FEED GAS HEATER	1	EA.	145000		
		S-T ______ OTHER ______					
		TYPE ______ SIZE ______					
		No. Shells/Unit ______					
		Heat Transfer Area 12,575 S.F.					
		Bare Tube Surface/Shell ______ s.f.					
		Heat Exchanged (Design) Btu/Hr. ______					
		SHELL / TUBE					
		Design Pressure 275 psig / 500 psig					
		Design Temp 470 °F / 470 °F					
		Material C.S. SA 516-Gr 70 / Adm. SB-111 Alloy 445					
		TEMA CLASS: R					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes ______ O.D. ______					
		BWG ______ Length ______					
		FLANGES: 300#FF					
		Weight ______ lbs.					
		ERECTION					
		Field ______ Shop ______ Assembled					
		Quote By Western Supply					
		Date 4/12/79 Freight					
		Export Box					
		Painted Area ______ s.f.					
		Insulated Area ______ s.f.					
		SCHEDULED DELIVERY ______ wks.after P.O.					
		TERMS OF PAYMENT:					
					145000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ______ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ______ DATE ______

AT INDIANAPOLIS, INDIANA PAGE NO. 7-6 ESTIMATE NO. 2292

(place one copy in the equipment log)

Est. - 721 Rev. 1 10/74

J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
7.0		AERIAL COOLERS					
		TAG # E-8					
		SERVICE: COLD RECYCLE COOLER	1	EA.	25000		
		(AIR COOLER EXCHANGER)					
		SIZE AND TYPE OF BAYS					
		No. of Bays					
		Finned Surface/Bay ______ s.f.					
		Bare Tube Surface/Bay ______ s.f.					
		Heat Exchanged ______ Btu/Hr.					
		Tube Press. ______ psig. Tube Temp ______ °F					
		Material Tube ______ Mtl. Header ______					
		Type of Finn					
		FAN:					
		Dia. ______ Mtl. ______ No/Bay ______					
		DRIVER					
		Exp. Proof ______ TEFC ______ Other ______					
		No/Bay ______					
		HP ______ V/Ø/Hz ______					
		TYPE OF DRIVE: V-Belt ______ Gear ______					
		ERECTION:					
		Field ______ Shop ______ Assembled					
		Weight ______ lbs.					
		Quote By MARLEY COMPANY					
		Date ______					
		SCHEDULED DELIVERY ______ wks. after P.O.					
		TERMS OF PAYMENT:					
					25000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ______ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ______ DATE ______

AT INDIANAPOLIS, INDIANA PAGE NO. 7-7 ESTIMATE NO. 2398

(place one copy in the equipment log)

Est.-721 Rev. 1 10/74 **J. F. PRITCHARD AND COMPANY** KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT NO		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
7.0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-9					
		SERVICE: Gas/Gas Exchanger	1	EA.	35000		
		S-T ______ OTHER ______					
		TYPE ______ SIZE ______					
		No. Shells/Unit ______					
		Heat Transfer Area 2530 S.F.					
		Bare Tube Surface/Shell ______ s.f.					
		Heat Exchanged (Design) Btu/Hr. ______					
		SHELL / TUBE					
		Design Pressure 860 psig / 825 psig					
		Design Temp. 700 °F / 850 °F					
		Material C.S. SA-516 Gr. 70 / Adm. SB-111 Alloy 445					
		Temp Class: R					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes ______ O.D. ______					
		BWG ______ Length ______					
		Flanges: 300#					
		Weight ______ lbs.					
		ERECTION					
		Field ______ Shop ______ Assembled					
		Quote By Western Supply					
		Date 4/12/79 Freight					
		Export Box					
		Painted Area ______ s.f.					
		Insulated Area ______ s.f.					
		SCHEDULED DELIVERY ______ wks. after P.O.					
		TERMS OF PAYMENT:					
					35000		

TYPE OF JOB Methanation of Purox Off-Gas MADE BY ______ DATE 4/2/79

FOR Sassi Corporation CHECKED BY ______ DATE ______

AT Indianapolis, Indiana PAGE NO. 7-8 ESTIMATE NO. 2295

(place one copy in the equipment log)

