6.5.13.3 METHANOL SYNTHESIS AND PURIFICATION - UNIT 21

DESIGN BASIS

Purpose of Unit

The purpose of this unit is to convert raw gas from the Rectisol unit into crude methanol which is further processed to obtain a high purity methanol product.

Scope of Unit

The unit consists of following major sections: Gas Compression, Methanol Conversion, and Methanol Purification. The crude methanol stream after methanol conversion is flashed successively to produce gas for recycle to conversion, a purge gas for feed to the Methanation unit and a fuel gas. The process is licensed by Lurgi Mineraloltechnik of West Germany.

General Design Criteria

The unit consists of two 50 percent capacity trains. The unit will be designed to produce 3,857 ST/D of crude methanol.

H_2, CO, and CO_2 in feed gas to the Methanol Synthesis unit are controlled at a ratio to optimize methanol conversion. The unit onstream factor is compatible with the overall plant stream factor of 332 days per year. All compressors are turbine-driven and all pumps are motor-driven.

Process Performance Objective

The unit operates at a CO conversion efficiency to produce 6.4 mole percent of methanol in the reactor effluent gas.

6.5.13.3 (Continued)

Feed Streams

The composition, flow rate, and the process conditions of the feed stream to the Methanol Synthesis unit are given below:

Component	Mole %
H_2	56.41
N_2/Ar (as N_2)	0.33
CO	25.21
CH_4	15.58
C_2H_6	0.43
CO_2	2.04

Feed Streams

Flow Rate, MM SCFD	399.845
lb/hr	518,691
Temperature, °F	68
Pressure, psia	355

6.5.13.3 (Continued)

Product Streams

The summary of product streams with their composition, flow rate, and process conditions is as follows:

	Pure Methanol Product	Purge Gas to Methanation & PSA Unit	Fuel Gas From 1st Flash	Fuel Gas From 2nd Flash
Phase	Liquid	Vapor	Vapor	Vapor
Component Mole %				
H_2		34.27	11.97	1.61
N_2/Ar (as N_2)		1.06	0.48	0.16
CO		10.59	6.52	1.61
CH_4		48.52	3.53	32.74
C_2H_6		0.62	5.56	3.21
CO_2		3.68	57.04	32.74
C_2H_4		0.62	14.86	1.61
MeOH	99.8	0.64	-	26.32
C_2 Alcohols	0.2			
H_2O	10 ppm wt.	-	0.04	-
Flow Rate	9,664.8 (1)	112.311 (2)	3.4665 (2)	0.56743 (2)
Temperature, °F	95	100	95	93
Pressure, psia	75	1,055	75	14.7

NOTES: (1) Lb-moles/hr

(2) MM SCFD

6.5.13.3 (Continued)

Utility Summary

Consumption

550 psig steam @ 756°F, lb/hr	312,256
120 psig saturated steam, lb/hr	9,368
50 psig saturated steam, lb/hr	383,300
Cooling Water, gpm	26,200
Boiler Feed Water, lb/hr	332,230
Electric Power, kW	1,455

Production

570 psig saturated steam, lb/hr	328,940
Vacuum Condensate, lb/hr	312,256
LP Condensate, lb/hr	392,668
Fuel Gas, MM Btu/hr	67.154

PROCESS DESCRIPTION

The flow diagram is shown on Drawing No. 835704-21-R-301. The material balance is given on Table 6.5.13-3. The plot plan (Drawing No. 835704-21-4-051) and the equipment list (Table 6.5.13-4) follow.

Pure synthesis gas from Rectisol unit is compressed in two stages before it is combined with recycle gas. The mixed gas, constituting the total feed to the reactors, is passed through the final stage of compression. The total feed after final compression is preheated in the feed/effluent exchanger before being fed into the reactors.

6.5.13.3 (Continued)

The reactions take place inside catalyst-packed tubes which are totally submerged in saturated pressurized water. The methanol conversion is an exothermic reaction process, as a result of which, the heat released is utilized in generating high pressure steam. The steam generated is superheated by the incinerator flue gas and mixed with additional high pressure superheated steam before it is utilized within the unit in compressor turbine drivers.

The reactor design is similar to a vertical shell and tube heat exchanger with the process stream flowing downward, and the boiling water circulating upward counter-currently. This configuration is designed to maintain operation of the reactors at constant temperature for preventing damage to the catalyst.

The reactor effluent is cooled successively by the feed to the reactors, by air and finally by cooling water. Crude methanol is condensed out and separated in the Methanol/Recycle Gas Separator. The gaseous stream off the separator represents a total stream constituting the recycle gas and the purge gas. The recycle gas going to the reactors serves the purpose of moderating the rate of reaction in the catalyst tubes. The function of the purge gas to the Methanation unit is to prevent the build-up of inerts in the reaction loop.

The gases dissolved in crude methanol are separated, as crude methanol is flashed in the fuel gas flash drum at the lower pressure. The vapors off the separator are piped to the fuel gas system and the bottom liquid product containing methanol is further purified.

The final purification process removes residual dissolved gases, volatiles, higher alcohols and water to meet product specification.

6.5.13.3 (Continued)

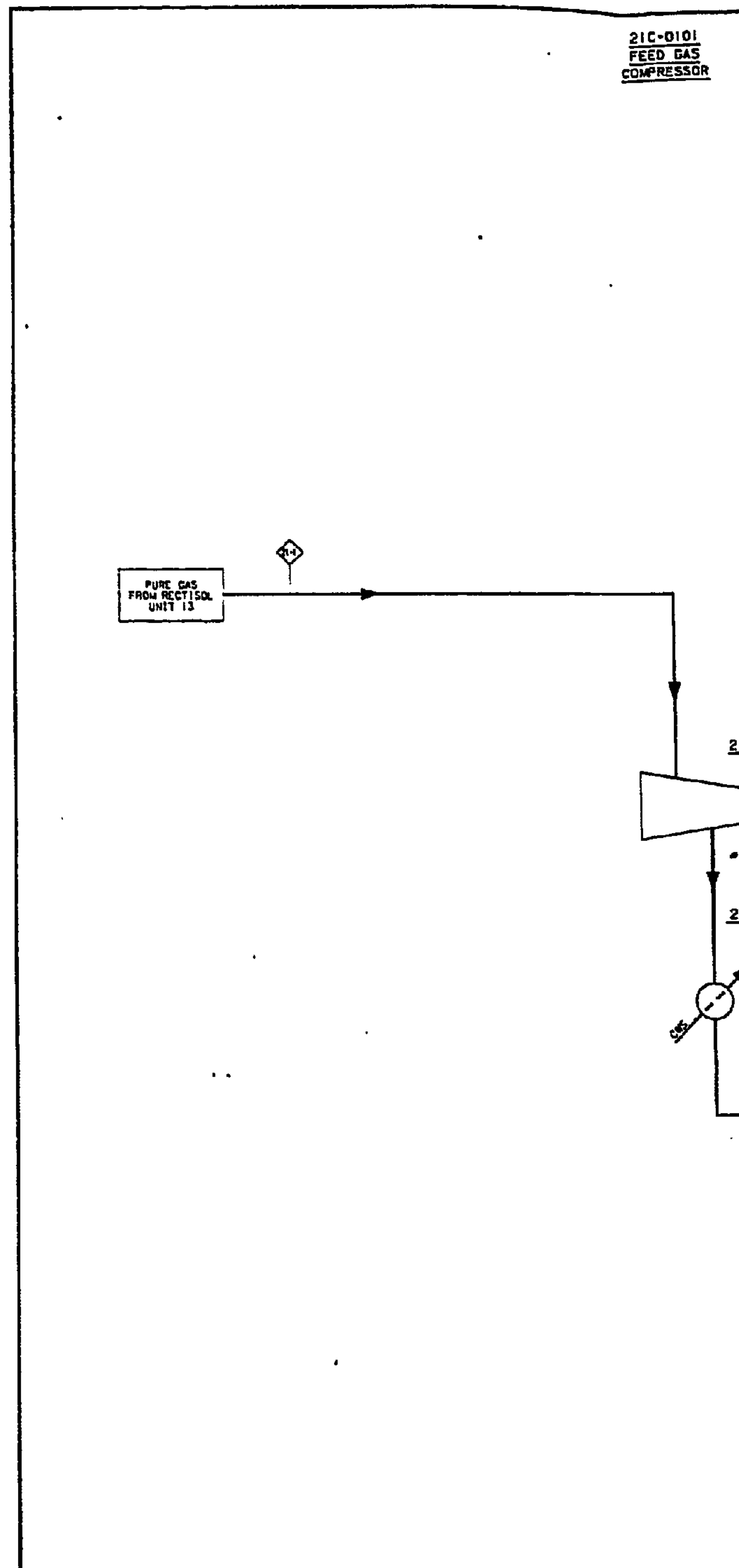
Crude methanol obtained as the liquid product from the fuel gas flash drum is preheated by the bottom product of the devolatilizing column in the feed/effluent exchanger. Crude methanol is further heated in a heat exchanger by hot tempered water before it is fed to the devolatilizing column. The removal of residual dissolved gases from crude methanol is accomplished by the devolatilizing column.

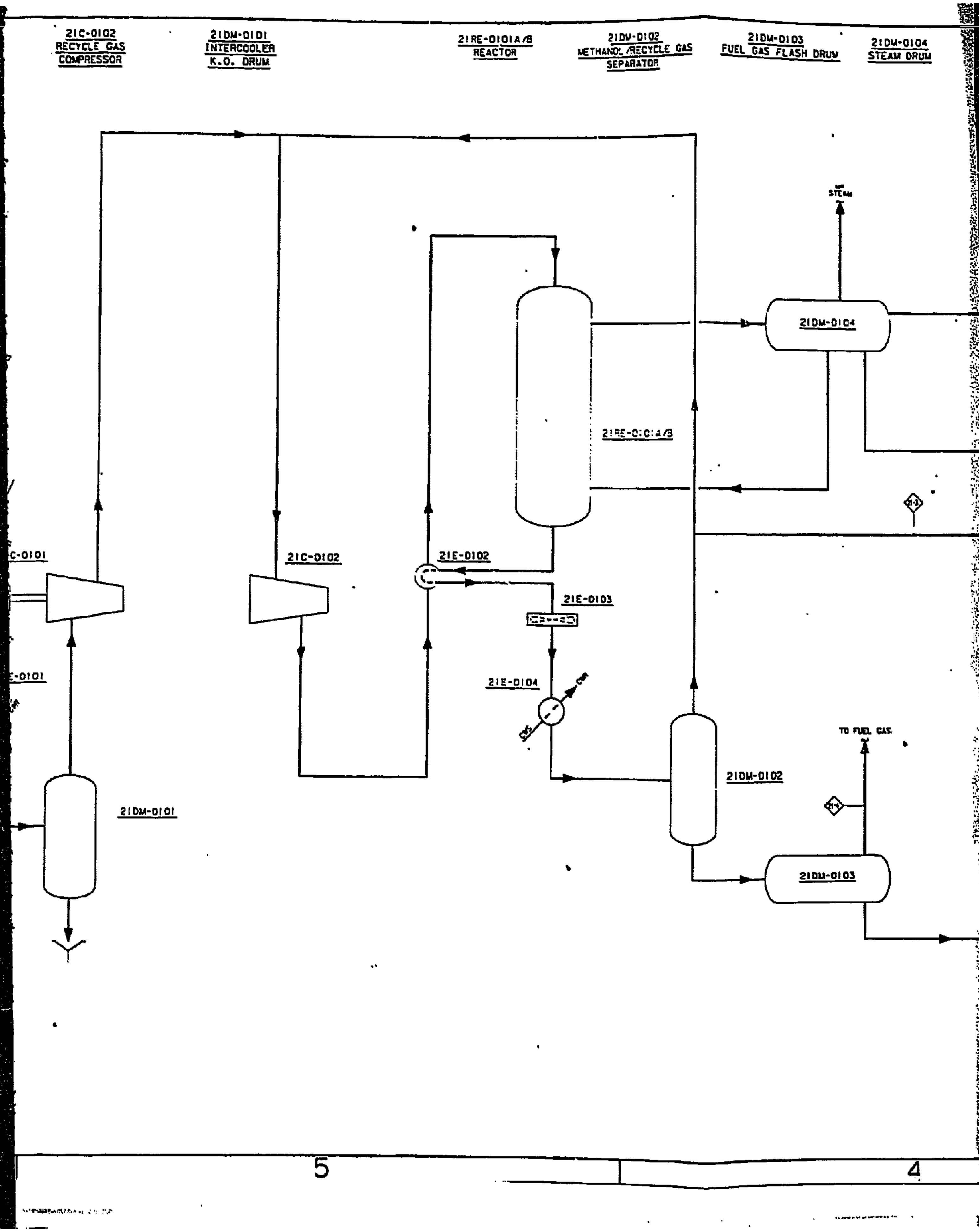
To prevent corrosion in the unit, caustic soda is injected in the crude methanol feed stream to raise the pH prior to entering preheat exchangers. The mixing of caustic soda with the crude methanol chemically binds undesirable compounds such as volatiles to promote easy separation from methanol.

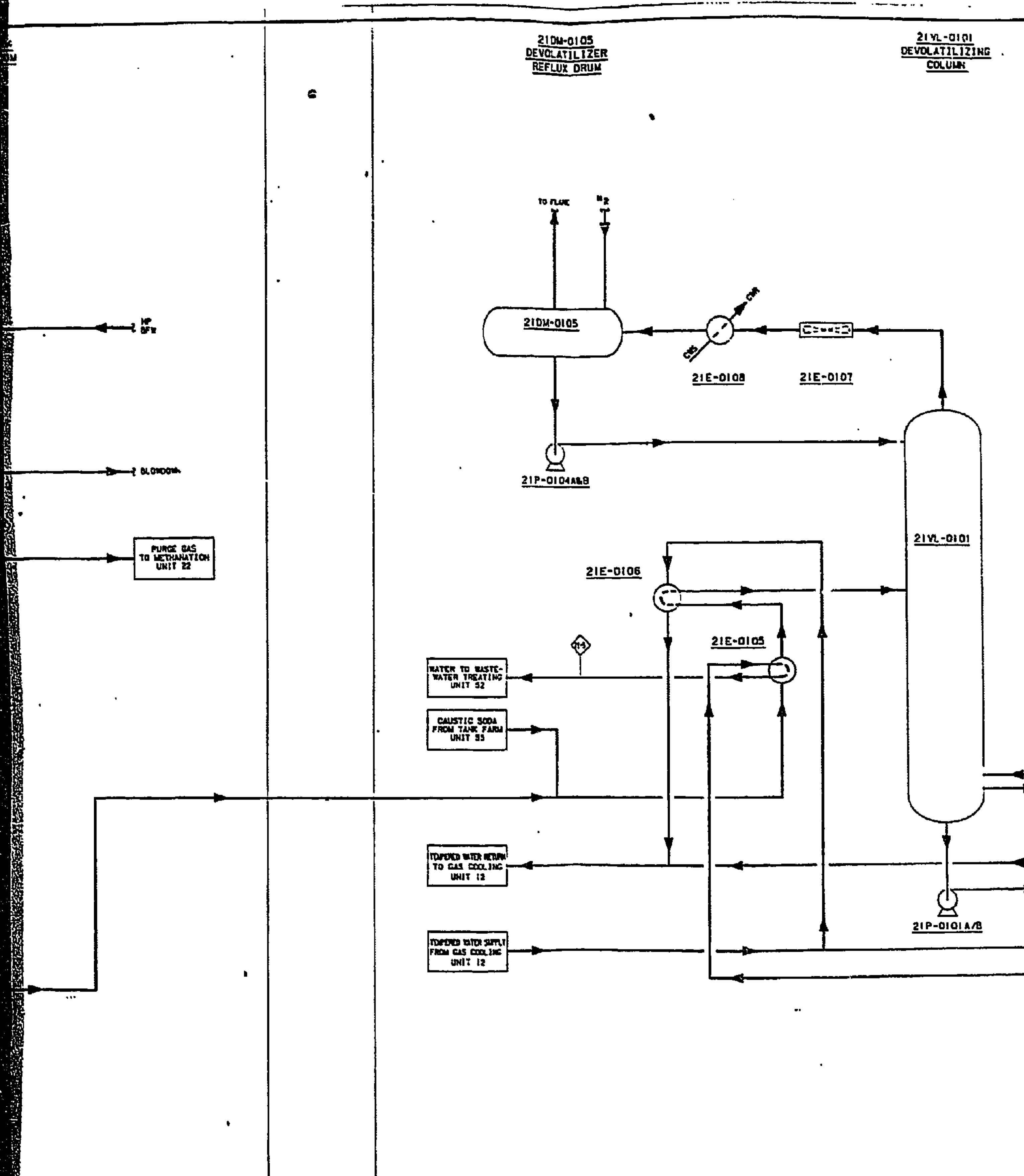
The overhead vapor stream carrying dissolved gases from the devolatilizing column is air cooled and condensed by cooling water. The dissolved gases are separated at nearly atmospheric pressure in the devolatilizer reflux drum. The liquid condensate is refluxed back to the column.

