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MASTER

PIPELINE GAS DEMONSTRATION PLANT

Phase I

Abbreviated Version of
PROCESS EVALUATION REPORT
CONCEPTUAL COMMERCIAL PLANT

SECTION 5 BASELINE PROCESS ¹CONCEPT - BOOK 1

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PROCESS EVALUATION REPORT

CONCEPTUAL COMMERCIAL PLANT

This Process Evaluation Report (PER) contains the results and recommendations of comprehensive analyses and studies which were made to optimize the ICGG Commercial Plant Baseline Process Concept for producing synthetic pipeline gas (SPG) from coal. Design studies to optimize the thermal efficiency and economic attractiveness of the COGAS Process Areas of the plant were conducted along with design studies and trade-off studies of available process subsystems to complement the COGAS Process Areas. The results, recommendations and description of the work accomplished in developing the PER are contained in six separately bound sections of the PER which are summarized as follows:

Section 1 - Executive Summary

This section provides an overview of the total PER and presents results, recommendations and conclusions in a brief format.

Section 2 - Process Analysis - Commercial Plant Concept

This section gives a brief description of plant size, configuration, feedstocks, operating conditions, products and by-products for the Commercial Plant Concept.

Section 3 - Process Design Studies

This section describes various design studies which were conducted to optimize the COGAS Process Areas and other plant areas.

Section 4 - Trade-off Studies

This section describes those trade-off studies which were made to select processes which would best complement the COGAS Process Areas and provide the most efficient and economical Commercial Plant Concept.

Section 5 - Baseline Process Concept

This section describes the ICGG Commercial Plant Baseline Process Concept which was developed from the Tentative Baseline Design (TBD) and was used as a standard for measuring the results of the Process Design Studies and Trade-off Studies.

Section 6 - Baseline Economic Evaluation

This section describes an economic evaluation which has been performed for the Commercial Plant Baseline Process Concept, described in Section 5.

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5.0 Baseline Process Concept

5.1 Facility Description

This section describes the Baseline Process Concept for the ICGG Commercial Plant Facility. It includes those unit process subsystems selected initially for the Tentative Baseline Design (TBD) before trade-off evaluations and process design studies were undertaken. The baseline process concept together with the corresponding economic evaluation in Section 6.0 forms the technical and economic baseline against which process alternatives are evaluated.

The ICGG Commercial Plant, using the COGAS Process, is a self contained, grass roots facility designed to produce 256 million standard cubic feet per day (SCFD) of synthetic pipeline gas (SPG) from Illinois No. 6 coal. Run of mine (ROM) coal, raw water and miscellaneous catalysts and chemicals constitute the total feed to the plant. All utilities including electric power are produced on-site, except electricity needed to operate the river water pumping station. By-products from the plant are in finished, marketable form and include a synthetic crude oil, a light hydrocarbon stream, anhydrous ammonia, sodium sulfate and flaked sulfur. Major waste streams exiting the facility are slag, water treatment sludges, carbon dioxide, and desulfurized flue gas. Aqueous wastes are evaporated and recycled internally, thus, facilitating essentially "zero discharge".

The Facility, as shown on Block Flow Diagram 100-100-1 (page 5-2), is divided into twenty processing areas each containing one or more unit process systems. Area designations are:

<u>Area</u>	<u>Description</u>
101	Coal Unloading and Handling
102	Coal Preparation
103	Pyrolysis and Gasification
104	Oil Recovery and Treatment
105	Gas Purification
106	Hydrogen Generation
107	Shift and Methanation
108	Bulk CO ₂ Removal



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5.1 Facility Description - continued

<u>Area</u>	<u>Description</u>
109	Gas Compression and Dehydration
110	Flue Gas Power Recovery
111	SO ₂ Removal
112	Sulfur Recovery
113	Ammonia Recovery
114	Thermal Oxidizer and Flare
115	Utilities
116	Water Supply
117	Water Treatment Systems
118	Waste Treatment and Disposal
119	Fire Protection System
120	Facilities

Due to equipment size limitations, the main processing areas are composed of three parallel trains. These include Area 102, Coal Preparation, Area 103, Pyrolysis and Gasification, Area 104, Oil Recovery and Treatment, Area 105, Gas Purification, Area 107, Shift and Methanation, Area 108, Bulk CO₂ Removal and Area 110, Flue Gas Power Recovery. The remaining areas are basically single train with multiple equipment items provided on an as-required basis. A brief description of the function of facilities in each area follows.

Area 101 Coal Unloading and Handling

Run of mine coal is delivered to the plant either by overland conveyor or by unit train. The Coal Unloading and Handling Area is a single train system with facilities to receive the coal on an intermittent basis, crush it to 1-1/2" x 0", store it in outdoor piles for 30 days, reclaim it and deliver it to Area 102, Coal Preparation, on a continuous basis.

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5.1 Facility Description - continued

Area 102 Coal Preparation

Coal feed from the storage area is split into three parallel streams and fed to Fluid-Flo Dryers in the three train Coal Preparation Area. The moisture content of the coal is reduced from 10% to 7% by contacting it with hot flue gas generated in a coal-fired dryer furnace. The coal is then crushed, screened to a minus 10 mesh size and elevated into a storage silo. A lock hopper feeding system raises the pressure of the coal from the silo from atmospheric to 60 psig and feeds the coal to the first stage pyrolysis vessel in Area 103.

Area 103 Pyrolysis and Gasification

The Pyrolysis and Gasification area is the heart of the Commercial Plant. It is here that coal is converted into the raw oil and synthesis gas which, after treatment, become the major plant products. Ground, dried coal is fed from the lock hopper system to the first stage pyrolysis vessel. The coal is devolatilized in four pyrolysis stages during which pyrolysis gas is formed and the resulting char then enters the gasifier where it reacts with steam to produce additional gas. Gasifier gas is returned to pyrolysis to supply heat and becomes part of the gas leaving pyrolysis. Pyrolysis gas is then sent to Area 104, Oil Recovery and Treatment. The un-gasified char is burned in the combustor and supplies heat to the gasifier through a char recycle stream. Flue gas leaving the combustor flows to Area 110, Flue Gas Power Recovery. The ash in the feed coal is rejected from the combustor as slag and is sent to a landfill after quench.

Area 104 Oil Recovery and Treatment

Gas leaving the pyrolysis section of Area 103 is quench cooled in a series of venturi scrubbers to condense the oil and water vapors. The liquid from each scrubber is decanted and the water is cooled and recycled with the excess water going to Ammonia Recovery, Area 113. Uncondensed synthesis gas flows to Area 105, Gas Purification. Oil recovered in the decanters is dehydrated by heating followed by flash separation of water and dissolved gas from the oil. Dehydrated oil is then stored or sent to hydrotreating. Hydrotreating involves treating the oil with hydrogen (from Area 106) in ebullating bed catalytic reactors. Hydrotreated oil is sent to storage. (Area 120).

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5.1 Facility Description - continuedArea 105 Gas Purification

In this area the uncondensed synthesis gas from Area 104, Oil Recovery and Treatment, is first compressed to 465 psig. Acid gases such as H_2S and CO_2 are removed from the gas stream by the Selexol Process, and acid gas is sent to Area 112, Sulfur Recovery for further treatment. The desulfurized synthesis gas is then scrubbed with oil in an absorber to remove light hydrocarbons. Light hydrocarbons recovered from the gas are exported as a by-product and/or used to enrich the product gas. The purified synthesis gas stream leaving Area 105, rich in carbon monoxide and hydrogen, is split; the bulk of it flows to Area 107, Shift and Methanation while the remainder is sent to Area 106, Hydrogen Generation.

Area 106 Hydrogen Generation

This area provides the hydrogen required for hydrotreating the oil in Area 104. Purified synthesis gas feed is received from Area 105, preheated, and the last traces of sulfur compounds are removed. The gas then passes through three shift converters in series where carbon monoxide is reacted with steam to form hydrogen and carbon dioxide. This gas stream then passes through a carbon dioxide absorber to remove CO_2 . Gas is then reheated and passed through a single-stage methanator to convert any residual carbon monoxide to methane. Hydrogen product is then sent to make-up compressors in Area 104.

Area 107 Shift and Methanation

The purified synthesis gas feed to this area from Area 105, Gas Purification, first passes through two zinc oxide beds to remove residual sulfur. It then passes through multiple stages of shift-methanation, wherein a portion of the CO is reacted with steam to produce H_2 for the methanation reaction. One part carbon monoxide and three parts of hydrogen then react to produce methane. After the final stage of shift-methanation, the gas is sent to Area 108, Bulk CO_2 Removal. After the CO_2 is removed, the gas is returned to Area 107, where it passes through a stage of methanation to reduce the carbon monoxide level to 0.1%. The gas then leaves Area 107 and flows to Area 109, Gas Compression and Dehydration.

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5.1 Facility Description - continued

Area 108 Bulk CO₂ Removal

In this area, carbon dioxide is removed from the methanated gas by the Selexol Process. The gas contacts the Selexol solvent (dimethyl ether of polyethylene glycol) in the CO₂ absorber. The gas which has been scrubbed of CO₂ is returned to Area 107 for final methanation. The solvent is regenerated in the Selexol regenerator for reuse in the absorber, while the carbon dioxide is vented to the atmosphere.

Area 109 Gas Compression and Dehydration

Gas from Area 107 is compressed to approximately 1070 psig, then cooled to 100°F. The gas which is saturated with water at these conditions, is then fed to a dehydration column where water vapor is removed in a glycol solution. The glycol is regenerated for reuse, while the water is sent to Area 118 Waste Treatment and Disposal. Dehydrated synthetic pipeline gas (SPG) flows to gas surge in Area 120 or directly to the gas pipeline.

Area 110 Flue Gas Power Recovery

Flue gas from the combustor in Area 103, first enters the Flue Gas Oxidizer where it is burned to remove residual CO and generate 1500 psig steam. Hot gas leaving the oxidizer is then cooled, cleaned of any remaining particulate matter and expanded through expander turbines to atmospheric pressure. These expander turbines are used to drive air compressors which supply the air to the oxidizer and to the Combustor in Area 103. After additional heat is removed, the flue gas stream is sent to Area 111, SO₂ Removal.

Area 111 SO₂ Removal

Gas streams containing SO₂ flow from Area 102, Coal Preparation, Area 110, Flue Gas Power Recovery, and Area 112, Sulfur Recovery for treatment in Area 111 where the Wellman-Lord Process is used to remove the sulfur dioxide. Flue gas is contacted with a sodium sulfite solution to remove SO₂, then is vented to the atmosphere. Rich solution is regenerated and the SO₂ removed is sent to Area 112, Sulfur Recovery. A slip stream of the solution is treated to remove non-regenerable sodium sulfate and recover it as a by-product.

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5.1 Facility Description - continued

Area 112 Sulfur Recovery

Gas streams containing sulfur as either SO_2 or H_2S are processed to produce elemental sulfur. H_2S bearing gas streams are received from Area 105, Gas Purification and Area 113, Ammonia Recovery. A portion of the H_2S is burned in a waste heat boiler to produce SO_2 . Both the burned and unburned portions of these streams are mixed with the SO_2 stream from Area 111 and passed through a series of Claus reactors. The gas, after each reaction stage, is cooled to condense product sulfur then reheated prior to entering the next stage. The sulfur, which is initially recovered in the molten state is cooled in a flaker to produce flake sulfur as a saleable by-product. The tail gas from the last Claus reactor is incinerated to convert all sulfur to SO_2 and sent to Area 111, SO_2 Removal.

Area 113 Ammonia Recovery

Sour water produced in Area 103, Pyrolysis and Gasification and Area 104, Oil Recovery and Treatment, is processed to recover anhydrous ammonia in the Phosam-W Process. The sour water is stripped with steam to remove ammonia and H_2S . Stripped water flows to Area 118, Waste 118. Waste Treatment and Disposal, while stripper gas is routed through an ammonia scrubber to remove the ammonia in an ammonium phosphate solution. The remaining gas (H_2S and H_2O) is sent to Area 112 Sulfur Recovery. The rich solution from the ammonia scrubber is then stripped of its ammonia and lean phosphate solution is thus regenerated and recycled. Ammonia is condensed and sent to storage in Area 120, Facilities, for ultimate sale.

Area 114 Thermal Oxidizer and Flare

Thermal Oxidizer - Waste streams from collection points in the plant are piped to this area. Liquid and gas are separated and fed to the thermal oxidizer, mixed with combustion air, ignited and burned. Auxiliary fuel and steam are used as needed to insure complete combustion.

Flare - Any off-spec product from the plant is sent to the flare. The gas first enters a knock-out drum where the entrained oil is separated and pumped to raw oil storage. The gas enters the flare where it is burned and steam is added to ensure complete oxidation.

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5.1 Facility Description - continued

Area 115 Utilities

This area provides the utilities needed to operate the plant. Included in Area 115 are the following systems.

- Instrument Air
- Plant Air
- Cooling Tower
- Condensate Return Units
- Auxiliary Boiler
- Refrigeration System-Freon 12
- Inert Gas Generation
- Emergency Power Generation-Diesel Drive
- Main Power Generation-Steam Drive

Area 116 Water Supply

Water is withdrawn from the Mississippi River through bar screens to prevent large debris from entering the system. It then passes through self-cleaning traveling screens to eliminate smaller debris. Screened water enters the pipeline where chlorine and cationic polymer are injected. It is then pumped 20 miles overland to the plant site where it enters Area 117, Water Treatment Systems.

Area 117 Water Treatment Systems

The incoming river water is treated to produce cooling water makeup, process and potable water and high and low pressure boiler feed water makeup. All of the raw water is subjected to softening/clarification and sand filtration. This is adequate for cooling tower makeup and low pressure boiler feed water makeup. Potable water is also chlorinated. Water which is to be used as makeup to the high pressure boiler feed water system is also subjected to carbon filtration and deionization.

Area 118 Waste Treatment and Disposal

Aqueous waste streams from throughout the plant are treated in Area 118 with the treatment tailored to suit the composition of each stream. Oil bearing streams from Area 113, Ammonia Recovery, and from various drains and separators are fed to an API separator. Oil is fed to Area 104 while the water is cooled and mixed with sanitary waste and treated in a biotreatment plant. The treated water is used

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5.1 - Facility Description - continued

Area 118 Waste Treatment and Disposal - continued

as cooling tower make up and the sludge is sent to an on-site landfill with the slag from Area 113. Cooling tower blowdown and spent deionizer reagent are treated in a ten effect evaporator. The solids are sent to an on-site impoundment, while the water is returned to form part of the boiler feed water. Water containing suspended solids from Areas 111 and 117 is treated in a sludge dewatering system. Water flows to the softener/clarifier in Area 117 and the solids are sent to landfill.

Area 119 Fire Protection

Water is received directly from the river water pumping station and stored for five days in a holding pond. Water is pumped to plant users through a distribution system. Users include fire hydrants, hose stations, and sprinkler systems.

Area 120 Facilities

This area includes the administration building, maintenance shop, laboratory, personnel facilities in all areas, railroad facilities, roads and parking facilities, security fencing, and warehouse space. Storage is also provided for major plant products, by-products and make up chemical reagents.

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5.2 Design Basis

AREA 101 - COAL UNLOADING & HANDLING

Coal Transportation

- Washed ROM coal is received by unit train or overland belt conveyor. Facilities for unloading four 100 car, 100 tons/car, unit trains are required. The overland belt conveyor is operated 7 days/week; 16 hours/day to deliver 28,800 Tons/day of coal. The overland conveyor is supplied by others.

Coal Type

- Illinois No. 6

Capacity

- 28,800 Tons/operating day.

Coal Size

- ROM 6" x 0

Coal Analysis (water free)

- Component	wt%
C	69.0
H ₂	4.7
N ₂	1.3
S	3.8
O	9.3
Ash	11.9

Raw coal will include 10 wt% moisture as received.

Coal Storage

- ROM coal will be crushed to 1-1/2" x 0" and stored in open storage piles. Coal storage capacity is for 30 days. A four day live storage capacity will be maintained.

Coal Reclaim

- Emergency reclaim facilities from the coal storage pile are required.

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5.2 - Design Basis

AREA 101 - COAL UNLOADING & HANDLING - continued

Coal Pile Runoff Water

- The coal storage area is diked and the runoff water is collected and transferred to waste treatment. The waste water has the following characteristics:

Acidity, mg. KOH/g	0.33
pH Value	2.8
Hexane Soluble, mg/l	3.3
Phenols, mg/l	Not Detected (less than 1)
Iron, mg/l	25.6
Manganese, mg/l	4.3
Calcium, mg/l	584
Magnesium, mg/l	132
Sodium, mg/l	435
Ammonia, mg/l	0.0
Silica, mg/l	200
Nitrate, mg/l	0.1
Chloride, mg/l	120
Sulfate, mg/l	3,146
Alkalinity, mg.KOH/g	0.00
Total Hardness as mg CaCO ₃ per l	2,047
Total Dissolved solids, mg/l	5,000
Total Suspended Solids, mg/l	238

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5.2 Design Basis

AREA 102 - COAL PREPARATION

Coal Dryer Surge Capacity	- 12 hours
Coal Drying	- Dry crushed 1-1/2" x 0 coal from 10% to 7% by direct contact with hot flue gas. Maximum dryer exit gas temperature is 150°F. Flue gas is generated in furnace fired with ground coal.
Coal Pulverization	- Grind dried coal to required feed stock size consist and recycle oversize to inlet grinder.
Pulverized Coal Surge Capacity	- 12 hours
Coal Feeding	- Lock hopper system pressurized with cold oxygen-free flue gas.
	Surge Hopper Capacity - 1 hour of Coal Feed
	Lock Hopper Capacity - 20 minutes of Coal Feed
	Fluidizing Lock Hopper capacity 40 minutes of Coal Feed
	1.5 Lockhopper cycles are performed each hour.

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5.2 Design Basis

AREA 103 - PYROLYSIS AND GASIFICATION

Gasification - Combustion

Slag Removal

- Slag is collected and cooled in a water filled agitated tank. Slag concentration is 10% by weight. Slag leaving the slurry tank is crushed to -1/16".

Slurry is lock-hoppered from the System and transported to disposal by jet pumps.

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5.0 Baseline Process Concept

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5.2 Design Basis

AREA 104 - OIL RECOVERY AND TREATMENT

Process Scheme

- Raw oil vapors and sour aqueous liquor constituents contained in the gas from pyrolysis are condensed and separated. The collected oil is dehydrated and hydrotreated, in two stages, to a fuel oil and then to syncrude. The sour aqueous liquor is sent to ammonia recovery.

Gas Quenching and Decanting of Liquids

- Venturi scrubbers operating at high efficiency.

Decanters operating in series, amount of oil (phenol) and $(\text{NH}_4)_2\text{S}$ in sour water based on COED operation.

Gas leaving decanters:

Saturated with water vapor at temperature and pressure of decanter.

- Phenols in the sour liquor

0.09% (wt) of dry coal, distributed on a weight basis between the sour liquor streams in pyrolysis and oil recovery.

Oil Dehydration

- Dehydrators are operated to remove free and dissolved water from the oil.

Ebullating Bed Hydrotreatment

- An ebullating bed allows the reaction to take place at isothermal conditions. Char solids in the fuel oil plus any coke formed from oil cracking are passed through the reactor.

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5.2 Design BasisAREA 104 - OIL RECOVERY AND TREATMENT - continued

Ebullating Bed Hydrotreatment - Naphtha yield and composition:
(cont'd) 35% (wt) of fuel oil at 500°F

C	86.31% (wt)
H	13.36
N	0.03
S	0.04
O	0.26
	100.00

- Debutanizer - Operated to remove dissolved gases and naphtha from the hydrotreated oil.
- Vacuum Oil Filter - Operated to remove solid particles, char and ash, from oil prior to fixed bed hydrotreating.
- Fixed Bed Hydrotreatment - Operates to complete treatment of oil to produce syncrude.
- °API gravity improvement 25.2° API
for fuel
oil 31.2°
API for
syncrude
- HHV of oil 18,288 Btu/
lb (fuel oil)
18,960 Btu/
lb (syncrude)
- Product Stripper - Operated to remove dissolved gases in the hydrotreated fuel oil.

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5.2 Design Basis

AREA 105 - GAS PURIFICATION

Gas Compression

- Number of Trains - Three (3)
- Number of Compressors - Twelve (12)
- Capacity - 62,000 SCFM each
- Suction Pressure - 40 psia
- Discharge Pressure - 480 psia

Acid Gas Removal

- Process Scheme - Selexol Process
- Number of Trains - Three (3)
- Feed Gas - 355.8 MM SCFD Total
 - CO₂ - 6.944%
 - H₂S - 1.687%
- Purified Gas - CO₂ - 4.7%
 - H₂S - 3 ppm Max.
- Acid Gas - CO₂ - 60%
 - H₂S - 40%

Light Hydrocarbon Recovery

- Process Scheme - Heptane Absorption
- Number of Trains - Absorption/Fractionation System: Three (3)
 - Heptane Recovery System: One (1)

Light Hydrocarbon Product Specification

- H₂S < 3 ppm by Vol.
- CO₂ < 0.1%
- CH₄ < 1.0%
- C₂-C₄ - composition of mixture unspecified.

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5.2 Design Basis

AREA 106 - HYDROGEN GENERATION

Process Scheme

- This process area produces the hydrogen required for the hydro-treating facilities of the plant. It generates a gas product with a minimum hydrogen concentration of 92 Volume % from purified make gas feed containing 58 Volume % hydrogen. The process scheme consists of three principal process systems, CO Conversion to H₂ (Shift Conversion), CO₂ Removal, and Methanation, with a scavenging desulfurization unit included as a precautionary measure to remove trace quantities of sulfur compounds that greatly reduce the activity of the shift conversion catalyst.

Purified Make Gas Feed

<u>Component</u>	<u>lbs/hr</u>
CO ₂	27,735
CO	120,482
H ₂	15,699
CH ₄	8,753
Ar	26
N ₂	4,326
	<u>177,021</u>

Hydrogen Product

- Production Rate - 23,818 lbs/hr
- Hydrogen Concentration - 92 Vol. %, dry basis, Minimum
- CO Concentration - < 20 ppm dry basis
- Temperature - 100°F
- Pressure - 315 psig

Desulfurization

- Feed Gas Sulfur Content - 3 ppm H₂S
- Exit Gas Sulfur Content - < 0.1 ppm H₂S

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5.2 Design Basis

AREA 106 - HYDROGEN GENERATION - continued

Desulfurization (cont'd) - Temperature - 725°F
 Pressure (Inlet) - 420 psig
 Catalyst (Adsorbent) - ZnO

CO Shift - CO Conversion - 99.3%
 Steam to Shift - 2 Moles steam per mole of purified make gas.
 Number of Shift Converters - Three (3)
 CO in Shifted Gas - 0.17 Vol% dry basis
 (Outlet of Final Shift Converter)
 Inlet Pressure
 Shift Converter No. 1 420 psig
 Allowable Pressure Drop 30 psi
 Catalyst - Iron Oxide

CO₂ Removal

- Feed Gas - Component	lbs/hr
CO ₂	215,715
CO	843
H ₂	24,310
H ₂ O	24,668
CH ₄	8,753
Ar	26
N ₂	4,326
	<u>278,641</u>

CO₂ Content of Product Gas -
 0.25 Vol% dry basis, Maximum

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5.2 Design Basis

AREA 106 - HYDROGEN GENERATION - continued

CO₂ Removal - continued

CO₂ Absorption Fluid - Hot Carbonate

Feed Temperature - 245°F

Product Gas Temperature - 160°F

Absorber Pressure - 365 psig

Reagent Regenerator Pressure - 5 psig
(Top of Tower)

Temperature of Vented CO₂ - 140°F

Methanation

- Feed Gas (CO₂, CO content, dry basis)
 - 0.25 Vol.% CO₂
 - 0.24 Vol.% CO

Product Gas (Hydrogen and CO content)
H₂ 92 Vol%, dry basis, Minimum
CO < 20 PPM by Volume, dry basis.

Catalyst - Nickel Base

Temperatures - Inlet, °F 625

Inlet Pressure - 345 psig

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5.2 Design Basis

AREA 107 - SHIFT AND METHANATION

Process Scheme

- R. M. Parsons Company Combined Shift & Methanation Process

Number of Trains Feed Stream

- Three
- CO concentration, 32.05% vol.
 $H_2/CO = 1.8/1$, $H_2S + COS \leq 3$ ppm

Final Desulfurization

- Two Zinc oxide catalyst beds per train.

Operating conditions:

Temperature 750°F

Pressure 400 psig

Catalyst: Zinc oxide, 1/8" - 3/16"
sphere or pellets

Catalyst life: 3 years

The Final Desulfurizer is designed to remove trace quantities of sulfur compounds from the feed gas stream, and provides protection for the nickel type catalysts employed in the Methanators.

Bulk Methanation

- Multiple catalyst bed Methanators per train.

Operating conditions:

Temperature range: 800°F to 1500°F

Pressure range: 380 psig to 290 psig

Catalyst: Nickel type

Catalyst life: 2 years

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5.0 Baseline Process Concept

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5.2 Design Basis

AREA 107 - SHIFT AND METHANATION - continued

Bulk Methanation (cont'd)

CO Conversion: 97%

The heat released in each Methanator reactor is recovered in generating 1500 psig steam.

Final Methanation

- One catalyst bed Methanator per train.

Operating conditions:

Inlet temperature: 600°F

Max. operating temperature: 800°F

Outlet temperature: 645°F

Inlet pressure: 255 psig

Outlet pressure: 240 psig

Catalyst: Nickel type pellets

Catalyst life: 2 years

CO Conversion: 99.8%

Product gas stream: (Dry basis)

Maximum H₂ conc: 3% volume

CO conc: 0.1% volume

HHV: 934 Btu/SCF

To meet the HHV of 950 Btu/SCF, a portion of the by product light hydrocarbon is to be blended into the product SPG.

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5.0 Baseline Process Concept

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5.2 Design Basis

AREA 108 - BULK CO₂ REMOVAL

Process Scheme	- Allied Chemical Corporation Selexol Process
No. of Trains	- Three (3)
CO ₂ Absorption	- CO ₂ in entering gas to absorption - 38.2 Mole%. CO ₂ in gas leaving absorbers 1 mole % max.
	Equilibrium H ₂ O content in cir- culating selexol - 1% by weight
Selexol Regeneration	- Stripping Agent - Air Operating temperatures

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AREA 109 - GAS COMPRESSION AND DEHYDRATION

Gas Compression

- Number of Trains - One (1)
Number of Compressors - Three;
two-operating, one-spare
Capacity - 90,000 SCFM each
Suction Pressure - 230 psig
Discharge Pressure - 1070 psig
Number of Stages - Two (2)

Feed Streams

Methanated Gas from Shift and
Methanation, Area 107 pressure
230 psig and 150°F; HHV 943.6
Btu/SCF

Light Hydrocarbon Enrichment
Gas from Gas Purification,
Area 105, pressure 335 psig
and 140°F. HHV 2196.7 Btu/SCF

Discharge Stream - Wet SNG
Pressure 1070 psig and 100°F
HHV 951 Btu/SCF

Dehydration System

- Glycol Absorption

Number of Trains - One (1)
Discharge Stream
256.6 MM SCFD SPG Product;
Pressure 1050 psig and 100°F
HHV 951 BTU/SCF
Moisture Content 6.5 lbs. H₂O/
MM SCF

Absorbent - Triethylene Glycol

Effluent - Process condensate to
Waste Treatment

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5.2 Design Basis

AREA 109 - GAS COMPRESSION AND DEHYDRATION - continued

Product SPG Specifications

Property/Index	Limiting Value Permissible	Value Achieved Shown for PER
<u>IMPURITIES:</u>		
Carbon Monoxide	0.1% by vol. max.	0.008% by vol.
Carbon Dioxide	3.0% by vol. max.	1% by vol.
Carbon Dioxide Plus Inerts	7.0% by vol. max.	4.9% by vol.
Hydrogen	5.0% by vol. max.	3.2% by vol.
Water (vapor)	7.0 lb/MM SCF	6.6 lb/MM SCF.
Hydrocarbons	Dew point:-40°F max.	Dew point:-40°F

INDICES:

Flash Back	1.18 max.	1.0035
Yellow Tip	0.9 min.	0.98
Lifting Index	1.02 max.	0.973

HIGHER HEATING VALUE (HHV)

Btu/SCF (Dry)	950 min.	951

5.0 Baseline Process Concept

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AREA 110 - FLUE GAS POWER RECOVERY

Number of Trains	- Three (3)
Flue Gas Oxidizer	- Flue Gas Outlet Conditions
	Conc.: Mole%
	O ₂ - 2.0
	CO - 200 ppmv
	SO ₂ - 2060 ppmv
	Dust Loading - <2 grains/ACF
	Temperature - 1200°F
	Function: Generation of 1500
	psig saturated steam
	and superheating 100
	psig reaction steam
	to 1000°F
Tertiary Separators	- Inlet Dust Loading: <2 grains/ACF
	Outlet Dust Loading: <0.006 grains/A

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AREA 111 - SO₂ REMOVAL

Process Scheme

- Wellman-Lord Process; Process Licensors - Davy Powergas, Inc.

Number of Trains

- Three (3)

Feedstreams

- Flue gas from Flue Gas Power Recovery, Area 110
Total Flow rate - 2,084,910 SCFM
SO₂ Conc. - 2,060 ppmv
Particulate - 0.053 grains/SCF

Flue Gas from Coal Preparation, Area 102
Total Flow Rate - 230,661 SCFM
SO₂ Conc. - 435 ppmv
Particulate - NIL

Flue Gas from Utility Boilers, Area 115
Total Flow Rate - 134,847 SCFM
SO₂ Conc. - 1,552 ppmv
Particulate - NIL

Tail Gas From Sulfur Recovery, Area 112
Total Flow Rate - 61,722 SCFM
SO₂ Conc. - 16,161 ppmv
Particulate - NIL

Effluents Streams

- Clean Flue Gas
SO₂ Conc. 500 ppm
Particulate 0.1 lb/MM BTU or 0.03 grains/SCF

Sodium Sulfate By-Product
Purity 99.5%

THE ILLINOIS COAL GASIFICATION GROUP

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AREA 111 - SO₂ REMOVAL - continued

Effluents Streams - cont'd

- Venturi Scrubber Liquid-
Waste Effluent; ph 8

Regenerated SO₂ Gas
SO₂ Conc. 92%
H₂O Conc. 8%

Conversion

- 83% SO₂ Removal (minimum)

Pressure & Temperature

Regenerated SO₂ Gas: 15 psig
and 250°F

Reagents

- Soda Ash
Lime

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AREA 112 - SULFUR RECOVERY

Process Scheme

- Claus Process;
Process Licensor: The Ralph
M. Parsons Company

No. of Trains

- One (1)

Feed Streams

- Gas from SO₂ Removal; Area 111
Stream 11/29
Total Flow: SCFM 3,962
lb/hr 37,877
SO₂ Content, ppmv 922,000

Gas from Flash Tank; Area 105
Stream 5/5
Total Flow: SCFM 31,632
lb/hr 198,904
H₂S Content, ppmv 396,000

Acid Gas from Ammonia Re-
covery; Area 113
Stream 13/6
Total Flow: SCFM 134
lb/hr 705
H₂S Content, ppmv 948,000

Effluent Streams

- Solid Sulfur Product
Stream 12/18
Production Rate: lb/hr 77,586

Claus Plant Incinerator Tail
Gas
Stream 12/16
Total Flow: SCFM 61,802
lb/hr 307,726
SO₂ Content, ppmv 16,161

Sour Water
Stream 12/19 Neg.

Conversion

- Solid Sulfur Product
99.9% Purity
94.0% Recovery

5.0 Baseline Process Concept

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5.2 -Design Basis

AREA 112 - SULFUR RECOVERY - continued

Pressure & Temperature

- Feed Streams

Stream 11/29 15 psig 250°F
Stream 5/5 15 psig 100°F
Stream 13/6 15 psig 104°F

Effluent Streams

Stream 12/18 0 psig 120°F
Stream 12/16 2.3 psig 400°F
Stream 12/19 15 psig 100°F

Catalyst

- Alumina

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5.2 Design Basis

AREA 113 - AMMONIA RECOVERY

Process Scheme

- Phosam - W Process
USS Engineers and Consultants, Inc.

Sour Water Feed

- Flow Rate 1598 (GPM)
798987 (lb/hr)
Temperature 140 (°F)
Pressure: 5 psig (Min.)

Composition: Wt. %	
NH ₃	0.726
H ₂ S	0.086
HCl	(trace)
CO ₂	(unknown)
H ₂ O	98.947
*Phenol	0.241
Total	100.000

* All dissolved and entrained hydrocarbons are expressed as phenol.

Ammonia Product

- Purity 99.99% by Wt.
Impurity Levels:
H₂O 100 ppm (Max.)
Oil 2 ppm (Max.)
CO₂ 3 ppm (Max.)
Chlorine 2 ppm (Max.)
H₂S trace

Physical state: as liquid

Acid Gas to Sulfur Recovery

- NH₃ concentration < 50 ppm by volume
Composition: H₂S - 94.5%
H₂O - 5.5%

Temperature 100 (°F) (Min.)
Pressure 4 (psig) (Min.)

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5.2 Design Basis

AREA 113 - AMMONIA RECOVERY - continued

Waste Water Output

- Waste Water from the system will contain dissolved phenolics and approximately:

NH₃ 100 ppm by wt.
H₂S 5 ppm by wt.

Reagents

- 50% Caustic Solution and Phosphoric Acid

AREA 114 - THERMAL OXIDIZER AND FLARE

Flare

- Flare of sufficient capacity to safely combust the vapors produced in one train of the commercial plant. For use during start-up, shutdown, emergencies, and the disposal of off-spec gas streams.

Thermal Oxidizer

- Thermal oxidizer of sufficient capacity to safely combust any off-spec liquid products. Surge capacity to be provided by off-spec tanks.

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5.2 - Design Basis

AREA 115 - UTILITIES

Steam Generation

- In plant steam will be available at the following pressure levels.

1500 psig; 850°F (turbine steam)
600 psig; 489°F (process steam)
150 psig; 366°F (process steam)
100 psig; 1000°F (reaction steam)
50 psig; 297°F (process steam)

A separate Power Generation Boiler burning carbonaceous wastes from Areas 103 and 104 will supplement plant needs for 1500 psig turbine steam and electric power. Condensing pressure will be 4" Hg Abs. and any excess electricity will be exported. A coal fired Auxiliary Boiler will also be provided for plant start-up.

Boiler Feed Systems

- Separate feed pumps and deaeration systems will be provided for each plant area in which steam is generated. If both high (1500 psig) and lower pressure steam (600 psig and lower) are generated in the same area separate systems will be provided.

Condensate

- Condensate return units will be provided in all plant areas as required. Flash tanks will be provided for let down of 600 and 150 psig steam. Flashed overheads will feed to the 50 psig steam header.

THE ILLINOIS COAL GASIFICATION GROUP

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5.2 - Design Basis

AREA 115 - UTILITIES - continued

Boiler Feed Water Preheat

- Whenever possible, cold condensate from turbine condensers and boiler make-up water should be preheated to 220°F by interchange with suitable process streams.

Chemical Treatment

- Softened water (15 mg/l or less) will be used as make-up for low pressure (600 psig and lower) steam generators. Demineralized water and clean process condensate will be used for the high pressure (1500 psig) system.

Electric Power

- Electric power will be imported for plant lighting and the river water pumping station only. All other power will be generated on site. 13,800V, 4160V, 2400V, 480V, 240V, and 120V will be available as required.

Cooling Water

- Cooling water will be available at 60 psig and 85°F. Maximum temperature rise is 25°F. Make-up water will be softened (15 mg/l or less) and 7 concentration cycles will be used. Turbine condensers will use cooling water with 25°F rise.

Refrigeration

- A refrigeration system (-10°F) will be provided for storage area users. Users in other areas will be supplied by local refrigeration systems.

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5.2 - Design Basis

AREA 115 - UTILITIES - continued

Inert Gas

- An inert gas generating system will be provided for start-up, shutdown and other purging operations. Gas is available at 100 psig and 100°F.

Plant Air

- Plant air will be available at 100 psig and saturated at 100°F under normal conditions. A drying system will also be provided (-40°F dew point) for extremely cold weather.

Instrument Air

- Instrument air will be distributed at 100 psig and -40°F dew point, reduced to 15 psig locally.

Process Water

- General purpose process water will be softened water with 15 mg/l of hardness. It is available at 30 psig and ambient temperature.

In-Plant Fuel

- By-product fuel oil, generated on site will be used as in-plant fuel. Major start-up loads will be satisfied with imported No. 6 Fuel oil while minor loads will use imported natural gas.

THE ILLINOIS COAL GASIFICATION GROUP

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5.2 Design Basis

AREA 116 - WATER SUPPLY

Process Scheme	- Intake and Pipeline														
Number of Trains	- One (1)														
Description	- River Water Pumping Station Including Bulkhead Channel, Bar Screens, Traveling Screens, Debris Conveying System, Hydrasieve, Pumps and Chlorine and Polymer Addition System to prohibit biological growth in transmission line and provide mixing and retention time for polymer.														
Pipeline	- 20 Mile Overland from Mississippi River to Plant.														
Raw Water Receiving and Pumping Rate	- 11,305 GPM														
Chlorine Addition Rate	- 11 lb/hr														
Cation Polymer Addition Rate	- 12 lb/hr														
Raw Water Analysis (90% Values)	<table><tr><th><u>Characteristic</u></th><th><u>Value, mg/l</u></th></tr><tr><td>Total hardness as CaCO_3</td><td>254</td></tr><tr><td>Total dissolved solids</td><td>381</td></tr><tr><td>Suspended solids</td><td>400</td></tr><tr><td>Calcium as CaCO_3</td><td>172</td></tr><tr><td>Magnesium as CaCO_3</td><td>82</td></tr><tr><td>M - Alkalinity as CaCO_3 (Total)</td><td>157</td></tr></table>	<u>Characteristic</u>	<u>Value, mg/l</u>	Total hardness as CaCO_3	254	Total dissolved solids	381	Suspended solids	400	Calcium as CaCO_3	172	Magnesium as CaCO_3	82	M - Alkalinity as CaCO_3 (Total)	157
<u>Characteristic</u>	<u>Value, mg/l</u>														
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AREA 116 - WATER SUPPLY - continued

Raw Water Analysis (90% Values) cont'd	- <u>Characteristic</u>	<u>Value, mg/l</u>
	Sulfate	101
	Silica	15
	pH	7.4 to 7.9

THE ILLINOIS COAL GASIFICATION GROUP

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5.2 Design Basis

AREA 117 - WATER TREATMENT SYSTEMS

Process Scheme	- Lime-Soda Softening
Purpose	- Remove suspended solids to 15 mg/l or less and reduce hardness to 70 mg/l or less.
Number of Softener Reactor Clarifiers	- Two (2)
Auxiliary Systems	- Each Clarifier to include sludge sump and softened water tank. Slaked Lime Preparation and Feed System. Anionic Polymer Feed System
Feed Streams to Reactor Clarifier	- River Water 11,305 GPM Lime Slurry Water 44,500 lb/hr Lime 1,146 lb/hr Soda Ash Solution Water 3,388 lb/hr Soda Ash 847 lb/hr Anionic Polymer Solution Water 1,150 lb/hr Polymer 2 lb/hr Boiler Blowdown 198 GPM Other Recycle Streams 948 GPM
Discharge Stream From Reactor Clarifier	- Softened, Clarified Water 12,276 GPM Sludge Stream 274 GPM Hardness 70mg/l Calcium 30mg/l

THE ILLINOIS COAL GASIFICATION GROUP

5.0 Baseline Process Concept

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5.2 Design Basis

AREA 117 - WATER TREATMENT SYSTEMS - continued

Process Scheme	- Sand Filtration	
Number of Sand Filters	- Ten (10), Gravity type	
Purpose	- To reduce suspended solids to 3-5 mg/l.	
Feed Stream	- Softened, Clarified Water	12,276 GPM
Discharge Streams	- Filtered Water	11,893 GPM
	To Deionizer	1,414 GPM
	To Cooling Tower Make up	8,853 GPM
	To Potable Water	50 GPM
	To Other Process Users	1,576 GPM
	Recycle Dirty Filter Back-wash Water	383 GPM
Process Scheme	- Carbon Filtration and Deionization	
Purpose	- To remove chlorine, organics and/or suspended solids detrimental to the ion exchange resin life and efficiency and to produce water of a quality suitable for high pressure boiler water make up.	
Number of Carbon Filters	- Eighteen (18)	
Number of Deionizer Trains	- Six (6)	
Feed Streams to Carbon Filters	- Softened, Sand Filtered Water	1414 GPM
	Steam Condensate	1682 GPM

THE ILLINOIS COAL GASIFICATION GROUP

5.0 Baseline Process Concept

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5.2 Design Basis

AREA 117 - WATER TREATMENT SYSTEMS - continued

Feed Streams to Deionization	- Softened, Sand and Carbon Filtered Water	1414 GPM

Feed Streams to Deionizer Regeneration	- 93% H_2SO_4 50% NaOH	178 lb/hr 296 lb/hr

Discharge Streams from Carbon Filters	- To Deionization	1334 GPM
	Steam Cond. To Boiler	
	Make up	1682 GPM
	Backwash Water	80 GPM

Discharge Streams from Deionizer	- Deionized Water to Boiler Make up	1178 GPM
	Spent Regenerant to regeneration and/or Waste Treatment	156 GPM

THE ILLINOIS COAL GASIFICATION GROUP

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5.2 Design Basis

AREA 118 - WASTE TREATMENT AND DISPOSAL

Biotreatment Feed Preparation System

Cooling Pond	- Single pond with two floating spray coolers capable of reducing waste temperature from 230°F to 100°F max.
Carbon Dioxide Neutralizer Tank	- Dual tanks to utilize process CO ₂ off-gas stream to lower pH from 12.5-13.0 to 7.5-8.0.
Oil Water Separators	- Dual unit capable of reducing oil content in waste stream to less than 15 mg/l oil.
Feed Streams to Biosystem	- Ammonia Stripper Bottoms 1811 GPM Plant Drains 175 GPM Dehydration K.O. Drum 7 GPM Oil Recovery K.O. Drum 86 GPM
Discharge Stream to Aeration Basins	- 1809 GPM

Aeration and Clarification System

Aeration Basins	- Designed for complete mixing of activated sludge with sufficient volume to develop a phenolics concentration between 400-500 mg/l.
Number of Trains	- Two (2)

* This is the dominant waste stream for design of the Biotreatment System. - See composition at end of this section.

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Aeration and Clarification System - cont'd

Aeration	- To be provided by both mechanical, floating, surface aerators and submerged turbine aerators.
Clarifiers	- Design surface settling rate - 300 gpd/sq. ft. Design weir overflow rate-10,000 gpd/ft
Clarifier Sludge Thickeners	- Reduce Digester volume requirements by concentrating slurry from 0.9% to 4.0% solids by weight.
Aerobic Sludge Digesters	- 20 day digestion time with mechanical surface aerators to produce a stable sludge for disposal.
Feed Streams to Bio-System	- From Aerators and Cooling 1809 GPM Sanitary Wastes 50 GPM Plant Separators 366 GPM
Discharge Streams	- Digested Sludge to Thickener 109 GPM Clarified Water to Pressure Filter 2243 GPM
Pressure Filter	- Dual media pressure filters to reduce bio-system effluent to suspended solids and BOD levels compatible with reuse as cooling tower make up.

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5.0 Baseline Process Concept

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5.2 Design Basis

AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Thickening and Filtering

Number of Trains	- Two (2)	
Sludge Thickeners	- Dissolved air flotation system producing 5% suspended solids sludge stream.	
Auxiliary Equipment	- Thickener Polymer Feed System	
Feed Streams	- Digested Sludge	109 GPM
	Clarified Water to Press.	
	Filter	2243 GPM
Discharge Streams	- Thickened sludge to sludge press	59 GPM
	Filtered water to C.T. cold well	2209 GPM

Sludge Filtration

Equipment	- Sludge Press Conditioning Tank and Agitator	
	Sludge Press Polymer Feed System	
	Sludge Press	
Feed Stream to Sludge Presses	- Thickened Sludge at 5% TSS	59 GPM
Discharge Streams	- Filter Cake to Disposal at 15% TSS	
	1487 lb/hr (DW)	
	Filtrate to Press Filter	43 GPM

THE ILLINOIS COAL GASIFICATION GROUP

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5.2 Design Basis

AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

pH Adjustment and Disposal

Number of Trains	- One (1)
Equipment	- In-Line Mixer Feed Tank pH Adjustment Sludge Press Sludge Press Polymer Feed System
Feed Streams	- Water Treatment Sludge 274, GPM 6130 lb/hr (DW) SO ₂ Venturi Scrubber Bottoms 843 GPM, 938 lb/hr (DW)
Discharge Streams	- Filter Cake to Landfill at 30% TSS 6927 lb/hr (DW) Sludge Press Filtrate 1085 GPM

Evaporation

Number of Trains	- One (1)
Equipment	- Evaporator Hold Tank with Agitator Ten Effect Evaporator System Carbon Filters for Distillate Polishing
Purpose	- To produce dry solids for disposal from the high, inorganic dissolved solids waste streams.

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5.2 Design Basis

AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Evaporation - cont'd

Feed Streams	- Cooling Tower Blowdown	1150 GPM
		(2300 lb/hr TDS)
	Stream from Deionizer Resin	
	Regeneration	156 GPM
	Evaporator Recycle Oil	145 GPM

Discharge Streams	- Waste Solids	9487 lb/hr
	Water	1306 GPM

Slag Landfill System

Criterion	- Designed as a landfill operation for disposal of 262,970 lbs/hr (DW) waste solids which are compatible with landfill operation.

Feed Streams	- Slag	244,287 lb/hr (DW)
	Ash	10,269 lb/hr (DW)
	Sludge Press Cake	1,487 lb/hr (DW)
	pH Adjustment	
	Sludge Press	
	Cake	6,927 lb/hr (DW)

Waste Solids Pond

Description	- A lined pond for containment of easily redissolved evaporator solids accumulated at the rate of 9487 lb/hr (DW). Provision for leachate collection included.

THE ILLINOIS COAL GASIFICATION GROUP

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5.2 Design Basis

AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

<u>Dominant Waste Stream</u>	<u>Ammonia Stripper Bottoms</u>
Flow, GPM (1)	1,811
BOD , lb/day	94,800
Suspended solids, lb/day	60
Oil and Grease, lb/day	1,975
Phenolics, lb/day	47,262
Caustic, lb/day	164,600
Ammonia, lb/day	1,975
H ₂ S, lb/day	100
Temperature, °F (2)	230
Chlorides , mg/l	500

(1) Based on an assumed 2 lb. BOD/lb Phenolics.

(2) Assumed value obtained from literature for Illinois No. 6 coal.

THE ILLINOIS COAL GASIFICATION GROUP

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5.2 - Design Basis

AREA 119 - FIRE PROTECTION SYSTEM

Impoundment	- To contain required fire water storage plus emergency raw water storage. Five(5) days hold-up (83 MM Gal)
Equipment	- Raw Water Settling Tank Raw Water Strainer Fire Water Strainer Fire Water Jockey Pump Fire Protection Pumps Fuel Tank
Feed Stream	- River Water (Intermittent) 11,305 GPM
Discharge Streams	- River Water (Intermittent or Emergency) 11,305 GPM Emergency Fire Water 10,000 GPM

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5.2 - Design Basis

AREA 120 - FACILITIES

Facilities Storage	- 30 days storage provided for plant products, by-products, and chemicals.
Gas Pipeline	- Synthetic gas pipeline to transport 257 MM SCFD of SNG to market. Pipeline built to transport gas at 1000 psig.
Administration Building	- Administration building will contain ample office space for plant administrative personnel.
Maintenance Shop	- Maintenance shop will serve as central repair facility for the plant. Specialized maintenance will be contracted out.
Laboratory	- Laboratory building will be equipped with the equipment needed to monitor feedstock, product and by-product quality. Waste streams will be monitored for compliance with applicable environmental regulations.
Locker and Change Rooms	- Adequate lunch areas, lockers and shower and toilet facilities will be provided for plant personnel.
Railroad Service	- Rail service will be provided by extending a spur from an existing rail line. Facilities will be used for receiving equipment and chemicals and for shipping products and byproducts to market.
Plant Roads	- Plant road system will provide access to the entire plant.

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5.0 Baseline Process Concept

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5.2 - Design Basis

AREA 120 - FACILITIES - continued

Plant Parking

- Sufficient parking area will be provided for plant personnel and visitors.

Utility Distribution

- Distribution piping will be provided to deliver utilities to all plant areas as required.

Warehouse

- Interior and exterior warehouse space will be provided for storing equipment and supplies.

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5.3 Process Description

AREA 101 - COAL UNLOADING AND HANDLING: PFD 101-100-1, 2

The primary feedstock for the Commercial Plant is washed run of mine (ROM) coal which must be received and stored in a safe and efficient manner. Continuous feed to Coal Preparation must be maintained. This feedstock coal is received by the Commercial Plant by either:

Conveyor Belt from a Mine

Unit Train Hopper Car

A minimum 30-day supply (861,500 tons), to satisfy full Commercial Plant capacity, will be crushed and stored in piles from which it must be reclaimed for delivery to the Coal Preparation process step. The stored coal must be compacted to prevent deterioration and ignition.

The Process Flow Diagram (PFD 101-100-1) depicts unloading by unit train, or conveyor. If these units are unloaded simultaneously, separate conveyors, solid samplers and scales would be required.

Unit trains will have the cars routed through a Thaw Shed before they enter the Rotary Car Dumpers (101-48001-1,2). A 100-ton car would be dumped every two minutes, with up to four unit trains being handled per day. The coal is first dumped into Car Surge Hoppers (101-34003-1,2). It is then fed by Coal Feeders (101-43021-1,2) onto the Coal Conveyor (101-43022). Two shifts are adequate to unload the daily coal requirements for the Commercial Plant. Any required storage build-up during plant operation will be done on a third shift basis for the Commercial Plant.

Coal Conveyor (101-43022) conveys the coal to Transfer House (T-1). At this point the coal will pass under ROM Magnetic Separator (101-45001) to remove tramp metal as the coal is transferred either to the Emergency Stackout Conveyor (101-43001) or to the ROM Coal Conveyor (101-43007).