Est.- 721 Rev. 1 10/74

J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
7.0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-1C					
		SERVICE: GAS COOLER	1	EA.	8500		
		S-T ______ OTHER ______					
		TYPE ______ SIZE ______					
		No. Shells/Unit ______					
		Heat Transfer Area 6977 S.F.					
		Bare Tube Surface/Shell ______ s.f.					
		Heat Exchanged (Design) Btu/Hr. ______					
		SHELL / TUBE					
		Design Pressure 275 psig / 75 psig					
		Design Temp. 400 °F / 400 °F					
		Material C.S. SA-516 GR 70 / ADM. SB-111 ALLOY 445					
		TEMA CLASS: C					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes ______ O.D. ______					
		BWG ______ Length ______					
		FLANGES: SHELL - 300# RF, TUBE - 150# RF					
		Weight ______ lbs.					
		ERECTION					
		Field ______ Shop ______ Assembled					
		Quote By Western Supply					
		Date 4/12/79 Freight					
		Export Box					
		Painted Area ______ s.f.					
		Insulated Area ______ s.f.					
		SCHEDULED DELIVERY ______ wks. after P.O.					
		TERMS OF PAYMENT:					
					8500		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ______ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ______ DATE ______

AT INDIANAPOLIS, INDIANA PAGE NO. 7-9 ESTIMATE NO. 2292

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Cat.-721 Rev. 1 10/74

J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

IT. NO.	DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
	S-T, FIN TUBE, U-TUBE, EXCHANGERS					
M.H.	TAG # E-11					
	SERVICE: CRG FEED COOLER (UNFIRED STEAM BOILER)	1	EA	18000		
	S-T ____ OTHER ____					
	TYPE ____ SIZE ____					
	No. Shells/Unit ____					
	Heat Transfer Area 575 S.F.					
	Bare Tube Surface/Shell ____ s.f.					
	Heat Exchanged (Design) Btu/Hr. ____					
	SHELL / TUBE					
	Design Pressure 500 psig 850 psig					
	Design Temp. 500 °F 800 °F					
	Material C.S. SA-516-70 SA-178-C					
	CONSTRUCTION CODE: ASME SECT VIII DIV. I					
	TUBE SIZE AND DESCRIPTION					
	INTERNAL BY-PASS REQUIRED					
	No. Tubes ____ O.D. ____					
	BWG ____ Length ____					
	FLANGES: 300 # RF					
	Weight ____ lbs.					
	ERECTION					
	Field ____ Shop ____ Assembled					
	Quote By Western Supply					
	Date 4/12/79 Freight					
	Export Box					
	Painted Area ____ s.f.					
	Insulated Area ____ s.f.					
	SCHEDULED DELIVERY ____ wks. after P.O.					
	TERMS OF PAYMENT:			18000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ____ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ____ DATE ____

AT INDIANAPOLIS, INDIANA PAGE NO. 7-10 ESTIMATE NO. 2392

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Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
7.0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-12					
		SERVICE: CRG EFFLUENT COOLER	1	EA	100000		
		(UNFIRED STEAM BOILER)					
		S-T ______ OTHER ______					
		TYPE ______ SIZE ______					
		No. Shells/Unit ______					
		Heat Transfer Area 7,382 S.F.					
		Bare Tube Surface/Shell ______ s.f.					
		Heat Exchanged (Design) Btu/Hr. ______					
		SHELL TUBE					
		Design Pressure 500 psig 250 psig					
		Design Temp. 500 °F 975 °F					
		Material C.S. SA-516-70 SA-250-T16					
		CONSTRUCTION CODE: ASME SECT. VIII, DIV. I					
		TUBE SIZE AND DESCRIPTION					
		INTERNAL BY-PASS REQUIRED					
		No. Tubes ______ O.D. ______					
		BWG ______ Length ______					
		FLANGES: 300 # RF					
		Weight ______ lbs.					
		ERECTION					
		Field ______ Shop ______ Assembled					
		Quote By Western Supply					
		Date 4/12/79 Freight					
		Export Box					
		Painted Area ______ s.f.					
		Insulated Area ______ s.f.					
		SCHEDULED DELIVERY ______ wks.after P.O.					
		TERMS OF PAYMENT:					
					100000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ______ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ______ DATE ______

