DOE/RA/50351-1300

CROW TRIBE
OF
INDIANS

SYNFUELS FEASIBILITY STUDY

VOLUME II

PROCESS DESIGN AND COST ESTIMATE
BOOK III: SECTIONS 6.5 THROUGH 6.9

AUGUST, 1982

PREPARED FOR THE DEPARTMENT OF ENERGY
UNDER GRANT NO. DE-FG01-81RA50351

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DE83 001314

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PREFACE

Volume II, Process Design and Cost Estimate, is a three book volume. Section 1.0 through 6.2 are presented in Book I. Book II contains sections 6.3 and 6.4, Base Case Utilities and Offsite Units - Engineering Data and The Contents and Results of the Power Self-Sufficiency Case. This book contains Section 6.5 through 6.9, Coproduction Case, Shell Coal Case, Process Studies, Design Plans and Drawings and Cost Estimate. The Table of Contents for Volume II is presented in total in each of the three books.

6.5 COPRODUCTION CASE

6.5.1 OVERALL PLANT DESCRIPTION

The principal difference in the design for the Coproduction Case is that methanol and substitute natural gas (SNG) are the major products as opposed to only SNG in the Base Case. The pure syngas is fed to a methanol synthesis unit producing methanol which is purified. The purge gas from the Methanol Synthesis unit is converted to SNG by methanation. Other process and utility/offsite units are similar to the Base Case except there is no requirement for a CO Shift unit and there is a slight variation in size of some units to accommodate the change in processing scheme.

Coal feed to gasification and boilers is identical to the Base Case. Feed and product rates for this case are given in Section 6.5.2. Other than the methanol and SNG products, the byproduct rates are only marginally different from the Base Case. Power available for export is less than the Base Case, due mainly to the additional energy consumed in the Methanol Synthesis unit.

6.5.2 FEED AND PRODUCT SUMMARY

Table 6.5.2-1 contains a summary of the raw materials used and the products and solid wastes generated in the Westmoreland Coal Coproduction Case.

TABLE 6.5.2-1

FEED AND PRODUCT SUMMARY[1]

CASE: WESTMORELAND COAL - COPRODUCTION

	UNITS	QUANTITY
Raw Material		
Coal from Mine	ST/D	18,000
Lurgi Gasification Feed	ST/D	10,800
Boiler Feed	ST/D	7,200
Bulk Materials		
Liquids	ST/D	72
Solids	ST/D	150
Water	Acre-Ft/D	24.4
Products[3]		
SNG	MM SCF/D	67.35[2]
Aromatic Naphtha	BPSD	804
Anhydrous Ammonia	ST/D	76.7
Sulfur	ST/D	86.7
Methanol	ST/D	3,752
Solid Wastes		
Gasifier Ash (Dry)	ST/D	827.2
Boiler Ash (Dry)	ST/D	531.1
Gypsum	ST/D	387
Plant Refuse	ST/D	50
Raw Water Treatment Sludge	ST/D	20
Spent Catalyst	ST/D	0.02
Biotreating Incinerator Ash and Cooling Tower Sludge	ST/D	26

NOTES: (1) All quantities per stream day
(2) SNG production equals 61.23 MM SCF/D calendar day basis
(3) Plant also produces 212.3 MW power for sales

6.5.3 THERMAL EFFICIENCY CALCULATION

Table 6.5.3-1 summarizes the overall thermal efficiency calculation for the Westmoreland Coal Coproduction Case.

TABLE 6.5.3-1

THERMAL EFFICIENCY CALCULATION

CASE: WESTMORELAND COAL - COPRODUCTION

	Design Flow[1]	Mass Flow lb/hr	Energy Content HHV	MM Btu/hr
Feed Streams				
Coal to Gasifiers	10,800 ST/D	900,000	8,612 Btu/lb	7,751
Coal to Boilers	7,200 ST/D	600,000	8,612 Btu/lb	5,167
			TOTAL	12,918
Product Streams				
SNG	67.35 MM SCFD	121,055	987 Btu/scf	2,770
Methanol	3,751.9 ST/D	312,657	9,740 Btu/lb	3,045
Aromatic Naphtha	804 BPSD	9,731	20,500 Btu/lb	199
Ammonia (99.5% liquid)	76.7 ST/D	6,389	9,030 Btu/lb	58
Sulfur (liquid)	86.7 ST/D	7,229	4,000 Btu/lb	29
Export Power	212.3 MW	212,300	3,414 Btu/kWh	725
			TOTAL	6,826

$$\text{Thermal Efficiency} = \frac{\text{Products}}{\text{Feed}} \times 100 = \frac{6,826}{12,918} \times 100 = \underline{52.8\%}$$

[1] Stream-day rates

6.5.4 DESIGN BASIS

The design of the Westmoreland Coal - Coproduction Case plant is based on the same coal feed rate as the Base Case plant. Coal feed to the gasifiers is 10,800 ST/SD, and the feed to the boilers is 7,200 ST/SD. The principal products in this case are chemical grade methanol and SNG instead of only SNG in the Base Case. All of the pure gas is fed to a conventional methanol synthesis loop and the purge gas is methanated.

Changes in process units are described in Section 6.5.13, and changes in utility and offsite units are described in Section 6.5.14.

6.5.5 PLANT UNITS

The plant units required for the Westmoreland Coal - Coproduction Case are the same as those required for the Base Case (Section 6.1.5) with the following exceptions:

Unit 11: CO Shift - deleted

Unit 21: Methanol Synthesis - changed to Methanol Synthesis and Purification.

6.5.6 PLANT TRAIN PHILOSOPHY

The train philosophy for the units in the Coproduction Case remains the same as established for the Base Case with the following exceptions:

Unit No.	Unit Name	No. of Trains
11	CO Shift	Unit deleted
21	Methanol Synthesis & Purification	2 x 50%

6.5.7 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 Desulfuration (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.

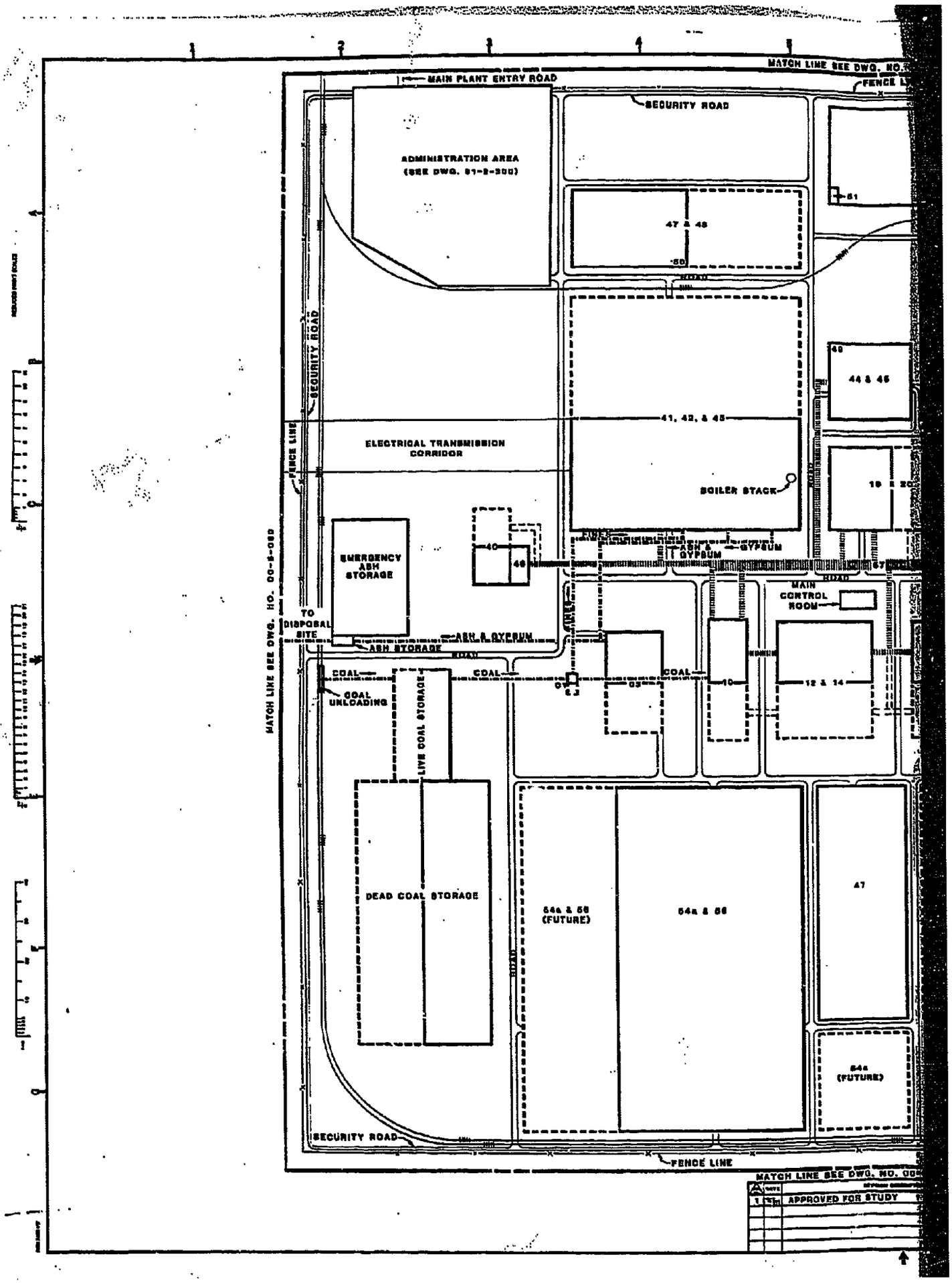
The Flares (Unit 53) are located in the Solar Evaporation Pond (Unit 54B) to minimize plant acreage.

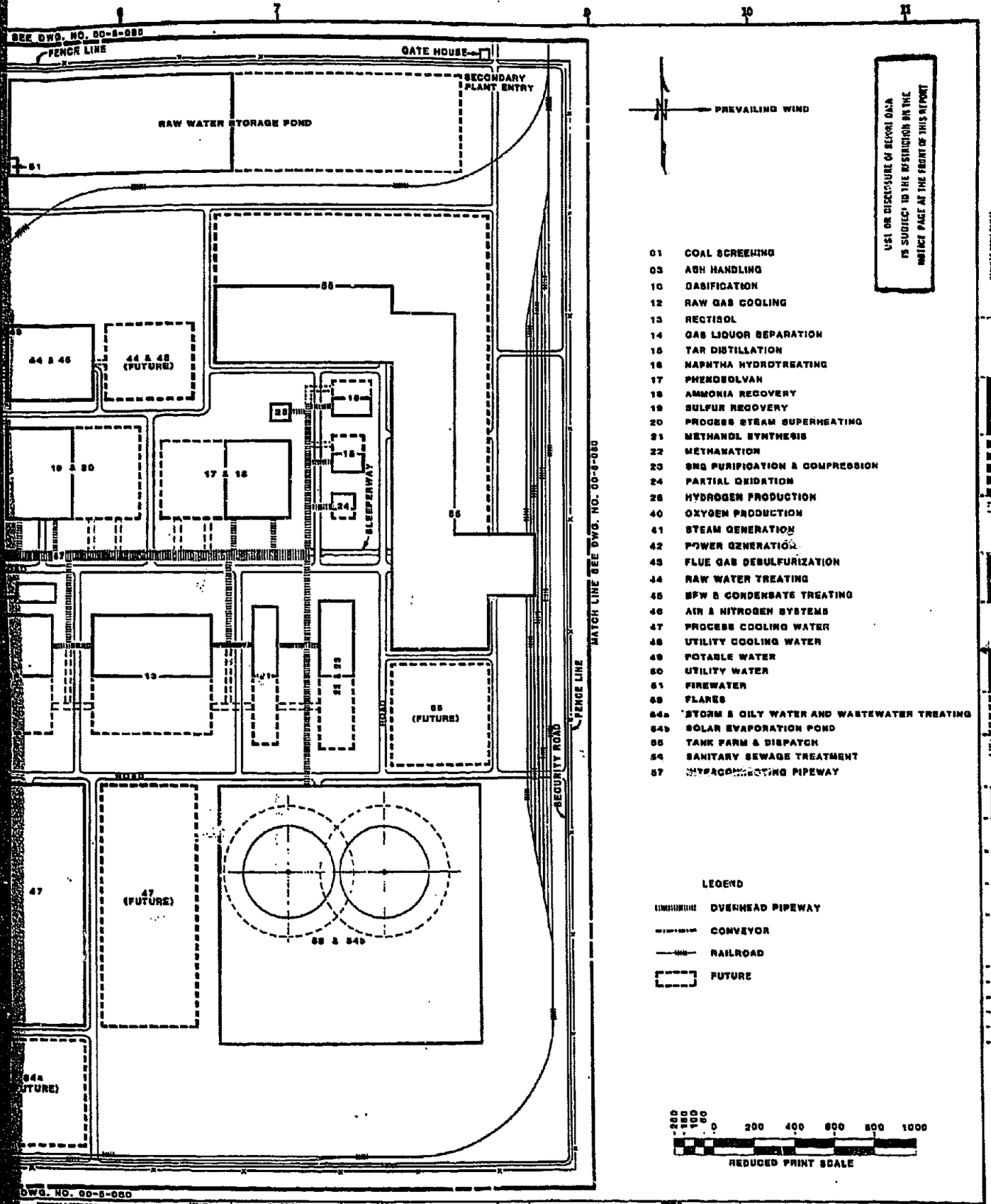
6.5.7 (Continued)

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 Coproduction Case, Drawing Number 835704-00-5-052 is on the following page.


MATCH LINE SEE DWG. NO.
MAIN PLANT ENTRY ROAD
FENCE L
SECURITY ROAD
ADMINISTRATION AREA
(SEE DWG. 61-2-200)
47 & 48
50
51
SECURITY ROAD
49
44 & 45
41, 42, & 43
FENCE LINE
ELECTRICAL TRANSMISSION
CORRIDOR
BOILER STACK
18 & 20
40
46
ASH & GYPSUM
GYPSUM
67
EMERGENCY
ASH
STORAGE
MAIN
CONTROL
ROOM
TO
DISPOSAL
SITE
ASH & GYPSUM
ASH STORAGE
COAL
COAL
COAL
COAL
UNLOADING
LIVE COAL STORAGE
10
12 & 14
DEAD COAL STORAGE
54a & 56
(FUTURE)
54a & 56
47
54a
(FUTURE)
SECURITY ROAD
FENCE LINE
MATCH LINE SEE DWG. NO. 61-2-099
MATCH LINE SEE DWG. NO.
APPROVED FOR STUDY



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

DWG. NO. 00-S-080

OR STUDY

CO-S-079	AREA MAP
00-S-080	VICINITY MAP

FLUOR

R. LIVEKANA
J. NUTTEN
T. CONTI
J. SMITH
D. LAND

SITE #1 PLOT PLAN
ALTERNATE #2 CO-PRODUCTION
SYNFUELS FEASIBILITY STUDY
CROW TRIBE OF INDIANS MONTANA

1" = 200'

838704-00-S-082

1

6.5.8 BLOCK FLOW DIAGRAMS

6.5.8.1 OVERALL MATERIAL BALANCE

The overall material balance for the Westmoreland Coal - Coproduction Case is shown on Drawing No. 835704-00-4-301. The drawing shows the flow of materials through the process plant and the following utility/offsite units: Oxygen Production, Steam Generation, Power Generation, and Flue Gas Desulfurization.

The process differs from the Base Case in that there is no CO Shift and the entire pure gas stream enters the Methanol Synthesis and Purification Unit where the methanol product is produced. A purge system from Methanol Synthesis is methanated, purified, and compressed to SNG.

6.5.8.2 PLANT WATER BALANCE

Drawing No. 835704-00-R-302 is the Block Flow Diagram of the plant water balance for the Westmoreland Coal - Coproduction Case. The diagram shows the same overall management scheme as the Base Case.

The presence of the large Methanol Synthesis & Purification unit raises the vacuum condensate flow while reducing the process water flow from Methanation. These two combined streams are added to the 1500 psig boiler feed water upstream of the polishing filters and returned to the plant through the power generation turbines.

6.5.8.3 SULFUR BALANCE

The sulfur balance for the Westmoreland Coal - Coproduction Case is shown on Drawing No. 835704-00-4-304. The description of the drawing given in Section 6.1.8 also applies to this case.