The devolatilizing bottom product free of dissolved gases and containing chiefly methanol and water is pumped to the steam reboiled refining column for the final separation of water from methanol. Methanol, as the overhead stream, is distilled off the refining column. Methanol vapors are totally condensed by the air cooler and accumulated in the refiner reflux/product drum. The major portion of the condensate is returned as reflux to the refining column. The overflow is withdrawn as product methanol and pumped to the tank farm for storage.

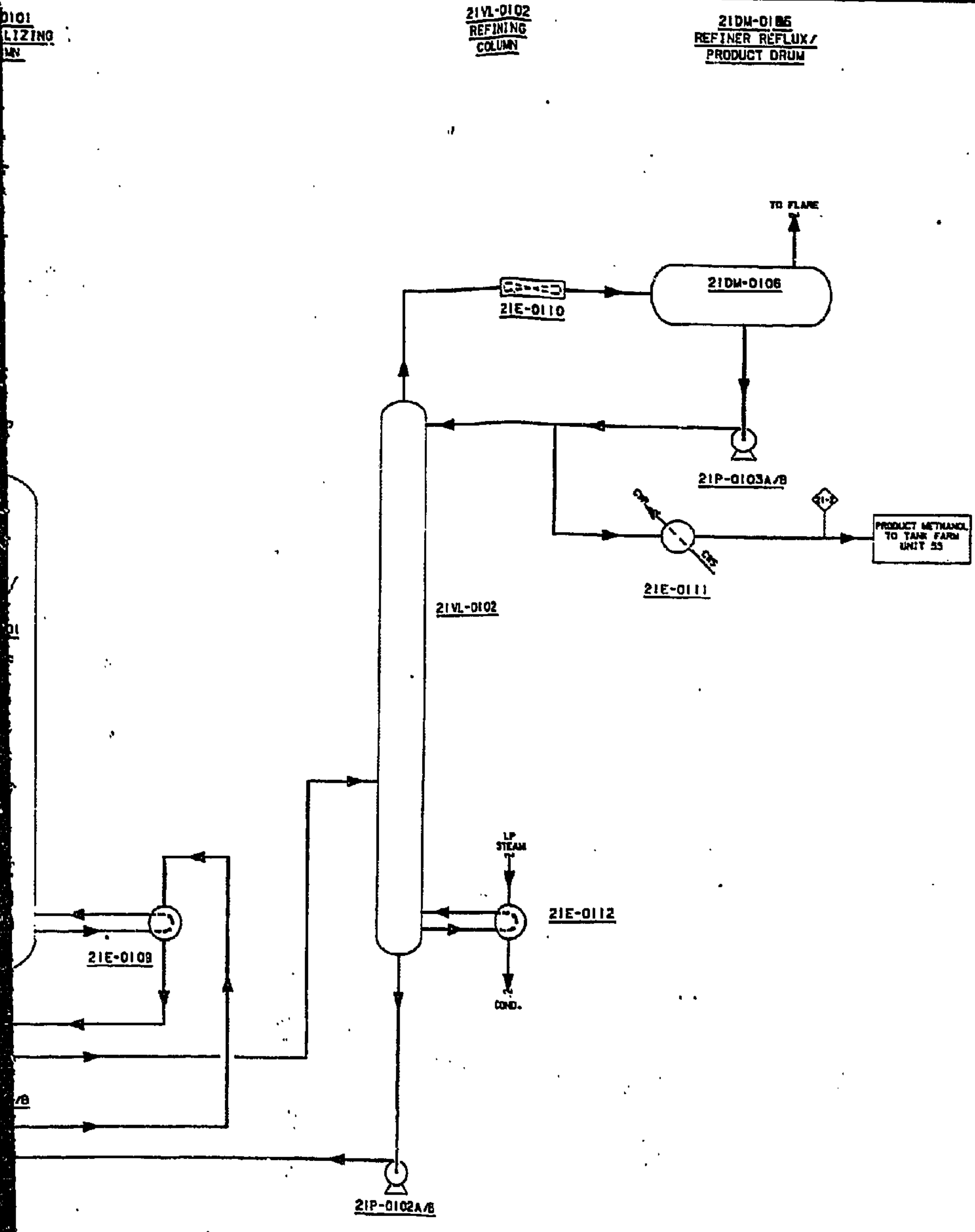
The water collected as the bottom stream of the refining column is cooled by exchanging heat with the crude methanol feed in the feed/effluent exchanger and pumped to the waste water treating unit.


21C-0101
FEED GAS
COMPRESSOR
PURE GAS
FROM RECTISOL
UNIT 13
21C
21E
CWS


21C-0102
RECYCLE GAS
COMPRESSOR
21DM-0101
INTERCOOLER
K.O. DRUM
21RE-0101A/B
REACTOR
21DM-0102
METHANOL/RECYCLE GAS
SEPARATOR
21DM-0103
FUEL GAS FLASH DRUM
21DM-0104
STEAM DRUM
STEAM
21DM-0104
21RE-0101A/B
C-0101
21C-0102
21E-0102
21E-0103
E-0101
21E-0104
TO FUEL GAS
21DM-0102
21DM-0101
21DM-0103
5
4



DRAWING NO.	REV.	FRAME
835T04-21-R-301	1	2 OF 2



NOTES:

1. THIS DRAWING REPRESENTS ONE TRAIN OF A T
CAPACITY OF EACH TRAIN IS 50% OF UNIT DE

2. THIS DRAWING IS A SIMPLIFIED FLOW DIAGRA
PROPRIETARY UNIT. STREAM CONFIGURATIONS
ARE NOT COMPLETELY REPRESENTED.

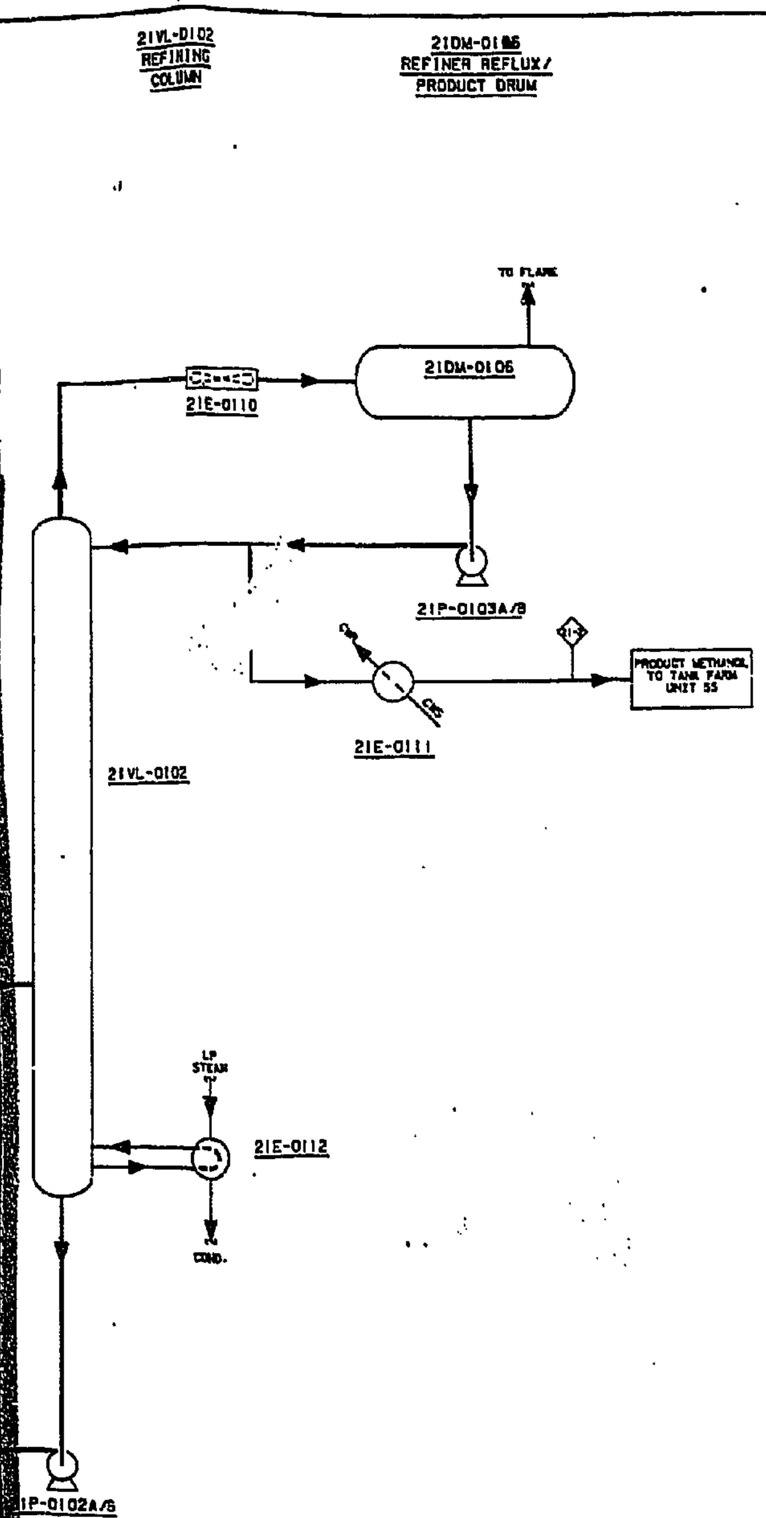
3. THE FLOW QUANTITIES, PRESSURES, AND TEM
REFERENCED BY DIAMONDS ARE SHOWN ELSEWHE

FLUOR

R. WHITE
C.C. ABATAY
W.O'BELMITD
R. McCARTHY
R. LANG
NONE

PROCESS FL
METHANOL SYNTHESIS AND
CASE: CO-PR
CROW TRIBE OF INDIANS
835

2



NOTES:

1. THIS DRAWING REPRESENTS ONE TRAIN OF A TWO TRAIN UNIT. CAPACITY OF EACH TRAIN IS 50% OF UNIT DESIGN.
2. THIS DRAWING IS A SIMPLIFIED FLOW DIAGRAM OF A PROPRIETARY UNIT. STREAM CONFIGURATIONS AND/OR EQUIPMENT ARE NOT COMPLETELY REPRESENTED.
3. THE FLOW QUANTITIES, PRESSURES, AND TEMPERATURES REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.

USE OR DISCLOSURE OF REPORT DATA IS SUBJECT TO THE RESTRICTION ON THE NOTICE PAGE AT THE FRONT OF THIS REPORT

FLUOR

R. WHITE	PROCESS FLOW DIAGRAM
C.C. ABATAY	METHANOL SYNTHESIS AND PURIFICATION - UNIT 21
V. D'BELMITO	CASE: CO-PRODUCTION
R. McCARTHY	CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY
R. LANG	NONE — 835704-21-R-301 — 1
	MICROFILM FRAME 1 OF 2

003 35721301

2

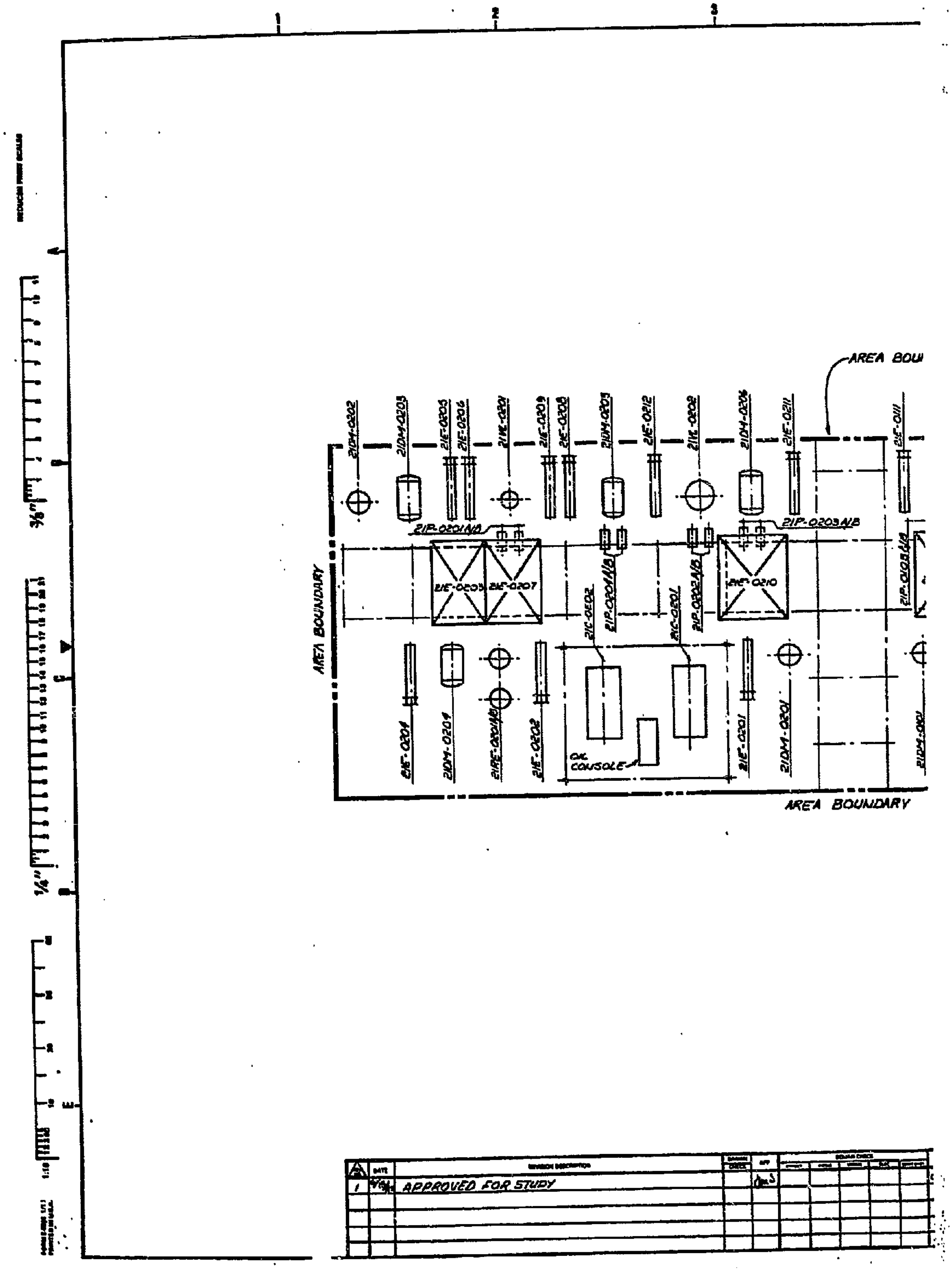
TABLE 6.5.13-3

MATERIAL BALANCE

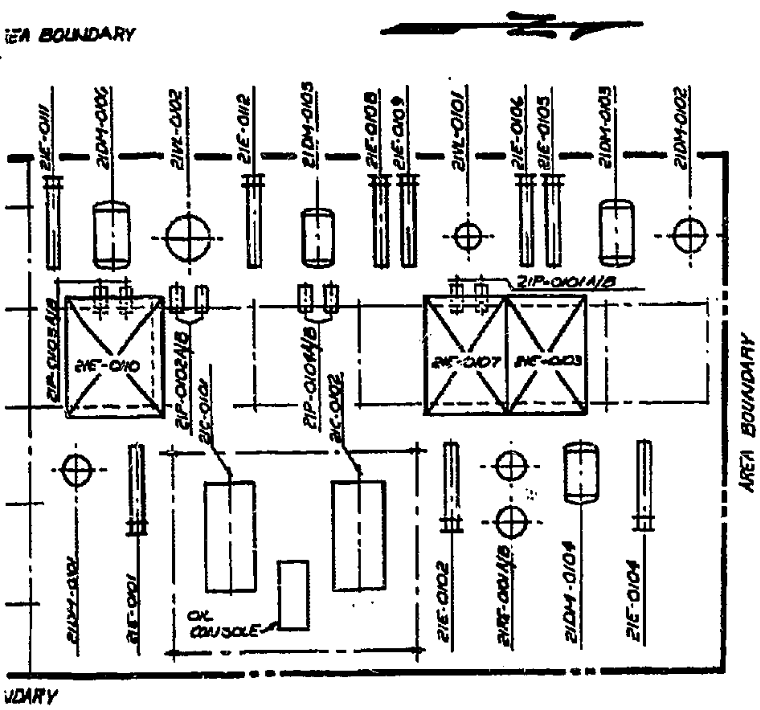
METHANOL SYNTHESIS AND PURIFICATION - UNIT 21

Stream Number / Stream Name	21-1 Pure Gas from Rectisol		21-2 Methanol Product	21-3 Purge Gas to Methanation		21-4 Fuel Gas to Plant Fuel Gas		21-5 Water to Waste Treating
Component	lb-mol/hr	Mol%		lb-mol/hr	Mol%	lb-mol/hr	Mol%	
H_2	24,764.6	56.41		4,529.5	34.33	46.5	10.51	
N_2	146.1	0.33		144.2	1.09	1.9	0.43	
CO	11,065.1	25.21		1,403.5	10.64	25.8	5.83	
CH_4	6,841.2	15.58		6,415.8	48.63	237.3	53.64	
C_2H_6	187.0	0.43		128.6	0.97	16.5	3.73	
CO_2	896.4	2.04		487.0	3.69	76.9	17.38	
CH_3OH				84.6	0.64	37.5	8.48	
Dry Gas, lb-mol/hr	43,900.4	100.00		13,193.2	100.00	442.4	100.00	
H_2O, lb-mol/hr	-	-		-	-	0.2		
Wet Gas, lb-mol/hr	43,900.4			13,193.2	100.00	442.6		
Dry Gas lb/hr	518,619		-	183,416		9,758		-
H_2O lb/hr	-		-	-		4		11,567
CH_3OH (liq.) lb/hr	-		313,143	-		-		-
Total lb/hr	518,619		313,143	183,416		9,762		11,567
Pressure, psia	360		20	1,055		75		30
Temperature, °F	68		100	100		95		110

NOTES: Flow quantities, pressures, and temperatures shown are for the total unit on a stream day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.