AT INDIANAPOLIS, INDIANA PAGE NO. 7-11 ESTIMATE NO. 9292

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Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-13					
		SERVICE: METHANATOR EFFLUENT COOLER #1					
		(UNFIRED STEAM BOILER)	1	EA.	50000		
		S-T ______ OTHER ______					
		TYPE ______ SIZE ______					
		No. Shells/Unit ______					
		Heat Transfer Area 3,318 S.F.					
		Bare Tube Surface/Shell ______ s.f.					
		Heat Exchanged (Design) Btu/Hr. ______					
		SHELL / TUBE					
		Design Pressure 500 psig / 250 psig					
		Design Temp. 500 °F / 900 °F					
		Material C.S. SA-516-70 / SA-550-TII					
		CONSTRUCTION CODE: ASME SECT. VIII, DIV. I					
		TUBE SIZE AND DESCRIPTION					
		INTERNAL BY-PASS REQUIRED					
		No. Tubes ______ O.D. ______					
		BWG ______ Length ______					
		FLANGES: 300# RF					
		Weight ______ lbs.					
		ERECTION					
		Field ______ Shop ______ Assembled					
		Quote By Western Supply					
		Date 4/12/79 Freight					
		Export Box					
		Painted Area ______ s.f.					
		Insulated Area ______ s.f.					
		SCHEDULED DELIVERY ______ wks. after P.O.					
		TERMS OF PAYMENT:					
					50000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ______ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ______ DATE ______

AT INDIANAPOLIS, INDIANA PAGE NO. 7-18 ESTIMATE NO. 2392

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Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-14					
		SERVICE: METHANATOR EXCHANGER	1	EA.	68000		
		S-T OTHER					
		TYPE SIZE					
		No. Shells/Unit					
		Heat Transfer Area 10,613 S.F.					
		Bare Tube Surface/Shell s.f.					
		Heat Exchanged (Design) Btu/Hr.					
		SHELL / TUBE					
		Design Pressure 250 psig / 250 psig					
		Design Temp. 550 °F / 550 °F					
		Material C.S. SA-516-70 / SA-179					
		TEMA CLASS: R					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes O.D.					
		BWG Length					
		FLANGES: 300# RF					
		Weight lbs.					
		ERECTION					
		Field Shop Assembled					
		Quote By Western Supply					
		Date 4/12/79 Freight					
		Export Box					
		Painted Area s.f.					
		Insulated Area s.f.					
		SCHEDULED DELIVERY wks. after P.O.					
		TERMS OF PAYMENT:					
					68000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY DATE

AT INDIANAPOLIS, INDIANA PAGE NO. 7-13 ESTIMATE NO. 2392

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Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
.0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-15					
		SERVICE: METHANATOR EFFLUENT COOLER #2					
		S-T ____ OTHER ____	1	EA.	250000		
		TYPE ____ SIZE ____					
		No. Shells/Unit ____					
		Tot. Heat Transfer Area 40,288 S.F.					
		Bare Tube Surface/Shell ____ s.f.					
		Heat Exchanged (Design) Btu/Hr. ____					
		SHELL TUBE					
		Design Pressure 210 psig 75 psig					
		Design Temp. 320 °F 320 °F					
		Material C.S. SA-516-70 SA-179					
		TEMA CLASS: C					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes ____ O.D. ____					
		BWG ____ Length ____					
		Weight ____ lbs.					
		ERECTION					
		Field ____ Shop ____ Assembled					
		Quote By Western Supply					
		Date 4/12/79 Freight					
		Export Box					
		Painted Area ____ s.f.					
		Insulated Area ____ s.f.					
		SCHEDULED DELIVERY ____ wks.after P.O.					
		TERMS OF PAYMENT:					
					$250000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ____ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ____ DATE ____

AT INDIANAPOLIS, INDIANA PAGE NO. 7-14 ESTIMATE NO. 2292

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/79

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Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
7.0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-16					
		SERVICE: METHANATOR EFFLUENT COOLER #3					
		(UNFIRED STEAM BOILER)	1	EA.	16000		
		S-T ______ OTHER ______					
		TYPE ______ SIZE ______					
		No. Shells/Unit ______					
		Heat Transfer Area 1146 S.F.	16000				
		Bare Tube Surface/Shell ______ s.f.					
		Heat Exchanged (Design) Btu/Hr. ______					
		SHELL / TUBE					
		Design Pressure 500 psig 850 psig					
		Design Temp. 500 °F 600 °F					
		Material C.S. SA-516-70 SA-178-C					
		CONSTRUCTION CODE: ASME SECT. VIII, DIV. I					
		TUBE SIZE AND DESCRIPTION					
		INTERNAL BY-PASS REQUIRED					
		No. Tubes ______ O.D. ______					
		BWG ______ Length ______					
		FLANGES: 300# RF					
		Weight ______ lbs.					
		ERECTION					
		Field ______ Shop ______ Assembled					
		Quote By Western Supply					
		Date 4/12/75 Freight					
		Export Box					
		Painted Area ______ s.f.					
		Insulated Area ______ s.f.					
		SCHEDULED DELIVERY ______ wks.after P.O.					
		TERMS OF PAYMENT:					
					16000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ______ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ______ DATE ______