6.5.8.4 AIR EMISSIONS

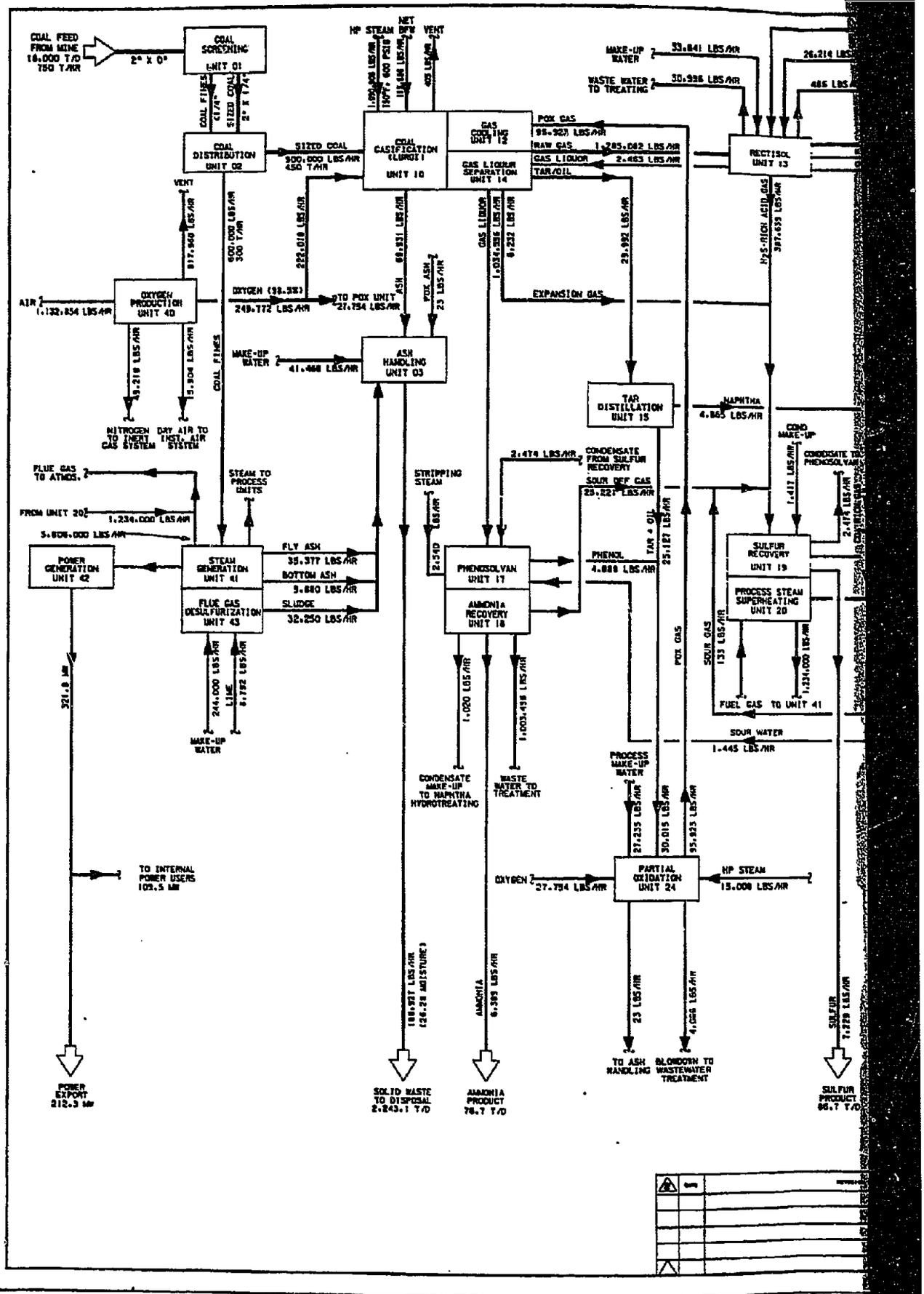
The air emissions diagram for the Westmoreland Coal - Coproduction Case is shown on Drawing No. 835704-00-4-305. The description of the drawing given in Section 6.1.8 also applies to this case.

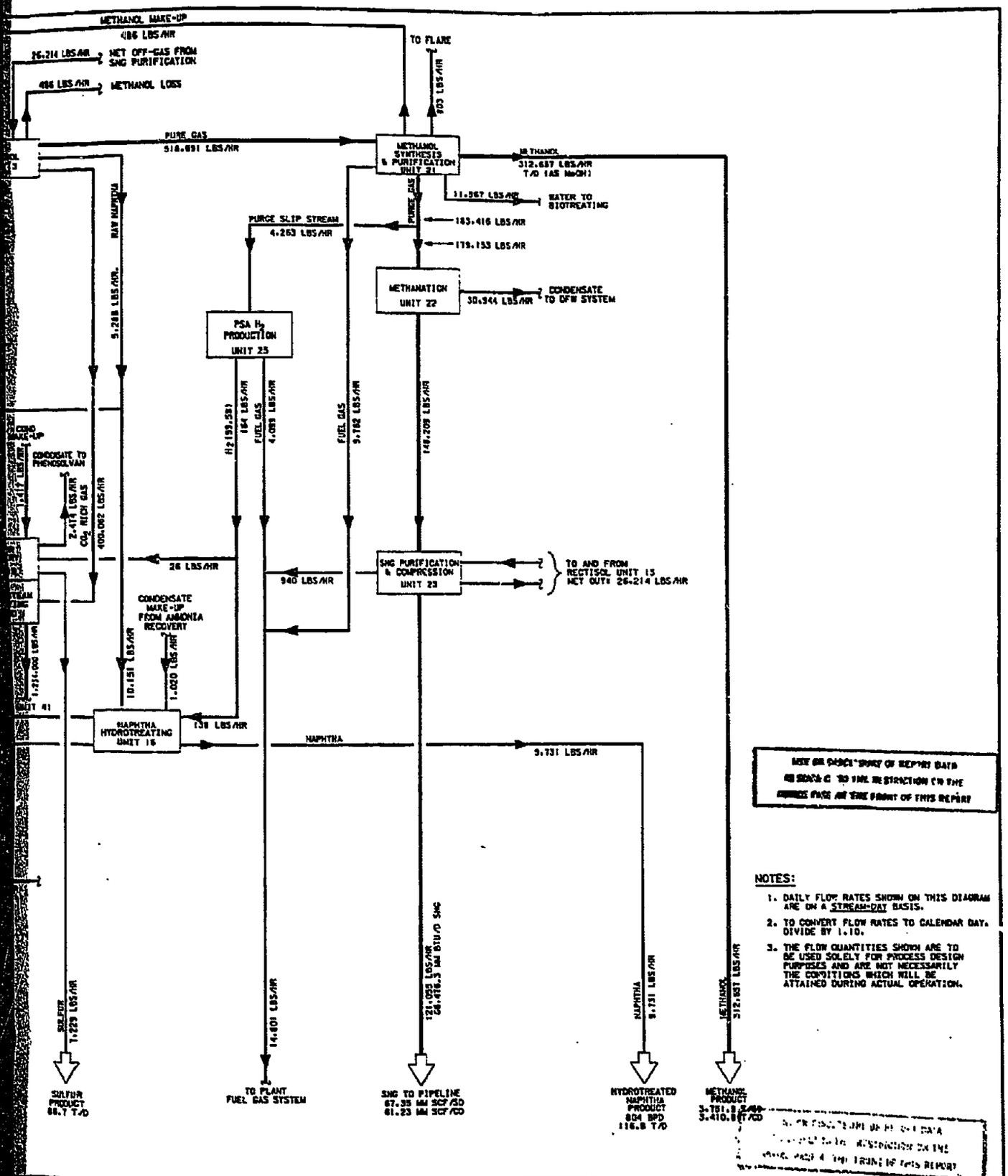
6.5.8.5 SOLID EFFLUENT

The solid effluent diagram for the Westmoreland Coal - Coproduction Case is shown on Drawing No. 835704-00-4-306. The description of the drawing given in Section 6.1.8 also applies to this case.

6.5.8.6 STEAM BALANCE

The steam balance for the Westmoreland Coal - Coproduction Case is shown on Drawing No. 835704-00-R-307. The description of the drawing given in Section 6.1.8 also applies to this case.


COAL FEED FROM MINE 16,000 T/D 750 T/HR
2" X 0"
COAL SCREENING UNIT 01
COAL FINES
SIZED COAL 2" X 1/4"
COAL DISTRIBUTION UNIT 02
SIZED COAL 900,900 LBS/HR 450 T/HR
COAL GASIFICATION (LURGI) UNIT 10
GAS COOLING UNIT 12
GAS LIQUOR SEPARATION UNIT 14
HP STEAM
NET BFW
VENT
POX GAS 98,923 LBS/HR
RAW GAS 1,285,082 LBS/HR
GAS LIQUOR 2,463 LBS/HR
TAR/OIL
RECTISOL UNIT 13
MAKE-UP WATER 33,841 LBS/HR
WASTE WATER TO TREATING 30,936 LBS/HR
H2S-RICH ACID GAS 387,439 LBS/HR
OXYGEN PRODUCTION UNIT 40
AIR 1,132,854 LBS/HR
OXYGEN (98.5%) 249,772 LBS/HR
TO POX UNIT 27,754 LBS/HR
ASH
POX ASH 23 LBS/HR
EXPANSION GAS
ASH HANDLING UNIT 03
MAKE-UP WATER 41,468 LBS/HR
NITROGEN TO INERT GAS SYSTEM
DRY AIR TO INSTR. AIR SYSTEM
TAR DISTILLATION UNIT 15
NAPHTHA 4,865 LBS/HR
COND. MAKE-UP
CONDENSATE TO PHENOSOLVAN
FLUE GAS TO ATMOS.
STEAM TO PROCESS UNITS
FROM UNIT 20 1,234,000 LBS/HR
5,826,000 LBS/HR
STRIPPING STEAM
2,474 LBS/HR
CONDENSATE FROM SULFUR RECOVERY
SOUR OFF GAS 25,227 LBS/HR
TAR + OIL 25,127 LBS/HR
POWER GENERATION UNIT 42
STEAM GENERATION UNIT 41
FLUE GAS DESULFURIZATION UNIT 43
FLY ASH 35,377 LBS/HR
BOTTOM ASH 9,880 LBS/HR
SLUDGE 32,250 LBS/HR
2,510 LBS/HR
PHENOSOLVAN UNIT 17
AMMONIA RECOVERY UNIT 18
PHENOL 4,888 LBS/HR
SULFUR RECOVERY UNIT 19
PROCESS STEAM SUPERHEATING UNIT 20
SOUR GAS 133 LBS/HR
1,234,000 LBS/HR
FUEL GAS TO UNIT 41
SOUR WATER 1,445 LBS/HR
321.8 MW
TO INTERNAL POWER USERS 102.5 MW
244,000 LBS/HR LIME
8,792 LBS/HR MAKE-UP WATER
1,000 LBS/HR
1,003,498 LBS/HR
CONDENSATE MAKE-UP TO NAPHTHA HYDROTREATING
WASTE WATER TO TREATMENT
PROCESS MAKE-UP WATER
POX GAS
21,235 LBS/HR
30,019 LBS/HR
55,923 LBS/HR
OXYGEN 27,754 LBS/HR
PARTIAL OXIDATION UNIT 24
HP STEAM 15,000 LBS/HR
23 LBS/HR
4,056 LBS/HR
TO ASH HANDLING
BLOWDOWN TO WASTEWATER TREATMENT
SULFUR 7,229 LBS/HR
POWER EXPORT 212.3 MW
188,937 LBS/HR (26.2% MOISTURE)
SOLID WASTE TO DISPOSAL 2,243.1 T/D
AMMONIA 6,389 LBS/HR
AMMONIA PRODUCT 76.7 T/D
SULFUR PRODUCT 86.7 T/D



NOTES:

1. DAILY FLOW RATES SHOWN ON THIS DIAGRAM ARE ON A STREAM-DAY BASIS.
2. TO CONVERT FLOW RATES TO CALENDAR DAY, DIVIDE BY 1.10.
3. THE FLOW QUANTITIES SHOWN ARE TO BE USED SOLELY FOR PROCESS DESIGN PURPOSES AND ARE NOT NECESSARILY THE CONDITIONS WHICH WILL BE ATTAINED DURING ACTUAL OPERATION.

FLUOR

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L.C. ABATAY
R.D. BELMITO
R. McCARTNEY
R. LANG

BLOCK FLOW DIAGRAM
OVERALL MATERIAL BALANCE
CASE: WESTMORELAND COAL - CO-PRODUCTION
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-00-4-301 | 1