AREA BOUNDARY
AREA BOUNDARY
AREA BOU
21D4-0202
21D4-0203
21E-0205
21E-0206
21E-0201
21E-0209
21E-0208
21D4-0205
21E-0212
21E-0202
21D4-0206
21E-0211
21E-0111
21P-0201A/B
21P-0203A/B
21E-0203
21E-0207
21E-0210
21C-0202
21P-0204A/B
21C-0201
21P-0202A/B
21P-0105A/B
21E-0204
21DM-0204
21RE-0201A/B
21E-0202
OIL CONSOLE
21E-0201
21DM-0201
21DM-0101
1/4"
3/8"
1
APPROVED FOR STUDY

USE OR DISCLOSURE OF REPORT DATA IS SUBJECT TO THE RESTRICTION ON THE NOTICE PAGE AT THE FRONT OF THIS REPORT



REDUCED PRINT SCALE

ALL EQUIPMENT SIZES AND LOCATIONS ARE APPROXIMATE

00-G-003	SITE™ CO-PRODUCTION PLOT PLAN

FLUOR

R MILLER

CONT'I

SMETS

R LANG

PLOT PLAN - UNIT 21

METHANOL SYNTHESIS AND PURIFICATION ALTERNATE #2 - CO-PRODUCTION CASE

CROW TRIBE OF INDIANS MONTANA

1" = 20'-0" | 835704-21-4-051 | 1

TABLE 6.5.13-4

EQUIPMENT LIST
METHANOL SYNTHESIS AND PURIFICATION - UNIT 21

Item No.	Equipment Description	Number Required Operating	Number Required Spare
21RE-0101 A/B	Reactor	4	-
21VL-0101	Devolatilizing Column	2	-
21VL-0102	Refining Column	2	-
21DM-0101	Feed Surge Drum	2	-
21DM-0102	Intercooler K.O. Drum	2	-
21DM-0103	Aftercooler K.O. Drum	2	-
21DM-0104	Methanol/Recycle Gas Separator	2	-
21DM-0105	Fuel Gas Flash Drum	2	-
21DM-0106	Steam Drum	2	-
21DM-0107	Devolatilizer Reflux Drum	2	-
21DM-0108	Refiner Reflux/Product Drum	2	-
21E-0101	Feed Gas Compressor Air Intercooler	2	-
21E-0102	Feed Gas Compressor Air Aftercooler	2	-
21E-0103	Feed/Effluent Preheater	2	-
21E-0104	Effluent Air Cooler	2	-
21E-0105	Effluent Trim Cooler	2	-
21E-0106	Feed Turbine Surface Condenser	2	-
21E-0107	Recycle Turbine Surface Condenser	2	-
21E-0108	Feed/Refiner Bottom Exchanger	2	-
21E-0109	Feed Preheater	2	-
21E-0110	Devolatilizer Air Condenser	2	-

TABLE 6.5.13-4 (Continued)

Item No.	Equipment Description	Number Required Operating	Number Required Spare
21E-0111	Devolatilizer Water Condenser	2	-
21E-0112	Devolatilizer Reboiler	2	-
21E-0113	Refiner Air Condenser	2	-
21E-0114	Product Methanol Cooler	2	-
21E-0115	Refining Column Reboiler	2	-
21C-0101	Feed Gas Compressor	2	-
21T-0101	Feed Compressor Steam Turbine	2	-
21C-0102	Recycle Gas Compressor	2	-
21T-0102	Recycle Compressor Steam Turbine	2	-
21P-0101 A/B	Devolatilizer Bottoms Pump	2	2
21P-0102 A/B	Refiner Bottoms Pump	2	2
21P-0103 A/B	Refiner Reflux Pump	2	2
21P-0104 A/B	Devolatilizer Reflux Pump	2	2
21P-0105 A/B	Feed Turbine Condensate Pump	1	1
21P-0106 A/B	Recycle Turbine Condensate Pump	1	1

NOTE: Train Number 2 equipment numbers which are not shown are the same as indicated above except the train designation is 02 instead of 01.

Example:	Train #1	Train #2
	12RE-0101 A/B	12RE-0201 A/B

6.5.13.4 METHANATION - UNIT 22

DESIGN BASIS

Purpose of Unit

The purpose of the Methanation Unit is to produce substitute natural gas (SNG) from the methanol unit purge gas by the catalytic reaction of CO, CO_2, and CnHm with H_2 to form CH_4.

Scope of Unit

The unit has two stages of methanation in series. The heat released by the exothermic reaction in the methanation reaction is recovered by preheating the feed to the first methanator and generating 650 psig steam.

The unit also includes compression and recycle of a portion of the first stage methanator effluent, downstream of the waste heat boiler.

General Design Criteria

The unit has two 50 percent capacity trains which process approximately 4.6 MM SCF/H of Methanol unit purge gas as feed. The unit onstream factor is compatible with the overall plant stream factor of 332 days per year. Compressors in this unit are motor-driven.

Process Performance Objectives

To achieve the design conversion of CO and CO_2 to CH_4, a ratio of 3.2 lb-mols H_2 per lb-mol CO in the feed stream is maintained. The outlet temperature of the first stage methanator is maintained at 840°F. The excess CO_2 contained in the methanated gas is removed in a downstream unit.

6.5.13.4 (Continued)

Feed Streams

The composition, flow rate, and process conditions of the feed stream are as follows:

Component	Mole %
H_2	34.27
N_2/Ar (as N_2)	1.06
CO	10.59
CH_4	48.52
C_2H_6	0.62
C_2H_4	0.62
CO_2	3.68
MeOH	0.64
Flow Rate, MM SCFD	110.3
lb/hr	179,153

Temperature, °F	100
Pressure, psia	1055

6.5.13.4 (Continued)

Product Streams

Methanator Product Gas

The composition, flow rate, and process conditions of the methanator product are as follows:

Component	Mole %
H_2	0.34
N_2/Ar (as N_2)	1.56
CO	0.01
CH_4	92.70
CO_2	5.30
H_2O	0.09
Flow Rate, MM SCFD	73.6

Temperature, °F	100
Pressure, psia	1005

Utility Summary

Consumption

Cooling Water, gpm	300
Boiler Feed Water, lb/hr	137,700
Electric Power, kW	1,185

Production

650 psig sat. steam, lb/hr	135,500

6.5.13.4 (Continued)

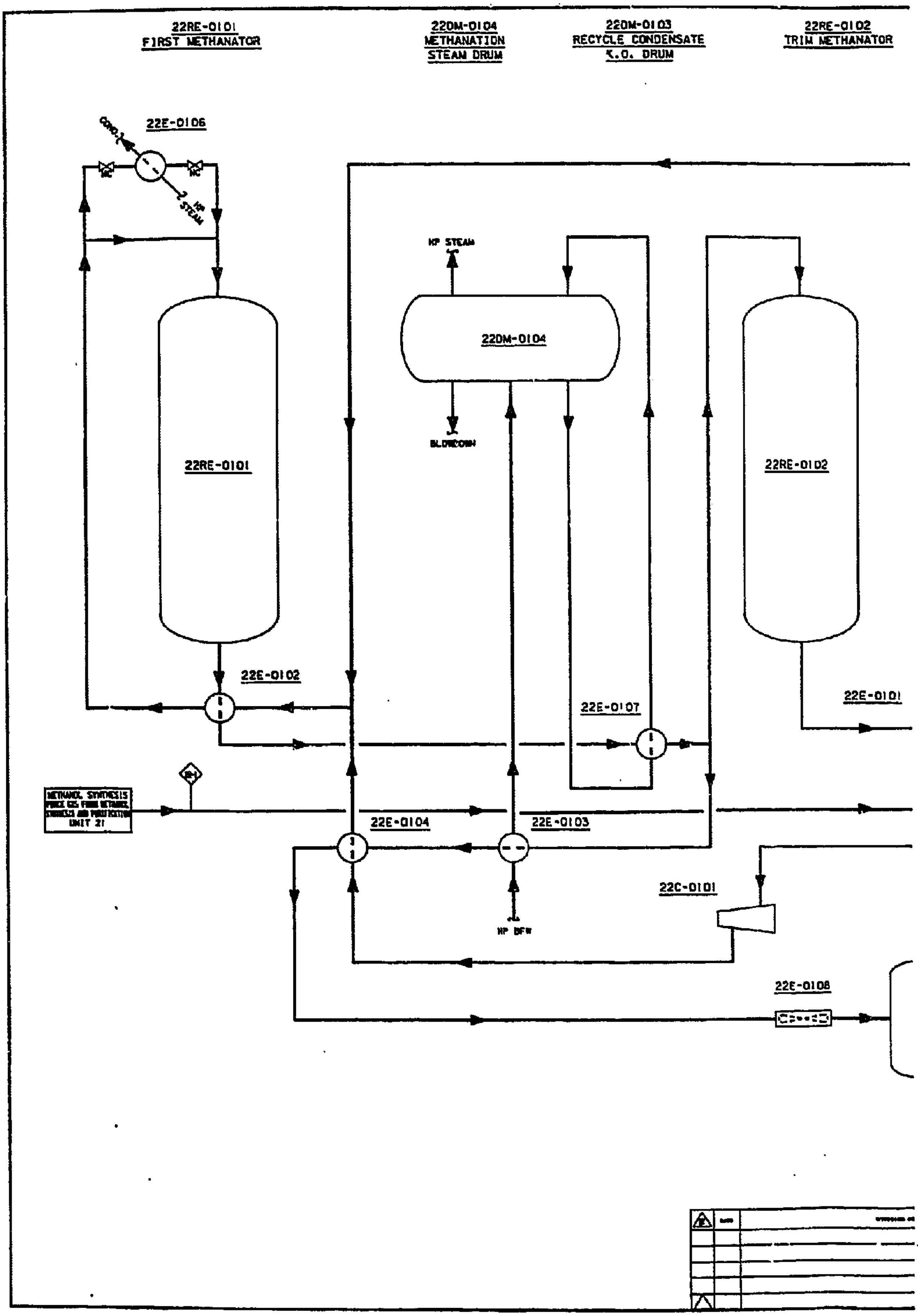
PROCESS DESCRIPTION

The flow diagram is shown on Drawing No. 835704-22-4-301. The material balance is shown on Table 6.5.13-5. The plot plan (Drawing No. 835704-22-4-051) and the equipment list (Table 6.5.13-6) follow.

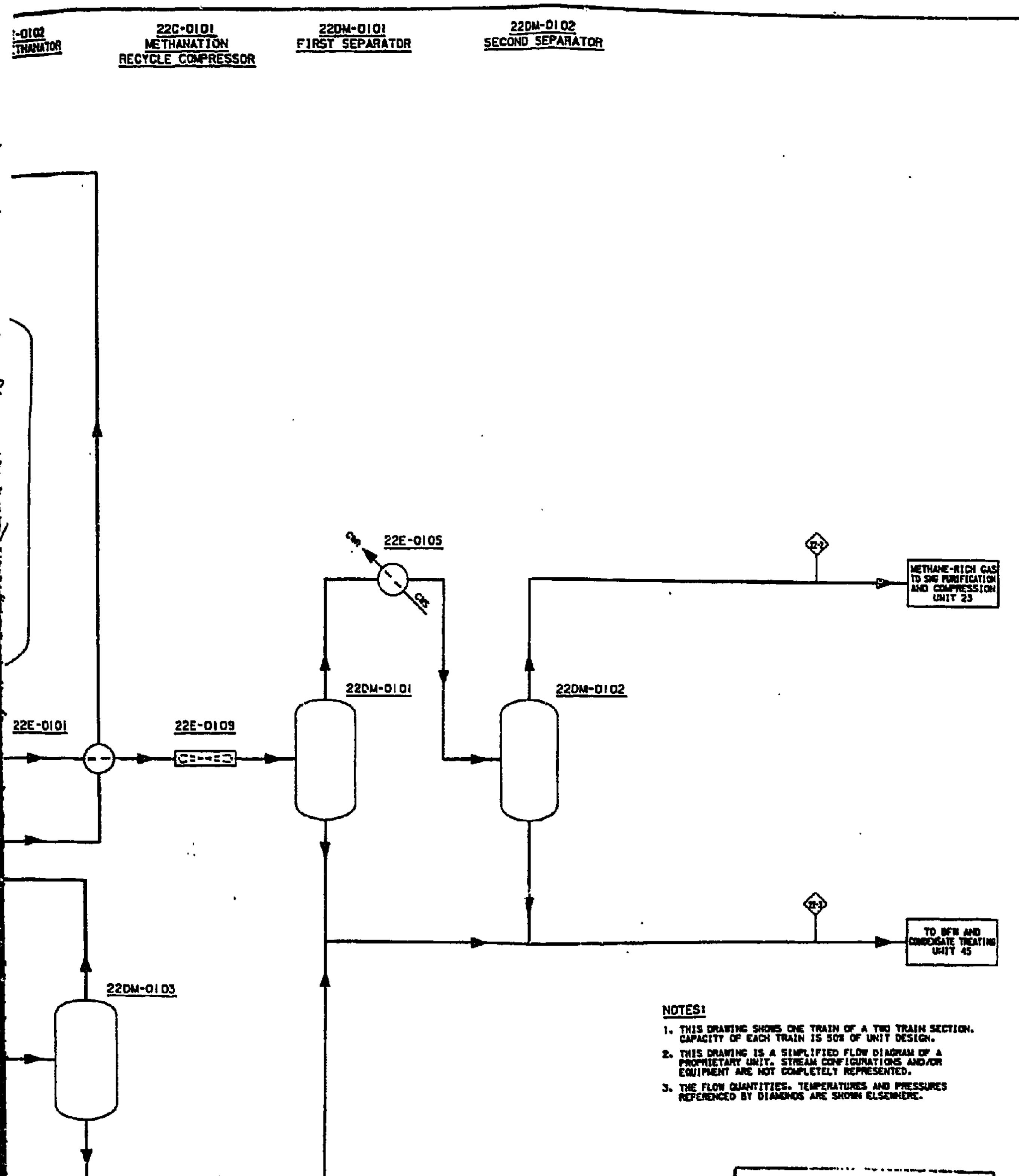
Purge gas from Methanol Synthesis Unit is the feed to this unit. The feed stream is preheated in a series of exchangers by effluent streams of both methanators. The feed stream is combined with the reaction loop recycle gas before it is charged to the primary methanator. The function of the recycle gas is to moderate the reaction temperature to optimum level.

The heat carried by the effluent from the first methanator is utilized in preheating the combined feed to the first methanator and generating high pressure saturated steam. A large portion of the cooled effluent is further cooled to condense out as much water as possible in a series of heat exchangers heating boiler feed water and recycle gas. This cooled gas is further air cooled and after having condensate knocked out, it is compressed and recycled to combine with the feed to the first methanator.

The remaining portion of the cooled effluent from the first methanator is fed to the trim methanator. The heat released by the reaction and contained by the effluent stream is utilized in preheating the feed stream. It is further cooled by air and cooling water to condense out water and passed through the knockout drum. The condensate collected in knockout drum is pumped to the condensate Collecting and Distributing unit.



22RE-0101
FIRST METHANATOR
22DM-0104
METHANATION
STEAM DRUM
22DM-0103
RECYCLE CONDENSATE
K.O. DRUM
22RE-0102
TRIM METHANATOR
22E-0106
HP STEAM
22DM-0104
BLOWDOWN
22RE-0101
22RE-0102
22E-0102
22E-0107
22E-0101
UNIT 21
22E-0104
22E-0103
HP BFW
22C-0101
22E-0108



NOTES:

1. THIS DRAWING SHOWS ONE TRAIN OF A TWO TRAIN SECTION. CAPACITY OF EACH TRAIN IS 50% OF UNIT DESIGN.
2. THIS DRAWING IS A SIMPLIFIED FLOW DIAGRAM OF A PROPRIETARY UNIT. STREAM CONFIGURATIONS AND/OR EQUIPMENT ARE NOT COMPLETELY REPRESENTED.
3. THE FLOW QUANTITIES, TEMPERATURES AND PRESSURES REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.