AT INDIANAPOLIS, INDIANA PAGE NO. 7-15 ESTIMATE NO. 2392

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Est.- 721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT NO		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
'.0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-25					
		SERVICE: Gas/Gas Exchanger					
			1	EA	98000		
		S-T ______ OTHER ______					
		TYPE ______ SIZE ______					
		No. Shells/Unit ______					
		Heat Transfer Area 15,074 S.F.	9¢/ft²				
		Bare Tube Surface/Shell ______ s.f.					
		Heat Exchanged (Design) Btu/Hr. ______					
		SHELL / TUBE					
		Design Pressure 225 psig 225 psig					
		Design Temp. 550 °F 550 °F					
		Material C.S. SA-516-70 SA-179					
		TEMA CLASS: R					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes ______ O.D. ______					
		BWG ______ Length ______					
		FLANGES: 300# RF					
		Weight ______ lbs.					
		ERECTION					
		Field ______ Shop ______ Assembled					
		Quote By Western Supply					
		Date 4/12/79 Freight					
		Export Box					
		Painted Area ______ s.f.					
		Insulated Area ______ s.f.					
		SCHEDULED DELIVERY ______ wks.after P.O.					
		TERMS OF PAYMENT:					
					98000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ______ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ______ DATE ______

AT INDIANAPOLIS, INDIANA PAGE NO. 7-46 ESTIMATE NO. 2278

Est.-721 Rev. 1 10/74 J. F. PRITCHARD AND COMPANY KANSAS CITY, MISSOURI

ESTIMATING SHEET

ACCT. NO.		DESCRIPTION	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR UNIT	LABOR TOTAL
7.0		S-T, FIN TUBE, U-TUBE, EXCHANGERS					
	M.H.	TAG # E-26					
		SERVICE: CRG EFFLUENT STEAM CONDENSER	1	EA.	200000		
		S-T ____ OTHER ____					
		TYPE ____ SIZE ____					
		No. Shells/Unit ____					
		Heat Transfer Area S.F.					
		Bare Tube Surface/Shell ____ s.f.					
		Heat Exchanged (Design) Btu/Hr. ____					
		SHELL / TUBE					
		Design Pressure ____ psig ____ psig					
		Design Temp. ____ °F ____ °F					
		Material					
		TUBE SIZE AND DESCRIPTION					
		No. Tubes ____ O.D. ____					
		BWG ____ Length ____					
		Weight ____ lbs.					
		ERECTION					
		Field ____ Shop ____ Assembled					
		Quote By NEELEY COMPANY					
		Date ____ Freight					
		Export Box					
		Painted Area ____ s.f.					
		Insulated Area ____ s.f.					
		SCHEDULED DELIVERY ____ wks.after P.O.					
		TERMS OF PAYMENT:					
					200000		

TYPE OF JOB METHANATION OF PUROX OFF-GAS MADE BY ____ DATE 4/2/79

FOR SASSI CORPORATION CHECKED BY ____ DATE ____

AT INDIANAPOLIS, INDIANA PAGE NO. 7-17 ESTIMATE NO. 2392

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4/2/79

2392

TOTAL

EST. 906- 1/78

CUSTOMER SASSI

LOCATION INDIANAPOLIS, IND

PROJECT METHANATION OF PUROX OFF GAS

CONSTRUCTION COSTS

7.0 ACCOUNT

EXCHANGERS

J.F. PRITCHARD AND CO.
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2392
MADE BY [initials] APPRV. ____

A/C No.	DESCRIPTION			QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
7.0	E-27 Cold Recycle Cooler #1										65000		
		Gas Side	Stm Side										
	Flow #/hr	33192	4145										
	Des Press psign	300	75										
	Temp @ Boiler In °F	700	—										
	" @ " Out °F	360	—										
	Sat Temp °F	—	298										
	Feed H_2O Temp °F	—	100										
	Carbon Steel												

