6.1.8 BLOCK FLOW DIAGRAMS

6.1.8.1 OVERALL MATERIAL BALANCE

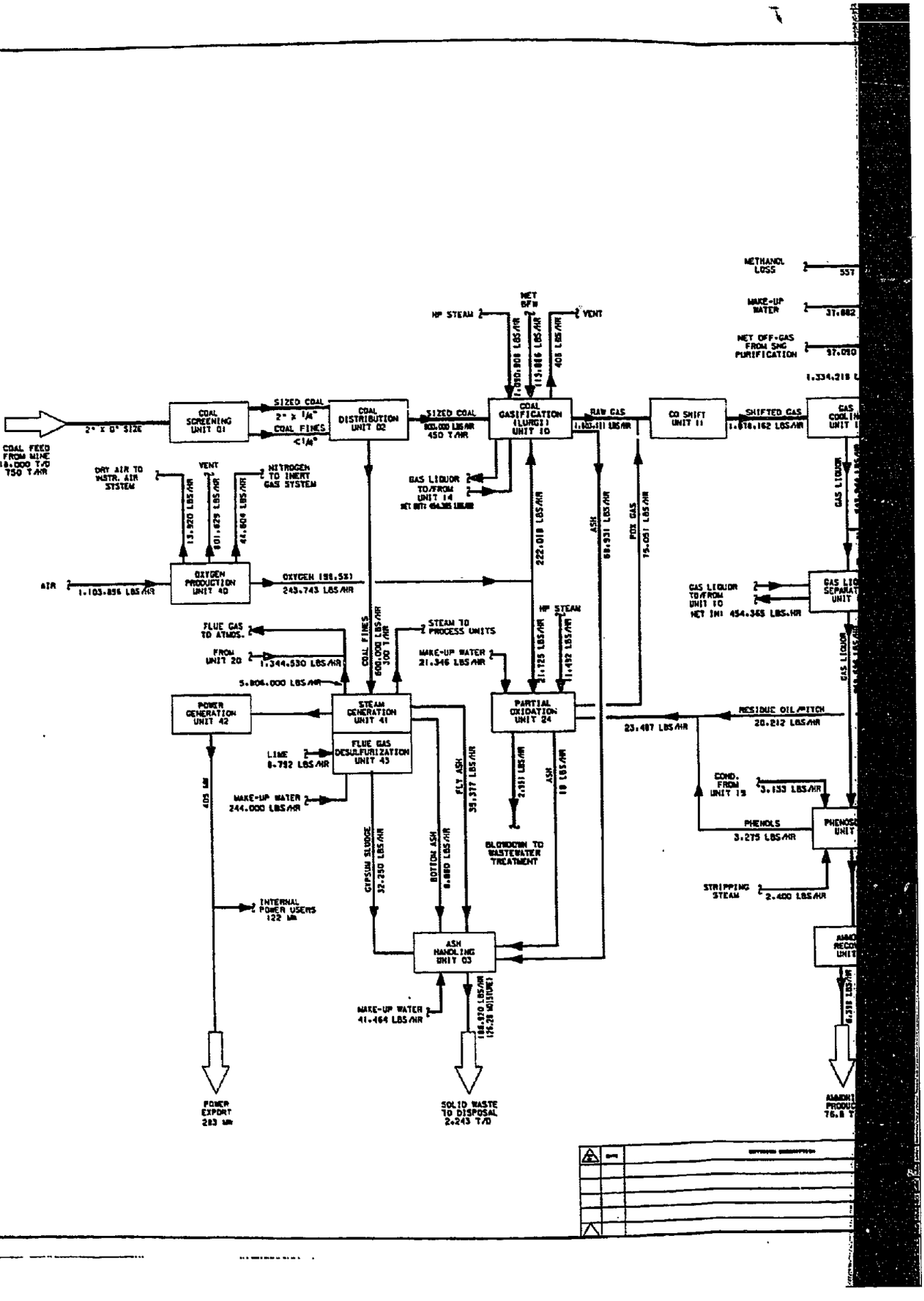
The Overall Material Balance for the Westmoreland Coal 40% Fines - SNG Base Case (Drawing No. 835704-00-4-101) shows the flow of materials through the plant. Flow rates are given for each stream. Utility and offsite units except Oxygen Production, Steam Generation, Power Generation, and Flue Gas Desulfurization are not shown.