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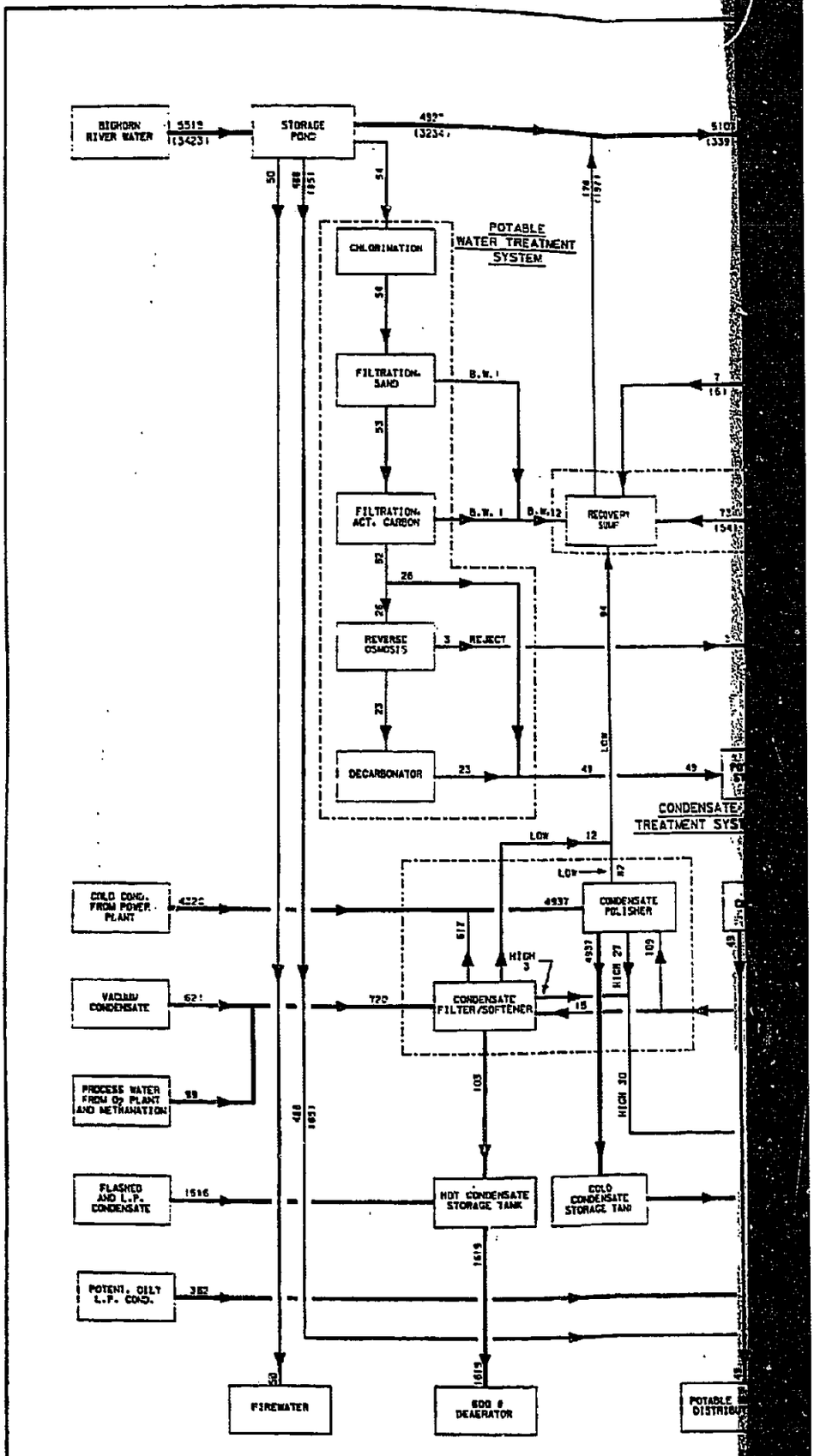
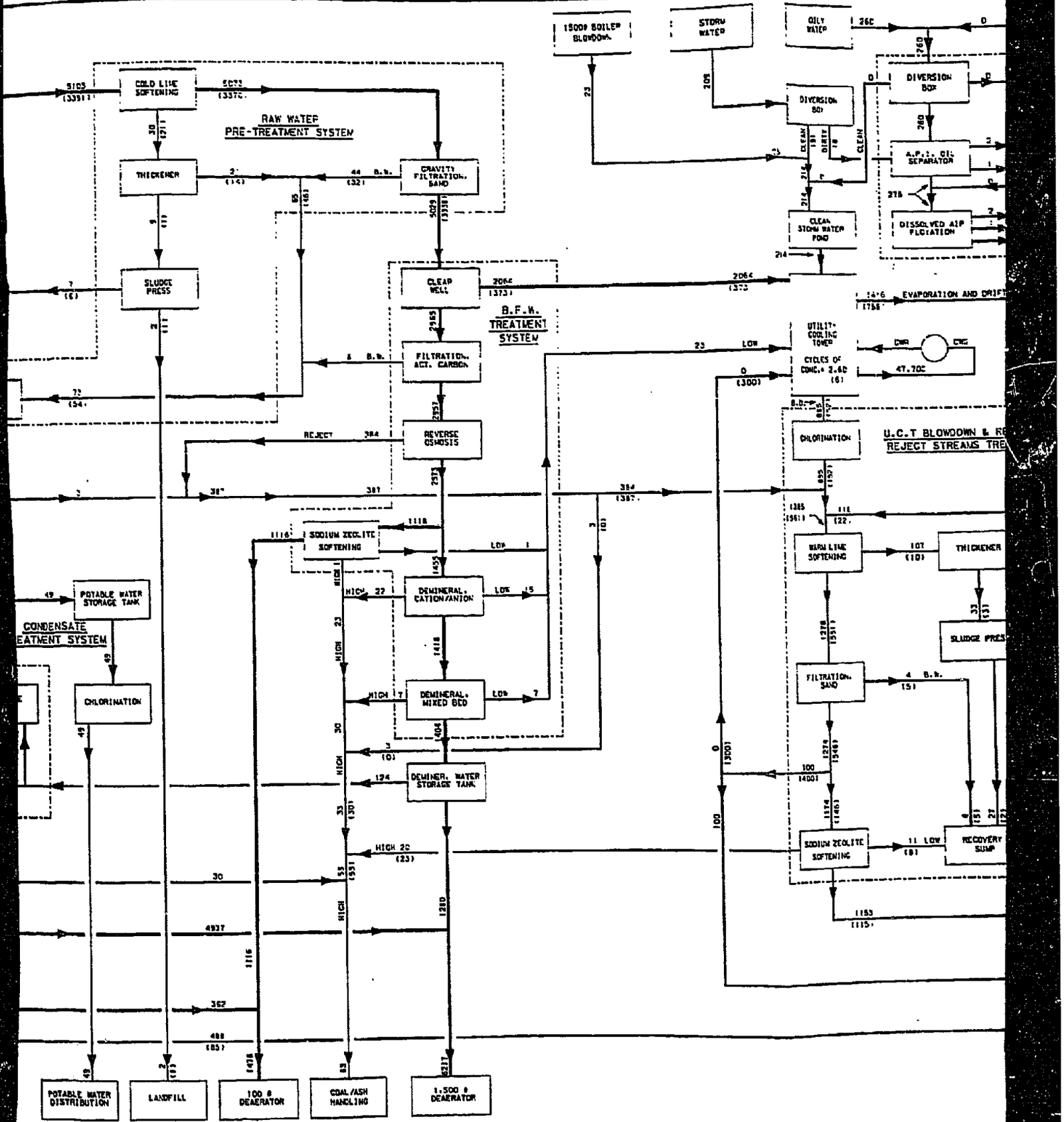
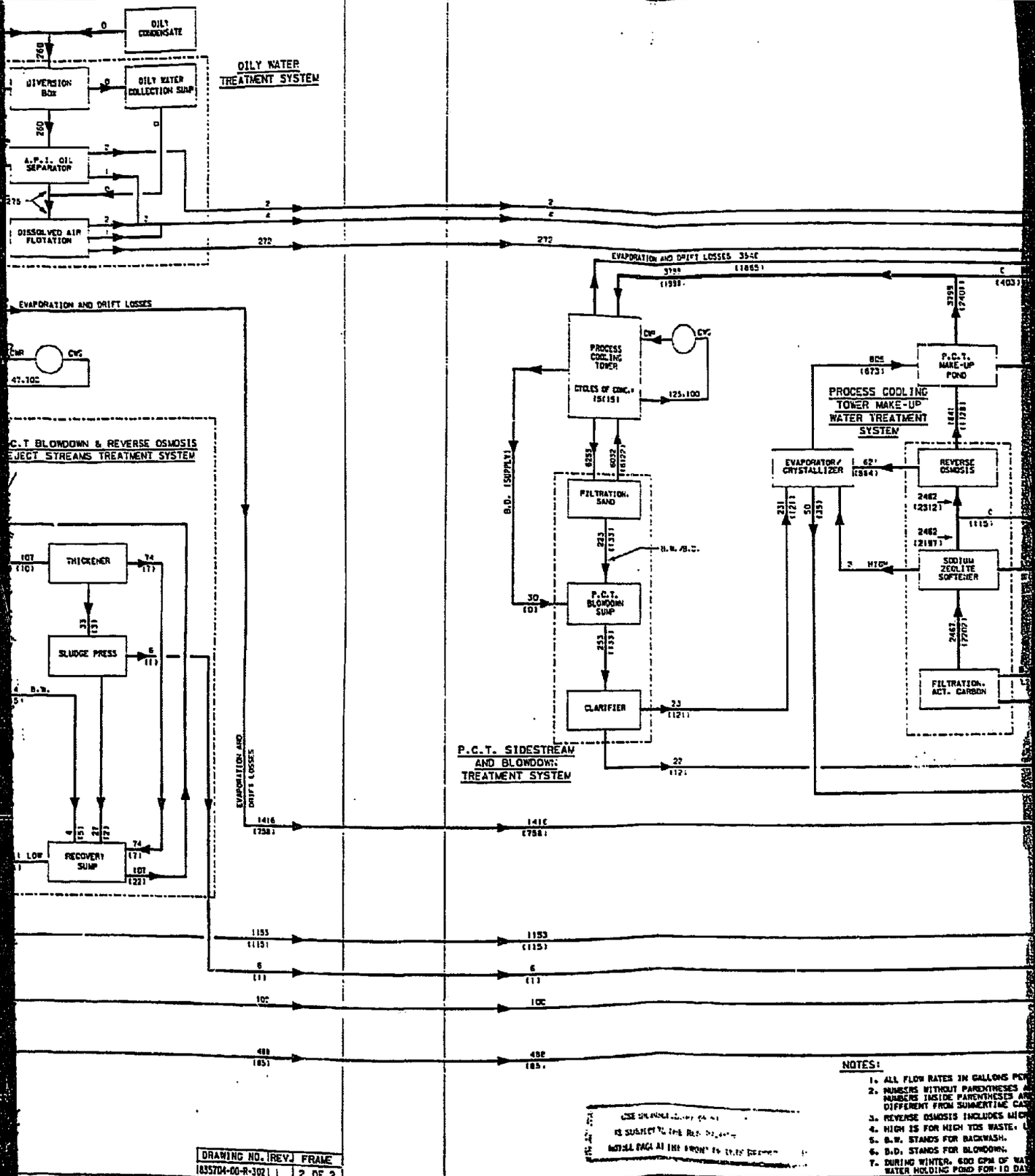
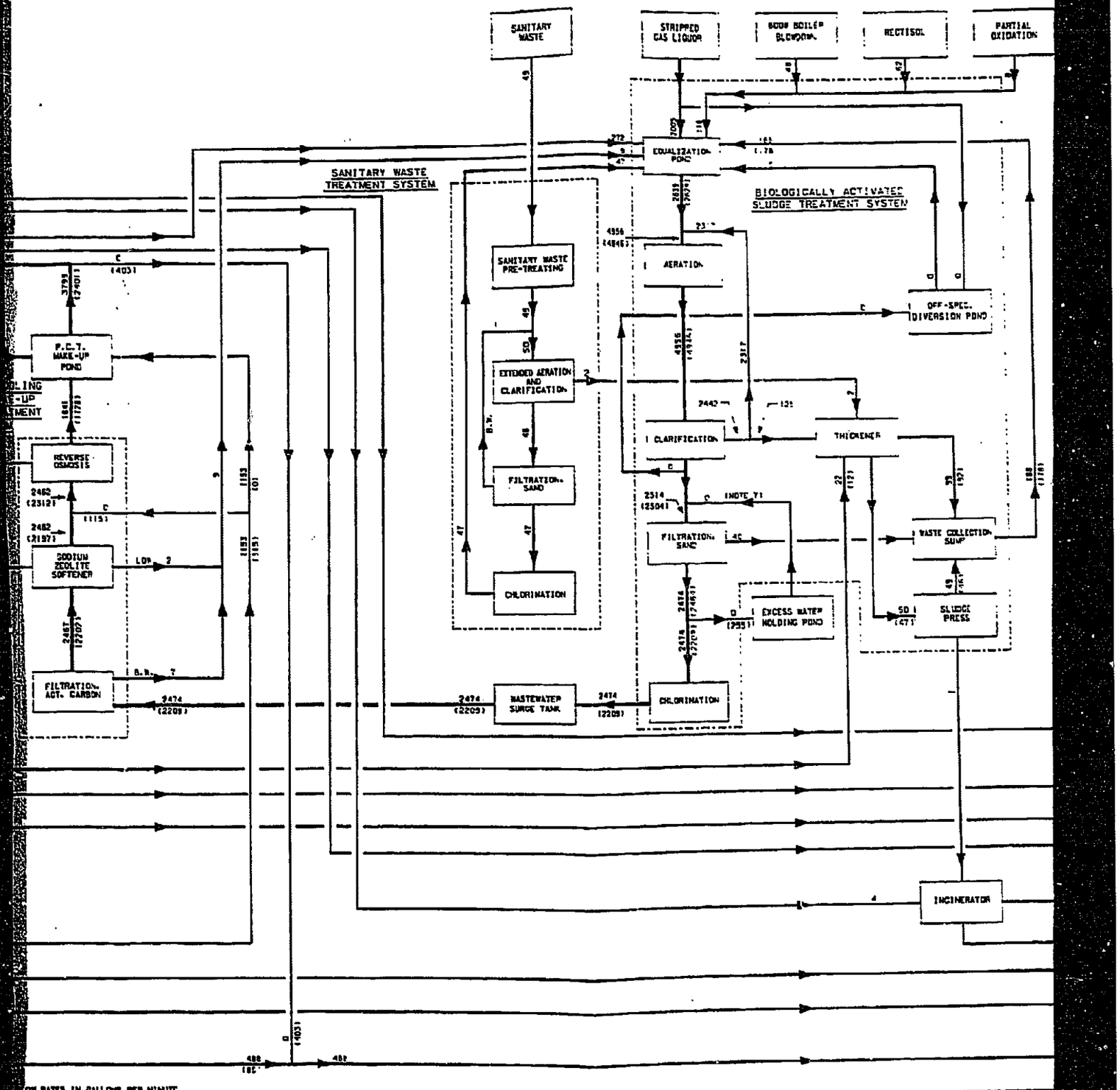

BIGHORN RIVER WATER
5519
(5423)
STORAGE POND
492*
(3234)
510
(339)
POTABLE WATER TREATMENT SYSTEM
CHLORINATION
FILTRATION SAND
B.W.
FILTRATION ACT. CARBON
B.W.
B.W.12
RECOVERY SUMP
REVERSE OSMOSIS
3
REJECT
DECARBONATOR
23
49
CONDENSATE TREATMENT SYS
LOW
12
COLD COND. FROM POWER PLANT
4220
CONDENSATE POLISHER
4937
VACUUM CONDENSATE
621
720
CONDENSATE FILTER/SOFTENER
15
HIGH
3
PROCESS WATER FROM Op PLANT AND METHANATION
99
FLASHED AND L.P. CONDENSATE
1516
HOT CONDENSATE STORAGE TANK
COLD CONDENSATE STORAGE TANK
POTENT. OILY L.P. COND.
382
FIREWATER
600 # DEAERATOR
POTABLE DISTRIBU


RAW WATER
PRE-TREATMENT SYSTEM
COLD LIME SOFTENING
THICKENER
GRAVITY FILTRATION, SAND
SLUDGE PRESS
CLEAR WELL
B.F.W.
TREATMENT
SYSTEM
FILTRATION, ACT. CARBON
REVERSE OSMOSIS
SODIUM ZEOLITE SOFTENING
DEMINERAL., CATION/ANION
DEMINERAL., MIXED BED
DEMINER. WATER STORAGE TANK
POTABLE WATER STORAGE TANK
CONDENSATE
EATMENT SYSTEM
CHLORINATION
1500# BOILER BLOWDOWN
STORM WATER
OILY WATER
DIVERSION BOX
DIVERSION BOX
A.P.I. OIL SEPARATOR
CLEAN STORM WATER POND
DISSOLVED AIR FLOTATION
EVAPORATION AND DRIFT
UTILITY COOLING TOWER
CYCLES OF CONC.= 2.6D
47.7DC
CHLORINATION
U.C.T BLOWDOWN & R
REJECT STREAMS TRE
WARM LIME SOFTENING
THICKENER
SLUDGE PRES
FILTRATION, SAND
SODIUM ZEOLITE SOFTENING
RECOVERY SUMP
POTABLE WATER DISTRIBUTION
LANDFILL
100 # DEAERATOR
COAL/ASH HANDLING
1,500 # DEAERATOR


OILY CONDENSATE
DIVERSION BOX
OILY WATER COLLECTION SUMP
A.P.I. OIL SEPARATOR
DISSOLVED AIR FLOTATION
OILY WATER TREATMENT SYSTEM
EVAPORATION AND DRIFT LOSSES
CWR
CWS
47.700
C.T BLOWDOWN & REVERSE OSMOSIS
EJECT STREAMS TREATMENT SYSTEM
THICKENER
SLUDGE PRESS
RECOVERY SUMP
B.W.
LOW
EVAPORATION AND DRIFT LOSSES
1416
(758)
1153
(115)
6
(1)
100
488
(85)
EVAPORATION AND DRIFT LOSSES 3548
(1865)
3798
(1998)
(403)
3798
(2400)
PROCESS COOLING TOWER
CYCLES OF CONC.
(5C15)
125,100
CWR
CWS
6253
6032
(6127)
B.D. (SUPPLY)
FILTRATION, SAND
223
(133)
B.W. /B.D.
30
(0)
P.C.T. BLOWDOWN SUMP
253
(133)
CLARIFIER
23
(12)
22
(12)
P.C.T. SIDESTREAM AND BLOWDOWN TREATMENT SYSTEM
EVAPORATOR/ CRYSTALLIZER
62
(584)
231
(121)
50
(25)
REVERSE OSMOSIS
2462
(2312)
2462
(2197)
C
(115)
HIGH
SODIUM ZEOLITE SOFTENER
2462
(2707)
FILTRATION, ACT. CARBON
P.C.T. MAKE-UP POND
805
(673)
1441
(1128)
PROCESS COOLING TOWER MAKE-UP WATER TREATMENT SYSTEM
NOTES:
1. ALL FLOW RATES IN GALLONS PER
2. NUMBERS WITHOUT PARENTHESES A
NUMBERS INSIDE PARENTHESES AR
DIFFERENT FROM SUMMERTIME CA
3. REVERSE OSMOSIS INCLUDES MIC
4. HIGH IS FOR HIGH TDS WASTE
5. B.W. STANDS FOR BACKWASH.
6. B.D. STANDS FOR BLOWDOWN.
7. DURING WINTER, 600 GPM OF WA
WATER HOLDING POND FOR 10 DA
DRAWING NO. 835704-00-R-302
REV. 1
FRAME 2 OF 2
4
3



...ON RATES IN GALLONS PER MINUTE.
...S WITHOUT PARENTHESES ARE FOR SUMMERTIME CASE!
...S INSIDE PARENTHESES ARE FOR WINTERTIME CASE IF
...ENT FROM SUMMERTIME CASE.
...C OSMOSIS INCLUDES MICRON FILTRATION.
...S FOR HIGH TDS WASTE. LOW IS FOR LOW TDS WASTE.
...STANDS FOR BACKWASH.
...STANDS FOR BLOWDOWN.
...D WINTER, 600 GPM OF WATER IS STORED IN THE EXCESS
... HOLDING POND FOR 10 DAYS FOR LATER USAGE.

FLUOR

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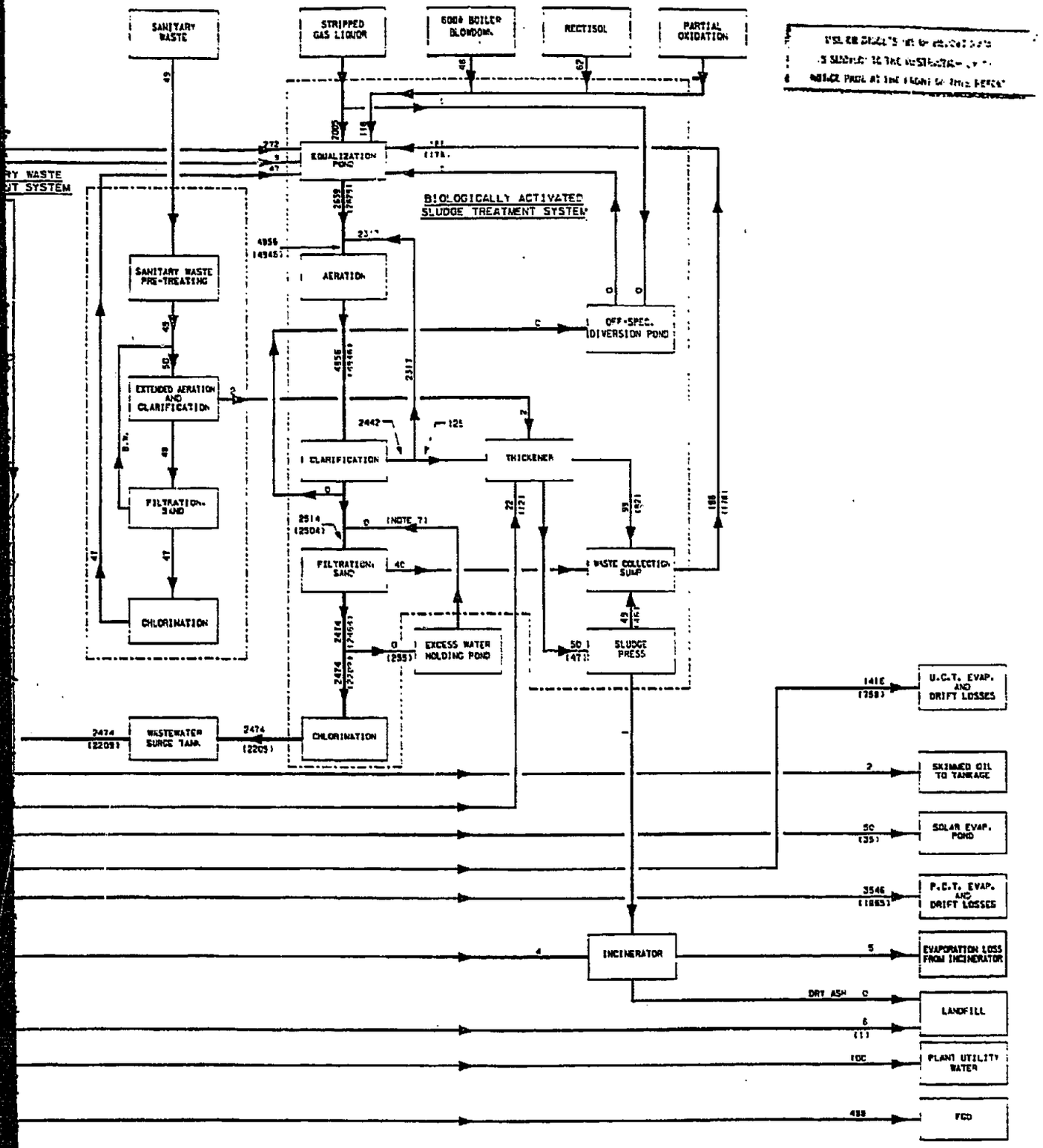
W. D. BELMITO
R. McCARTHY
R. LANG



FLUOR

R. WHITE
C. C. ABATAY
R. D'BELMITO
R. McCARTHY
R. LANG

BLOCK FLOW DIAGRAM
PLANT WATER BALANCE
CASE: WESTMORELAND COAL - CO-PRODUCTION
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE

835704-00-R-302
MICROFILM FRAME 1 OF 2

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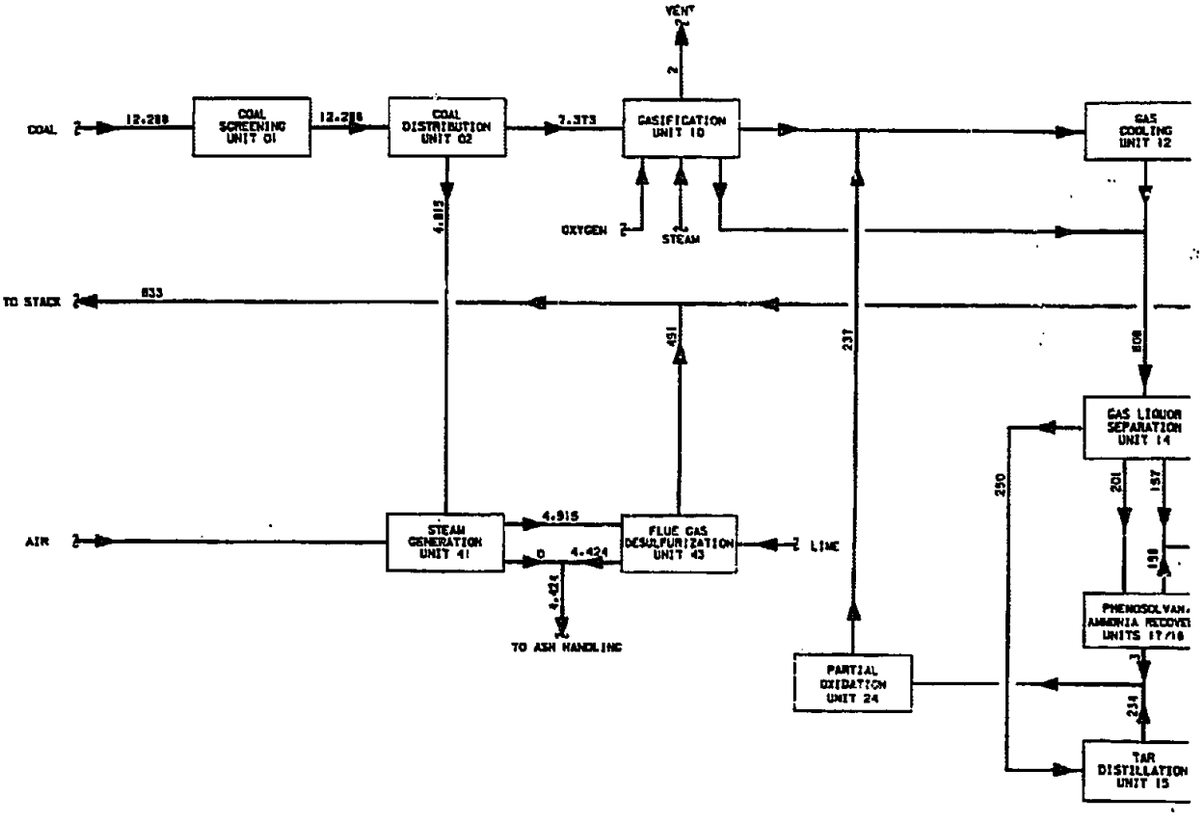
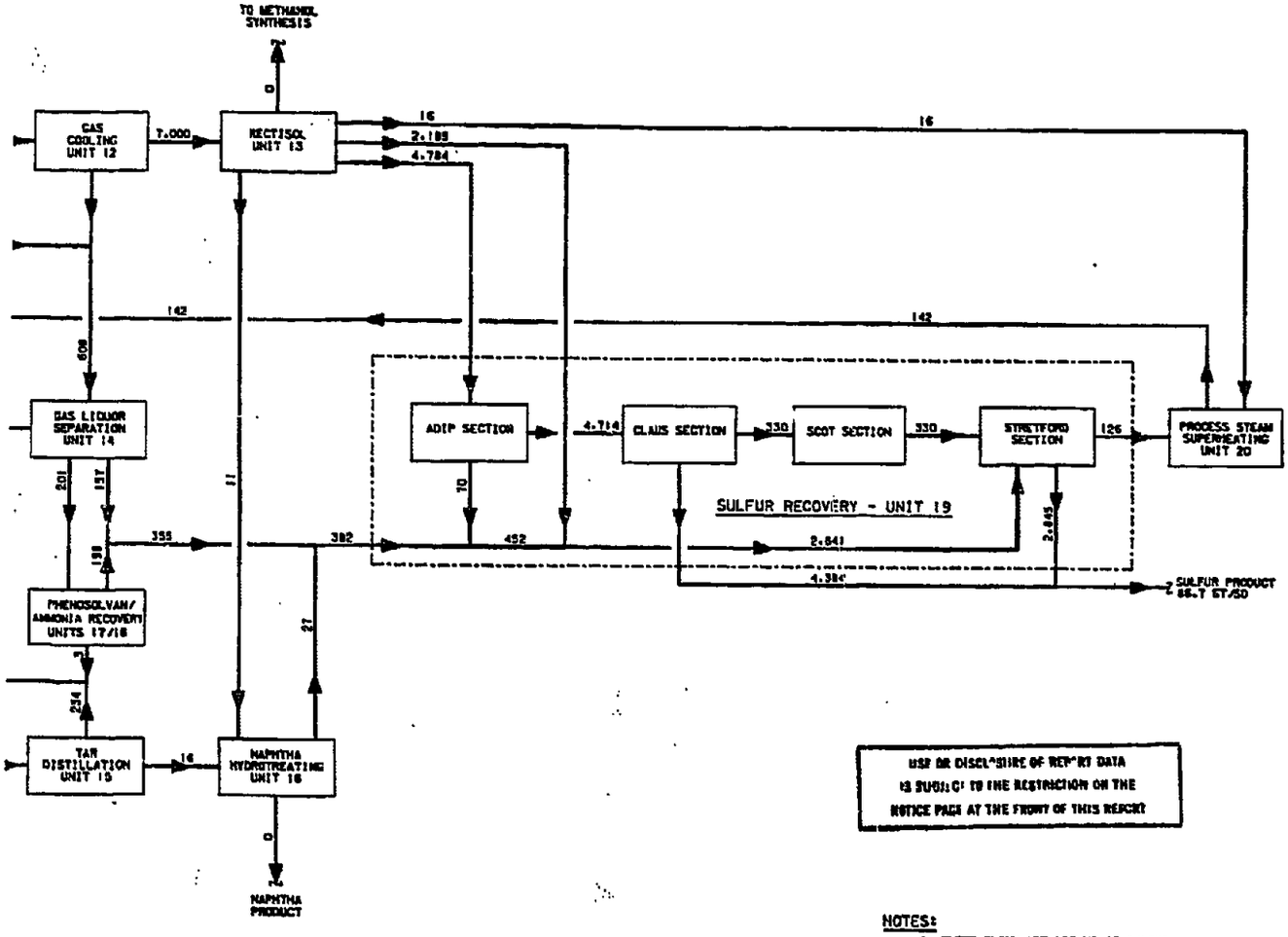
2


VENT
2
COAL
12,288
COAL SCREENING UNIT 01
12,288
COAL DISTRIBUTION UNIT 02
7,373
GASIFICATION UNIT 10
GAS COOLING UNIT 12
4,813
OXYGEN
STEAM
TO STACK
833
451
237
808
GAS LIQUOR SEPARATION UNIT 14
290
201
157
AIR
STEAM GENERATION UNIT 41
4,915
4,424
FLUE GAS DESULFURIZATION UNIT 43
LIME
4,424
TO ASH HANDLING
PHENOSOLVAN. AMMONIA RECOVE UNITS 17/18
PARTIAL OXIDATION UNIT 24
214
TAR DISTILLATION UNIT 15



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NOTES:

1. FLOWS SHOWN ARE LBS/HR OF SULFUR.
2. DESIGN BASIS IS 750 T/HR COAL TO PLANT.
   GASIFIER FEED COAL= 450 T/HR
   BOILER FEED COAL= 300 T/HR
3. FGD SULFUR REMOVAL EFFICIENCY IS 90%.
4. MORE THAN 98% OF SULFUR ENTERING GASIFICATION IS RECOVERED.
5. THE FLOW QUANTITIES SHOWN ARE TO BE USED SOLELY FOR PROCESS DESIGN PURPOSES AND ARE NOT NECESSARILY THE CONDITIONS WHICH WILL BE ATTAINED DURING ACTUAL OPERATIONS.

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

FLUOR

DRAWN BY	D.P. HALVERSON
CHECKED BY	C.C. ABATAY
APPROVED BY	R.D'BELMITO
	R. McCARTHY
	R. LAND

BLOCK FLOW DIAGRAM
SULFUR BALANCE
CASE: WESTMORELAND COAL - CO-PRODUCTION
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE	835704-00-4-304	1

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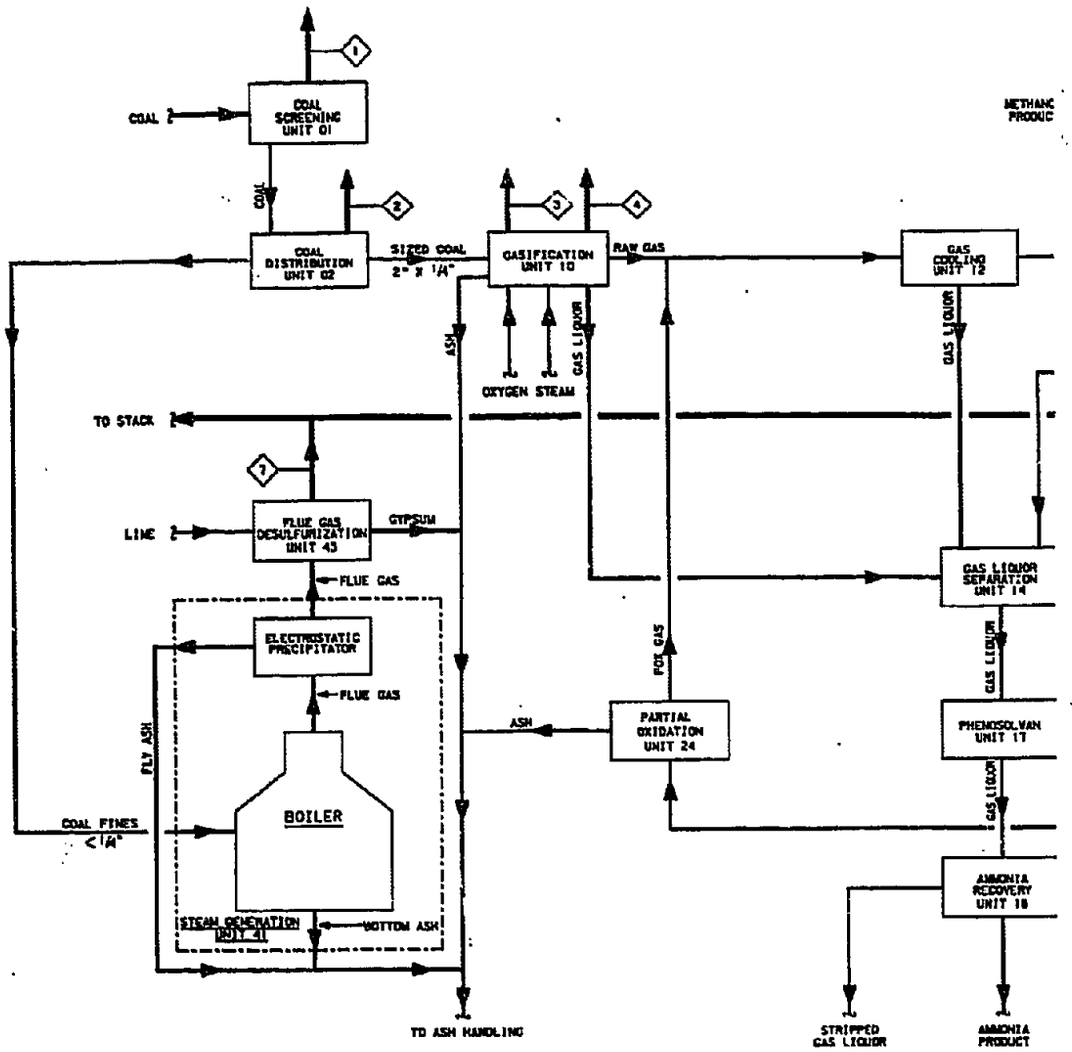
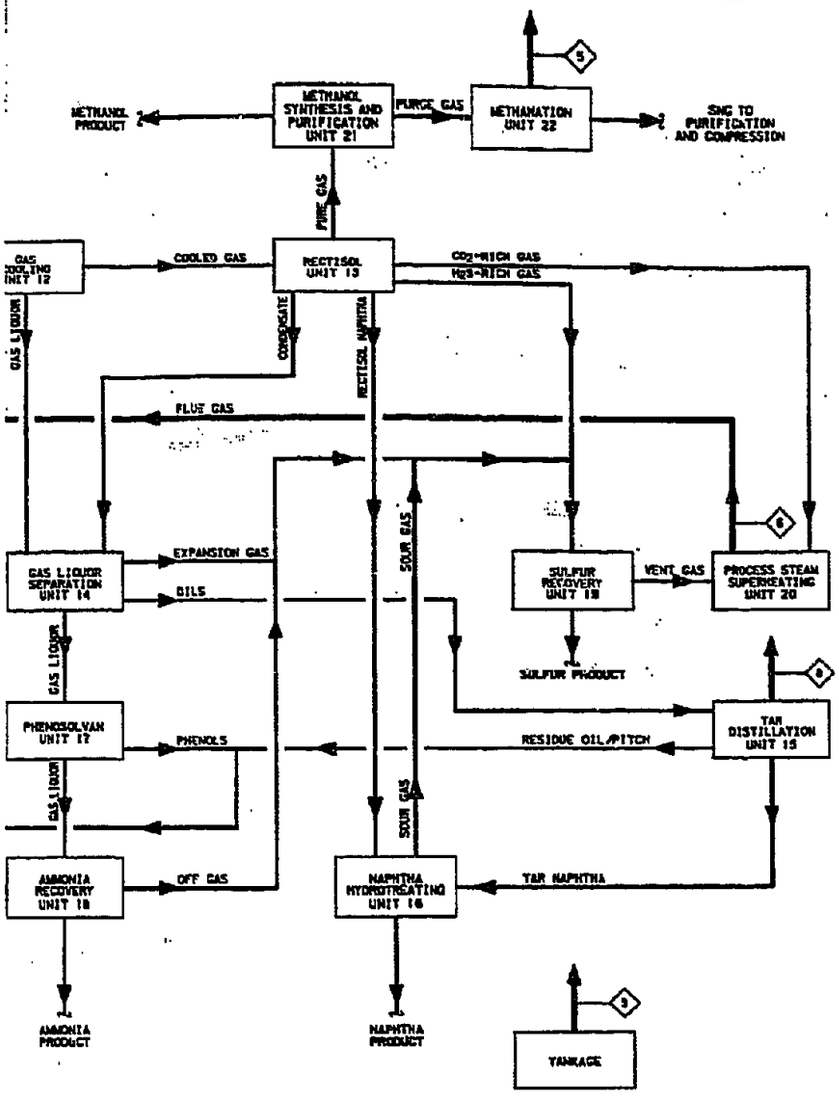


NOTE: NUMBERS IN PARENTHESES REFER TO NOTES AT RIGHT.

		① COAL SCREENING	② COAL DISTRIBUTION	③ GASIFICATION LOCK GAS VENT	④ (3) GASIFIER START-UP VENT	⑤ (4) HEATER FLUE GAS	⑥ SUPERHEATER FLUE GAS	⑦ BOILER FLUE GAS	⑧ (7) HEATER FLUE GAS	⑨ (8) PRODUCT STORAGE TANK FARM
O_2	LBS/HR				CONFIDENTIAL	300	29,003	269,832	362	
N_2	LBS/HR			1		7,558	324,284	3,027,712	3,132	
CO_2	LBS/HR			263		1,774	851,751	1,112,320	2,144	
H_2O	LBS/HR			1		1,224	46,771	593,442	1,479	
SO_2	LBS/HR						282	(5) 983		
H_2S	LBS/HR			2						
COS	LBS/HR			TRACE						
NO_x	LBS/HR					6	192	2,584	7	
CO	LBS/HR			88		TRACE	4	300	TRACE	
CH_4	LBS/HR			33						
H_2	LBS/HR			15						
HYDROCARBONS	LBS/HR			5						5
PARTICULATES	LBS/HR	5	2					(6) 143		
TOTAL FLOW	LBS/HR	5	2	405		10,862	1,252,287	5,809,316	13,124	5
TOTAL FLOW	LBMOL/HR			19		388	34,440	203,438	468	
TEMPERATURE	°F	AMB.	AMB.			300	400	128	300	AMB.
ELEVATION OF RELEASE	FT	75	150	200		100	625	625	100	40



NOTES:

1. BOILER DESIGN MEETS EPA CODE OF FEDERAL REGULATIONS-TITLE 40 EMISSION LIMITS:
   SO_x = 1.2 LB/MMBTU
   NO_x = 0.5 LB/MMBTU
   PARTICULATES = 0.03 LB/MMBTU
2. BOILER FEED COAL = 300 T/HR (AS RECEIVED).
   GASIFIER FEED COAL = 430 T/HR (AS RECEIVED).
3. COMPOSITION AND DURATION OF GASIFIER START-UP VENT ARE CONFIDENTIAL LURGI INFORMATION.
   MAXIMUM EMISSIONS:
   SO_2: 372 LBS/HR
   HYDROCARBONS: 484 LBS/HR
4. CATALYST REDUCTION REQUIRES FUEL GAS. FLOW SHOWN IS OF SHORT DURATION.
5. SO_2 VENTED IS BASED ON FGD REMOVAL EFFICIENCY OF 90%.
6. PARTICULATES VENTED ARE BASED ON AN EXIT CONCENTRATION OF 0.013 GR/SCF. OVERALL REMOVAL EFFICIENCY IS 99.7%.
7. HEATER FLUE GAS EMISSIONS BASED ON THE FOLLOWING HEATER DUTY:
   TAR DISTILLATION 14.5 MMBTU/HR
8. HYDROCARBON EMISSIONS FROM STORAGE TANKS BASED ON FLOATING ROOF DESIGN WITH SECONDARY SEALS AND VAPOR RECOVERY SYSTEMS UTILIZED ON CONE ROOF TANKS.
9. THE TEMPERATURES, FLOW QUANTITIES AND COMPOSITIONS SHOWN ARE TO BE USED SOLELY FOR PROCESS DESIGN PURPOSES AND ARE NOT, NECESSARILY THE CONDITIONS WHICH WILL BE ATTAINED DURING ACTUAL OPERATIONS.