DATE ____

REV. NO. ____

REV. DATE ____

PAGE NO. ____

EST. 906- 1/78

CUSTOMER SASSI

LOCATION INDIANAPOLIS, IND

PROJECT METHANATION OF PUROX OFF-GAS

CONSTRUCTION COSTS

7.0 ACCOUNT

EXCHANGERS

J.F. PRITCHARD AND CO.
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2392
MADE By ____ APPRV. ____

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
7.0	E-28 Cold Recycle Cooler # 2							est	40000		
	Size 10'x12'										
	Bare Tube 900 SF										
	Design Press 280 PSI										
	Design Temp 425 °F										
	Carbon Steel										
	Heat Exchanged Norm 3,124,000 BTU/HR										
	Design 3,436,000										

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CUSTOMER Sassi Corporation

LOCATION Indianapolis, Indiana

PROJECT Methanation of Purox Off-Gas

CONSTRUCTION COSTS

9.0 Account

Mech. Equip.

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2392
MADE By JB APPRV. ____

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	Mechanical Equipment										
	Page 9-2 PG-1 A/B	2	Ea							8000000	
	9-3 PG-2	1	"						35000		
	9-4 PG-3	1	"						770000		
	9-5 PG-4	1	"						210000		
	9-6 PG-5	1	"							3800000	
	9-7 PG-5 chemicals								w/chemical & packing cost		
	9-8 C-2 A/B	2	"						50000		
	9-9 C-3 A/B	2	"						28000		
	9-10 P-4 A/B	2	"						12000		
	P-5 A/B	2	"						13000		
	P-6 A/B	2	"						3000		
	P-7	1	"						2000		
	9-11 P-9 A/B	2	"						10000		
	P-10	1	"						5000		
	P-11	1	"						5000		
	9-12 M-1 & M-2	2	"						20000		
	B-2 A/B	2	"						20000		
	Subtotal								1183000	11800000	
	Design Allowance								38000	354000	
	Freight Allowance								47000	—	
	Total								1,268,000	12,154,000	

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CUSTOMER Sassi Corporation

CONSTRUCTION COSTS

THE PRITCHARD CORPORATIO

CUSTOMER Sassi Corporation

LOCATION Indianapolis, Indiana

PROJECT Methanation of Purox Off-Gas

CONSTRUCTION COSTS

9.0 Account

Mech. Equip.

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No. ______ JOB No. 2392
MADE By JB APPRV. ______

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	PG-1A/B Feed Gas Compressor Pkg	2	Ea					$4MM	8000000		
	Incl - C-1A/B Feed Gas Compressors								(installed)		
	D-1A/B Interstage Separators								w/all inter.		
	D-2A/B " "										
	TK-1A/B Coolant Surge Tanks										
	E-1A/B Interstage Coolers										
	E-2A/B " "										
	E-3A/B " "										
	E-4A/B " "										
	ST-1A/B Steam Turbine Drivers										
	P-1A/B/C/D Coolant Pumps										
	P-2A/B/C/D " Booster Pumps										
	P-3A/B Oil Skimmer "										
	3-Stage										
	Water injection system - units self										
	total independent - self contained										
	lube system - water/chem. feed										
	injector, gas/chem feed injector to										
	inhibit polymerization.										
									8000000		

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CUSTOMER Sassi Corporation
LOCATION Indianapolis, Indiana
PROJECT Methanation of Purox Off-Gas

CONSTRUCTION COSTS
9.0 Account
Mech. Equip.

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2392
MADE By JB APPRV. ____

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	Pt-2 Carbon Disulfide Inj. Unit								35000		
	Capacity 0-75 lbs/hr										
	of CS_2 @ 275 psig										
	Price per A.M.S. Systems Engineering								35000		
	Inc., 2/8/79										

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CUSTOMER Sassi Corporation
CONSTRUCTION COSTS
THE PRITCHARD CORPORATIC

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CUSTOMER SASSI CORPORATION
LOCATION INDIANOPOLIS, INDIANA
PROJECT METHANATION OF PUROX OFF-GAS