FLUOR

D.P. HALVERSON	PROCESS FLOW DIAGRAM	
C.C. ABATAY	METHANATION-UNIT 22	
G.D. ROMO	CASE: CO-PRODUCTION	
R. McCARTHY	CROW TRIBE OF INDIANS	SYNFUELS FEASIBILITY STUDY
R. LANG	NONE	835704-22-4-301	1

003 35722301

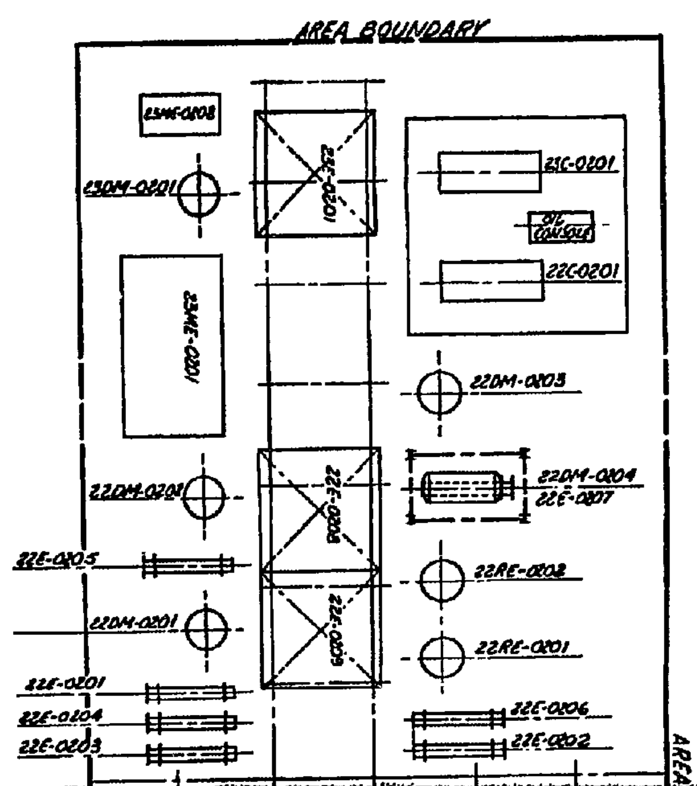
TABLE 6.5.13-5

MATERIAL BALANCE
METHANATION - UNIT 22

Stream Number	22-1		22-2		22-3	
Stream Name	Purge Gas From Unit 21		Methane Rich Gas to Unit 23		Condensate to Unit 45	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
H_2	4424.2	34.33	28.1	0.33		
N_2	140.9	1.09	136.4	1.63		
CO	1370.9	10.64	0.8	0.01		
CH_4	6266.9	48.63	7766.5	92.73		
C_2H_6	125.6	0.97	-			
CO_2	475.7	3.69	443.8	5.30		
CH_3OH	82.6	0.64	-			
Dry Gas, lb-mol/hr	12,886.5	100.00	8,375.6			
H_2O lb-mol/hr	-	10.4				
Wet Gas, lb-mol/hr	12,886.5		8,386.0			
Dry Gas, lb/hr		179,153		148,022		
H_2O, lb/hr		-		187		30,944
CH_3OH (liq.) lb/hr			-		-	-
Total, lb/hr		179,153		148,209		30,944
Pressure, psia		1,055		970		1090
Temperature, °F		100		68		120

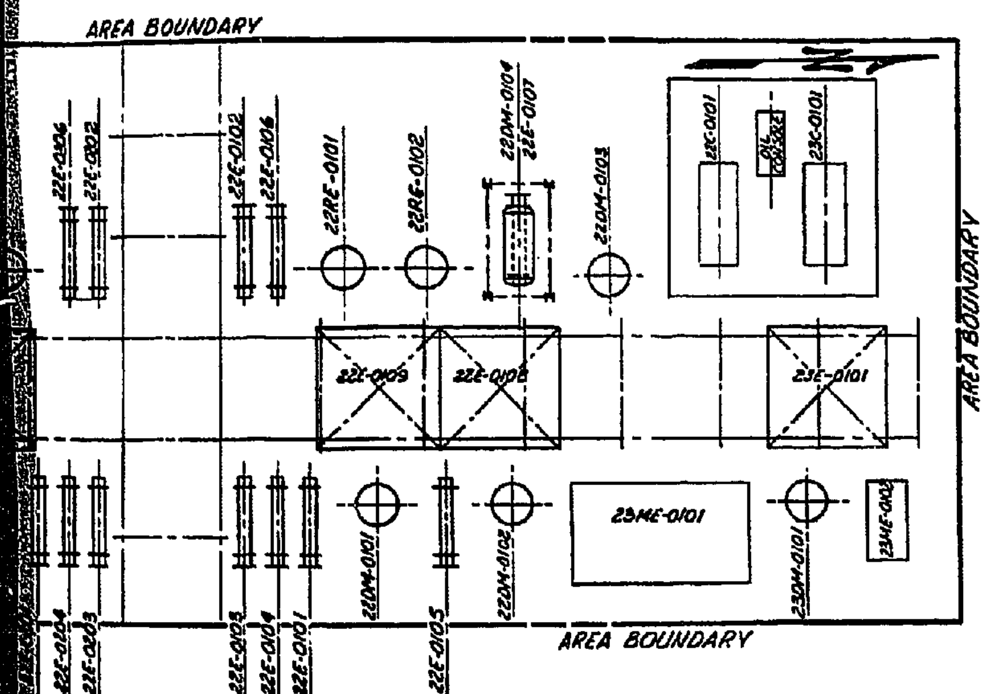
NOTES: Flow quantities, pressure, and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

REDUCED PRINT SCALES



	DATE	REVISION DESCRIPTION		APP
1		APPROVED FOR STUDY		

USE OR DISCLOSURE OF REPORT DATA IS SUBJECT TO THE RESTRICTION ON THE NOTICE PAGE AT THE FRONT OF THIS REPORT



ALL EQUIPMENT SIZES AND LOCATIONS ARE APPROXIMATE.

Reference drawing no.	Title
00-B-092	SITE #1 CO-PRODUCTION PLOT PLAN

FLUOR

J.PARODI
HUTTEN
T.CONTI
J.SMETS
R.LANG

PLOT PLAN-UNITS 22-23
METHANATION AND SNG PURIFICATION & COMPRESSION
ALTERNATE #2 - CO-PRODUCTION CASE
CROW TRIBE OF INDIANS — MONTANA

Scale: 1"=20'-0" | Drawing no.: 835704-22-4-051 | Rev.: 1

TABLE 6.5.13-6

EQUIPMENT LIST
METHANATION - UNIT 22

Item No.	Equipment Description	Number Required: Operating	Number Required: Spare
22RE-0101	First Methanator	2	-
22RE-0102	Trim Methanator	2	-
22DM-0101	First Separator	2	-
22DM-0102	Second Separator	2	-
22DM-0103	Recycle Condensate K.O. Drum	2	-
22DM-0104	Methanation Steam Drum	2	-
22E-0101	First Feed/Product Exchanger	2	-
22E-0102	Second Feed/Product Exchanger	2	-
22E-0103	Recycle/BFW Exchanger	2	-
22E-0104	Methanation Recycle Exchanger	2	-
22E-0105	Trim Cooler	2	-
22E-0106	Methanation Startup Heater	2	-
22E-0107	Methanation Steam Generator	2	-
22E-0108	Recycle Gas Air Cooler	2	-
22E-0109	SNG Air Cooler	2	-
22C-0101	Methanation Recycle Compressor	2	-

NOTE: Train Number 2 equipment numbers which are not shown are the same as indicated above except the train designation is 02 instead of 01.

Example:	Train #1	Train #2
	22RE-0101	22RE-0201

6.5.13.5 SNG PURIFICATION AND COMPRESSION - UNIT 23

DESIGN BASIS

Purpose of Unit

The purpose of this unit is to remove the CO_2 in the SNG from the methanation unit to acceptable levels for pipeline transport and sales and compress the SNG product to the pressure required for pipeline transport.

Scope of Unit

The unit includes compression of SNG from methanation unit, high pressure Rectisol wash, and the final compression and cooling of the product SNG to pipeline operating conditions. Flow metering of the gas and Btu analysis are carried out to provide in-plant information and to set the quantity of odorant to be injected into the product gas. Refrigeration and solvent regeneration associated with the Rectisol wash of SNG are included in the Rectisol Unit 13.

General Design Criteria

SNG compression consists of two 55 percent trains.

There are two 55 percent parallel trains of SNG purification which interface with the two train operation of the Rectisol Unit 13. The CO_2 absorption is accomplished at a high pressure requiring methanation unit product gas to be compressed. This reduces hot regeneration requirements with little added compression cost (except for the additional CO_2 compression) since the SNG must be compressed to pipeline pressure in any case. The overall unit onstream factor is compatible with the overall plant stream factor of 332 days per year.

6.5.13.5 (Continued)

Process Performance Objectives

The Rectisol wash is designed to reduce the CO_2 in SNG to a level such that the SNG product has the specified HHV of 987 Btu/SCF. Under normal operating conditions, this corresponds to approximately 0.57 percent CO_2 in the SNG product. The compressors are designed to deliver 67.35 MM SCF/SD of SNG to a pipeline operating at 1435 psia and 115°F.

Feedstock

SNG from Methanation

Dry Gas	8,375.6 lb-mol/hr
Water	10.4 lb-mol/hr
Total Gas	8,386.0 lb-mol/hr or 148,209 lb/hr

Battery Limit Conditions: Temperature 86°F
Pressure 1005 psia

Composition:

Component	Dry Mol %
H_2	0.33
N_2	1.63
CO	0.01
CH_4	92.73
CO_2	5.30

6.5.13.5 (Continued)

Products

SNG to Pipeline

SNG Production Rate	7,394.8 lb-mol/hr 67.35 MM SCF/SD
Battery Limit Conditions	Tempterature 115°F Pressure 1435 psia

Composition:

Component	Dry Mol %
H_2	0.38
N_2	1.83
CO	0.01
CH_4	97.21
CO_2	0.57
H_2O	nil

HHV = 987 Btu/SCF

Utility Requirements

The utilities associated with the Rectisol wash are included in Rectisol Unit 13. The utilities for SNG compression are the following:

Electric Power, kW 1770

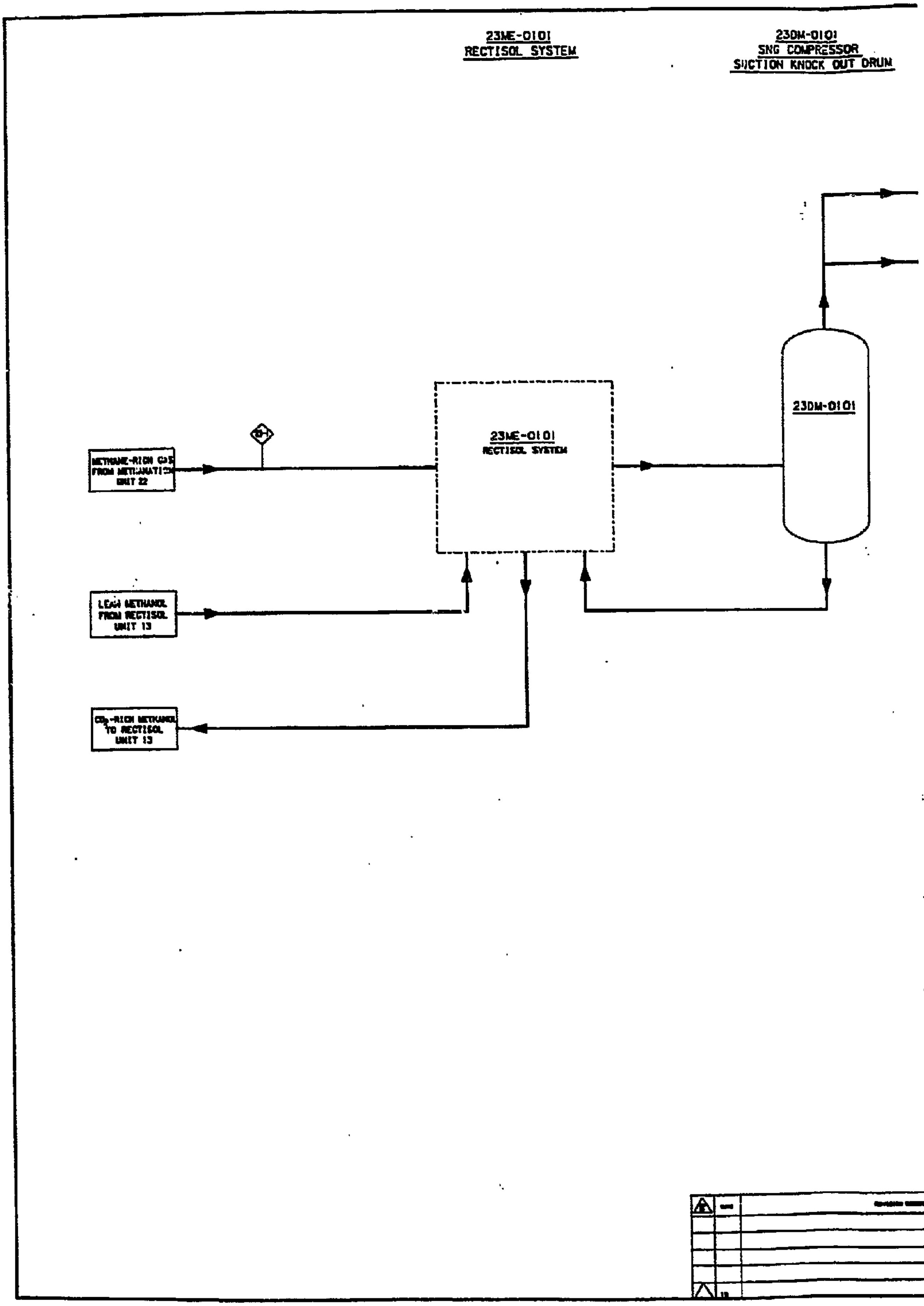
6.5.13.5 (Continued)

PROCESS DESCRIPTION

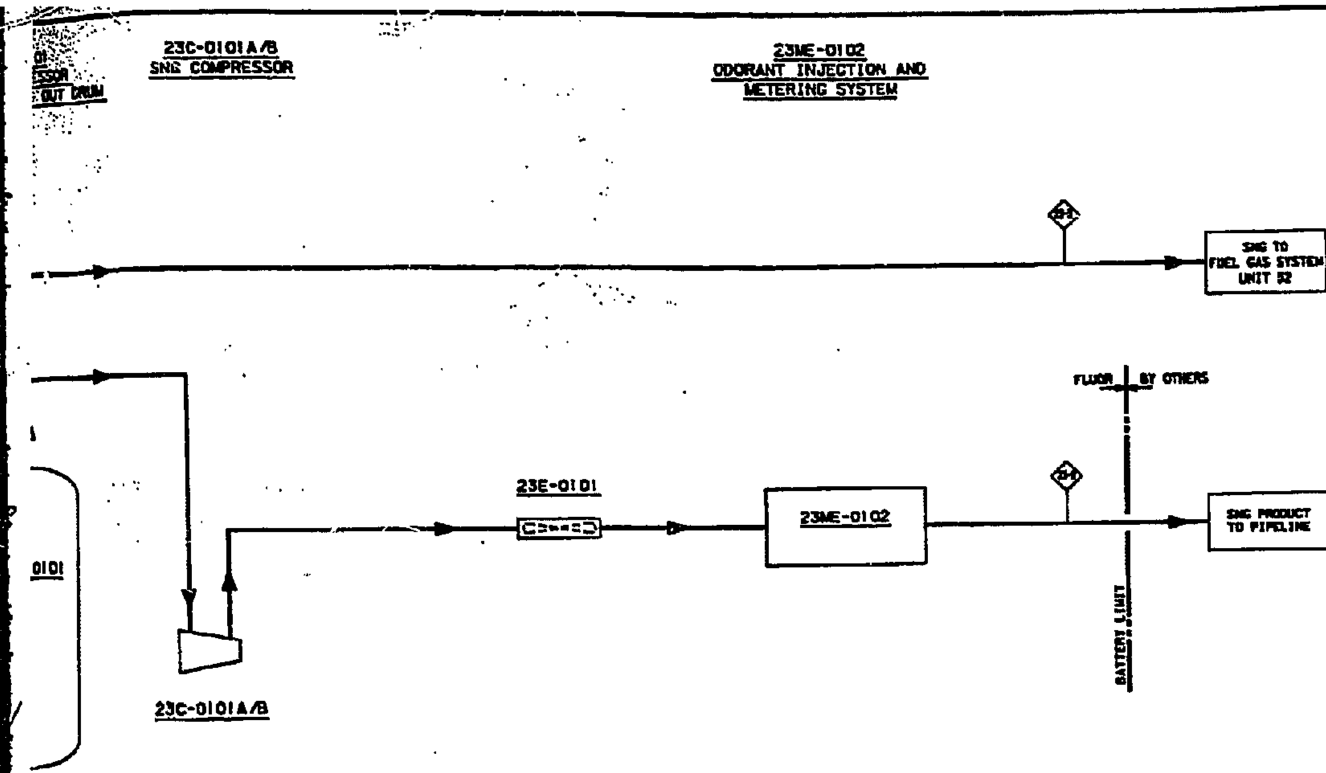
The following diagram for Unit 23 is shown on Drawing 835704-23-4-301; the material balance for Unit 23 is given on Table 6.5.13-7. The equipment for Unit 23 is listed in Table 6.5.13-8. Material balances are then given for:

Rectisol Unit 13	--	Table 6.5.13-9
Gas Liquor Separation Unit 14	--	Table 6.5.13-10
Tar Distillation Unit 15	--	Table 6.5.13-11
Naphtha Hydrotreating Unit 16	--	Table 6.5.13-12
Phenosolvan Unit 17	--	Table 6.5.13-13
Ammonia Recovery Unit 18	--	Table 6.5.13-14
Sulfur Recovery Unit 19	--	Table 6.5.13-15
Process Steam Superheating Unit 20	--	Table 6.5.13-16
Partial Oxidation Unit 24	--	Table 6.5.13-17
PSA Hydrogen Production Unit 25	--	Table 6.5.13-18

The SNG purification and compression process for the Coproduction Case is identical to the Base Case, the description for which is contained in Section 6.2.17.