The Emergency Stackout Conveyor dumps coal at the Stackout Tower (101-43003). This area has the capacity to handle a unit train load (about 10,000 tons). This allows completion of rail unloading when down stream equipment is inoperative. When this equipment is back in service the coal from the emergency stackout area is delivered by ROM Coal Reclaim Conveyor (101-43002) onto ROM Coal Conveyor (101-43007).

THE ILLINOIS COAL GASIFICATION GROUP

5.0 Baseline Process Concept

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5.3 -Process Description

AREA 101 - COAL UNLOADING AND HANDLING: PFD 101-100-1,2 - continued

The ROM Coal Conveyor takes the coal to the Crusher House where the coal enters the ROM Coal Surge Hopper (101-34001). ROM Coal Crusher Feeders (101-43018-1,3) feed the coal to Coal Crushers (101-46001-1,3). Here the coal is crushed to minus 1-1/2 inch size. A crusher bypass stackout is provided.

The crushed coal feeds to the Crushed Coal Conveyor (101-43008) which can deliver it to the Coal Stacker-Reclaimer (101-43009) or to the T-2 Crushed Coal Conveyors (101-43013-1,2). The Coal Stacker-Reclaimer can perform the following functions:

- Stack all Material

- Pass through the required process feed and stack the remainder

- Reclaim coal from the live storage pile.

Stacking capacity is 2070 tons per hour while the reclaiming capacity is 1560 tons per hour. During periods when coal is not being received, coal is reclaimed at the process demand rate of 1196 tons per hour. Provision is made to insure an uninterrupted flow of coal to the process. When the Crushed Coal Conveyor or Stacker Reclaimer is out of service, coal is recovered from the dead storage area by using Emergency Reclaim Conveyor Feeders (101-43011-1,2) and the two Emergency Reclaim Conveyors (101-43010 and 101-43012) to deliver coal to the T-2 Crushed Coal Conveyors (101-43013-1,2). These conveyors transport the coal to a 300 ton Crushed Coal Surge Hopper (101-34002) in Transfer House T-3.

Coal from the Crushed Coal Surge Hopper is fed to the Crushed Coal Weigh Belt (101-43016) by Crushed Coal Feeders (101-43015-1,2). The weigh belt feeds the Coal Dryer Feed Conveyor (101-43017) in the Coal Preparation section.

The 30-day storage capacity of approximately 861,500 tons will be divided into 4 days (114,900 tons) of live storage and 26 days (746,600 tons) of dead storage.

The coal handling facilities are designed to minimize pollution from coal dust. Dust collectors are provided at transfer points within the transfer houses, and water sprays are provided at transfer points in the yard.

Three dozers (101-49001-1,3) are provided for stacking and reclaiming.

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5.3 Process Description

AREA 102 - COAL PREPARATION: PFD 102-100-1, 2

The Coal Preparation area receives sized and washed 1-1/2" by 0" coal from Coal Unloading and Handling, Area 101. The coal is first predried to facilitate screening, crushing and pressurization. Drying is done at low temperatures, 150°F maximum, to prevent oxidation of the coal, which if allowed would reduce oil yield. The coal is then screened and crushed to provide feed of the proper size consist.

After crushing and grinding, the coal is stored in a silo which furnishes surge capacity. Leaving the silo at atmospheric pressure, the coal is pressurized before being fed into the first stage of pyrolysis.

The low pressure of the COGAS process permits the use of a lock hopper pressurization system that has been commercially proven to feed coal against similar pressures in blast furnaces.

Process Flow Diagrams (PFD) 102-100-1, and 102-100-2 depict design flow rates and operating conditions for the Coal Preparation process step.

Description

The process scheme for Coal Preparation consists of four basic functions:

- Predrying
- Screening and Crushing
- Storage
- Pressurizing

Predrying (PFD 102-100-1)

Coal received from Coal Unloading and Handling, Area 101, via the coal Dryer Feed Conveyor (101-43017) is collected in Dryer Feed Bin (102-34004-1,3). The crushed coal is fed from the bin by Dryer Feeders (102-43013-1,3) and is weighed and conveyed to the Coal Dryer System (102-44002-1,3) by Dryer Weigh Belt (102-43001-1,3).

In the dryer, the coal passes through a shallow fluidized bed with a gas exit velocity of 15 to 20 feet per second. Flue gas from the coal-fired Dryer Furnaces is used as the drying and fluidizing medium. The total moisture content (A.S.T.M.) of the coal is reduced from 10%

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to 7% with the coal exiting at a temperature of 130°F. It is critical to maintain the exit temperature of coal sufficiently low to prevent oxidation or actual combustion in the downstream equipment where air may be present. This is accomplished by controlling the dryer exit gas temperature below 150°F. Coal fines swept out of the dryer with the exiting gases are removed in single-stage Dryer Cyclones (102-45003-1,3), and recombined with the dried coal.

The particulates remaining in the gas (about 5 grains/ACF) are removed in Dryer Bag Collectors (102-45002-1,6) and are used as partial fuel for the Dryer Furnace. The exit gas is sent to SO₂ Removal, Area 111.

Fuel for the dryer furnace consists of fines from the Dryer Bag Collector and 1-1/2" x 0" coal. Coal is delivered from the feed bin to the grinder by Dryer Furnace Feeder (102-43014-1,3) and Dryer Furnace Weight Belt (102-43012-1,3). The combined fuel is swept through the Dryer Coal Grinders (102-46002-1,3) by primary air from the Primary Air Blower (102-42003-1,3) and reduced to 95% minus 200 mesh. The coal-primary air mixture is fired along with secondary air in the Dryer Furnace. Flue gas from the furnace is employed to fluidize the coal in the Dryer.

Screening and Crushing (PFD 102-100-1)

Belt Conveyors I (102-43002-1,3) transports the dried coal to continuous bucket Coal Elevators (102-43006-1,3) feeding Feed Bins (102-34001-1,6) with 15 minutes surge capacity.

Coal is fed through the Feed Bin Rotary Feeders (102-43009-1,6) to the Coal Grinders (102-46001-1,6). A coal grinder machine, such as a Gundlach Cage-Paktor or Pennsylvania Coalpaktor, will be used. In these machines, the speed and/or breaker plate setting are adjusted to give the best grind. About 80% of the 1-1/2" x 0" coal fed is reduced to minus 10 mesh.

Coal exits the Coal Grinder and is fed by the Grinder Product Distributor Conveyors (102-43004-1,3) to the Coal Screens (102-45004-1,24). The Coal Screens remove the oversize fraction from the Coal Grinder product.

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AREA 102 - COAL PREPARATION: PFD 102-100-1, 2 - continued

which is recycled by Belt Conveyors-II (102-43003-1,3) to the Coal Elevator, Feed Bin and Coal Grinder.

Storage (PFD 102-100-1)

Crushed and sized coal is moved via the Grinder Product Conveyors (102-43018-1,3) to the Pulverized Coal Elevators (102-43007-1,3), which discharge into storage Coal Silos (102-34002-1,6), which provide a surge capacity of 12 hours. All conveyors, bucket elevators, and screens are enclosed and vented to the Vent Dust Collectors (102-45005-1,3) and Vent Blower (102-42002-1,3).

Pressurizing (PFD 102-100-2)

The crushed coal flows from the silos via Pulverized Coal Weigh Belts (102-43005-1,3) to the top of the Coal Hoppers (102-34003-1,3). The Coal Hoppers are covered and the Dust Control Systems (102-47001-1,3), each consisting of a hopper vent filter and an exhaustor, are provided to minimize dusting during filling of the hopper.

The inert gas required for pressurizing the lock hoppers and conveying coal to Pyrolysis is obtained from the Pyrolysis First Stage Gas Scrubbing system. It is delivered to Area 102, saturated with water vapor at 160°F and 25 psig for compression within the Lock Hopper system. The gas passes thru the Inert Gas Precooler (102-31001-1,3) and the Inert Gas K.O. Drum (102-35002-1,3) to the lock hopper gas compressor. After further cooling the gas is piped to the lock hopper.

Coal is fed from the Coal Hopper to the Pneumatic Conveying System (102-43016-1,12) by the Coal Hopper Rotary Feeders (102-43015-1,12). Coal is conveyed with inert gas from the Inert Gas Blower to the Surge Hopper Cyclone where it is discharged through the rotary airlock valve and a chute to Surge Hoppers (102-35001-1,6). The disengaged inert gas passes through Surge Hopper Dust Collectors, which also discharge coal through a rotary airlock valve to the Surge Hoppers, and Dual Element Filters, and then flows back to the Inert Gas Blower intake.

The Surge Hoppers have a one hour surge capacity. Coal is discharged from the Surge Hoppers into one of two parallel Lock Hoppers per train. Each Lock Hopper is sized for 20 minutes coal holdup. A typical cycle of operation as applied to one train is described.

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5.3 - Process Description

AREA 102 - COAL PREPARATION: PFD 102-100-1, 2 - continued

1. With the top valve open and one Lock Hopper at atmospheric pressure, coal rapidly fills the Lock Hopper.
2. After the Lock Hopper is filled, the top valve closes.
3. Inert gas from the Lock Hopper Gas Compressor is then used to pressurize the Lock Hopper to system operating pressure.
4. At this point, an equalizing valve in the line between the Lock Hopper and the Fluidizing Lock Hopper opens to equalize any slight pressure differential between them.
5. The bottom valve on the Lock Hopper then opens and coal discharges into the Fluidizing Lock Hopper, which still contains a small amount of coal.
6. When the Lock Hopper is empty, the bottom valve and equalization line valve close.
7. The inert gas is vented through the Lock Hopper Dust Collector to the Utility Boiler in Area 115. The top valve is opened to receive another batch of coal. This, then, completes the cycle.

Coal is conveyed from the Fluidizing Lock Hopper directly to the First Stage Pyrolyzers in Area 103. The fluidizing Lock Hoppers are sized for 40 minutes hold up of coal.

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5.3 Process Description

AREA 103 - PYROLYSIS AND GASIFICATION: PFD 103-100-1, 4

Raw synthesis gas and raw oil that are later upgraded to the primary product (synthetic pipeline gas) and by-product (syncrude) oil, are produced from coal feedstock in the Pyrolysis and Gasification process step.

Description

Pyrolysis

In the Pyrolysis section of the plant, partially dried and ground coal is heated in four fluidized bed vessels in series to:

- Complete drying
- Evolve oil and gas fractions
- Produce a low volatile char for gasification

Heating is done in the absence of free oxygen to maximize oil yield, and the staging temperatures and residence times have been chosen to prevent bed agglomeration.

Pressurized coal from Coal Preparation, Area 102, is pneumatically conveyed with inert gas to the First Stage Pyrolyzers (103-33001-1,3). In these vessels, the coal is preheated to 300-500°F and the residual moisture in the coal (after drying in Area 102) is driven off. The coal is fluidized and partially heated by gas which exits from the Second Stage Pyrolyzers (103-33002-1,3). The remaining heating and drying load is supplied from a steam coil immersed in each First Stage Pyrolyzer fluidized bed.

The off-gas from the First Stage Pyrolyzers passes through internal cyclones and through two Recycle Gas Venturi Scrubbers (103-45011-1,3 and 103-45019-1,3) in series to remove particulates and a small amount of oil. The mixture of gas, oil, water and particulates from each Venturi enters its own Gas-Liquid Separator (103-35015-1,3 and 103-35017-1,3). The inert gas, after separation, is recompressed by the Recycle Gas Compressor (103-42001-1,3) and reheated in the Auxiliary Furnace (103-44001-1,3) for reuse as fluidizing gas in the Second Stage Pyrolyzer. This recycle gas is heated by combination with hot flue gas resulting from the combustion of fuel oil in air in the Auxiliary Furnace.

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AREA 103 - PYROLYSIS AND GASIFICATION: PFD 103-100-1,4 - continued

A portion of the inert gas from the suction of the Recycle Gas Compressor flows to the Pressurization Section of Area 102 to pressurize the Lock Hopper Feeding System (102-43017-1,6) and to transport coal from the Lock Hopper Feeding System to the First Stage Pyrolyzer.

The excess inert gas is vented to the Utility Boiler in Area 115.

Coal particulates and oil are decanted from the bulk of the aqueous portion of the scrub liquor in the Pyrolysis Decantor (103-34009-1,3) and flow to an Oil Fines Slurry Tank (103-36001-1,3). The resulting fines-oil-water slurry is pumped from the Oil Fines Slurry Tank by the Oil Fines Slurry Pump (103-41004-1,6) to the Utility Boiler. Decanted water is pumped by the Recycle Venturi Circulation Pump (103-41005-1,6) through Recycle Venturi Cooler (103-31004-1,3) back to the Venturi Scrubbers. Excess water produced by coal drying is directed to Ammonia Recovery, Area 113.

Dried and preheated coal flows from the First Stage Pyrolyzer to the Second Stage Pyrolyzer. In the Second Stage Pyrolyzer, the coal is heated to 400-700°F and partially pyrolyzed by hot inert recycle gas from the Auxiliary Furnace. The gases from the Second Stage Pyrolyzer exit through two stages of internal cyclones and are routed to the First Stage Pyrolyzer.

The dry, slightly devolatilized coal is conveyed to the Third Stage Pyrolyzer (103-33003-1,3) then to the Fourth Stage Pyrolyzer (103-33004-1,3). The Third and Fourth Stage Pyrolyzers are fluidized and heated to 800-1100°F by a counter-current stream of gasifier gas from the Gasifier (103-33005-1,3) at 1600-1700°F. The gaseous and liquid hydrocarbons are driven off as vapors, mixed with gasifier transport gas, and flow to Oil Recovery and Treatment, Area 104.

The char leaving the Fourth Stage Pyrolyzer is transported to the Gasifier.

Pyrolysis staging temperatures are controlled by varying char recycle from the Fourth Stage to the Third Stage. Each reactor is equipped with internal cyclones.

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The Oil Recovery and Treatment process step condenses the raw oil vapors and sour water liquor contained in the vapor stream from Pyrolysis and Gasification, Area 103, and upgrades the raw oil to syncrude.

Description

The process scheme for the Oil Recovery and Treatment Process step is comprised of five basic functions:

1. Oil Recovery
2. Oil Dehydration
3. First Stage Hydrotreating (Ebullated Bed)
4. Oil Filtration
5. Second Stage Hydrotreating (Fixed Bed)

Oil Recovery

The gas stream leaving the Third Stage of Pyrolysis, Area 103, consists of raw synthesis gas, vaporized oil and water and a small quantity of entrained solids.

The gas stream is quenched in Venturi Scrubber I, (104-45001-1,3) by the vaporization of quench water, reducing the temperature of the gas stream and condensing most of the oil vapor.

The gas stream and condensed liquids pass to Quench Separator I (104-35001-1,3), where the gas stream is separated from the liquids and is sent to Venturi Scrubber II (104-45002-1,3). The liquids are further separated in Oil Decanter I, (104-35002-1,3), into oil and water phases.

Most of the oil collected in the first stage scrubber system is heavier than water but some is lighter. Oil Decanter I is designed for separation of both oil fractions from the water. The heavy oil is removed from the bottom of Oil Decanter I and the light oil is removed from the top of Oil Decanter I. Both oil streams are combined and sent to the Oil Dehydration section. Water is pumped by Scrubber Pump I, (104-41001-1,6), from the middle of Oil Decanter I to Venturi Scrubber I along with makeup water from the third stage scrubber. The amount of makeup water returned to Venturi Scrubber I is regulated by the water/light oil interface level in Oil Decanter I.

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AREA 104 - OIL RECOVERY AND TREATMENT: PFD 104-100-1,6 - continued

The second stage scrubbing system is similar to the first, except that Venturi Scrubber II, (104-45002-1, 3), is designed for high scrubber efficiency. Essentially all of the remaining char and oil contained in the entering gas stream is removed and collected. The cooled gas stream is separated from the condensed liquids and water in Quench Separator II, (104-35003-1, 3), where light and heavy-oil phases are separated from the water. Both oil streams are sent to the Oil Dehydration section. The water separated in Oil Decanter II is recycled along with makeup water from downstream processing by Scrubber Pump II, (104-41002-1, 6), to Venturi Scrubber II.

The effluent gas from the second scrubbing system is cooled by the 1500 psig BFW Preheater, (104-31013-1,3), the Softened BFW Preheater (104-31014-1,3), and the Air Cooled Condenser, (104-44001-1,15), in series. The balance of the oil and most of the water vapor in the gas is condensed. The water condensate is removed from the gas stream in the Separator, (104-35009-1,3), and is sent to Oil Decanter III (104-35006-1,3). The residual oil vapor tends to condense as a fog in the gas stream. The oil is removed in the third, final stage, high efficiency Venturi Scrubber III (104-45003-1,3). The liquid stream of oil and water is separated from the gas stream in Quench Separator III (104-35005-1,3). The oil and water are separated in Oil Decanter III (104-35006-1,3). The water underflow from Oil Decanter III is pumped by the Condensate Pump, (104-41003-1,6) through Recycle Sour Water Cooler (104-31015-1,3) to Venturi Scrubber III and to the first and second scrubbing stages as required for makeup water.

The light overhead from Oil Decanter III is fed to Oil Decanter IV, (104-35007-1,3), from which the light oil flows to the oil dehydration section and flashed vapors are recycled to Quench Separator III. Sour water underflow from Oil Decanter IV, containing H_2S , NH_3 , phenol and traces of oil, is sent to Ammonia Recovery, Area 113.

The gas stream leaving Quench Separator III is split. A portion of the gas is compressed by the Recycle Pyrolysis Gas Compressors, (104-42001-1,3) and (104-42009-1,3) and recycled to the Pyrolysis section of the Pyrolysis and Gasification, Area 103, for use as transport gas. The main portion of the gas stream is cooled to 100°F with cooling water in the Product Gas Aftercooler, (104-31001-1,3). Condensed water is separated out in the Product Gas Knockout Drum (104-35008-1,3) and sent to the Ammonia Recovery, Area 113. The cool synthesis gas stream goes to the Gas Compression section in Gas Purification, Area 105.

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5.3 Process DescriptionAREA 104 - OIL RECOVERY AND TREATMENT: PFD 104-100-1,6 - continued

The oil recovery scrubbing system removes essentially all of the char fines contained in the gas stream. The char is removed along with the oil.

Oil Dehydration

The oil from the Oil Recovery Section contains free and dissolved water. The oil is heated in a steam heated Dehydration Feed Preheater (104-31012-1,3), and then flashed in the Oil Dehydrator, (304-35017-1,3) to remove the water vapor and dissolved gases. The dehydrated oil is pumped from the bottom of the Dehydrator by the Dehydration Recycle Pump, (104-41014-1,6), to the Oil Hydrotreating section and a portion of the oil is recycled.

The overhead vapor from the Oil Dehydrator is cooled in the Air Cooled Water Condenser, (104-44010-1,3). The condensed water is then collected in the Dehydration Overhead Knockout Drum (104-35018-1,3). Any gas not condensed is vented from the Dehydration Overhead Knockout Drum to Thermal Oxidizer and Flare, Area 114. The condensed water flows to the Oil-Water Separator, (118-45001-1,2), Waste Treatment and Disposal, Area 118. Any oil that condenses is separated from the water and pumped by the Overhead Condensed Oil Pump, (104-41015-1,6), to the Oil Hydrotreating section or to the Unfiltered Oil Storage Tank, (104-34001-1,6). Oil is pumped from the Unfiltered Oil Storage Tank by Oil Transfer Pump, (104-41016-1,6), to the Oil Hydro-treating section.

First Stage Oil Hydrotreating (Ebullating Bed)

Dehydrated, raw oil is heated in the Feed Preheater, (104-31005-1,3), by hot hydrotreated oil. During startup, the oil fired Startup Heater I, (104-44004-1,3) provides heat. The preheated oil is then pressurized to >2000 psig by the Hydrotreater Feed Pump, (104-41004-1,6), mixed with hot recycle and makeup hydrogen, and fed into the bottom of the First Stage Ebullating Bed Hydrotreater (104-33001-1,3), where the raw oil and hydrogen react. The heat of this highly exothermic reaction is dissipated by heating oil. The turbulent mixing in the ebullating bed provides essentially an isothermal reactor.

The First Reactor Pump, (104-41005-1, 6), takes suction from a downcomer originating above the expanded catalyst bed. The pump discharge, combined with the oil and hydrogen gas entering the reactor provides the necessary upward velocity to ebullate the bed. Maintaining the reactor in an ebullated state allows the char solids in the feed oil plus any coke formed from oil cracking to pass through the reactor. Also, since there is no buildup of solids on the catalyst, reactor pressure drop problems are manageable.

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5.3 Process DescriptionAREA 104 - OIL RECOVERY AND TREATMENT: PFD 104-100-1,6 - continued

Oil is continuously removed from the First Stage Ebullating Bed Hydrotreater and is mixed with cold recycle hydrogen gas. This mixture is then fed to the Second Stage Ebullating Bed Hydrotreater (104-33002-1, 3). Oil is continuously removed from the Second Stage Ebullating Bed Hydrotreater and is cooled in the following sequence: (1) heating recycle and makeup hydrogen in the Recycle Gas Heater I (104-31003-1, 3); (2) heating oil in the Debutanizer Feed Heater I (104-31004-1, 3); (3) heating feed oil in the Feed Preheater (104-31005-1, 3); (4) heating recycle and makeup hydrogen in the Recycle Gas Heater II (104-31006-1, 3); (5) producing 50 psig steam in the Steam Generator (104-44012-1, 3); (6) heating oil in the Debutanized Feed Heater II (104-31008-1, 3); and (7) cooled in Air Fin Cooler I (104-44002-1, 3).

The cooled oil is collected and separated into oil and vapor in the High Pressure Separator I (104-35011-1,3). Washwater, injected into the oil prior to entering the Debutanized Feed Heater II, dissolves the ammonium sulfide from the oil. In the High Pressure Separator I, the washwater is separated from the oil and fed to Ammonia Recovery, Area 113.

Recycle hydrogen from the High Pressure Separator I is compressed in the Hydrotreater Recycle Gas Compressor (104-42004-1,3), and split into two streams. One stream is cold recycle to the Second Stage Ebullating Bed Hydrotreater and the other stream is mixed with the makeup hydrogen and sent back to the First Stage Ebullating Bed Hydrotreater.

The makeup hydrogen stream is produced in Hydrogen Generation, Area 106. This hydrogen stream at 100°F and 315 psig is compressed in the First Stage Makeup Hydrogen Compressor (104-42002-1,3); cooled with cooling water in the Compressor Intercooler (104-31002-1,3), separated of any water in the Water Knockout Drum (104-35010-1,3); and further compressed in the Second Stage Makeup Hydrogen Compressor (104-42003-1,3).

This compressed hydrogen stream is mixed with the recycle hydrogen stream and then heated in both Recycle Gas Heaters I & II (104-31003-1,3 and 104-31006-1,3). The hot recycle and makeup hydrogen stream is then fed to the First Stage Ebullating Bed Hydrotreater. A Startup Heater (104-44004-1,3) is used to heat the hydrogen during startup.

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A small portion of the gas from the High Pressure Separator is purged to prevent buildup of light hydrocarbons and H_2S in the hydrogen recycle stream. This purge stream is depressurized to 500 psig and fed to Gas Purification, Area 105. The pressure of the separated oil from the High Pressure Separator is reduced by the Hydraulic Letdown Turbine I (104-42006-1,3), and then flashed in the Intermediate Pressure Separator I (104-35012-1,3). Hydraulic letdown Turbine I partially drives the Hydrotreater Feed Pump (104-41004-1,6). The flashed gases are sent to Gas Purification, Area 105. Any separated water in the Intermediate Pressure Separator is sent to the Ammonia Recovery Area, Area 113.

Oil from Intermediate Pressure Separator I is reheated by reactor effluent oil and vapor from the Second Stage Ebullating Bed Hydrotreater in both Debutanizer Feed Heaters (104-31008-1,3 and 104-31004-1,3). The pressure of this reheated oil is reduced across a valve and the oil is then fed to the Debutanizer (104-32001-1,3). In the Debutanizer, the oil is stripped with steam to remove any dissolved gases and to separate the naphtha fraction from the oil.

The overhead vapor from the Debutanizer is cooled by the Debutanizer Overhead Air Fin Cooler, (104-44003-1, 3) and the condensed naphtha and water are separated from the gas stream in the Debutanizer Overhead Knockout Drum (104-35013-1, 3). This separated gas stream is fed to Gas Purification, Area 105. Part of the condensed naphtha is recycled by the Debutanizer Reflux Pump, (104-41008-1, 6), to the Debutanizer while the balance is sent downstream to the Stripper Overhead Knockout Drum (104-35016-1, 3) then to the Product Stripper, (104-32002-1, 3). Condensed water separated in the Debutanizer Overhead Knockout Drum is sent to Ammonia Recovery, Area 113.

A portion of the oil from the bottom of the Debutanizer is recycled to the Debutanizer by the Debutanizer Bottoms Recycle Pump (104-41007-1, 6). The remaining oil from the Debutanizer is sent to oil filtration.

Facilities are provided for addition and withdrawal of catalyst from the Ebullating Bed Hydrotreaters to replace catalyst destroyed due to attrition and to withdraw catalyst that has lost its activity. This addition and withdrawal of catalyst creates an equilibrium catalyst mixture with constant activity.

Oil Filtration

Oil from the bottom of the Debutanizer is cooled by heat

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AREA 104 - OIL RECOVERY AND TREATMENT: PFD 104-100-1,6 - continued

exchange with cold filtered oil in the Filtration Feed/Effluent Cooler (104-31009-1,3), and then is further cooled in the Filtration Air Fin Trim Cooler, (104-44005-1,3). This cooled oil is then filtered to remove the solids in the continuous rotary drum Vacuum Oil Filter, (104-45004-1,3).

Cooled oil surge is provided by the Filter Feed Surge Tank, (104-36002-1, 3). The Filter Feed Pump, (104-41019-1, 6), transfers feed from this tank to the Vacuum Oil Filter.

The vacuum for filtration is provided by Vacuum Pump (104-42008-1, 3). The discharge from the Vacuum Pump consisting of vapors generated during vacuum filtration are cooled and condensed in the Filtration Condenser, (104-44011-1, 3).

Gases are separated from condensed liquids in the Filtration Knock-out Drum (104-35019-1, 3), and sent to Thermal Oxidizer and Flare, Area 114. The condensed liquids are separated into water and oil phases in the Filtration Knockout Drum. The separated water is sent to Ammonia Recovery, Area 113. The separated oil is combined with the filtered oil and makes up the feed stream to the Fixed Bed Hydrotreating section. A portion of this stream flows to storage in Area 120, for eventual use as fuel oil in various fired heaters in the process or for storage if the Fixed Bed Hydrotreating Section is not operating.

Oil is filtered through a precoat layer of filter aid on the Vacuum Oil Filter. The precoat layer is removed with the filter cake and must be renewed periodically. To renew the precoat layer, filter aid is slurried with filtered oil in the Filtration Mixing Tank, (104-36001-1, 3). The slurry is then pumped by the Filter Aid Makeup Pump (104-41018-1, 6) to the Vacuum Oil Filter. When renewing the precoat layer, oil flow is diverted to a holding tank. Filter Aid is received from unloading facilities in Area 120 using Filter Aid Storage Bin, (104-34002). The Filter Aid is delivered to the filtration mixing tank by the Filter Aid Feeder, (104-43001-1, 3).

The filter cake from the Vacuum Oil Filter, consisting of the solids, oil and filter aid, is sent to the Power Generation Boiler in Area 115 as part of the fuel requirement of that boiler.

The filtered oil from the Vacuum Oil Filter is pumped by the Filtration

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Effluent Pump (104-41009-1, 6) to the Filtered Oil Surge Tank (104-35022-1, 3). The Filtered Oil Pump, (104-41020-1, 6) then transfers filtered oil to the Filtration Feed/Effluent Cooler, (104-31009-1,3) where the oil is heated by hot unfiltered oil and subsequently, to the suction of the Fixed Bed Feed Pump (104-41011-1, 6).

Second Stage Oil Hydrotreating (Fixed Bed)

The filtered oil is again pumped to >2000 psig by the Fixed Bed Feed Pump (104-41011-1,6) and is mixed with recycle and makeup hydrogen. This mixture is heated by heat exchange with hot reactor effluent oil in the Feed/Effluent Exchanger, (104-31010-1,3). It is then fed to the Fixed Bed Hydrotreater (104-33003-1,3), which has one intermediate quench distributor for temperature control in the reactor. Recycle hydrogen is used as the quenching gas from the Fixed Bed Recycle Gas Compressor (104-42005-1,3). An oil fired Startup Heater II, (104-44007-1,3) is provided to heat the feed oil stream to the Fixed Bed Hydrotreater during startup.

After fixed bed hydrotreating, the hot effluent oil and vapor is cooled by (1) exchanging heat in the Feed/Effluent Exchanger; (2) exchanging heat to the downstream Product Stripper, (104-32002-1,3), in the Stripper Feed Heater, (104-31011-1,3); and (3) in the Air Fin Cooler II (104-44006-1,3). Washwater is injected into the effluent oil and vapor stream prior to the Stripper Feed Heater to dissolve any ammonium sulfide present. The oil stream is then separated into oil and gas in the High Pressure Separator II, (104-35014-1,3). Most of the separated gas is recompressed by the Fixed Bed Recycle Gas Compressor, (104-42005-1,3) and is recycled to the hydrotreater. A small portion of this gas stream is purged from the system and sent to Gas Purification, Area 105. Washwater that contains the dissolved ammonium sulfide is separated from the oil in the High Pressure Separator and sent to Ammonia Recovery, Area 113.

The pressure of the oil is reduced by the Hydraulic Letdown Turbine II, (104-42007-1, 3), and flashed in the Intermediate Pressure Separator II, (104-35015-1, 3). Hydraulic Letdown Turbine II partially drives the Fixed Bed Feed Pump. Flashed gases are sent to Gas Purification, Area 105. Any water present is separated from the oil and sent to Ammonia Recovery, Area 113.

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5.3 Process Description

AREA 104 - OIL RECOVERY AND TREATMENT: PFD-104-100-1,6 - continued

The oil is reheated by the hot reactor effluent oil and vapor in the Stripper Feed Heater (104-31011-1, 3) and fed to the Product Stripper, (104-32002-1, 3). In this Product Stripper, steam strips the light gases and water from the oil. The overhead vapor from the stripper is cooled in the Stripper Overhead Air Fin Cooler, (104-44008-1, 3). The condensed liquids are separated from the vapor stream and combined with naptha from the Debutanizer in the Stripper Overhead Knockout Drum, (104-35016-1, 3). The separated vapor stream is fed to Gas Purification, Area 105. Oil is recycled by the Stripper Overhead Recycle Pump, (104-41012-1, 6), to the top of the Product Stripper. All of the sour water from Oil Recovery and Treatment is pumped by the Sour Water Pump (104-41010-1, 6) to Ammonia Recovery, Area 113.

The product syncrude from the bottom of the Product Stripper is cooled to 150°F by the Product Air Fin Cooler (104-44009-1, 3), and pumped by the Syncrude Pump, (104-41013-1, 6), to storage in Area 120.

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5.3 - Process Description

AREA 105 - GAS PURIFICATION: PFD 105-100-1,3

The process scheme for Gas Purification is comprised of three functions:

- Gas Compression
- Gas Purification
- Light Hydrocarbon Recovery

Gas Compression

Gas compression is accomplished by a condensing turbine that drives two stage centrifugal Gas Compressors (105-42002-1,12). These compressors are package units. Each includes a Steam Turbine drive, Condenser, Condensate Receiver, complete lube oil and seal oil systems, and other related auxiliary equipment. Each compressor package also includes a gas Intercooler and Aftercooler.

Raw synthesis gas from the Oil Recovery and Treatment, Area 104, enters the first stage of the compressor at 25 psig and 100°F. The first stage discharge gas, at an intermediate pressure, is cooled in the intercooler by cooling water before entering the second stage. Discharge gas leaves the second stage at 465 psig and is cooled to 150°F in the aftercooler using cooling water. The gas stream then enters the knockout pot where condensed water is removed. This water contains dissolved hydrogen sulfide and other contaminants and is sent Ammonia Recovery, Area 113. Gas from the knockout pot flows to the Selexol purification system.

Gas Purification

The Selexol process is a physical absorption system utilizing Selexol solvent as the absorbing medium. Basic equipment includes an Acid Gas Absorber column (104-32004-1,3), and associated pumps and heat exchangers.

Sour gas from the Gas Compressor containing H_2S and CO_2 is cooled in two stages before entering the Absorber. Initial cooling is accomplished in the Feed Gas Cooler (105-31011-1,3) using cooling water and additional cooling is by cold Acid Gas Absorber outlet gas in the Gas/Gas Interchanger (105-31012-1,3). The Absorber reduces the H_2S and CO_2 concentration through absorption into the solvent. Purified gas then flows from the Acid Gas Absorber through the Gas/Gas Interchanger to the light hydrocarbon removal section.

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5.3 Process Description

AREA 105 - GAS PURIFICATION: PFD 105-100-1,3 - continued

Rich solvent is passed from the Acid Gas Absorber bottom, through the Hydraulic Expansion Turbine (105-48001-1,3) before flowing to the Flash Tank (105-35004-1,3). This provides part of the total horsepower required for driving the Lean Solution Pump (105-41007-1,9). In the Flash Tank, co-absorbed hydrocarbons and part of the acid gas are desorbed by pressure reduction. Off-gases are recompressed by the Recycle Gas Compressor (105-42003-1,3) and returned to the Absorber inlet. Liquid from the Flash Tank is pumped by the Stripper Feed Pump (105-41008-1,9) through the Solution Interchanger (105-31010-1,3) where it is heated by hot lean solvent and then into the Selexol Stripper (105-32005-1,3). In the Selexol Stripper, the rich solvent is stripped of the remainder of the acid gas by steam which is generated in the Selexol Stripper Reboiler (105-31014-1,3). Steam is condensed out of the overhead stream in the Stripper Overhead Condenser (105-44003-1,3), a fin-fan unit.

Condensate is returned to the Stripper as reflux. The acid gas from the Stripper Overhead Condenser is sent to Sulfur Recovery, Area 112.

Lean solvent from the bottom of the Stripper is pumped by the Lean Solution Pump (105-41007-1,9) through the Solution Interchanger where it is cooled by rich solvent.

The Selexol is then cooled by the Lean Solution Chiller (105-44002-1,3), a package refrigeration unit, before entering the top of the Acid Gas Absorber.

Any solvent spillage or drainage is collected in a sump and transferred by the Selexol Sump Pump (105-41009-1,3) to a storage tank located in the tank farm. Initial solvent charging as well as periodic makeup is accomplished by pumping filtered solvent into the system from storage tank.

Sulfur-free synthesis gas from the Selexol system must be processed to remove light hydrocarbons before being sent to Shift and Methanation, Area 107 and Hydrogen Generation, Area 106. This is accomplished by a light oil scrubbing system comprised of three basic parts:

- Hydrocarbon absorption
- Oil Fractionation
- Secondary Oil Fractionation

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5.3 Process DescriptionAREA 105 - GAS PURIFICATION: PFD 105-100-1,3 - continued

Feed gas is first cooled by Hydrocarbon Absorber overhead gas in the Feed/Product Gas Interchanger (105-31001-1,3) and then cooled further in the Feed Gas Chiller (105-31002-1,3). Leaving the Feed Gas Chiller, the gas enters the Hydrocarbon Knockout Drum (105-35001-1,3). Condensate is removed from the gas in the Knockout Drum and sent to the Oil-Water Separator (118-45001-1,2), in Area 118.

The gas is next fed to the bottom of the Hydrocarbon Absorber (105-32001-1,3), where light hydrocarbons are absorbed from the gas stream by heptane. Heat of absorption is removed by refrigerant in two Absorber Chillers (105-31003-1,6) which cool recirculated column sidestreams. Absorber overhead gas, free of light hydrocarbons, flows through the Feed/Product Gas Interchanger and then to Shift and Methanation, Area 107 and Hydrogen Generation, Area 106.

Rich oil flows from the bottom of the Absorber through the Lean/Rich Oil Interchanger (105-31004-1,3) into the Light Oil Fractionator (105-32002-1,3) whose function is to separate dissolved light hydrocarbons from the heptane. Column heat is supplied in steam-heated Light Oil Fractionator Reboilers (105-31006-1,3). Overheads from the column are partially condensed in the Fractionator Overhead Cooler (105-31007-1,3) and then sent to the Light Oil Knockout Drum (105-35002-1,3). Condensate from the drum is pumped by the Light Oil Fractionator Reflux Pump (105-41002-1,6) as reflux back to the top of the fractionator. The light hydrocarbon product vapor from the Light Oil Knockout Drum is transferred to Gas Compression and Dehydration, Area 109 or to Storage, Area 120 by the Hydrocarbon Gas Compressors (105-42001-1,3). The hydrocarbons going to storage are condensed for storage as a liquid by the Light Hydrocarbon Condenser (105-31015-1,3).

Lean Oil from the bottom of the Light Oil Fractionator is cooled by cold rich oil in the Lean/Rich Oil Interchanger, cooled further by heat exchange with refrigerant in the Lean Oil Chiller (105-31005-1,3) and then returns to the Absorber.

After the Absorption-Recovery System has been in operation for a long period, a concentration of heavier hydrocarbons will build up in the oil. This concentration is kept at a reasonable level by periodically diverting a portion of the lean oil flow to the Oil Blow-down Hold Tank (105-34002). This accumulated blowdown is batch fractionated to yield a heptane cut overhead and heavy hydrocarbon bottoms. After the level in the hold tank has built up to a working level, oil is fed by the Secondary Fractionator Feed Pump (105-41003) to the Secondary Fractionator (105-32003). Heat for

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5.3 Process Description

AREA 105 - GAS PURIFICATION: PFD 105-100-1,3 - continued

distillation is supplied by steam in the Secondary Fractionator Reboiler (105-31008). The Secondary Fractionator Bottoms Pump (105-41004) transfers heavy hydrocarbons to the Unfiltered Oil Storage Tank (104-34001-1,6) in the Oil Recovery and Treatment Area, Area 104, for hydrogenation. Overhead vapor is condensed in the water-cooled Secondary Fractionator Overhead Condenser (105-31009) and flows to the Reflux Pump Tank (105-35003) from which it is pumped by the Secondary Fractionator Reflux Pump (105-41006) either to the Light Oil Tank (120-34009) or back to the column as reflux.

A Hydrocarbon Removal Refrigeration Unit (105-44001-1,3), including circulating pumps, is provided to supply refrigerant to heat exchangers in the system.

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The process scheme for Hydrogen Generation is comprised of three basic functions:

- Shift Conversion
- CO₂ Removal
- Methanation

Shift Conversion

Purified make gas, received from Gas Purification, Area 105, is heated by heat exchange first with inlet gas to the No. 3 Shift Converter (106-32004) and then with inlet gas to the No. 2 Shift Converter (106-32003). The purified gas stream is initially heated in No. 2 Converter Exchanger (106-31003) and then further heated in No. 1 Converter Exchanger (106-31001). The Startup Heater (106-44001) is used to heat the feed stream only during startup. The heated make gas passes through the Desulfurizer (106-32001-1, 2) before it is mixed with steam. The mixture then flows to the No. 1 Shift Converter (106-32002) where CO and steam react to form H₂ and CO₂ over the catalyst bed. Partially shifted outlet gas is cooled in the No. 1 Converter Exchanger (106-31001) by heating the cold inlet feed gas.

Cooled partially shifted gas and steam then enter the No. 2 Shift Converter (106-32003) for additional shifting of the CO. The effluent gas from the No. 2 Shift Converter (106-32003) is initially cooled in the No. 2 Converter Waste Heat Boiler (106-44006), and then in the No. 2 Converter Exchanger (106-31003) before entering the No. 3 Shift Converter (106-32004), where the shifting of the CO is completed. The shifted make gas is then cooled in No. 3 Converter Waste Heat Boiler (106-44007) before entering the first Condensate Separator (106-35001-1).

CO₂ Removal

The shifted gas stream from the Condensate Separator is further cooled in the Carbonate Regenerator Reboiler (106-31005) and enters the second Condensate Separator (106-35001-2). Water condensate is separated from the gas stream in the Condensate Separators and fed to the Condensate Stripper (106-32005) where the water is stripped with steam to remove any dissolved gases. Water is then transferred to the Boiler Feed Water (BFW) system by the Stripper Condensate Pump (106-41001-1, 2).

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5.3 Process Description

AREA 106 - HYDROGEN GENERATION: PFD 106-100-1,2 - continued

The overhead steam from the Condensate Stripper is fed to the Carbonate Regenerator (106-32006) to supply part of the regenerator stripping steam requirements.

The cooled shifted gas stream is next fed to the CO₂ Absorber (106-32007) where the gas stream is countercurrently contacted with potassium carbonate solution to remove essentially all of the CO₂ from the gas stream.

Before the high pressure, rich carbonate solution is fed to the Carbonate Regenerator (106-32006) it flows through one of the Power Recovery Units (106-48001-1, 2) which drive one of the Lean Solution Circulation Pumps (106-41002-1, 3). Heat for regeneration is provided by hot shifted make gas in the Carbonate Regenerator Reboiler (106-31005) and by the overhead vapors from the Condensate Stripper (106-32005).

The overhead stream from the Carbonate Regenerator is partially condensed in the air-cooled Regenerator Overhead Cooler (106-44003). Condensed water is separated from the CO₂ gas stream in the Regenerator Overhead Accumulator (106-35002).

A portion of the separated water is returned as reflux to the Carbonate Regenerator, and the remaining water is sent to the BFW System, by the Regenerator Reflux Pumps (106-41003-1, 2). The regenerated lean carbonate solution from the bottom of the Carbonate Regenerator is pumped back to the CO₂ Absorber (106-32007) by the Lean Solution Circulation Pumps (106-41002-1, 3). The lean solution from the discharge of the Lean Solution Circulation Pumps is split into two portions and enters the CO₂ absorber at two different elevations. The portion of the lean solution, which is fed to the CO₂ absorber at the higher elevation, flows through the Lean Solution Cooler (106-44005) and is cooled before it enters the CO₂ Absorber.

Methanation

The make gas stream leaving the top of the CO₂ Absorber contains some non-shifted carbon monoxide that must be removed to protect the catalyst in the syncrude hydrotreating area. This is accomplished by methanating the gas stream. Make gas from the CO₂ Absorber is heated by Methanator effluent in the Methanator Exchanger (106-31006) prior to entering the Methanator (106-32008). During startup the Methanator

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AREA 106 - HYDROGEN GENERATION: PFD 106-100-1,2 - continued

feed is heated by No. 1 Shift Converter effluent in the Methanator Startup Heater (106-31007).

The hot methanated gas stream is cooled in the Methanator Exchanger (106-31006), the air-cooled Methanated Gas Cooler (106-44004) and the water-cooled Trim Cooler (106-31008). From the Trim Cooler the gas flows to the Methanated Gas Knockout Drum (106-35003) where condensed water is separated from the gas. The recovered water is then sent to the BFW System.

The purified H₂ gas from the Methanated Gas Knockout Drum is then fed to the First Stage Makeup Hydrogen Compressor (104-42002-1, 3) in Oil Recovery and Treatment, Area 104.

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5.3 Process Description

AREA 107 - SHIFT AND METHANATION: PFD 107-100-1, 3

The process scheme for Shift and Methanation is comprised of three basic functions:

- Final Desulfurization
- Bulk Methanation
- Final Methanation

Final Desulfurization

The cold feed gas is interchanged with the No. 6 Methanator (107-32006-1, 3) effluent in Feed/Product Interchanger (107-31007-1, 3) to bring its temperature to 379°F. Additional heat is provided by the Final Desulfurizer Heaters (107-44004-1, 3) to raise the gas stream to 750°F before it enters the Final Desulfurizers (107-32008-1, 6). The Final Desulfurizers are two zinc oxide catalyst beds operating at about 405 psig and 750°F to remove trace quantities of sulfur compounds that might escape gas clean-up in the Gas Purification process step. This is precautionary protection for the nickel type catalysts employed in the Methanators.

Bulk Methanation

The effluent from Final Desulfurizers (107-32008-1, 6) is fed to the first three Methanators (107-32001-1, 3, 107-32002-1, 3 and 107-32003-1, 3) in individually controlled streams. A portion of the total gas flow is mixed with high pressure steam. This mixture is heated in the No. 1 Methanator Feed Heater (107-44001-1, 3) before entering the No. 1 Methanator (107-32001-1, 3). Steam at 400 psig is required for the shift reactions and the total steam requirement is introduced at this point in the process. More than the stoichiometric quantity necessary to shift the carbon monoxide to achieve the proper hydrogen to carbon monoxide ratio is fed to the process. Steam is not only a thermal diluent, but also thermodynamically limits the temperature rise in each adiabatic reactor because steam is a coproduct of the methanation reaction.

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5.3 Process Description

AREA 107 - SHIFT AND METHANATION: PFD 107-100-1, 3 - continued

The RMProcess permits operations for bulk methanation at temperatures ranging from 800°F to 1500°F. Since the shift reaction occurs simultaneously with methanation in this temperature range, the total heat released by both the shift and methanation reactions is recovered by generating 1500 psig steam in the Methanator Steam Generators. This steam is produced at its saturation temperature of 597°F. About 80% of the quantity generated is exported to other areas of the plant, but it must be superheated to about 850°F for use as turbine steam. The energy to superheat this steam is provided by both the No. 1 Methanator Feed Heater (107-44001-1, 3) and the Final Desulfurizer Heater (107-44004-1, 3). A portion of the heat released in the No. 5 Methanator (107-32005-1, 3) and all of the heat released in the No. 4 Methanator (107-32004-1, 3) is required in heating boiler feed water from about 220°F to 597°F.

The methanated gas discharged from the No. 6 Methanator (107-32006-1, 3) is cooled in the Final Methanator Feed Heater (107-31010-1,3) and the Methanator Gas Air Cooler (107-44002-1,3) to 150°F. Over the temperature range from 350°F to 150°F water vapor in the gas stream is condensed until only 1.25% of it remains in the exit gas from the Methanator Gas Knockout Pot (107-35001-1,3). An exit gas temperature higher than 150°F would overload the CO₂ removal system thermally and physically with excessive quantities of water.

Final Methanation

The gas effluent from the CO₂ removal system is heated from 70°F to 160°F in the Final Methanator Feed Heater (107-31010-1, 3) while cooling the methanated gas from the No. 6 Methanator. This feed stream to final methanation contains between 1.0 and 5.0 volume % carbon monoxide and about 1.0% carbon dioxide. Final methanation reduces the carbon monoxide to less than 0.1%, and the carbon dioxide remains approximately 1.0%.

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5.3 Process Description

AREA 107 - SHIFT AND METHANATION: PFD 107-100-1, 3 - continued

Part of the feed stream to final methanation is heated by heat transferred from the Final Methanator (107-32007-1,3) effluent in the Final Methanator Interchanger (107-31009-1,3). This heated feed stream is methanated in the top bed of the dual catalyst bed Final Methanator. The heat of reaction in the top bed increases the gas stream temperature which is then reduced by blending with the remaining feed stream before entering the bottom catalyst bed.

The synthetic gas effluent from final methanation is cooled to 150°F in the air cooled Final Methanator Air Cooler (107-44003-1, 3). The water formed in final methanation is condensed and removed from the product gas stream in the Final Methanation Knockout Pot (107-35003-1, 3) to be discharged to the boiler feed water system. The cooled product gas stream is discharged to Gas Compression and Dehydration, Area 109, to be compressed and dried for end use.

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The basic process for Bulk CO₂ Removal is the Selexol Process. Equipment includes:

- CO₂ absorber column
- Solvent regenerator column
- Hydraulic turbines
- Flash tanks
- Recycle compressor
- Associated pumps and heat exchangers

Incoming gas from the Shift and Methanation process step, which contains 33 volume percent CO₂, is cooled before entering the absorber, first by cooling water in the Feed Gas Cooler (108-31002-1,3) and by cold absorber outlet gas in the Gas/Gas Interchanger (108-31001-1, 3).

Recycle gas from the Recycle Gas Compressor (108-42002-1,3), consisting mainly of carbon dioxide and methane, is mixed with the cold feed gas at the outlet of the interchanger. In the CO₂ Absorber (108-32001-1,3), the CO₂ concentration of the gas is reduced to 1 volume percent by absorption into the recirculating Selexol solvent. CO₂ lean gas flows from the absorber through the Gas/Gas Interchanger (108-31001-1,3) to final methanation in Area 7.

CO₂ rich solvent from the absorber at approximately 270 psig is subcooled in the Rich Solution Chiller (108-44001-1,3) and is allowed to flow through the Primary Hydraulic Turbine (108-48001-1,3) which will recover a portion of the total energy required for pumping. Solvent then flows from the primary turbine to the Primary Flash Tank (108-35001-1,3). Methane bearing gases from the flash tank are recycled to the CO₂ Absorber (108-32001-1,3) inlet via the Recycle Gas Compressor (108-42002-1,3) and the aftercooler.

Liquid from the Primary Flash Tank (108-35001-1,3) is let down, through the Secondary Hydraulic Turbine (108-48002-1,3). This Secondary Turbine recovers another portion of the total energy required for pumping. Both hydraulic turbines are used to partially drive one of the Lean Solution Pumps (108-41001-1,9). From the Secondary Hydraulic Turbine (108-48002-1,3), the solvent flows to the Secondary Flash Tank (108-35002-1,3).

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May 19805.3 Process DescriptionAREA 108 - BULK CO₂ REMOVAL: PFD 108-100-1 - continued

The CO₂ gas liberated in the Secondary Flash Tank is vented to the atmosphere pressure control. Liquid from this tank is pumped by the Stripper Feed Pumps (108-41003-1,9) to the top of the Selexol Regenerator (108-32002-1,3).

In the Selexol Regenerator, the rich solvent is stripped of the remainder of the dissolved CO₂ by air. Air is supplied to the bottom of the regenerator by an Air Blower (108-42001-1,3). Air and CO₂ are discharged from the regenerator to the atmosphere. Lean solvent is pumped by the Lean Solution Pumps (108-41001-1,9) to the top of the CO₂ Absorber (108-32001-1,3).