CONSTRUCTION COSTS

9.0 ACCOUNT
MECH. EQUIP.

THE PRITCHARD CORPORATIC
KANSAS CITY, MISSOURI
E.W.O. No ____ JOB No. 239
MADE By JB APPRV. ____

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	PG-3 Package Hydrogen Plant								770000		
	Rate, as pure H_2, SCFD min. 0.5 million										
	Purity, volume % min 99.9										
	(@ 275 psig & 100°F										
	Includes natural feed gas compr										
	to compress the natural gas from										
	30 psig to 350 psig										
	Major process steps: Nat. Gas Compr.,										
	Desulfurization, Reforming, Stm.										
	Generation, Shift Conversion, Cooling &										
	Selective Adsorption of Impurities										
	Supplied prefabricated to the maximum										
	extent practicle										
	Note- Installation at $140,000										
	Price per Howe-Baker Engineers, Inc										
	2/7/79								770000		

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CONSTRUCTION COSTS

9.0 ACCOUNT

MECH. EQUIP.

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2392
MADE By JB APPRV. ____

CUSTOMER SASSI CORPORATION
LOCATION INDIANOPOLIS, INDIANA
PROJECT METHANATION OF PUROX OFF-GAS

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	PG-4 Glycol Dehydration Pkg Unit								210000		
	Price from Maloney Crawford on similar unit for ONV								210000		

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CONSTRUCTION COSTS

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI

CUSTOMER SASSI CORPORATION

THE PRITCHARD CORPORATIC
KANSAS CITY, MISSOURI
E.W.O. No.______ JOB No. 239:
MADE By JB APPRV.______

CONSTRUCTION COSTS

CUSTOMER Sassi Corporation
LOCATION Indianapolis, Indiana
PROJECT Methanation of Purox Off-Gas

9.0 Account
Mech. Equip.

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	PG-5 - Amine Plant - CO_2 Removal Pkg									3800000	
	Incl- T-3 CO_2 Stripper									(installed)	
	T-4 CO_2 Absorber										
	D-10 K.O. Drum										
	D-11 Reflux Drum										
	D-12 Solution Mix Tank										
	D-13 MEA Carbon Filter										
	FIL-1 Sump Filter										
	TK-8 MEA Storage Tank										
	TK-9 MEA Sump										
	E-17 MEA Reboiler										
	E-18 MEA Stm Reboiler										
	E-19 MEA Regeneration										
	E-20 Stripper O.H. Cond.										
	E-21 Lean MEA/Rich MEA Exch.										
	E-22 Gas Cooler										
	E-23 MEA Cooler										
	P-12 A/B Stripper Reflux Pump										
	P-13 A/B MEA Charge Pump										
	P-14 MEA Make Up Pump										
	P-15 MEA Sump Pump									3800000	
	con't.										

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CONSTRUCTION COSTS

9.0 ACCOUNT
MECH. EQUIP.

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No.____ JOB No. 2392
MADE By JB____ APPRV.____

CUSTOMER SASSI CORPORATION
LOCATION INDIANAPOLIS, INDIANA
PROJECT METHANATION OF PUROX OFF-GAS

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	PG-5 (con't)										
	The system would be charged with								w/chem.		
	approx. $500,000 of MEA and								&packing		
	the initial charge of Amine Guard										
	inhibitors would total about $30M										
	Price per Union Carbide - 12/21/78										

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CONSTRUCTION COSTS

THE PRITCHARD CORPORATION

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CUSTOMER Sassi Corporation

LOCATION Indianapolis, Indiana

PROJECT Methanation of Purox Off-Gas

CONSTRUCTION COSTS

9.0 Account

Mech. Equip.

THE PRITCHARD CORPORATIO[N]
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2393
MADE By JB APPRV. ____

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	C-2 A/B Recycle Compressor allow								50000		
									50000		

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THE PRITCHARD CORPORATION
KANSAS CITY
E.W.O. No. 332
MADE BY

CONSTRUCTION COSTS

CUSTOMER Sassi Corporation

LOCATION Indianopolis, Indiana

PROJECT Methanation of Purox Off-Gas

9.0 Account

Mech. Equip.