23ME-0101
RECTISOL SYSTEM
23DM-0101
SNG COMPRESSOR
SUCTION KNOCK OUT DRUM
METHANE-RICH GAS
FROM METHANATION
UNIT 22
23ME-0101
RECTISOL SYSTEM
23DM-0101
LEAN METHANOL
FROM RECTISOL
UNIT 13
CO2-RICH METHANOL
TO RECTISOL
UNIT 13



USE OR DISCLOSURE OF REPORT DATA
IS SUBJECT TO THE RESTRICTION ON THE
NOTICE PAGE AT THE FRONT OF THIS REPORT

NOTES:

1. THIS DRAWING REPRESENTS ONE TRAIN OF A TWO TRAIN UNIT. CAPACITY OF EACH TRAIN IS 55% OF UNIT DESIGN. SNG COMPRESSOR 23C-0101 HAS ONE SPARE COMMON TO BOTH TRAINS.
2. THIS DRAWING IS A SIMPLIFIED FLOW DIAGRAM OF A PROPRIETARY UNIT. THE STREAM CONFIGURATIONS AND/OR EQUIPMENT ARE NOT COMPLETELY REPRESENTED.
3. THE FLOW QUANTITIES, PRESSURES AND TEMPERATURES REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.

USE OR DISCLOSURE OF REPORT DATA
IS SUBJECT TO THE RESTRICTION ON THE
NOTICE PAGE AT THE FRONT OF THIS REPORT

FLUOR

R. WHITE
C.C. ABATAY
G.G. ROMO
R. McCARTHY
R. LANG

PROCESS FLOW DIAGRAM
SNG PURIFICATION AND COMPRESSION - UNIT 23
CASE: CO-PRODUCTION
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-23-4-301 | 1

003 3572330

TABLE 6.5.13-7

MATERIAL BALANCE
SNG PURIFICATION AND COMPRESSION - UNIT 23

Stream Number	23-1		23-2		23-3	
Stream Name	SNG from Methanation		SNG to Pipeline		SNG to Fuel Gas	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
H_2	28.1	0.33	27.9	0.38	0.2	0.38
N_2	136.4	1.63	135.2	1.83	1.2	1.83
CO	0.8	0.01	0.8	0.01	-	0.01
CH_4	7,766.5	92.73	7,188.4	97.21	55.8	97.21
CO_2	443.8	5.30	42.5	0.57	0.3	0.57
		100.00		100.00		100.00
Dry Gas, lb-mol/hr	8,375.6	99.88	7,394.8		57.5	
H_2O Vapor, lb-mol/hr	10.4	0.12	-	-0-	-	-0-
Wet Gas, lb-mol/hr	8,386.0	100.00	7,394.8	100.00	57.5	100.00
Dry Gas, lb/hr	148,022		121,055		940	
H_2O Vapor, lb/hr	187		-		-	
Total, lb/hr	148,209		121,055		940	
Pressure, psia	970		1,448		960	
Temperature, °F	100		115		80	

NOTES: Flow quantities, pressure, and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.5.13-8

EQUIPMENT LIST
SNG PURIFICATION AND COMPRESSION - UNIT 23

Item No.	Equipment Description	Number Required Operating	Number Required Spare
23DM-0101	SNG Compressor Suction K.O. Drum	2	0
23E-0101	SNG Air Cooler		20
23C-1010 A/B	SNG Compressor		21
23ME-0101	Rectisol System	2	0
23ME-0102	Odorant Injection System	2	0

NOTE: Train Number 2 equipment numbers which are not shown are the same as indicated above except the train designation is 02 instead of 01.

Example:	Train #1	Train #2
	23DM-0101	23DM-0201

TABLE 6.5.13-9

MATERIAL BALANCE

RECTISOL - UNIT 13

Stream Number	13-1		13-3		13-4		13-5	
Stream Name	Raw Gas from Gas Cooling		Pure Gas to MeOH Synthesis		CO_2-Rich Gas to Stm. Superheater		H_2S Lean Gas t Stretford	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol
H_2	24,772.1	40.67	24,764.6	56.41			7.5	0.0
N_2	146.1	0.24	146.1	0.33				
CO	11,071.7	18.18	11,065.1	25.21			6.6	0.0
CH_4	6,318.9	10.37	6,841.2	15.58				
C_2	361.9	0.59	187.0	0.43	116.1	1.27	57.9	0.7
C_3	72.4	0.12			9.2	0.10	42.2	0.5
C_4	18.0	0.03					3.5	0.0
CO_2	17,935.5	29.44			9,002.3	98.62	7,817.5	97.6
H_2S	213.6	0.35					66.3	0.8
COS	4.8	0.01			0.5	0.01	2.1	0.0
		100.00				100.00		100.0
Dry Gas, lb-mol/hr	60,915.8	99.77	43,900.4	100.00	9,128.1	100.00	8,003.6	100.0
H_2O vapor, lb-mol/hr	136.7	0.23	-	-0-	-	-0-	-	-0-
Wet Gas, lb-mol/hr	61,052.5	100.00	43,900.4	100.00	9,128.1	100.00	8,003.6	100.0
Dry Gas, lb/hr	1,277,333		518,691		400,062		350,365	
H_2O vapor, lb/hr	2,463							
H_2O liquid, lb/hr								
Naphtha, lb/hr	5,275							
Org. Sulfur, lb/hr	11							
TOTAL, lb/hr	1,285,082		518,691		400,062		350,365	
Pressure, psia	405		360		25		23	
Temperature, °F	100		68		100		75	

NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day bas design purposes, and are not necessarily the conditions which will be attained during actual

TABLE 6.5.13-9

MATERIAL BALANCE

RECTISOL - UNIT 13

3-3		13-4		13-5		13-6		13-7	13-8
Gas to Synthesis		CO_2-Rich Gas to Stm. Superheater		H_2S Lean Gas to Stretford		H_2S Rich Gas to ADIP Seper.		Gas Liquor to Gas Liq. HT	Naphtha to Nap.
ar	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%		-
.6	58.41			7.5	0.09				
.1	0.33								
.1	25.21			6.6	0.08				
.2	15.58								
.0	0.43	116.1	1.27	57.9	0.73	0.9	0.11		
		9.2	0.10	42.2	0.52	21.0	2.60		
				3.5	0.04	14.5	1.81		
		9,002.3	98.62	7,817.5	97.67	620.2	76.94		
				66.3	0.83	147.3	18.27		
		0.5	0.01	2.1	0.03	2.2	0.27		
			100.00		100.00		100.00		
.4	100.00	9,128.1	100.00	8,003.6	100.00	806.1			
	-0-	-	-0-	-	-0-				
.4	100.00	9,128.1	100.00	8,003.6	100.00		100.00		
18,691		400,062		350,365		37,274		-	-
						2,463			-
								2,463	
								-	5,286
									11
18,691		400,062		350,365		37,274		2,463	5,275
360		25		23		25		230	40
68		100		75		80		56	113

s shown are for the total unit on a stream-day basis, are to be used solely for process
le conditions which will be attained during actual operations.

TABLE 6.5.13-10

MATERIAL BALANCE

GAS LIQUOR SEPARATION - UNIT 14

Stream Number Stream Name	14-1 Oily Gas Liquor (2)	14-2 Gas Liquor from Rectisol	14-3 Gas Liquor to Phenosolvan	14-4 Tar/Oil to Tar Distillation	14-5 Expansion Gas to Stretford
H_2, lb/hr	80				80
CO, lb/hr	465				465
CH_4, lb/hr	244				244
CO_2, lb/hr	6,855		21,820		5,035
H_2S, lb/hr	276		215		167
H_2O, lb/hr	543,655	2,463	999,315	29,790	193
Tar/Oils, lb/hr	29,790				
Phenols, lb/hr	5,095		5,095		
Fatty Acids, lb/hr	1,139		1,139		
Ammonia, lb/hr	6,835		6,787		
HCl, lb/hr	185		185		
Org. Sulfur, lb/hr	202			202	
TOTAL, lb/hr	614,821	2,463	1,034,556	29,992	6,184
Pressure, psia	225	225	55	90	20
Temperature, °F	233	56	95	104	135

NOTES: (1) Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes and are not necessarily the conditions which will be attained during actual operations.

(2) Represents net Gas Liquor flow from Gas Cooling Unit to Gas Liquor Separation.

(3) Net inflow to the Unit of Dusty Gas Liquor from Gasification Unit equals 453,448 lb/hr, assumed to be all water.

TABLE 6.5.13-11

MATERIAL BALANCE
TAR DISTILLATION - UNIT 15

Stream Number Stream Name	15-1 Tar/Oil from Gas Liquor Separation	15-2 Tar Naphtha to Hydrotreating	15-3 Residue Oil to POX
Tar/Oils, lb/hr	25,313	-	25,127
Naphtha, lb/hr	4,679	4,679	-
TOTAL, lb/hr	29,992	4,679	25,127
Pressure, psia	85	55	55
Temperature, °F	104	158	329

NOTE: Flow quantities, pressures, and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.5.13-12

MATERIAL BALANCE

NAPHTHA HYDROTREATING - UNIT 16

Stream Number Stream Name	16-1 Naphtha from Rectisol	16-2 Tar Naphtha from Tar Dist.	16-3 Makeup Hydrogen		16-4 Naphtha Product
Component			lb.mol/hr	mol. %	
H_2			63.8	99.5	
N_2			0.3	0.5	
CO					
CH_4					
C_2H_6					
C_3H_8					
C_4H_{10}					
CO_2					
H_2S					
Dry Gas, lb.mol/hr			64.1	100.00	
H_2O Vapor, lb.mol/hr			-	-0-	
Wet Gas, lb.mol/hr			64.1	100.00	
Dry Gas, lb/hr	-	-	138		-
H_2O Vapor, lb/hr	-	-	-		-
H_2O Liquid, lb/hr	-	-	-		-
Naphtha, lb/hr	5,275	4,663	-		9,731
Org. Sulfur, lb/hr	11	16	-		-
Misc.		186			
TOTAL, lb/hr	5,286	4,865	138		9,731
Pressure, psia	35	50	890		50
Temperature, °F	113	158	380		108

NOTES: Flow quantities, pressures, and temperatures shown are on a stream-day basis, are to be u
and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.5.13-12

MATERIAL BALANCE

NAPHTHA HYDROTREATING - UNIT 16

2 ha from ist.	16-3 Makeup Hydrogen		16-4 Naphtha Product	16-5 Sour Gas to Stretford		16-6 Sour Water to Phenosolvan
	lb.mol/hr	mol. %		lb.mol/hr	mol. %	
	63.8	99.5		4.0	46.86	
	0.3	0.5		1.0	11.43	
				0.05	0.57	
				1.4	16.00	
				0.6	7.43	
				0.4	4.57	
				0.3	2.86	
				0.5	0.57	
				0.8	9.71	
	64.1	100.00		8.6	100.00	
	-	-0-		-	-0-	
	64.1	100.00		8.6	100.00	
	138		-	133		-
	-		-	-		-
	-		-	-		1,445
63	-		9,731	-		-
16	-		-	-		-
.86						
65	138		9,731	133		1,445
50	890		50	25		75
.58	380		108	100		100

res shown are on a stream-day basis, are to be used solely for process design purposes,
h will be attained during actual operations.

TABLE 6.5.13-13

MATERIAL BALANCE
PHENOSOLVAN - UNIT 17

Stream Number	17-1	17-2	17-3
Stream Name	Gas Liquor Feed	Gas Liquor to NH_3 Recon.	Phenols to POX
CO_2, lb/hr	21,820		
H_2S, lb/hr	215		
H_2O, lb/hr	999,315	1,002,602	
Phenols, lb/hr	5,095	207	4,888
Fatty Acids, lb/hr	1,139	1,139	
Ammonia, lb/hr	6,787	7,773	
HCl, lb/hr	185	185	
TOTAL, lb/hr	1,034,556	1,010,906	4,888
Pressure, psia	55	100	72
Temperature, °F	95	120	180-285

NOTE: Flow quantities, pressures, and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.5.13-14

MATERIAL BALANCE
AMMONIA RECOVERY - UNIT 18

Stream Number	18-1	18-2	18-3	18-4
Stream Name	Gas Liquor Feed	Ammonia Product	Stripped Gas Liquor	Acid Gas to Stretford
CO_2, lb/hr				23,973
H_2S, lb/hr				212
H_2O, lb/hr	1,002,602	34	1,001,548	1,036
Phenols, lb/hr	207		207	
Fatty Acids, lb/hr	1,139		1,139	
Ammonia, lb/hr	6,773	6,355	418	
HCl, lb/hr	185		185	
Total, lb/hr	1,010,906	6,389	1,003,497	25,221
Pressure, psia	100	220	145	20
Temperature, °F	120	100	100	120

NOTE: Flow quantities, pressure, and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

M

SULFU

Stream Number	19-1		19-2	
Stream Name	H_2S-Rich Gas from Rectisol		Make-up Water	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%
H_2				
N_2				
CO				
SO_2				
CH_4				
C_2H_4	0.2	0.02		
C_2H_6	0.7	0.09		
C_3H_6	10.5	1.30		
C_3H_8	10.5	1.30		
C_4H_8	7.3	0.91		
C_4H_{10}	7.2	0.90		
CO_2	620.2	76.94		
H_2S	147.3	18.27		
COS	2.2	0.27		
S_6				
O_2				
Total Dry Gas	8.06	100.00		
H_2O				
Total Wet Gas		100.00		
Dry Gas, lb/hr	37,274			
H_2O, lb/hr			441	
Sulfur, lb/hr				
TOTAL, lb/hr	37,274		441	
Pressure, psia	25		60	
Temperature, °F	80		290	

NOTE: Flow quantities, pressures, and temperatures shown a
design purposes, and are not necessarily the conditions

TABLE 6.5.13-15

MATERIAL BALANCE

SULFUR RECOVERY - UNIT 19

-2 s-up ter	19-3 Off Gas to Stretford		19-4 Process Gas to CLAUS		19-5 Atmospheric Air		19-6 Air to SCOT	
r· Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
					498.7	79.00	73.6	79.00
			0.2	0.06				
	0.5	0.11	0.2	0.06				
	8.1	1.75	2.4	0.70				
	8.1	1.75	2.4	0.70				
	5.4	1.16	1.9	0.55				
	5.4	1.16	1.8	0.53				
	433.7	93.59	186.5	54.42				
	0.5	0.11	146.8	42.84				
	1.7	0.37	0.5	0.14				
					132.5	21.00	19.6	21.00
		100.00		100.00		100.00		100.00
	463.4		342.7		631.2		93.2	
	18.4		6.1		12.6		1.8	
	481.8	100.00	348.8	100.00	643.8	100.00	95.0	100.00
	20,536		16,738		18,212		2,689	
441	331		110		227		32	
441	20,867		16,848		18,439		2,721	
60	22		28		24		24	
290	100		100		180		180	

shown are for the total unit on a stream-day basis, are to be used solely for process conditions which will be attained during actual operations.