Inlet gas from Shift and Methanation, Area 107, contains about 1 per cent water. This water is absorbed by the Selexol solvent in the CO₂ Absorber (108-32001-1,3) and must be removed to prevent the concentration from building up in the solvent. This is accomplished by taking a sidestream from the discharge of the Stripper Feed Pumps (108-41003-1,9) and passing it through the Solution Drying Unit (108-48003-1,3). This is a packaged, distillation-type, liquid hydrocarbon drying unit. The solvent-water concentration will reach an acceptable equilibrium value based on the capacity of the drying unit.

Any solvent spillage or drainage is collected in a sump and transferred by the Selexol Sump Pump (108-41002-1,3) to a storage tank located in Area 120. Initial solvent charging and periodic solvent makeup due to mechanical and overhead solvent losses is accomplished by pumping filtered solvent into the system from the storage tank.

5.3 Process Description

AREA 109 - GAS COMPRESSION AND DEHYDRATION: PFD 109-100-1

Methanated gas leaving Shift and Methanation, Area 107, at 230 psig and 150°F, and light hydrocarbon enrichment gas from Gas Purification, Area 105, at 335 psig and 140°F are directed to Area 109, Gas Compression and Dehydration. The methanated gas and the enrichment gas are blended together to upgrade the methanated gas to conform to the minimum pipeline gas specification.

Compression

After blending of the methanated gas and enrichment gas, the combined stream of synthetic pipeline gas flows into the Pipeline Compressor Knockout Pot (109-35004). This vessel separates any entrained liquid hydrocarbon and condensate from the gas stream prior to its entry into the Pipeline Compressor (109-42001-1,3). It also provides surge to smooth out sudden changes in pressure that may occur upstream on the suction side of the Pipeline Compressor.

Since the pressure of the natural gas grid at the battery limit is 1000 psig, it is necessary to increase the pressure of product gas from 250 psig to 1070 psig. This increase in pressure is accomplished by the Pipeline Compressor, which is a centrifugal compressor driven by a steam turbine. The compressor will have two stages of compression, from 250 to 500 psig and from 500 to 1070 psig. A water cooled, Compressor Intercooler (w/109-42001-1, 3) is provided to remove the heat of compression from the first stage. The gas leaving the Compressors is cooled to 150°F in the Compressor Aftercooler (109-44002), a mechanical air fin-fan cooler. To further reduce the gas temperature from 150°F to 100°F, it is cooled in the Pipeline Gas Cooler (109-31004). Cooling tower water is used as the cooling medium in the Pipeline Gas Cooler. This temperature is the maximum allowable for operation of the dehydration system since a higher inlet temperature would increase the dew point of the product gas leaving it.

The cooled gas then flows to the Dehydration Column Knock Out Pot (109-35003) which contains an entrainment separator to eliminate any carry-over of entrained liquids from the gas. Gas enters the dehydration unit saturated with water vapor at 1055 psig and 100°F.

Dehydration

To meet gas pipeline specifications, the moisture content of the gas must be reduced to 6.5 lbs H₂O per MM SCF. A conventional glycol dehydration process was selected to remove moisture from the wet SPG.

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May 19805.3 Process DescriptionAREA 109 - GAS COMPRESSION AND DEHYDRATION: PFD-109-100-1 - continued

Water saturated product gas enters the bottom of the Dehydration Column (109-32001), where it is contacted countercurrently with triethylene glycol (TEG) flowing downward through the column. A mist eliminator is installed at the top of the column to remove entrained liquid droplets from the product gas. The dehydrated product gas leaving the column is then sent either to gas surge in Area 120 or directly to the pipeline.

Lean glycol enters the Dehydration Column at 100°F with approximately 98.5% by weight TEG. It leaves the bottom of the Dehydration Column at 96% by weight TEG and 4% water.

Water rich TEG flows from the dehydration column at 100°F and 1050 psig through the Lean/Rich Glycol Interchanger (109-31002) where it is heated to 240°F. From the Lean/Rich Glycol Interchanger, the rich TEG is flashed to approximately 20 psig in the Rich Glycol Flash Drum (109-35001). Dissolved gases are released from the TEG due to the pressure reduction in the flash drum and vented to the Thermal Oxidizer in Area 114. Rich TEG flows from the flash drum through the Rich Glycol Filter (109-48001) to the Regeneration Column (109-32002). This filter is a standard, pipeline cartridge filter that will retain solid particles larger than three microns.

The Regeneration Column (109-32002) is a packed column in which the water is distilled from the TEG. The separation of water from triethylene glycol is an easy operation due to the wide difference in boiling points.

Water vapor passing through the regeneration column leaves the top of the column and enters the air cooled, Regeneration Column Condenser (109-44001) where it is condensed and cooled to 120°F. The condensate is collected in the Reflux Drum (109-35002). Part of the condensate is returned to the Regeneration Column as reflux by the Reflux Pump (109-41002-1, 2), while the remainder is pumped to Waste Treatment and Disposal, Area 118.

Lean TEG flows from the base of the Regeneration Column into the Regeneration Column Reboiler (109-31003) where it is indirectly heated to 400°F by 600 psig steam flowing through a tube bundle. Additional water is evaporated and the lean solution exits the reboiler at 98.5% by weight TEG.

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5.3 Process Description

AREA 109 - GAS COMPRESSION AND DEHYDRATION - PFD-109-100-1 - continued

Lean TEG is pumped from the Regeneration Column Reboiler by the Lean Glycol Pump (109-41001-1, 2) through the Lean/Rich Glycol Inter-changer (109-31002) where it is cooled to 150°F. Further cooling to 100°F is done in the Lean Glycol Cooler (109-31001) before the TEG is returned to the Dehydration Column. Cooling tower water is used as the cooling medium in the lean glycol cooler.

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5.3 Process Description

AREA 110 - FLUE GAS POWER RECOVERY: PFD 110-100-1

The flue gas stream, leaving the Flue Gas Cyclone (103-45008-1,36) in Pyrolysis and Gasification, Area 103, contains approximately half the heat generated in the Combustor (103-33006-1,3) and sufficient kinetic energy to drive Air Compressor (110-42002-1,6). Recovery of the energy contained in the flue gas stream is essential to achieve high plant thermal efficiency.

Design of this process step is based on maximum use of existing commercial technology, paralleling fully commercial fluidized catalytic cracking (Fluid Cat Cracker) regenerator flue gas heat and power recovery designs.

Description

Flue Gas Power Recovery is comprised of three basic functions:

- Flue Gas Oxidation and Heat Recovery
- Particulate Removal
- Power Recovery and Air Compression

Flue Gas Oxidation and Heat Recovery

The hot flue gases from the Flue Gas Cyclones, Area 103 flow to the Flue Gas Oxidizer (110-44001-1,3) and are burned with air. The heat of combustion is recovered as steam and the CO content is reduced to meet emission standards. At the same time, H_2S is converted to SO_2 , H_2 is converted to H_2O , and the char fines are burned to produce an ash residue which is later removed in a Tertiary Separator (110-45002-1,6). The mixed air and flue gas temperature to the Flue Gas Oxidizer is above the ignition temperature for CO. Supplementary fuel oil is provided for combustion stability. Superheated steam at 1500 psig, and 850°F is generated in the Flue Gas Oxidizer for use in turbine drives and other process uses.

A portion of the 1500 psig, 850°F steam flows through the Flue Gas Oxidizer Power Generator (110-48002-1,3) where it is superheated. The superheated steam flows to Pyrolysis and Gasification, Area 103 where it is used as a fluidizing medium.

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The temperature of the effluent gas from the Flue Gas Oxidizer is 1200°F. Combustion of CO in the Flue Gas Oxidizer has reduced the concentration in the stream so that it meets a 200 ppm CO environmental specification. The flue gases then pass through the Tertiary Separator (110-45002-1,6) and the Expanders which are part of the Air Compressor (110-42002-1,6) package.

A portion of the ash formed by the combustion of char fines in the Flue Gas Oxidizer is captured there as wall and tube deposits. These are removed by the action of steam-actuated soot blowers, quenched in a water filled tank, and transferred as a water slurry to the Slag Removal System (103-47001-1,3) in Area 103, Pyrolysis and Gasification.

The expanded flue gases enter the 600 psig Waste Heat Boiler (110-44002-1,3) which generates 600 psig steam for use in the Steam Coil of the First Stage Pyrolyzer, Area 103, then preheats 1500 psig boiler feed water for Flue Gas Oxidizer. The flue gas exits the High Pressure BFW Preheater (110-31001-1,9) and flows to SO₂ Removal, Area 111.

Particulate Removal

The particulate level in the flue gas stream entering Area 110 is partially reduced by combustion of the char fines to ash in the Flue Gas Oxidizer. The Tertiary Separator, a high efficiency cyclone separator, further reduces the particulate loading of the flue gas stream to a level acceptable for single-stage power recovery expanders.

A part of the flue gas underflows the Tertiary Separator carrying with it solids that have been removed from the bulk of the flue gas. The underflow gas flows to the Separator Cyclone (110-45003-1, 6) where the underflow gas is separated from the solids. The underflow gas rejoins the main flue gas stream downstream of the Expanders and enters the Waste Heat Boiler. The Separator Cyclone discharges the solids into Separator Slurry Tanks (110-35003-1,6) and the resulting slurry is transferred to the Slag Removal System in Area 103.

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AREA 110 - FLUE GAS POWER RECOVERY: PFD 110-100-1 - continued

Power Recovery and Air Compression

The main flue gas stream, leaving the Tertiary Separator at 1200°F is piped to the Expanders. The pressure available at the inlet to the Expanders is in excess of 50 psig which is sufficient to give an expansion ratio of about 4. This exceeds a practical expansion ratio for a single stage expander turbine (the only type commercially proven in "dusty gas" service). Thus, two single-stage turbines with lower expansion ratios are used in series.

The two Expanders are connected on a single shaft to one axial Air Compressor (110-42002-1,6). A steam turbine drive is also connected to the same shaft for use during startup and shutdown and as a backup power source should an expander fail or when inlet gas quality is not suitable for the Expanders.

The power, which can be recovered through expansion, balances the air compression requirements for combustion. To maintain a pressure balance throughout the system (i.e. the Pyrolysis, Gasification and Combustion substeps), the inlet pressure to the Expanders will be controlled by allowing some flue gases to bypass the Expanders and flow directly to the 600 psig Waste Heat Boiler (110-44002-1,6). This bypass will be designed to handle 100% of the flue gas stream so that it can be utilized during start-up and shutdown or to allow the Expanders to be removed from service.

Fresh ambient air for the process is drawn through Air Silencers, Air Filters and is compressed to about 65 psig in Air Compressors (110-42002-1,6).

One commercial plant train will consist of one or two Flue Gas Oxidizers dictated by arrangement and economic considerations. Downstream of the Flue Gas Oxidizers, two trains of Tertiary Separators, Expander-compressor sets, and Waste Heat Boilers will be required to stay within the limits of commercially proven and available equipment.

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AREA 111 - SO₂ REMOVAL: PFD-111-100-1, 4

The process scheme for SO₂ Removal consists of four basic functions:

- Particulate Scrubbing
- SO₂ Absorption
- SO₂ Regeneration
- Sodium Sulfate Purge

Flue gas input streams to SO₂ Removal originate in Coal Preparation, Area 102; Flue Gas Power Recovery, Area 110; Sulfur Recovery Area 112; and the boiler in the Utilities area, Area 115.

Particulate Scrubbing

The combined flue gas streams, at approximately 200°F and 2 psig, are fed to the Venturi Scrubbers (111-47001-1, 6) to remove entrained particulates prior to the SO₂ scrubbing. Particulates are scrubbed from the gas stream with water and the slurry is collected in the Venturi Surge Tank (111-36001-1, 6). The particulate-water sludge is removed from the bottom of the Venturi Surge Tank and pumped by the Sludge Pumps (111-41002-1, 9) to pH adjustment in Waste Treatment and Disposal, Area 118. Water from the top of the Venturi Surge Tank including recycled filtered water from Waste Treatment and Disposal, Area 118, is pumped to the Venturi Scrubber by the Venturi Recycle Pumps (111-41001-1, 15). Softened plant process water and excess condensate from the downstream SO₂ Stripper (111-32001-1, 3) constitute makeup water to the Venturi Scrubber System. Makeup water is provided by the Venturi Makeup Water Pumps (111-41009-1,6).

SO₂ Absorption

The flue gas stream at 125°F with the particulate material removed is then fed to the SO₂ Absorber (111-32002-1, 6). The SO₂ Absorber is a multi stage tower with a SO₂ Demister (111-32002-1D,6D). In the Absorber, the flue gas is countercurrently contacted with the saturated sodium sulfite (Na₂SO₃) solution. The Na₂SO₃ solution absorbs the SO₂ and any SO₃ and produces sodium bisulfite

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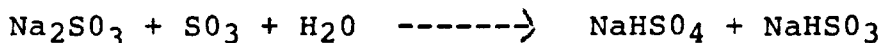
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5.3 Process Description

AREA 111 - SO₂ REMOVAL: PFD-111-100-1, 4 - continued

(NaHSO₃) and sodium bisulfate (NaHSO₄) by the following chemical reactions:



The SO₂ Absorber requires recirculation of the solution around each stage since the quantity of fresh feed solution is insufficient to irrigate the trays. Recycling is done by the First Stage Absorber Recycle Pumps (111-41003-1, 12) the Second Stage Absorber Recycle Pumps (111-41004-1, 6), and the Third Stage Absorber Recycle Pumps (111-41005-1, 6).

The gas stream from the SO₂ Absorber with most of the SO₂ removed (<300 ppmv) is reheated to 175°F with steam in the Flue Gas Reheater (111-31001-1, 6) to prevent condensation and improve buoyancy. It is then blown up the Flue Gas Exhaust Stack (111-48001-1, 3) by the Flue Gas Induced Draft Fan (111-47002-1, 6) and discharged to the atmosphere.

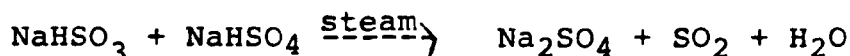
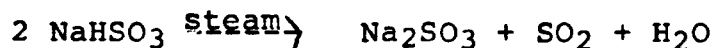
SO₂ Regeneration

Rich NaHSO₃ solution is withdrawn for regeneration and is pumped by the First Stage Absorber Recycle Pumps (111-41003-1, 6) to the SO₂ Absorber Surge Tank (111-35002-1, 3). The use of a solution surge tank enables the process to operate smoothly during changes in gas flow rate or SO₂ concentration and will permit upsets and shutdown of the regeneration section for maintenance without interruption of SO₂ absorption. The rich NaHSO₃ solution is divided into two fractions. One fraction is utilized as feed solution to the sodium sulfate purge section, while the second is employed as direct feed to the SO₂ regeneration section of the process.

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The rich NaHSO₃ solution fraction that is fed to the SO₂ regeneration section is pumped by the Absorber Surge Tank Pumps (111-41011-1,6) to the SO₂ Regeneration Evaporator-Crystallizer (111-31003-1,3). It is combined with the NaHSO₃ solution recycled from Na₂SO₄ purge system (from Feed Cooler (111-31007-1,3) to be the feed solution to the Evaporator-Crystallizer (111-31003-1,3). Here it is mixed with the circulating solution and flows through the Evaporator Crystallizer Heater (111-31002-1,3) which heats it to its atmospheric boiling point. At this temperature the acid salts in the spent solution are thermally decomposed to release SO₂ and regenerate the sorbent by the following chemical reactions:



The SO₂ and water vapor pass overhead from the Evaporator-Crystallizer to the water cooled Primary Condenser (111-31004-1,3). Condensed water is separated from the gas stream and goes to the SO₂ Stripper (111-32001-1,3) where the condensate is stripped with steam to remove dissolved SO₂. Stripping steam is provided by the Desuperheater (111-44001-1,3).

The gas stream from the Primary Condenser (111-31004-1,3) is further cooled along with steam and SO₂ from the SO₂ Stripper, in the water cooled, Secondary Condenser (111-31005-1,3). Condensed water also goes to the SO₂ Stripper. The SO₂ stream exiting the secondary condenser is compressed to 15 psig in the SO₂ Compressor (111-42001-1,3) and is sent to the Claus Plant Sulfur Recovery, Area 112.

A slurry of the Na₂SO₃ crystals is continuously removed from the bottom of the SO₂ Regeneration Evaporator-Crystallizer and fed to the Dissolving Tank (111-36002-1,3) where the Na₂SO₃ crystals are dissolved in condensate from the SO₂ Stripper. The regenerated, lean Na₂SO₃ solution is recirculated to the top of the SO₂ Absorber (111-32002-1,6) by the SO₂ Absorber Feed Pump (111-41006-1,6).

Makeup of sodium lost in Na₂SO₄ purge is provided by adding soda ash to the Na₂SO₃ solution. Soda ash is added as a solution through the Soda Ash Mixing Tank (111-36003-1,3) and the Soda Ash Feed Pump (111-41007-1,6) to the Dissolving Tank (111-36002-1,3).

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AREA 111 - SO₂ REMOVAL: PFD-111-100-1, 4 - continued

Sodium Sulfate (Na₂SO₄) Purge

Unregenerable sodium sulfate, Na₂SO₄, is formed by oxidation in the absorber and must be purged to prevent its saturating the solution. A sidestream of solution is diverted from the SO₂ Absorber Surge Tank (111-35002-1, 3) through the Feed Cooler (111-31007-1,3) where cold NaHSO₃ solution cools it to 68°F. The solution is further cooled to crystallize the Na₂SO₄ as Glauber's salt (Na₂SO₄ · 10H₂O) while the NaHSO₃ remains in solution. This is done in the Chiller Crystallizer System which includes a Tank (111-36004-1,3) with an Agitator (111-39004-1,3) and Cooling Coil (111-31006-1,3) Coolant for the Chiller Crystallizer System is cold glycol from the Refrigeration Unit (111-44002-1,3) circulated by the Glycol Pump (111-41010-1,6).

The solution with Na₂SO₄ crystals from the Chiller Crystallizer System is pumped by the Chiller Crystallizer Pumps (111-41012-1, 6) to the Centrifuge (111-45001-1,3) where a slurry is separated from the NaHSO₃ solution. The NaHSO₃ solution is collected in the Centrate Tank (111-35004-1, 3) and is then pumped by the Centrate Pumps (111-41013-1, 6) to the Feed Cooler (111-31007-1, 3) to be recycled to the Evaporator-Crystallizer Heater (111-31002-1, 3).

The Na₂SO₄ slurry from the Centrifuge is transferred by the Centrifuge Conveyor (111-43005-1, 3) to the Rotary Dryer (111-31008-1, 3). Moisture is removed from the Na₂SO₄ by hot air from the Steam/Air Heater (111-44003-1, 3). Dried Na₂SO₄ is transferred by the

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AREA 111 - SO₂ REMOVAL: PFD-111-100-1, 4 - continued

Dryer Conveyor (111-43007-1, 3) and the Bucket Elevator (111-43008-1, 3) to the Recycle Bin (111-35005-1, 3) via a Vibrator Feeder (111-43009-1, 3). The heavier, partially dried Na₂SO₄ is recycled by the Recycle Bin Weigh-Feeder (111-48002-1, 3) and the Recycle Conveyor (111-43006-1, 3) to the Rotary Dryer. Lighter anhydrous Na₂SO₄ overflows the Recycle Bin to the Product Bin Loading Conveyor (111-43012-1, 3).

The hot air from the Rotary Dryer carries out anhydrous Na₂SO₄ dust which is separated from the air in the Dust Collection System (111-47005-1, 3). Dust Conveyors I and II, (111-43010-1, 3 and 111-43011-1, 3) transfer it to the Product Bin Loading Conveyor. The exhaust from the Dust Collection System is returned by the Dust Collection System Exhaust Fan (111-47004-1, 3) to the Venturi Scrubber (111-47001-1, 6).

Anhydrous Na₂SO₄ from both the Recycle Bin and the Dust Collection System is transferred by the Product Bin Loading Conveyor to the Product Bin (111-35006-1, 3) which is large enough to hold one week's production of Na₂SO₄. The Product Bin is equipped with Product Bin Vibrators (111-43013-1, 6) for loading the Na₂SO₄ into trucks for shipping.

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5.3 - Process Description

AREA 112 - SULFUR RECOVERY: PFD 112-100-1

The process scheme for the Sulfur Recovery is comprised of three basic functions:

- Claus Plant
- Tail Gas Incineration
- Sulfur Byproduct Handling

Claus Plant

The three gas streams containing H_2S or SO_2 which are fed to the Sulfur Recovery process step are fed directly to the Claus Plant, (112-47001).

The two H_2S streams are combined and fed to the Acid Gas Knockout Drum where any entrained liquid is separated from the gas stream. The separated liquid is sent to the Ammonia Recovery, Area 113.

The H_2S stream is then split into two streams. One stream is fed to the Burner of the Reactor Furnace and is combusted with air. Sufficient H_2S is converted to SO_2 to render the $H_2S:SO_2$ ratio in the three feed gas streams as close to 2:1 as possible. Air for combustion in the Reactor Furnace Burner is provided by the Combustion Air Blower which is equipped with an inlet Air Filter. The amount of air provided is just sufficient to burn the required amount of H_2S to SO_2 . Fuel oil is provided to the Burner for start-up of the Claus Plant.

The combustion gases from the Reactor Furnace at 2000 to 2600°F are then cooled to 500°F in the Waste Heat Boiler. Cooling the gases generates 600 psig steam on the shell side of the Waste Heat Boiler. This steam is used internally in the Claus Plant in the Reactor Feed Heaters.

The gas stream from the Waste Heat Boiler is then further cooled in Sulfur Condenser I, which condenses any sulfur that has formed. The condensed sulfur is separated from the gas stream and is sent to the Sulfur Pit. The gas stream is then reheated in Reactor I Feed Heater. Heat is provided by 600 psig steam. The reheated gas stream is next fed to Reactor I.

Also fed to Reactor I is the H_2S stream bypassing the Reactor Furnace/Waste Heat Boiler and the SO_2 stream from the SO_2 Removal

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process step in Area 111. The H_2S stream that bypasses the Reactor Furnace/Waste Heat Boiler is heated in the Acid Gas Feed Heater by 600 psig steam and then fed to Reactor I.

The SO_2 stream first enters the SO_2 Knockout Drum where any entrained liquids are separated from the gas stream. The separated liquids are sent to Ammonia Recovery in Area 113. The SO_2 stream is then heated in the SO_2 Feed Heater by 600 psig steam and fed to Reactor I.

In Reactor I, the H_2S and SO_2 in the three combined gas streams react over an alumina catalyst to form sulfur. The heat of the exothermic reaction between H_2S and SO_2 heats the gas stream. The gas stream is then cooled in the second Sulfur Condenser where the sulfur that has formed is condensed, separated and sent to the Sulfur Pit.

The gas stream leaving the second Sulfur Condenser is reheated in Reactor II Feed Heater by 600 psig steam and then fed to Reactor II. Additional sulfur is formed over the catalyst in Reactor II. The gas stream leaves Reactor II and is then cooled in the third Sulfur Condenser. Again, the sulfur that has formed is condensed, separated from the gas stream, and directed to the Sulfur Pit.

The gas stream leaves the Third Sulfur Condenser and is reheated in Reactor III Feed Heater by 600 psig steam and is then fed to Reactor III.

The gas stream is reacted over catalyst in Reactor III. The hot effluent gas from Reactor III is cooled in the fourth Sulfur Condenser. Again, the sulfur that has formed is condensed, separated from the gas stream, and sent to the Sulfur Pit.

The Sulfur Condenser is a combined condenser-separator. It combines in one vessel all the condenser tube passes and gas-liquid sulfur separators. 50 psig steam is generated in this unit for plant use and for export.

Most of the elemental sulfur is formed in Reactor I. The sulfur formed in the Reactors and Reactor Furnace flows as a liquid from the Sulfur Condenser to the Sulfur Pit which has a capacity to hold five days production.

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AREA 112 - SULFUR RECOVERY: PFD 112-100-1 - continued

Tail Gas Incineration

The tail gas leaving the Claus Plant usually contains sulfur compounds principally in the form of hydrogen sulfide and sulfur dioxide with some elemental sulfur, COS and CS₂. The total quantity of sulfur corresponds to about 15,000 ppm of SO₂ in the tail gas. The sulfur compounds H₂S, COS, CS₂, and S are converted to SO₂ in the Tail Gas Incinerator Unit (112-44001). The Tail Gas Incinerator Unit is equipped with a Waste Heat Boiler to recover energy from the products of combustion from the incinerator by the generation of 50 psig steam. The effluent gas leaving the Waste Heat Boiler is fed to SO₂ Removal in Area 111.

Sulfur Byproduct Handling

The liquid sulfur collected in the Sulfur Pit is transferred to the Sulfur Flaker (112-46001) by the Sulfur Pump. The piping used to transport liquid sulfur is jacketed. Steam (150 psig) is used as the heating medium to maintain the sulfur temperature at approximately 270°F in both the Sulfur Pit and the transfer lines.

The Sulfur Flaker is a double drum type flaker with a variable speed drive and adjustable knife. Cold water is sprayed on the drum's interior surface while molten sulfur is cooled and solidified on the drum's exterior surface. The solid sulfur is stripped from the rolls in flakes of nominally 1/4-inch size. The sulfur flakes are conveyed by the Sulfur Storage Conveyor (112-43001) to the storage area. The flaked sulfur is recovered from storage by the Sulfur Reclaimer (112-43002), and transported to the Sulfur Elevator (112-43004) by the Reclaimed Sulfur Conveyor (112-43003). Sulfur is stored in the Sulfur Bin (112-35001) before being loaded into Hopper cars.

5.3 Process Description

AREA 113 - AMMONIA RECOVERY: PFD 113-100-1,2

The Ammonia Recovery process step is comprised of four basic functions:

- Sour Water Stripping
 - NH_3 Absorption
 - NH_3 Stripping
- NH_3 and H_2O Fractionation

Sour Water Stripping

Sour water from various areas is fed to the top of the Sour Water Stripper (113-32001-1, 2) where NH_3 and H_2S are stripped from the sour water by countercurrently contacting and heating the water with steam. A portion of the heat required for stripping is provided by feeding the hot bottoms from the downstream Ammonia Fractionator (113-32004) to the middle of the Sour Water Stripper. The top half of the Sour Water Stripper, termed the free leg, is used to break the free ammonium salts. The lower half of the stripper, termed the fixed leg, is used to break the fixed ammonium salts by the addition of caustic solution. Caustic is fed to the Sour Water Stripper from the 50% Caustic Surge Tank (113-35004) by the Caustic Supply Pump (113-41009). Stripper bottoms containing phenol and oil are transferred by the Sour Water Stripper Bottoms Pump (113-41001-1,3) to the waste water treatment section of Waste Treatment and Disposal, Area 118.

NH_3 Absorption

The overhead from the Sour Water Stripper containing NH_3 , H_2S , and water vapor is fed to the bottom section of the Ammonia Removal Scrubber, (113-32002).

The gas stream is contacted with recirculated ammonium phosphate solution which absorbs the bulk of the NH_3 . The solution is circulated by the Scrubber Circulation Pump (113-41010-1,2) from the bottom of the scrubber through the Solution Interchanger (113-31006) back to the scrubber. The gas stream then enters the upper section of the Ammonia Removal Scrubber and is countercurrently contacted with lean ammonium phosphate solution which has been cooled in the

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AREA 113 - AMMONIA RECOVERY: PFD 113-100-1,2 - continued

Lean Solution Cooler (113-31001). The ammonium phosphate solution selectively absorbs the NH_3 from the acid gas and increases the NH_3 content in the ammonium phosphate solution. The ammonia free overhead from the Ammonia Removal Scrubber is then cooled in the Acid Gas Condenser (113-31005). The condensed water is separated from the gas stream in the Acid Gas Knockout Drum (113-35005), and the water with a small amount of NH_3 and a trace amount of H_2S is recycled to the top of the Sour Water Stripper by the Acid Gas Condensate Pump (113-41004-1,2).

The acid gas stream from the Acid Gas Knockout Drum, (113-35005), is fed to Sulfur Recovery, Area 112.

NH_3 Stripping

Net rich ammonium phosphate solution from the Ammonia Removal Scrubber is sent to the solution regeneration system. Rich solution is pumped through No. 1 Stripper Condenser (113-31002) where the rich solution is preheated by heat exchange with the overhead from the Ammonia Removal Stripper (113-32003). The rich solution is then fed to the top of the Ammonia Removal Stripper. In the Ammonia Removal Stripper, the rich solution is heated and the absorbed ammonia is stripped from the solution. Reboiler heat is provided by steam in the Stripper Reboiler (113-31007). The regenerated, lean ammonium phosphate solution then leaves the bottom of the Ammonia Removal Stripper, is cooled first in the Solution Interchanger (113-31006) and then by cooling water in the Lean Solution Cooler (113-31001), before entering the Ammonia Removal Scrubber.

Ammonia phosphate solution is made up by adding phosphoric acid to the bottom of the Ammonia Removal Scrubber. Phosphoric acid is transferred from drums by the Phosphoric Acid Addition Pump (113-41003).

The overhead from the Ammonia Removal Stripper consisting of NH_3 and water vapor is partially condensed in the No. 1 Stripper Condenser by heat exchange with cooler rich solution feed to the Ammonia Removal Stripper. The overhead is totally condensed by the water cooled, No. 2 Stripper Condenser (113-31003). The condensed aqueous ammonia solution is collected in the Fractionator Feed Tank (113-35001). Any inert gases not condensed are vented from the Fractionator Feed Tank and are combined with the acid gas stream from the Acid Gas K.O.

5.3 Process Description

AREA 113 - AMMONIA RECOVERY: PFD 113-100-1,2 - continued

Drum, (113-35005) and fed to Sulfur Recovery, Area 112.

NH₃ and H₂O Fractionation

The aqueous ammonia solution is pumped from the Fractionator Feed Tank to the middle of the Ammonia Fractionator (113-32004) by the Fractionator Feed Pump (113-41006-1, 2). In the Ammonia Fractionator the NH₃ and water are separated by distillation into an overhead product of 99.99% NH₃ and a bottom stream of water containing less than 0.1% NH₃. Heat for distillation is provided by the steam heated Fractionator Reboiler (113-31008).

If small amounts of CO₂ and H₂S are dissolved in the Fractionator feed, they would collect in the fractionator in the form of their free ammonium salts. To prevent the accumulation of acid gases in the Ammonia Fractionator, a small amount of 50% caustic solution is continuously fed with aqueous ammonia feed into the Ammonia Fractionator. The NaOH chemically combines with the acid gases, freeing the ammonia, and forms sodium salts which dissolve in the water and leave the bottom of the Ammonia Fractionator. Caustic is pumped to the Fractionator Feed Tank by the Caustic Injection Pump (113-41008) from the 50% Caustic Surge Tank, (113-35004).

The overhead from the Ammonia Fractionator is condensed by the water cooled Ammonia Condenser (113-31004) and then collected in the Ammonia Receiver (113-35002). The Ammonia Product/Reflux Pump (113-41007-1, 2) provides reflux to the Ammonia Fractionator. NH₃ product is sent to Storage, Area 120. The water from the bottom of the Ammonia Fractionator is sent to the Sour Water Stripper and is flashed to recover its heating value.

Steam condensate from the reboilers on the stripper and fractionator are collected and flashed in the Condensate Flash Tank (113-35003). The flashed steam, along with some live steam sparged into the flash tank, enters the Ammonia Removal Stripper to aid in stripping and also to achieve the necessary water balance. Condensate from the flash tank is routed to the condensate return system, Area 115, for inplant use.

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5.3 Process Description

AREA 114 - THERMAL OXIDIZER AND FLARE: PFD 114-100-1

The process scheme for the Thermal Oxidizer and Flare is comprised of two basic functions:

- Thermal Oxidizer
- Flare

The Feed streams to this area are summarized in the following table:

<u>Process Step or Area</u>	<u>Waste to Thermal Oxidizer and Flare</u>	
	<u>Liquids</u>	<u>Vapors</u>
Coal Unloading and Handling		
Coal Preparation		X
Pyrolysis-Gasification	X	X
Oil Recovery and Treatment	X	X
Gas Purification	X	X
Hydrogen Generation		X
Shift Methanation		X
Bulk CO ₂ Removal		X
Gas Compression and Dehydration		X
Flue Gas Power Recovery		X
SO ₂ Removal		X
Sulfur Recovery		X
Ammonia Recovery	X	X
Utilities	X	X
Facilities	X	X

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5.3 Process DescriptionAREA 114 - THERMAL OXIDIZER AND FLARE: PFD 114-100-1 - continued

Waste liquids piped from collection points throughout the Commercial Plant, enter the Incinerator Feed Tank (114-35001-1, 3), which provides surge and separates the liquids from their vent gases. Liquid wastes are drawn from the bottom of these tanks by the Incinerator Feed Pump (114-41001-1, 4) and are pumped to the Thermal Oxidizer (114-44001-1, 3), where they rejoin the vent gases, are combined with combustion air, and are ignited and burned. Fuel gas and steam are injected as required to achieve complete oxidation. Hot gases from combustion are cooled by passing them through an economizer which is part of the Thermal Oxidizer. The economizer preheats incoming combustion air and exhausts cooled combustion gases to the atmosphere.

Flare

Process flow streams are piped to the flare only when emergency conditions occur or during startup/shutdown/upset, or when the quality of the SPG product is below that specified for pipeline gas. Process streams to be flared enter the Flare Knockout Drum (114-34002), which separates entering liquids and gases. The gases are then piped to the Flare (114-44002) and ignited. Fuel gas and steam are added as necessary to achieve complete oxidation before exhausting combustion products to the atmosphere. Liquids collected in Flare Knockout Drum (114-34002) are pumped by the Flare Knockout Drum Pump (114-41002-1, 2) to the Raw Oil Storage Tank (120-34007) and recycled to the process. Flare Water Pump (114-41003-1, 2) pumps the aqueous phase out of the Flare Knockout Drum to Waste Treatment and Disposal, Area 118.

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All the utilities required for the Commercial Plant, with the exception of electricity for the river water pumping station and for plant security lighting, will be generated on site. Principal equipment items required to supply the utilities are shown on the Area 115 Process Flow Diagrams. Facilities provided in Area 115, Utilities, include Condensate Return Systems, Deaerators for boiler feed water, Boilers for start-up and Power Generation, Inert Gas Generation System, Plant Refrigerant Supply System, Cooling Tower and Plant Air and Instrument Air Systems. A functional description of each utility sub-system follows.

Condensate Return Systems: - (Boiler Feed Water System) -
PFD 115-100-1, 2

Four different condensates, namely 600 psig condensate, 150 psig condensate, 50 psig condensate and turbine condensate are handled in the plant. The 600 and 150 psig condensates are collected at various points in the plant in their appropriate headers, and are then subjected to equilibrium flash at 50 psig in the Condensate Flash Tank (115-34001). The 50 psig vapors generated join the 50 psig steam supply to the plant. The liquid from the Condensate Flash Tank joins the 50 psig condensate and is cooled while heating turbine condensate in the Demineralized BFW Interchanger (115-31007). The cooled condensate combines with the demineralized water makeup and condensate return from Area 117, both of which have also heated the turbine condensate, and proceeds to the demineralized BFW Deaerators. At the Deaerators this condensate is joined by the turbine condensate which has been routed from the condensate return units and the aforementioned heat exchangers through the Demineralized Water Storage Tank (115-34003) the Demineralized Condensate Feed Pumps (115-41015-1, 2), and 1500 psig BFW Preheater (104-31013-1, 3). Treatment chemicals are added as needed to the deaerators, which will be located in the same plant areas as the boilers they supply. This deaerated condensate along with water recovered in Waste Evaporator System (118-47001), serves as the feed water for the high pressure boilers.

Clean process condensate from Shift & Methanation, Area 107, Ammonia Recovery, Area 113, and Hydrogen Generation, Area 106, is flashed down to atmospheric pressure in the Soft Condensate Receiver (115-34008). Any vapors are vented to atmosphere. This condensate is then deaerated, treated with the appropriate chemicals, and pumped to the low and medium pressure boilers as feed water. Soft water make-up is furnished

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AREA 115 - UTILITIES: PFD 115-100-1,6 - continued

from feed pumps in Area 117, Water Treatment, heated in Softened BFW Preheater (104-31014-1, 3), and then fed into the Soft Water Deaerators.

Steam and Power Generation: PFD 115-100-3

High pressure (1500 psig) steam from electric power generation and turbine drivers are produced in either of two boilers in the Utilities area. One of these, the Auxiliary Boiler (115-44001) is a pulverized coal fired unit which is used during start-up. The other, the Power Generation Boiler (115-44007), runs continuously and is fired with oil bearing and gas bearing waste streams from Areas 102, 103, 104, and 120. Each of the Boilers is furnished with the conventional accessories such as Blowdown Systems (115-48003, 115-48004) and Electrostatic Precipitators for the Flue Gas (115-45003, 115-45004). The Auxiliary Boiler also has provision for coal storage and pulverization.

High pressure steam generated in the plant and not used for turbine drivers is fed to the 150 Psig Back-Pressure Turbine Generator (115-48002), and the Main Power Generation Unit (115-48001). The extracted exhausts from these turbines are at 50 psig, 150 psig, 600 psig, and are used in balancing plant demand for steam at these pressure levels. A diesel driven Emergency Power Generator (115-47012) is kept on a ready, stand-by status. This system will provide the plant with electric power for lighting, partial operation, and safe shutdown should the main power generating facilities for the plant fail.

Inert Gas Generation: PFD 115-100-4

The inert gas generating system will produce a nonflammable gas for start-up and purging operations. Fuel oil is combusted and cooled in the Inert Gas Generator (115-47016-1, 26). The combustion products are then compressed in the Inert Gas Compressor (115-42003-1, 2). Between the stages of the compressor the Inert Gas Compressor Intercooler (115-44008-1, 2) and Inert Gas Compressor Trim Intercooler (115-31008-1, 6) cool the gas. After compression, the Inert Gas Cooler (115-44004-1, 2) and Inert Gas Trim Cooler (115-31006-1, 6) cool the gas prior to its distribution to users.

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AREA 115 - UTILITIES: PFD 115-100-4 - continued

Refrigeration: PFD 115-100-4

Freon 12 will be used as the refrigerant in the plant. Spent refrigerant is collected and returned to the refrigerant system compressor. The gas is compressed and condensed and stored in the refrigerant holder. Refrigerant is then supplied to users in the Storage area.

AREA 115 - UTILITIES: PFD 115-100-5

Cooling Tower: PFD 115-100-5

The multi-cell Cooling Tower (115-44002) cools spent cooling water prior to recirculation to users. The standard accessories such as the hot well and cold well and chemical additive systems are provided. Blowdown is pumped to the water treatment evaporation system in Area 118 for removal of dissolved solids and eventual recycle to the demineralized BFW system.

Plant and Instrument Air: PFD 115-100-6

Plant and instrument air are obtained by compressing ambient air. The compressed air is cooled, and any water condensed out is fed to the cooling tower hot well.

During warm weather, this is all that needs to be done to the plant air prior to distribution. If a chance of freezing is present, the plant air will be partially dewatered in the Plant Air Dryer prior to distribution. Instrument air will always be dried to a -40°F dew point to prevent condensation or freezing in instruments or instrument air lines.

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AREA 116 - WATER SUPPLY: PFD-116-100-1

The water supply system is housed in the river water pumping station 116-47001 and provides three basic functions:

- Screening
- Preliminary Treatment
- Pumping

Screening

The water intake opening in the pumping station is provided with a heavy, Mechanically Cleaned Bar Screen (116-45001-1,2) to prevent large debris from entering the wet well. Self cleaning Traveling Screens (116-45002-1,4) at the inlet to each pump sump protect the pumps from trash (i.e. sticks, branches, leaves, stones, etc.). The material removed by the travelling screens is spray washed from the screens and dewatered on a Hydrosieve (116-45003-1,4). The trash from the hydrosieve and the debris from the bar screens is deposited on the Conveyor System (116-43002) which carries it to a commercial hauler's removal truck bed for ultimate disposal in an approved land fill, or by other approved means.

Pumping

Pumping water from screening facilities enters the concrete sump where it is lifted by Raw Water Feed Pumps (116-41001-1,4) to above the high water level and discharged to the Raw Water Booster Pumps (116-41003-1,2) which discharge the water at 175 psig into the pipeline.

Emergency Raw Water Feed Pump (116-41002-1,3) and Emergency Raw Water Booster Pumps (116-41004-1,2) are provided to allow pumping to continued uninterrupted during electrical outages or maintenance downtime. These emergency pumps are fueled with diesel fuel provided by Fuel Oil Pump (116-41005) which draws fuel oil from Fuel Oil Storage Tank (116-34001). Provision is made for automatic switchover by the emergency units to emergency power supply from the normal purchased power supply.

Treatment

The Chlorine Addition Unit (116-47002) injects chlorine into the raw water to prevent biological growth in the pipeline. Such growth, if not curbed, could adversely affect the flow capacity. A cationic polymer, is injected by a Polymer Feed Pump (116-41007-1,2) to utilize the mixing characteristics and residence time available in the pipeline.

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AREA 116 - WATER SUPPLY: PFD-116-100-1 - continued

Polymer is fed neat from the Cationic Polymer Storage Tank (116-34002) which is periodically filled from a tank truck by the Transfer Pump (116-41006).

Pipeline

A 36-inch (nominal diameter) steel pipeline will receive the initially treated water from the Raw Water Booster Pumps (116-41003-1,2) 175 psig. This 20 mile pipeline (designed for 250 psig maximum) will be of welded construction and have an external asphalt coating and an epoxy based inner coating to prevent corrosion. The pipeline will be cathodically protected to prevent external corrosion.

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5.3 Process DescriptionAREA 117 - WATER TREATMENT SYSTEMS: PFD-117-100-1, 3

The process scheme for Water Treatment Systems is comprised of four basic functions:

- Softening/Clarification
- Sand Filtration
- Carbon Filtration
- Deionization

The analysis of the raw water and the required treatment for each water use is shown in the following table:

Raw Water Analysis

<u>Characteristic</u>	<u>Value, mg/l</u>
Total hardness as CaCO_3	254
Total dissolved solids	381
Suspended solids	400
Calcium as CaCO_3	172
Magnesium as CaCO_3	82
P - Alkalinity	0
M - Alkalinity	157
Sulfate	101
Silica	15
pH	7.4 to 7.9

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<u>Water Use Category</u>	<u>Water Treatment Systems</u>			
	Softening- Clarifica- tion	Sand Filtration	Carbon Filtration	Deioni- zation
Cooling Water Make up	X	X		
Potable Water*	X	X		
Low Pressure Boiler Make up	X	X		
High Pressure Boiler Make up	X	X	X	X

* Requires chlorination

Softening/Clarification

The largest volume of water needed for the process is cooling water. To minimize the cooling water requirement, the treated waste water from the process is recycled back to the cooling towers. The number of cooling tower cycles is limited by the dissolved and suspended solids in the recycling water.

Evaluation of the raw water analyses presented leads to the conclusion that with suspended solids removal, cooling tower cycles are limited to 2.5 primarily because of the magnesium and silica concentration.

Depending upon various operating conditions, such as raw water temperature, reproducibility of reagent make-up, etc., it is anticipated that the hardness of the lime-soda softened water will be between 70 and 80 mg/l.

While it is theoretically possible to obtain cold lime-soda softened water to permit 9 to 10 cooling tower cycles, it is felt that from a practical, operating stand point the cycles should be limited to 7.

Raw river water is pumped to the water treatment plant area via over-land pipeline by the Raw Water Booster Pump (116-41003-1, 2). This water is mixed with recycle water streams from the Primary Water Treatment Pumps (settled raw water) (119-41004-1,2) the pH Adjustment Filtrate Pumps (from the sludge press) (118-41007-1,2) the Dirty Carbon Filter

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AREA 117 - WATER TREATMENT SYSTEMS: PFD-117-100-1,3 - continued

Backwash Pumps (117-41008-1,2) and the (Gravity Sand Filter) Dirty Backwash Pumps (117-41002-1,2) and fed to the Softener Reactor Clarifier (117-45001-1,2).

Lime from the Lime Bin (117-34010) is slaked by the Lime Feed System (w/117-47003) and mixed with water in the Lime Supply Tank (117-36001) where suspension and mixture is maintained by the Lime Supply Tank Agitator (117-39001). The resulting lime solution is metered to the Reactor Clarifier by the Softener Lime Feed Pump (117-41012-1,2).

Soda ash from the Soda Ash Storage Bin (120-34014) is converted to a solution and pumped to the Reactor-Clarifier with the Soda Ash Feed Pump (120-41003-1, 2). Anionic polymer from the Anionic Polymer Feed System (w/117-47002) is also added to the reactor clarifier to aid in the settling of suspended matter.

The center compartment of the Softener Reactor Clarifier (117-45001-1,2) provides the necessary reaction time to complete the softening. Any large suspended solids and precipitated material will also be separated from the water in the Clarifier.

Softened and clarified water then overflows the Softener Reactor Clarifier into the Softened Water Tank (117-34008-1,2). Precipitated solids from the clarifier and other separated material is discharged to the Reactor-Clarifier Sludge Sump (117-34007-1, 2) and then pumped via the Reactor Clarifier Sludge Pumps (117-41013-1,4) to the In-Line Mixer (118-39054) in Waste Treatment and Disposal, Area 118, for pH adjustment prior to filtration.

Softened water is pumped by the Sand Filter Charge Pumps (117-41001-1,4) to ten Gravity Sand Filters (117-45002-1,10) to remove the fine flock and suspended solids from the water. The filtered water flows to the Filter Sump (117-34009) from which the Filter Sump Pump (117-41014-1,2) delivers it to the Filtered Water Tank (117-34001).

When a Gravity Sand Filter becomes loaded with solids, the filter is taken off-stream and backwashed with softened water and air. Air is provided by the Backwash Air Blowers (117-42001-1, 2). Backwash water is supplied by Filter Backwash Pumps (117-41016-1, 2). Backwash water is collected in the Dirty Backwash Tank (117-34002) and then pumped by the Dirty Backwash Pumps (117-41002-1, 2) to the Softener Reactor Clarifiers (117-45001-1, 2).

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5.3 Process Description

AREA 117 - WATER TREATMENT SYSTEMS: PFD-117-100-1,3 - continued

The water in the Filtered Water Tank is suitable for cooling water make up and low pressure boiler makeup water. Low Pressure Boiler Water Pumps (117-41006-1,2) and Cooling Tower Make up Pumps (117-41003-1,2) supply the respective applications.

Part of the filtered water is chlorinated by the Chlorinator (117-47001) and stored in the potable water compartment within the Filtered Water Tank (117-34001). Potable Water Pumps (117-41004-1,2) supply the users in the plant.

Carbon Filtration

Softened and sand filtered water is pumped by the Carbon Filter Feed Pumps (117-41005-1,2) to the Carbon Filters (117-45003-1,18) to remove any dissolved organic material and also any residual particulate matter in the water. When the carbon beds become loaded, filtered water from the Carbon Filter Backwash Tank (117-34003) is pumped by the Carbon Filter Backwash Pumps (117-41007-1,2) through the Carbon Filters to backwash the filters. Backwash water is collected in the Dirty Carbon filter Backwash Tank (117-34004) and then pumped by the Dirty Carbon Filter Backwash Pumps (117-41008-1,2) to the feed well of the Softener Reactor Clarifiers (117-45001-1,2).

Deionization

The water is then fed to the two Cation-Anion Deionization Units (117-32001-1,6 and 117-32002-1,6) to reduce its silica and ion content to a level acceptable for high pressure boiler water make-up.

Sulfuric Acid and caustic solutions are used for regeneration of the Cation and Anion Units respectively. Spent regenerant solution is collected in the Spent Regenerant Tank (117-34005) and then pumped by the Spent Regenerant Pumps (117-41009-1,2) to the Evaporator Hold Tanks (118-36004) in Waste Treatment and Disposal, Area 118. After regeneration, the Deionization Units are backwashed with deionized water pumped by the respective Ion Unit Backwash Pumps (117-41010-1,2 and 117-41015-1,2) pumping from their respective Backwash Mix Tanks (117-34012) and (117-34011). Backwash water is also collected in the Spent Regenerant Tank and is then pumped to the Evaporator Hold Tank in Area 118.

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5.3 Process Description

AREA 117 - WATER TREATMENT SYSTEMS: PFD-117-100-1,3 - continued

Deionized water is collected in the Deionized Water Tank (117-34006) and is pumped by the Deionized Water Pumps (117-41011-1,2) to the high pressure boiler water system and to any other process user requiring deionized water.

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5.3 Process Description

AREA 118 - WASTE TREATMENT AND DISPOSAL: PFD 118-100-1,7

The process scheme for Waste Treatment and Disposal is comprised of four basic functions:

- Pretreatment
- Biotreatment
- Inorganic Suspended Solids Waste Treatment
- High Dissolved Solids Waste Treatment
- Solid Waste Disposal

Pretreatment

Before the feed streams undergo biological treatment, they must be pre-treated to render them compatible with biological activity. The Ammonia Stripper bottoms (stream 13/4) contains an amount of sodium hydroxide sufficient to raise the pH of the combined waste streams to 13. The biological system cannot function reliably at this pH, therefore, it is necessary to reduce this pH to the 7-8 range. Since there is an off gas stream in Area 108 (8/13), which is primarily carbon dioxide, of more than the amount needed for neutralization, stream 13/4 is routed through a Flue Gas Neutralizer (118-34010-1, 2) prior to combining it with the other waste streams for further treatment.

Additional pre-treatment of the total waste stream is necessary to assure maintaining a maximum oil and temperature level compatible with efficient biological treatment. Oil-water separation and cooling is provided for this purpose.

The Oil-Water Separators are constructed in accordance with A.P.I. criteria to provide sufficient detention time, longitudinal velocity, and length of travel to permit all fine oil globules having a diameter of 0.015 centimeter or larger to float to the surface and the greater portion of the suspended solids to settle.