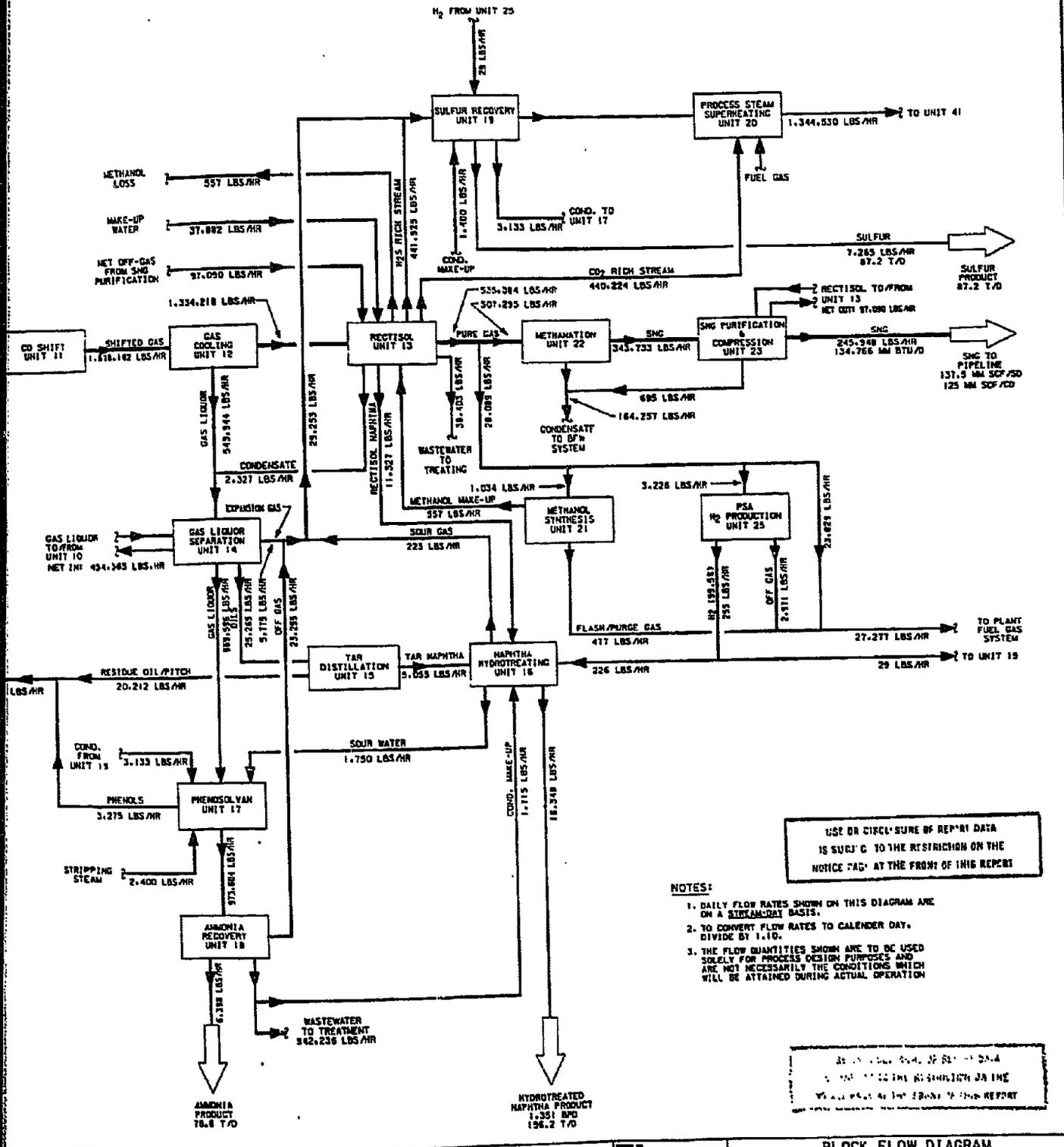
Coal is screened and distributed to Gasification and the Boilers. Oxygen is produced from atmospheric air, and steam is generated from boiler feed water. The gas produced in the Gasification and Partial Oxidation units undergoes CO shift, cooling, H_2S and CO_2 removal (Rectisol), methanation, purification, and compression as it is upgraded to pipeline quality substitute natural gas (SNG). The liquids produced in the plant are treated to recover naphtha and ammonia byproducts as well as stripped gas liquor which is further treated in the Wastewater Treating Unit. Residual tar, pitch, and phenols are gasified in the Partial Oxidation Unit. Byproduct sulfur is recovered from the H_2S removed from the gas in the Rectisol Unit. Ash is generated in the Gasification, Partial Oxidation, and Steam Generation units and is prepared for disposal in the Ash Handling Unit.