TABLE 6.5.13-15 (Continued)

MATERIAL BALANCE

SULFUR RECOVERY - UNIT 19

Stream Number	19-7		19-8		19-9		19-10	
Stream Name	Sulfur to Tank Farm		Tail Gas to SCOT		Reducing Gas from Unit 25		SCOT Tailgas to Stretford	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol
H_2			0.10	0.02	11.4	99.13	7.1	0.9
N_2			422.9	65.59	0.1	0.87	498.7	67.6
CO			0.02					
SO_2			2.8	0.43				
CH_4								
C_2H_4								
C_2H_6								
C_3H_6								
C_3H_8								
C_4H_8								
C_4H_{10}								
CO_2			212.6	32.98			221.2	30.0
H_2S			5.2	0.81			10.3	1.4
COS			1.0	0.15				
S_6			0.1	0.02				
O_2								
Total Dry Gas			644.72	100.00	11.5	100.00	737.3	100.0
H_2O			176.42	78.52			56.6	7.1
Total Wet Gas			821.14	100.00		100.00	793.9	100.0
Dry Gas, lb/hr			21,641		26		24,072	
H_2O, lb/hr			3,178				1,020	
Sulfur, lb/hr	4,384							
TOTAL, lb/hr	4,384		24,819		26		25,092	
Pressure, psia	50		18		900		20	
Temperature, °F	285		280		380		100	

NOTE: Flow quantities, pressures, and temperatures shown are for the total unit on a stream-day design purposes, and are not necessarily the conditions which will be attained during actual c

TABLE 6.5.13-15 (Continued)

MATERIAL BALANCE

SULFUR RECOVERY - UNIT 19

19-8 Tail Gas to SCOT		19-9 Reducing Gas from Unit 25		19-10 SCOT Tailgas to Stretford		19-11 Wastewater to Phenosolvan		19-12 Sour Gas FM Naphtha HTRT	
l/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
].10	0.02	11.4	99.13	7.1	0.96			4.0	46.86
3.9	65.59	0.1	0.87	498.7	67.64			1.0	11.43
].02								0.05	0.57
2.8	0.43								
								1.4	16.00
								0.6	7.43
								0.4	4.57
								0.3	2.86
2.6	32.98			221.2	30.00			0.05	0.57
5.2	0.81			10.3	1.40			0.8	9.71
1.0	0.15								
0.1	0.02								
	100.00		100.00		100.00				100.00
4.72		11.5		737.3				8.6	
6.42	78.52			56.6	7.13				
1.14	100.00		100.00	793.9	100.00				100.00
21,641		26		24,072				133	
3,178				1,020		2,474			
24,819		26		25,092		2,474		133	
18		900		20		65		20	
280		380		100		100		100	

res shown are for the total unit on a stream-day basis, are to be used solely for process he conditions which will be attained during actual operations.

TABLE 6.5.13-15 (Continued)

MATERIAL BALANCE

SULFUR RECOVERY - UNIT 19

Stream Number	19-13		19-14		19-15		19-16	
Stream Name	Off Gas FM Ammonia Recovery		Expansion Gas FM Gas Liquor Separation		H_2S Lean Gas FM Rectisol		Oxidation Vent	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol
H_2			39.7	20.81	7.5	0.09		
N_2							373.9	82.2
CO			16.6	8.70	6.6	0.08		
SO_2								
CH_4			15.2	7.96				
C_2H_4					9.3	0.12		
C_2H_6					48.6	0.61		
C_3H_6					21.0	0.26		
C_3H_8					21.2	0.26		
C_4H_8					1.7	0.02		
C_4H_{10}					1.8	0.02		
CO_2	544.7	98.87	114.4	59.96	7,817.5	97.67	7.8	1.7
H_2S	6.2	1.13	4.9	2.57	66.3	0.83		
COS					2.1	0.03		
S_6								
O_2							73.2	16.0
		100.00		100.00		100.00		100.0
Total Dry Gas	550.9	90.55	190.8	94.69	8,003.6		454.9	
H_2O	57.5	9.45	10.7	5.31			6.7	
Total Wet Gas	608.4	100.00	201.5	100.00		100.00	461.6	100.0
Dry Gas, lb/hr	24,185		6,039		350,365		13,159	
H_2O, lb/hr	1,036		193				121	
Sulfur, lb/hr								
TOTAL, lb/hr	25,221		6,232		350,365		13,280	
Pressure, psia	20		20		23		13.5	
Temperature, °F	120		135		75		104	

NOTE: Flow quantities, pressures, and temperatures shown are for the total unit on a stream-da design purposes, and are not necessarily the conditions which will be attained during actual

TABLE 6.5.13-15 (Continued)

MATERIAL BALANCE

SULFUR RECOVERY - UNIT 19

19-14 ·pansion Gas 1 Gas Liquor Separation		19-15 H_2S Lean Gas FM Rectisol		19-16 Oxidation Vent		19-17 Sulfur to Tank Farm		19-18 Vent Gas to Process Steam Superheater	
ıol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
39.7	20.81	7.5	0.09					58.3	
				373.9	82.20			499.7	
16.6	8.70	6.6	0.08					23.25	
15.2	7.96							16.6	
		9.3	0.12					9.3	
		46.6	0.61					49.7	
		21.0	0.26					29.1	
		21.2	0.26					29.7	
		1.7	0.02					7.1	
		1.8	0.02					7.5	
14.4	59.96	7,817.5	97.67	7.8	1.72			9,119.6	
4.9	2.57	66.3	0.83					0.1	
		2.1	0.03					3.8	
				73.2	16.08				
	100.00		100.00		100.00				100.00
.90.8	94.69	8,003.6		454.9				9,853.75	94.40
10.7	5.31			6.7				584.60	5.60
01.5	100.00		100.00	461.6	100.00			10,438.35	100.00
6,039		350,365		13,159				421,964	
193				121				10,532	
						2,845			
6,232		350,365		13,280		2,845		432,496	
20		23		13.5		50		18	
135		75		104		285		100	

ures shown are for the total unit on a stream-day basis, are to be used solely for process the conditions which will be attained during actual operations.

TABLE 6.5.13-16

MATERIAL BALANCE

PROCESS STEAM SUPERHEATING - UNIT 20

Stream Number	20-1		20-2		20-3		20-4	
Stream Name	CO_2-Rich Gas from Rectisol		Vent Gas from Sulfur Recovery		Oxidant		Flue Gas to Stack	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
NO_2							4.2	0.01
SO_2							4.4	0.01
H_2		58.3	0.59					
N_2		499.7	5.07		11,072.9	79.09	11,575.5	36.35
CO		23.25	0.24			0.1	1.003	
CH_4			16.6	0.17				
C_2H_4	23.0	0.25	9.3	0.09				
C_2H_6	93.1	1.02	49.7	0.50				
C_3H_6	4.7	0.05	29.1	0.30				
C_3H_8	4.5	0.05	29.7	0.30				
C_4H_8			7.1	0.07				
C_4H_{10}			7.5	0.08				
CO_2	9,002.3	98.62	9,119.6	92.55	7.0	0.05	19,353.15	60.78
H_2S			0.1					
COS	0.5	0.01	3.8	0.04				
O_2					2,920.0	20.86	906.3	2.85
Total Dry Gas	9,128.1	100.00	9,853.75	100.00	13,999.9	100.00	31,843.65	100.00
H_2O			584.6		188.8		2,596.1	
Total Wet Gas		100.00	10,438.35	100.00	14,188.7	100.00	34,439.75	100.00
Dry Gas lb/hr	400,062		421,964		403,933		1,205,496	
H_2O lb/hr			10,532		3,401		46,771	
Total lb/hr			432,496		407,334		1,252,267	
Pressure, psia	25		18		13		13.5	
Temperature, °F	100		100		60		400	

NOTE: Flow quantities, pressure, and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

PAR

Stream Number Stream Name	24-1 Feed		24-2 Oxidant		24-3 Steam	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	
H_2						
N_2			13.1			
CO						
CH_4						
CO_2						
H_2S						
COS						
O_2			854.8			
				100.00		
Total Dry Gas			867.9			
H_2O					833.0	
Total Wet Gas				100.00		
Dry Gas, lb/hr			27,754			
H_2O, lb/hr					15,088	
Tars, lb/hr						
Oils, lb/hr	24,902					
Phenols, lb/hr	4,844					
Ash, lb/hr						
TOTAL, lb/hr	29,746		27,754		15,008	
Pressure, psia	115		485		613	
Temperature, °F	350		284		489	

NOTE: Flow quantities, pressures, and temperatures sho design purposes, and are not necessarily the condi

TABLE 6.5.13-17

MATERIAL BALANCE

PARTIAL OXIDATION - UNIT 24

24-3 Steam		24-4 Makeup Oil		24-5 Makeup Condensate		24-6 Raw Gas to Unit 12		24-7 Blowdown to Unit 54		24-8 Ash to Unit 03	
lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
						1,483.8	41.34				
						19.3	0.54				
						1,831.3	51.03				
						12.0	0.33				
						234.4	6.53				
						7.0	0.01				
						0.4	0.01				
						0.8	0.02				
							100.00		100.00		100.00
						3,589.0					
833.0						1,682.0					
							100.00		100.00		100.00
						65,620					
15,088				27,235		30,303		4,066			
		225									
		44									
										23	
15,008		269		27,235		95,923		4,066		23	
613		115		460		450		70		Ambient	
489		350		212		355		269		235	

res shown are for the total unit on a stream-day basis, are to be used solely for process
he conditions which will be attained during actual operations.

TABLE 6.5.13-18

MATERIAL BALANCE
PSA HYDROGEN PRODUCTION - UNIT 25

Stream Number	25-1		25-2		25-3	
Stream Name	Syngas Feed		Hydrogen Product		Purge Gas to Fuel Gas	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
H_2	105.3	34.33	75.8	99.50	29.5	12.80
N_2	3.3	1.09	0.4	0.50	2.9	1.26
CO	32.6	10.64			32.6	14.14
MeOH	2.0	0.64			2.0	0.87
CH_4	149.2	48.63			149.2	64.73
C_2H_6	3.0	0.97			3.0	1.30
CO_2	11.3	3.69			11.3	4.90
Total, lb-mol/hr	306.7	100.00	76.2	100.00	230.5	100.00
Pressure, psia	355		900		75	
Temperature, °F	68		380		100	

NOTE: Flow quantities, pressure, and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

6.5.14 UTILITY AND OFFSITE UNITS

6.5.14.1 GENERAL

Coproduction of methanol and SNG changes the process by eliminating the Shift Unit, expanding the Methanol unit scope to process all the pure gas and revising the Methanation unit to process only the Methanol unit purge.

Without the Shift unit reaction the flow rate and composition of the raw gas changes. This change affects the oxygen required for POX. The off-gases from Rectisol require a Sulfur Recovery unit which is different from the Base Case and the Process Steam Superheater has a different heat load. The change in superheated steam from the Steam Superheater unit and the overall electric load differences from the Base Case alter the Power Generation system for the Coproduction Case.

The Utility and Offsite units that have capacity changes from the Base Case are:

Unit 40	Oxygen Production
Unit 42	Power Generation
Unit 44	Raw Water
Unit 45	Boiler Feed Water
Unit 47	Process Cooling Water
Unit 48	Utility Cooling Water
Unit 52	Fuel Gas
Unit 54	Waste Water Treatment
Unit 55	Tank Farm and Dispatch

6.5.14.2 OXYGEN PRODUCTION - UNIT 40

Higher oxygen requirements in Partial Oxidation (POX) Unit 24 increases the oxygen production rate from 2925 tons/day to 2997. The material balance for Unit 40 for the Coproduction Case follows as Table 6.5.14-1.

6.5.14.3 POWER GENERATION - UNIT 42

The elimination of the Shift Unit in the process plant also eliminates a large producer of 600 psig superheated steam. The steam users in the plant are then supplied by the 600 psig steam that, in the Base Case, goes to condensing turbines for power generation. The total power generation of Unit 42 for the Coproduction Case drops from 405 MW to 320.6 MW. The material balance for Unit 42 for the Coproduction Case follows as Table 6.5.14-2.

6.5.14.4 RAW WATER TREATMENT - UNIT 44

The raw water requirements for the plant range from 6813 gpm in the Base Case to 5529 gpm in the Coproduction Case. The material balance for the Raw Water Unit 44 for this case follows as Table 6.5.14-3.

6.5.14.5 BOILER FEED WATER AND CONDENSATE UNIT 45

The flows of condensate that differ from the Base Case are the flashed and low pressure condensate flowing to the process 600 psig waste heat boilers which contains the flow from the methanol purification reboilers, and the vacuum condensate flow which returns to the boilers from the plant compressor turbines. Recycle of the above condensate streams lowers the total boiler feed water requirement from 9,977 gpm in the Base Case to 9,314 gpm in the Coproduction Case. The material balance for Unit 45 for this case follows as Table 6.5.14-4.

6.5.14.6 PROCESS COOLING WATER - UNIT 47

Lower power generation requires less cooling water to the surface condensers. The large requirements for the Methanol Synthesis turbine condensers is offset by changing the SNG compressors to electric motors. The net effect is lower process plant cooling water requirements and lower total cooling water requirements, to 125,100 gpm from 152,000 gpm for the Base Case. The material balance for Unit 47 for the Coproduction Case follows as Table 6.5.14-5.

6.5.14.7 UTILITY COOLING WATER - UNIT 48

Lower power generation cooling water requirements reduce the utility cooling water circulation from 64,900 gpm in the Base Case to 47,700 gpm in the Coproduction Case. The material balance for Unit 48 for this case follows as Table 6.5.14-6.

6.5.14.8 FUEL GAS - UNIT 52

The fuel gas generated in the Methanol unit increases and the fuel gas requirement in Process Steam Superheater decreases in the Coproduction Case. A small amount of finished product SNG is used as supplement fuel gas when needed. Total fuel gas heating value required for this case decreases to 207.8 Million Btu/hr from 369.2 million Btu/hr for the Base Case. The material balance for Unit 52 for the Coproduction Case follows as Table 6.5.14-7.

6.5.14.9 WASTE WATER TREATING - UNIT 54

The Coproduction Case generates an additional 121 gpm of stripped gas liquor to that for the Base Case. This plus small changes in the Rectisol and POX waste water streams result in a total waste water flow of 2,369 gpm versus 2,536 gpm in the Base Case. The material balance for Unit 54 for the Coproduction Case follows as Table 6.5.14-8.

6.5.14.10 TANK FARM AND DISPATCH

Elimination of the Shift unit increases the POX feed, requiring an increase in the size of the POX feed storage tank in the intermediate tank area. The naphtha flow to hydrotreating drops by 40 percent, decreasing the size of the intermediate and finished product storage and dispatch for naphtha. Methanol storage, only 5,000 bbl in the Base Case, rises to 233,000 bbl for 30 day production capacity of the Coproduction Case. The material balance for Unit 55 for this case follows as Table 6.5.14-9.

TABLE 6.5.14-1

MATERIAL BALANCE

OXYGEN PRODUCTION - UNIT 40

Stream Number		40-1		40-2		40-3		40-4		40-5		40-6	
Stream Name		Oxygen Product		Nitrogen Product		Dry Instrument		Vent to Atmosphere		Process Condensate		HHP Steam	
Component		lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
N_2		117.2	1.5	1756.8	100	428.4	78.0	28,210.7	97.3				
Ar						5.2	0.9	366.3	1.3				
O_2		7702.8	98.5			115.5	21.1	405.4	1.4				
Total Dry Gas		7820.0	100.0	1756.8	100.0	549.1	100.0	28,982.4	100.0				
H_2O													
Total Wet Gas		7820.0		1756.8		549.1		28,982.4					
Dry Gas	lb/hr	249,772		49,218		15,904		817,960					
H_2O	lb/hr									11,300			
Steam	lb/hr											1,256,400	
Total	Lb/hr	249,772		49,218		15,904		817,960		11,300		1,256,400	
Pressure, psia		503		63		63						1,463	
Temperature, °F		230 (max)		75		75						925	

NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.5.14-2

MATERIAL BALANCE

POWER GENERATION - UNIT 42

Stream Number		42-1	42-2	42-3	42-4	42-5	42-10
Stream Name		Reheat Steam	HHP Steam	HHP Exhaust Steam	Condensate from LP Heaters	Cold Condensate	Power Output
H_2O	lb/hr				289,500	2,160,000	
Steam	lb/hr	3,009,400	2,865,000	2,865,000			
MW							321.8
Total	lb/hr	3,009,400	2,865,000	2,865,000	289,500	2,160,000	321.8
Pressure, psia		563	1463	663	3.5	110	
Temperature, °F		756	925	710	90	125	

NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.5.14-3

MATERIAL BALANCE

RAW WATER TREATMENT - UNIT 44

Stream Number		44-1	44-2	44-3	44-4	44-5	44-6
Stream Name		Raw Water Makeup	To Potable Water Treatment Unit 49	To FGD Unit 43	RO Reject from Unit 49	To U.C.T. Makeup	To BFW Treat-ment Unit 45
Water	lb/hr	2,764,500	27,000	244,000	1000	1,032,000	1,482,500
	(gpm)	(5529)	(54)	(488)	(2)	(2064)	(2965)
Total	lb/hr	2,764,500	27,000	244,000	1000	1,032,000	1,482,500
Pressure, psia		13.7	63.7	88.7	300	43.7	33.7
Temperature, °F		60	60	60	80	80	80

NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

M

BOILER FEED WATER A

Stream Number		45-1	45-2	45-3	45-4
		BFW Feed from Unit 44	Demin. Water to Distri- bution	Cold Con- densate for Polishing	Polished Cold Condensate
Water	lb/hr	1,482,500	702,000	2,160,000	2,468,500
	(gpm)	(2965)	(1404)	(4320)	(4937)
Total	lb/hr	1,482,500	702,000	2,160,000	2,468,500
Pressure, psia		33.7	88.7	40	88.7
Temperature, °F		80	100	285	100

NOTE: Flow quantities, pressures and temperatures shown are purposes, and are not necessarily the conditions which

TABLE 6.5.14-4

MATERIAL BALANCE

ATER AND CONDENSATE TREATMENT - UNIT 45

-4	45-5	45-6	45-7	45-8	45-9	45-10
ished old densate	Vacuum Condensate from Unit 21	Process Condensate from Unit 22 and Unit 40	Softened Vacuum and and Process Condensate	High TDS Reject to Ash Handling	Low TDS Reject to U.C.T. Makeup	Softened Water to LP Deaerator
8,500 7)	310,500 (621)	49,500 (99)	360,000 (720)	41,500 (83)	11,500 (23)	58,000 (116)
8,500	310,500	49,500	360,000	41,500	11,500	58,000
	40	88.7	78.7	63.7	63.7	88.7
	285	100	100	100	100	100

wn are for the total unit on a stream-day basis, are to be used solely for process design which will be attained during actual operations.