Mechanical flight skimmer-scrapers collect the oil and solids at opposite ends of the separator. The oil is drained off to the Slop Oil Tank (118-34001) and then is pumped, via the Slop Oil Pump (118-41011-1, 2), to the oil dehydration section of Oil Recovery and Treatment,

5.3 Process Description

AREA 118 - WASTE TREATMENT AND DISPOSAL: PFD-118-100-1,7 - continued

Area 104. The clear water drawn off from the Oil-Water Separators is routed through the Spray Coolers, (118-39050-1, 2) by means of the Cooling Pond Return Pump (118-41012-1, 2) to Aeration Basins (118-45009-1, 2). The sludge withdrawn from the Oil-Water Separator is pumped by means of the API Sludge Pump (118-41001-1, 3) to the In-Line Mixer (118-39054) and thereon to the pH Adjustment Feed Tank (118-36003).

The sewage from the potable water supply will be added to the Oil-Water Separator's effluent, but the waste stream will be deficient in both phosphorous and nitrogen. Phosphoric acid and ammonia will be added to the total effluent stream from the separator. Feed rates will be automatically controlled according to flow and water analysis. Phosphoric acid will be fed by the Phosphoric Acid Metering Pump (120-41025-1, 2) from the Phosphoric Acid Storage Tank (120-34015), while ammonia is introduced from the Ammonia Vaporizer, (120-31007).

Effluent from the Oil-Water Separators will flow to the Aeration Basins. Because the major portion of this stream is from Ammonia Recovery, Area 113, there may be times when the temperature of the waste entering the Aeration Basins could be detrimental to the basin biology. There may also be occasions when accidents or process unit upsets occur and wastes will be produced in a quantity and concentration which would result in upset of the activated sludge system. The capability to shunt these flows to a cooling pond with a one-day storage capacity at normal flow is provided. The basin will be equipped with a floating surface Spray Cooler (118-39050-1, 2) which can thoroughly mix the basin contents to provide chemical equalization and an oil skimming device of the "oil mop" type to remove any floating oil. The effluent will be withdrawn by an adjustable device permitting either surface or subsurface removal. A spare unit for the floating surface coolers will be stocked.

Biotreatment

Because of the high Biochemical Oxygen Demand (BOD) loading resulting from the magnitude of the phenol in the discharge from the Ammonia Recovery process step, it is necessary to provide seven days aeration detention time. The low flow, high BOD relationship appears to favor the use of submerged Turbine Aerators. The Aeration Basin will be provided with both Turbine Aerators (118-39052-1, 10) and Floating Surface Aerators (118-39051-1, 10) to assure adequate oxygen transfer. The aerators are spaced to make effective use of the area of influence of each unit. The waste flow is divided and introduced in equal quantities beneath each of the aerators to achieve adequate contacting.

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AREA 118 - WASTE TREATMENT AND DISPOSAL: PFD-118-100-1,7 - continued

Aeration Air Blowers (118-42001-1, 4) provide the air for the Turbine Aerators.

Aeration Basins are followed by circular Clarifiers (118-45002-1, 3). Interconnecting piping and valving make possible the diversion of the total flow to any of the Clarifiers. Rapid sludge removal clarifiers assure the return of sludge to the aeration basins with a minimum oxygen depletion. The Clarifiers are provided with separate Sludge Recycle Pumps, (118-41004-1, 4), to provide maximum flexibility in operation. A Clarifier Sump, (118-34009), provides surge capacity.

The Sludge Recycle Pump (118-41004-1, 4) returns the active biological sludge to an influent mixing chamber at the head end of the Aeration Basins. The sludge will be intimately mixed with the inlet water stream just prior to introduction to the Aeration Basin to promote new biological growth.

The supernatant liquid from the Clarifiers is sent to a Clarifier Clearwell, (118-34003), from which it is pumped to the Pressure Filter, (118-45003-1, 4).

Both the solids loading and the overflow rate for the Clarifiers are conservatively chosen so that during periods when contaminated storm-water flow must be handled, the chances of a clarifier upset are minimal.

The extremely high Biochemical Oxygen Demand (BOD) level of the waste will result in a very large daily production of sludge. As a result, digester volume of 3.14 million gallons is required.

A portion of the clarifier sludge is sent to the Clarifier Sludge Thickener (118-45008-1, 2) to reduce the volume which must be digested. The Supernatant Pump (118-41021-1, 2) returns the supernatant to the Aeration Basin and the thickened sludge is transferred to the digester by the Thickened Sludge Pump (118-41022-1, 2). The sludge is held in the Aerobic Sludge Digestors (118-45010-1, 2) for 20 days and aerobically digested to a low volatile solids content. Digester Aerators (118-39053-1, 6) furnish the necessary oxygen for the digestion process.

The digested sludge is transferred by means of the Digested Sludge Transfer Pump (118-41006-1, 2) to the Sludge Thickeners (118-45005-1, 2) which are provided to thicken the sludge from the Aerobic Sludge Digestors (118-45010-1, 2) prior to dewatering. Polymer conditioning of the sludge is provided by the Thickener Polymer Feed System

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AREA 118 - WASTE TREATMENT AND DISPOSAL: PFD-118-100-1,7 - continued

(w/118-47003) via the Thickener Polymer Transfer Pump (118-41016-1, 2). Thickening is accomplished by dissolved air flotation which yields a higher suspended solids concentration than gravity thickening. Dissolved air flotation is achieved by introducing air with the Thickener Air Blowers, (118-42003-1, 2), and providing sufficient detention time to permit dissolving the air into the sludge. The sludge is then introduced into an internal flotation chamber which is at atmospheric pressure. The sudden release of pressure will result in the air coming out of solution in a cloud of extremely fine bubbles. The suspended solids rise by air bubble flotation. A surface skimming device will remove the solids, air, and liquid scum to the skimming sump.

The clear effluent from the Clarifiers (118-45002-1, 3) is collected in the Clarifier Clearwell (118-34003) and pumped by the Clarified Clearwell Pump (118-41013-1, 2) along with the effluent from the Sludge Thickeners (118-45005-1, 2) which is fed from the Thickener Clearwell (118-34004) by the Thickener Clearwell Pump (118-41014-1, 2). Filtration will allow the effluent to be reused as cooling tower make up water. Pressure Filter Backwash Tank (118-34005), Pressure Filter Backwash Pumps (118-41017-1, 2) and Backwash Air Blowers (118-42002-1, 2), are provided to backwash the Filters. Backwash water is collected in the Dirty Pressure Filter Backwash Tank (118-34006) and then returned by the Dirty Pressure Filter Backwash Pump (118-41018-1, 2) to the influent to the clarifiers.

Thickened sludge from the Sludge Thickeners is fed by the Thickener Bottoms Pumps (118-41015-1, 3) to the Sludge Press Conditioning Tank (118-36002). Thorough mixing and solid suspension is obtained with the Sludge Press Conditioning Tank Agitator (118-39002). The Sludge Press Polymer Feed System (w/118-45004) feeds conditioning chemicals from a two-stage mixing unit. The conditioned sludge is then fed by the Sludge Press Feed Pump (118-41019-1, 2) to Sludge Press (118-45004-1, 5) which is a horizontal belt filter press where gravity filtration and moderate pressure and shearing action is applied by a top belt operating at a slightly different speed. The sludge cake produced by the Sludge Press is disposed of in an onsite landfill operation. The filtrate is discharged to the Sludge Press Filtrate Tank (118-34007) and will be returned to the influent of the Final Pressure Filters (118-45003-1, 4) by means of the Sludge Press Filtrate Pump (118-41002-1, 2) prior to reuse as cooling tower make up.

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5.3 Process Description

AREA 118 - WASTE TREATMENT AND DISPOSAL: PFD-118-100-1,7 - Continued

Inorganic Suspended Solids Waste Treatment

The inorganic sludge from the Softener Reactor Clarifier (117-45001-1, 2) which is pumped from the Reactor Clarifier Sludge Sump (117-34007-1, 2) by the Reactor Clarifier Sludge Pumps (117-41013-1, 4) is mixed with the waste stream from the SO₂ Removal process, Area 111, for pH Adjustment. Slaked lime solution, fed by the Softener Lime Feed Pumps (117-41012-1, 2) is added to the mixed sludge streams in an In-line Mixer (118-39054). Sludge conditioning polymer from the pH Adjustment Sludge Press Polymer Feed System (w/118-45006) is added to this sludge stream in the pH Adjustment Feed Tank, (118-36003) and the sludge is pumped by the pH Adjustment Sludge Press Filter Pumps (118-41008-1, 20) to the pH Adjustment Sludge Press (118-45006-1, 10). The filter cake is transported by trucks and disposed of in an on-site landfill. The filtrate is discharged to the Filtrate Tank (118-34002) and recycled by the pH Adjustment Filtrate Pumps (118-41007-1, 2) to the Softener Reactor Clarifier (117-45001-1, 2) and to SO₂ Removal in Area 111.

High Dissolved Solids Waste Treatment

A multiple-effect Waste Evaporator System (w/118-47001) is employed to dry the dissolved solids in the waste streams containing high dissolved solids. Streams from the Spent Regenerant Pumps (117-41009-1, 2), Area 117, and from the main Cold Well Pumps (115-41010-1, 9), Area 115, are mixed and sent to the Evaporator Hold Tank (118-36004), which is agitated by Agitator (118-39004). This is the source of the feed to the evaporation system. An Emergency Storage Pond is provided as a buffer to handle excess emergency surges. Discharge to the Emergency Storage Pond is returned to the evaporation system by the Emergency Storage Pump (118-41010-1, 2). From the Evaporator Hold Tank the waste stream is pumped by the Transfer Pumps (118-41009-1, 2) into the Waste Evaporator System (w/118-47001). In this system a carrier oil is added to the waste stream to carry the precipitated solids through the last few stages of evaporation where complete removal of water occurs. The mixed stream is then concentrated in a ten effect evaporator system. The oil-concentrated sludge mixture is centrifuged to separate the oil and the dehydrated sludge. The solids are then conveyed by the Solids Waste Conveyor (118-43001) to the lined Waste Solids Pond while the oil is recycled and mixed with the feed. The

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5.3 Process Description

AREA 118 - WASTE TREATMENT AND DISPOSAL: PFD-118-100-1,7 - continued

distillate from the Waste Evaporation System is recycled back through a Carbon Filter (118-45007-1, 2) to remove any residual oil and the filtrate is sent to Area 115, Utilities, as boiler feed water. The Carbon Filter is backwashed and the filtrate is collected in the Backwash Tank (118-34008). Dirty Backwash is then sent to the Oil-Water Separator (118-45001-1, 2).

Solid Waste Disposal

Crushed slag from Area 103, Pyrolysis and Gasification is conveyed to the on-site landfill by the Slag Belt Conveyor (103-43002-1, 3). Similarly fly ash and spent filter aid from the Auxiliary Boiler in Area 115, is charged to landfill by the Auxiliary Boiler Ash Conveyor (115-43003). The accumulated solids are then distributed and compacted with equipment provided in the Slag Landfill System (118-47004).

Waste solids from the Waste Evaporator System are transported to the Evaporation Pond by the Solids Waste Conveyor (118-43001). Since the solids are water soluble, the impoundment area must be lined and diked to prevent run off during rainfall.

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5.3 Process Description

AREA 119 - FIRE PROTECTION SYSTEMS: PFD-119-100-1

The process flow diagram for the Fire Protection System depicts three functions and implies the fourth:

- Water Supply
- Pumping and Hardware
- Distribution (End uses)
- Detection (Not shown)

Water Supply

Water for the Fire Protection System will be available from two sources:

- Raw Water Settling Tank (119-34001) (1 million gallons)
- Plant Raw Water Reservoir (83 million gallons)

Each of the above sources receives its supply from Water Supply, Area 116. One million gallons of fire water will be available at all times from the Raw Water Settling Tank (119-34001) which serves as the primary supply for the Fire Protection System. Backup supplies are available from the Plant Raw Water Reservoir (5 days supply or approximately 83 million gallons) which is fed by the pipeline from the Mississippi River. Emergency water supply is provided from the Reservoir via the Raw Water Settling Tank through the Raw Water Strainer (119-45002-1, 2) and the Primary Water Treatment Feed Pump (119-41004-1, 2).

Pumping and Hardware

Water from the Raw Water Settling Tank (119-34001) flows through Fire-water Strainers (119-45001-1, 2) to Fire Water Jockey Pumps (119-41001-1, 2) and Fire Protection Pumps (119-41002-1, 10) of 10,000 gpm capacity each. These pumps are electrically driven and are backed up by diesel-powered Secondary Fire Protection Pumps (119-41003-1, 2) which provide firewater in case of electrical failures or primary pump failure. The Fuel Tank (119-34002) provides diesel fuel for the diesel-powered Secondary Fire Protection Pumps (119-41003-1, 2).

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5.3 Process Description

AREA 119 - FIRE PROTECTION SYSTEMS: PFD-119-100-1 - continued

Distribution

Fire Water is distributed throughout the plant by an appropriate piping network to the following users in the plant:

- Fire Hydrants
- Hose Stations
- Sprinkler Areas
- Piping

The water will be available at a pressure of 100-125 psig at the hose nozzle. Each major plant area will be serviced by this firewater piping system and its own dedicated firewater piping loop complete with hydrants, turret nozzles, and hosehouses spaced at regular intervals and conforming to N.F.P.A. Codes.

Detection

Early detection of potential or real fire/explosion situations will be achieved by locating gas detectors, smoke detectors, ultraviolet flame detectors, heat sensors, and other suitable detection devices throughout the facility. These devices provide automatic detection capability for real and potential fire/explosion situations. All sensors and detectors will be connected to the plant emergency alarm system to issue local and remote (plant wide) alarms by both visual and audible means. Manual alarm loops will parallel the automatic loops, and plant personnel will provide a backup to the automatic alarm system. These alarms will also serve as warning devices for other emergencies (i.e., tornado, bomb scare, sabotage, etc.).

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5.3 Process Description

AREA 120 - FACILITIES: PFD-120-100-1, 6

Facilities provided in the Commercial Plant are included in the following list:

Synthetic Gas Pipeline	Guardhouses
Administration Building	Lighting
Maintenance Shop	Warehouse
Laboratory	Sanitary Sewers
Personnel Facilities	Storm Sewers
Railroad Facilities	Chemical Sewers
Plant Roads	Product Storage
Parking Areas	By-Product Storage
Distribution Piping	Chemical Reagent Storage
Plant Fence	

The gas pipeline is utilized to transport the 256.64 MM SCFD of SPG to market. The pipeline will be built to 1050 psig design standards and will meet Illinois Commerce Commission and U.S. Department of Transportation standards for high pressure gas pipelines.

The Administration Building will be designed to provide ample office space for plant administrative personnel. In addition, the Administration Building will accommodate a data processing center, dispensary and first aid station, classrooms and meeting rooms, a lunchroom, visitor reception area, and toilet facilities.

The maintenance shop will serve as the central repair facility for the Commercial Plant. Areas of the maintenance shop include a machine shop, tool storage, small parts and hardware storage, vehicle repair, plant equipment repair, welding shop, electric and instrument shop, and fire and emergency vehicle garages. Maintenance that requires highly specialized equipment, such as milling machines, will be contracted out to commercial machine shops. Special maintenance (rebuilding refractory linings, expander rotor wheel blade

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5.0 Baseline Process Concept

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5.3 Process Description

AREA 120 - FACILITIES: PFD-120-100-1, 6 - continued

rebuilding, etc.), will be contracted to specialists in those areas. Small parts and hardware (bearings, belts, chains, etc.) will be kept in stock so that most repairs can be made readily on site. This preventive action will help minimize downtime due to equipment outages.

The laboratory building will be equipped with the necessary analytical instrumentation to monitor feedstock, product, and by-product quality. All plant waste streams will be monitored on a continuous basis to ensure compliance with local, state, and federal pollution regulations.

Personnel facilities will be provided in all operating areas to allow easy access with minimal "lost-time". The administration, maintenance, warehouse, and laboratory buildings will provide lunch areas, lockers, and shower and toilet facilities for plant personnel. In addition, toilet facilities will be available in all other areas where personnel are on continuous duty.

A spur will be extended from an existing line to provide railroad service to the Commercial Plant. The rail siding will be constructed during site preparation and will be available for the delivery of equipment during the construction phase of the Commercial Plant. The completed spur will include side space for loading and unloading rail cars. Equipment will also be installed for loading and unloading these rail cars.

Plant roads will provide access to all areas of the Commercial Plant. Additional gravel or asphalt side roads will be constructed within individual plant areas. This road network will make the entire plant easily accessible in any situation that may arise.

Sufficient parking area for plant personnel and visitors' vehicles will be provided near the administration building. This location will increase security by controlling access to the plant site, since everyone entering the plant must enter through the main gate. The parking area will have an asphalt surface.

Distribution piping will be provided to deliver utilities to all plant areas where these services are required. Overhead racks will be used to route these pipes throughout the plant. Steam tracing will be used for freeze protection as required. Fire water and potable water

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5.0 Baseline Process Concept

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5.3 Process Description

AREA 120 - FACILITIES: PFD-120-100-1, 6 - continued

distribution piping will be buried below the frost line.

A security fence will enclose the Commercial Plant and provide primary protection against unauthorized entry onto the plant site. Guardhouses will be provided at all plant entrances and will be manned when in use. Yard lighting will provide additional plant security.

Interior and exterior warehouse space will be provided for storing equipment and supplies for the Commercial Plant. Materials to be stored include spare parts for equipment, spare equipment (motors, pumps, etc.) and housekeeping, maintenance, and process supplies.

Facilities will be provided for 30 days storage of products, process chemicals, and utility treatment chemicals. The storage facilities are shown on the Area 120, Process Flow Diagrams. These materials will be handled and stored by methods common to petroleum/petrochemical and chemical plants using readily available commercial storage tanks, pumps, bins, drums, etc. Illinois Commerce Commission, OSHA, EPA, and NFPA codes and regulations pertaining to the handling and storage of chemicals and materials will be followed.

Fuel oil and Syncrude produced in the plant are each stored in its respective day tank, (hold tank), off spec tank or storage tank. From the storage tank they will be pumped to tank cars.

Ammonia and light hydrocarbons are stored in spheres with provisions made for compressing, condensing, and returning vapors from the sphere.

Nitrogen and chlorine are purchased as liquids, vaporized and sent to plant users.

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5.4 Process Flow Diagrams (See Supplement)

<u>Number</u>	<u>Revision</u>	<u>Case*</u>	<u>Title</u>
<u>GENERAL</u>			
7051-100-100-0	0	PE	Legend
<u>AREA 101 - COAL UNLOADING AND HANDLING</u>			
7051-101-100-1	0	PE	Receiving and Crushing
7051-101-100-2	0	PE	Storage and Reclaiming
<u>AREA 102 - COAL PREPARATION</u>			
7051-102-100-1	0	PE	Drying and Grinding
7051-102-100-2	0	PE	Pressurization and Feeding
<u>AREA 103 - PYROLYSIS AND GASIFICATION</u>			
7051-103-100-1	0	PE-TIC	Pyrolysis and Drying
7051-103-100-2	0	PE-TIC	Inert Gas Systems
7051-103-100-3	0	PE-TIC	Gasification and Combustion
<u>AREA 104 - OIL RECOVERY AND TREATMENT</u>			
051-104-100-1	0	PE-TIC	Gas Quenching
051-104-100-2	0	PE-TIC	Gas Recycle and Oil Treatment
051-104-100-3	0	PE-TIC	Ebullating Bed Hydrotreating
051-104-100-4	0	PE-TIC	Debutanization and Hydrogen Compression
051-104-100-5	0	PE-TIC	Oil Filtration
051-104-100-6	0	PE-TIC	Fixed Bed Hydrotreating

PE - Process Evaluation

PE - TIC Process Evaluation - TIC Version

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5.0 Baseline Process Concept

5.4 Process Flow Diagrams

<u>Number</u>	<u>Revision</u>	<u>Case*</u>	<u>Title</u>
<u>AREA 105 - GAS PURIFICATION</u>			
7051-105-100-1	0	PE-TIC	Acid Gas Removal
7051-105-100-2	0	PE-TIC	Hydrocarbon Recovery
7051-105-100-3	0	PE-TIC	Solvent Recovery
<u>AREA 106 - HYDROGEN GENERATION</u>			
7051-106-100-1	0	PE-TIC	CO Shift
7051-106-100-2	0	PE-TIC	CO ₂ Removal and Light Methanati
<u>AREA 107 - SHIFT AND METHANATION</u>			
7051-107-100-1	0	PE-TIC	Preheating and Methanation No. 1 and 2
7051-107-100-2	0	PE-TIC	No. 3,4,5 and 6 Methanators
7051-107-100-3	0	PE-TIC	Final Methanation
<u>AREA 108 - BULK CO₂ REMOVAL</u>			
7051-108-100-1	0	PE-TIC	Selexol Process
<u>AREA 109 - GAS COMPRESSION AND DEHYDRATION</u>			
7051-109-100-1	0	PE	Gas Compression and Dehydration
<u>AREA 110 - FLUE GAS POWER RECOVERY</u>			
7051-110-100-1	0	PE-TIC	Oxidation and Air Compression

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5.4 Process Flow Diagrams

<u>Number</u>	<u>Revision</u>	<u>Case*</u>	<u>Title</u>
<u>AREA 111 - SO₂ REMOVAL</u>			
7051-111-100-1	0	PE-TIC	SO ₂ Absorption
7051-111-100-2	0	PE-TIC	SO ₂ Regeneration
7051-111-100-3	0	PE-TIC	Purge Treatment
7051-111-100-4	0	PE-TIC	Product Collection
<u>AREA 112 - SULFUR RECOVERY</u>			
7051-112-100-1	0	PE-TIC	Claus Plant and Storage
<u>AREA 113 - AMMONIA RECOVERY</u>			
7051-113-100-1	0	PE	Sour Water - Ammonia Separation
7051-113-100-2	0	PE	Stripping and Fractionation
<u>AREA 114 - THERMAL OXIDIZER AND FLARE</u>			
7051-114-100-1	0	PE	Thermal Oxidizer and Flare
<u>AREA 115 - UTILITIES</u>			
7051-115-100-1	0	PE	Condensate Return
7051-115-100-2	0	PE	Deaeration
7051-115-100-3	0	PE	Steam Power Generation
7051-115-100-4	0	PE	Inert Gas Generation and Refrigeration Systems
7051-115-100-5	0	PE	Cooling Water
7051-115-100-6	0	PE	Plant and Instrument Air

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5.4 Process Flow Diagrams

<u>Number</u>	<u>Revision</u>	<u>Case*</u>	<u>Title</u>
<u>AREA 116 - WATER SUPPLY</u>			
7051-116-100-1	0	PE	Intake and Pipeline
<u>AREA 117 - WATER TREATMENT SYSTEMS</u>			
7051-117-100-1	0	PE	Lime-Soda Softening
7051-117-100-2	0	PE	Sand Filtration
7051-117-100-3	0	PE	Deionization
<u>AREA 118 - WASTE TREATMENT AND DISPOSAL</u>			
7051-118-100-1	0	PE	Biotreatment Feed Preparation
7051-118-100-2	0	PE	Biotreatment - Aeration and Filtration
7051-118-100-3	0	PE	Thickening and Filtering
7051-118-100-4	0	PE	Biotreatment - Sludge Filtering
7051-118-100-5	0	PE	pH Adjustment
7051-118-100-6	0	PE	Evaporation
7051-118-100-7	0	PE	Ash Disposal and Waste Solid Pond
<u>AREA 119 - FIRE PROTECTION SYSTEMS</u>			
7051-119-100-1	0	PE	Fire Protection

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5.4 Process Flow Diagrams

<u>Number</u>	<u>Revision</u>	<u>Case*</u>	<u>Title</u>
<u>AREA 120 - FACILITIES</u>			
7051-120-100-1	0	PE	Product Storage I
7051-120-100-2	0	PE	Product Storage II
7051-120-100-3	0	PE	Product Storage III
7051-120-100-4	0	PE	Chemical Storage I
7051-120-100-5	0	PE	Chemical Storage II
7051-120-100-6	0	PE	Chemical Storage III

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5.5 Utility Requirements

ELECTRIC POWER SUMMARY

Power Generation:

	<u>ITEM NUMBER</u>	<u>KW</u>
Main Power Generation Unit	115-48001	
Air Compressor Expander	110-42001-1,12	
150 PSIG Back-Pressure Turbine Generator	115-48002	
Flue Gas Oxidizer Power Generator	110-48002-1,3	
Total In-Plant Generation		213,308 KW

Process Power Usage: 179,060

Excess Power For Export: 34,248

Purchased Power:

River Water Pumping Station	1,360
Plant Lighting	<u>3,600</u>
Total Purchased Power	4,960 KW

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5.0 Baseline Process Concept

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5.5 Utility Requirements

ELECTRIC POWER SUMMARY - continued

<u>USAGE</u>	<u>PURCHASED KW</u>	<u>KW</u>
AREA 101		2,125
AREA 102		59,589
AREA 103		59,589
AREA 104		59,589
AREA 105		22,556
AREA 106		2,998
AREA 107		1,531
AREA 108		6,323
AREA 109		365
AREA 110		0
AREA 111		40,041
AREA 112		1,191
AREA 113		131
AREA 114		2
AREA 115		37,799
AREA 116	1360	
AREA 117		710
AREA 118		3,306
AREA 119		1
AREA 120		392
Plant Lighting	<u>3600</u>	<u> </u>
TOTAL	4960	179,060

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5.0 Baseline Process Concept

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5.5 Utility Requirements

AREA 101 - COAL UNLOADING AND HANDLING

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	0	0

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	139

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5.0 Baseline Process Concept

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5.5 Utility Requirements

AREA 101 - COAL UNLOADING AND HANDLING - continued

Plant Fuel

Fuel Oil (Generated on Site)

18,286 BTU/LB HHV 0 LBS/HR

SPG

950 BTU/SCF HHV 0 SCFM

Coal Feed

11,160 BTU/LB 0 LBS/HR

Electric Power

2125 KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Emergency Stack-out Conveyor	101-43001	0	0
ROM Coal Reclaim Conveyor	101-43002	0	0
Stack Out Tower	101-43003	0	0
ROM Belt Scale	101-43004	1	38
Reclaim Coal Feeder	101-43006-1,2	0	0
ROM Coal Conveyor	101-43007	1	206
Crushed Coal Conveyor to T-2	101-43008	1	134
Coal Stack Out Reclaimer	101-43009	1	247
Emergency Reclaim Conveyor #1	101-43010	0	0
Emergency Reclaim Conveyor Feeder	101-43011-1,2	0	0
Emergency Reclaim Conveyor #2	101-43012	0	0
T-2 Crushed Coal Conveyor .	101-43013-1,2	1	134
Crushed Coal Feeder	101-43015-1,2	2	17

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5.0 Baseline Process Concept

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5.5 Utility Requirements

AREA 101 - COAL UNLOADING AND HANDLING - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Crushed Coal Weigh Belt	101-43016	1	38
Coal Dryer Feed Conveyor	101-43017	1	134
ROM Coal Crusher Feeder	101-43018-1,3	3	17
Dust Suppression System	101-43020	0	0
Coal Feeder	101-43021-1,2	2	24
Coal Conveyor	101-34022	1	12
ROM Magnetic Separator	101-45001	1	0
Coal Crusher	101-46001-1,3	3	983
Dust Collection System T-1	101-47001	1	0
Dust Collection System-Crusher House	101-47002	1	0
Dust Collection System - T-2	101-47003	0	0
Dust Collection System-Emergency Reclaim	101-47004	0	0
Dust Collection System - T-3	101-47005	1	0
Dust Collection System-Coal Feed	101-47006	1	0
Rotary Car Dumpers	101-48001-1,2	2	141
	TOTAL		2125

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5.5 Utility Requirements

AREA 102 - COAL PREPARATION

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	898	25

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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5.5 Utility Requirements

AREA 102 - COAL PREPARATION - continued

Plant Fuel

Fuel Oil (Generated on Site) 18,286 BTU/LB HHV	0	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	14,478	LBS/HR
Electric Power	29,501	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Dryer Exhaust Blower	102-42001-1,3	3	12,610
Vent Blower	102-42002-1,3	3	90
Primary Air Blower	102-42003-1,3	3	7,597
Dryer Weigh Belt	102-43001-1,3	3	112
Belt Conveyor I	102-43002-1,3	3	7
Belt Conveyor II	102-43003-1,3	3	7
Grinder Product Distributor Conveyor	102-43004-1,3	3	7
Pulverized Coal Weigh Belt	102-43005-1,3	3	108
Coal Elevator	102-43006-1,3	3	213
Pulverized Coal Elevator	102-43007-1,3	3	264
Dryer Cyclone Rotary Feeder	102-43008-1,3	3	2
Feed Bin Rotary Feeder	102-43009-1,6	6	169

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5.5 Utility Requirements

AREA 102 - COAL PREPARATION - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Coal Silo Rotary Feeder	102-43010-1,6	6	169
Bridge Crane	102-43011-1,3	0	0
Dryer Furnace Weigh Belt	102-43012-1,3	3	0
Dryer Feeder	102-43013-1,3	3	25
Dryer Furnace Feeder	102-43014-1,3	3	0
Coal Hopper Rotary Feeder	102-43015-1,12	12	144
Pneumatic Conveying System	102-43016-1,12	12	2,465
Lock Hopper Feeding System	102-43017-1,6	6	3,638
Grinder Product Conveyor	102-43018-1,3	3	7
Coal Screens	102-45004-1,24	24	169
Coal Grinder	102-46001-1,6	6	1,692
Dryer Coal Grinder	102-46002-1,3	3	6
Dust Control System	102-47001-1,3	0	<u>0</u>
	TOTAL		29,501

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5.5 Utility Requirements

AREA 105 - GAS PURIFICATION

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	1,299,072	2598
600 PSIG at 489°F	74,483	149
150 PSIG at 366°F	131,272	262
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	37,800	10
85°F	136,040	25

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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5.5 Utility Requirements

AREA 105 - GAS PURIFICATION - continued

Plant Fuel

Fuel Oil (Generated on Site)
18,286 BTU/LB HHV

0

LBS/HR

SPG

950 BTU/SCF HHV

0

SCFM

Coal Feed

11,160 BTU/LB

0

LBS/HR

Electric Power

22,556

KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Lean Oil Pump	105-41001-1,6	3	250
Light Oil Fractionator Reflux Pump	105-41002-1,6	3	8
Secondary Fractionator Feed Pump	105-41003	1	3
Secondary Fractionator Bottoms Pump	105-41004	1	1
Secondary Fractionator Reflux Pump	105-41006	1	3
Lean Solution Pumps	105-41007-1,9	6	1361
Stripper Feed Pump	105-41008-1,9	6	257
Selexol Sump Pumps	105-41009-1,3	0	0
Absorber Pump	105-41010-1,6	6	30
Hydrocarbon Gas Compressor	105-42001-1,3	3	433
Gas Compressor	105-42002-1,12	12	65
Recycle Gas Compressor	105-42003-1,3	3	1939

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5.0 Baseline Process Concept

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5.5 Utility Requirements

AREA 105 - GAS PURIFICATION - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Hydrocarbon Removal Refrig. Unit	105-44001-1,3	3	6644
Lean Solution Chillers	105-44002-1,3	3	11372
Stripper OVHD Condenser	105-44003-1,3	3	190
	TOTAL		22,556

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5.5 Utility Requirements

AREA 106 - HYDROGEN GENERATION

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	483,556	0
315 PSIG at 100°F	0	7
150 PSIG at 366°F	0	0
80 PSIG at 267°F	0	777
50 PSIG at 297°F	4,000	0
25 PSIG at 140°F	0	48

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	310,317	651	31

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	123	25
85°F	1272	10

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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AREA 106 - HYDROGEN GENERATION - continued

Plant Fuel

Fuel Oil (Generated on Site) 18,286 BTU/LB HHV	0	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	0	LBS/HR
Electric Power	2,997	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Stripper Condensate Pump	106-41001-1,2	1	25
Lean Soln. Circulation Pump	106-41002-1,3	2	2037
Regenerator Reflux Pump	106-41003-1,2	1	5
Regenerator OVHD Cooler	106-44003	1	738
Methanated Gas Cooler	106-44004	1	47
Lean Solution Cooler	106-44005	1	<u>145</u>
	TOTAL		2997

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AREA 107 - SHIFT AND METHANATION

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
1500 PSIG at 597°F	445,518	0
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	1,721,793	4551	139
1500 PSIG at 597°F	445,518	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	38,750	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	671	25
Process Condensate	1300	

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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AREA 107 - SHIFT AND METHANATION - continued

Plant Fuel

Fuel Oil (Generated on Site) 1,286 BTU/LB HHV	51,174	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	0	LBS/HR
Electric Power	1,531	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Steam Generator Circulating Pump	107-41001-1,6	3	240
No. 1 Methanation Feed Heater	107-44001-1,3	3	0
Methanator Gas Air Coolers	107-44002-1,3	3	911
Final Methanator Air Cooler	107-44003-1,3	3	380
Final Desulfurizer Heater	107-44004-1,3	3	0
Final Methanator Start-Up Heater	107-44005-1,3	3	<u>0</u>
	TOTAL		1,531

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AREA 108 - BULK CO₂ REMOVAL

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	23,000	46
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	3110	25
85°F	7210	10

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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5.5 Utility Requirements

AREA 108 - BULK CO₂ REMOVAL - continued

Plant Fuel

Fuel Oil (Generated on Site) 18,286 BTU/LB HHV	0	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	0	LBS/HR
Electric Power	6323	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Lean Solution Pump	108-41001-1,9	6	2,113
Stripper Feed Pump	108-41003-1,9	6	660
Air Blower	108-42001-1,3	3	691
Rich Solution Chiller	108-44001-1,3	3	<u>2,859</u>
	TOTAL		6,323

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5.5 Utility Requirements

AREA 109 - GAS COMPRESION & DEHYDRATION

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	177,794	355
600 PSIG at 489°F	1,281	2.6
150 PSIG at 366°F	0	0
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	16,780	25

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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5.5 Utility Requirements

AREA 109 - GAS COMPRESSION & DEHYDRATION - continued

Plant Fuel

Fuel Oil (Generated on Site) 18,286 BTU/LB HHV	0	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	0	LBS/HR
Electric Power	365	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Lean Glycol Pump	109-41001-1,2	1	16
Reflux Pump	109-41002-1,2	1	1
Glycol Transfer Pump	109-41003-1,2	1	1
Regeneration Column Condenser	109-44001	1	7
Compressor Aftercooler	109-44002	1	<u>340</u>
	TOTAL		365

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5.5 Utility Requirements

AREA 110 - FLUE GAS POWER RECOVERY

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	0	0

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Bridge Crane	110-43001-1,3	0	0
	TOTAL		0

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AREA 111 - SO₂ REMOVAL

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	159,500	319
150 PSIG at 366°F	2,500	0
50 PSIG at 297°F	267,000	525

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	28,000	25
85°F	3,600	10

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	321

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5.5 Utility Requirements

AREA 111 - SO₂ REMOVAL - continued

Plant Fuel

Fuel Oil (Generated on Site) 18,286 BTU/LB HHV	0	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	0	LBS/HR
Electric Power	40,041	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Rotary Dryer	111-31008-1,3	3	285
Venturi Surge Tank Agitator	111-39001-1,6	6	80
Dissolving Tank Agitator	111-39002-1,3	3	20
Soda Ash Mixing Tank Agitator	111-39003-1,3	3	5
Chiller-Crystallizer Tank Agitator	111-39004-1,3	3	10
Venturi Recycle Pump	111-41001-1,15	12	2,670
Sludge Pump	111-41002-1,9	6	200
First Stage Absorber Recycle Pump	111-41003-1,12	6	950
Second Stage Absorber Recycle Pump	111-41004-1,6	6	570
Third Stage Absorber Recycle Pump	111-41005-1,6	6	570
SO ₂ Absorber Feed Pump	111-41006-1,6	3	95

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AREA 111 - SO₂ REMOVAL - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Soda Ash Feed Pump	111-41007-1,6	3	15
Evaporator-Crystallizer Circulation Pump	111-41008-1,6	3	760
Venturi Make-up Water Pumps	111-41009-1,6	3	190
Glycol Pumps	111-41010-1,6	3	190
Absorber Surge Tank Pumps	111-41011-1,6	3	100
Chiller-Crystallizer Pumps	111-41012-1,6	3	60
Centrate Pumps	111-41013-1,6	3	30
SO ₂ Gas Compressor	111-42001-1,3	3	285
Anti-Oxidant Conveyor	111-43004-1,3	3	0.5
Centrifuge Conveyor	111-43005-1,3	3	0.5
Recycle Conveyor	111-43006-1,3	3	0.5
Dryer Conveyor	111-43007-1,3	3	0.5
Bucket Elevator	111-43008-1,3	3	6
Recycle Bin Vibrator Feeder	111-43009-1,3	3	6
Dust Conveyor #1	111-43010-1,3	3	0.5
Dust Conveyor #2	111-43011-1,3	3	0.5
Product Bin Loading Conveyors	111-43012-1,3	3	1
Product Bin Vibrator	111-43013-1,6	3	2
Refrigeration Units	111-44002-1,3	3	1150
Centrifuge	111-45001-1,3	3	380

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5.5 Utility Requirements

AREA 111 - SO₂ REMOVAL - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Flue Gas ID Fans	111-47002-1,6	6	30,450
Venturi Stream Nozzles	111-47003-1,30	3	3
Dust Collection System Exhaust Fan	111-47004-1,3	3	950
SO ₂ Absorber Steam Nozzles	111-47006-1,30	3	3
Recycle Bin Weigh Feeder	111-48002-1,3	3	1
Anti-oxidant Weigh Feeder	111-48003-1,3	2	<u>2</u>
		TOTAL	40041

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AREA 112 - SULFUR RECOVERY

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	67,700	136
150 PSIG at 366°F	5,000	10
50 PSIG at 297°F	3,000	6

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	30,000	63	3
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	136,624	287	14

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	1187	10
85°F	93	25

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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5.5 Utility Requirements

AREA 112 - SULFUR RECOVERY - continued

Plant Fuel

Fuel Oil (Generated on Site) 18,286 BTU/LB HHV	0	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	0	LBS/HR
Electric Power	669	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Sulfur Storage Conveyor	112-43001	1	11
Reclaimed Sulfur Conveyor	112-43003	1	11
Sulfur Elevator	112-43004	1	26
Tail Gas Incinerator Unit	112-44001	1	49
Water Chiller	112-44002	1	522
Sulfur Flaker	112-46001	1	72
Claus Plant	112-47001	1	<u>500</u>
	TOTAL		1191

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AREA 113 - AMMONIA RECOVERY

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	62397	0
250 PSIG at 406°F	0	89
50 PSIG at 297°F	81781	1

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	4547	25

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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AREA 113 - AMMONIA RECOVERY - continued

Plant Fuel

Fuel Oil (Generated on Site) 18,286 BTU/LB HHV	0	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	0	LBS/HR
Electric Power	131	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Sour Water Stripper Bottoms Pump	113-41001-1,3	2	31
Phosphoric Acid Addition Pump	113-41003	1	1
Acid Gas Condensate Pump	113-41004-1,2	1	3
Scrubber Bottoms Pump	113-41005-1,2	1	69
Fractionator Feed Pump	113-41006-1,2	1	10
Ammonia Product/Reflux Pump	113-41007-1,2	1	9
Caustic Injection Pump	113-41008	1	Negligible
Caustic Supply Pump	113-41009	1	2
Scrubber Circulating Pump	113-41010-1,2	1	6
	TOTAL		131

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AREA 114 - THERMAL OXIDIZER AND FLARE

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	0	

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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AREA 114 - THERMAL OXIDIZER AND FLARE - continued

Plant Fuel

Fuel Oil (Generated on Site)
18,286 BTU/LB HHV

0

LBS/HR

SPG

950 BTU/SCF HHV

48

SCFM

Coal Feed

11,160 BTU/LB

0

LBS/HR

Electric Power

0

KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Incinerator Feed Pump	114-41001-1,4	0	0
Flare Knockout Drum Pump	114-41002-1,2	0	0
Flare Water Pump	114-41003-1,2	0	0
	TOTAL		0

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AREA 115 - UTILITIES

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	1,506,819	2,015
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	219,212	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	465,000	976	46
600 PSIG at 489°F	274,844	0	0
150 PSIG at 366°F	224,272	0	0
50 PSIG at 297°F	67,537	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	79,918	25

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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AREA 115 - UTILITIES - continued

Plant Fuel

Fuel Oil (Generated on Site)
18,286 BTU/LB HHV

0

LBS/HR

SPG
950 BTU/SCF HHV

0

SCFM

Coal Feed
11,160 BTU/LB

0

LBS/HR

Electric Power

37,799

KW, Operating

Electric Power Generated

118,570

KW

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Area 7 BFW Pump	115-41005	0	0
Area 10 BFW Pump	115-41006	0	0
1500 PSIG BFW Pump	115-41007	0	0
Main Hot Well Pump	115-41008-1,10	10	7,009
Main Cold Well Pump	115-41010-1,9	9	16,412
Auxiliary Boiler BFW Pump	115-41012	0	0
Demineralized Condensate Feed Pump	115-41015-1,2	1	268
Soft Condensate Receiver Pump	115-41016-1,2	1	77
Area 3 BFW Pump	115-41022	0	0
Area 4 BFW Pump	115-41023-1,2	1	4
Area 6 BFW Pump	115-41024-1,2	1	35
600 PSIG BFW Pump	115-41029-1,2	1	274
Area 12 50 PSIG BFW Pump	115-41030-1,2	1	15

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AREA 115 - UTILITIES - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Area 12 600 PSIG BFW Pump	115-41031-1,2	1	34
Area 5 Condensate Transfer Pump	115-41032-1,6	3	31
Area 5 Condensate Return Pump	115-41033-1,6	3	52
Area 15 Condensate Transfer Pump	115-41034-1,2	1	36
Area 15 Condensate Return Pump	115-41035-1,2	1	74
Instrument Air Compressors	115-42001-1,4	3	2,237
Plant Air Compressor	115-42002-1,3	3	2,237
Inert Gas Compressor	115-42003-1,2	0	0
Area 15 Bridge Crane	115-43001	0	0
Aux. Boiler Pulverizer Feeder	115-43002	0	0
Aux. Boiler Ash Conveyor	115-43003	0	0
Auxiliary Boiler c/w Auxiliaries	115-44001	0	0
Cooling Tower	115-44002	1	6,635
Refrigeration System	115-44003	1	175
Inert Gas Cooler	115-44004-1,2	0	0
Power Generation Boiler	115-44007	1	2,025
Inert Gas Compressor Inter- cooler	115-44008-1,2	0	0
Auxiliary Boiler ESP	115-45003	0	0
Power Generation Boiler ESP	115-45004	1	48
Auxiliary Boiler Coal Pulverizer	115-46001	0	0

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AREA 115 - UTILITIES - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Area 3 Condensate Return Unit	115-47001-1,2	2	6
Hydrazine Preparation	115-47003	1	0.4
Disodium Phosphate Prep	115-47004	1	0.4
Dispersant and Neutralizing Prep	115-47005	1	0.4
Soft Water Sulfite Preparation	115-47007	1	0.4
Soft Water Phosphate Preparation	115-47008	1	0.4
Soft Water Dispersant Preparation	115-47009	1	0.4
Cooling Tower Hypochlorite Preparation	115-47010	1	0.4
Instrument Air Dryer	115-47011-1,4	3	45
Cooling Tower Acid Preparation	115-47013	1	0.4
Cooling Tower Additive Preparation	115-47014	1	0.4
Plant Air Dryer	115-47015-1,3	0	0
Inert Gas Generator	115-47016-1,26	0	0
Area 4 Condensate Return Unit	115-47017-1,3	3	25
Area 8 Condensate Return Unit	115-47019-1,3	0	7
Area 9 Condensate Return Unit	115-47028	1	15
Area 7 Condensate Return Unit	115-47030	1	5
Area 3 BFW Condensate Return Unit	115-47031	1	3
Area 10 Condensate Return Unit	115-47033-1,3	1	<u>7</u>
5-155	TOTAL		37,799

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5.5 Utility Requirements

AREA 116 - WATER SUPPLY

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	0	

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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5.5 Utility Requirements

AREA 116 - WATER SUPPLY - continued

Plant Fuel

Fuel Oil (Generated on Site) 18,286 BTU/LB HHV	0	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	0	LBS/HR
Electric Power	1,359	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Raw Water Feed Pumps	116-41001-1,4	3	203
Raw Water Booster Pump	116-41003-1,2	1	1,136
Transfer Pump	116-41006	1	1
Cationic Polymer Feed Pump	116-41007-1,2	1	0
Conveyor System	116-43002	1	11
Mechanically Cleaned Bar Screen	116-45001-1,2	1	4
Traveling Screen	116-45002-1,4	3	<u>4</u>
	TOTAL		1,359

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5.5 Utility Requirements

AREA 117 - WATER TREATMENT SYSTEMS

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	0	

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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5.5 Utility Requirements

AREA 117 - WATER TREATMENT SYSTEMS - continued

Plant Fuel

Fuel Oil (Generated on Site)

18,286 BTU/LB HHV	0	LBS/HR

SPG

950 BTU/SCF HHV	0	SCFM

Coal Feed

11,160 BTU/LB	0	LBS/HR

Electric Power

710	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Sand Filter Charge Pumps	117-41001-1,4	3	82
Dirty Backwash Pump	117-41002-1,2	1	4
Cooling Tower Make-Up Pump	117-41003-1,2	1	295
Potable Water Pumps	117-41004-1,2	1	2
Carbon Filter Feed Pump	117-41005-1,2	1	44
Low Pressure Boiler Water Pump	117-41006-1,2	1	35
Carbon Filter Backwash Pump	117-41007-1,2	1	1
Dirty Carbon Filter Backwash Pump	117-41008-1,2	1	1
Spent Regenerant Pump	117-41009-1,2	1	1
Cation Unit Backwash Pump	117-41010-1,2	1	1
Deionized Water Pump	117-41011-1,2	1	31
Softener Lime Feed Pump	117-41012-1,2	1	1
Reactor-Clarifier Sludge Pump	117-41013-1,4	1	6

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5.5 Utility Requirements

AREA 117 - WATER TREATMENT SYSTEMS - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Filter Sump Pump	117-41014-1,2	1	81
Anion Unit Backwash Pump	117-41015-1,2	2	1
Filter Backwash Pump	117-41016-1,2	1	2
Backwash Air Blowers	117-42001-1,2	1	119
Softener Reactor-Clarifier	117-45001-1,2	2	2
Anionic Polymer Feed System		1	0
Lime Feed System		1	<u>1</u>
	TOTAL		710

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5.5 Utility Requirements

AREA 118 - WASTE TREATMENT & DISPOSAL

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	0	0
150 PSIG at 366°F	88,000	176
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	6700	25

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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5.5 Utility Requirements

AREA 118 - WASTE TREATMENT & DISPOSAL - continued

Plant Fuel

Fuel Oil (Generated on Site)		
18,286 BTU/LB HHV	0	LBS/HR
SPG		
950 BTU/SCF HHV	0	SCFM
Coal Feed		
11,160 BTU/LB	0	LBS/HR
Electric Power	3,306	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Sludge Press Cond. Tank Mixer	118-39002	1	3
pH Adjustment Feed Tank Agitator	118-39003	1	5
Evap. Hold Tank Agitator	118-39004	1	3
Spray Coolers	118-39050-1,2	2	75
Floating Surface Aerators	118-39051-1,10	10	559
Turbine Aerators	118-39052-1,10	10	932
Digester Aerators	118-39053-1,6	6	447
API Sludge Pump	118-41001-1,3	2	0
Sludge Press Filtrate Pump	118-41002-1,2	1	1
Sludge Recycle Pumps	118-41004-1,4	2	10
Contaminated Storm Water Pump	118-41005-1,2	1	7
Digested Sludge Transfer Pump	118-41006-1,2	1	2
pH Adjustment Filtrate Pump	118-41007-1,2	1	11

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5.5 Utility Requirements

AREA 118 - WASTE TREATMENT & DISPOSAL - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
ph Adjust. Sludge Press Feed Pump	118-41008-1,20	1	25
Transfer Pump	118-41009-1,2	1	10
Emergency Storage Pump	118-41010-1,2	1	4
Slop Oil Pump	118-41011-1,2	1	0
Cooling Pond Return Pump	118-41012-1,2	1	16
Clarifier Clear Well Pump	118-41013-1,2	1	72
Thickener Clear Well Pump	118-41014-1,2	1	1
Thickener Bottoms Pump	118-41015-1,3	1	1
Thickener Polymer Transfer Pump	118-41016-1,2	1	0
Pressure Filter Backwash Pump	118-41017-1,2	1	0
Dirty Pressure Filter Backwash Pump	118-41018-1,2	1	0
Sludge Press Feed Pump	118-41019-1,2	1	1
Carbon Filter Backwash Pump	118-41020-1,2	1	28
Supernatant Pump	118-41021-1,2	1	5
Thickened Sludge Pump	118-41022-1,2	1	1
Aeration Air Blowers	118-42001-1,4	3	224
Thickener Air Blower	118-42003-1,2	1	4
Solids Waste Conveyer	118-43001	1	13
Clarifier	118-45002-1,3	3	1

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5.5 Utility Requirements

AREA 118 - WASTE TREATMENT & DISPOSAL - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Sludge Press	118-45004-1,5	4	9
Sludge Thickener	118-45005-1,2	2	16
Waste Evaporator System	118-47001	1	820
Thickener Polymer Feed System	118-47003	1	<u>0</u>
	TOTAL		3306

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5.5 Utility Requirements

AREA 119 - FIRE PROTECTION SYSTEM

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	0	0

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	0	

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	0

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5.5 Utility Requirements

AREA 119 - FIRE PROTECTION SYSTEM - continued

Plant Fuel

Fuel Oil (Generated on Site) 18,286 BTU/LB HHV	0	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	0	LBS/HR
Electric Power	1	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Fire Water Jockey Pump	119-41001-1,2	1	1

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5.5 Utility Requirements

AREA 120 - FACILITIES

<u>Steam Usage</u>	<u>LBS/HR Continuous</u>	<u>Cond. Returned GPM, Continuous</u>
1500 PSIG at 850°F	0	0
600 PSIG at 489°F	0	0
150 PSIG at 366°F	0	0
50 PSIG at 297°F	525	1

<u>Steam Generated</u>	<u>LBS/HR Continuous</u>	<u>BFW GPM</u>	<u>Blowdown GPM</u>
1500 PSIG at 850°F	0	0	0
600 PSIG at 489°F	0	0	0
150 PSIG at 366°F	0	0	0
50 PSIG at 297°F	0	0	0