FLUOR

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BLOCK FLOW DIAGRAM
AIR EMISSIONS
CASE: WESTMORELAND COAL-CO-PRODUCTION
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-00-4-305 | 1

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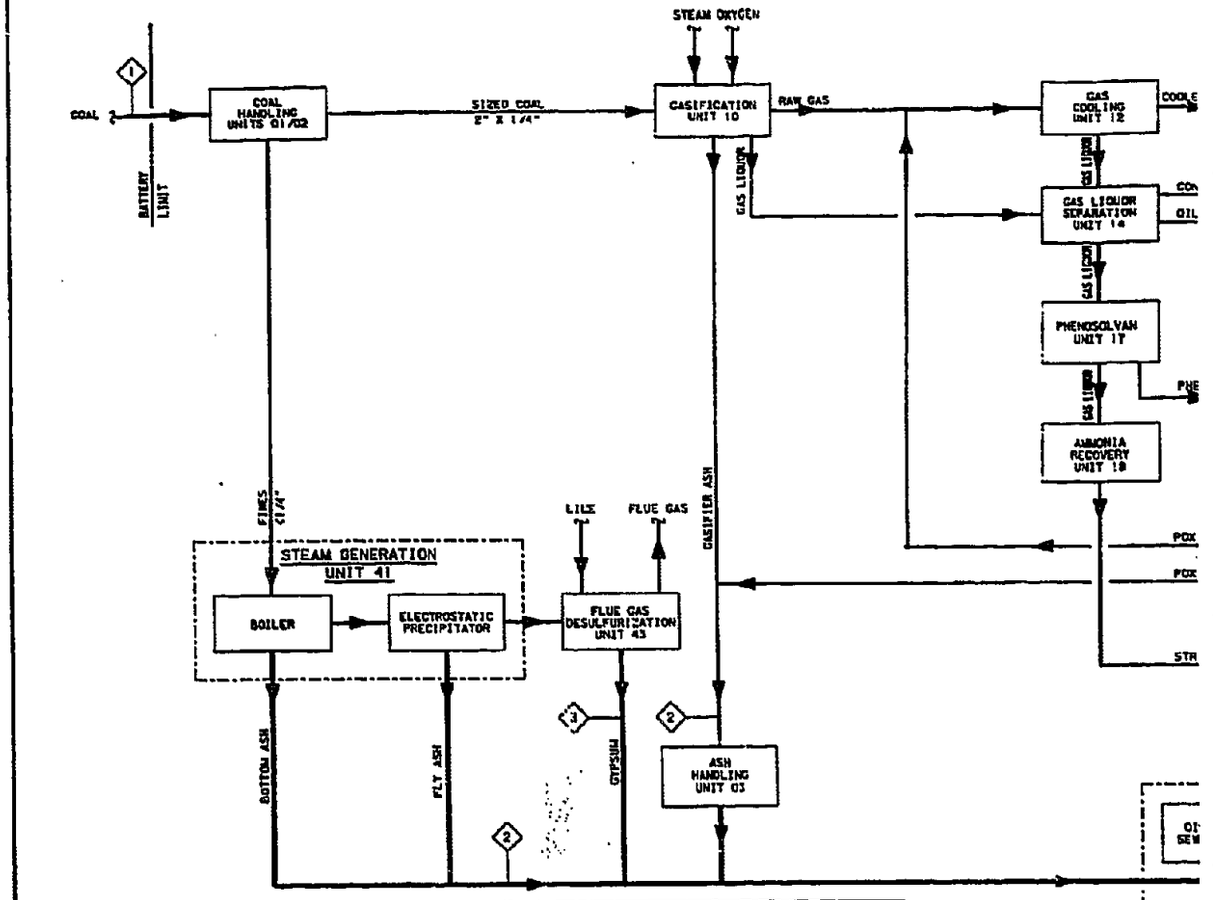
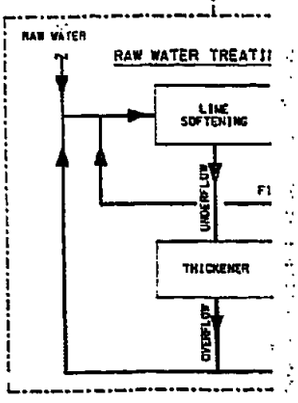
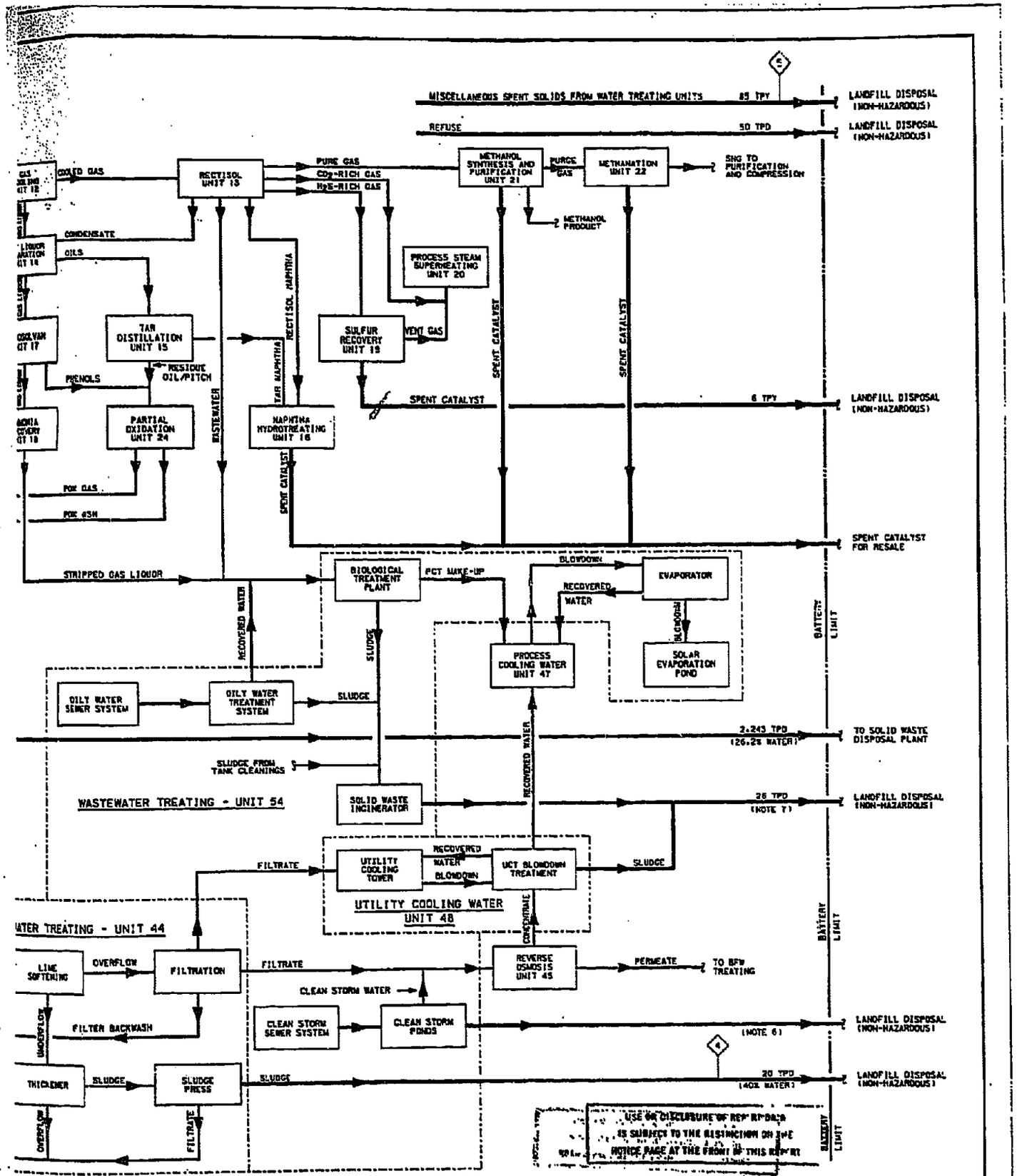


① COAL (NOTE 1)		② ASH (NOTES 2 - 4)		③ FGD GYPSUM (NOTE 5)		④ RAW WATER TREATMENT SLUDGE		⑤ WATER TREATING	
TRACE ELEMENTS	ppm	MINERAL ASH ANALYSIS	WT%		WT%		WT%		WT%
ANTIMONY	0.67	SiO_2	35.9	H_2O	23.0	$CaCO_3$	55.5	SPENT ACTIVATED CARBON	41.7
ARSENIC	1.77	Al_2O_3	19.2	$CaSO_4 \cdot 2H_2O$	75.0	$Mn(OH)_2$	0.9		
BARIUM	181.60	Fe_2O_3	7.5	$CaCl_2$	0.8	H_2O	40.0	SPENT ION EXCHANGE RESIN	58.3
BERYLLIUM	1.25	Na_2O	3.0	INERT SOLIDS	1.5	MISCELLANEOUS	3.6		
BORON	218.60	K_2O	0.18	$Ca(OH)_2$	TRACE				
BROMINE	18.35	CaO	14.5	$Ca(COOH)_2$	TRACE				
CADMIUM	1.80	MgO	2.4						
CERIUM	17.64	TiO_2	1.2						
CHROMIUM	6.36	P_2O_5	0.28						
COBALT	3.62	SO_3	14.1						
COPPER	21.42	INDETERMINATE	1.74						
FLUORINE	227.40								
LEAD	3.30								
LITHIUM	35.20								
MANGANESE	202.00								
MERCURY	0.08								
NICKEL	7.42								
SELENIUM	1.30								
SILVER	0.09								
STRONTIUM	497.02								
THALLIUM	0.23								
URANIUM	1.43								
VANADIUM	18.48								
ZINC	15.70								
ZIRCONIUM	128.50								



NOTES:

1. TRACE ELEMENT ANALYSIS FROM WESTMORELAND MINE ENVIRONMENTAL IMPACT STATEMENT.
2. MINERAL ASH ANALYSIS BASED ON LURGI DATA, WESTMORELAND MINE. GASIFIER ASH ALSO CONTAINS 4% CARBON.
3. AMOUNT OF GASIFIER ASH CALCULATED BASED ON 450 T/HR GASIFIER COAL CONSUMED.
4. AMOUNT OF BOILER ASH CALCULATED BASED ON 300 T/HR BOILER COAL CONSUMED.
5. TOTAL GYPSUM PRODUCED BASED ON FGD LICENSOR INFORMATION.
6. THE CLEAN STORM WATER PONDS ARE CLEANED AS NECESSARY. THE AMOUNT OF SOLIDS REMOVED FROM THESE PONDS IS INDETERMINATE.
7. THE COMPOSITIONS OF THE INCINERATOR WASTE AND UCT BLOWDOWN TREATMENT SLUDGE ARE NOT AVAILABLE.
8. THE FLOW QUANTITIES AND COMPOSITIONS SHOWN ARE TO BE USED SOLELY FOR PROCESS DESIGN PURPOSES AND ARE NOT NECESSARILY THE CONDITIONS WHICH WILL BE ATTAINED DURING ACTUAL OPERATIONS.



FLUOR

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BLOCK FLOW DIAGRAM
SOLID EFFLUENT
CASE: WESTMORELAND COAL - CO-PRODUCTION
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-00-4-306 | 1