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR
9.0	C-3 A/B Exhauster	2	Ea					14000	28000	
	Gas Handled - Purox Off-Gas									
	Flow lb/min normal - 1186									
	rated - 1422									
	Inlet Temp °F normal - 100									
	rated - 100									
	Compressibility factor - 1.0									
	Inlet volume cfm normal - 18750									
	rated - 22500									
	Dish Press psia normal - 15.8									
	rated - 15.8									
	Dsh Temp °F normal - 100									
	rated - 100									
	BHP / RPM 166 / 1770									
	Driver / Enclosure Motor / TEFC									
	Volts / Hz / Phase 460/60/3									
	Driver HP / RPM (rated) 200/1800									
	Price per Garden City (lowest acceptable									
	bid) 12-4-78								28000	

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CONSTRUCTION COSTS

THE PRITCHARD CORPORATI

Sassi Corporation

EST. 906- 1.78

CUSTOMER Sassi Corporation

LOCATION Indianapolis, Indiana

PROJECT Methanation of Purox Off-Gas

CONSTRUCTION COSTS

9.0 Account

Mech. Equip.

THE PRITCHARD CORPORATI
KANSAS CITY, MISSOURI
E.W.O. No. ______ JOB No. 23
MADE By JB APPRV. ______

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	P-4A/B Rich Oil Pump	2	Ea						12000		
	Case - Ductile Iron										
	Trim - Cast Iron										
	50 HP										
	P-5A/B Lean Oil Pump	2	Ea						13000		
	Case - Dictile Iron										
	Trim - Cast "										
	60 HP										
	P-6A/B Lean Oil Mak-up Pump	2	Ea						3000		
	Case - Ductile Iron										
	Trim - Cast "										
	1.5 HP										
	P-7 Benzol Condensate Pump	1	Ea						2000		
	Case - Ductile Iron										
	Trim - Cast Iron										
	1.5HP										
	Above Prices per - Gould 11-28-78										

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CUSTOMER Sassi Corporation
LOCATION Indianapolis, Indiana
PROJECT Methanation of Purox Off-Gas

CONSTRUCTION COSTS

9.0 Account
Mech. Equip.

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2392
MADE By JB APPRV. ____

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	P-9A/B Lean Solution Pump - allow	2	Ea						10000		
	P-10 Slurry Pump allow	1	Ea						5000		
	P-11 Sump Pump allow	1	Ea						5000		

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CONSTRUCTION COSTS THE PRITCHARD CORPORATION

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CUSTOMER Sassi Corporation
LOCATION Indianapolis, Indiana
PROJECT Methanation of Purox Off-Gas

CONSTRUCTION COSTS

9.0 Account
Mech. Equip.

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2392
MADE By JB APPRV. ____

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
9.0	M-1 Kinecs Mixer - Contactor - allow	1	Ea						10000		
	M-2 Slurry Tank Mixer	1	Ea						10000		
	est 5 hp for 16'Ø Tank										
	B-2 A/B Air Blower	2	Ea						20000		
	est 10 hp 600-800 CFM										

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JOB NO. 2392

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CUSTOMER SASSI CORPORATION

LOCATION INDIANAPOLIS, INDIANA

PROJECT METHANATION OF PUROX OFF-GAS

CONSTRUCTION COSTS

Chemicals

THE PRITCHARD CORPORATION
KANSAS CITY, MISSOURI
E.W.O. No. ____ JOB No. 2392
MADE By JB APPRV. ____

A/C No.	DESCRIPTION	QUANT	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT S.C.	COST/UNIT MAT'L	MATERIALS	SUB-CONTR.	LABOR
15.0	Chemicals & Packing										
	R-1 A/B Catalyst 2200×2	4400	CF					180	792000		
	Packing (Alumina Balls) 500×2	1000	CF					20	20000		
	R-2 A/B/C/D Catalyst 760×4	3000	CF					180	540000		
	Packing 760×4 Alumina Balls	3000	CF					20	60000		
	R-3 A/B Catalyst 425×2	950	CF					180	171000		
	Packing 350×2 Alumina Balls	700	CF					20	14000		
	R-4 Catalyst	380	CF					180	68000		
	Packing Alumina Balls	280	CF					20	6000		
	R-5 Catalyst	350	CF					180	63000		
	Packing Alumina Balls	280	CF					20	6000		
	T-1 Wood Grid Packing	15200	CF					15	285000		
	T-2 Raschig Rings Packing	11400	CF					32	364000		
	PG-5 MEA charge & initial charge of Amine Guard inhibitors								530000		
	Subtotal								2922000		
	Misc Frt								78000		
	Total								3000000		

1/19/79 Catalyst Cost / Katalco

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JOB NO. 2392