<u>Cooling Water</u>	<u>GPM</u>	<u>Temp. Rise °F</u>
85°F	251	7

<u>Process Water</u>	<u>GPM Continuous</u>
60°F, 30 PSIG	34

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5.5 Utility Requirements

AREA 120 - FACILITIES - continued

Plant Fuel

Fuel Oil (Generated on Site) 18,286 BTU/LB HHV	0	LBS/HR
SPG 950 BTU/SCF HHV	0	SCFM
Coal Feed 11,160 BTU/LB	0	LBS/HR
Electric Power	167	KW, Operating

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Antifoam Agent Agitator	120-39001	1	1
Soda Ash Feed Tank Agitator	120-39002	0	0.5
Sulfuric Acid Unloading Pump	120-41001	0	0
Caustic Unloading Pump	120-41002	0	0
Soda Ash Feed Pump	120-41003-1,2	1	1
Antifoam Agent Pump	120-41004	0	0
Cooling Tower Inhibitor Pump	120-41005	0	0
Cooling Tower Dispersant Pump	120-41006	0	0
Selexol Unloading Pump	120-41007	0	0
Potassium Carbonate Unloading Pump	120-41008	0	0
Raw Oil Feed Pump	120-41010-1,2	0	0
Syncrude Loading Pump	120-41011-1,8	0	0

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5.5 Utility Requirements

AREA 120 - FACILITIES - continued

Motor List

<u>User</u>	<u>Item No.</u>	<u>No. Oper. Continuously</u>	<u>KW Operating</u>
Ammonia Loading Pump	120-41012	0	0
Phosphoric Acid Unloading Pump	120-41014	0	0
Ethylene Glycol Unloading Pump	120-41015	0	0
Plant Fuel Pump	120-41016-1,2	1	7
Light H/C Loading Pump	120-41017-1,4	0	0
Light Oil Transfer Pump	120-41019-1,2	0	0
Fuel Oil Transfer Pump	120-41020-1,2	1	6
Fuel Oil Off-Spec Pump	120-41021	0	0
Syncrude Transfer Pump	120-41022-1,2	1	16
Syncrude Off-Spec Pump	120-41023	0	0
Antifoaming Agent Drum Pump	120-41024	0	0
Phosphoric Acid Metering Pump	120-41025-1,2	0	0
Cooling Tower Inhibitor #2 Pump	120-41026	0	0
Ammonia Storage Compressor	120-42001-1,2	1	75
Filter Air Transfer Blower	120-42002	0	0
Light Hydrocarbon Storage Compressor	120-42003-1,3	2	60
5 T Bridge Crane	120-43001	0	0
10 T Bridge Crane	120-43002	0	0
35/5 T Bridge Crane	120-43003	0	0
Soda Ash Feeder	120-43004	1	<u>0.5</u>
	5-169	TOTAL	167

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5.5 Utility Requirements

Utility Flow Diagrams - See Supplement

<u>Number</u>	<u>Revision</u>	<u>Case</u>	<u>Title</u>
7051-100-120-1	0	PE	Water-Waste Water Base Case
7051-100-120-2	0	PE - TIC	Cooling Water I Base Case
7051-100-120-3	0	PE - TIC	Cooling Water II Base Case
7051-100-120-4	0	PE - TIC	Process Water Base Case
7051-100-120-5	0	PE - TIC	Overall Steam Supply Case A Base Case
7051-100-120-6	0	PE - TIC	Steam Power Balance Base Case
7051-100-120-7	0	PE - TIC	50 PSIG Steam Generation and Users I Base Case
7051-100-120-8	0	PE	50 PSIG Steam Generation and Users II Base Case
7051-100-120-9	0	PE - TIC	100 PSIG Steam Generators and Users Base Case
7051-100-120-10	0	PE - TIC	600 PSIG Steam Generators and Users Base Case

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5.5 Utility Requirements

Utility Flow Diagrams - continued

<u>Number</u>	<u>Revision</u>	<u>Case</u>	<u>Title</u>
7051-100-120-11	0	PE - TIC	1500 PSIG Steam Generator and Users I Base Case
7051-100-120-12	0	PE - TIC	1500 PSIG Steam Generators and Users II
7051-100-120-13	0	PE - TIC	Fuel Oil Base Case

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5.6 Energy Balance

AREA 101 - COAL UNLOADING & HANDLING

<u>Input Total</u>	MM BTU/HR
See PFD-101-100-1	-253.5
<u>Output Total</u>	
See PFD-101-100-1	-253.5
<u>Net - Addition/Subtraction</u>	
See PFD-101-100-1	0.0
Heater Subtotal	0
Cooler Subtotal	0
Heat of Reaction Subtotal	0
Heat Losses	<u>0</u>
TOTAL	0.0

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5.6 Energy Balance

AREA 102 - COAL PREPARATION

Input Total MM BTU/HR

See PFD-102-100-1 - 248.1

Output Total

See PFD-102-100-1 - 115.6

Net - Addition/Subtraction

See PFD-102-100-1 + 132.5

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution</u> <u>MM BTU/HR</u>
Coal Dryer Furnace	w/102-44002-1,3	+164.7
Heater Subtotal		<u>164.7</u>
Cooler with Pneumatic Conveying System	102-43016-1,12	-6.2
Cooler with Lock Hopper Feeding System	102-43017-1,6	-5.0
		<u>-11.2</u>
Heat of Reaction Subtotal		0
Dryer Exhaust Blower	102-42001-1,3	+11.9
Vent Blower	102-42002-1,3	negligible
Primary Air Blower	102-42003-1,3	+4.5
Compressors with	102-43016-1,12	+4.6
Compressors with	102-43017-1,6	+6.9
Compressor Subtotal		<u>+27.9</u>
Heat Losses		-48.9
	TOTAL	<u>+132.5</u>

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5.6 Energy Balance

AREA 105 - GAS PURIFICATION

<u>Input Total</u>	<u>MM BTU/HR</u>

See PFD-105-100-1	34.8

Output Total

See PFD-105-100-1	- 27.4

Net - Addition/Subtraction

See PFD-105-100-1	- 62.2

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution MM BTU/HR</u>
Light Oil Fractionator Reboiler	105-31006-1,3	
Selexol Stripper Reboiler	105-31014-1,3	
Heater Subtotal		+166.5
Feed Gas Chiller	105-31002-1,3	
Absorber Chiller	105-31003-1,6	
Lean Oil Chiller	105-31005-1,3	
Fractionator Overhead Cooler	105-31007-1,3	
Feed Gas Cooler	105-31011-1,3	
Light Hydrocarbon Condenser	105-31015-1,3	
Hydrocarbon Gas Compressor	105-42001-1,3	
Gas Compressor W/Auxiliaries	105-42002-1,12	
Recycle Gas Compressor	105-42003-1,3	
Lean Solution Chiller	105-44002-1,3	
Stripper Overhead Condenser	105-44003-1,3	
Cooler Subtotal		-724.6
Heat of Reaction Subtotal		
Hydrocarbon Gas Compressor	105-42001-1,3	
Gas Compressor W/Auxiliaries	105-42002-1,12	
Recycle Gas Compressor	105-42003-1,3	
Compressor Subtotal		+494.3
Heat Gain		+1.6
TOTAL		-62.2

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5.6 Energy Balance

AREA 106 - HYDROGEN GENERATION

<u>Input Total</u>	<u>MM BTU/HR</u>
See PFD-106-100-1	+ 58.9

<u>Output Total</u>	
See PFD-106-100-1	-328.1

<u>Net Subtraction</u>	
See PFD-106-100-1	-387.0

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution</u> <u>MM BTU/HR</u>
Heater Subtotal		0
Trim Cooler	106-31008	
Regenerator Overhead Cooler	106-44003	
Methanated Gas Cooler	106-44004	
Lean Solution Cooler	106-44005	
No. 2 Converter Waste Heat Boiler	106-44006	
No. 3 Converter Waste Heat Boiler	106-44007	
Cooler Subtotal		<u>-510.3</u>
Heat of Reaction Subtotal		+123.3
Compressor Subtotal		0
Heat Losses		<u>0</u>
TOTAL		-387

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5.6 Energy Balance

AREA 107 - SHIFT & METHANATION

Input Total MM BTU/HR

See PFD-107-100-1 22.8

Output Total

See PFD-107-100-1 -397.3

Net - Addition/Subtraction

See PFD-107-100-1 -420.1

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution</u> <u>MM BTU/HR</u>
No. 1 Methanator Feed Heater	107-44001-1,3	
Final Desulfurizer Heater	107-44004-1,3	
Heater Subtotal		+935.8
No. 1 Methanator Steam Generator	107-31001-1,3	
No. 2 Methanator Steam Generator	107-31002-1,3	
No. 3 Methanator Steam Generator	107-31003-1,3	
No. 4 Methanator BFW Heater	107-31004-1,3	
No. 5 Methanator Steam Generator	107-31005-1,3	
No. 6 Methanator Steam Generator	107-31006-1,3	
Feed/Prod. Interchanger	107-31007-1,3	
No. 5 Methanator BFW Heater	107-31008-1,3	
Final Methanator Interchanger	107-31009-1,3	
Final Methanator Feed Heater	107-31010-1,3	
Methanator Gas Air Cooler	107-44002-1,3	
Final Methanator Air Cooler	107-44003-1,3	
Cooler Subtotal		-3436.3
No. 1 Methanator	107-32001-1,3	+2085.0
No. 2 Methanator	107-32002-1,3	
No. 3 Methanator	107-32003-1,3	
No. 4 Methanator	107-32004-1,3	
No. 5 Methanator	107-32005-1,3	
No. 6 Methanator	107-32006-1,3	
Final Methanator	107-32007-1,3	
Heat of Reaction Subtotal		+2085.0

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5.6 Energy Balance

AREA 107 - SHIFT & METHANATION - continued

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution</u> <u>MM BTU/HR</u>
Compressor Subtotal		0
Heat Losses		<u>-4.6</u>
	TOTAL	-420.1

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5.6 Energy Balance

AREA 108 - BULK CO₂ REMOVAL

<u>Input Total</u>	<u>MM BTU/HR</u>
See PFD-108-100-1	+36.1
<u>Output Total</u>	
See PFD-108-100-1	-5.6
<u>Net Addition/Subtraction</u>	
See PFD-108-100-1	-41.7

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution MM BTU/HR</u>
Heater Subtotal		0
Feed Gas Coolers	108-31002-1,3	
Rich Solution Chiller	108-44001-1,3	
Recycle Comp. Aftercooler	w/ 108-42002-1,3	
Cooler Subtotal		- 46.2
Heat of Reaction Subtotal		0
Recycle Gas Compressor	108-42002-1,3	+ 5.4
Compressor Subtotal		+ 5.4
Heat Losses		- 0.9
TOTAL		-41.7

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5.6 Energy Balance

AREA 109 - GAS COMPRESSION AND DEHYDRATION

<u>Input Total</u>	<u>MM BTU/HR</u>
See PFD-109-100-1	+16.6

<u>Output Total</u>	
See PFD-109-100-1	+6.5

<u>Net Addition/Subtraction</u>	
See PFD-109-100-1	-10.1

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution MM BTU/HR</u>
Regeneration Column Reboiler	109-31003	+0.9
Glycol Storage Tank	109-35005	+0.1
Heater Subtotal		+1.0
Lean Glycol Cooler	109-31001	-0.4
Pipeline Gas Cooler	109-31004	-14.0
Compressor Intercooler	w/109-42001	-38.6
Regeneration Column Condenser	109-44001	-0.5
Compressor Aftercooler	109-44002	-22.5
Cooler Subtotal		-76.0
Heat of Reaction Subtotal		0
Pipeline Compressor	109-42001-1,3	+64.9
Compressor Subtotal		+64.9
Heat Losses		0.0
TOTAL		-10.1

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5.6 Energy Balance

AREA 111 - SO₂ REMOVAL

Input Total

MM BTU/HR

See PFD-111-100-1

-67.3

Output Total

See PFD-111-100-1

-145.2

Net - Addition/Subtraction

See PFD-111-100-1

-77.9

Services

Item No.

Contribution
MM BTU/HR

Flue Gas Reheater

111-31001-1,6

Desuperheater

111-44001-1,3

Steam-Air Heater

111-44003

Heater Subtotal

+378.8

Primary Condenser

111-31004-1,3

Secondary Condenser

111-31005-1,3

Chiller Crystallizer System

Venturi Scrubber

111-47001-1,6

Cooler Subtotal

-488.1

SO₂ Absorption, Crystallization of Na₂SO₄

+6.2

Heat of Reaction Subtotal

+6.2

SO₂ Compressors

111-42001-1,3

Flue Gas I.D. Fans

111-47002-1,6

Compressor Subtotal

+25.2

Heat Losses

0

TOTAL

-77.9

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5.6 Energy Balance

AREA 112 - SULFUR RECOVERY

Input Total

MM BTU/HR

See PFD-112-100-1

+3.0

Output Total

See PFD-112-100-1

+28.0

Net - Addition/Subtraction

See PFD-112-100-1

+25.0

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution MM BTU/HR</u>
Sulfur Flaker (50 PSIG steam)	112-46001	+2.7
Claus Plant (150 PSIG steam)	112-47001	+25.7
Claus Plant (600 PSIG steam)	112-47001	+45.9
Heater Subtotal		<u>+74.3</u>
Claus Plant (50 PSIG steam)	112-47001	-141.2
Claus Plant (600 PSIG steam)	112-47001	-33.7
Water Chiller	112-44002	-5.9
Blowdown Units	112-48001	
	112-48002	-1.2
	112-48003	
Cooler Subtotal		<u>-182.0</u>
Heat of Reaction Subtotal		+132.7
Compressor Subtotal		0
Heat Losses		<u>0</u>
	TOTAL	+25.0

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5.6 Energy Balance

AREA 113 - AMMONIA RECOVERY

<u>Input Total</u>	<u>MM BTU/HR</u>
See PFD-113-100-1	- 764.6
<u>Output Total</u>	
See PFD-113-100-1	- 830.6
<u>Net - Addition/Subtraction</u>	
See PFD-113-100-1	- 66.0

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution MM BTU/HR</u>
50% Caustic Surge Tank (Heater)	113-35004	+0.3
Heater Subtotal		+0.3
Acid Gas Condenser	113-31005	-2.0
Lean Solution Cooler	113-31001	-32.6
No. 2 Stripper Condenser	113-31003	-13.5
Ammonia Condenser	113-31004	-8.2
Cooler Subtotal		-56.3
Heat of Reaction Subtotal		-0.3
Compressor Subtotal		0
Heat Losses		-9.7
	TOTAL	-66.0

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5.6 Energy Balance

AREA 114 - THERMAL OXIDIZER AND FLARE

<u>Input Total</u>	<u>MM BTU/HR</u>
See PFD-114-100-1	0.0

<u>Output Total</u>	
See PFD-114-100-1	+ 2.5

<u>Net - Addition/Subtraction</u>	
See PFD-114-100-1	+ 2.5

<u>SERVICES</u>	<u>Contribution MM BTU/HR</u>
Heater Subtotal	0.0
Cooler Subtotal	0.0
SNG to Flare	+ 2.5
Heat of Reaction Subtotal	+ 2.5
Compressor Subtotal	0
Heat Losses	<u>0</u>
Total	+2.5

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AREA 115 - UTILITIES

Input Total

MM BTU/HR

See PFD-115-100-1

- 204,333.5

Output Total

See PFD-115-100-1

- 204,847.3

Net Addition/Subtraction

See PFD-115-100-1

- 513.8

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution MM BTU/HR</u>
1500 PSIG BFW Preheater	104-31013-1,3	+87.0
Softened BFW Preheater	104-31014-1,3	+54.2
Heater Subtotal		+141.2
Instrument Air Aftercooler	115-31001-1,4	-2.5
Plant Air Aftercooler	115-31002-1,3	-2.5
Area 7 BFW Turbine Pump Condenser	w/115-41001-1,2	-52.9
Area 10 BFW Turbine Pump Condenser	w/115-41002-1,2	-59.7
1500 PSIG BFW Turbine Pump Condenser	w/115-41003	-11.4
Area 3 BFW Turbine Pump Condenser	w/115-41017	-7.2
Instrument Air Compressor Intercooler	w/115-42001-1,4	-2.8
Plant Air Compressor Intercooler	w/115-42002-1,3	-2.8
Refrigeration System	115-44003	-1.6
Main Power Generation Unit Condensers	w/115-48001	-851.4
Power Generation Boiler Blowdown System	115-48004	-1.8
Cooler Subtotal		-996.6
Power Generator Boiler	115-44007	+698.2
Heat of Reaction Subtotal		+698.2
Compressor Subtotal		0
Electrical Input		+129.0
Electrical Output		-404.8
Heat Losses		-80.8
	TOTAL	-513.8

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5.6 Energy Balance

AREA 116 - WATER SUPPLY

<u>Input Total</u>	<u>MM BTU/HR</u>
See PFD-116-100-1	-5989.1
<u>Output Total</u>	
See PFD-116-100-1	-5989.1
<u>Net Addition/Subtraction</u>	
See PFD-116-100-1	0

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution MM BTU/HR</u>
Heater Subtotal		0
Cooler Subtotal		0
Heat of Reaction Subtotal		0
Compressor Subtotal		0
Heat Losses		<u>0</u>
	TOTAL	0

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5.6 - Energy Balance

AREA 117 - WATER TREATMENT

<u>Input Total</u>	<u>MM BTU/HR</u>
See PFD-117-100-1	-6994.3

<u>Output Total</u>	
See PFD-117-100-1	-7022.0

<u>Net - Addition/Subtraction</u>	
See PFD-117-100-1	-27.7

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution MM BTU/HR</u>
Heater Subtotal		0
Cooler Subtotal		0
Lime Slaking		+ 0.4
NaOH Dilution		+ 0.8
H ₂ SO ₄ Dilution		+ 1.4
Heat of Reaction Subtotal		+ 2.6
Compressor Subtotal		0
Heat Losses		- 30.3
	TOTAL	- 27.7

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5.6 Energy Balance

AREA 118 - WASTE TREATMENT & DISPOSAL

<u>Input Total</u>	<u>MM BTU/HR</u>
See PFD-118-100-1	-2480.1

<u>Output Total</u>	
See PFD-118-100-1	-2579.0

<u>Net - Addition/Subtraction</u>	
See PFD-118-100-1	-98.9

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution MM BTU/HR</u>
Heater Subtotal		0
Cooler Subtotal		0
Heat of Reaction Subtotal		+ 7.1
Compressor Subtotal		0
Heat Losses (Evaporation)		<u>-106.0</u>
	TOTAL	- 98.9

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5.6 Energy Balance

AREA 119 - FIRE PROTECTION SYSTEM

Input Total MM BTU/HR

See PFD-119-100-1 0

Output Total

See PFD-119-100-1 0

Net - Addition/Subtraction

See PFD-119-100-1 0

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution</u> <u>MM BTU/HR</u>
Heater Subtotal		0
Cooler Subtotal		0
Heat of Reaction Subtotal		0
Compressor Subtotal		0
Heat Losses		<u>0</u>
	TOTAL	0

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5.0 Baseline Process Concept

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5.6 Energy Balance

AREA 120 - FACILITIES

<u>Input Total</u>	<u>MM BTU/HR</u>
See PFD-120-100-1	-15.7
<u>Output Total</u>	
See PFD-120-100-1	-15.7
<u>Net - Addition/Subtraction</u>	
See PFD-120-100-1	0

Services

<u>Item</u>	<u>Item No.</u>	<u>Contribution</u> <u>MM BTU/Hr</u>
Ammonia Vaporizer	120-31007	+ 0.16
Chlorine Vaporizer	120-31006	+ 0.06
Heater Subtotal		+ 0.22
Ammonia Desuperheater	120-31001	
Ammonia Condenser	120-31002	- 0.88
Ammonia Vent Condenser	120-31003	
Light H/C Storage Condensers	120-31004-1,2	- 1.63
Cooler Subtotal		- 2.51
Heat of Reaction Subtotal		0
Compressor Subtotal		0
Heat Gain		+ 2.29
TOTAL		0

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5.7 Reagent Summary

<u>AREA OF USAGE</u>	<u>CHEMICAL OR CATALYST</u>	<u>UNIT</u>	<u>INITIAL CHARGE</u>	<u>ANNUAL USAGE</u>
Area : Oil Recovery 104 and Treatment	Filter Aid (Diatomaceous Earth)	Tons	C *	7,187
	Hydrotreatment Catalyst	Tons	150	600
Area : Gas Puri- 105 fication	Selexol Solvent	Gallons	90,000	19,800
	n. Heptane	Gallons	19,500	136,800
Area : Hydrogen 106 Generation	ZnO Catalyst	Cu. Ft.	15,200	2,535
	Shift Catalyst	Cu. Ft.	7,800	1,560
	Methanation Catalyst	Cu. Ft.	970	970
	K ₂ CO ₃ Solution (30 wt %)	Gallons	75,540	25,180
	Additive No. 1	Gallons	2,700	900
	Additive No. 2	Pounds	4,095	1,365
Area : Shift and 107 Methanation	ZnO Catalyst	Cu. Ft.	18,420	7,000
	Ni-type Catalyst	Cu. Ft.	37,380	17,820
Area : Bulk CO ₂ 108 Removal	Selexol Solvent	Gallons	173,000	7,370

C = Continuous

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5.0 Baseline Process Concept

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5.7 Reagent Summary - continued

<u>AREA OF USAGE</u>	<u>CHEMICAL OR CATALYST</u>	<u>UNIT</u>	<u>INITIAL CHARGE</u>	<u>ANNUAL USAGE</u>
Area : Gas Com- 109 pression and Dehydration	Triethylene Glycol	Pounds	20,800	324,720
Area : SO ₂ Removal 111	Soda Ash	Tons	C *	13,266
	Antioxident	Tons	C	257
	Ethylene Glycol	Gallons	6,000	1,635
	Lime	Tons	C	25
	Refrigerant (R-11)	Gallons	w/Ref. Unit Cost	1,635
Area : Sulfur 112 Recovery	Bauxite Catalyst	Cu. Ft.	5,642	1,880
Area : Ammonia 113 Recovery	45% H ₃ PO ₄	Gallons	C	6,970
	50% NaOH	Barrels	C	204,030
Area : Utilities 115	Betz 35	Tons	C	23
	Betz 65	Tons	C	23
	Betz C-30	Tons	C	3
	Chlorine	Tons	C	172
	Betz Corrogen	Tons	C	3
	Betz Poly-sperce	Tons	C	54
	Betz Hyzeen	Tons	C	1
	Betz NA ₃	Tons	C	21
	Disodium Phosphate	Tons	C	6
	H ₂ SO ₄ (93%)	Tons	C	2,004

C = Continuous

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5.7 Reagent Summary - continued

<u>AREA OF USAGE</u>	<u>CHEMICAL OR CATALYST</u>	<u>UNIT</u>	<u>INITIAL CHARGE</u>	<u>ANNUAL USAGE</u>
Area : Water Supply 116	Chlorine	Tons	C *	44
	Betz 2890	Tons	C	48
Area : Water Treat- 117 ment Systems	Lime	Tons	C	4,537
	Soda Ash	Tons	C	3,354
	H ₂ SO ₄ (93%)	Tons	C	705
	50% NaOH	Barrels	C	1,508
	Betz 2800	Pounds	C	15,840
	Chlorine	Pounds	C	395
Area : Waste Treat- 118 ment and Disposal	100% NH ₃	Tons	C	1,140
	75% H ₃ PO ₄	Gallons	C	118,295
	Lime	Tons	C	614
	Polymer	Tons	C	30

C = Continuous

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5.8 Equipment List

AREA 101 - COAL UNLOADING AND HANDLING

Item 101-34001 - ROM Coal Surge Hopper

No. required	- One (1), Divided into three sections
Type	- Vertical, Rectangular, with 55° minimum Valley Angle
Size (300 Ton Oper. Cap.)	- 10'-0" x 30'-0" x 40'-0" Str. Side with Pyramidal Bottoms, 7'-0" Deep
Product	- ROM Illinois #6 Coal, Density = 53 Lb/Cu. Ft.
Operating conditions:	
Temperature	- 60°F
Pressure	- Atmospheric
Materials of construction	- A/R Carbon Steel with 410 S.S. Wear Plates on Pyramidal Sections

Item 101-34002 - Crushed Coal Surge Hopper

No. required	- One (1) Divided into Two Sections
Type	- Vertical, Rectangular, with 55° Minimum Valley Angle
Size (300 Ton Oper. Cap.)	- 24'-0" x 13'-0" x 40'-0" Str. Side with Pyramidal Bottoms, 8'-0" Deep.
Product	- Crushed Illinois #6 Seam Coal, 1-1/2" x 0", Density = 50 Lb/Cu. Ft.
Operating conditions:	
Temperature	- 60°F
Pressure	- Atmospheric
Materials of construction	- A/R Carbon Steel with 410 S.S. Wear Plates on Pyramidal Sections

Items 101-34003-1,2 - Car Surge Hoppers

No. required	- Two (2)
Type	- Vertical, Rectangular, Tapered Hoppers
Size (300 Ton Oper. Cap. Each)	- 10'-0" x 40'-0" x 20'-0" Str. Side, Pyramidal Bottom, 24'-0" Deep with 7'-0" x 7'-0" Bottom Opening.
Product	- ROM Illinois #6 Coal, S.G. = 0.8 (Bulk)
Operating conditions:	
Temperature	- 60°F
Pressure	- Atmospheric
Materials of construction	- A/R Carbon Steel

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5.8 Equipment List

AREA 101 - COAL UNLOADING AND HANDLING

Item 101-41001-1,2 - Sump Pumps

No. Required	- Two (2)
Type	- Vertical, centrifugal pump w/ motor, coupling, suction strainer, & mounting plate.
Capacity	- 550 GPM of run-off water @ ambient suction conditions, 115 ft. TDH.
Materials of Construction	- Cast Iron
HP	- 30 HP

Item 101-43001 - Emergency Stack-Out Conveyor

No. Required	- One (1)
Type	- Troughed Idler Belt Conveyor w/TEFC Motor, Drive, Frame, idlers, Belt, Automatic Gravity Take-up, Guard and Cover
Capacity	- 1800 TPH of 6" x 0 Ill. No. 6 Coal at 50 lb./ft. ³ . Length/Lift to be 187 ft./59 ft.
Materials of Construction	- Manufacturer's Standard
HP	- 200 HP

Item 101-43002 - ROM Coal Reclaim Conveyor

No. Required	- One (1)
Type	- Troughed Idler Belt Conveyor with Explosion Proof Motor, Drive, Frame, idlers, Belt, Automatic Gravity Take-Up, Cover and Guard
Capacity	- 1800 TPH of 6" x Ill. No. 6 Coal at 50 lb./ft. ³ length/lift to be 220 ft/36 ft.
Materials of Construction	- Manufacturer's Standard
HP	- 100 HP

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5.8 Equipment List

AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-43003 - Stack Out Tower

No. Required	- One (1)
Type	- Concrete, Multi-Window Stackout Tower for Dust Suppression
Capacity	- 1800 TPH of 6" x 0 Ill. No. 6 Coal at 50 lb./ft. ³ . To be 12 ft. dia. x 67 ft. high
Materials of Construction	- Concrete
HP	- None

Item 101-43004 - ROM Belt Scale

Included with Item 101-43022

Item 101-43006-1,2 - Reclaim Coal Feeder

No. Required	- Two (2)
Type	- Fixed Rate Electromechanical Vibratory Feeder with Explosion Proof Motor, Excitor Weights and Isolation Mounts.
Capacity	- 900 TPH of 6" x 0 Ill. No. 6 Coal at 50 lb./ft. ³
Materials of Construction	- Manufacturer's Standard
HP	- 7-1/2 HP

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5.8 Equipment List

AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-43007 - R.O.M. Coal Conveyor

No. Required	- One (1)
Type	- Troughed Idler Belt Conveyor with Explosion Proof Motor, Drive, Frame, Idlers, Belt, Automatic Gravity Take-Up, Cover and Guard.
Capacity	- 1800 TPH of 6" x 0 Ill. No. 6 Coal at 50 lb./ft. ³ . length/lift to be 360 ft./117 ft.
Materials of Construction	- Manufacturer's Standard
HP	- 300 HP

Item 101-43008 - Crushed Coal Conveyor To T-2

No. Required	- One (1)
Type	- Troughed Idler Belt Conveyor with Explosion Proof Motor, Drive, Frame, Idlers, Belt, Automatic Gravity Take-Up, Cover and Guards.
Capacity	- 1800 TPH of 1-1/2" x 0 Ill. No. 6 Coal at 50 lb./ft. ³ . Length is 1890 ft.
Materials of Construction	- Manufacturer's Standard
HP	- 250 HP

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5.8 Equipment List

AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-43009 - Coal Stacker Reclaimer

No. Required	- One (1)
Type	- Bucket Wheel Stacker Reclaimer with Drives, Motors, Siewing and Luffing Capability, Operator's Cab, Electrical House, Traveling Belt Tripper with Bypass Chute, Cable Reel and Controls for Automatic and Manual Operation
Capacity	- 1800 TPH Rated, 1630 TPH Avg. Stacking; 1200 TPH Rated, 1080 TPH Avg. Reclaim of 1-1/2" x 0 111. No. 6 Coal at 50 lb./ft. ³
Materials of Construction	- Manufacturer's Standard
HP	- 300 HP Total

Item 101-43010 - Emergency Reclaim Conveyor No. 1

No. Required	- One (1)
Type	- Troughed Idler Belt Conveyor with Explosion Proof Motor, Drive, Frame, Idlers, Belt, Automatic Gravity Take-Up, Cover and Guard.
Capacity	- 1200 TPH of 1-1/2" x 0 111. No. 6 Coal at 50 lb./ft. ³ Length/lift to be 260 ft./23 ft.
Materials of Construction	- Manufacturer's Standard
HP	- 60 HP

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5.8 Equipment List

AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-43011-1,2 - Emergency Reclaim Conveyor Feeder

No. Required	- Two (2)
Type	- Variable Rate Electromagnetic vibratory feeder w/dust tight enclosures, flexible connections and controls for variable flow
Capacity	- 600 TPH of 1-1/2" x 0 Ill No. 6 coal at 50 lb/ft. ³
Material of construction	- Manufacturer's standard
HP	- 6 HP

Item 101-43012 - Emergency Reclaim Conveyor No. 2

No. Required	- One (1)
Type	- Troughed idler belt conveyor w/explosion proof motor, drive frame, idlers, automatic gravity take-up, cover and guards.
Capacity	- 1200 TPH of 1-1/2" x 0 Ill. No. 6 coal at 50 lb/ft. ³ . Length/Lift to be 115 ft./23
Material of construction	- Manufacturer's standard
HP	- 50 HP

Item 101-43013-1,2 - T-2 Crushed Coal Conveyor

No. required	- Two (2)
Type	- Troughed idler belt conveyor w/explosion proof motor, drive, frame, idlers, automatic gravity take-up, cover and guard.
Capacity	- 1200 TPH of 1-1/2" x 0 Ill No. 6 Coal at 50 lb/ft ³ . Length/Lift to be 460 ft./150 ft.
Material of construction	- Manufacturer's standard
HP	- 250 HP

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5.8 Equipment List

AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-43015-1,2 - Crushed Coal Feeder

No. Required	- Two (2)
Type	- Variable Rate Electromagnetic vibratory feeder, w/dust tight enclosures, flexible connections and controls for variable flow.
Capacity	- 600 TPH of 1-1/2" x 0 Ill. No. 6 coal at 50 lb/ft. ³
Materials of construction	- Manufacturer's standard
HP	- 6 HP

Item 101-43016 - Crushed Coal Weigh Belt

No. Required	- One (1)
Type	- Troughed idler belt conveyor, w/explosion proof motor, drive, frame, idlers, belt, take-up, weigh section consisting of load cells, rate totalizer and belt speed sensor, cover and guard
Capacity	- 1200 TPH of 1-1/2" x 0 Ill. No. 6 coal at 50 lb/ft. ³ . Length is 40 ft.
Material of construction	- Manufacturer's standard
HP	- 10 HP

Item 101-43017 - Coal Dryer Feed Conveyor

No. Required	- One (1)
Type	- Troughed idler belt conveyor w/explosion proof motor, drive, frame, idlers, belt, automatic gravity take-up, cover and guard
Capacity	- 1200 TPH of 1-1/2" x 0 Ill. No. 6 coal at 50 lb/ft. ³ . Length/lift to be 480 FT/20ft.
Material of construction	- Manufacturer's standard
HP	- 75 HP

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5.8 - Equipment List

AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-43018-1,3 - R.O.M. Coal Crusher Feeder

No. Required	- Three (3)
Type	- Variable Rate Electromagnetic vibratory feeder w/dust tight enclosures, flexible connections and controls for variable flow.
Capacity	- 900 TPH of 6" x 0 Ill. No. 6 coal at 50 lb/ft ³ .
Material of construction	- Manufacturer's standard
HP	- 7-1/2 HP

Item 101-43019-1,11 - Coal Slide Gates

No. required	- Eleven (11)
Type	- Chain and Wheel Operated Dust tight slide gate
Capacity	- To pass 900 TPH of 6" x 0 Ill. No. 6 Coal at 50 lb/ft. ³
Material of construction	- A/R Carbon Steel
HP	- None

Item 101-43020 - Dust Suppression System

No. required	- One (1)
Type	- System with piping, spray nozzles, valves, hose, and controls.
Capacity	- 1.2 million gallons/month of water
Material of construction	- Manufacturer's standard
HP	- None

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5.8 Equipment List

AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-43021-1,2 - Coal Feeder

No. Required	- Two (2)
Type	- Fixed rate electromechanical vibratory feeder w/explosion proof motor, excitor weights and isolation mounts.
Capacity	- 900 TPH of 6" x 0 Ill. No. 6 coal at 50 lb/ft. ³
Material of construction	- Manufacturer's standard
HP	- 7-1/2 HP

Item 101-43022 - Coal Conveyor

No. Required	- One (1)
Type	- Troughed idler belt conveyor w/explosion proof motor, drive, frame, idlers, belt, automatic gravity take-up, cover guard and weigh section with totalizer.
Capacity	- 1800 TPH of 6" x 0 Ill. No. 6 coal at 50 lb/ft. ³ . Length/lift to be 225 ft/60 ft.
Material of construction	- Manufacturer's standard
HP	- 7-1/2 HP

Item 101-45001 - R.O.M. Magnetic Separator

No. Required	- One (1)
Type	- Self-Cleaning Type electromagnetic separator w/motor, drive, belt, magnetic section, rollers, guard and mounting assembly.
Capacity	- To clean 1800 TPH of Ill No. 6 Coal at 50 lb/ft. ³ on 42" W. belt. Located Parallel to conveyor at discharge pulley.
Material of construction	- Manufacturer's standard
HP	- 1 HP

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5.8 Equipment List

AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-46001-1,3 - Coal Crusher

No. Required	- Three (3)
Type	- Ring type granulator with motor, drive, guards, bypass chute, and flop gates.
Capacity	- 900 TPH of 6" x 0 feed of Ill. No. 6 coal at 50 lb/ft. ³ on 42" w. belt. Located Parallel to conveyor at discharge pulley.
Material of construction	- Manufacturer's standard
HP	- 500 HP

Item 101-47001 - Dust Collection System, T-1

No. Required	- One (1)
Type	- Bag filter type system w/exhaust fan and motor, bag house, reverse gas cleaning of bags, and controls.
Capacity	- To control dust at transfer points in transfer tower T-1.
Material of construction	- Manufacturer's standard
HP	- Est. 20 HP

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AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-47002 - Dust Collection System-Crusher House

No. required	- One (1)
Type	- Bag Filter Type System w/Exhaust Fan and Motor, Bag House, Reverse Gas Cleaning of Bags and Controls
Capacity	- To Control Dust at Transfer Points and Crusher in Crusher House.
Material of construction	- Manufacturer's Standard
HP	- Est. 20 HP

Item 101-47003 - Dust Collection System T-2

No. required	- One (1)
Type	- Bag Filter Type System w/Exhaust Fan and Motor, Bag House, Reverse Gas Cleaning of Bags and Controls.
Capacity	- To Control Dust at Transfer Points in Transfer Tower T-2
Material of construction	- Manufacturer's Standard
HP	- Est. 20 HP

Item 101-47004 - Dust Collection System - Emergency Reclaim

No. required	- One (1)
Type	- Bag Filter Type System w/Exhaust Fan and Motor, Bag House, Reverse Gas Cleaning of Bags and Controls.
Capacity	- To Control Dust in Emergency Reclaim Tunnel
Material of construction	- Manufacturer's Standard
HP	- Est. 20 HP

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AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-47005 - Dust Collection System T-3

No. Required	- One (1)
Type	- Bag Filter Type System with Exhaust Fan and Motor, Bag House, Reverse Gas Cleaning of Bags and Controls
Capacity	- To Control Dust at Transfer Points in Transfer Tower T-3
Materials of Construction	- Manufacturer's Standard
HP	- Est. 20 HP

Item 101-47006 - Dust Collection System - Coal Feed

No. Required	- One (1)
Type	- Bag Filter Type System with Exhaust Fan and Motor, Bag House, Reverse Gas Cleaning of Bags and Controls
Capacity	- To Control Dust at Transfer Points from Overland Conveyor
Materials of Construction	- Manufacturer's Standard
HP	- Est. 100 HP

Item 101-48001-1,2 - Rotary Car Dumper

No. Required	- Two (2)
Type	- Centerline Rotation Type Rotary Dumper with Car Clamping Mechanism, Car Spotting Control, Motors, Drives, Guards and Controls
Capacity	- Dump One 100 Ton Car in 2 Minutes
Materials of Construction	- Manufacturer's Standard
HP	- Est. 100 HP

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AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-48002 - R.O.M. Coal Sampler

No. Required	- One (1)
Type	- Automatic Sampling System with Chutes, Hoppers, Conveyors, Motors, Process Equipment, and Controls.
Capacity	- Collect 50 lb. Sample from 1800 TPH Ill. No. 6 Coal Flow 50 lb./ft. ³ , 6" x 0 Size
Materials of Construction	- Manufacturer's Standard
HP	- Est. 40 HP

Item 101-48003 - Surge Hopper Sampler

No. Required	- One (1)
Type	- Automatic Sampling System with Chutes, Hoppers, Conveyors, Motors, Process Equipment and Controls
Capacity	- Collect 50 lb. Sample From 1200 TPH Ill. No. 6 Coal Flow 50 lb./ft. ³ , 1-1/2" x 0 Size.
Materials of Construction	- Manufacturer's Standard
HP	- Est. 40 HP

Item 101-48004-1,2 - Car Positioner

No. Required	- Two (2)
Type	- Automatic Winch Type Positioner with Motor, Drive, Base, and Controls
Capacity	- 100 cars @ 100 tons each with 4 locomotives @ rate of 2 mins/car unloading.
Materials of Construction	- Manufacturer's Standard
HP	- 200 HP

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AREA 101 - COAL UNLOADING AND HANDLING - continued

Item 101-49001-1,3 - Dozer

No. Required	- Three (3)
Type	- Crawler Type Diesel Engine Dozer with Coal Blade
Capacity	- 280 HP Diesel Engine
Materials of Construction	- Manufacturer's Standard
HP	- No Electrical

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AREA 102 - COAL PREPARATION

Items 102-31001-1,3 - Inert Gas Precoolers

No. Required	- Three (3)
Type	- Shell and Tube
Surface area	- 1558. SQ.FT. (Ea)
Duty	- 896.MM BTU/HR (Ea)
Operating conditions: (Shell side)	- Gas (70% N ₂ , 18% CO ₂ , 11.9% H ₂ O, 0.01% SO ₂)
Temperature	- 350°F to 120°F
Pressure	- 30.2 PSIG
Operating conditions: (Tube side)	- Cooling Water
Temperature	- 86°F to 110°F
Pressure	- 60. PSIG
Materials of construction	- Shell: Carbon Steel Tube: Carbon Steel
Note:	- Item used only when gas inlet temp. greater than 160°F

Items 102-34001-1,6 - Feed Bins

No. Required	- Six (6) (2 Req'd Per Train)
Type	- Vertical, Cyclindrical, W/45° Cone Bottom
Size (3000.C.F.EA. Oper)	- 10'DIA x 25 ' ST. Side
Product	- Coal, 1 1/2" to 0"
Bulk Density	- 50#/C.F.
Operating condition:	
Temperature	- 120°F
Pressure	- -2"W.C.
Materials of construction	- Carbon Steel with 410 S.S. or A/R STL. Wear Plate on Conical Section.

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AREA 102 - COAL PREPARATION - continued

Items 102-34002-1,6 - Coal Silos

No. Required	- Six (6) (2 Req'd. per Train)
Type	- Vertical, cylindrical, W/45° Cone Bottom
Size (125,000. C.F.EA. oper.)	- 40'DIA. x 90' ST. Side
Product	- Ground Coal
Bulk Density	- 40#/C.F.
Operating conditions:	
Temperature	- 120°F
Pressure	- -2"W.C.
Materials of construction	- Concrete Slip-Formed W/410 S.S. or A/R Steel Liner on Lower Section

Item 102-34003-1,3 - Coal Hopper

No. Required	- Three (3), Divided into Four Sections
Type	- Vertical, Rectangular, Tapered Hoppers
Size (100 Tons Oper. Cap. Each)	- 32'-0" x 8'-0" x 20'-0" Str. Side with Pyramidal Bottoms, 7'-0" Deep
Product	- Ground Illinois #6 Coal, Bulk = 43 Lb./Cu. Ft.
Operating conditions:	
Temperature	- 60°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel with 410 S.S. or A/R Steel Liner on Pyramidal Sections

Items 102-34004-1,3 - Dryer Feed Bins

No. Required	- Three (3)
Type	- Vertical, Cylindrical
Size (250,000 C.F. Each)	- 45' DIA x 150' T/T, W/60° Cone Bottom
Product	- Ground Coal
Bulk Density	- 40#/C.F.
Operating conditions:	
Temperature	- AMB
Pressure	- -2" W.C.
Materials of construction	- Concrete Slip Form with 410 S.S. or A/R Steel Liner on Lower Section

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AREA 102 - COAL PREPARATION - continued

Items 102-35001-1,6 - Surge Hoppers

No. Required	- Six (6)
Type	- Cylindrical, W/Conical Bottom
Size (10,000 C.F. EA. oper)	- 14'DIA. x 72' T/T x 78' Overall
Product	- Ground Coal 100%
Bulk Density	- 43.#/C.F.
Operating conditions:	
Temperature	- 100°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel with A/R Steel Liners on Conical Section

Items 102-35002-1,3 - Inert Gas K.O. Drums

No. Required	- Three (3)
Type	- Vertical, W/Dished Heads
Size (110.C.F. EA.)	- 4'DIA. x 10' T/T
Product	- Water, S.G. - 1.0
Operating conditions:	
Temperature	- 160°F
Pressure	- 20. PSIG
Materials of construction	- 304 Stainless Steel

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AREA 102 - COAL PREPARATION

Items 102-42001-1,3 - Dryer Exhaust Blower

No..Required	- Three (3)
Type	- Centrifugal compressor with motor, drive, inter & after coolers, base, & controls
Capacity	- 117,000 ICFM Design @ 13.7 psia/250°F Max. inlet, 18 psia outlet. 27.7 Avg.MW transport gas w/4.2Grains per solids. K=1.4
Materials of construction	- Carbon Steel
HP	- 2630 BHP

Items 102-42002-1,3 - Vent Blower

No. Required	- Three (3)
Type	- Centrifugal Blower with TEFC motor, coupling, guard, & Base.
Capacity	- 5500 SCFM of Air @ Ambient temp/-0.5 psig inlet, + 0.5 psig outlet
Materials of construction	- Carbon Steel
HP	- 75 HP

Items 102-42003-1,3 - Primary Air Blower

No. Required	- Three (3)
Type	- Centrifugal Blower with motor, coupling, drive, guard, & base
Capacity	- 70,000 ICFM of Air @ 60°F/ Atmospheric Pressure inlet, 2 psig outlet
Materials of construction	- Carbon Steel
HP	- 730 BHP

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AREA 102 - COAL PREPARATION - continued

Items 102-43001-1,3 - Dryer Weigh Belt

No. Required	- Three (3)
Type	- Belt conveyor W/Motor, Drive Belt, Frame, Idlers, weigh section W/Controls, Cover, & Guard
Capacity	- 420TPH of 1 1/2" x 0 Ill #6 Coal @ 50 LB/FT ³ . Length/Lift to be 350 FT/100FT.
Materials of construction	- MFRS Standard
HP	- 75HP

Items 102-43002-1,3 - Belt Conveyor - I

No. Required	- Three (3)
Type	- Troughed idler belt conveyor W/Motor, Drive, Belt, Frame Idlers, screw type take-up Cover, & Guard.
Capacity	- 420 TPH of 1 1/2" x 0 Ill #6 Coal @ 50 LB/FT ³ . Length is 50 FT.
Materials of construction	- MFRS Standard
HP	- 5 HP

Items 102-43003-1,3 - Belt Conveyor - II

No. Required	- Three (3)
Type	- Troughed idler belt conveyor W/motor, drive, belt, frame, idlers, screw type take-up, cover, & guard
Capacity	- 110 T/HR of 1 1/2" x 1/8 Ill#6 Coal @ 50 LB/FT ³ . Length is 50 FT.
Materials of construction	- MFRS Standard
HP	- 5 HP

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AREA 102 - COAL PREPARATION - continued

Items 102-43004-1,3 - Grinder Product Distributor Conveyor

No. Required	- Three (3)
Type	- Troughed idler belt conveyor W/motor, drive, belt, frame idlers, screw type take-up, cover, & guard
Capacity	- 530 TPH of -1 1/2" Ill #6 Coal @ 43 LB/FT ³ . Length is 50 FT.
Materials of construction	- MFRS Standard
HP	- 5 HP

Items 102-43005-1,3 - Pulverized Coal Weigh Belt

No. Required	- Three (3)
Type	- Belt conveyor W/motor, drive frame, idlers, belt, automatic gravity take-up, cover, weigh section W/Rate totalizer & speed sensor, & controls.
Capacity	- 420 TPH of ground Illinois #6 Coal @ 43 LB/FT ³ . Length/ lift to be 400 FT/90FT
Materials of construction	- MFRS Standard
HP	- 75 HP

Items 102-43006-1,3 - Coal Elevator

No. Required	- Three (3)
Type	- Chain mounted bucket elevator W/motor, drive, take-up, feed & discharge sections, & guards
Capacity	- 530 TPH of 1 1/2" x 0 Ill #6 Coal @ 43 LB/FT ³ . Lift is 80 FT.
Materials of construction	- A/R Carbon Steel
HP	- 60 HP

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AREA 102 - COAL PREPARATION - continued

Items 102-43007-1,3 - Pulverized Coal Elevator

No. Required	- Three (3)
Type	- Chain mounted bucket elevator W/motor, drive, take-up, feed & discharge sections, & guards
Capacity	- 420 TPH of ground Ill #6 Coal @ 43 LB/FT ³ . Lift to be 180 FT
Materials of construction	- A/R Carbon Steel
HP	- 100 HP

Items 102-43008-1,3 - Dryer Cyclone Rotary Feeder

No. Required	- Three (3)
Type	- Rotary airlock valve W/motor, drive, seals, vent & purge connections, & guards.
Capacity	- 8500 LB/HR of 40 LB/FT ³ Coal Dust @ 150°F & 0.3 psig
Materials of construction	- A/R Carbon Steel Rotor, Cast iron Housing
HP	- 1/2 HP

Items 102-43009-1,6 - Feed Bin Rotary Feeder

No. Required	- Six (6)
Type	- Rotary airlock valve W/motor, variable speed drive, seals, vent & Purge connections, guard, & controls
Capacity	- 210 TPH of 1 1/2" x 0 Ill #6 Coal @ 50 LB/FT ³ . 130°F
Materials of construction	- Cast Iron
HP	- 20 HP

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AREA 102 - COAL PREPARATION - continued

Items 102-43010-1,6 - Coal Silo Rotary Feeder

No. Required	- Six (6)
Type	- Rotary airlock valve W/motor, variable speed drive, seals, vent & purge connections, guard, & controls.
Capacity	- 210 TPH of - ground Coal @ 43 LB/FT ³ . 130°F
Materials of construction	- Cast Iron
HP	- 20 HP

Items 102-43011-1,3 - Bridge Crane

No. Required	- Three (3)
Type	- Traveling bridge crane W/motor, drives, hoist, operator's cab, guards, & controls.
Capacity	- 25 Tons @ 30FT W/30FT Span
Materials of construction	- MFRS Standard
HP	- 30 HP

Items 102-43012-1,3 - Dryer Furnace Weigh Belt

No. Required	- Three (3)
Type	- Weigh belt conveyor W/motor, drive, frame, idlers, load cells, rate totalizer, speed sensors, guards, & controls
Capacity	- 1800 LB/HR of 50 LB/FT ³ , 1 1/2" x 0 Ill #6 Coal
Materials of construction	- MFRS Standard
HP	- 1 1/2 HP

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AREA 102 - COAL PREPARATION - continued

Items 102-43013-1,3 - Dryer Feeder

No. Required	- Three (3)
Type	- Variable rate electromagnetic vibratory feeder W/dust enclosure, flexible connections, & controls for variable flow.
Capacity	- 440 TPH max. of 1 1/2" x 0 Ill #6 Coal @ 50 LB/FT ³ .
Materials of construction	- Carbon Steel W/ A/R Liner.
HP	- 6 HP

Items 102-43014-1,3 - Dryer Furnace Feeder

No. Required	- Three (3)
Type	- Variable rate electromagnetic vibratory feeder W/ dust enclosure, flexible connections & controls for variable flow.
Capacity	- 1800 LB/HR of 1 1/2" x 0 Ill #6 Coal @ 50 LB/FT ³ .
Materials of construction	- Carbon Steel W/ A/R Liner
HP	- 10 HP