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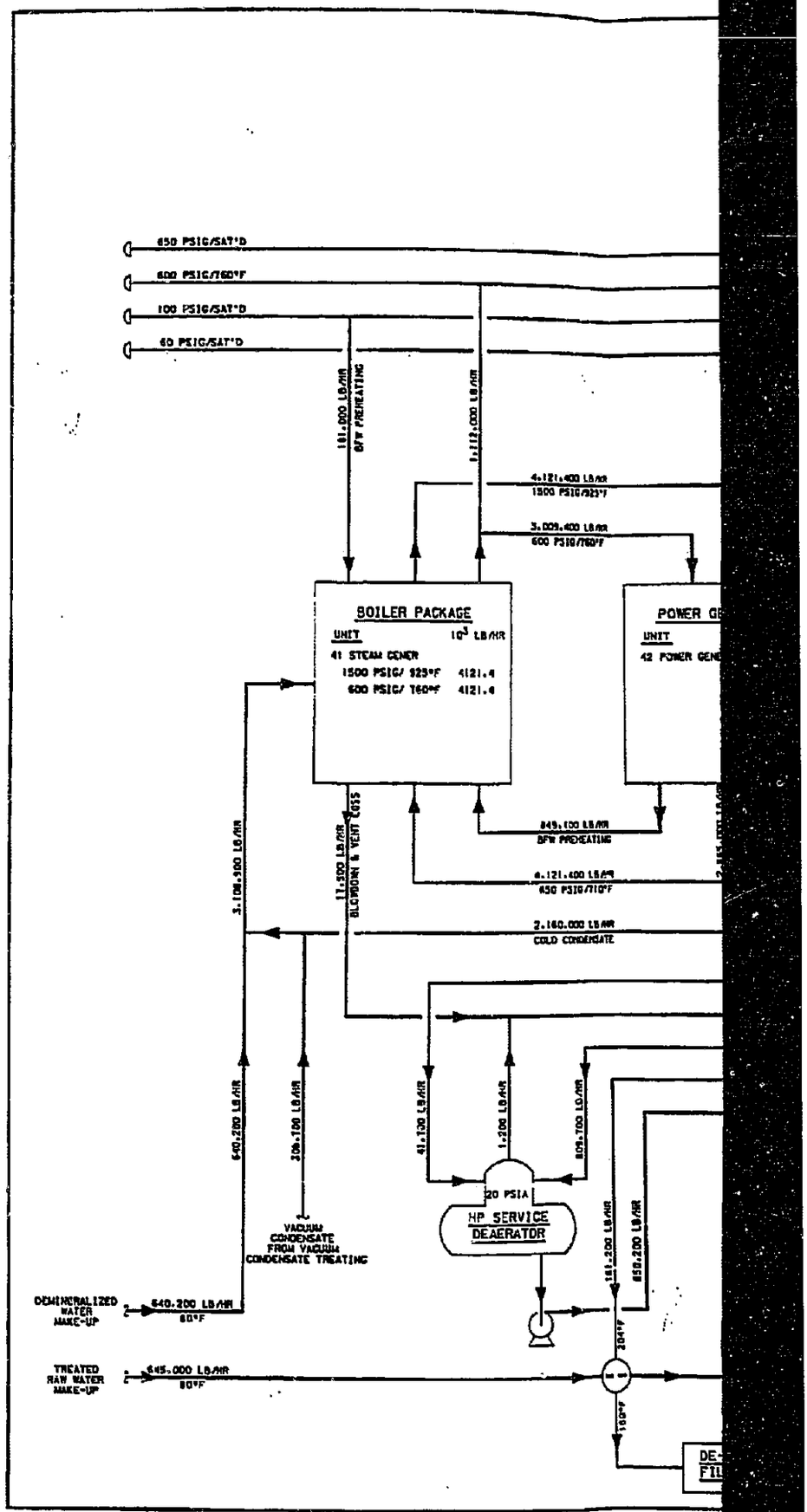
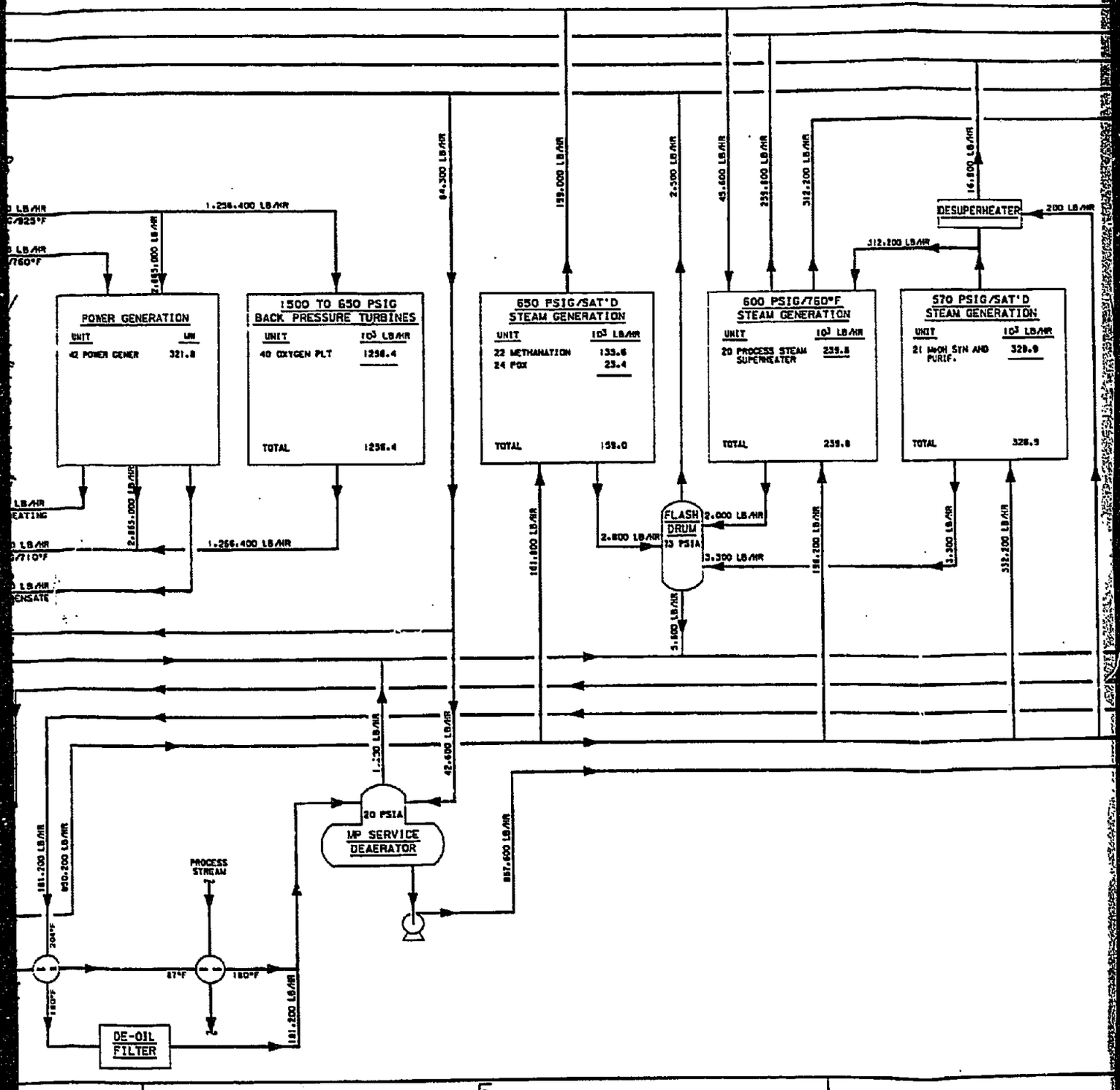
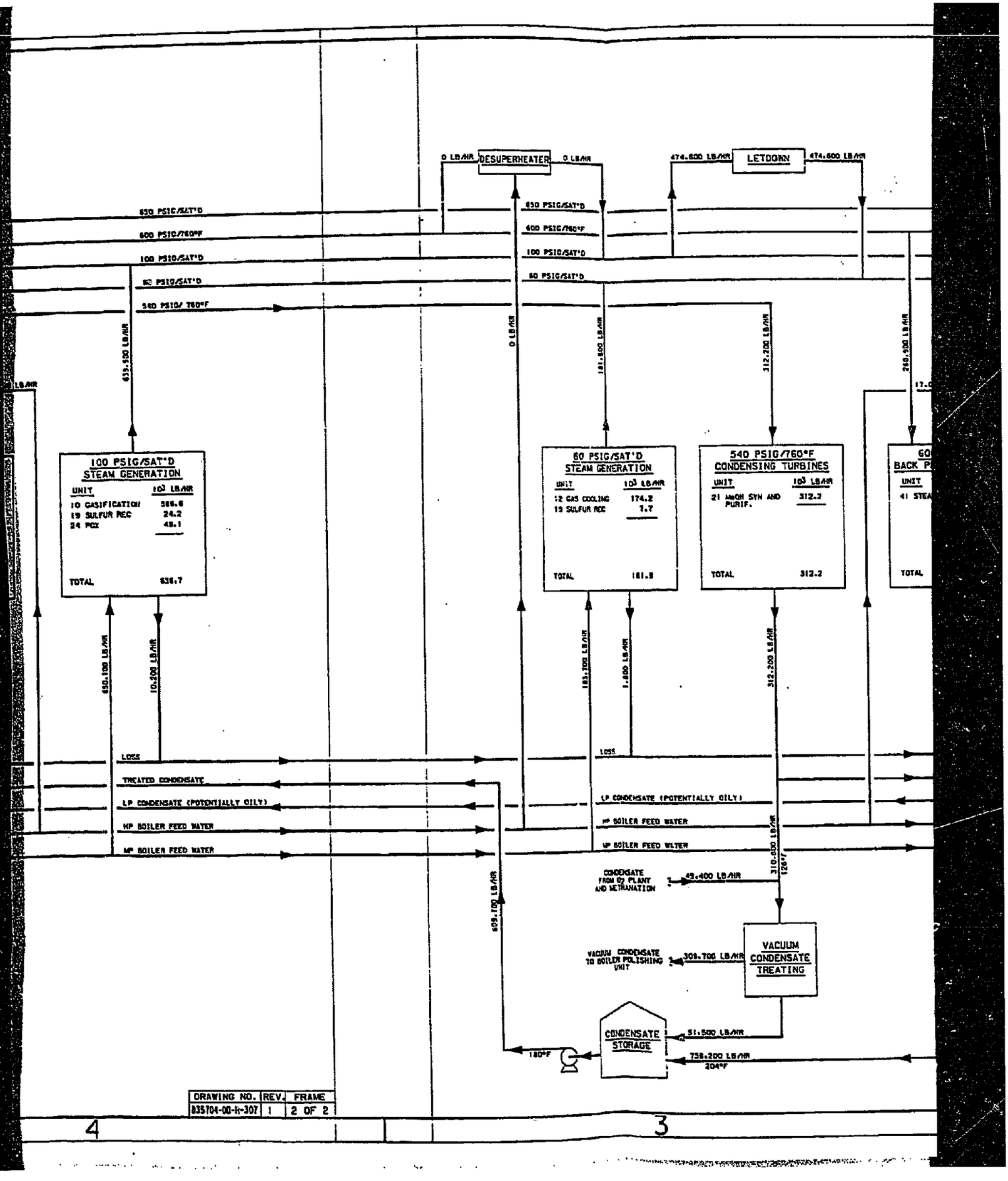
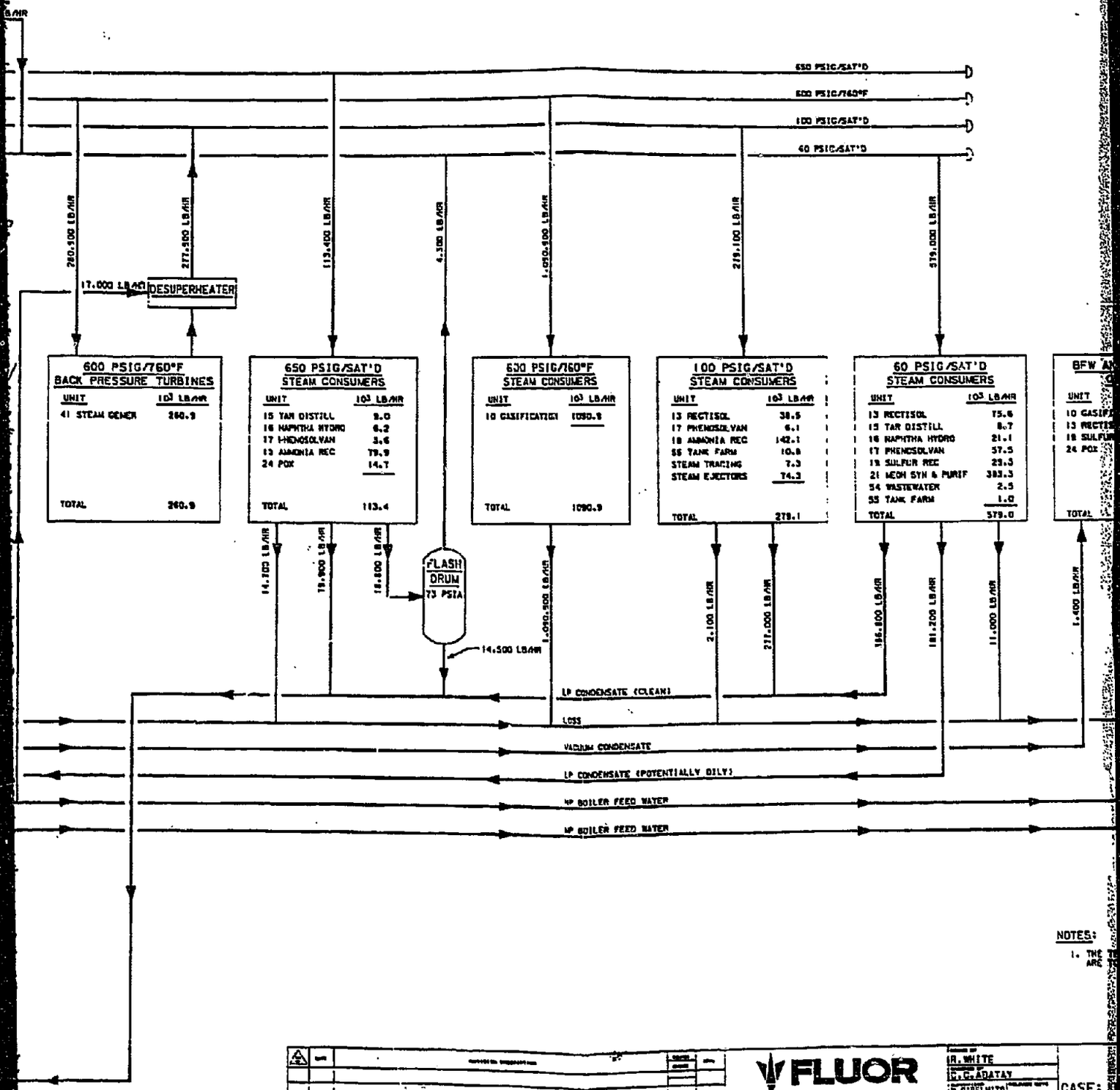

650 PSIG/SAT'D
600 PSIG/760°F
100 PSIG/SAT'D
60 PSIG/SAT'D
181,000 LB/HR
BFW PREHEATING
1,112,000 LB/HR
4,121,400 LB/HR
1500 PSIG/923°F
3,009,400 LB/HR
600 PSIG/760°F
BOILER PACKAGE
UNIT
10³ LB/HR
41 STEAM GENER
1500 PSIG/ 923°F 4121.4
600 PSIG/ 760°F 4121.4
POWER GE
UNIT
42 POWER GENE
849,100 LB/HR
BFW PREHEATING
4,121,400 LB/HR
650 PSIG/710°F
3,108,100 LB/HR
11,500 LB/HR
BLOWDOWN & VENT LOSS
2,160,000 LB/HR
COLD CONDENSATE
640,200 LB/HR
308,100 LB/HR
41,130 LB/HR
1,200 LB/HR
809,700 LB/HR
20 PSIA
HP SERVICE
DEAERATOR
181,200 LB/HR
659,200 LB/HR
204°F
160°F
VACUUM
CONDENSATE
FROM VACUUM
CONDENSATE TREATING
DEMINERALIZED
WATER
MAKE-UP
640,200 LB/HR
60°F
TREATED
RAW WATER
MAKE-UP
645,000 LB/HR
60°F
DE-
FIL


POWER GENERATION
UNIT
42 POWER GENER
321.8
1500 TO 650 PSIG
BACK PRESSURE TURBINES
UNIT
10³ LB/HR
40 OXYGEN PLT
1256.4
TOTAL
1256.4
650 PSIG/SAT'D
STEAM GENERATION
UNIT
10³ LB/HR
22 METHANATION
133.6
24 POX
23.4
TOTAL
159.0
600 PSIG/760°F
STEAM GENERATION
UNIT
10³ LB/HR
20 PROCESS STEAM SUPERHEATER
239.8
TOTAL
239.8
570 PSIG/SAT'D
STEAM GENERATION
UNIT
10³ LB/HR
21 MeOH SYN AND PURIF.
326.9
TOTAL
326.9
DESUPERHEATER
200 LB/HR
312,200 LB/HR
16,800 LB/HR
64,300 LB/HR
159,000 LB/HR
2,300 LB/HR
45,600 LB/HR
239,800 LB/HR
312,200 LB/HR
1,256,400 LB/HR
2,855,000 LB/HR
1,256,400 LB/HR
FLASH DRUM
73 PSIA
2,000 LB/HR
2,800 LB/HR
3,300 LB/HR
2,800 LB/HR
161,800 LB/HR
156,100 LB/HR
3,300 LB/HR
332,200 LB/HR
1,230 LB/HR
42,600 LB/HR
20 PSIA
MP SERVICE
DEAERATOR
857,600 LB/HR
181,200 LB/HR
830,200 LB/HR
PROCESS STREAM
204°F
87°F
180°F
180°F
181,200 LB/HR
DE-OIL FILTER


0 LB/HR
DESUPERHEATER
0 LB/HR
474,600 LB/HR
LETDOWN
474,600 LB/HR
850 PSIG/SAT'D
800 PSIG/760°F
100 PSIG/SAT'D
60 PSIG/SAT'D
540 PSIG/ 760°F
639,100 LB/HR
0 LB/HR
181,800 LB/HR
312,200 LB/HR
265,100 LB/HR
100 PSIG/SAT'D STEAM GENERATION
UNIT
10³ LB/HR
10 GASIFICATION 388.6
19 SULFUR REC 24.2
24 PCX 49.1
TOTAL 536.7
60 PSIG/SAT'D STEAM GENERATION
UNIT
10³ LB/HR
12 GAS COOLING 174.2
19 SULFUR REC 7.7
TOTAL 181.9
540 PSIG/760°F CONDENSING TURBINES
UNIT
10³ LB/HR
21 MeOH SYN AND PURIF. 312.2
TOTAL 312.2
BACK P
UNIT
41 STEA
TOTAL
LB/HR
630,100 LB/HR
10,200 LB/HR
181,700 LB/HR
1,800 LB/HR
312,200 LB/HR
LOSS
LOSS
TREATED CONDENSATE
LP CONDENSATE (POTENTIALLY OILY)
HP BOILER FEED WATER
MP BOILER FEED WATER
LP CONDENSATE (POTENTIALLY OILY)
HP BOILER FEED WATER
MP BOILER FEED WATER
310,600 LB/HR
126°F
CONDENSATE FROM O2 PLANT AND METHANATION
43,400 LB/HR
609,700 LB/HR
VACUUM CONDENSATE TO BOILER POLISHING UNIT
308,700 LB/HR
VACUUM CONDENSATE TREATING
CONDENSATE STORAGE
51,500 LB/HR
758,200 LB/HR
204°F
180°F
DRAWING NO. 835704-00-K-307
REV. 1
FRAME 2 OF 2
4
3



NOTES:

1. THE T
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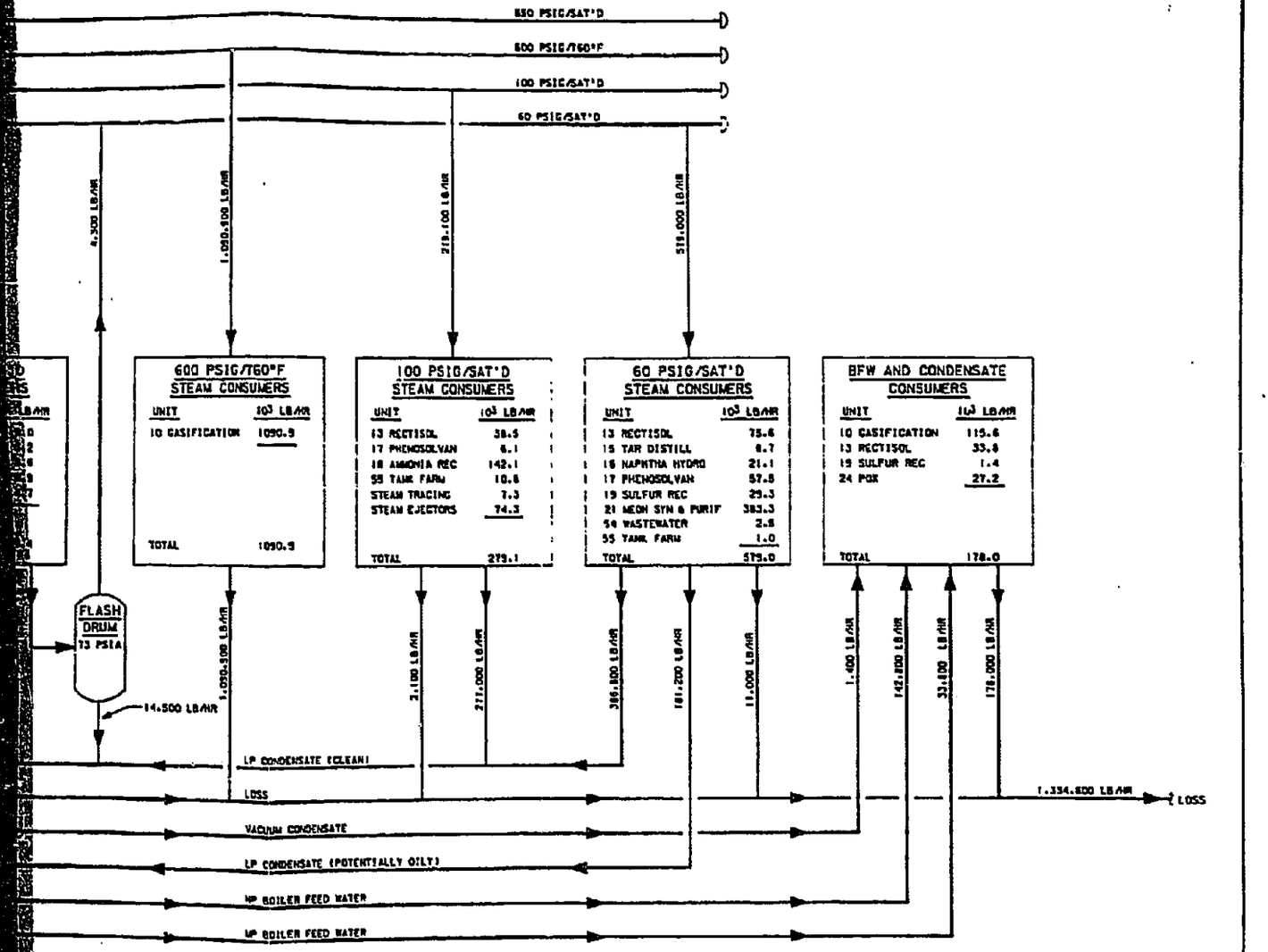
FLUOR

R. WHITE
R.C. ADATAY
R.O'BELMITO
R. McCARTHY
R. LANG

CASE:
NON



NOTES:

1. THE TEMPERATURES, PRESSURES, AND FLOW QUANTITIES SHOWN ARE TO BE USED SOLELY FOR PROCESS DESIGN PURPOSES.

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

FLUOR

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	R. LANG

BLOCK FLOW DIAGRAM
PLANT STEAM BALANCE
CASE: WESTMORELAND COAL-CO-PRODUCTION
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE

835704-00-R-307

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6.5.9 UTILITY SUMMARY

Table 6.5.9-1 indicctes the utilities generated or consumed by each process or utility/offsite unit in the Westmoreland Coal - Coproduction Case.