M

PROCESS

Stream Number		47-1	47-2	47-3	47-4
Stream Name		P.C.T. to Side Stream Filtration	P.C.T. Blowdown	Side Stream Filtration to P.C.T.	High TDS Effluent to Evaporation Unit 54
Water	lb/hr	3,127,500	15,000	3,016,000	115,500
	(gpm)	(6255)	(30)	(6032)	(231)
Total	lb/hr	3,127,500	15,000	3,016,000	115,500
Pressure, psia		13.7	13.7	13.7	63.7
Temperature, °F		110	110	80	100

NOTE: Flow quantities, pressures and temperatures shown are f
purposes and are not necessarily the conditions which w

TABLE 6.5.14-5

MATERIAL BALANCE

ROCESS COOLING WATER - UNIT 47

-4	47-5	47-6	47-7	47-8	47-9	47-10
h TDS uent to poration nit 54	Treated Waste water to P.C.T. Makeup	From U.C.T. Blowdown Treatment	From Evaporator To P.C.T.	From Makeup Water Treatment	Makeup to Process Cooling Tower	R.O. Reject to Evaporator
500	1,237,000 (2474)	576,500 (1153)	402,500 (805)	920,500 (1841)	1,899,500 (3799)	310,500 (621)
00	1,237,000	576,500	402,500	920,500	1,899,500	310,500
	63.7	43.7	13.7	13.7	20.7	63.7
	65	80	100	65	80	85

f n are for the total unit on a stream-day basis, are to be used solely for process design w hich will be attained during actual operations.

TABLE 6.5.14-6

MATERIAL BALANCE

UTILITY COOLING WATER - UNIT 48

Stream Number		48-1	48-2	48-3	48-4	48-5
Stream Name		U.C.T. Blowdown	RO Reject from Unit 45	RO Reject from Unit 49	Treated Water to P.C.T. Makeup Pond	Sludge to Landfill
Water	lb/hr	442,500	190,500	1500	576,500	3000
	(gpm)	(885)	(381)	(3)	(1153)	(6)
Solids	lb/hr					500
Total	lb/hr	442,500	190,500	1500	576,500	3500
Pressure, psia		13.7	300	300	15.7	13.7
Temperature, °F		110	80	80	80	70

NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.5.14-7

MATERIAL BALANCE

FUEL GAS - UNIT 52

Stream Number	52-1		52-2		52-3		52-4	
Stream Name	Fuel Gas from Unit 21		Fuel Gas from Unit 25		Fuel Gas from SNG Storage		Total Fuel Gas	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
H_2	46.5	10.5	29.5	12.8	.2	.4	76.2	10.4
N_2	1.9	.4	2.9	1.3	1.2	1.8	5.9	.8
CO	25.8	5.8	32.6	14.1			58.4	8.0
CO_2	76.9	17.4	11.3	4.9	.3	.6	88.5	12.1
CH_4	237.3	53.6	149.2	64.7	55.8	97.2	442.3	60.6
C_2H_6	16.5	3.8	3.0	1.3			19.5	2.7
CH_3OH	37.5	8.5	2.0	.9			39.5	5.4
Total Dry gas lb/hr	442.4	100.0	230.5	100.0	57.5	100.0	730.3	100.0
H_2O	.2		.1				.3	
Total Wet gas	442.6		230.6				730.6	
Dry Gas lb/hr	9762		4099		942		14,799	
H_2O	4		2				6	
Total lb/hr	9762		4101		942		14,805	
Pressure, psia	75		80		75		75	
Temperature, °F	95		75		100		80	
MM Btu	119.2		67.1		21.5		207.8	

NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.5.14-8

MATERIAL BALANCE

WASTE WATER TREATMENT - UNIT 54

Stream Number		54-1	54-2	54-3	54-4
Stream Name		Storm Water	Oily Water	Oily Condensate	1500lb Boiler Blowdown
Water	lb/hr	104,500	130,000	Normally 0	11,500
	(gpm)	(209)	(260)		(23)
Solids	lb/hr				
Total	lb/hr	104,500	130,000		11,500
Pressure, psia		13.7	13.7		53.7
Temperature, °F		60	60		285

NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.5.14-8 (Continued)

MATERIAL BALANCE

WASTE WATER TREATMENT - UNIT 54

Stream Number		54-5	54-6	54-7	54-8
Stream Name		U.C.T. Makeup Water	DAF Effluent to Biotreating	Stripped Gas Liquor	Waste Heat Boiler Blow-down
Water	lb/hr	107,000	136,000	1,002,500	24,000
	(gpm)	(214)	(272)	(2005)	(48)
Solids	lb/hr				
Total	lb/hr	107,000	136,000	1,002,500	24,600
Pressure, psia		38.7	13.7	145	53.7
Temperature, °F		80	65	100	285

TABLE 6.5.14-8 (Continued)

MATERIAL BALANCE

WASTE WATER TREATMENT - UNIT 54

Stream Number		54-9	54-10	54-11	54-12
Stream Name		Treated Water from Sanitary Unit 56	Water From Rectisol	Water From POX Unit 24	Ash to Landfill
Water	lb/hr	23,500	31,000	4000	
	(gpm)	(47)	(62)	(8)	
Solids	lb/hr				870
Total	lb/hr	23,500	31,000	4000	870
Pressure, psia		13.7	13.7	13.7	13.7
Temperature, °F		80	63	100	100

TABLE 6.5.14-8 (Continued)

MATERIAL BALANCE

WASTE WATER TREATMENT - UNIT 54

Stream Number		54-13	54-14	54-15	54-16
Stream Name		Incinerator Evaporation Loss	Effluent to P.C.T. Treating	Evap. Feed From NaZ Softener	Evaporator Fed From P.C.T.-RO Reject
Water	lb/hr	2500	1,237,000	1500	310,500
	(gpm)	(5)	(2474)	(3)	(621)
Solids	lb/hr				
Total	lb/hr	2500	1,237,000	1500	310,500
Pressure, psia		13.7	63.7	13.7	300
Temperature, °F		208	80	80	80

TABLE 6.5.14-8 (Continued)

MATERIAL BALANCE

WASTE WATER TREATMENT - UNIT 54

Stream Number	54-17	54-18	54-19	54-20
Stream Name	Evaporator Feed From P.C.T. Blowdown	Combined Evaporator Load	Evaporator Brine To Solar Pond	Evaporator Effluent To P.C.T.
Water lb/hr	115,500	427,500	25,000	402,500
(gpm)	(231)	(855)	(50)	(805)
Solids lb/hr				
Total lb/hr	115,500	427,500	25,000	402,500
Pressure, psia	15.7	13.7	13.7	13.7
Temperature, °F	80	80	100	100

TABLE 6.5.14-9

MATERIAL BALANCE

TANK FARM AND DISPATCH - UNIT 55

Stream Number		55-11		55-12		55-13		55-14	
Stream Name		Raw Naphtha To Storage		Raw Naphtha To HDT Unit 16		Crude Tars To Storage		Crude Tars To Tar Dist.	
Component		lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
Total Dry Gas									
H_2O									
Total Wet Gas									
H_2O	lb/hr								
Tar	lb/hr					12,947		12,947	
Oil	lb/hr					16,843		16,843	
Naphtha	lb/hr	9938		9938					
Phenols	lb/hr								
Fatty Acids	lb/hr								
Org. Sulfur	lb/hr	27		27		202		202	
Ammonia	lb/hr								
HCl	lb/hr								
Lightends	lb/hr	186		186					
Total	lb/hr	10,151		10,151		29,992		29,992	
Pressure, psia		40		63.7		90		88.7	
Temperature, °F		115		120		104		150	

NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.5.14-9 (Continued)

MATERIAL BALANCE

TANK FARM AND DISPATCH - UNIT 55

Stream Number		55-15	55-16	55-21	55-22
Stream Name		Resids To Storage	Resids To POX Unit 24	Naphtha Product to Storage	Naphtha Product To Dispatch
Component		lb-mol/hr Mol%	lb-mol/hr Mol%	lb-mol/hr Mol%	lb-mol/hr Mol%
Total Dry Gas					
H_2O					
Total Wet Gas					
H_2O	lb/hr				
Tar	lb/hr	8547	8547		
Oil	lb/hr	16,580	16,580		
Naphtha	lb/hr			9731	9731
Phenols	lb/hr	4888	4888		
Fatty Acids	lb/hr				
Org. Sulfur	lb/hr				
Ammonia	lb/hr				
HCl	lb/hr				
Lightends	lb/hr				
Total	lb/hr	30,015	30,015	9731	9731
Pressure, psia		115	88.7	50	63.7
Temperature, °F		350	200	108	100

TABLE 6.5.14-9 (Continued)

MATERIAL BALANCE

TANK FARM AND DISPATCH - UNIT 55

Stream Number		55-31		55-41		55-51		55-52	
Stream Name		Methanol Product To Storage		Molten Sulfur Product To Dispatch		Ammonia Product To Storage		Ammonia Product To Dispatch	
Component		lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
CH_3OH		9664.8	100.0						
Total Dry Gas		9664.8	100.0						
H_2O									
Total Wet Gas									
H_2O	lb/hr					34		824	
Tar	lb/hr								
Oil	lb/hr								
Naphtha	lb/hr								
Phenols	lb/hr								
Fatty Acids	lb/hr								
Molten Sulfur	lb/hr			7229					
Org. Sulfur	lb/hr								
Ammonia	lb/hr					6355		6355	
HCl	lb/hr								
Methanol	lb/hr	309,680							
Total	lb/hr	309,680		7229		6389		7179	
Pressure, psia		63.7		88.7		220		210	
Temperature, °F		100		300		43		100	

6.5.15 CAPACITY FACTORS

The utility requirements and unit costs for the units in the Coproduction Case are capacity factored from the Base Case with a few exceptions. The capacity factors used and their basis for this case are tabulated in Table 6.5.15-1.

The units which are substantially different in this case from the Base Case are described in detail under Section 6.5.13. The utility requirements and cost estimates were developed for these units from Fluor in-house data.

T

UNIT C

UNIT

No.	Name		Basis
01	Coal Screening		Coal, TPD
02	Coal Distribution		Coal, TPD
03	Ash Handling		Gasifier Ash, TPD
10	Coal Gasification		Number of Gasifiers
11	CO Shift		Catalyst Volume, ft^3
12	Gas Cooling		Cooling Duty, MM Btu/hr
13	Rectisol		Acid Gas Removed, lb-mol/h
14	Gas Liquor Separation		Net Gas Liquor Feed, lb/hr
15	Tar Distillation		Tar/Oil Feed, lb/hr
16	Naphtha Hydrotreating		Naphtha Feed, lb/hr
17	Phenosolvan		Net Gas Liquor Feed, lb/hr
18	Ammonia Recovery		Ammonia Product Rate, lb/h
19	Sulfur Recovery - ADIP		Gas Feed, lb-mol/hr
			H_2S Absorbed, lb-mol/hr
		Claus	Sulfur Product Rate, TPD
		SCOT	Gas Geed, lb-mol/hr
		Stretford	Gas Feed, lb-mol/hr
			Sulfur Product Rate, TPD
20	Process Steam Superheating		Vent Gas Feed Rate, lb-mol
			Fired Duty, MM Btu/hr
21	Methanol Synthesis & Purification		---------- Estimated from F
22	Methanation		---------- Estimated from F
23	SNG Purification & Compression		---------- Estimated from F
24	Partial Oxidation		Liquids Feed Rate, lb/hr
25	PSA H_2 Production		H_2 Production Rate, lb-mol/
40	Oxygen Production		O_2 Production Rate, TPD

TABLE 6.5.15-1

UNIT CAPACITY FACTORS

	Base Case	Westmoreland Coal Coproduction Case	Factor
	18,000	18,000	1.0
	18,000	18,000	1.0
	827	827	1.0
	14	14	1.0
s	4,055	-0-	-0-
Btu/hr	673.9		Major Equipment
lb-mol/hr	19,940	17,659 (1)	0.824 (1)
d, lb/hr	1,000,636	1,070,732	1.070
	25,265	29,992	1.187
r	16,380	10,151 (1)	0.607 (1)
d, lb/hr	969,596	1,034,556 (1)	1.062 (1)
ate, lb/hr	6,398	6,389	0.999
r	690.9	806.1	1.167
ol/hr	114.4	146.8	1.283
, TPD	53.5	52.6	0.983
r	898.3	821.4	0.914
r	11,368.7	10,097.8	0.888
, TPD	33.7	34.1	1.012
, lb-mol/hr	21,870.2	19,566.5 (1)	0.876 (1)
/hr	320	170	0.531
d from Fluor In-house Data ----------			
d from Fluor In-house Data ----------			
d from Fluor In-house Data ----------			Major Equipment
lb/hr	23,487	30,015	1.278
, lb-mol/hr	118.6	76.2	0.641
, TPD	2,925	2,997	1.025

UNIT

No.	Name	Basis
41	Steam Generation	Steam Production Rate, M ll
		No. of Boilers
42	Power Generation	Generation Capacity, MW
		No. of Trains
43	Flue Gas Desulfurization	Flue Gas Feed Rate, MMSCI
		SO_2 Removed, lb-mol/hr
44	Raw Water Treating	Raw Water Flow Rate, gpm
45	BFW and Condensate Treating	Total BFW Flow Rate, gpm
46	Air and Nitrogen System	N_2 + Air Quantity, SCFM
47	Process Cooling Water	Cooling Water Flow, gpm
48	Utility Cooling Water	Cooling Water Flow, gpm
49	Potable Water	Water flow, gpm
50	Utility Water	Design Capacity, gpm
51	Fire Water	Design Capacity, gpm
52	Fuel Gas	Fuel Gas Quantity, MM Btu.
53	Flare	Design Capacity, MM lb/hr.
54	Wastewater Treating	Wastewater Flowrate, gpm
55	Tank Farm & Dispatch	Working Capacity, BBL
	-Naphtha	
	-Ammonia	
	-Sulfur	
	-Intermediate: PONS	
	-MeOH	
	-PROP/IPE	
	-Inorg. Chemicals	

TABLE 6.5.15-1 (Continued)

UNIT CAPACITY FACTORS

	Base Case	Westmoreland Coal Coproduction Case	Factor
			Major Equipment
te, M lb/hr	4,120		
	3		
, MW	405	320.6 [1]	0.785 [1]
	3	3	3
/ MMSCFM	1.2	1.2	1.0
l/hr	138	138	1.0
', gpm	6813	5529	0.812 [2]
', gpm	9977	9314	0.934 [2]
SCFM	23,100	23,100	1.0
gpm	152,000	125,100	0.823 [2]
gpm	64,900	47,700	0.735 [2]
	54	54	1.0
m	500	500	1.0
m	7500	7500	1.0
MM Btu/hr	369.2	207.8	0.563 [2]
1 lb/hr	1.878	1.878	1.0
, gpm	2536	2639	1.041 [2]
BL			
	41,200	24,500	0.595
	29,400	29,400	1.0
	7,800	7,800	1.0
	68,100	68,240	1.002
	Major Equipment		
	5,550	5,550	1.0
	10,650	10,650	1.0

UNIT

No.	Name		Basis
56	Sanitary Sewer	-	
57	Interconnecting Pipeway	-	

NOTE (1): Minor discrepancy between the capacity factors indica
balance subsequent to cost estimating.