Items 102-43015-1,12 - Coal Hopper Rotary Feeder

No. Required	- Twelve (12)
Type	- Rotary airlock valve W/ motor, variable speed drive, seams, vent & purge connections, & guard.
Capacity	- 97.5 TPH of - ground Ill #6 Coal @ 43 LB/FT ³ .
Materials of construction	- A/R Carbon Steel Rotor, Cast Iron Housing.
HP	- 10 HP

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AREA 102 - COAL PREPARATION - continued

Items 102-43016 - 1, 12 - Pneumatic Conveying System

No. Required	- Twelve (12)
Type	- Dilute phase pneumatic conveying system w/blower, motors, aftercooler, dust collector, cyclone, rotary valves, in-line filters, guards, and controls.
Capacity	- 97.5 TPH of ground Ill #6 Coal @ 43 LB/FT ³ . Length/lift to be 20 FT/150 FT. Conveying gas to be inert gas.
Materials of Construction	- Manufacturer's Standard
HP	- 150 HP

Items 102-43017 - 1, 6 - Lock Hopper Feeding System

No. Required	- Six (6)
Type	- Dense phase lock hopper system W/compressor, motors, aftercooler, dust collector, in-line filter, gas receiver, rotary valves, and controls.
Capacity	- 192.5 TPH - ground Ill #6 Coal @ 43 LB/FT ³ . Length/lift to be 30 FT/175 FT. System must feed against 47 psia back pressure.
Materials of Construction	- Manufacturer's Standard
HP	- 755 BHP

Item 102-43018 - 1, 3 - Grinder Product Conveyor

No. Required	- Three (3)
Type	- Troughed idler belt conveyor with motor, drive, frame, idlers, belt, take-up, guards, and cover.
Capacity	- 420 TPH of ground Ill #6 coal @ 43 LB/FT ³ . Length to be soft.
Materials of Construction	- Manufacturer's Standard
HP	- 5 HP

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AREA 102 - COAL PREPARATION - continued

Items 102-44002-1, 3 - Coal Dryer System

No. Required	- Three (3)
Type	- Fluidized bed dryer with inlet surge hopper, feeders, fluidizing chamber, rotary valves, coal fired furnace, and controls.
Capacity	- 360 TPH MF of 1 1/2" x 0 @ 10% H ₂ O (13% max) Ill #6 Coal @ inlet/3% H ₂ O outlet (130°F) 860°F Flue gas in/150°F out.
Materials of Construction	- Manufacturer's Standard
HP	- None

Items 102-45002 - 1, 6 - Dryer Bag Collector

No. Required	- Six (6)
Type	- Fabric filter type dust collector with bags, housing, bottom hopper, reverse air cleaning, and stands.
Capacity	- 40,000 SCFM of flue gas @ 130°F with 5 grains/SCF dust loading of Coal Fines. 18 psia inlet pressure.
Materials of Construction	- Manufacturer's Standard
HP	- None

Items 102-45003- 1, 3 - Dryer Cyclone

No. Required	- Three (3)
Type	- Cyclone with gas inlet and outlet, dust outlet and Vortex finder
Capacity	- 80,000 SCFM @ 150°F/14 psia with 10 grains/SCF Coal Fines. Gas is flue gas.
Materials of Construction	- Carbon Steel with A/R steel impact plates
HP	- None

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AREA 102 - COAL PREPARATION - continued

Items 102-45004-1,24 - Coal Screens

No. Required	- Twenty-four (24)
Type	- Double deck vibratory screens W/ motors, drives, guards, vibration isolators, springs, & Controls.
Capacity	- 48 TPH (100TPH max.) of 1 1/2" x 0" I11 #6 Coal @ 50 LB/FT ³ .
Materials of construction	- 304 Stainless Steel
HP	- 10 HP

Items 102-45005-1,3 - Vent Dust Collector

No. Required	- Three (3)
Type	- Fabric filter dust collector W/ bags, housing, bottom hopper reverse air cleaning, & stands.
Capacity	- 5500 SCFM of Air @ Ambient temp/14.2psia W/ 1 grain/SCF Coal Fines
Materials of construction	- Carbon Steel
HP	- None

Items 102-46001-1,6 - Coal Grinder

No. Required	- Six (6)
Type	- Hammermill type coal grinder W/ motor, drive, guards, tramp iron hopper, & Bottom screen.
Capacity	- 200 TPH of -1 1/2" I11 #6 Coal at 50 LB/FT ³ , 130°F product.
Materials of construction	- MFRS Standard
HP	- 400 HP

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AREA 102 - COAL PREPARATION - continued

Items 102-46002-1,3 - Dryer Coal Grinder

No. Required	- Three (3)
Type	- Gas swept roller mill W/ Coal inlet, gas inlet, tramp iron hopper, internal class- ifier, motor, drive, & con- trols.
Capacity	- 3.0 TPH of -1 1/2" Ill #6 Coal @ 50 LB/FT ³ to -200 MESH pro- duct. Feed @ 13% moisture max. & 3% out.
Materials of construction	- MFRS Standard
HP	- 45 HP Total

Items 102-47001-1,3 - Dust Control System

No. Required	- Three (3)
Type	- System, W/ Fabric filter dust collector, exhaust fan, & motor.
Capacity	- 5000 SCFM of Air W/Coal Fines.
Materials of construction	- MFRS Standard
HP	- 1 HP

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AREA 103 - PYROLYSIS AND GASIFICATION

<u>Item No.</u>	<u>Equipment Description</u>	<u>Qty Req'd</u>
103-31004	Recycle Venturi Coolers	3
103-33001	First Stage Pyrolyzers	3
103-33002	Second Stage Pyrolyzers	3
103-33003	Third Stage Pyrolyzers	3
103-33004	Fourth Stage Pyrolyzers	3
103-33005	Gasifiers	3
103-33006	Combustor	3
103-34001	Steam Drums	3
103-34002	Combustor Mixing Section	3
103-34009	Pyrolysis Decanters	3
103-35003	Combustor Lift Tubes	3
103-35015,17	Gas-Oil Water Separators	6
103-36001	Oil-Fines Slurry Tanks	3
103-39001	Oil-Fines Slurry Agitator	3
103-41001,2	Circulating Water Pumps	6
103-41003	Quench Water Pumps	6
103-41004	Oil-Fines Slurry Pump	6
103-41005	Recycle Venturi Circulation Pump	6
103-42001	Recycle Gas Compressors	3

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AREA 103 - PYROLYSIS AND GASIFICATION

<u>Item No.</u>	<u>Equipment Description</u>	<u>Qty Req'd</u>
103-44001	Auxiliary Furnace	3
103-45015, n	Pyrolysis Cyclones	-
103-45005,6	Make Gas Cyclone Set	-
103-45007,8	Flue Gas Cyclones	-
103-45011,19	Recycle Gas Venturi Scrubbers	6
103-47001	Solids Removal System	3

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AREA 104 - RECOVERY & TREATMENT

<u>ITEM NO.</u>	<u>EQUIPMENT DESCRIPTION</u>	<u>Q'TY REQ'D</u>
104-31001	Product Gas Aftercoolers	3
104-31002	Compressor Intercoolers	3
104-31003	Recycle Gas Heaters - I	3
104-31004	Debutanizer Feed Heaters - I	3
104-31005	Feed Preheaters	3
104-31006	Recycle Gas Heaters - II	3
104-31008	Debutanizer Feed Heaters - II	3
104-31009	Filtration Feed Effluent Coolers	3
104-31010	Feed/Effluent Exchangers	3
104-31011	Stripper Feed Heaters	3
104-31012	Dehydration Feed Preheaters	3
104-31013	1500 psig BFW Preheaters	3
104-31014	Softened BFW Preheaters	3
104-31015	Recycle Sour Water Coolers	3
104-32001	Debutanizers	3
104-32002	Product Strippers	3
104-33001	1st Stage Ebullating Bed Hydrotreaters	3
104-33002	2nd Stage Ebullating Bed Hydrotreaters	3
104-33003	Fixed Bed Hydrotreaters	3
104-34001	Unfiltered Oil Storage Tanks	6
104-34002	Filter Aid Storage Bin	1
104-35001	Quench Separators I	3
104-35002	Oil Decanters I	3
104-35003	Quench Separators II	3
104-35004	Oil Decanters II	3
104-35005	Quench Separators III	3
104-35006	Oil Decanters III	3
104-35007	Oil Decanters IV	3
104-35008	Product Gas K.O. Drums	3
104-35009	Separators	3
104-35010	Water Knockout Drums	3
104-35011	High Pressure Separators I	3
104-35012	Intermediate Pressure Separators I	3
104-35013	Debutanizer Overhead K.O. Drums	3
104-35014	High Pressure Separators II	3
104-35015	Intermediate Pressure Separators II	3
104-35016	Stripper Overhead Knockout Drums	3
104-35018	Dehydrations Overhead K.O. Drums	3
104-35019	Filtration Knockout Drums	6
104-35020	Catalyst Transfer Vessels	3
104-35022	Filtered Oil Surge Tanks	3
104-36001	Filtration Mixing Tanks	3
104-36002	Filter Feed Surge Tanks	3
104-36003	Oil Dehydrators	3

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AREA 104 - OIL RECOVERY & TREATMENT - continued

<u>ITEM NO.</u>	<u>EQUIPMENT DESCRIPTION</u>	<u>Q'TY REQ'D</u>
104-39001	Filtration Mixing Tank Agitators	3
104-39002	Filter Feed Surge Tank Agitators	3
104-39003	Oil Dehydrator Agitators	3
104-41001	Scrubber Pumps I	6
104-41002	Scrubber Pumps II	6
104-41003	Condensate Pumps	6
104-41004	Hydrotreater Feed Pumps	6
104-41005	First Reactor Pumps	6
104-41006	Second Reactor Pumps	6
104-41007	Debutanizer Bottoms Recycle Pumps	6
104-41008	Debutanizer Reflux Pumps	6
104-41009	Filtration Effluent Pumps	6
104-41010	Sour Water Pumps	6
104-41011	Fixed Bed Feed Pumps	6
104-41012	Stripper Ovhd. Recycle Pumps	6
104-41013	Syncrude Pumps	6
104-41014	Dehydration Recycle Pumps	6
104-41015	Overhead Condensed Oil Pumps	6
104-41016	Oil Transfer Pumps	6
104-41017	Catalyst Make-up Slurry Pumps	6
104-41018	Filter Aid Make-up Pumps	6
104-41019	Filter Feed Pumps	6
104-41020	Filtered Oil Pumps	3
104-42001	Recycle Pyrolysis Gas Compressors I	3
104-42002	1st Stage Make-up Hydrogen Compressors	3
104-42003	2nd Stage Make-up Hydrogen Compressors	3
104-42004	Hydrotreater Recycle Gas Compressors	3
104-42005	Fixed Bed Recycle Gas Compressors	3
104-42006	Hydraulic Letdown Turbines I	3
104-42007	Hydraulic Letdown Turbines II	3
104-42008	Vacuum Pumps	3
104-42009	Recycle Pyrolysis Gas Compressors II	3
104-43001	Filter Aid Feeders	1
104-43002	Filter Cake Conveyor	15
104-44001	Air Cooled Condensers	3
104-44002	Air Fin Coolers I	3
104-44003	Debutanizer Overhead Air Fin Coolers	3
104-44004	Start-up Heaters I	3
104-44005	Filtration Air Fin Trim Coolers	3

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AREA 104 - OIL RECOVERY & TREATMENT - continued

<u>ITEM NO.</u>	<u>EQUIPMENT DESCRIPTION</u>	<u>Q'TY REQ'D</u>
104-44006	Air Fin Coolers II	3
104-44007	Start-up Heaters II	3
104-44008	Stripper Ovhd. Air Fin Coolers	3
104-44009	Product Air Fin Coolers	3
104-44010	Air Cooled Water Condensers	3
104-44011	Filtration Condensers	3
104-44012	Steam Generators	3
104-45001	Venturi Scrubbers I	3
104-45002	Venturi Scrubbers II	3
104-45003	Venturi Scrubbers III	3
104-45004	Vacuum Oil Filters	3
104-45005	Filter Aid Dust Collector	1
104-48001	Blowdown Units	3

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AREA 105 - GAS PURIFICATION

<u>ITEM NO.</u>	<u>EQUIPMENT DESCRIPTION</u>	<u>Q'TY REQ'D</u>
105-31001	Feed/Product Gas Interchangers	3
105-31002	Feed Gas Chillers	3
105-31003	Absorber Chillers	3
105-31004	Lean/Rich Oil Interchangers	3
105-31005	Lean Oil Chillers	3
105-31006	Light Oil Fractionator Reboilers	3
105-31007	Fractionator Overhead Coolers	3
105-31008	Secondary Fractionator Reboiler	1
105-31009	Secondary Fractionator Overhead Condenser	1
105-31010	Solution Interchangers	3
105-31011	Feed Gas Coolers	3
105-31012	Gas/Gas Interchangers	3
105-31014	Selexol Stripper Reboilers	3
105-31015	Light Hydrocarbon Condensers	3
105-32001	Hydrocarbon Absorbers	3
105-32002	Light Oil Fractionators	3
105-32003	Secondary Fractionator	1
105-32004	Acid Gas Absorbers	3
105-32005	Selexol Strippers	3
105-34002	Oil Blowdown Hold Tank	1
105-35001	Hydrocarbon K.O. Drums	3
105-35002	Light Oil K.O. Drums	3
105-35003	Reflux Pump Tank	1
105-35004	Flash Tanks	3
105-35005	K.O. Pots	3
105-41001	Lean Oil Pumps	6
105-41002	Light Oil Fractionator Reflux Pumps	6
105-41003	Secondary Fractionator Feed Pump	1
105-41004	Secondary Fractionator Bottoms Pump	1
105-41006	Secondary Fractionator Reflux Pump	1
105-41007	Lean Solution Pumps	9
105-41008	Stripper Feed Pumps	9
105-41009	Selexol Sump Pumps	3
105-41010	Absorber Pumps	6
105-42001	Hydrocarbon Gas Compressors	3
105-42002	Gas Compressors w/Auxiliaries	12
105-42003	Recycle Gas Compressors w/Aftercoolers	3
105-43001	40/5 T Bridge Cranes	3
105-43002	5 T Bridge Cranes	3
105-44001	Hydrocarbon Removal Refrigeration Units	3
105-44002	Lean Solution Chillers	3
105-44003	Stripper Ovhd. Condensers	3
105-48001	Hydraulic Expansion Turbines	3

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AREA 106 - HYDROGEN GENERATION

<u>ITEM NO.,</u>	<u>EQUIPMENT DESCRIPTION</u>	<u>Q'TY REQ'D</u>
106-31001	No. 1 Converter Exchanger	1
106-31003	No. 2 Converter Exchanger	1
106-31005	Carbonate Regenerator Reboiler	1
106-31006	Methanator Exchanger	1
106-31007	Methanator Start-up Heater	1
106-31008	Trim Cooler	1
106-32001	Desulfurizers	2
106-32002	No. 1 Shift Converter	1
106-32003	No. 2 Shift Converter	1
106-32004	No. 3 Shift Converter	1
106-32005	Condensate Stripper	1
106-32006	Carbonate Regenerator	1
106-32007	CO2 Absorber	1
106-32008	Methanator	1
106-35001	Condensate Separators	2
106-35002	Regenerator Ovhd. Accumulator	1
106-35003	Methanated Gas Knock-out Drum	1
106-41001	Stripper Condensate Pumps	2
106-41002	Lean Solution Circulation Pumps	3
106-41003	Regenerator Reflux Pumps	2
106-44001	Start-up Heater	1
106-44003	Regenerator Overhead Cooler	1
106-44004	Methanated Gas Cooler	1
106-44005	Lean Solution Cooler	1
106-44006	No. 2 Converter Waste Heat Boiler	1
106-44007	No. 3 Converter Waste Heat Boiler	1
106-48001	Power Recovery Units	2
106-48002	No. 2 WHB Blowdown Unit	1
106-48003	No. 3 WHB Blowdown Unit	1

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AREA 107 - SHIFT AND METHANATION

<u>ITEM NO.</u>	<u>EQUIPMENT DESCRIPTION</u>	<u>Q'TY REQ'D</u>
107-31001	No. 1 Methanator Steam Generators	3
107-31002	No. 2 Methanator Steam Generators	3
107-31003	No. 3 Methanator Steam Generators	3
107-31004	No. 4 Methanator BFW Heaters	3
107-31005	No. 5 Methanator Steam Generators	3
107-31006	No. 6 Methanator Steam Generators	3
107-31007	Feed/Product Interchangers	3
107-31008	No. 5 Methanator BFW Heaters	3
107-31009	Final Methanator Interchangers	3
107-31010	Final Methanator Feed Heaters	3
107-32001	No. 1 Methanators	3
107-32002	No. 2 Methanators	3
107-32003	No. 3 Methanators	3
107-32004	No. 4 Methanators	3
107-32005	No. 5 Methanators	3
107-32006	No. 6 Methanators	3
107-32007	Final Methanators	3
107-32008	Final Desulfurizers	6
107-35001	Methanator Gas K.O. Pots	3
107-35002	Methanator Steam Drums	3
107-35003	Final Methanation K.O. Pots	3
107-41001	Steam Generator Circul. Pumps	6
107-44001	No. 1 Methanator Feed Heaters	3
107-44002	Methanator Gas Air Coolers	3
107-44003	Final Methanator Air Coolers	3
107-44004	Final Desulfurizer Heaters	3
107-44005	Final Methanator Start-up Heaters	3
107-48001	Methanation Boiler Blowdown Units	3

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AREA 108 - Bulk CO₂ Removal

<u>ITEM NO.</u>	<u>EQUIPMENT DESCRIPTION</u>	<u>Q'TY REQ'D</u>
108-31001	Gas/Gas Interchangers	3
108-31002	Feed Gas Coolers	3
108-32001	CO ₂ Absorbers	3
108-32002	Selexol Regenerators	3
108-35001	Primary Flash Tanks	3
108-35002	Secondary Flash Tanks	3
108-41001	Lean Solution Pumps	9
108-41002	Selexol Sump Pumps	3
108-41003	Stripper Feed Pumps	9
108-42001	Air Blowers w/Filters	3
108-42002	Recycle Gas Compressors w/Aftercoolers	3
108-42003	Carbon Dioxide Compressor	2
108-44001	Rich Solution Chillers	3
108-48001	Primary Hyd. Expansion Turbines	3
108-48002	Secondary Hyd. Expansion Turbines	3
108-48003	Solution Drying Units	3

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AREA 109 - GAS COMPRESSION AND DEHYDRATION

Item 109-31001 - Lean Glycol Cooler

No. required	- One (1)
Type	- Shell and Tube
Surface area	- 275 Ft. ²
Duty	- 422,000 BTU/HR
Operating conditions:	- Tower Water
(Shell side)	
Temperature	- 85°F to 110°F
Pressure	- 50 PSIG
Operating conditions:	- Triethylene Glycol
(Tube side)	S.G. = 1.13
Temperature	- 150°F to 100°F
Pressure	- 1075 PSIG
Materials of construction	- Shell: Carbon Steel
	Tubes: Carbon Steel

Item 109-31002 - Lean/Rich Glycol Interchanger

No. required	- One (1)
Type	- Shell and Tube
Surface area	- 890 Ft. ²
Duty	- 2,206,000 BTU/HR
Operating conditions:	- Triethylene Glycol
(Shell side)	S.G. = 1.13
Temperature	- 100°F to 347°F
Pressure	- 1040 PSIG
Operating conditions:	- Triethylene Glycol
(Tube side)	S.G. = 1.13
Temperature	- 400°F to 150°F
Pressure	- 1065 PSIG
Materials of Construction	- Shell: Carbon Steel
	Tubes: Carbon Steel

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AREA 109 - GAS COMPRESSION AND DEHYDRATION - continued

Item 109-31003 - Regeneration Column Reboiler

No. required	- One (1)
Type	- Kettle Type
Surface area	- 200 Ft. ²
Duty	- 940,000 BTU/HR
Operating conditions:	- Triethylene Glycol
(Shell side)	S.G. = 1.13
Temperature	- 400°F
Pressure	- 2 PSIG
Operating conditions:	- Steam
(Tube side)	
Temperature	- 489°F
Pressure	- 600 PSIG
Materials of construction	- Shell: Carbon Steel
	Tubes: Carbon Steel

Item 109-31004 - Pipeline Gas Cooler

No. required	- One (1)
Type	- Shell and Tube
Surface area	- 27,400 Ft. ²
Duty	- 14 MM BTU/HR
Operating conditions:	- Tower Water
(Shell side)	
Temperature	- 85°F to 110°F
Pressure	- 50 PSIG
Operating conditions:	- Pipeline Gas
(Tube side)	
Temperature	- 150°F to 100°F
Pressure	- 1050
Materials of construction	- Shell: Carbon Steel
	Tubes: Carbon Steel

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AREA 109 - GAS COMPRESSION AND DEHYDRATION - continued

Item 109-32001 - Dehydration Column

No. required	- One (1)
Type	- Absorption Column, Vertical, Dished Heads
Size	- 10'-0" Dia. x 25'-0" TL/TL
Operating conditions:	
Temperature	- 80°F to 120°F
Pressure	- 1050 PSIG
Operating capacity	-
Products:	
Vapor	- Synthetic Pipeline Gas
Liquid	- Triethylene Glycol
S.G.	- 1.13
Tray Description	- Bubble Cap Trays
Tray Height	- Trays Equally Spaced
Materials of construction	- Carbon Steel
Remarks	- Gas flow rate = 468,409 lb/hr Liquid circulation rate=25 GPM

Item 109-32002 - Regeneration Column

No. required	- One (1)
Type	- Packed Column, Vertical, Dished Heads
Size	- 2'-0" Dia. x 25'-0" TL/TL
Operating Conditions:	
Temperature	- 400°F
Pressure	- Atmospheric
Operating capacity	-
Products:	
Vapor	- Water
Liquid	- Triethylene Glycol
S.G.	- 1.13
Materials of Construction	- Carbon Steel
Remarks	- Vapor flow = 425 lb/hr Liquid flow = 25 GPM

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AREA 109 - GAS COMPRESSION AND DEHYDRATION - continued

Item 109-35001 - Rich Glycol Flash Drum

No. required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 2'-0" Dia. x 5'-0" TL/TL
Product	- Triethylene Glycol S.G. = 1.13
Operating conditions:	
Temperature	- 100°F
Pressure	- 50 PSIG
Materials of construction	- Carbon Steel

Item 109-35002 - Reflux Drum

No. required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 2'-0" Dia. x 3'-0" TL/TL
Product	- Water
Operating conditions:	
Temperature	- 150°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

Item 109-35003 - Dehydration Column K.O. Pot

No. required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 9'-0" Dia. x 10'-0" TL/TL
Product	- Synthetic Pipeline Gas
Operating conditions:	
Temperature	- 100°F
Pressure	- 1050 PSIG
Materials of construction	- Carbon Steel

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AREA 109 - GAS COMPRESSION AND DEHYDRATION - continued

Item 109-35004 - Pipeline Compressor K.O. Pot

No. required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 12'-0" Dia. x 10'-0" TL/TL
Product	- Synthetic Pipeline Gas

Operating conditions:

Temperature	- 100°F
Pressure	- 250 PSIG
Materials of construction	- Carbon Steel

Item 109-35005 - Glycol Storage Tank

No. required	- One (1)
Type	- Vertical, Cylindrical, Flat Bottom, Dome Roof
Size	- 11'-0" Dia. x 11'-0" STR. Side
Product	- Triethylene Glycol S.G. = 1.13

Operating conditions:

Temperature	- 50°F to 100°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

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AREA 109 - GAS COMPRESSION & DEHYDRATION - continued

Item 109-41001-1,2 - Lean Glycol Pump

No. Required	- Two (2)
Type	- Reciprocating pump with TEFC motor to handle triethylene glycol
Capacity	- 25 GPM @ 2243' TDH (2 psig. suction, 1070 psig discharge).
Materials of Construction	- Carbon Steel
HP	- 40

Item 109-41002-1,2 Reflux Pump

No. Required	- Two (2)
Type	- Metering pump with TEFC motor to handle water
Capacity	- 19 GPH @ 53' TDH
Materials of Construction	- Carbon Steel
HP	- 1/4

Item 109-41003-1,2 - Glycol Transfer Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle triethylene glycol
Capacity	- 25 GPM @ 101' TDH
Materials of Construction	- Carbon Steel
HP	- 2

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AREA 109 - GAS COMPRESSION & DEHYDRATION - continued

Item 109-42001-1,3 - Pipeline Compressor

No. Required	- Three (3)
Type	- Horizontal centrifugal compressor with steam turbine gear box, inter-cooler, and after cooler to handle 125°F synthetic pipeline gas
Capacity	- 90,000 SCFM synthetic pipeline gas from 230 psig to 1070 psig Steam available @ 1500 psig, 850°F
Materials of Construction	- Manufacturer's standard
HP	- 14,000 BHP.

Item 109-43001 - Bridge Crane

No. Required	- One (1)
Type	- Traveling bridge crane with motor, drive, hoist, operator's cab, guard, and controls
Capacity	- 30 ton @ 30ft. lift with 30 ft. span
Materials of Construction	- Manufacturer's standard
HP	- 35

Item 109-44001 - Regeneration Column Condenser

No. Required	- One (1)
Type	- Air-cooled heat exchanger to be complete fan, drive, and TEFC motor to cool steam and condensate.
Capacity	- 425 lb./HR steam and condensate to cool from 212°F to 150°F. 438,400 BTU/HR.
Materials of Construction	- Carbon Steel
HP	- 1/2

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AREA 109 - GAS COMPRESSION & DEHYDRATION - continued

Item 109-44002 - Compressor After-Cooler

No. Required	- One (1)
Type	- Air-cooled heat exchanger to be complete with fan, drive, and TEFC motor. Unit to cool 1050 psig pipeline gas
Capacity	- 469,000 lb./HR pipeline gas cooled from 236°F to 150°F 22.5 MM BTU/HR.
Materials of Construction	- Carbon steel tube, manufacturer's standard for exterior
HP	- 5

Item 109-48001 - Rich Glycol Filter

No. Required	- One (1)
Type	- Cartridge type filter to remove solid in triethylene glycol
Capacity	- 28 GPM triethylene glycol at 50 psig, 100°F; viscosity: 48 centipoise @ 68°F
Materials of Construction	- Carbon steel, manufacturer's standard material for the filtration element.

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AREA 110 - FLUE GAS POWER RECOVERY

<u>ITEM NO.</u>	<u>EQUIPMENT DESCRIPTION</u>	<u>Q'TY REQ'D</u>
110-31001	H. P. BFW Preheaters	9
110-35003	Separator Slurry Tanks	6
110-42002	Air Compressors/expander/generator	6
110-43001	Bridge Cranes	3
110-44001	Flue Gas Oxidizers	3
110-44002	600 psig Waste Heat Boilers	3
110-45002	Tertiary Separators	6
110-45003	Separator Cyclones	6
110-48001	Flue Gas Oxidizer Blowdown Units	3
110-48002	Flue Gas Oxidizer Power Generators	3
110-48004	600 psig W.H. Boiler Blowdown Units	6
110-48006	Separator Eductors	6

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AREA 111 - SO₂ REMOVAL

<u>ITEM NO.</u>	<u>EQUIPMENT DESCRIPTION</u>	<u>Q'TY REQ'D</u>
111-31001	Flue Gas Reheaters	6
111-31002	Evaporator-Crystallizer Heaters	3
111-31003	SO ₂ Regen. Evaporator-Crystallizers	3
111-31004	Primary Condensers	3
111-31005	Secondary Condensers	3
111-31006	Chiller-Crystallizer Tank Coil	3
111-31007	Feed Coolers	3
111-31008	Rotary Dryers	3
111-32001	SO ₂ Strippers	3
111-32002	SO ₂ Absorbers	6
111-32002	SO ₂ Absorber Demisters	60
111-35002	SO ₂ Absorber Surge Tanks	3
111-35003	Glycol Tanks	3
111-35004	Centrate Tanks	3
111-35005	Recycle Bins	3
111-35006	Product Bins	3
111-36001	Venturi Surge Tanks	6
111-36002	Dissolving Tanks	3
111-36003	Soda Ash Mix Tanks	3
111-36004	Chiller-Crystallizer Tanks	3
111-39001	Venturi Surge Tank Agitators	6
111-39002	Dissolving Tank Agitators	3
111-39003	Soda Ash Mixing Tank Agitators	3
111-39004	Chiller-Crystallizer Tank Agitators	3
111-41001	Venturi Recycle Pumps	15
111-41002	Sludge Pumps	9
111-41003	1st Stage Absorber Recycle Pumps	12
111-41004	2nd Stage Absorber Recycle Pumps	6
111-41005	3rd Stage Absorber Recycle Pumps	6
111-41006	SO ₂ Absorber Feed Pumps	6
111-41007	Soda Ash Feed Pumps	6
111-41008	Evaporator-Crystallizer Cir. Pumps	6
111-41009	Venturi Make-up Water Pumps	6
111-41010	Glycol Pumps	6
111-41011	SO ₂ Absorber Surge Tank Pumps	6
111-41012	Chiller Crystallizer Pumps	6
111-41013	Centrate Pumps	6
111-42001	SO ₂ Compressors	3
111-43005	Centrifuge Conveyors	3
111-43006	Recycle Conveyors	3

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AREA 111 - SO₂ REMOVAL - continued

<u>ITEM NO.</u>	<u>EQUIPMENT DESCRIPTION</u>	<u>Q'TY REQ'D</u>
111-43007	Dryer Conveyors	3
111-43008	Bucket Elevators	3
111-43009	Recycle Bin Vibrator Feeder	3
111-43010	Dust Conveyors I	3
111-43011	Dust Conveyor II	3
111-43012	Product Bin Loading Conveyor	3
111-43013	Product Bin Vibrator	6
111-44001	Desuperheaters	3
111-44002	Refrigeration Units	3
111-44003	Steam/Air Heaters	3
111-45001	Centrifuges	3
111-47001	Venturi Scrubbers	6
111-47002	Flue Gas ID Fans	6
111-47004	Dust Collection Sys. Exhaust Fans	3
111-47005	Dust Collection Systems	3
111-48001	Flue Gas Exhaust Stack	3
111-48002	Recycle Bin Weigh-Feeders	3

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AREA 112 - SULFUR RECOVERY

Item 112-35001 - Sulfur Bin

No. required	- One (1)
Type	- Vertical, Cylindrical, Cone Roof, Conical Bottom
Size	- 26'-0" Dia. x 67'-0" Str. Side with 45° Cone Bott.
Product	- Sulfur Flakes Density = 60 Lb/Ft. ³
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Aluminum with External Carbon Steel Reinforcing

Item 112-43001 - Sulfur Storage Conveyor

No. Required	- One (1)
Type	- Troughed idler belt conveyor with TEFC motor, drive, idlers, belt, frame, automatic gravity take-up, cover, and guards
Capacity	- 40 TPH of 60 lb./ft. ³ sulfur flakes. Length/lift to be 500 ft./150 ft.
Materials of Construction	- Rubber belt, carbon steel
HP	- 30 HP

Item 112-43002 - Sulfur Reclaimer

No. Required	- One (1)
Type	- Front end loader with diesel engine drive and material handling bucket
Capacity	- 60 TPH of 60 lb./ft. ³ flaked sulfur
Materials of Construction	- Mfr's standard
HP	- None (Electrical)

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AREA 112 - SULFUR RECOVERY - continued

Item 112-43003 - Reclaimed Sulfur Conveyor

No. Required	- One (1)
Type	- Troughed idler belt conveyor with TEFC motor, drive, idlers, belt, frame, automatic gravity take-up, cover, and guards
Capacity	- 60 TPH of 60 lb./ft. ³ flaked sulfur. Length of 200 ft.
HP	- 7 1/2 HP

Item 112-43004 - Sulfur Elevator

No. Required	- One (1)
Type	- Chain mounted bucket elevator with TEFC motor, drive, take-up, frame, and guards
Capacity	- 60 TPH of 60 lb./ft. ³ sulfur flakes. 100 ft. discharge ht.
Materials of Construction	- Mfr's standard
HP	- 20 HP

Item 112-44001 - Tail Gas Incinerator Unit

No. Required	- One (1)
Type	- Fuel oil fired incinerator with fuel oil burners, waste heat boiler section, boiler feed water pumps and motors, combustion air fans and motors, and flame safety controls.
Capacity	- 2.83 MM SCFH of 1% H ₂ S, 0.5% SO ₂ , 30.7% CO ₂ , 41.8% H ₂ O, 25.3% N ₂ , 0.14% COS, 0.14% CS ₂ , 0.34% S @ 300°F inlet/17 psia. To generate 50 psig sat. steam
Materials of Construction	- Mfr's standard
	- 75 HP

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AREA 112 - SULFUR RECOVERY - continued

Item 112-44002 - Water Chiller

No. Required	- One (1)
Type	- Open type centrifugal water chiller with TEFC motor, centrifugal compressor, lube system, automatic purge system, condenser and cooler sections, and controls.
Capacity	- 297 Tr Chilling 1979 GPM of water from 71°F to 65°F
Materials of Construction	- Mfr's standard
HP	- 300 HP

Item 112-46001 - Sulfur Flaker

No. Required	- One (1)
Type	- Double drum flaker with steam heater, motors, variable speed drive, adjustable drum and knife, dust tight enclosures, and controls.
Capacity	- 1030 tons/day of sulfur @ 275°F inlet. Chilled water available @ 65°F in/ 71° f out and 50 psia sat. steam available
Materials of Construction	- Mfr's standard
HP	- 100 HP total

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AREA 112 - SULFUR RECOVERY - continued

Item 112-47001 - Claus Plant

No. Required	- One (1)
Type	- Claus plant to burn H_2S to SO_2 and chemically react SO_2 to recover molten elemental sulfur. Plant shall include burner, combustion air fan and motor, controls, reactors, waste heat boilers, sulfur condensers, vessels, heat exchangers, pumps, and motors.
Capacity	- 2000 moles/HR total of H_2S and 577 Moles/Hr of SO_2 from 3 feed streams to be converted to 1030 TPD of sulfur. 600 psia sat. and 50 psig sat. steam shall be produced.
Materials of Construction	- Mfr's standard
HP	- Est. 200 HP total

Item 112-48001 - Tail Gas Blowdown Unit

No. Required	- One (1)
Type	- System with flash tank, mixing tee, vent valve, cooling water thermostat and control valve, and controls.
Capacity	- 4000 lb./HR of 50 psig, 298°F water to be cooled to 200°F by 85°F cooling water. Flash steam to be vented to atmosphere
Materials of Construction	- Carbon Steel
HP	- None

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AREA 112 - SULFUR RECOVERY - continued

Item 112-48002 - Waste Heat Boiler Blowdown Unit

No. Required	- One (1)
Type	- System with flash tank, cooling water thermostat and control valve, heat exchanger section, and controls.
Capacity	- 3500 lb./ HR of 600 psig/ 489°F water inlet. Steam to be flashed off @ 50 psig Remaining water to be cooled to 200°F
Materials of Construction	- Carbon Steel
HP	- None

Item 112-48003 - Sulfur Condenser Blowdown Unit

No. Required	- One (1)
Type	- System with flash tank, mixing tee, vent valve, cooling water thermostat and control valve, and controls.
Capacity	- 8500 lb./HR of 50 psig 298°F water to be cooled to 200°F vented to atmosphere
Materials of Construction	- Carbon Steel
HP	- None

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AREA 113 - AMMONIA RECOVERY

Item 113-31001 - Lean Solution Cooler

No. Required	- One (1)
Type	- Shell & Tube
Surface Area	- 2209 FT ²
Duty	- 32.55MM BTU/HR
Fluids:	
Shell Side	- Cooling Water
Tube Side	- Lean Phosphate Solution
Materials of construction	- Shell: Carbon Steel
	- Tube: 304 Stainless Steel

Item 113-31002 - No. 1 Stripper Condenser

No. Required	- One (1)
Type	- Shell & Tube
Surface area	- 3269 FT ²
Duty	- 16.8MM BTU/HR
Fluids:	
Shell side	- Rich Phosphate Solution
Operating Conditions:	
Tube side	- Aqua Ammonia Vapor
Materials of construction	- Shell: 304 Stainless Steel
	- Tube: 304 Stainless Steel

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AREA 113 - AMMONIA RECOVERY - continued

Item 113-31003 - No. 2 Stripper Condenser

No. Required	- One (1)
Type	- Shell & Tube, Vertical
Surface area	- 745 FT ²
Duty	- 13.5MM BTU/HR
Fluids:	
Shell Side	- Cooling Water
Tube Side	- Aqua Ammonia
Materials of construction	- Shell: Carbon Steel
	Tube: 304 Stainless Steel

Item 113-31004 - Ammonia Condenser

No. Required	- One (1)
Type	- Shell & Tube
Surface Area	- 1508 FT ²
Duty	- 8,201,403 BTU/HR
Fluids:	
Shell Side	- Anhydrous Ammonia
Tube Side	- Cooling Water
Materials of construction	- Shell: Carbon Steel
	Tube: Carbon Steel

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AREA 113 - AMMONIA RECOVERY - continued

Item 113-31005 - Acid Gas Condenser

No. Required	- One (1)
Type	- Shell & Tube, Vertical
Surface area	- 1004 FT ²
Duty	- 1,962,126 BTU/HR
Fluids:	
Shell Side	- Cooling Water
Tube Side	- Humid Acid Gas
Materials of construction	- Shell: Carbon Steel
	Tube: 316 Stainless Steel

Item 113-31006 - Solution Interchanger

No. required	- One (1)
Type	- Shell & Tube
Surface area	- 74 FT ²
Duty	- 885,780 BTU/HR
Fluids:	
Shell Side	- Rich Solution
Tube Side	- Lean Solution
Materials of Construction	- Shell: 304 Stainless Steel
	Tube: 304 Stainless Steel

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5.8 Equipment List

AREA 113 - AMMONIA RECOVERY - continued

Item 113-31007 - Stripper Reboiler

No. Required	- One (1)
Type	- Shell & Tube, Vertical Thermosiphon
Surface area	- 712 FT ²
Duty	- 26,595,378 BTU/HR
Fluids:	
Shell Side	- Steam
Tube Side	- Lean Solution
Materials of construction	- Shell: Carbon Steel Tubes: 304 Stainless Steel

Item 113-31008 - Fractionator Reboiler

No. Required	- One (1)
Type	- Shell & Tube, Vertical, Thermosiphon
Surface area	- 592 FT ²
Duty	- 10,039,788 BTU/HR
Fluids:	
Shell Side	- Steam
Tube Side	- Water (Fractionator Bottom Fluid)
Materials of construction	- Shell: Carbon Steel Tube: 304 Stainless Steel

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AREA 113 - AMMONIA RECOVERY - continued

Item 113-32001-1,2 - Sour Water Strippers

No. Required	- Two (2)
Type	- Bubble Cap Stripping Tower, Vertical, Dished Heads
Size	- 14'-0" DIA. x 50'-0" TL/TL
Products:	
Vapor	- Gas Mixture of Ammonia, Acid gas, and Steam
Liquid	- Water with some oil
S.G.	
Tray Description	- Bubble Caps
Tray Height	- 22 Trays @ 2'0" spacing
Materials of construction	- Carbon Steel - 304 Stainless Steel Clad

Item 113-32002 - Ammonia Removal Scrubber

No. Required	- One (1)
Type	- Trayed Absorber, Vertical, Dished Heads
Size	- 4'-8" Dia. x 35'-0" TL/TL
Products:	
Vapor	- Acid Gas Saturated with Steam
Liquid	- Ammonia Phosphate Solution
S.G.	- 1.17
Tray Description	- Dual Flow Bubble Cap
Number Trays	- Five (5)
Materials of Construction	- 304-L Stainless Steel

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AREA 113 - AMMONIA RECOVERY - continued

Item 113-32003 - Ammonia Removal Stripper

No. Required	- One (1)
Type	- Valve Tray Stripping Tower, Vertical, Dished Heads
Size	- 5'3"Dia. x 60'-0" TL/TL
Products:	
Vapor	- Aqua Ammonia
Liquid	- Lean Phosphate Solution
S.G.	- 1.17
Tray Description	- Valve Trays
No. Trays	- 30
Materials of construction	- 304 Stainless Steel

Item 113-32004 - Ammonia Fractionator

No. Required	- One (1)
Type	- Trayed Distillation Tower, Vertical, Dished Heads
Size	- 2'8" Dia. x 60'-0" TL/TL
Products:	
Vapor	- Anhydrous Ammonia
Liquid	- Water
S.G.	- 1.0
Tray Description	- Dual Flow Bubble Cap
No. Trays	- 40
Materials of Construction	- 304 Stainless Steel

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AREA 113 - AMMONIA RECOVERY - continued

Item 113-35001 - Fractionator Feed Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 6'-0" Dia. x 21'-0" TL/TL
Product	- Aqua Ammonia, S.G. = .77
Materials of construction	- 304 Stainless Steel
Remarks:	- Complete with 2'-0" Dia. x 6'-0" High Baffled Fill Tube

Item 113-35002 - Ammonia Receiver

No. Required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 2'6" Dia. x 5'-0" TL/TL
Product	- Anhydrous Ammonia Condensate S.G. = .578
Materials of construction	- Carbon Steel

Item 113-35003 - Condensate Flash Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 3'-0" Dia. x 15'-0" TL/TL
Product	- Steam/Condensate
Materials of Construction	- Carbon Steel

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AREA 113 - AMMONIA RECOVERY - continued

Item 113-35004 - 50% Caustic Surge Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Conical Top, Flat Bottom
Size	- 10'-0"DIA. x 16'-0" STR. Side
S.G.	- 1.52
Operating conditions:	
(Shell)	- 50% Caustic
Temperature	- 86°F
Pressure	- Atmospheric
Operating conditions:	
(Coil)	- Steam
Temperature	- 250°F
Pressure	- 50 PSIG
Materials of construction	- Shell: Carbon Steel
	- Coil: Nickel

Item 113-35005 - Acid Gas KO. Drum

No. Required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads, Demister
Size	- 2'-0"DIA. x 8'-0" TL/TL
Product	- Water with NH ₃ and H ₂ S
	- S.G. = 1.0
Materials of construction	- 316 Stainless Steel

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AREA 113 - AMMONIA RECOVERY

Item 113-41001-1,3 - Sour Water Stripper Bottoms Pump

No. Required	- Three (3)
Type	- Horizontal centrifugal AVS type pump with motor, coupling, packing, and base.
Capacity	- 996 GPM of water with oil at 70 Ft. TDH, 0.95 S. G.
Materials of Construction	- Cast Iron
HP	- 30 HP

Item 113-41003 - Phosphoric Acid Addition Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with motor, coupling, seal, and base.
Capacity	- 10 GPM of 75% phosphoric acid at 30 ft. TDH, 1.58 S. G., 23 centipoise.
Materials of Construction	- 316 Stainless Steel
HP	- 2 HP

Item 113-41004-1,2 - Acid Gas Condensate Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal AVS type pump with motor, coupling, seal, and base.
Capacity	- 40 GPM of sour water @ 110 ft. TDH, 1.0 S. G.
Materials of Construction	- 304 Stainless Steel
HP	- 5 HP

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AREA 113 - AMMONIA RECOVERY - continued

Item 113-41005-1,2 - Scrubber Bottoms Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal AVS type pump with motor, coupling, seal and base.
Capacity	- 435 GPM of Ammonium phosphate solution @ 510 ft. TDH, 1.24 S.G.
Materials of Construction	- 304 Stainless Steel
HP	- 200 HP

Item 113-41006-1,2 - Fractionator Feed Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal, AVS type pump with motor, coupling, seal, and base.
Capacity	- 82 GPM of Aqua Ammonia @ 395 ft. TDH, 0.77 S.G.
Materials of Construction	- 304 Stainless Steel
HP	- 10 HP

Item 113-41007-1,2 - Ammonia Product/Reflux Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal AVS type pump with motor, coupling, seal and base.
Capacity	- 69 GPM of anhydrous ammonia @ 285 ft. TDH, 0.58 S.G.
Materials of Construction	- 304 Stainless Steel impeller carbon steel case
HP	- 25 HP

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AREA 113 - AMMONIA RECOVERY - continued

Item 113-41008 - Caustic Injection Pump

No. Required	- One (1)
Type	- Diaphragm metering pump with motor, drive, and base
Capacity	- 10 GPH of 50% caustic @ 250 psig discharge, 1.52 S.G.
Materials of Construction	- 316 Stainless steel diaphragm, carbon steel case
HP	- 1/2 HP

Item 113-41009 - Caustic Supply Pump

No. Required	- One (1)
Type	- Horizontal centrifugal AVS pump with motor, coupling, seal, and base
Capacity	- 23 GPM of 50% caustic @ 76 ft. TDH, 1.52 S.G.
Materials of Construction	- 316 Stainless steel impeller, carbon steel case
HP	- 3 HP

Item 113-41010-1,2 - Scrubber Circulating Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal AVS pump with motor, coupling, seal, and base.
Capacity	- 435 GPM of phosphate solution @ 38 ft. TDH, 1.23 S.G.
Materials of Construction	- 304 Stainless Steel
HP	- 7 1/2 HP

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AREA 114 - THERMAL OXIDIZER, AND FLARE

Item 114-34002 - Flare Knockout Drum

No. Required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 25'-0" DIA. x 50'-0" TL/TL
Product	- Hydrocarbons and Water S.G. = 0.80 to 1.0
Operating conditions:	
Temperature	- 800°F
Pressure	- 50 PSIG MAX.
Materials of construction	- 1/2% Chrome-Steel (No Corr. All.) or C. Steel W/1/8" Corr. All.

Items 114-35001-1,3 - Incinerator Feed Tanks

No. Required	- Three (3)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 12'-0" DIA. x 26'-0" TL/TL
Product	- 50 percent water, 50 percent oil S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- 120°F
Pressure	- 20 PSIG
Materials of construction	- Carbon Steel (1/16" Corr. All.)

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AREA 114 - THERMAL OXIDIZER & FLARE

Items 114-41001-1, 4 - Incinerator Feed Pump

No. Required	- Four (4)
Type	- Horizontal centrifugal API type pump with TEFC motor to handle 50% water and 50% oil at 120°F
Capacity	- 100 GPM @ 21' TDH
Materials of construction	- Carbon Steel
HP/RPM	- 1/1750

Items 114-41002-1,2 - Flare Knock-Out Drum Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal API type pump with TEFC motor to handle 150°F light hydrocarbon
Capacity	- 100 GPM @ 274' TDH
Materials of construction	- Carbon steel
HP/RPM	- 20/3600

Items 114-41003-1,2 - Flare Water Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal API type pump with TEFC motor to handle 150°F oily water.
Capacity	- 100 GPM @ 220' TDH
Materials of construction	- Carbon steel
HP/RPM	- 15/3500

Items 114-44001-1,3 - Thermal Oxidizer

No. Required	- Three (3)
Type	- Direct combustion thermal oxidizer for burning the plant waste. Synthetic gas of 950 BTU/SCF for auxiliary fuel.
Capacity	- 100 GPM @ 20 psig
Materials of construction	- Manufacturer's standard

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AREA 114 - THERMAL OXIDIZER & FLARE - continued

Items 114-44002 - Flare

No. Required	- One (1)
Type	- Self-supporting type smokeless flare for the combustions of unwanted gas and liquid material either at regular operation or at emergency.
Capacity	- Size to be 7'-0 Diameter, Flare tip, 180'-0 Height
Materials of construction	- Manufacturer's standard

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5.8 - Equipment List

AREA 115 - UTILITIES

Items 115-31001-1,4 - Instrument Air Aftercoolers and Separators

No. required	- Four (4)
Type	- Shell and Tube, Horizontal
Surface area	- 270 Ft. ² Each
Duty	- 841,800 BTU/HR Each
Operating conditions:	- Cooling Water
(Shell side)	
Temperature	- 85°F to 110°F
Pressure	- 60 PSIG
Operating conditions:	- Compressed Air
(Tube side)	
Temperature	- 291°F to 100°F
Pressure	- 100 PSIG
Materials of construction	- Shell: Carbon Steel
	Tubes: Carbon Steel - A-214
Remarks	- Includes Separator Section to Disentrain Condensed Water.
	Separator Section - 2'-0" Dia. x 6'-0" Str. Side with Mesh.

Items 115-31002-1,3 - Plant Air Aftercoolers and Separators

No. required	- Three (3)
Type	- Shell and Tube, Horizontal
Surface area	- 270 Ft. ² Each
Duty	- 841,800 BTU/HR Each
Operating conditions:	- Cooling Water
(Shell side)	
Temperature	- 85°F to 110°F
Pressure	- 60 PSIG
Operating conditions:	- Compressed Air
(Tube side)	
Temperature	- 291°F to 100°F
Pressure	- 100 PSIG
Materials of construction	- Shell: Carbon Steel
	Tubes: Carbon Steel - A-214
Remarks:	- Includes Separator Section to Disentrain Condensed Water.
	Separator Section - 2'-0" Dia. x 6'-0" Str. Side with Mesh.

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5.8 Equipment List

AREA 115 - UTILITIES - continued

Items 115-31006-1,6 - Inert Gas Trim Coolers

No. required	- Six (6)
Type	- Shell and Tube, Horizontal
Surface area	- 12,442 Ft. ² Each
Duty	- 1,223,800 BTU/HR Each
Operating conditions:	- Cooling Water
(Shell side)	
Temperature	- 85°F to 110°F
Pressure	- 60 PSIG
Operating conditions:	- Inert Gas
(Tube side)	
Temperature	- 150°F to 100°F
Pressure	- 100 PSIG
Materials of construction	- Shell: Carbon Steel
	Tubes: Carbon Steel

Item 115-31007 - Demineralized BFW Interchanger

No. required	- One (1)
Type	- Shell and Tube, Horizontal
Surface area	- 1713 Ft. ²
Duty	- 26.9 MM BTU/HR
Operating conditions:	- Demineralized Turbine
(Shell side)	Condensate
Temperature	- 154°F to 164°F
Pressure	- 50 PSIG MAX.
Operating conditions:	- Steam Condensate
(Tube side)	
Temperature	- 298°F to 195°F
Pressure	- 60 PSIG
Materials of construction	- Shell: 304 ST. STL.
	Tubes: 304 ST. STL.