U

CASE: WESTMO

UNIT		STEAM (M lb/h			
NO.	NAME	1500 lb 925°F	650 lb Sat'd	600 lb 760°F	100 lb Sat'd
01	Coal Screening				
02	Coal Distribution				
03	Ash Handling				
10	Coal Gasification			-1090.9	+566.6
12	Gas Cooling				
13	Rectisol				-38.5
14	Gas Liquor Separation				
15	Tar Distillation		-9.0		
16	Naphtha Hydrotreating		-6.2		
17	Phenosolvan		-3.6		-6.1
18	Ammonia Recovery		-79.9		-142.1
19	Sulfur Recovery				+24.2
20	Process Steam Superheating		-357.8	+552.0	
21	Methanol Synthesis & Purification		-328.9(**)	-312.2(*)	-9.4
22	Methanation		+135.6		
23	SNG Compression & Purification				
24	Partial Oxidation		+8.7		+49.1
25	PSA Hydrogen Production				
40	Oxygen Production	-1,256.4	+1,256.4		
41	Steam Generation	+4,121.4	-4,138.1(*)	+3860.5	-360.8
42	Power Generation	-2,865.0	+2,865.0(**)	-3009.4	-64.9
43	Flue Gas Desulfurization				
44	Raw Water Treating				

TABLE 6.5.9-1

UTILITY SUMMARY

WESTMORELAND COAL - COPRODUCTION

(M lb/hr)				Steam & Condensate	Cooling Water			
100 lb Sat'd	60 lb Sat'd	Condensate (M lb/hr)	BFW (M lb/hr)	Loss (M lb/hr)	(MM Btu/hr)	(gpm)	Electric Power (MW)	Fuel Gas (MM Btu/hr)
							-1.00	
							-0.10	
							-0.70	
+566.6			-690.7	1,215.0	-8.27	-551	-2.40	-0.7
	+174.2		-176.0	1.8	-9.60	-640	-0.35	
-38.5	-75.6	+114.1	-33.8	33.8	-168.40	-11,127	-21.69	
					-89.13	-5,936	-0.69	
	-8.7	+17.7			-4.30	-285	-0.23	-14.5
	-21.1	+27.3			-1.88	-125	-0.12	(+0.9)
-6.1	-57.5	+57.9		9.3	-12.40	-627	-0.39	
-142.1		+222.0			-122.5	-8,157	-0.50	
+24.2	-21.6	+26.2	-32.1	3.3	-41.6	-2,780	-2.88	-11.1
			-196.2	2.0			-1.79	-176.8
*) -9.4	-383.3	+704.9	-332.2	3.3	-392.9	-26,192	-1.46	+119.2
			-137.7	2.1	-4.5	-301	-1.19	(-11.9)
					-1.34	-90	-1.80	+21.5
+49.1			-101.9	44.1	-8.93	-595	-0.22	-0.1
					-0.38	-25.2	-0.62	+67.1
					-156.5	-10,400	-11.60	
-360.8	+477.1	-849.4	-3,126.1	15.4			-23.30	
-64.9		+3074.3			-1644.0	-109,800	+321.60	
							-5.07	
							-1.42	

CASE: WESTI

UNIT NO.	NAME	1500 lb 925°F STEAM (M l	650 lb Sat'd	600 lb 760°F	100 Sat'
45	BFW & Condensate Treating				
46	Air & Nitrogen Systems				
47	Process Cooling Water				
48	Utility Cooling Water				
49	Potable Water				
50	Utility Water				
51	Fire Water				
52	Fuel Gas				
53	Flare				
54	Waste Water Treating				
55	Tank Farm & Dispatch				-10
56	Sanitary Sewer				
	Steam Tracing				-7
	Export				
	Total (Process Units)	0	+16.7	-851.1	+443
	Total (Utility Units)	0	-16.7	+851.1	-443
	TOTAL	0	0	0	0

Legend: ( ) indicates intermittent use. Not included in totals.
+ indicates production.
- indicates consumption.

(*) The steam produced is 570 psig/sat'd. It is superheate within the Methanol Synthesis Unit.

(**) 650 psig/710°F steam

(***) Included in Wastewater Treating (Unit 54).

TABLE 6.5.9-1 (Continued)

UTILITY SUMMARY

WESTMORELAND COAL - COPRODUCTION

AM (M lb/hr)					Steam & Condensate Loss (M lb/hr)	Cooling Water		Electric Power (MW)	Fuel Gas (MM Btu/hr)
	100 lb Sat'd	60 lb Sat'd	Condensate (M lb/hr)	BFW (M lb/hr)		(MM Btu/hr)	(gpm)		
-		-80.0	-4749.1	+4826.7	2.4			-6.72	
						-10.4	-700	-3.76	
						+1876.0	+125,085	-9.01	
						+715.0	+47,674	-3.28	
								-0.03	
								-0.03	
								-0.02	
								-	
								-0.03	-2.0
		-2.5	+2.5					-6.26	-2.5
	-10.8	-1.0	+9.7		2.1	-1.1	-74	-0.68	
								(***)	
	-7.3		+7.3						
1	+443.8	-393.6	+1170.1	-1700.6	1314.7	-778.8	-51,785	-38.13	+4.5
1	-443.8	+393.6	-2504.7	+1700.6	19.9	+778.8	+51,785	+250.39	-4.5
	0	0	-1334.6	0	+1334.6	0	0	+212.26	0

totals.

uperheated in the process steam superheater to 540 psig/760°F and used to drive turbine

6.5.10 CATALYST AND CHEMICAL SUMMARY

The catalysts and chemicals required for each unit in the Westmoreland Coal - Coproduction Case are shown in Table 6.5.10-1.

TABLE 6.5.10-1

CATALYST AND CHEMICAL SUMMARY

CASE: WESTMORELAND COAL - COPRODUCTION

Unit	Item	Initial Cost, $	Annual Cost, $
03	Ash Handling		
	Flocculent	150	1,760
13	Rectisol		
	Propylene	32,300	45,700
	Caustic	-	79,100
16	Naphtha Hydrotreating		
	Dimethyl Sulfide	840	330
	Confidential Catalyst	34,700	11,600
17	Phenosolvan		
	Isopropylether Solvent	274,100	95,100
	Gravel	1,530	190
	Sand	3,400	420
	Filtrilur	110,400	13,800
18	Ammonia Recovery		
	Phosphoric Acid (100%)	155,500	74,500
	Sodium Hydroxide (50% soln.)	479,700	159,800

TABLE 6.5.10-1 (Continued)

CATALYST AND CHEMICAL SUMMARY

CASE: WESTMORELAND COAL - COPRODUCTION

Unit	Item	Initial Cost, $	Annual Cost, $
19	Sulfur Recovery		
	Diisopropanolamine	6,580	3,250
	Claus Catalyst	18,500	6,180
	Shell 634 Catalyst	43,600	14,500
	Citric Acid	6,180	13,300
	ADA	62,000	132,400
	Caustic (50%)	5,870	(58,700) (1)
	Vanadium	48,900	-
21	Methanol Synthesis & Purification		
	Synthesis Catalyst	2,903,000 (2)	968,000 (2)
	Caustic	37,500 (2)	450,000 (2)
22	Methanation		
	Synthesis Catalyst	278,000 (3)	92,600 (3)
41	Steam Generation		
	Hydrazine Hydrate	870	9,540
	Sodium Phosphate	90	930
	Morpholine	7,440	82,400

TABLE 6.5.10-1 (Continued)

CATALYST AND CHEMICAL SUMMARY

CASE: WESTMORELAND COAL - COPRODUCTION

Unit	Item	Initial Cost, $	Annual Cost, $
43	Flue Gas Desulfurization		
	Lime (90% CaO)	24,700	1,120,000
	Formic Acid (90% soln.)	35,600	330,000
	Anti Foulant (Nalco 7319)	320	3,400
	HCl (30% soln.)	6,180	-
44,45 & 49	Raw Water, BFW Treating & Potable Water		
	Poly-electrolyte	3,270	39,000
	Chlorine	3,770	45,500
	Quick Lime	2,700	6,530
	Soda Ash (Dense Bulk)	23,650	894,900
	Alum	2,600	4,240
	Hexametaphosphate	8,420	103,300
	Sulfuric Acid (93%)	23,400	101,500
	Caustic (50% soln.)	129,300	516,800
	Activated Carbon	67,500	33,000
	Hydrazine Hydrate	480	5,290
	Morpholine	3,970	44,000
	Chelant (EDTA)	920	10,100
46	Air & Nitrogen System		
	Activated Alumina	1,150	320

TABLE 6.5.10-1 (Continued)

CATALYST AND CHEMICAL SUMMARY

CASE: WESTMORELAND COAL - COPRODUCTION

Unit	Item	Initial Cost, $	Annual Cost, $
47	Process Cooling Water		
	Chlorine	4,640	54,500
	Sulfuric Acid (93%)	910	289,600
	Inhibitor	11,300	135,600
	Dispersant	3,080	36,900
	Biocide	12,700	61,000
	Nalprep	82,000	210
	Activated Carbon	48,000	24,000
	Hexametaphosphate	3,060	36,000
48	Utility Cooling Water		
	Chlorine	2,610	30,600
	Sulfuric Acid (93%)	11,600	137,500
	Inhibitor	4,400	52,600
	Dispersant	1,200	14,400
	Biocide	3,510	18,100
	Nalprep	24,000	70
	Poly-electrolyte	990	11,800
	Quick Lime	810	1,980
	Soda Ash (Dense Bulk)	7,050	270,000

TABLE 6.5.10-1 (Continued)

CATALYST AND CHEMICAL SUMMARY

CASE: WESTMORELAND COAL - COPRODUCTION

Unit	Item	Initial Cost, $	Annual Cost, $
54	Wastewater Treating		
	Caustic (50%)	162,100	3,637,500
	Sulfuric Acid (93%)	5,190	125,500
	Poly-electrolyte	220	26,600
	Phosphoric Acid (100%)	3,650	43,100
55	Tank Farm & Dispatch		
	SNG Odorant (Ethyl/Amyl Mercaptan)	70	830
	NaCl	1,760	473,200
TOTAL		$5,243,950	$10,994,870

NOTES:

(1) First year only, not included in total

(2) Methanol unit in this case is significantly larger than and different from that in the Base Case.

(3) Methanation process scheme in this case is different from the Base Case and the unit is smaller.

6.5.11 OPERATING MANPOWER

The operating manpower for the Coproduction Case was determined in the same way as the Base Case manpower.

The total operating staff is 426. There are 59 shift operating positions for the Coproduction Case versus 58 for the Base Case.

6.5.12 MAINTENANCE MANPOWER

Annual maintenance cost is estimated as a percentage of the plant installed cost. The same procedure for determining maintenance cost as used on the Base Case (Section 6.1.12) was followed for the Coproduction Case yielding a cost of $36,300,000, which is 60 percent materials and 40 percent labor.

The labor portion of $14,500,000 is equivalent to 415 maintenance staff positions using the same assumptions as the Base Case.

6.5.13 PROCESS UNITS ENGINEERING DATA

6.5.13.1 DIFFERENCES

The process configuration for the Coproduction Case differs from the Base Case primarily in the processing of pure gas from Rectisol. The syngas (pure gas) is converted to methanol in the Methanol Synthesis and Purification Unit 21. The purge gas from the methanol synthesis reaction is methanated, purified, and compressed in the Methanation and SNG Purification and Compression Units 22 and 23. The H_2/CO ratio requirement for methanol synthesis is such that no CO Shift (Unit 11) is needed in this case. Due to the absence of the exothermic shift reaction and also due to differences in the heat recovery scheme employed, the Gas Cooling Unit 12 is different in this case. Because of the significant differences in the process configuration of the above units, 12, 21, 22, and 23, detailed information including Design Basis, Process Description, Process Flow Diagram, etc. are provided following this discussion.

The rest of the processing scheme is similar to the Base Case, although slight variations occur in the unit material balances which are included at the end of this section. Deletion of the CO shift eliminates consumption of reaction water, additional production of CO_2, and hydrocracking of tars and oils. As a result, flows through gas liquor processing (Units 14, 17, and 18) and Lurgi liquids processing (Units 15, 16, and 24) are altered. Rectisol, Sulfur Recovery, and Process Steam Superheating units handle less CO_2. The material balance tables provide the flow rates in detail.

6.5.13.2 GAS COOLING - UNIT 12

DESIGN BASIS

Purpose of the Unit

The purpose of the Gas Cooling Unit is to cool the hot gas stream leaving the Gasification Unit for feed to the Rectisol Unit and recover the aqueous and organic condensates for further processing.

The substantial amount of heat released from this unit is recovered for use in the plant by generating low pressure steam and heating tempered water and condensate.

Scope of Unit

The unit consists of two major sections: Waste Heat Recovery and Cooling. The waste heat recovery section includes low pressure steam generator and associated equipment, tempered water heater and associated equipment, and makeup water heater. The cooling section includes air cooler, C.W. trim coolers, and knockout drums.

General Criteria

The unit consists of two 50 percent capacity parallel trains. The unit is designed to process approximately 561.1 SCFD of dry gas containing 594,000 lb/hr of water and condensable organics. The design onstream factor is 91 percent, and all rotating equipment are motor driven.

6.5.13.2 (Continued)

Feed Streams

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

Component	Mole %
H_2	40.27
N_2	0.24
CO	18.00
CO_2	30.10
CH_4	10.28
C_2	0.59
C_3	0.12
C_4	0.03
H_2S	0.36
COS	0.01

Flow Rate: Dry Gas, MM SCFD	561.11
Water and Heavier Hydrocarbon Compounds, lb/hr	594,000
Temperature, °F	355
Pressure, psig	417

6.5.13.2 (Continued)

Product Streams

The composition, flow rate, and process conditions of the cooled gas to Rectisol unit are as follows:

Component	Mole %
H_2	40.67
N_2	0.24
CO	18.00
CO_2	29.44
CH_4	10.37
C_2	0.59
C_3	0.12
C_4	0.03
H_2S	0.35
COS	0.01

Flow Rate: Dry Gas, MM SCFD	554.82
Water and Heavier Hydrocarbon Compounds, lb/hr	7,800
Temperature, °F	100
Pressure, psig	397

The flow rate and process conditions of the gas liquor to the gas liquor separation are as follows:

Flow Rate, lb/hr	614,000
Temperature, °F	233
Pressure, psig	212

6.5.13.2 (Continued)

Miscellaneous Streams

The flow rate and inlet and outlet process conditions of the tempered water and makeup condensate are given below:

	Inlet Conditions			Outlet Conditions		
Stream Name	Flow Rate lb/hr	Temp. °F	Press. psig	Flow Rate lb/hr	Temp. °F	Press. psig
Tempered Water	1,150,000	200	445	1,150,000	300	435
Makeup Condensate	470,000	90	75	470,000	180	70

Utilities

Consumption

LP Boiler Feedwater, lb/hr	175,950
Cooling Water, gpm	640
Electric Power, kW	500

Production

LP Steam, lb/hr	174,186

PROCESS DESCRIPTION

The flow diagram is shown on Drawing No. 835704-12-4-301 and the material balance is on Table 6.5.13-1. The plot plan (Drawing No. 835704-12-5-051) and equipment list (Table 6.5.13-2) follow.

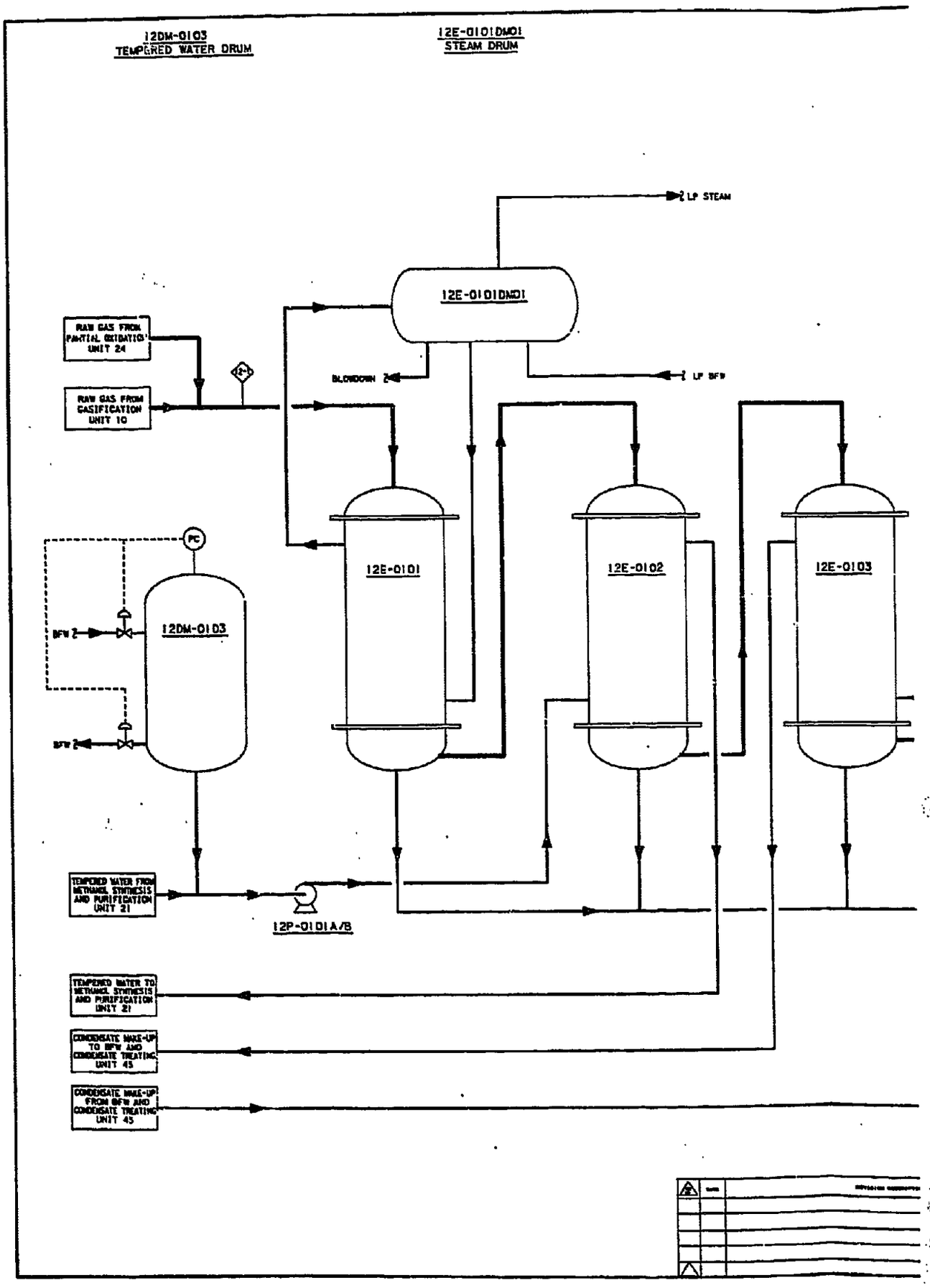
6.5.13.2 (Continued)

The crude gas from the Gasification unit is passed through a series of heat exchangers to recover heat. The first in the series is the waste heat boiler generating low pressure steam. It is followed by the tempered water heater and the makeup condensate heater. Heavy tarry products with higher boiling points are condensed out in these three heat exchangers.