TABLE 6.5.15-1 (Continued)

UNIT CAPACITY FACTORS

	Base Case	Westmoreland Coal Coproduction Case	Factor
	-	-	1.0
	-	-	1.0

rs indicated and the ratio of flowrates is due to slight adjustments made in the material

6.6 SHELL COAL CASE

6.6.1 OVERALL PLANT DESCRIPTION

The only difference in the design for the Shell Coal Case from the Base Case is the coal feed. The plant in this case is minemouth (Site 23) and the coal feed is obtained from the adjacent proposed Shell mine. The process and utility/offsite unit configuration and the product slate are identical to the Base Case. The differences in the coal properties give a slightly lower coal feed rate to the plant to produce the 125 MM SCF/D SNG. Also, more power, naphtha, and ammonia are produced, and less sulfur, ash, and gypsum are produced.

6.6.2 FEED AND PRODUCT SUMMARY

Table 6.6.2-1 contains a summary of the raw materials used and the products and solid wastes generated in the Shell Coal - 40% Fines - SNG Case at Site 23.

TABLE 6.6.2-1

FEED AND PRODUCT SUMMARY[1]

CASE: SHELL COAL - 40% FINES - SNG

Raw Materials	UNITS	QUANTITY
Coal from Mine	ST/D	17,600
Lurgi Gasification Feed	ST/D	10,560
Boiler Feed	ST/D	7,040
Bulk Chemicals		
Liquids	ST/D	72
Solids	ST/D	76
Water	Acre-Ft/D	31.3
Products[3]		
SNG	MM SCF/D	137.5[2]
Aromatic Naphtha	BPSD	2,428
Anhydrous Ammonia	ST/D	90.3
Sulfur	ST/D	39.9
Methanol	ST/D	-0-
Solid Wastes		
Gasifier Ash (Dry)	ST/D	447.6
Boiler Ash (Dry)	ST/D	286.9
Gypsum	ST/D	165
Trash & Scrap Metal	ST/D	50
Raw Water Treatment Sludge	ST/D	20
Spent Catalyst	ST/D	0.01
Biotreating Incinerator Ash and Cooling Tower Sludge	ST/D	31

NOTES: (1) All quantities per stream day

(2) SNG production equals 125 MM SCF/D calendar day basis

(3) Plant also produces 301.7 MW power for sales

6.6.3 THERMAL EFFICIENCY CALCULATION

Table 6.6.3-1 summarizes the overall thermal efficiency calculation for the Shell Coal - 40% Fines - SNG Case. The calculation basis is the same as described in Section 6.1.3 for the Base Case.

TABLE 6.6.3-1

THERMAL EFFICIENCY CALCULATION

CASE: Shell Coal - 40% Fines - SNG

	Design Flow(1)	Mass Flow lb/hr	Energy Content HHV	MM Btu/hr
Feed Streams				
Coal to Gasifiers	10,560 ST/D	880,000	9,090 Btu/lb	7,999
Coal to Boilers	7,040 ST/D	586,667	9,090 Btu/lb	5,333
TOTAL				13,332
Product Streams				
SNG	137.5 MMSCFD	245,736	980 Btu/scf	5,615
Methanol	-	-	-	-
Aromatic Naphtha	2,428 BPSD	29,385	20,500 Btu/lb	602
Ammonia (99.5% liquid)	90.3 ST/D	7,526	9,030 Btu/lb	68
Sulfur (liquid)	39.9 ST/D	3,323	4,000 Btu/lb	13
Export Power	301.7 MW	301,700 kW	3,414 Btu/kWh	1,030
TOTAL				7,331

$$\text{Thermal Efficiency} = \frac{\text{Products}}{\text{Feed}} \times 100 = \frac{7,331}{13,332} \times 100 = 55.0\%$$

NOTE: (1) Stream-day rates

6.6.4 DESIGN BASIS

The design basis for the Shell Coal - 40% Fines - SNG Case is identical to the Base Case (described in Section 6.1.4) except that the coal is supplied from the proposed Shell mine. The plant produces 125 MM SCF per day of SNG. The coal feed is 60 percent sized coal (two inch by one-fourth inch) to the gasifiers and 40 percent fines (less than one-fourth inch) to the boilers. This case is minemouth (Site 23).

6.6.5 PLANT UNITS

The plant units required for the Shell Coal - 40% Fines - SNG Case are the same as those required for the Base Case. The units are listed in Table 6.1.5-1.

6.6.6 PLANT TRAIN PHILOSOPHY

The plant train philosophy for the Shell Coal - 40% Fines - SNG Case is the same as that described in Section 6.1.6 for the Westmoreland Coal - 40% Fines - SNG Case.

6.6.7 PLOT PLAN

The development of plot plans involves conforming to industry standard practices, in addition to economics, constructability and operability. The units are spaced to comply with risk insurers recommendations.

For the overall plot plan, the units are arranged as much as possible, in the same sequence as the process flow of the plant. Some units, however, are located out of sequence and adjacent to or near other units for economic reasons, such as minimizing long runs of large diameter of exotic piping. For example:

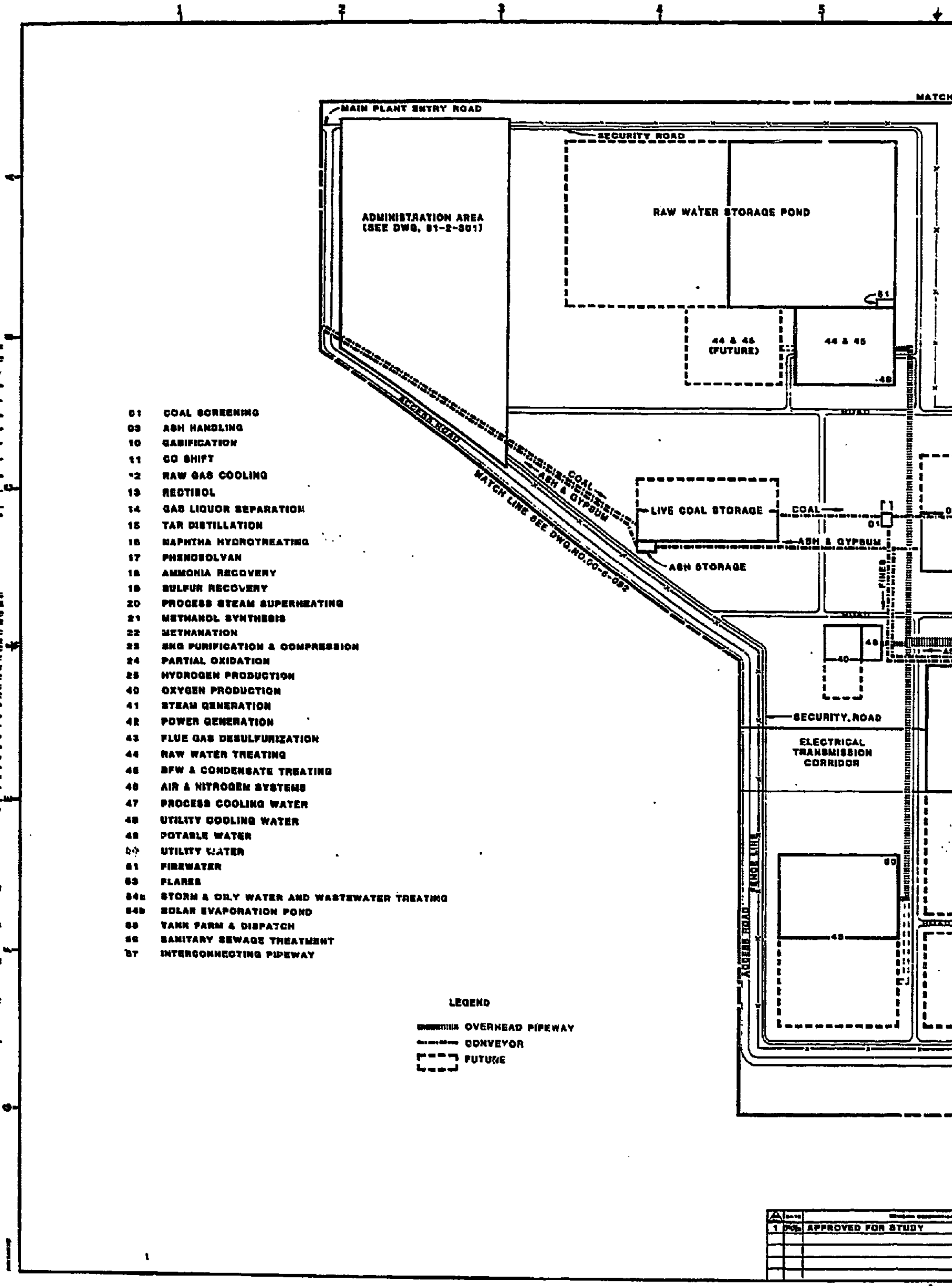
> The Steam Generation (Unit 41) area is located adjacent to Oxygen Production (Unit 40) which requires large quantities of high pressure steam.
>
> Sulfur Recovery (Unit 19) is located adjacent to Flue Gas Desulfurization (Unit 43) in order to utilize a common stack.
>
> Oxygen Production (Unit 40) is located such that it is upwind of the rest of the plant (based upon the prevailing wind).
>
> The cooling towers are located such that the water vapor plume does not interfere with the plant operation.
>
> Ponds are, in general, grouped together and located in the low area of the plant.
>
> The Flares (Unit 53) are located in the Solar Evaporation Pond (Unit 54B) to minimize plant acreage.

6.6.7 (Continued)

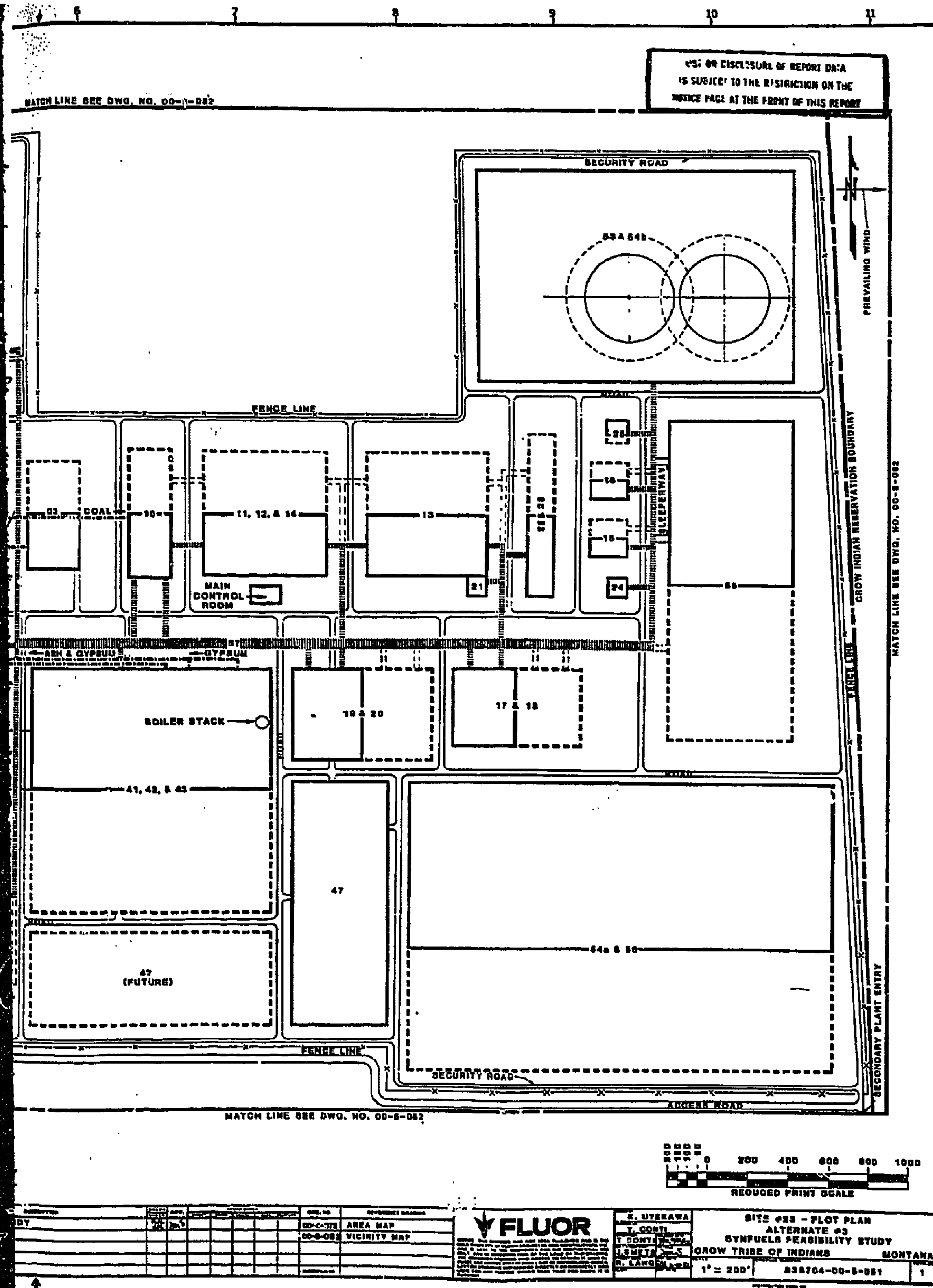
The main control building is centrally located.

Sufficient railroad switchyard is provided to allow for makeup of trains, switching, and sorting of incoming cars and storage of cars. A spur is also provided to the maintenance and warehouse area, and Flue Gas Desulfurization (Unit 43) for unloading of supplies.

The plot plan for the Shell Coal Case, Drawing Number 835704-00-5-051 is on the following page. This case is located at Site 23.



MAIN PLANT ENTRY ROAD
MATCH L
SECURITY ROAD
ADMINISTRATION AREA (SEE DWG. 81-2-801)
RAW WATER STORAGE POND
44 & 45 (FUTURE)
44 & 45
ACCESS ROAD
COAL
ASH & GYPSUM
MATCH LINE SEE DWG.NO.00-6-002
LIVE COAL STORAGE
ASH STORAGE
FINES
ROAD
SECURITY ROAD
ELECTRICAL TRANSMISSION CORRIDOR
FENCE LINE
01 COAL SCREENING
03 ASH HANDLING
10 GASIFICATION
11 CO SHIFT
12 RAW GAS COOLING
13 RECTISOL
14 GAS LIQUOR SEPARATION
15 TAR DISTILLATION
16 NAPHTHA HYDROTREATING
17 PHENOSOLVAN
18 AMMONIA RECOVERY
19 SULFUR RECOVERY
20 PROCESS STEAM SUPERHEATING
21 METHANOL SYNTHESIS
22 METHANATION
23 SNG PURIFICATION & COMPRESSION
24 PARTIAL OXIDATION
25 HYDROGEN PRODUCTION
40 OXYGEN PRODUCTION
41 STEAM GENERATION
42 POWER GENERATION
43 FLUE GAS DESULFURIZATION
44 RAW WATER TREATING
45 BFW & CONDENSATE TREATING
46 AIR & NITROGEN SYSTEMS
47 PROCESS COOLING WATER
48 UTILITY COOLING WATER
49 POTABLE WATER
50 UTILITY WATER
51 FIREWATER
53 FLARES
54a STORM & OILY WATER AND WASTEWATER TREATING
54b SOLAR EVAPORATION POND
55 TANK FARM & DISPATCH
56 SANITARY SEWAGE TREATMENT
57 INTERCONNECTING PIPEWAY
LEGEND
OVERHEAD PIPEWAY
CONVEYOR
FUTURE
APPROVED FOR STUDY



USE OR DISCLOSURE OF REPORT DATA IS SUBJECT TO THE RESTRICTION ON THE NOTICE PAGE AT THE FRONT OF THIS REPORT
MATCH LINE SEE DWG. NO. 00-5-082
SECURITY ROAD
PREVAILING WIND
FENCE LINE
COAL
MAIN CONTROL ROOM
11, 12, & 14
13
21
24
55
SLEEPERWAY
CROW INDIAN RESERVATION BOUNDARY
MATCH LINE SEE DWG. NO. 00-5-082
ASH & GYPSUM
GYPSUM
BOILER STACK
19 & 20
17 & 18
41, 42, & 43
47
47 (FUTURE)
54a & 56
FENCE LINE
SECURITY ROAD
ACCESS ROAD
SECONDARY PLANT ENTRY
MATCH LINE SEE DWG. NO. 00-5-082
0 200 400 600 800 1000
REDUCED PRINT SCALE
AREA MAP
VICINITY MAP
FLUOR
K. UTEKAWA
T. CONTI
SITE #23 - PLOT PLAN
ALTERNATE #3
SYNFUELS FEASIBILITY STUDY
CROW TRIBE OF INDIANS
MONTANA
1" = 200'
1