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AREA 115 - UTILITIES - continued

Items 115 - 31008-1,6 - Inert Gas Compressor Trim Intercoolers

No. required	- Six (6)
Type	- Shell and Tube, Horizontal
Surface area	- 12,442 Ft. ² Each
Duty	- 1,223,800 BTU/HR Each
Operating conditions:	- Cooling Water
(Shell side)	
Temperature	- 85°F to 110°F
Pressure	- 60 PSIG
Operating conditions:	- Inert Gas
(Tube side)	
Temperature	- 150°F to 100°F
Pressure	- 45 PSIG
Materials of construction	- Shell: Carbon Steel
	Tubes: Carbon Steel

Item 115-31009 - Turbine Condensate Heater

No. required	- One (1)
Type	- Shell & Tube, Horizontal
Surface area	- 4904 FT ²
Duty	- 81.4 MM BTU/HR
Operating conditions	- Turbine Condensate
(Shell side)	
Temperature	- 125°F to 154°F
Pressure	- 50 PSIG MAX.
Operating conditions:	- Demineralized Water
(Tube side)	
Temperature	- 251°F to 195°F
Pressure	- 50 PSIG
Materials of construction	- Shell: Carbon Steel
	Tubes: 304 ST. STL.

Item 115-34001 - Condensate Flash Tank

No. required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 13'-0" Dia. x 10'-0" TL/TL
Product	- Steam Condensate
Operating conditions:	
Temperature	- 320°F
Pressure	- 75 PSIG
Materials of construction	- Carbon Steel

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AREA 115 - UTILITIES - continued

Item 115-34003 - Demineralized Water Storage Tank

No. required	- One (1)
Type	- Vertical, Cylindrical, Flat Bottom, Conical Roof
Size	- 25'-0" Dia. x 22'-0" Str. Side
Product	- Demineralized Water
	S.G. = 1.0
Operating conditions:	
Temperature	- 124°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel with 304 ST.STL. Cladding, or FRP

Item 115-34004 - Area 110 Deaerator Vessel

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 20'-0" Dia. x 44'-0" TL/TL
Product	- BFW
	S.G. ≈ 1.0
Operating conditions:	
Temperature	- 228°F
Pressure	- 5 PSIG
Materials of construction	- Carbon Steel - Epoxy Coated Interior
Remarks	- Deaerator Specified in Mechanical Equipment List.

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5.8 - Equipment List

AREA 115 - UTILITIES - continued

Item 115-34006 - Auxiliary Boiler Deaerator Vessel

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 16'-0" Dia. x 31'-0" TL/TL
Product	- Demineralized BFW S.G. $\approx$.95
Operating conditions:	
Temperature	- 228°F
Pressure	- 5 PSIG
Materials of construction	- Carbon Steel - Epoxy Coated Interior
Remarks	- Deaerator specified in Mechanical Equipment List.

Item 115-34008 - Soft Condensate Receiver

No. required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 14'-0" Dia. x 24'-0" TL/TL
Product	- Soft Water S.G. = 1.0
Operating conditions:	
Temperature	- 200°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

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AREA 115 - UTILITIES - continued

Item 115-34009 - Area 103 Deaerator Vessel

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 14'-0" Dia. x 25'-0" TL/TL
Product	- BFW
	SG = 1.0
Operating conditions:	
Temperature	- 228°F
Pressure	- 5 PSIG
Materials of construction	- Carbon Steel - Epoxy Coated Interior
Remarks	- Deaerator specified in Mechanical Equipment List.

Item 115-34014 - Auxiliary Boiler Coal Storage Bin

No. required	- One (1)
Type	- Vertical, Cylindrical, Conical Top, Cone Bottom
Size	- 20'-0" Dia. x 21'-0" Str. Side with approx. 6'-0" Deep Cone
Product	- Coal
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel
Remarks	- Vibrator specified in Mechanical Equipment List

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AREA 115 - UTILITIES - continued

Item 115-34015 - Area 107 Deaerator Vessel

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 20'-0" Dia. x 39'-0" TL/TL
Product	- BFW
	- S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- 228°F
Pressure	- 5 PSIG
Materials of construction	- Carbon Steel - Epoxy Coated Interior
Remarks	- Deaerator specified in Mechanical Equipment List.

Item 115-34017 - Inert Gas Receiver

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 23'-6" Dia. x 40'-0" TL/TL
Product	- Inert Gas
Operating conditions:	
Temperature	- 100°F
Pressure	- 100 PSIG
Materials of construction	- Carbon Steel

Items 115-35001-1,4 - Instrument Air Receivers

No. required	- Four (4)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 10'0" Dia. x 13'-0" TL/TL
Product	- Compressed Air
Operating conditions:	
Temperature	- 100°F
Pressure	- 100 PSIG
Materials of construction	- Carbon Steel

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No. required	- Three (3)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 5'-0" Dia. x 8'-0" TL/TL
Product	- Compressed Air
Operating conditions:	
Temperature	- 100°F
Pressure	- 100 PSIG
Materials of construction	- Carbon Steel

Item 115-35006 - Cooling Tower Emergency Fuel Tank

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 12'-0" Dia. x 30'-0" TL/TL
Product	- Diesel Fuel
	S.G. $\approx$ 0.9
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

Item 115-35007 - 1500 PSIG Deaerator Vessel

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 12'-0" Dia. x 23'-0" TL/TL
Product	- BFW
	S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- 228°F
Pressure	- 5 PSIG
Materials of construction	- Carbon Steel - Epoxy Coated Interior
Remarks	- Deaerator specified in Mechanical Equipment List

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AREA 115 - UTILITIES - continued

Item 115-35008 - Area 104 Deaerator Vessel

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 5'-0" Dia. x 10'-0" TL/TL
Product	- BFW S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- 228°F
Pressure	- 5 PSIG
Materials of construction	- Carbon Steel - Epoxy Coated Interior
Remarks	- Deaerator specified in Mechanical Equipment List

Item 115-35009 - Area 106 Deaerator Vessel

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 10'-0" Dia. x 22'-0" TL/TL
Product	- BFW S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- 228°F
Pressure	- 5 PSIG
Materials of construction	- Carbon Steel - Epoxy Coated Interior
Remarks	- Deaerator specified in Mechanical Equipment List.

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AREA 115 - UTILITIES - continued

Item 115-35010 - 600 PSIG Deaerator Vessel

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 9'-0" Dia. x 20'-0" TL/TL
Product	- BFW S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- 228°F
Pressure	- 5 PSIG
Materials of construction	- Carbon Steel - Epoxy Coated Interior
Remarks	- Deaerator specified in Mechanical Equipment List.

Item 115-35011 - Area 112 Deaerator Vessel

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 8'-0" Dia. x 19'-0" TL/TL
Product	- BFW S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- 228°F
Pressure	- 5 PSIG
Materials of construction	- Carbon Steel - Epoxy Coated Interior
Remarks	- Deaerator specified in Mechanical Equipment List

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AREA 115 - UTILITIES - continued

Items 115-35012-1,3 - Area 105 Condensate Return Tanks

No. required	- Three (3)
Type	- Horizontal, cylindrical, dished heads
Size	- 7'-0" Dia. x 10'-0" TL/TL
Product	- Demineralized Condensate S.G.=1.0
Operating conditions:	
Temperature	- 125°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel, Polypropylene Lined

Item 115-35013 - Area 115 Condensate Return Tank

No. required	- One (1)
Type	- Horizontal, cylindrical, dished heads
Size	- 10'-0" Dia. x 20'-0" TL/TL
Product	- Demineralized Condensate S.G.=1.0
Operating conditions:	
Temperature	- 125°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel, Polypropylene Lined

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AREA 115 - UTILITIES

Item 115-41001-1,2 - Area 107 BFW Turbine Pump

No. Required	- Two (2)
Type	- Turbine Driven Horizontal Centrifugal Pump to Handle 228°F Boiler Feed Water
Capacity	- 2625 GPM at 4243' TDH (5 psig Suction, 1750 psig Discharge)
Material of Construction	- Carbon Steel
HP/RPM	- 4500/3600

Item 115-41002-1,2 - Area 110 BFW Turbine Pump

No. Required	- Two (2)
Type	- Turbine Driven Horizontal Centrifugal Pump to Handle 228°F Boiler Feed Water
Capacity	- 2960 GPM at 4243' TDH (5 psig Suction, 1750 psig Discharge)
Material of Construction	- Carbon Steel
HP/RPM	- 4500/3600

Item 115-41003 - 1500 PSIG BFW Turbine Pump

No. Required	- One (1)
Type	- Turbine Driven Horizontal Centrifugal Pump to Handle 228°F Boiler Feed Water
Capacity	- 1130 GPM at 4243' TDH (5 psig Suction, 1750 psig Discharge)
Material of Construction	- Carbon Steel
HP/RPM	- 1250/3600

Item 115-41005 - Area 107 BFW Pump

No. Required	- One (1)
Type	- Horizontal Centrifugal Pump to Handle 228°F Boiler Feed Water
Capacity	- 2625 GPM at 4243' TDH (5 psig Suction, 1750 psig Discharge)
Material of Construction	- Carbon Steel
HP/RPM	- 4500/3600

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AREA 115 - UTILITIES - continued

Item 115-41006 - Area 110 BFW Pump

No. Required	- One (1)
Type	- Horizontal Centrifugal Pump with TEFC Motor to Handle 228°F Boiler Feed Water
Capacity	- 2960 GPM at 4243' TDH (5 psig Suction, 1750 psig Discharge)
Material of Construction	- Carbon Steel
HP/RPM	- 4500/3600

Item 115-41007 - 1500 PSIG BFW Pump

No. Required	- One (1)
Type	- Horizontal Centrifugal Pump with TEFC Motor to Handle 228°F Boiler Feed Water
Capacity	- 1130 GPM at 4243' TDH (5 psig Suction, 1750 psig Discharge)
Material of Construction	- Carbon Steel
HP/RPM	- 1750/3600

Item 115-41008-1, 10 - Main Hot Well Pump

No. Required	- Ten (10)
Type	- Vertical Turbine Type Pump with TEFC Motor to Handle 110°F Cooled Water
Capacity	- 41935 GPM at 92' TDH
Material of Construction	- Cast Iron Casing; Cast Iron or Ni-Resist Moving Parts
HP	- 1500 hp

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AREA 115 - UTILITIES - continued

Item 115-41009 - Emergency Hot Well Pump

No. Required	- One (1)
Type	- Vertical Turbine Type Pump w/ Diesel Engine Drive.
Capacity	- 50,000 GPM of 110°F Water, 92 ft. TDH
Material of Construction	- Cast Iron Casing, Cast Iron or Ni-Resist Moving Parts

Item 115-41010-1, 9 - Main Cold Well Pump

No. Required	- Nine (9)
Type	- Vertical Turbine Type Pump with TEFC Motor to Handle 85°F Cooled Water
Capacity	- 46600 GPM at 139' TDH
Material of Construction	- Cast Iron
HP	- 2500 hp

Item 115-41011 - Emergency Cold Well Pump

No. Required	- One (1)
Type	- Vertical Turbine Type Pump w/ Diesel Engine Drive.
Capacity	- 50,000 GPM of Water at 85°F/0 psig Suction, 139 Ft. TDH
Material of Construction	- Cast Iron

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AREA 115 - UTILITIES - continued

Item 115-41012 - Auxiliary Boiler BFW Pump

No. Required	- One (1)
Type	- Multi-Stage, Horizontal, Centrifugal Pump w/Motor, Drive and Base.
Capacity	- 2350 GPM of Boiler Feed Water at 228°F/5 psig Suction, 4250 ft. TDH, 0.95 spgr
Material of Construction	- Cast Iron
HP	- 3300 hp

Item 115-41015-1,2 - Demineralized Condensate Feed Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle 164°F Demineralized Water.
Capacity	- 6180 GPM at 116' TDH
Material of Construction	- 304 SS
HP/RPM	- 250/1180

Item 115-41016-1,2 - Soft Condensate Receiver Pump

No. Required	- Two (2)
Type	- Horizontal, Centrifugal Pump with TEFC Motor to handle 200°F Soft Water
Capacity	- 2440 GPM at 116' TDH
Material of Construction	- Carbon Steel Casing, Ni Resistor. Cast Iron moving parts.
HP/RPM	- 100/1780

Item 115-41017 - Area 103 BFW Turbine Pump

No. Required	- One (1)
Type	- Turbine Driven Horizontal Centrifugal Pump to handle 228°F Boiler Feed Water
Capacity	- 1660 GPM at 1812' TDH (5 psig Suction, 750 psig Discharge)
Material of Construction	- Carbon Steel
HP/RPM	- 1250/3600

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AREA 115 - UTILITIES - continued

Item 115-41022 - Area 103 BFW Pump

No. Required	- One (1)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle 228°F BFW
Capacity	- 1660 GPM at 1812' TDH (5 psig Suction, 750 psig Discharge)
Material of Construction	- Carbon Steel
HP/RPM	- 1250/3600

Item 115-41023-1,2 - Area 104 BFW Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle 228°F BFW
Capacity	- 85 GPM at 170' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 10/3500

Item 115-41024-1,2 - Area 106 BFW Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle 228°F BFW
Capacity	- 750 GPM at 170' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 50/3500

Item 115-41029-1,2 - 600 PSIG BFW Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle 228°F BFW
Capacity	- 560 GPM at 1812' TDH (5 psig Suction, 750 psig Discharge)
Material of Construction	- Carbon Steel
HP/RPM	- 400/3600

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5.8 - Equipment List

AREA 115 - UTILITIES - continued

Item 115-41030-1,2 - Area 112 PSIG BFW Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle 228°F BFW
Capacity	- 315 GPM at 170' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 30/3500

Item 115-41031-1,2 - Area 112 600 PSIG BFW Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal Pump with TEFC Motor to Handle 228°F BFW
Capacity	- 70 GPM at 1812' TDH (5 psig Suction, 750 psig Discharge)
Material of Construction	- Carbon Steel
HP/RPM	- 40/1750

Item 115-41032-1,6 - Area 105 Condensate Transfer Pump

No. Required	- Six (6)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle Demineralized Condensate
Capacity	- 955 GPM at 46' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 25/1780

Item 115-41033-1,6 - Area 105 Condensate Return Pump

No. Required	- Six (6)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle Demineralized Condensate
Capacity	- 955 GPM at 116' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 40/1780

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AREA 115 - UTILITIES - continued

Item 115-41034-1,2 - Area 115 Condensate Transfer Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle Demineralized Condensate.
Capacity	- 2220 GPM at 46' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 60/1780

Item 115-41035-1, 2 - Area 115 Condensate Return Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle Demineralized Condensate.
Capacity	- 2220 GPM at 116' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 100/1780

Item 115-42001-1, 4 - Instrument Air Compressor

No. Required	- Four (4)
Type	- Centrifugal Compressor w/Motor, Drive, Inlet Filter/Silencer, After- cooler, Lube Oil System, Base and Controls.
Capacity	- 4000 SCFM of Air at ambient condi- tions on suction, 100 psig discharge
Material of Construction	- Manufacturer's Standard
HP	- 1000 hp

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AREA 115 - UTILITIES - continued

Item 115-42002-1, 3 - Plant Air Compressor

No. Required	- Three (3)
Type	- Centrifugal Compressor w/Motor, Drive, Inlet Filter/Silencer, Aftercooler, Lube Oil System, Base, and Controls.
Capacity	- 4000 SCFM of Air at ambient conditions on suction, 100 PSIG discharge.
Material of Construction	- Manufacturer's Standard
HP	- 1000

Item 115-42003-1,2 - Inert Gas Compressor

No. Required	- Two (2)
Type	- Multi-Stage, Centrifugal Compressor, w/Synchronous Motor, Driver, Inter and Aftercoolers, Lube and Seal Oil Systems, Base and Controls.
Capacity	- 78,500 ICFM of Inert Gas (MW = 30.1) at 100°F/-2 PSIG Suction, 105 PSIG discharge, K = 1.387
Material of Construction	- Manufacturer's Standard
HP	- 15,500 BHP

Item 115-43001 - Area 115 Bridge Crane

No. Required	- One (1)
Type	- Traveling Bridge Crane w/Motors, Drives, Dual Hoists, Operator's Cab, Guard and Controls.
Capacity	- 50 Ton w/5 Ton Auxiliary, 30 Ft. Lift, 30 Ft. Span
Material of Construction	- Manufacturer's Standard
HP	- 40 HP Total

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AREA 115 - UTILITIES - continued

Item 115-43002 - Auxiliary Boiler Pulverizer Feeder

Included with 115-44001

Item 115-43003 - Auxiliary Boiler Ash Conveyor

No. Required	- One (1)
Type	- Troughed Idler Belt Conveyor w/ TEFC Motor, Drive, Idlers, Auto- matic Gravity Take-ups, Cover, Frame, Belt and Guards.
Capacity	- 10 TPH of 43 Lb/Ft ³ Ash. Length/ Lift to be 2800 Ft/20 Ft Temp. to be under 200°F
Material of Construction	- Manufacturer's Standard
HP	- 7-1/2 HP

Item 115-44001 - Auxiliary Boiler c/w Auxiliaries

No. Required	- One (1)
Type	- Pulverized Coal Fired Boiler w/ ID and FD Fans, Feeders, Pulver- izers, Superheater, Economizers, Motors, Drives, Safety Devices, Controls and Field Erection.
Capacity	- MAX. 1.1 MM Lb/HR of 1500 PSIG/ 850°F Steam Burning Coal at 11,133 BTU/Lb (as Received)
Material of Construction	- Manufacturer's Standard
HP	- 5060 BHP

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AREA 115 - UTILITIES - continued

Item 115-44002 - Cooling Tower

No. Required	- One (1)
Type	- Multi-Tower, Multi-Cell, Cross Flow, Induced Draft, Field Erected Cooling Tower w/Fans, Motors, Drift Eliminators and Polypropylene Fill.
Capacity	- 420,000 GPM at 110°F Inlet/85°F Outlet, 79°F Wet Bulb
Material of Construction	- Manufacturer's Standard
HP	- 9040 BHP Total

Item 115-44003 - Refrigeration System

No. Required	- One (1)
Type	- Evaporative Refrigeration System w/Compressor, Motor, Drive, Cooler and Condenser Sections, Expansion Nozzles and Controls.
Capacity	- 136 TR Cooling Freon to Minus 10°F
Material of Construction	- Manufacturer's Standard
HP	- 275 BHP

Item 115-44004-1,2 - Inert Gas Cooler

No. Required	- Two (2)
Type	- Air Cooled Heat Exchanger w/Fan, Motor and Heat Exchanger Section.
Capacity	- 11.7 Avg. MM BTU/HR Cooling 309,182 Lb/HR of Inert Gas from 309°F to 150°F at 100 PSIG
Material of Construction	- Carbon Steel
HP	- 30 HP

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AREA 115 - UTILITIES - continued

Item 115-44007 - Power Generation Boiler

No. Required	- One (1)
Type	- Fuel Oil Fired Boiler w/Burners, F.D. and I.D. Fans, Motors, Drives, Economizer, Superheater Section, Safety Devices and Controls.
Capacity	- 510,000 Lb/HR of 1500 PSIG/850°F Steam Burning Fuel Oil containing 30% Wt. Filter Aid and other solids.
Material of Construction	- Manufacturer's Standard
HP	- 1660 BHP Total

Item 115-44008-1,2 - Inert Gas Compressor Intercooler

No. Required	- Two (2)
Type	- Air Cooled Heat Exchanger w/Fan, Motor and Heat Exchanger Section.
Capacity	- 14.2 Avg. MM BTU/HR Cooling 309,182 Lb/HR of Inert Gas from 344°F to 150°F at 45 PSIG
Material of Construction	- Carbon Steel
HP	- 30 HP

Item 115-45001-1, 4 - Instrument Air Filter

Included with 115-42001-1, 4

Item 115-45002-1,3 - Plant Air Filter

Included with 115-42002-1, 3

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AREA 115 - UTILITIES - continued

Item 115-45003 - Auxiliary Boiler ESP

No. Required	- One (1)
Type	- Electrostatic Precipitator w/Transformer, Rectifier, Electrical Distribution and Collection Systems, Discharge and Collector Electrodes, Bottom Hoppers w/ Screw Conveyor, Motor and Drive.
Capacity	- 715,000 ACFM of Flue Gas at 350°F w/4.68 Grain/SCF Fly Ash
Material of Construction	- Carbon Steel
HP	- 865 KVA

Item 115-45004 - Power Generation Boiler ESP

No. Required	- One (1)
Type	- Electrostatic Precipitator w/Transformer, Rectifier, Electrical Distribution and Collection Systems, Discharge and Collector Electrodes, Bottom Hoppers w/ Screw Conveyor, Motor and Drive.
Capacity	- 276,000 ACFM at 300°F of Flue Gas w/1.7 Grains/SCF Flyash
Material of Construction	- Carbon Steel
HP	- 535 KVA

Item 115-45005 - Side Stream Filter

No. Required	- One (1)
Type	- Tubular Strainer to Remove Solids from a Side Stream from the Cooling Tower.
Capacity	- Est. 20,200 GPM Max. at 65 PSIG/85°F of Cooling Water. To limit Solids Concentration to 150 MG/L on Flow of 404,410 GPM.
Material of Construction	- Manufacturer's Standard
HP	- None

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AREA 115 - UTILITIES - continued

Item 115-46001 - Auxiliary Boiler Coal Pulverizer

Included with 115-44001

Item 115-47001-1,2 - Area 103 Condensate Return Unit

No. Required	- Two (2)
Type and Description	- Condensate Return Unit to be complete with Receiver, Pumps, Motors and Controls. Unit to deliver Condensate from Steam Turbine Discharge to Deaerator.
Capacity	- 50 GPM
Material of Construction	- Manufacturer's Standard
HP/RPM	- None

Item 115-47003 - Hydrazine Preparation

No. Required	- One (1)
Type	- Packaged Chemical Feed System w/Tank, Agitator, Motors, Metering Pump, Stand and Controls.
Capacity	- 100 Gal. Tank. To feed 7 pounds/day of Hydrazine.
Material of Construction	- 316 St. Stl. Wetted Parts, Carbon Steel Others.
HP	- 1/2 HP

Item 115-47004 - Disodium Phosphate Preparation

No. Required	- One (1)
Type	- Packaged Chemical Feed System w/Tank, Agitator, Motors, Metering Pump, Stand and Controls.
Capacity	- 100 Gal. Tank to Feed 26 Lb/Day of Disodium Phosphate.
Material of Construction	- 304 or 316 St. Stl. Wetted Parts, Carbon Steel Others.
HP	- 1/2 HP

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AREA 115 - UTILITIES - continued

Item 115-47005 - Dispersant and Neutralizing Preparation

No. Required	- One (1)
Type	- Packaged Chemical Feed System w/Tank, Agitator, Motors, Metering Pump, Stand and Controls.
Capacity	- 200 Gal. Tank. To Feed 256 Lb/Day of Dispersant and 128 Lb/Day of Neutralizing Agent.
Material of Construction	- 304 or 316 St. Stl. Wetted Parts, Carbon Steel Others.
HP	- 1/2 HP

Item 115-47006 - Area 112 Deaerator

No. Required	- One (1)
Type	- Spray Type Deaerator w/Level Control Valves, Gauges, Relief Valve, Vacuum Breaker and Vent Valve. Storage Section by others (115-35011).
Capacity	- 171,051 Lb/HR of Softened Water and Condensate at 200°F. To operate at 5 PSIG/228PF w/50 PSIG Steam Available.
Material of Construction	- Stainless Steel Internals, Carbon Steel others.
HP	- None

Item 115-47007 - Soft Water Sulfite Preparation

No. Required	- One (1)
Type	- Packaged Chemical Feed System w/Tank, Agitator, Motors, Metering Pump, Stand and Controls.
Capacity	- 100 Gal. Tank. To Feed 14 Lb/Day of Sulfite Addition
Material of Construction	- Carbon Steel
HP	- 1/2 HP

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AREA 115 - UTILITIES - continued

Area 115-47008 - Soft Water Phosphate Preparation

No. Required	- One (1)
Type	- Packaged Chemical Feed System w/Tank, Agitator, Motors, Meter- ing Pump, Stand and Controls.
Capacity	- 100 Gal. Tank. To Feed 11 Lb/Day of Phosphate Addition.
Material of Construction	- 304 or 316 St. Stl. Wetted Parts, Carbon Steel others.
HP	- 1/2 HP

Item 115-47009 - Soft Water Dispersant Preparation

No. Required	- One (1)
Type	- Packaged Chemical Feed System w/Tank, Agitator, Motors, Meter- ing Pump, Stand and Controls.
Capacity	- 150 Gal. Tank. To Feed 72 Lb/Day of Dispersant Addition.
Material of Construction	- 304 or 316 St. Stl. Wetted Parts, Carbon Steel others.
HP	- 1/2 HP

Item 115-47010 - Cooling Tower Hypochlorite Preparation

No. Required	- One (1)
Type	- Packaged Chemical Feed System w/Tank, Agitator, Motors, Meter- ing Pump, Stand and Controls.
Capacity	- 200 Gal. Tank to Feed 2426 # CL/ Batch, 3 Times/Week
Material of Construction	- PVC Lined Tank (or FRP), Rubber Coated Carbon Steel Agitator, Durichlor 51 or Titanium Pump.
HP	- 1 HP

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AREA 115 - UTILITIES - continued

Item 115-47011-1, 4 - Instrument Air Dryer

No. Required	- Four (4)
Type	- Dual Tower Dessicant Type Air Dryer w/Electric Regeneration, 8 Hr. Cycle, Pre- and After Filters, Trap, Blower, Motor and Controls.
Capacity	- 4000 SCFM at 100°F/100 PSIG in, Minus 40°F Dewpoint Out.
Material of Construction	- Manufacturer's Standard
HP	- 260 BHP Total

Item 115-47012 - Emergency Power Generator

No. Required	- One (1)
Type	- Fuel Oil Fired Gas Turbine-Generator w/Burners, Turbine, Drive, Generator, Static Excitation System, Start-up Fuel Tank and Controls.
Capacity	- 15,000 KW at 13,800 Volt, 3 Phase, 60 Cycle Burning No. 2 Fuel Oil
Material of Construction	- Manufacturer's Standard
HP	- None

Item 115-47013 - Cooling Tower Acid Preparation

No. Required	- One (1)
Type	- Packaged Chemical Feed System w/Tank, Agitator, Motors, Metering Pump, Stand and Controls.
Capacity	- 200 Gal. Tank. To Feed 12,144 Lb/Day of Acid.
Material of Construction	- PVC Lined Tank, Rubber Covered Agitator, Alloy 20 or Durcon Pump.
HP	- 1 HP

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AREA 115 - UTILITIES - continued

Item 115-47014 - Cooling Tower Additive Preparation

No. Required	- One (1)
Type	- Packaged Chemical Feed System w/Tank, Agitator, Motors, Metering Pump, Stand and Controls.
Capacity	- 200 Gal. Tank. To Feed 138 Lb/Day Each of Inhibitor, Inhibitor #2 and Dispersant.
Material of Construction	- 304 St. Stl. Wetted Parts, Carbon Steel Others.
HP	- 1/2 HP

Item 115-47015-1, 3 - Plant Air Dryer

No. Required	- Three (3)
Type	- Dual Tower, Dessicant Type Air Dryer w/Electric Regeneration, 8 HR Cycle, Pre- and After Filters, Trap, Blower, Motor and Controls.
Capacity	- 4000 SCFM at 100°F/100 PSIG in, Minus 40°F Dewpoint Out.
Material of Construction	- Manufacturer's Standard
HP	- 260 BHP Total

Item 115-47016-1, 26 - Inert Gas Generator

No. Required	- Twenty six (26)
Type	- Inert Gas Generator Unit w/Burners, Combustion Chamber, Combustion Air Blower, Motor, Economizer Section, and Controls.
Capacity	- 4850 SCFM of Inert Gas at 400°F/. PSIG Burning Fuel Oil at 140,000 BTU/Gallon
Material of Construction	- Manufacturer's Standard
HP	- 1030 Total BHP

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AREA 115 - UTILITIES - continued

Item 115-47017-1, 3 - Area 104 Condensate Return Unit

No. Required	- Three (3)
Type	- Condensate Return Unit to be complete with Receiver, Pumps, Motors and Control. Unit to deliver Condensate from Steam Turbine Discharge to Deaerator.
Capacity	- 175 GPM
Material of construction	- Manufacturer's Standard
HP	- 10 HP

Item 115-47019-1, 3 - Area 108 Condensate Return Unit

No. Required	- Three (3)
Type	- Condensate Return Unit to be complete with Receiver, Pumps, Motors and Controls. Unit to deliver Condensate from Steam Turbine Discharge to Deaerator.
Capacity	- 20 GPM
Material of Construction	- Manufacturer's Standard

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AREA 115 - UTILITIES - continued

Item 115-47020 - Area 107 - Deaerator

No. Required	- One (1)
Type	- Spray Type Deaerator w/Level Control Valves, Gauges, Relief Valve, Vacuum Breaker and Vent Valve. Storage Section By Others (115-34015).
Capacity	- 2,275,471 Lb/HR of Demineralized Water and Condensate at 195°F. To operate at 5 PSIG/228°F w/50 PSIG Sat. Steam.
Material of Construction	- Stainless Steel Internals, Carbon Steel others.
HP	- None

Item 115-47021 - Area 110 - Deaerator

No. Required	- One (1)
Type	- Spray Type Deaerator w/Level Control Valves, Gauges, Relief Valve, Vacuum Breaker and Vent Valve. Storage Section by others (115-34004).
Capacity	- 2,564,613 Lb/HR of Demineralized Water and Condensate at 195°F. To operate at 5 PSIG/228°F w/50 PSIG Sat. Steam.
Material of Construction	- Stainless Steel Internals, Carbon Steel others.
HP	- None

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AREA 115 - UTILITIES - continued

Item 115-47022 - 1500 PSIG Deaerator

No. Required	- One (1)
Type	- Spray Type Deaerator w/Level Control Valves, Gauges, Relief Valve, Vacuum Breaker and Vent Valve. Storage Section by others (115-35007).
Capacity	- 488,250 Lb/HR of Demineralized Water and Condensate at 195°F. To Operate at 5 PSIG/228°F w/50 PSIG Sat. Steam.
Material of Construction	- Stainless Steel Internals, Carbon Steel others.
HP	- None

Item 115-47023 - Auxiliary Boiler Deaerator

No. Required	- One (1)
Type	- Spray Type Deaerator w/Level Control Valves, Gauges, Relief Valve, Vacuum Breaker and Vent Valve. Storage Section by others (115-34006).
Capacity	- 1,100,000 Lb/HR Max. of Demineralized Water and Condensate at 180°F. To operate at 5 PSIG/228°F w/50 PSIG Sat. Steam.
Material of Construction	- Stainless Steel Internals, Carbon Steel others.
HP	- None

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AREA 115 - UTILITIES - continued

Item 115-47024 - Area 103 - Deaerator

No. Required	- One (1)
Type	- Spray Type Deaerator w/Level Control Valves, Gauges, Relief Valve, Vacuum Breaker and Vent Valve. Storage Section by others (115-34009).
Capacity	- 728,049 Lb/HR of Softened Water and Condensate at 200°F. To operate at 5 PSIG/228°F w/50 PSIG Sat. Steam.
Material of Construction	- Stainless Steel Internals, Carbon Steel others.
HP	- None

Item 115-47025 - Area 104 - Deaerator

No. Required	- One (1)
Type	- Spray Type Deaerator w/Level Control Valves, Gauges, Relief Valve, Vacuum Breaker and Vent Valve. Storage Section by others (115-35008)
Capacity	- 35,817 Lb/HR of Softened Water and Condensate at 200°F. To operate at 5 PSIG/228°F w/50 PSIG Sat. Steam.
Material of Construction	- Stainless Steel Internals, Carbon Steel others.
HP	- None

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AREA 115 - UTILITIES - continued

Item 115-47026 - Area 106 - Deaerator

No. Required	- One (1)
Type	- Spray Type Deaerator w/Level Control Valve, Gauges, Relief Valve, Vacuum Breaker, and Vent Valve. Storage Section by others (115-35009).
Capacity	- 325,825 LB/HR of Softened Water and Condensate at 200°F. To operate at 5 PSIG/228°F w/50 PSIG Sat. Steam.
Material of Construction	- Stainless Steel Internals, Carbon Steel Others.
HP	- None

Item 115-47028 - Area 109 - Condensate Return Unit

No. Required	- One (1)
Type	- Condensate Return Unit to be complete with Receiver, Pumps, Motors and Controls. Unit to deliver Condensate from Steam Turbine Discharge to Deaerator.
Capacity	- 390 GPM
Material of Construction	- Manufacturer's Standard
HP	- 30 HP

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AREA 115 - UTILITIES - continued

Items 115-47030 - Area 107 Condensate Return Unit

No. Required	- One (1)
Type	- Condensate Return unit to be complete with receiver, pumps, motors and controls. Unit to deliver condensate from steam turbine discharge to deaerator.
Capacity	- 120 GPM
Material of construction	- Manufacturer's Standard
HP	- 15 HP

Item 115-47031 - Area 103 BFW Condensate Return Unit

No. Required	- One (1)
Type	- Condensate return unit to be complete with receiver, pumps, motors, and controls. Unit to deliver condensate to deaerator
Capacity	- 65 GPM
Material of construction	- Manufactuer's Standard

Items 115-47032 - 600 PSIG Deaerator

No. Required	- One (1)
Type	- Spray type deaerator W/Level control valves, gauges, relief valve, vacuum breaker, & vent valve. Storage section by others (115-35010).
Capacity	- 242, 131 lb/hr of softened water & condensate @ 200°F. to operate @ 5 psig/228°F W/50 psig sat steam.
Material of construction	- Stainless steel internals, carbon steel other.
HP	- None

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AREA 115 - UTILITIES - continued

Items 115-47033-1,3 - Area 110 - Condensate Return Unit

No. Required	- Three (3)
Type	- Condensate return unit to be complete with receiver, pumps, motors, and controls. Unit to deciver condensate from steam turbine discharge to deaerator.
Capacity	- 165 GPM
Material of construction	- Manufacturer's Standard
HP	- 15 HP

Items 115-48001 - Main Power Generation Unit

No. Required	- One (1)
Type	- Steam turbine driven generator W/ single automatic extraction condensing turbines, synchronous generators, static excitation system, lube & seal oil systems, bases, & controls.
Capacity	- 109,000 KW of 13,800 Volt, 3 phase, 60 hertz power total, produced by 2 units. One T-G set @ 630,000 lb/hr of 1500psig/ 850°F inlet, 275,000 lb/hr extracted @ 650 pisp, & remainder condensed @ 4" Hg. Second T-G set @ 630,000 lb/hr of 1500psig/ 850°F inlet, 150,000 lb/hr extracted @ 75 psig, & remainder condensed @ 4" Hg.
Material of construction	- Manufacturer's Standard
HP	- To Generate 109,000 KW total

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AREA 115 - UTILITIES - continued

Items 115-48002 - 150 PSIG Back Pressure Turbine Generator

No. Required	- One (1)
Type	- Steam Turbine Driven generator W/straight back pressure turbine synchronous generator, static excitation system, lube & seal oil systems, base, & controls.
Capacity	- 9790 KW of 13,800 volt, 3 phase, 60 Hertz power from 255,000 Lb/HR of 1500 PSIG/850°F Steam Inlet, 200 PSIG, Exhaust.
Material of Construction	- Manufacturer's Standard
HP	- To Generate 9790 KW

Items 115-48003 - Auxiliary Boiler Blowdown System

No. Required	- One (1)
Type	- System with Flash Tank, Cooling Water Thermostat and Control Valve, Heat Exchanger Section and Controls.
Capacity	- 55,000 Lb/HR at 1500 PSIG/597°F Inlet. Steam to be flashed off at 75 PSIG. Water to be cooled to 200°F.
Material of Construction	- Manufacturer's Standard
HP	- None

Items 115-48004 - Power Generation Boiler Blowdown System

No. Required	- One (1)
Type	- System with Flash Tank, Cooling Water Thermostat and Control Valve, Heat Exchanger Section and Controls.
Capacity	- 23,000 Lb/HR at 1500 PSIG/597°F Inlet. Steam to be flashed off at 75 PSIG. Water to be cooled to 200°F.
Material of Construction	- Manufacturer's Standard
HP	- None

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AREA 116 - WATER SUPPLY

Item 116-34001 - Fuel Oil Storage Tank

No. Required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 8'-0"DIA. x 16'-0" TL/TL
Product	- Fuel Oil S.G. $\approx$.86
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

Item 116-34002 - Cationic Polymer Storage Tank

No. Required	- One (1)
Type	- Vertical, cylindrical, dished Heads.
Size	- 5'-6" Dia. x 16'-3" TL/TL
Product	- Polymer, S.G. = 1.112
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- A-285 GR. "C"
Remarks:	- Item to be heat traced & insulated.

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AREA 116 - WATER SUPPLY

Item 116-41001-1, 4 - Raw Water Feed Pump

No. Required	- Four (4)
Type	- Vertical turbine type pump with TEFC motor to handle river water
Capacity	- 4100 GPM @ 231' TDH
Materials of Construction	- Cast Iron
HP/RPM	- 400/1180

Item 116-41002-1, 3 - Emergency Raw Water Feed Pump

No. Required	- Three (3)
Type	- Vertical turbine type pump with TEFC motor to handle river water
Capacity	- 4100 GPM @ 231' TDH
Materials of Construction	- Cast Iron
HP/RPM	- 400/1180

Item 116-41003-1,2 - Raw Water Booster Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle river water
Capacity	- 6200 GPM @ 254' TDH
Materials of Construction	- Cast Iron
HP/RPM	- 700/1170

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AREA 116 - WATER SUPPLY - continued

Item 116-41004-1, 2 - Emergency Raw Water Booster Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle river water
Capacity	- 6200 GPM @ 254' TDH
Materials of construction	- Cast Iron
HP/RPM	- 700/1170

Item 116-41005 - Fuel Oil Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with TEFC motor to handle No. 2 fuel oil
Capacity	- 10 GPM @ 134' TDH
Materials of construction	- Manufacturer's standard
HP/RPM	- 5/3500

Items 116-41006-1, 2 - Transfer Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle cationic polymer (viscosity 65 CPS @ 60°F)
Capacity	- 50 GPM @ 25' TDH
HP/RPM	- 1/1750

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AREA 116 - WATER SUPPLY - continued

Items 116-41007-1,2 - Cationic Polymer Feed Pump

No. Required	- Two (2)
Type	- Positive displacement metering pump to be complete with drive, motor, and variable feed controls to handle cationic polymer.
Capacity	- 0.5 to 5.0 GPH
Materials of construction	- Manufacturer's Standard
HP/RPM	- 1/2/1500

Items 116-43001 - Overhead Bridge Crane

No. Required	- One (1)
Type	- Traveling bridge crane with motor drive, hoist, operator's cab guard, and controls
Capacity	- 3 ton @ 30' lift with 30' span
Materials of construction	- Manufacturer's standard
HP	- 8

Items 116-43002 - Conveyor System

No. Required	- One (1)
Type	- Troughed idler belt conveyor W/ motor, drive, belt, automatic gravity take-up, idlers, cover, & guard.
Capacity	- 500 lb/hr/conveyer for 2-100FT. LG. conveyors.
Materials of construction	- MFRS Standard
HP	- 5 HP Total

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AREA 116 - WATER SUPPLY - continued

Items 116-45001-1,2 - Mechanically Cleaned Bar Screen

No. Required	- Two (2)
Type	- Bar Screen W/mechanical rake for cleaning W/motor drive, hoist, discharge box, & controls.
Capacity	- 1000 GPM W/water flow @ 1.5FT/second. 1.5FT Depth & 1" Bar opening
Material of construction	- MFRS Standard
HP	- 25 HP (intermittent)

Items 116-45002-1, 4 - Traveling Screen

No. Required	- Four (4)
Type	- Traveling Screen W/chain sprockets, screen sections, motor, drive, backwash spray nozzles, guard, & controls.
Capacity	- 5000 GPM @ 1.5FT/second W/ 1/8" screen openings. 35FT. total height W/ 4ft. water depth
Materials of construction	- MFRS Standard
HP	- 10 HP

Items 116-45003-1,4 - Hydrasieve

No. Required	- Four (4)
Type	- Hydrasieve to Dewater sludges.
Capacity	- Unit to be sized @ 28" wide with 1/8" opening
Materials of construction	- Manufacturer's Standard
HP	- None

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AREA 116 - WATER SUPPLY - continued

Item 116-47002 - Chlorine Addition Unit

No. Required	- One (1)
Type	- Chlorine addition unit to be complete with chlorine unloading pump, chlorine storage tank, evaporator, pre-mixing tank, pumps, motors, and automatic flow controls
Capacity	- 35 lb./hr
Materials of construction	- Manufacturer's standard
HP	- 30

Items 116-47004 - Emergency Power Generator

No. Required	- One (1)
Type	- Diesel engine driven emergency power generator with diesel engine, generator, base, and controls for automatic operation
Capacity	- 15KW @ 460 volt, 3 phase, 60 HZ
Materials of construction	- Manufacturer's standard
HP	- None

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AREA 117 - WATER TREATMENT SYSTEMS

Items 117-32001-1,6 - Cation Units

No. required	- Six (6)
Type	- Vertical, Fixed Bed with Hydrogen Cation Exchange Resins, Dished Heads
Size	- 8'-0" Dia. x 8'-0" TL/TL
Product	- Softened Water, S.G. = 1.0
Operating conditions:	
Temperature	- Ambient
Pressure	- 50 PSIG
Materials of construction	- 304 St. Stl. or FRP-Hetron 197
Remarks:	- Effluent Water required free from Cation.

Items 117-32002-1,6 - Anion Units

No. required	- Six (6)
Type	- Vertical, Fixed Bed with Hydroxyl Anion Exchange Resins, Dished Heads
Size	- 8'-0" Dia. x 8'-0" TL/TL
Operating conditions:	
Temperature	- Ambient
Pressure	- 50 PSIG
Materials of construction	- 304 St. Stl.
Remarks:	- Effluent Water required free from Anion.

Item 117-34001 - Filtered Water Tank

No. required	- One (1)
Type	- Rectangular, Closed Top
Size	- 18 MM Gallons
Product	- Softened Water
	S.G. = 1.0
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Concrete
Remarks:	- Provide 430,000 Gallon Potable Water Hold Tank inside

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-34002 - Dirty Backwash Tank

No. required	- One (1)
Type	- Rectangular, Open Top
Size	- 40'-0" x 70'-0" x 20'-0" Deep
Product	- Dirty Water
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Concrete

Item 117-34003 - Carbon Filter Backwash Tank

No. required	- One (1)
Type	- Rectangular, Open Top
Size	- 30'-0" x 24'-0" x 20'-0" Deep
Product	- Filtered Water
Operating conditions:	
Temperature	- 60°F to 200°F
Pressure	- Atmospheric
Materials of construction	- Concrete

Item 117-34004 - Dirty Carbon Filter Backwash Tank

No. required	- One (1)
Type	- Rectangular, Open Top
Size	- 30'-0" x 24'-0" x 20'-0" Deep
Product	- Dirty Backwash Water
Operating conditions:	
Temperature	- 60°F to 200°F
Pressure	- Atmospheric
Materials of construction	- Concrete

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-34005 - Spent Regenerant Tank

No. required	- One (1)
Type	- Vertical, Cylindrical, Flat Bottom, Open Top
Size	- 12'-0" Dia. x 15'-0" Str. Side
Product	- Salt Solution From Backwash S.G. $\approx$.90
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel with Monolithic Lining

Item 117-34006 - Deionized Water Tank

No. required	- One (1)
Type	- Vertical, Cylindrical, Crown Bottom, Cone Roof
Size	- 50'-0" Dia. x 26'-0" Str. Side
Product	- Pure Water from Demineralizer
Operating conditions:	
Temperature	- 60°F to 200°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel-Clad with 304 St. Stl. or PVC Lined

Items 117-34007,1,2 - Reactor Clarifier Sludge Sumps

No. required	- Two (2)
Type	- Rectangular Sump Tank, Open Top
Size	- 20'-0" x 10'-0" x 8'-0" Deep
Product	- Sludge from Lime-Soda Softener S.G. = 1.05
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Concrete

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Items 117-34008-1,2 - Softened Water Tanks

No. required	- Two (2)
Type	- Rectangular, Open Top
Size	- 26'-6" x 13'-0" x 15'-0" Deep
Product	- Softened Water
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Concrete

Item 117-34009 - Filter Sump

No. required	- One (1)
Type	- Rectangular, Open Top
Size	- 35'-0" x 25'-0" x 12'-0" Deep
Product	- Water
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Concrete

Item 117-34010 - Lime Bin

No. required	- One (1)
Type	- Vertical, Cylindrical, 60° Cone Bottom, 60° Cone Top
Size	- 15'-0" Dia. x 32'-0" Str. Side
Product	- Quick Lime Density = 60 Lb/Ft. ³
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-34011 - Anion Unit Backwash Mixing Tank

No. required	- One (1)
Type	- Vertical, Flat Bottom, Open Top
Size	- 8'-0" Dia. x 17'-0" Str. Side
Product	- Caustic Soda Solution (5% NaOH) S.G. = 1.22
Operating conditions:	
Temperature	- 60°F to 180°F
Pressure	- Atmospheric
Materials of construction	- FRP-Hetron 197 or PVC

Item 117-34012 - Cation Unit Backwash Mixing Tank

No. required	- One (1)
Type	- Vertical, Flat Bottom, Open Top
Size	- 8'-0" Dia. x 12'-0" Str. Side
Product	- Sulfuric Acid Solution (5% H ₂ SO ₄) S.G. $\approx$ 1.05
Operating conditions:	
Temperature	- 60°F to 180°F
Pressure	- Atmospheric
Materials of construction	- FRP-Hetron 197 or PVC

Item 117-34013-1,2 - Reactor Clarifier Tanks

With Item No. 117-45001-1,2

Item 117-34014-1,10 - Filter Tank

With Item No. 117-45002-1,10

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-36001 - Lime Supply Tank

No. required	- One (1)
Type	- Vertical, Flat Bottom, Flat Top
Size	- 8'-0" Dia. x 9'-0" Str. Side
Product	- Lime Solution (1% to 25%)
Operating conditions:	
Temperature	- 60°F to 200°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel
Remarks:	- Provide Supports for Agitator

Item 117-39001 - Agitator For Lime Supply Tank

No. required	- One (1)
Vessel Data	- Vertical, Flat Bottom, Flat Top 8'-0" Dia. x 9'-0" Str. Side
Description of mixing operation	- Suspension of 1% to 10% Lime Solution
Specific Gravity @ 60°F	- 1.07
Materials of construction	- Carbon Steel with PVC Coating
Remarks:	- Top Fixed Mount with Motor Drive

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AREA 117 - WATER TREATMENT SYSTEMS

Item 117-41001, 4 - Sand Filter Charge Pump

No. Required	- Four (4)
Type	- Horizontal centerifugal pump with TEFC motor to handle softened water from lime soda softener
Capacity	- 4500 GPM @ 92' TDH
Materials of Construction	- Cast iron casing, carbon steel moving parts
HP/RPM	- 125/1780

Item 117-41002-1,2 - Dirty Back Wash Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle dirty back wash water from sand filter
Capacity	- 450 GPM @ 46' TDH
Materials of Construction	- Epoxy or Equivalent
HP/RPM	- 10/3500

Item 117-41003-1,2 - Cooling Tower Make-Up Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle softened water
Capacity	- 9700 GPM @ 150' TDH
Materials of Construction	- Cast iron casing, carbon steel moving parts
HP/RPM	- 500/1180

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-41004-1,2 - Potable Water Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle water
Capacity	- 60 GPM @ 162' TDH
Materials of Construction	- Epoxy
HP/RPM	- 10/3500

Item 117-41005-1,2 - Carbon Filter Feed Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle water.
Capacity	- 1550 GPM @ 139' TDH
Materials of Construction	- Carbon steel, bronze fitted.
HP/RPM	- 100/1780

Item 117-41006-1,2 - Low Pressure Boiler Water Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle low pressure boiler feed water
Capacity	- 1700 GPM @ 231' TDH
Materials of Construction	- Cast iron, bronze fitted
HP/RPM	- 200/1150

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-41007-1,2 Carbon Filter Back-wash Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle softened water
Capacity	- 490 GPM @ 60' TDH
Materials of Construction	- Carbon Steel
HP/RPM	- 15/1150

Item 117-41008-1,2 Dirty Carbon Filter BW Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle water
Capacity	- 90 GPM @ 50' TDH
Materials of Construction	- Carbon Steel, bronze fitted or epoxy lined.
HP/RPM	- 3/3500

Item 117-41009-1,2 - Spent Regenerant Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle acid/alkali solution
Capacity	- 190 GPM @ 40' TDH
Materials of Construction	- Epoxy
HP/RPM	- 5/1750

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-41010-1,2 - Deionizer Cation Unit BW Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle 5% H ₂ SO ₄ solution
Capacity	- 75 GPM @ 25' TDH
Materials of Construction	- Epoxy, PVC, or Polypropylene
HP/RPM	- 1/1750

Item 117-41011-1,2 - Deionized Water Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle water
Capacity	- 1300 GPM @ 50' TDH
Materials of Construction	- 304 SS
HP/RPM	- 25/1180

Item 117-41012-1,2 - Softener Lime Feed Pumps

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle 10% lime slurry
Capacity	- 100 GPM @ 50' TDH
Materials of Construction	- Cast iron
HP/RPM	- 5/1750

Item 117-41013-1, 4 - Reactor-Clarifier Sludge Pump

No. Required	- Four (4)
Type	- Progressing cavity pump with TEFC motor to handle lime-soda softening sludge.
Capacity	- 160 GPM @ 100' TDH
Materials of Construction	- Cast iron
HP/RPM	- 15/1800

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-41014-1,2 - Filter Sump Pump

No. Required	- Two (2)
Type	- Vertical turbine type pump with TEFC motor to handle water
Capacity	- 13,500 GPM @ 30' TDH
Materials of Construction	- Cast iron, bronze fitted
HP/RPM	- 150/880

Item 117-41015-1,2 - Deionizer Anion Unit Backwash Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle 4% NaOH solution
Capacity	- 110 GPM @ 25' TDH
Materials of Construction	- Epoxy, PVC, or polypropylene
HP/RPM	- 1 1/2/1750

Item 117-41016-1,2 - Filter Backwash Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle water
Capacity	- 2560 GPM @ 30' TDH
HP/RPM	- 25/880