The hot tempered water from the heat recovery section is pumped to the Methanol Synthesis and Purification unit to preheat the feed to the devolatilizing column. The devolatilizing reboiler duty is also provided by the hot tempered water. The cooled tempered water is circulated back to the Gas Cooling Unit for heat recovery, keeping the tempered water system a close loop.

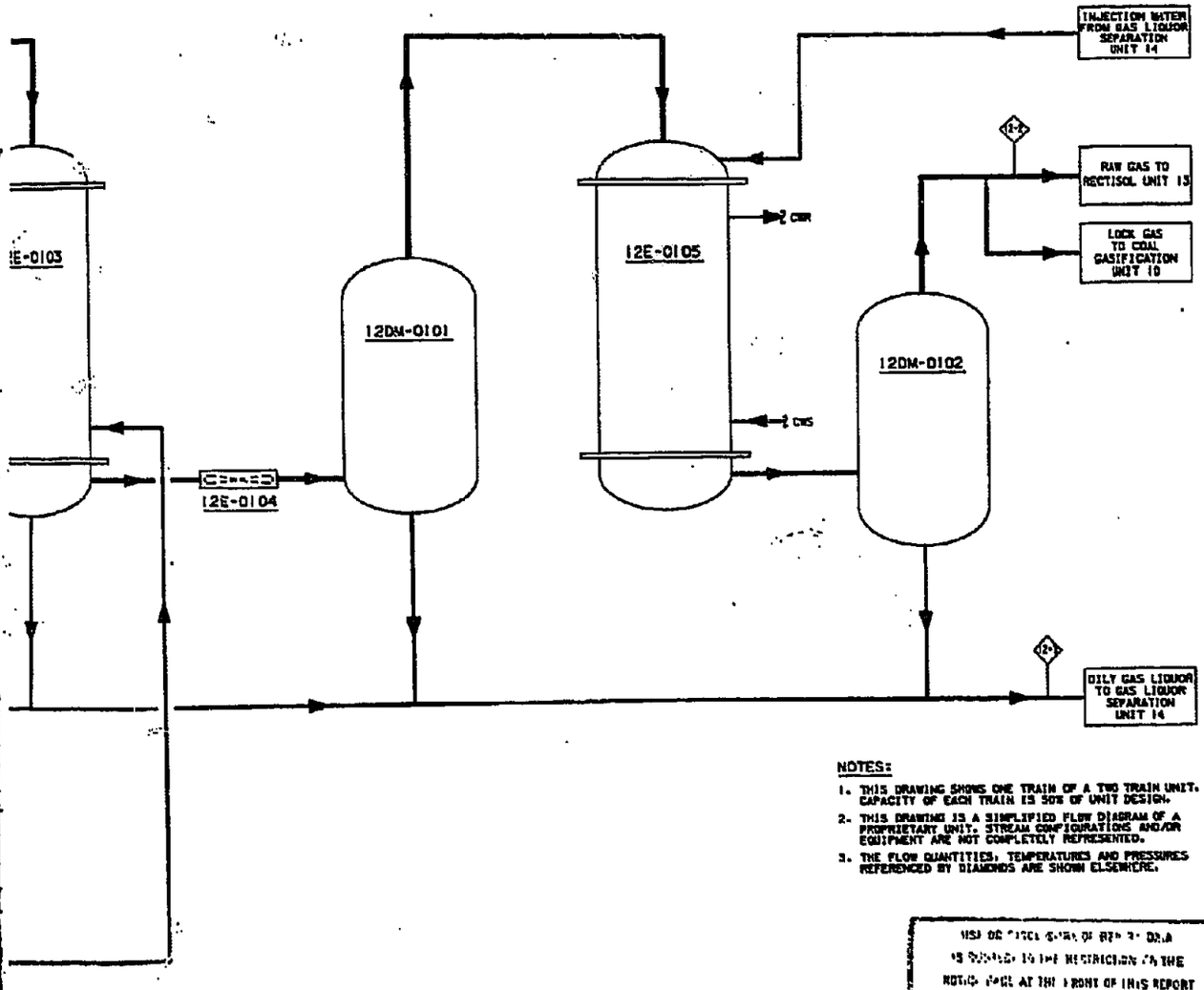
The cooled raw gas from the makeup condensate heater is further cooled by air cooling and finally by trim cooling before entering the Rectisol unit. The major portion of the gas liquor is condensed in the knockout drums downstream of the air cooler and the trim cooler. The gas liquor collected in the knockout drums and tarry liquor stream condensed out in the heat exchangers upstream of the air cooler are piped to the Gas Liquor Separation unit.

The plugging and fouling quality of the crude gas treated in this unit dictates that the shell and tube heat exchangers used be vertical type and the gas flow scheme be downwards. Rejection of the gas liquor in the final cooling stage provides washing of the heat exchanger tubes.


12DM-0103
TEMPERED WATER DRUM
12E-0101DM01
STEAM DRUM
LP STEAM
12E-0101DM01
RAW GAS FROM PARTIAL OXIDATION UNIT 24
RAW GAS FROM GASIFICATION UNIT 10
BLOWDOWN
LP BFW
12E-0101
12E-0102
12E-0103
PC
12DM-0103
BFW
BFW
TEMPERED WATER FROM METHANOL SYNTHESIS AND PURIFICATION UNIT 21
12P-0101A/B
TEMPERED WATER TO METHANOL SYNTHESIS AND PURIFICATION UNIT 21
CONDENSATE MAKE-UP TO BFW AND CONDENSATE TREATING UNIT 45
CONDENSATE MAKE-UP FROM BFW AND CONDENSATE TREATING UNIT 45

12DM-0101
AIR COOLED GAS SEPARATOR

12DM-0102
TRIM COOLED GAS SEPARATOR



NOTES:

1. THIS DRAWING SHOWS 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, TEMPERATURES AND PRESSURES REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.

USE OF THIS [illegible] DATA IS SUBJECT TO THE RESTRICTION ON THE NOTICE PAGE AT THE FRONT OF THIS REPORT

FLUOR

R. WHITE
C. C. ABATAY
W. B. DELMOTO
R. McCARTHY
R. LANG

PROCESS FLOW DIAGRAM
GAS COOLING-UNIT 12
CASE: CO-PRODUCTION
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-12-4-301 | 1

003 35712301

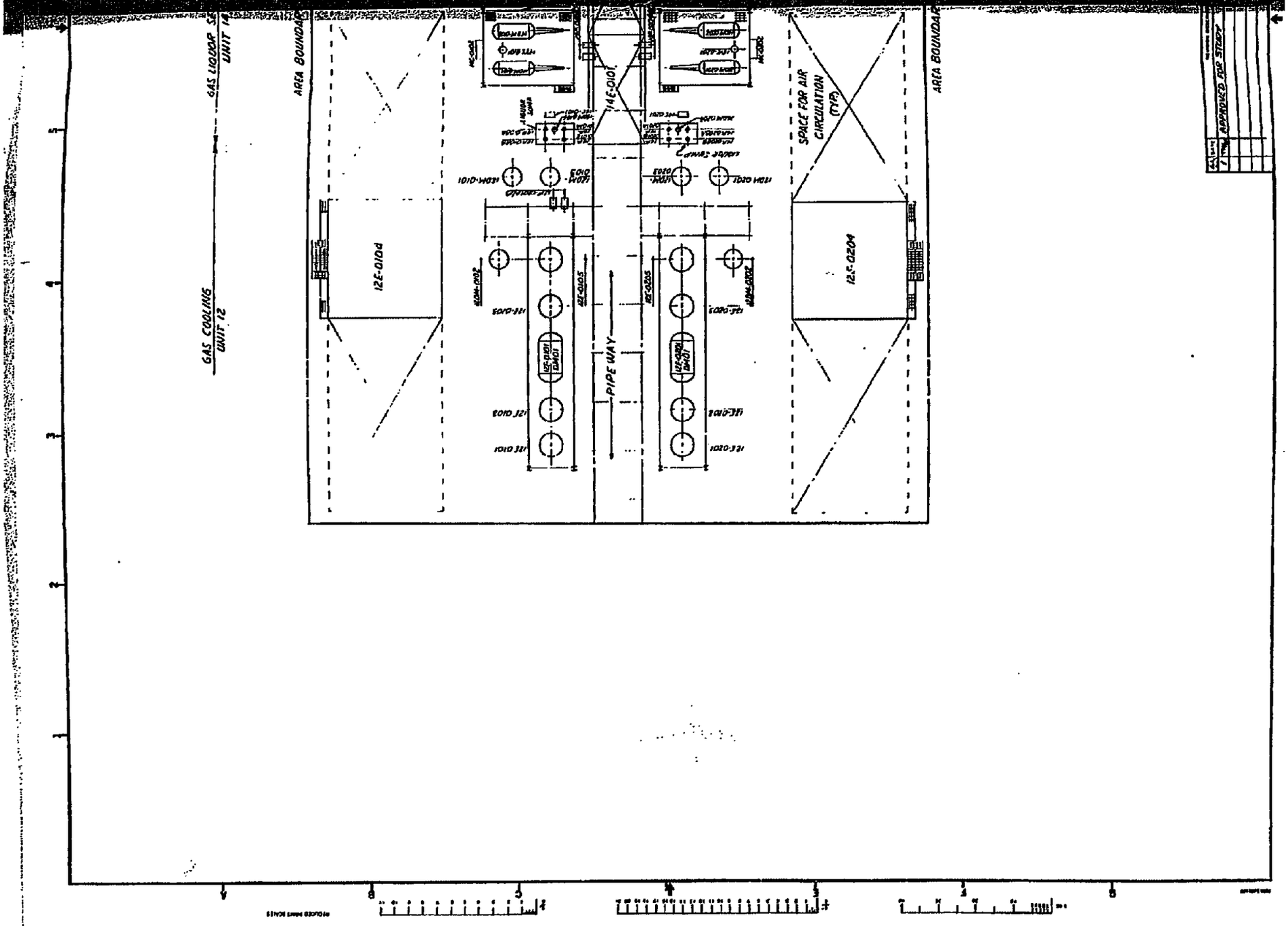
TABLE 6.5.13-1

MATERIAL BALANCE
GAS COOLING - UNIT 12

Stream Number	12-1		12-2		12-3	
Stream Name	Combined Gas		Raw Gas to Rectisol		Oily Gas Liquor (2)	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
H_2	24,811.8	40.27	24,772.1	40.67	39.7	5.75
N_2	146.9	0.24	146.9	0.24	-	-
CO	11,088.3	18.00	11,071.7	18.18	16.6	2.40
CH_4	6,334.1	10.28	6,318.9	10.37	15.2	2.20
C_2	361.9	0.59	361.9	0.59	-	-
C_3	72.4	0.12	72.4	0.12	-	-
C_4	18.0	0.03	18.0	0.03	-	-
CO_2	18,545.7	30.10	17,935.5	29.44	610.2	88.36
H_2S	221.7	0.36	213.6	0.35	8.1	1.17
COS	4.8	0.01	4.8	0.01	-	-
NH_3/HCN	0.8		-		0.8	0.12
		100.00		100.00		100.00
Dry Gas, lb-mol/hr	61,606.4	67.06	60,915.8	99.78	690.6	2.24
H_2O Vapor, lb-mol/hr	30,264.7	32.94	136.7	0.22	30,128.0	97.76
Wet Gas, lb-mol/hr	91,871.1	100.00	61,052.5	100.00	30,818.6	100.00
Dry Gas, lb/hr	1,305,315		1,277,333		27,982	
H_2O, Vapor, lb/hr	545,249		2,463			
H_2O, Liquid, lb/hr					542,786	
Tons, lb/hr	12,947		-		12,947	
Oils, lb/hr	16,843		-		16,843	
Naphtha, lb/hr	5,275		5,275		-	
Phenols, lb/hr	5,095		-		5,095	
Fatty Acids, lb/hr	1,139		-		1,139	
Org. Sulfur, lb/hr	213		11		202	
Ammonia, lb/hr	6,773		-		6,773	
HCl	185		-		185	
TOTAL, lb/hr	1,899,034		1,285,082		613,952	
Pressure, psia	415		405		250	
Temperature, °F	355		100		233	

NOTES: (1) 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.

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


GAS LIQUOR SE
UNIT 14
GAS COOLING
UNIT 12
AREA BOUNDAR
AREA BOUNDAR
SPACE FOR AIR
CIRCULATION
(TYP)
PIPE WAY
APPROVED FOR STUDY

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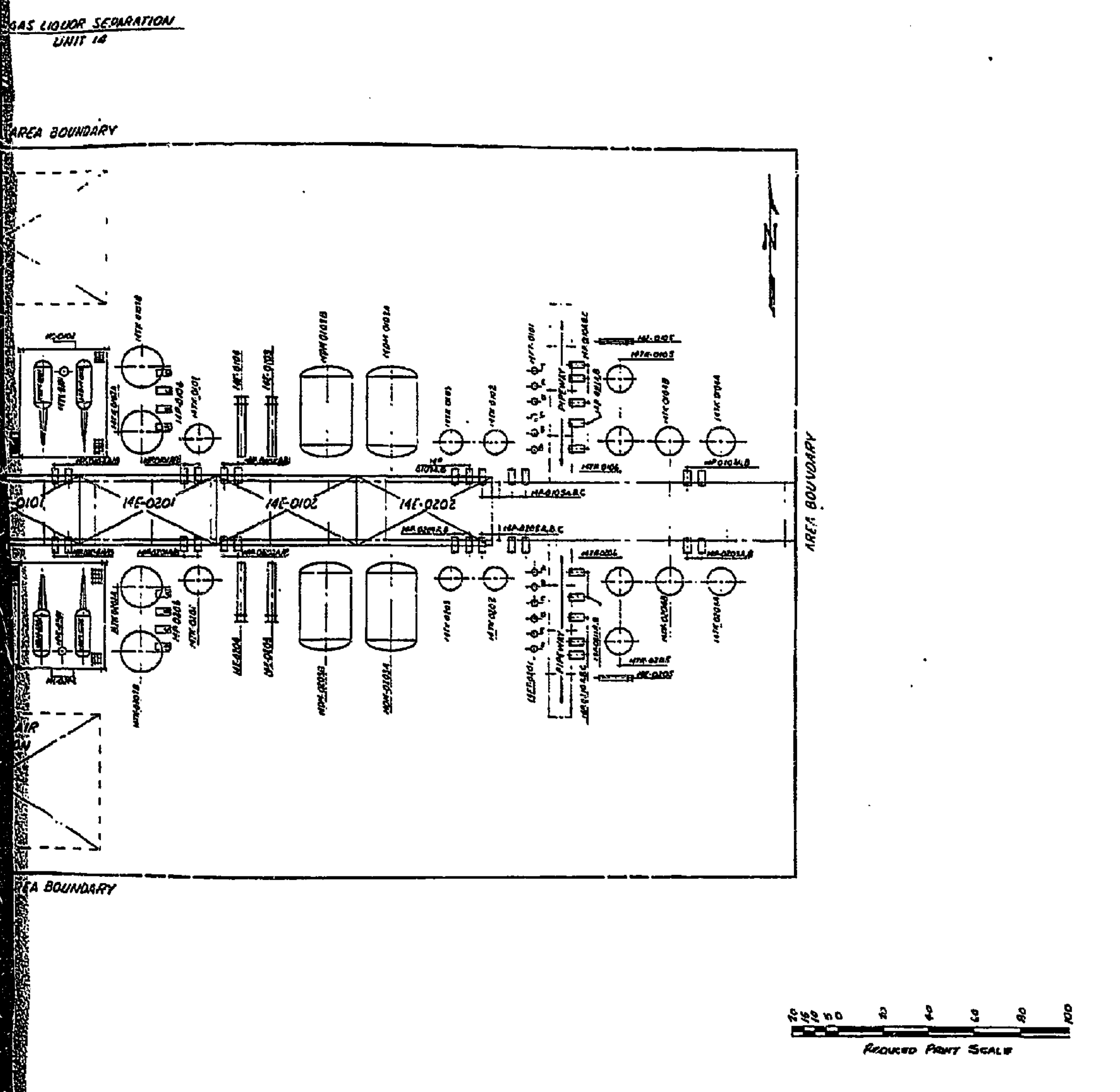

ALL EQUIPMENT SIZES AND LOCATIONS ARE APPROXIMATE.

FOR STUDY

FLUOR

J PARODI

PLOT PLAN-UNITS 12 & 14
GAS COOLING & GAS LIQUOR SEPARATION
ALTERNATE 2 - CO-PRODUCTION CASE

MONTANA

1"=20'-0"

835704-12-S-051