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-42001-1,2 Backwash Air Blower

No. Required	- Two (2)
Type	- Horizontal centrifugal blower with TEFC motor for air service
Capacity	- 1800 SCFM @ 10 PS4
Materials of Construction	- Carbon Steel
HP	- 100

Item 117-45001-1,2 - Softener Reactor-Clarifier

No. Required	- Two (2)
Type	- Circular clarifier of solid contact type to be complete with power lift on rake arm drive, walkway, and tank.
Capacity	- 6160 GPM
Materials of Construction	- Concrete
HP	- 20

Item 117-45002-1,10 - Gravity Sand Filter

No. Required	- Ten (10)
Type	- Gravity sand filter for softened water filtration
Capacity	- 1230 GPM
Materials of Construction	- Concrete

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-45003-1,18 - Carbon Filter

No. Required	- Eighteen (18)
Type	- Vertical pressure type carbon filter for softened water and steam condensate (with trace organic) filtration
Capacity	- 120 GPM @ 65 psig
Materials of Construction	- Carbon Steel

Item 117-47001 - Chlorinator

No. Required	- One (1)
Type	- Floor mounted chlorinator to be complete with evaporator, chlorinator, and automatic control.
Capacity	- 20 lb./Dry chlorine
Materials of Construction	- Manufacturer's standard

Item 117-47002 - Anionic Polymer Feed System

No. Required	- One (1)
Type	- Package system to feed dry or liquid polymer
Capacity	- 1 lb./HR
Materials of Construction	- Manufacturer's standard
HP	- 1/2

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AREA 117 - WATER TREATMENT SYSTEMS - continued

Item 117-47003 - Lime Feed System

No. Required	- One (1)
Type	- System complete with weigh belt feeder, slaking compartment with agitator, grit classifier, TEFC motors, drives, guards, valves, and controls.
Capacity	- 25,400 lb./day of CaO
Materials of Construction	- Carbon Steel
HP	- 1 1/4 HP total

Item 117-48001 - Lime Dust Collector

No. Required	- One (1)
Type	- Bag filter type bin vent dust collector with exterior housing, reverse gas cleaning, and controls.
Capacity	- 71 sq.ft. Filter area to filter lime dust @ ambient conditions.
Materials of Construction	- Carbon steel housing with polyester bags
HP	- None

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AREA 118 - WASTE TREATMENT AND DISPOSAL

Item 118-34001 - Slop Oil Tank

No. required	- One (1)
Type	- Vertical, Open Top, Flat Bottom
Size	- 5'-0" Dia. x 6'-0" Str. Side
Product	- Slop Oil
	S.G. = .90
Operating conditions:	
Temperature	- 220°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

Item 118-34002 - pH Adjustment Filtration Tank

No. required	- One (1)
Type	- Vertical, Open Top, Flat Bottom
Size	- 12'-0" Dia. x 8'-0" Str. Side
Product	- Inorganic Sludge
	S.G. = 1.12
Operating conditions:	
Temperature	- 60°F to 125°F
Pressure	- Atmospheric
Materials of construction	- FRP

Item 118-34003 - Clarifier Clearwell

No. required	- One (1)
Type	- Vertical, Flat Bottom, Open Top
Size	- 14'-0" Dia. x 13'-0" Str. Side
Product	- Effluent Water
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Item 118-34004 - Thickener Clearwell

No. required	- One (1)
Type	- Vertical, Cylindrical, Flat Bottom, Open Top
Size	- 265 Gallons Min. (Mfr's. Std.)
Product	- Water
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Polypropylene

Item 118-34005 - Pressure Filter Backwash Tank

No. required	- One (1)
Type	- Vertical, Open Top, Crown Bottom
Size	- 22'-0" Dia. x 13'-0" Str. Side
Product	- Water
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

Item 118-34006 - Dirty Pressure Filter Backwash Tank

No. required	- One (1)
Type	- Vertical, Open Top, Crown Bottom
Size	- 25'-0" Dia. x 13'-0" Str. Side
Product	- Water
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Item 118-34007 - Sludge Press Filtrate Tank

No. required	- One (1)
Type	- Vertical, Flat Bottom, Open Top
Size	- 7'-0" Dia. x 7'-0" Str. Side
Product	- Water
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel-Polypropylene Lined

Item 118-34008 - Backwash Tank

No. required	- One (1)
Type	- Vertical, Open Top, Crown Bottom
Size	- 30'-0" Dia. x 21'-0" Str. Side
Product	- Water
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

Item 118-34009 - Clarifier Sump

No. required	- One (1)
Type	- Vertical, Crown Bottom, Open Top
Size	- 18'-0" Dia. x 11'-0" Str. Side
Product	- Bio-Sludge Water S.G. = 1.0
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

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AREA 118 - WASTE TREATMENT & DISPOSAL - continued

Items 118-34010-1,2 - Carbon Dioxide Neutralizer Tanks

No. required	- Two (2)
Type	- Vertical, cylindrical, dished heads.
Size	- 12'-0" Dia. x 36'-0" TL/TL
Material Handled	- Caustic (NaOH)
Operating conditions:	
Temperature	- 230°F
Pressure	- 50 PSIG
Materials of construction	- Carbon Steel

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Item 118-36002 - Sludge Press Conditioning Tank

No. required	- One (1)
Type	- Vertical, Flat Bottom, Open Top
Size	- 8'-0" Dia. x 12'-0" Str. Side
Product	- 6% Digested Bio-Sludge
	S.G. = 1.01
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel
Remarks:	- Provide Supports for Agitator

Item 118-36003 - pH Adjustment Feed Tank

No. required	- One (1)
Type	- Vertical, Flat Bottom, Open Top
Size	- 12'-0" Dia. x 15'-0" Str. Side
Product	- Inorganic Sludge Water
	S.G. = 1.0
Operating conditions:	
Temperature	- 60°F to 210°F
Pressure	- Atmospheric
Materials of construction	- Carbon Steel
Remarks:	- Provide Supports for Agitator

Item 118-36004 - Evaporator Hold Tank

No. required	- One (1)
Type	- Vertical, Flat Bottom, Open Top
Size	- 12'-0" Dia. x 12'-0" Str. Side
Operating conditions:	
Temperature	- 60°F to 85°F
Pressure	- Atmospheric
Materials of construction	- FRP
Remarks:	- Provide supports for Agitator

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Item 118-39002 - Agitator For Sludge Press Conditioning Tank

No. required	- One (1)
Vessel Data	- See Item 118-36002
Description of mixing operation	- Maintain 6% Digested Activated Sludge Solids in Suspension
S.G.	- 1.01
Materials of construction	- Rubber Coated Carbon Steel
Remarks:	- Top Entry

Item 118-39003 - Agitator For pH Adjustment Feed Tank

No. required	- One (1)
Vessel Data	- See Item 118-36003
Description of mixing operation	- Maintain 12% Suspended Solids (Coal Ash) in Suspension
S.G.	- 1.0
Materials of construction	- Rubber Coated Carbon Steel
Remarks:	- Top Entry

Item 118-39004 - Agitator For Evaporator Hold Tank

No. required	- One (1)
Vessel Data	- See Item 118-36004
Description of mixing operation	- Completely Mix and Maintain 100 PPM Suspended Solids in Suspension
S.G.	- 1.0
Materials of construction	- Rubber Coated Carbon Steel
Remarks:	- Top Entry

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Items 118-39050-1,2 - Spray Coolers

No. required	- Two (2)
Type	- Floating Surface Spray Cooler
Size	- 50 HP (127 MM BTU/HR Duty)
Product	- Waste Water
	S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- 220°F In, 95°F Out (Wet Bulb 78°F)
Pressure	- Atmospheric
Materials of construction	- Mfr's. Std.
Remarks:	- Axial Flow Propeller Pump, Self Draining - Above Water Manifold And St. Stl. Anchor Cables Req'd

Items 118-39051-1,10 - Floating Surface Aerators

No. required	- Ten (10)
Type	- Floating Propeller Type
Size	- 75 HP (800 RPM) Each
Product	- Waste Water (Approx. 4% Solids)
	S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- 60°F to 90°F
Pressure	- Atmospheric
Materials of construction	- Mfr's. Std.
Remarks:	- Foam Filled FRP Floats, St. Stl. Anchor Cables Req'd.

Items 118-39052-1,10 - Turbine Aerators

No. required	- Ten (10)
Type	- Submerged Turbine
Size	- 125 HP
Product	- Waste Water (Approx. 4% Solids)
	S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- 60°F to 90°F
Pressure	- 17 Feet Water Head
Materials of construction	- Mfr's. Std.

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Items 118-39053-1,6 - Digester Aerators

No. required	- Six (6)
Type	- Vertical, Floating Propeller Type
Size	- 100 HP (900 RPM)
Product	- 4% Activated Sludge
	S.G. $\approx$ 1.02
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Mfr's. Std.

Item 118-39054 - In-Line Mixer

No. required	- One (1)
Type	- Static
Size	- 1200 GPM
Operating conditions:	
Temperature	- 109°F
Pressure	- Atmospheric
Materials of construction	- PVC

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AREA 118 - WASTE TREATMENT AND DISPOSAL

Items 118-41001-1, 3 - API Sludge Pump

No. Required	- Three (3)
Type	- Horizontal centrifugal pump with TEFC motor to handle 80°F-210°F sludge water from the bottom of API separator
Capacity	- 50 GPM @ 51' TDH
Materials of construction	- Carbon Steel or PVC
HP/RPM	- 2/3500

Items 118-41002-1,2 - Sludge Press Filtrate Pump

NO. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle filtrate waste water
Capacity	- 50 GPM @ 51' TDH
Materials of construction	- Carbon Steel or Plastic
HP/RPM	- 2/3500

Items 118-41004-1, 4 - Sludge Recycle Pump

No. Required	- Four (4)
Type	- Horizontal centrifugal pump to handle 1% Sludge water.
Capacity	- 1800 GPM @ 51' TDH
Materials of construction	- Carbon Steel
HP/RPM	- 30/1180

Items 118-41005-1,2 - Contaminated Storm Water Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle storm water
Capactiy	- 500 GPM @ 58'
Materials of construction	- Carbon Steel or FRP
HP/RPM	- 15/1150

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Items 118-41006-1,2 - Digested Sludge Transfer Pump

NO. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle digested active sludge (1.8% Solid)
Capacity	- 125 GPM @ 69' TDH
Materials of construction	- Carbon Steel or FRP
HP/RPM	- 5/1750

Items 118-41007-1,2 - PH Adjustment Filtrate Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle water
Capacity	- 1200 GPM @ 46' TDH
Materials of construction	- Carbon Steel
HP/RPM	- 20/1180

Items 118-41008-1, 20 - PH Adjustment Sludge Press Feed Pump

NO. Required	- Twenty (20)
Type	- Positive displacement pump with adjustable drive to handle sludge water
Capacity	- 70 GPM @ 25' TDH
Materials of construction	- Carbon Steel
HP/RPM	- 1/1800

Items 118-41009-1,2 - Transfer Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle 180°F water
Capacity	- 1750 GPM @ 35' TDH
Materials of construction	- Carbon Steel
HP/RPM	- 25/880

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AREA 118 - WATER TREATMENT AND DISPOSAL - continued

Items 118-41010-1,2 - Emergency Storage Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle water
Capacity	- 300 GPM @ 51' TDH
Materials of construction	- FRP or PVC
HP/RPM	- 10/1180

Items 118-41011-1,2 - Slop Oil Pump

No. Required	- Two (2)
Type	- Positive Displacement gear pump with TEFC motor to handle 200°F Waste oil.
Capacity	- 50 GPM @ 81' TDH
Materials of construction	- Carbon Steel
HP/RPM	- 5/1800

Items 118-41012-1,2 - Cooling Pond Return Pump

No. Required	- Two (2)
Type	- Vertical turbine type pump with TEFC motor to handle waste water.
Capacity	- 1990 GPM @ 51'
HP/RPM	- 40/1175

Items 118-41013-1,2 - Clarifier Clear Well Pump

NO. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle waste water
Capacity	- 2360 GPM @ 116' TDH
Materials of construction	- Carbon Steel
HP/RPM	- 100/1780

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Items 118-41014-1,2 - Thickener Clear Well Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle waste water
Capacity	- 60 GPM @ 51' TDH
Materials of construction	- Carbon Steel or FRP
HP/RPM	- 2/3500

Items 118-41015-1, 3 - Thickener Bottoms Pump

No. Required	- Three (3)
Type	- Horizontal centrifugal pump with TEFC motor to handle thickened sludge.
Capacity	- 70 GPM @ 77' TDH
Materials of construction	- Carbon Steel
HP/RPM	- 3/3500

Items 118-41016-1,2 - Thickener Polymer Transfer Pump

No. Required	- Two (2)
Type	- Rotary pump complete with variable speed drive to handle belt 2890 polymer liquid
Capacity	- 0.2 to 20 GPM @ 42' TDH
Materials of construction	- Carbon Steel
HP	- 2

Items 118-41017-1,2 - Pressure Filter Backwash Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle water.
Capacity	- 1000 GPM @ 23' TDH
Materials of construction	- Carbon Steel
HP/RPM	- 15/1180

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Items 118-41018-1,2 - Dirty Pressure Filter Backwash Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle water
Capacity	- 42 GPM @ 51' TDH
Materials of construction	- Carbon Steel or FRP or PVC
HP/RPM	- 2/1750

Items 118-41019-1,2 - Sludge Press Feed Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle 6% solids Bio-Sludge water.
Capacity	- 70 GPM @ 48' TDH
Materials of construction	- Carbon Steel or Plastic
HP/RPM	- 3/1150

Items 118-41020-1,2 - Carbon Filter Backwash Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle water
Capacity	- 1875 GPM @ 60'
HP/RPM	- 75/1750

Items 118-41021-1,2 - Supernatant Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle effluent water
Capacity	- 420 GPM @ 44'
Materials of construction	- Carbon Steel
HP/RPM	- 10/1180

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Items 118-41022-1,2 - Thickened Sludge Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle sludge water
Capacity	- 125 GPM @ 34' TDH
Materials of construction	- Carbon Steel
HP/RPM	- 3/1750

Items 118-42001-1, 4 - Aeration Air Blowers

No. Required	- Four (4)
Type	- Rotary positive displacement blower with TEFC motor to handle air.
Capacity	- 3200 SCFM @ 19 ps.
Materials of construction	- Manufacturer's Standard
HP/PM	- 200/1800

Items 118-42002-1,2 - Backwash Air Blower

No. Required	- Two (2)
Type	- Rotary positive displacement blower with TEFC motor to handle air.
Capacity	- 560 SCFM @ 10ps
Materials of construction	- Manufacturer's Standard
HP/RPM	- 40/1800

Items 118-42003-1,2 - Thickener Air Blower

No. Required	- Two (2)
Type	- Positive displacement blower with TEFC motor to handle air.
Capacity	- 9.5SCFM @ 100 ps.
Materials of construction	- Manufacturer's Standard
HP/RPM	- 2/1800

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Items 118-43001 - Solids Waste Conveyor

No. Required	- One (1)
Type	- Troughed idler belt conveyor W/ motor, drive, belt, idlers, automatic gravity take-ups, & frame.
Capacity	- 4.2 TPH of solids @ 300°F W/ 3% moisture.
Materials of construction	- Manufacturer's standard
HP	- 5 HP

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Items 118-45001-1,2 - Oil Water Separator

No. Required	- Two (2)
Type:	- API type oil water separator with top & bottom pipe skimmers, sludge, catch basin, diffusing baffles, & flanged connections.
Capacity	- 1895 GPM oper., 2700 GPM design of water W/ 30PPM oil @ 105°F
Materials of construction	- Carbon Steel
HP	- None

Items 118-45002-1, 3 Clarifier

No. Required	- Three (3)
Type	- Rapid sludge return, peripheral discharge clarifier to handle activated sludge mixed liquid.
Capacity	- 2700 GPM @ Atmospheric condition
Materials of construction	- Manufacturer's Standard
HP	- 1/2

Items 118-45003-1, 4 - Pressure Filter

No. Required	- Four (4)
Type	- Deep bed pressure type filter to be complete with filter media, drain and backwash system.
Capacity	- 550 gpm each @ 6 gpm/sq. ft. max.
Materials of construction	- Carbon Steel shell with sand filter media and gravel support

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Item 118-45004-1, 5 - Sludge Press

No. required	- Five (5)
Type	- Gravity Belt Type Filter Pressure to thicken Polymer conditioned Aerobically Digested Activated Sludge to about 30% by Weight Sludge.
Capacity	- 460 Lb./HR Dry Solid (Averaged 6 to 8% by Weight)
Material of Construction	- Manufacturer's Standard
HP	- 15

Item 118-45005-1,2 - Sludge Thickener

No. required	- Two (2)
Type	- Dissolved Air Flotation Type Sludge Thickener to Handle 1% Bio-Sludge.
Capacity	- 110 GPM
Material of Construction	- Concrete
HP	- 1.5

Item 118-45006-1, 10 - ph Adjustment Sludge Press

No. Required	- Ten (10)
Type	- Gravity Bolt Type Filter Press to Thicken 200°F Water Softening Sludge, API Separator Bottoms, and Venturi Soot Scrubber Sludge to about 30% by Weight.
Capacity	- 600 Lb./HR Dry Solid (Averaged 1% by Weight). PH - 6 to 9
Material of Construction	- Manufacturer's Standard to meet PH and Temperature Condition.
HP	- 50

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Item 118-45007-1,2 - Carbon Filter

No. Required	- Two (2)
Type	- Active Carbon Filter to handle 200°F Evaporator Condensate.
Capacity	- 660 GPM at 150 PSIG
Material of Construction	- Carbon Steel with Plastic 7122 Lined.

Item 118-45008-1,2 - Clarifier Sludge Thickener

No. Required	- Two (2)
Type	- Dissolved Air Type Clarifier Sludge Thickener to concentrate the Raw Biological Sludge.
Capacity	- 371 GPM of 0.8% Sludge Concentrate to 4%
Material of Construction	- Carbon Steel/FRP

Item 118-45009-1,2 - Aeration Basin

No. Required	- Two (2)
Type	- Concrete Basin for Aeration
Capacity	- 6.942 MM Gallon/Day
Material of Construction	- Concrete

Item 118-45010-1,2 - Aerobic Sludge Digester

No. Required	- Two (2)
Type	- Tank
Capacity	- 1,900,000 Gal/Day with 4% Bio-Solids
Material of Construction	- Concrete

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AREA 118 - WASTE TREATMENT AND DISPOSAL - continued

Item 118-47001 - Waste Evaporator System

No. Required	- One (1)
Type	- Multiple Effects Evaporator System to recover Water from the Process Waste. Unit to be Vertical Tube Type, Forced Circulation with Oil Carrier, System complete with Feed Mixing Tank, Evaporator, Centrifugal Vacuum Pump, Pumps, Motors and Accessories.
Capacity	- 800,000 Lb./HR (90% Water, 1.1% Solid, 8.9% Oil) 100% Solid Removal, 95 to 99% Oil Recycle
Material of Construction	- Manufacturer's Standard
HP	- 1000

Item 118-47003 - Thickener Polymer Feed System

No. Required	- One (1)
Type	- Thickener Polymer Feed System to be complete with Discharge Bin, Eductor, Agitation Mixing Tank, Agitator, Pumps, Motors and Controls for Variable Feed.
Capacity	- 24 Lb./Day Dry Polymer
Material of Construction	- Manufacturer's Standard
HP	- 1/2

Item 118-47004 - Slag Landfill System

No. Required	- One (1)
Type	- Landfill System consisting of a Diesel Driven Front End Loader (Cat No. 983D or Equal), 2 Diesel Driven, Off Highway Dump Trucks (Cat No. 773 or Equal) and a Diesel Driven Dozer-Compactor (Cat No. 825 or Equal).
Capacity	- 800 TPH Slag for 40 HR Week w/2 Mile Round Trip Haul.
Material of Construction	- Manufacturer's Standard
HP	- Diesel

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AREA 119 - FIRE PROTECTION SYSTEM

Item 119-34001 - Raw Water Settling Tank

No. required	- One (1)
Type	- Vertical, Crown Bottom, Cone Roof
Size	- 70'-0" Dia. x 36'-0" Str. Side
Product	- Raw River Water
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

Item 119-34002 - Fuel Tank

No. required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 3'-0" Dia. x 6'-0" TL/TL
Product	- No. 2 Diesel Oil S.G. = .86
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

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AREA 119 - FIRE PROTECTION SYSTEM

Items 119-41001-1,2 - Fire Water Jockey Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle River Water unit to meet NFPA regulation.
Capacity	- 25 GPM @ 231' TDH
Materials of construction	- Cast Iron or NI-Resist
HP/RPM	- 15/3500

Items 119-41002-1,10 - Fire Protection Pump

No. Required	- Ten (10)
Type	- Horizontal Centrifugal pump with TEFC Motor to handle raw river water for fire protection. Unit to meet NFPA regulation.
Capacity	- 1000 GPM @ 289' TDH
Materials of construction	- Cast Iron or NI-Resist
HP/RPM	- 125/3550

Items 119-41003-1,2 - Secondary Fire Protection Pump

NO. Required	- Two (2)
Type	- Horizontal Centrifugal Pump with TEFC motor to handle raw river water for fire protection. Unit to meet NFPA regulation.
Capacity	- 5000 GPM @ 289' TDH
Materials of construction	- Cast Iron or NI-Resist
HP/RPM	- 600/1780

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AREA 119 - FIRE PROTECTION SYSTEM - continued

Items 119-41004-1,2 - Primary Water Treatment Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal pump with TEFC motor to handle raw river water
Capacity	- 14400 GPM @ 231' TDH
Materials of construction	- Cast Iron
HP/RPM	- 1200/880

Item 119-45001-1,2 - Fire Water Strainer

No. Required	- Two (2)
Type	- Strainer to eliminate the suspended solid in the raw river water for fire water supply.
Capacity	- 12500 GPM
Materials of construction	- Carbon Steel Shell, 304S.S. element.

Items 119-45002-1,2 - Raw Water Strainer

No. Required	- Two (2)
Type	- Strainer to eliminate the suspended solids in the raw river water.
Capacity	- 14,400 GPM
Materials of construction	- Carbon Steel Shell, 304S.S. Element.

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AREA 120 - FACILITIES

Item 120-31001 - Ammonia Desuperheater

No. Required	- One (1)
Type	- Shell and tube , Horizontal
Surface Area	- 160 Ft. ²
Duty	- 111,400 BTU/HR
Operating Conditions:	- Cooling water
(Shell side)	
Temperature	- 91°F to 92°F
Pressure	- 60 PSIG
Operating Conditions:	- Ammonia
(Tube side)	
Temperature	- 200°F to 100°F
Pressure	- 207 PSIG
Materials of Construction	- Shell: Carbon Steel
	Tubes: 316 ST. STL.

Item 120-31002 Ammonia Condenser

No. Required	- One (1)
Type	- Shell and tube , Horizontal
Surface Area	- 735 Ft. ²
Duty	- 767,800 BTU/HR
Operating Conditions:	- Cooling water
(Shell side)	
Temperature	- 85°F to 91°F
Pressure	- 60 PSIG
Operating Conditions:	- Ammonia
(Tube side)	
Temperature	- 100°F
Pressure	- 202 PSIG
Materials of Construction	- Shell: Carbon Steel
	Tubes: 316 ST. STL.

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AREA 120 - FACILITIES - continued

Item 120-31003 - Ammonia Vent Condenser

No. Required	- One (1)
Type	- Shell and tube, vertical
Surface Area	- 40 Ft. ²
Duty	- 255,900 BTU/HR
Operating Conditions:	- Ammonia
(Shell side)	
Temperature	- 40°F to 40°F
Pressure	- 60 PSIG
Operating Conditions	- Freon-12
(Tube side)	
Temperature	- -10°F to -10°F
Pressure	- 5 PSIG
Materials of Construction	- Shell: 316 ST. STL.
	- Tubes: 316 ST. STL.

Items 120-31004-1,2 - Light Hydrocarbon Storage Condensers

No. Required	- Two (2)
Type	- Shell and tube
Surface Area	- 350 Ft. ² each
Duty	- 685,000 BTU/HR each
Operating Conditions:	- Freon-12
(Shell side)	
Temperature	- -10°F
Pressure	- 5 PSIG
Operating Conditions:	- Light Hydrocarbons
(Tube side)	
Temperature	- 40°F to 0°F
Pressure	- 180 PSIG
Materials of Construction	- Shell: A-516 Carbon Steel
	- Tubes: 304 ST. STL.
Note	- 5 PSIG Allowable Pressure Drop

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AREA 120 - FACILITIES - continued

Item 120-31005 - Liquid Nitrogen Vaporizer

No. Required	- One (1)
Type	- Shell and tube
Surface Area	- 18 Ft. ²
Duty	- 199,700 BTU/HR
Operating Conditions:	- Steam
(Shell side)	
Temperature	- 297°F to 297°F
Pressure	- 50 PSIG
Operating Conditions:	- Nitrogen
(Tube side)	
Temperature	- -300°F
Pressure	- 25 PSIG
Materials of Construction	- Shell: Carbon Steel
	Tubes: 9% Nickel Steel

Item 120-31006 - Chlorine Vaporizer

No. Required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads, Coil in Tank, (Size by vendor)
Surface Area	- 2 Ft. ²
Duty	- 59,400 BTU/HR
Operating Conditions:	- Steam
(Shell side)	
Temperature	- 297°F to 297°F
Pressure	- 50 PSIG
Operating Conditions:	- Chlorine
(Tube side)	
Temperature	- -20°F Min. to 60°F
Pressure	- 187 PSIG Max.
Materials of Construction	- Shell: Titanium
	Tubes: Titanium

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No. Required	- One (1)
Type	- Shell and tube
Surface Area	- 5 Ft. ²
Duty	- 161,600 BTU/HR
Operating Conditions:	- Steam
(Shell side)	
Temperature	- 297°F to 297°F
Pressure	- 50 PSIG
Operating Conditions:	- Ammonia
(Tube side)	
Temperature	- 40°F to 80°F
Pressure	- 60 PSIG in 55 PSIG out
Materials of Construction	- Shell: Carbon Steel
	- Tubes: 316 ST. STL.

Items 120-34001-1,2 - Fuel Oil Day Tanks

No. Required	- Two (2)
Type	- Vertical, Cylindrical, Cone Roof, Crown Bottom
Size	- 50'-0" Dia. X 19'-0" Str. Side
Product	- Fuel Oil, S.G. $\approx$.85
Operating Conditions:	
Temperature	- 150°F
Pressure	- 0.5 PSIG
Materials of Construction	- Carbon Steel - Low Alloy
Remarks	- Steam Coil and 1" insulation required.

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AREA 120 - FACILITIES - continued

Item 120-34002 - Fuel Oil Storage Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Cone Roof, Crown Bottom
Size	- 120'-0" Dia. X 23'-0" Str. Side
Product	- Fuel Oil, S.G. $\approx$.85
Operating Conditions:	
Temperature	- 150°F
Pressure	- 0.5 PSIG
Materials of Construction	- Carbon Steel - Low Alloy
Remarks	- Steam coil and 1" insulation required

Item 120-34003 - Syncrude Off-Spec Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Cone Roof, Crown Bottom
Size	- 140'-0" Dia. X 21'-0" Str. Side
Product	- Syncrude, S.G. $\approx$.80
Operating Conditions:	
Temperature	- 120°F
Pressure	- 0.5 PSIG
Materials of Construction	- Carbon Steel - Low Alloy
Remarks	- Steam Coil and 1" Insulation Required

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AREA 120 - FACILITIES - continued

Item 120-34005 - Potassium Carbonate Storage Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Cone Roof, Crown Bottom
Size	- 20'-0" Dia. X 14'-0" Str. Side
Product	- 47% K_2CO_3 Solution S. G. $\approx$ 1.2
Operating Conditions:	
Temperature	- Ambient
Pressure	- 0.5 PSIG
Materials of Construction	- Carbon Steel

Items 120-34006-1,2 - Syncrude Day Tanks

No. Required	- Two (2)
Type	- Vertical, Cylindrical, Cone Roof, Crown Bottom
Size	- 90'-0" Dia. X 25'-0" Str. Side
Product	- Syncrude, S.G. $\approx$.80
Operating Conditions:	
Temperature	- 120°F
Pressure	- 0.5 PSIG
Materials of Construction	- Carbon Steel - Low Alloy
Remarks	- Steam Coil and 1" Insulation required

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AREA 120 - FACILITIES - continued

Item 120-34007 Raw Oil Storage Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Cone Roof, Crown Bottom
Size	- 220'-0" Dia. X 27'-0" Str. Side
Product	- Raw Oil, S.G. = .85
Operating Conditions:	
Temperature	- 220°F max.
Pressure	- 0.5 PSIG
Materials of Construction	- Carbon Steel
Remarks	- Steam Coil and 1" Insulation required

Items 120-34008-1,6 - Syncrude Storage Tanks

No. Required	- Six (6)
Type	- Vertical, Cylindrical, Cone Roof, Crown Bottom
Size	- 200'-0" Dia. X 26'-0" Str. Side
Product	- Syncrude, S.G. = .80
Operating Conditions:	
Temperature	- Ambient
Pressure	- 0.5 PSIG
Materials of Construction	- Carbon Steel - Low Alloy
Remarks	- Steam Coil and 1" Insulation Required

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AREA 120 - FACILITIES - continued

Item 120-34009 - Light Oil Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Dome Roof, Crown Bottom
Size	- 24'-0" Dia. X 24'-0" Str. Side
Product	- N-Heptane, S.G. = .70
Operating Conditions:	
Temperature	- Ambient
Pressure	- $\pm$ 1" to 3" W. C.
Materials of Construction	- Carbon Steel

Item 120-34010 - Fuel Oil Off-Spec Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Cone Roof, Crown Bottom
Size	- 60'-0" Dia. X 26'-0" Str. Side
Product	- Fuel Oil, S.G. = .85
Operating Conditions:	
Temperature	- 150°F
Pressure	- 0.5 PSIG
Materials of Construction	- Carbon Steel - Low Alloy
Remarks	- Steam Coil and 1" Insulation Required

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AREA 120 - FACILITIES - continued

Items 120-34012-1,8 - Light Hydrocarbon Storage Spheres

No. Required	- Eight (8)
Type	- Spherical
Size	- 53'-0" DIA
Product	- Light Hydrocarbons S.G. $\approx$.60
Operating conditions:	
Temperature	- Ambient
Pressure	- 230 PSIG Max.
Materials of construction	- Carbon Steel-304 ST. STL. Clad
Remarks:	- Insulation Req'd

Item 120-34013 - Ammonia Product Storage Sphere

No. Required	- One (1)
Type	- Spherical
Size	- 60'-0" DIA
Product	- Ammonia, S.G. = .625
Operating conditions:	
Temperature	- 40°F
Pressure	- 60 PSIG
Materials of construction	- Carbon Steel
Remarks:	- Insulation Req'd

Item 120-34014 - Soda Ash Storage Bin

No. Required	- One (1)
Type	- Vertical, Cylindrical, Cone Roof, Cone Bottom
Size	- 35'-0"DIA. x 53'-0" STR. Side, 45° cone-17'-6" STR.
Product	- Soda Ash - Bulk Density= 55LB/FT ³ .
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

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AREA 120 - FACILITIES - continued

Item 120-34015 - Phosphoric Acid Storage Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Dome Roof, Crown Bottom
Size	- 16'-0"DIA. x 19'-0" STR.Side
Product	- 40% H_3PO_4 , S.G. = 1.25
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel-Rubber Lined Interior

Item 120-34016 - Caustic Storage Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Cone Roof, Crown Bottom
Size	- 100'-0"DIA. x 32'-0"STR. Side
Product	- 50% NaOH, S.G. = 1.5
Operating conditions:	
Temperature	- 60°F MIN.
Pressure	- 0.5 PSIG
Materials of construction	- Carbon Steel-Columbia No.7 Internal Lining
Remarks:	- Internal Nickel Steam Coil & 1" Insulation Req'd

Item 120-34017 - Sulfuric Acid Storage Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Cone Roof, Crown Bottom
Size	- 40'-0"DIA. x 21'-0" STR.Side
Product	- 93% Sulfuric Acid S.G. = 1.8
Operating conditions:	
Temperature	- Ambient
Pressure	- 0.5 PSIG
Materials of construction	- Carbon Steel

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AREA 120 - FACILITIES - continued

Item 120-34018 - Liquid Nitrogen Storage Sphere

No. Required	- One (1)
Type	- Spherical
Size	- 32'-0" DIA.
Product	- Liquid Nitrogen
Operating conditions:	
Temperature	- -300°F
Pressure	- 25 PSIG
Materials of construction	- MFR's. STD.

Item 120-35003 - Ammonia Knockout Drum

No. Required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 1'-0"DIA. x 2'-0" TL/TL
Product	- Ammonia Liquid and Vapor S.G. = .625 (Liquid)
Operating conditions:	
Temperature	- 40°F
Pressure	- 60 PSIG
Materials of construction	- 304 ST. STL.
Remarks:	- 2" Wire Mesh Demister Req'd.

Item 120-35004 - Ammonia Condensate Collection Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 1'-0"DIA. x 2'-0" TL/TL
Product	- Ammonia, S.G. = .625
Operating conditions:	
Temperature	- 40°F
Pressure	- 60 PSIG
Materials of construction	- 304 ST. STL.
Remarks	- Dip Tube Req'd.

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AREA 120 - FACILITIES - continued

Item 120-35006 - Ethylene Glycol Storage Tank

No Required	- One (1)
Type	- Vertical, Cylindrical, Dome Roof, Flat Bottom
Size	- 10'-0"DIA x 7'-0" STR. Side
Product	- Ethylene Glycol, S.G.=1.1
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel

Item 120-35008-1,2 - Light Hydrocarbon Storage Separators

No. Required	- Two (2)
Type	- Vertical, Cylindrical, dished heads
Size	- 3'-0"DIA. x 10'-0" TL/TL
Product	- Hydrocarbons, S.G. = .46 (Liquid)
Operating conditions:	
Temperature	- 10°F
Pressure	- 125 PSIG
Materials of construction	- 304 ST. STL.
Remarks	- Demister Req'd

Item 120-35009 - Cooling Tower Inhibitor Storage Tank

No. Required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 8'-0"DIA. x 16'-0" TL/TL
Product	- Inhibitor, S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- Ambient
Pressure	- 0.5 PSIG
Materials of construction	- MFR's STD.
Remarks:	- Steam Coil & 1" Insulation Req'd

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AREA 120 - FACILITIES - continued

Item 120-35010 - Cooling Tower Dispersant Storage Tank

No. Required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads.
Size	- 8'-0"DIA. x 16'-0" TL/TL
Product	- Dispersant, S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- Ambient
Pressure	- 0.5 PSIG
Materials of construction	- MFR's. STD.
Remarks:	- Steam Coil & 1" Insulation Req'd.

Item 120-35012 - Selexol Storage Tank

No. Required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 12'-1" Dia. x 27'-0" TL/TL
Product	- Selexol, S.G. $\approx$ 1.0
Operating conditions:	
Temperature	- Ambient
Pressure	- 0.5 PSIG
Materials of construction	- Carbon Steel

Item 120-35013 - Chlorine Storage Tank

No. Required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 8'-0" Dia. x 10'-0" TL/TL
Product	- Liquid Chlorine S.G. = 1.43
Operating conditions:	
Temperature	- 120°F Max., -20°F Min.
Pressure	- 187 PSIG MAX.
Materials of construction	- Carbon Steel-Titanium Clad

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AREA 120 - FACILITIES - continued

Item 120-35014 - Cooling Tower Inhibitor No. 2 Storage Tank

No. Required	- One (1)
Type	- Horizontal, Cylindrical, Dished Heads
Size	- 8'-0" Dia. x 16'-0" TL/TL
Product	- Inhibitor S. G. = 1.4
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- MFR's Std.

Item 120-36001 - Antifoaming Agent Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Dished Heads
Size	- 3'-6"DIA. x 4'-0" TL/TL
Product	- Antifoaming Agent S.G. $\approx$ 1.1
Operating conditions:	
Temperature	- Ambient
Pressure	- 0.5 PSIG
Materials of construction	- Carbon Steel
Remarks:	- Agitator Req'd.

Item 120-36002 - Soda Ash Feed Tank

No. Required	- One (1)
Type	- Vertical, Cylindrical, Open Top, Dished Bottom
Size	- 3'-0" Dia. x 5'-0" STR. SIDE
Product	- Soda Ash Slurry (20% by weight). S. G. = 1.2
Operating conditions:	
Temperature	- Ambient
Pressure	- Atmospheric
Materials of construction	- Carbon Steel
Remarks	- Agitator Req'd.

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AREA 120 - FACILITIES - continued

Item 120-39001 - Agitator For Antifoaming Agent Tank

No. Required	- One (1)
Vessel Data	- Vertical, Cylindrical, Dished Heads
Description of mixing operation	- Antifoaming agent from drum storage is diluted with process water.
Product	- Antifoaming Agent
S.G.	- Approx. 1.1
Materials of construction	- Carbon Steel

Item 120-39002 - Agitator For Soda Ash Feed Tank

No. Required	- One (1)
Vessel Data	- Vertical, Cylindrical, Open Top, Dished Bottom
Description of mixing operation	- Soda Ash from storage mixed with process water. 20% soda ash by weight produced
Product	- Soda Ash Slurry
S.G.	- 1.2
Materials of construction	- Carbon Steel

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AREA 120 - FACILITIES

Item 120-41001 - Sulfuric Acid Unloading Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with TEFC motor to handle concentrated sulfuric acid
Capacity	- 100 GPM @ 64' TDH
Materials of Construction	- Cast iron or Duriron
HP/RPM	- 7 1/2/1750

Item 120-41002 - Caustic Unloading Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with TEFC motor to handle 50% caustic
Capacity	- 100 GPM @ 77' TDH
Materials of construction	- Alloy 20
HP/RPM	- 7-1/2/3600

Item 120-41003 -1,2 - Soda Ash Feed Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal pump with TEFC motor to handle 20% Soda Ash Water Slurry
Capacity	- 50 GPM @ 39' TDH
Materials of Construction	- Carbon Steel
HP/RPM	- 2/1750

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AREA 120 - FACILITIES - continued

Item 120-41004 - Antifoam Agent Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with TEFC motor to handle anti-foaming agent.
Capacity	- 10 GPM @ 210' TDH
Materials of Construction	- Carbon Steel
HP/RPM	- 15/3600

Item 120-41005 - Cooling Tower Inhibitor Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with TEFC motor to handle inhibitor
Capacity	- 10 GPM @ 116' TDH
Materials of Construction	- Manufacturer's standard
HP/RPM	- 5/3500

Item 120-41006 - Cooling Tower Dispersant Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with TEFC motor to handle dispersant.
Capacity	- 10 GPM @ 116' TDH
Materials of Construction	- Manufacturer's standard
HP/RPM	- 5/3500

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AREA 120 - FACILITIES - continued

Item 120-41007 - Selexol Unloading Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with TEFC motor to handle selexol
Capacity	- 100 GPM @ 116' TDH
Materials of Construction	- Carbon Steel
HP/RPM	- 7 1/2/3500

Item 120-41008 - Potassium Carbonate Unloading Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with TEFC motor to handle potassium carbonate.
Capacity	- 200 GPM @ 55' TDH
Materials of Construction	- Carbon Steel
HP/RPM	- 10/3500

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AREA 120 - FACILITIES - continued

Item 120-41010-1,2 - Raw Oil Feed Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal API pump with TEFC motor to handle raw oil.
Capacity	- 1250 GPM @ 135' TDH
Materials of Construction	- Carbon Steel
HP/RPM	- 50/1750

Item 120-41011-1,8 - Syncrude Loading Pump

No. Required	- Eight (8)
Type	- Horizontal centrifugal API pump with TEFC motor to handle syncrude
Capacity	- 335 GPM @ 144' TDH
Materials of Construction	- Carbon Steel
HP/RPM	- 20/3500

Item 120-41012 - Ammonia Loading Pump

No. Required	- One (1)
Type	- Rotary gear type pump with TEFC motor to handle 40°F ammonia
Capacity	- 250 GPM @ 37' TDH
Materials of Construction	- Carbon steel casing, 316 SS moving parts.
HP/RPM	- 7 1/2/1800

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AREA - 120 - FACILITIES - continued

Item 120-41014 - Phosphoric Acid Unloading Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with TEFC motor to handle phosphoric acid
Capacity	- 150 GPM @ 37' TDH
Materials of Construction	- Epoxy
HP/RPM	- 5/1800

Item 120-41015 - Ethylene Glycol Unloading Pump

No. Required	- One (1)
Type	- Horizontal centrifugal pump with TEFC motor to handle ethylene glycol.
Capacity	- 100 GPM @ 105' TDH
Materials of Construction	- Carbon Steel
HP/RPM	- 7 1/2/3500

Item 120-41016-1,2 - Plant Fuel Pump

No. Required	- Two (2)
Type	- Horizontal centrifugal API type pump with TEFC motor to handle fuel oil
Capacity	- 200 GPM @ 136' TDH
Materials of Construction	- Carbon Steel
HP/RPM	- 15/3500

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AREA 120 - FACILITIES - continued

Item 120-41017-1, 4 - Light H/C Loading Pump

No. Required	- Four (4)
Type	- Horizontal centrifugal API pump with TEFC motor to handle 10°F light hydrocarbons
Capacity	- 150 GPM @ 674' TDH
Materials of Construction	- Carbon steel casing, 304 SS moving parts
HP/RPM	- 75/3600

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AREA 120 - FACILITIES - continued

Item 120-41019 - 1,2 - Light Oil Transfer Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal API Pump with TEFC Motor to handle 40°F Light oil.
Capacity	- 50 GPM at 610' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 20/1750

Item 120-41020 - 1,2 - Fuel Oil Transfer Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal API Pump with TEFC Motor to handle 150°F Fuel Oil
Capacity	- 275 GPM at 92' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 10/1750

Item 120-41021 - Fuel Oil Off-Spec Pump

No. Required	- One (1)
Type	- Horizontal Centrifugal API Pump with TEFC Motor to handle 130°F Fuel Oil
Capacity	- 120 GPM at 92' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 7-1/2/1750

Item 120-41022 - 1,2 - Syncrude Transfer Pump

No. Required	- Two (2)
Type	- Horizontal Centrifugal API Pump with TEFC Motor to handle 120°F Syncrude
Capacity	- 825 GPM at 87' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 20/1750

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AREA 120 - FACILITIES - continued

Item 120-41023 Syncrude Off-Spec Pump

No. Required	- One (1)
Type	- Horizontal Centrifugal API Pump with TEFC Motor to handle 120°F Syncrude
Capacity	- 120 GPM at 87' TDM
Material of Construction	- Carbon Steel
HP/RPM	- 5/1750

Item 120-41024 - Antifoaming Agent Drum Pump

No. Required	- One (1)
Type	- Portable Drum Pump to handle Antifoaming Agent
Capacity	- 5 GPM at 58' TDH
Material of Construction	- Carbon Steel
HP/RPM	- 2/1750

Item 120-41025 - 1,2 - Phosphoric Acid Metering Pump

No. Required	- Two (2)
Type	- Positive Displacement Metering Type Pump with TEFC Motor Feed 40% Phosphoric Acid. Unit to be with Variable Feed Control.
Capacity	- 1.5 GPM at 37' TDH
Material of Construction	- Polypropylene
HP	- 1/2

Item 120-41026 - Cooling Tower Inhibitor #2 Pump

No. Required	- One (1)
Type	- Horizontal Centrifugal Pump with TEFC Motor to handle Cooling Tower Inhibitor
Capacity	- 10 GPM at 82' TDH
Material of Construction	- Manufacturer's Standard
HP/RPM	- 5/1800

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AREA 120 - FACILITIES - continued

Item 120-42001-1,2 - Ammonia Storage Compressor

No. Required	- Two (2)
Type	- Reciprocating Compressor with TEFC Motor to handle 40°F Ammonia Vapor
Capacity	- 900 SCFM Ammonia from 60 PSIG to 207 PSIG
Material of Construction	- Manufacturer's Standard for Casing, 316SS Moving Parts
HP/RPM	- 20/1800

Item 120-42002 - Filter Aid Transfer Blower

No. Required	- One (1)
Type	- Positive Displacement Rotary Type Blower with TEFC Motor to provide Air for Filter and Transfer
Capacity	- 5400 SCFM Air from Atmospheric Pressure to 10 PSIG
Material of Construction	- Carbon Steel
HP/RPM	- 300/1800

Item 120-42003-1, 3 - Light Hydrocarbon Storage Compressor

No. Required	- Three (3)
Type	- Reciprocating Compressor with TEFC Motor to handle 10°F Light Hydrocarbon
Capacity	- 1000 SCFM Light Hydrocarbon from 125 PSIG to 180 PSIG
Material of Construction	- 304 SS
HP/RPM	- 5/1800

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AREA 120 - FACILITIES - continued

Item 120-43001 - 5T Bridge Crane

No. Required	- One (1)
Type	- Motor Driven Traveling Bridge Crane to be complete with Mono-rail, Hoist, Operator's Cab, Guard, Drum and Pallet Grabbing Auxiliaries, Motor and Controls.
Capacity	- 5 Tons at 40 Ft. Lift and 100 Ft. Span
Material of Construction	- Carbon Steel or Manufacturer's Standard
HP	- 8

Item 120-43002 - 10T Bridge Crane

No. Required	- One (1)
Type	- Motor Driven Traveling Bridge Crane to be complete with Mono-rail, Hoist, Operator's Cab, Guard, Drum and Pallet Grabbing Auxiliaries, Motor, and Controls.
Capacity	- 10 Tons at 90 Ft. Lift and 100 Ft. Span
Material of Construction	- Carbon Steel or Manufacturer's Standard
HP	- 11

Item 120-43003 - 35/5T Bridge Crane

No. Required	- One (1)
Type	- Motor Driven Traveling Bridge Crane to be complete with Mono-rail, Hoist, Operator's Cab, Guard, Motor and Controls.
Capacity	- 35 Tons at 50 Ft. Lift and 100 Ft. Span
Material of Construction	- Carbon Steel or Manufacturer's Standard
HP	- 25

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AREA 120 - FACILITIES - continued

Item 120-43004 - Soda Ash Feeder

No. Required	- One (1)
Type	- Volumetric Type Feeder with Drive, Motor and Controls to Feed Soda Ash.
Capacity	- 4300 LB./HR
Material of Construction	- Carbon Steel or Manufacturer's Standard
HP	- 1/2

Item 120-45001 - Selexol Filter

No. Required	- One (1)
Type	- Basket Type Filter to remove Pipe Scale or Rust from Selexol.
Capacity	- 100 GPM at 100 PSIG
Material of Construction	- Carbon Steel Shell, Manufacturer's Standard Material for Filtration Element.

Item 120-45002 - Soda Ash Dust Collector

No. Required	- One (1)
Type	- Bag Filter Type Bin Vent Dust Collector with Exterior Housing, Reverse Gas Cleaning and Controls.
Capacity	- 71 Ft. ² Filter Area to Filter 240 LB./HR Soda Ash Dust at Ambient Conditions.
Material of Construction	- Carbon Steel Housing w/Polyester Bags.

THE ILLINOIS COAL GASIFICATION GROUP

5.0 BASELINE PROCESS CONCEPT

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5.9 PLOT PLANS AND LAYOUT DRAWINGS

The baseline concept of the Commercial Plant is depicted on the following layout drawings and plot plans drawings; a print of each is included in the supplement:

<u>Drawing Number</u>	<u>Rev. No.</u>	<u>Case</u>	<u>Title</u>
<u>Plot Plans</u>			
7051-100-200-1	0	PE	Site Plot Plan
7051-100-200-2	0	PE	Plot Plan Sheet 1 of 7
7051-100-200-3	0	PE	Plot Plan Sheet 2 of 7
7051-100-200-4	0	PE	Plot Plan Sheet 3 of 7
7051-100-200-5	0	PE	Plot Plan Sheet 4 of 7
7051-100-200-6	0	PE	Plot Plan Sheet 5 of 7
7051-100-200-7	0	PE	Plot Plan Sheet 6 of 7
7051-100-200-8	0	PE	Plot Plan Sheet 7 of 7
<u>Layout Drawings</u>			
7051-101-200-1	0	PE	Coal Unloading & Storage Area 101 Plan
7051-102-200-1	0	PE	Coal Preparation Area 102 Plan
7051-102-200-2	0	PE	Coal Preparation Area 102 Plan
7051-105-200-1	0	PE	Gas Purification - Acid Gas Removal Area 105 Plan
7051-106-200-1	0	PE	Hydrogen Generation Area 106 Plan
7051-107-200-1	0	PE	Shift & Methanation Area 107 Plan
7051-108-200-1	0	PE	Bulk CO ₂ Removal Area 108 Plan
7051-109-200-1	0	PE	Gas Compression & Dehydration Area 109 Plan
7051-110-200-1	0	PE	Flue Gas Power Recovery Oxida- tion & Air Compression - Area 110 Plan
7051-111-200-1	0	PE	SO ₂ Removal Area 111 Plan
7051-112-200-1	0	PE	Sulfur Recovery Area 112 Plan
7051-112-200-2	0	PE	Sulfur Storage Area 112 Plan

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5.9 PLOT PLANS AND LAYOUT DRAWINGS

<u>Drawing Number</u>	<u>Rev. No.</u>	<u>Case</u>	<u>Title</u>
<u>Layout Drawings - continued</u>			
7051-113-200-1	0	PE	Ammonia Recovery Area 113 Plan
7051-115-200-1	0	PE	Boiler House Area 115 A Plan
7051-115-200-2	0	PE	Plant & Instrument Air Com- pressors Area 115 B Plan
7051-115-200-3	0	PE	Inert Gas Generation and Refrigeration Systems Area 115 D Plan
7051-115-200-4	0	PE	Deaeration Area 115 E Plan
7051-115-200-5	0	PE	Cooling Towers Area 115 F Plan
7051-117-200-1	0	PE	Water Treatment Area 117 Plan
7051-118-200-1	0	PE	Water Treatment Area 117 Plan
7051-119-200-1	0	PE	Fire Protection Area 119 Plan
7051-120-200-1	0	PE	Chemical & Product Storage Area 120 Plan
7051-120-200-2	0	PE	Product Storage Area 120 Plan