6.1.8.2 PLANT WATER BALANCE

Drawing No. 835704-00-R-102 is the block flow diagram of the plant water balance for the Westmoreland Coal - 40% Fines, SNG Case.

The basis of the plant water management philosophy is zero discharge. This philosophy requires that no waste water stream leave the plant


COAL FEED FROM MINE 18,000 T/D 750 T/HR
2" X 0" SIZE
COAL SCREENING UNIT 01
SIZED COAL 2" x 1/4"
COAL FINES <1/4"
COAL DISTRIBUTION UNIT 02
SIZED COAL 600,000 LBS/HR 450 T/HR
COAL GASIFICATION (LURGI) UNIT 10
RAW GAS
CO SHIFT UNIT 11
SHIFTED GAS 1,618,162 LBS/HR
GAS COOLING UNIT
HP STEAM
MET BFW 17,910,908 LBS/HR
VENT 408 LBS/HR
113,816 LBS/HR
METHANOL LOSS 557
MAKE-UP WATER 37,882
MET OFF-GAS FROM SNG PURIFICATION 97,010
1,334,218
GAS LIQUOR TO/FROM UNIT 14
NET IN: 454,365 LBS/HR
DRY AIR TO INSTR. AIR SYSTEM
VENT 801,629 LBS/HR
13,920 LBS/HR
NITROGEN TO INERT GAS SYSTEM 46,804 LBS/HR
222,018 LBS/HR
ASH 88,931 LBS/HR
FOX GAS 75,051 LBS/HR
GAS LIQUOR
AIR 1,103,856 LBS/HR
OXYGEN PRODUCTION UNIT 40
OXYGEN (98.5%) 243,743 LBS/HR
GAS LIQUOR TO/FROM UNIT 10
NET IN: 454,365 LBS/HR
GAS LIQUOR SEPARATION UNIT
FLUE GAS TO ATMOS.
FROM UNIT 20 1,344,530 LBS/HR
5,806,000 LBS/HR
COAL FINES 600,000 LBS/HR 300 T/HR
STEAM TO PROCESS UNITS
MAKE-UP WATER 21,346 LBS/HR
HP STEAM 21,725 LBS/HR 11,492 LBS/HR
POWER GENERATION UNIT 42
STEAM GENERATION UNIT 41
PARTIAL OXIDATION UNIT 24
RESIDUE OIL/PITCH 20,212 LBS/HR
23,487 LBS/HR
LIME 8,792 LBS/HR
FLUE GAS DESULFURIZATION UNIT 43
FLY ASH 38,317 LBS/HR
2,031 LBS/HR
ASH 18 LBS/HR
COND. FROM UNIT 13 3,133 LBS/HR
PHENOLS 3,279 LBS/HR
PHENOSOLVAN UNIT
MAKE-UP WATER 244,000 LBS/HR
405 MW
BLOWDOWN TO WASTEWATER TREATMENT
STRIPPING STEAM 2,400 LBS/HR
INTERNAL POWER USERS 122 MW
GYPSUM SLUDGE 32,250 LBS/HR
BOTTOM ASH 6,880 LBS/HR
ASH HANDLING UNIT 03
AMMONIA RECOVERY UNIT
MAKE-UP WATER 41,464 LBS/HR
186,870 LBS/HR (25.2% MOISTURE)
8,358 LBS/HR
POWER EXPORT 283 MW
SOLID WASTE TO DISPOSAL 2,243 T/D
AMMONIA PRODUCT 76.8 T/D



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

NOTES:

1. DAILY FLOW RATES SHOWN ON THIS DIAGRAM ARE ON A STREAM-DAY BASIS.
2. TO CONVERT FLOW RATES TO CALENDER 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	D.P. HALVERSON	BLOCK FLOW DIAGRAM OVERALL MATERIAL BALANCE		
	C.C. ABATAY	CASE: WESTMORELAND COAL-40% FINES-SNG		
	W.O. BRUNTO	CROW TRIBE OF INDIANS	SYNFUELS FEASIBILITY STUDY	
	R. McCARTHY	NONE	835704-00-4-101	1
	R. LANG			

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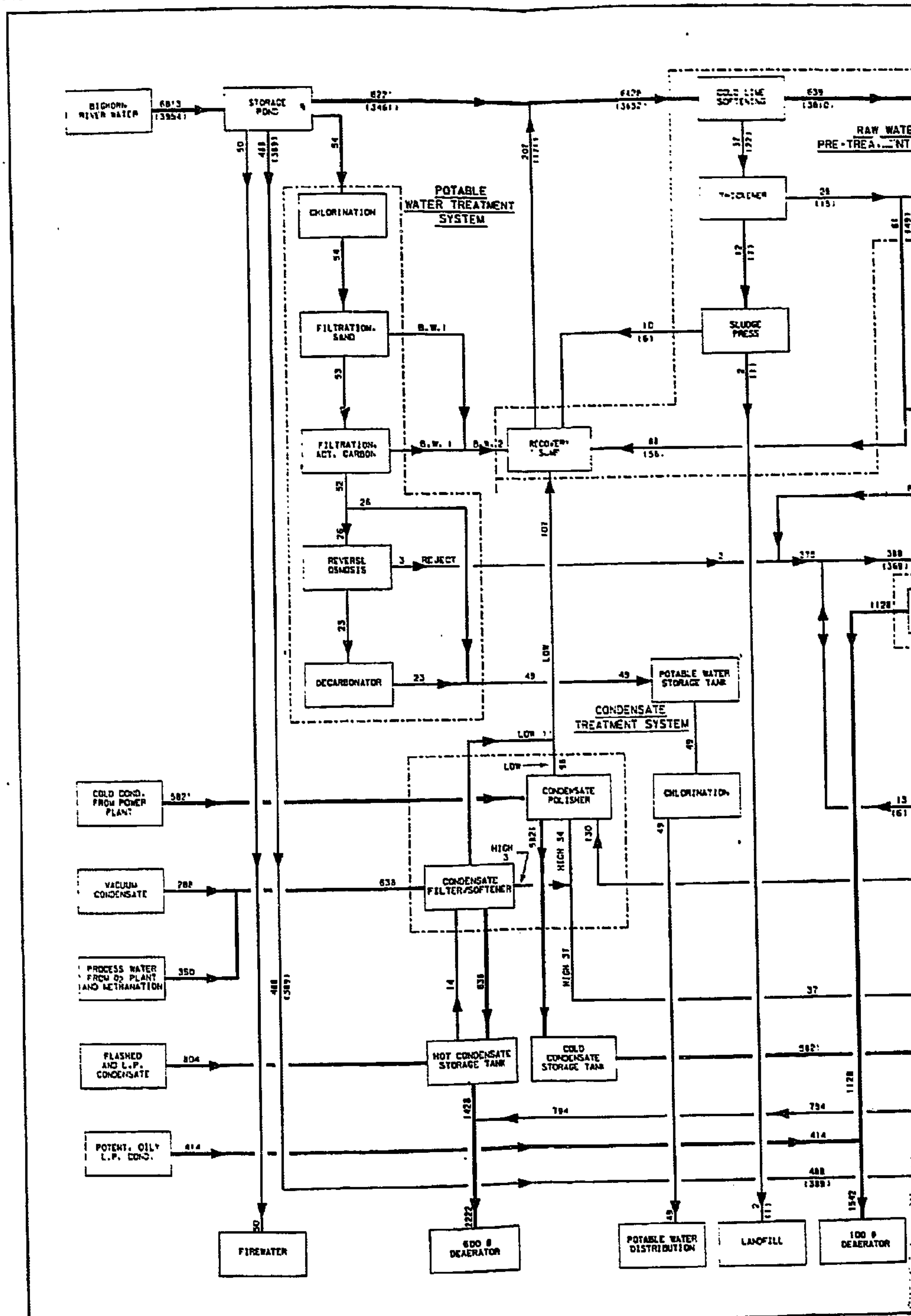
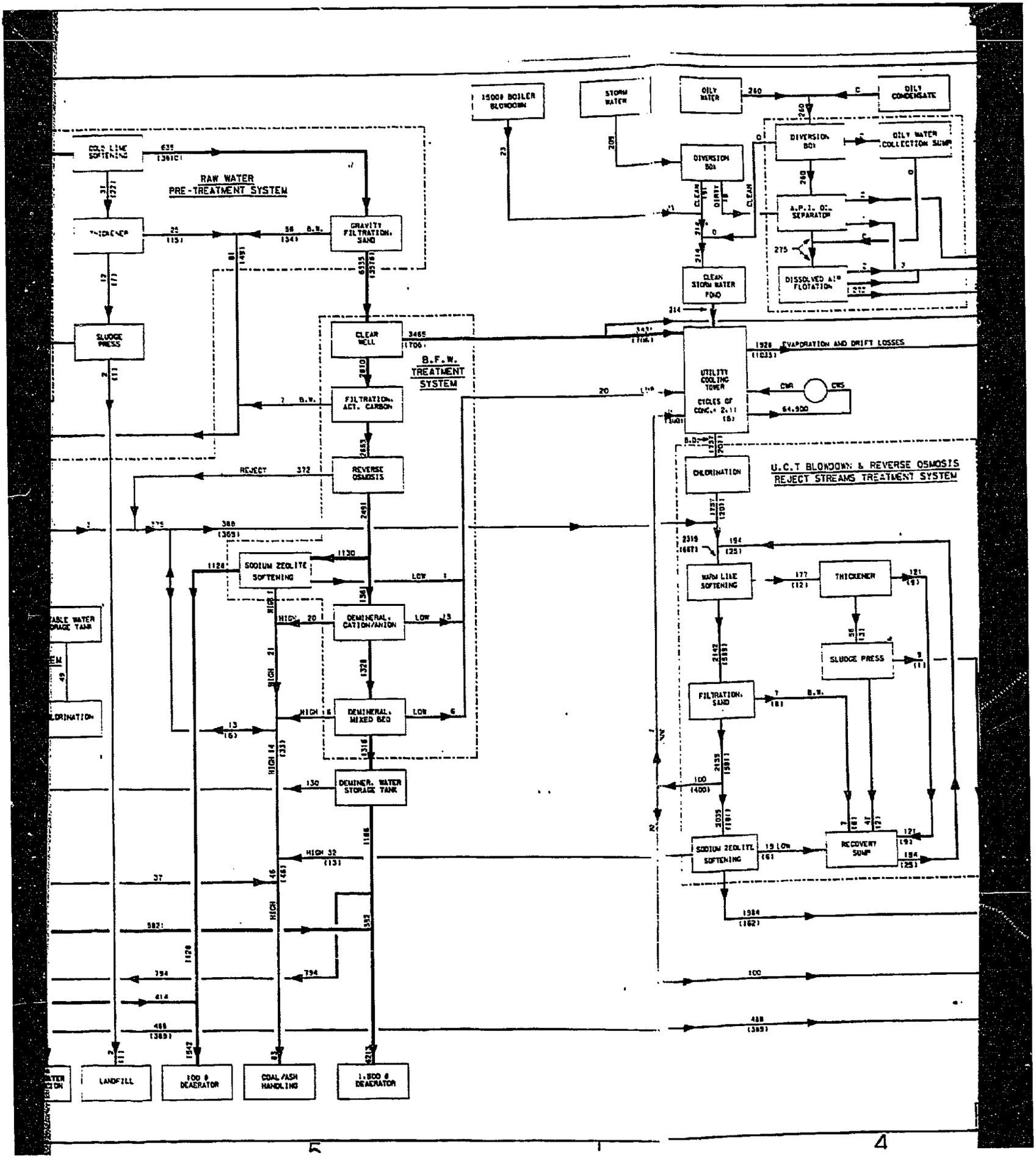
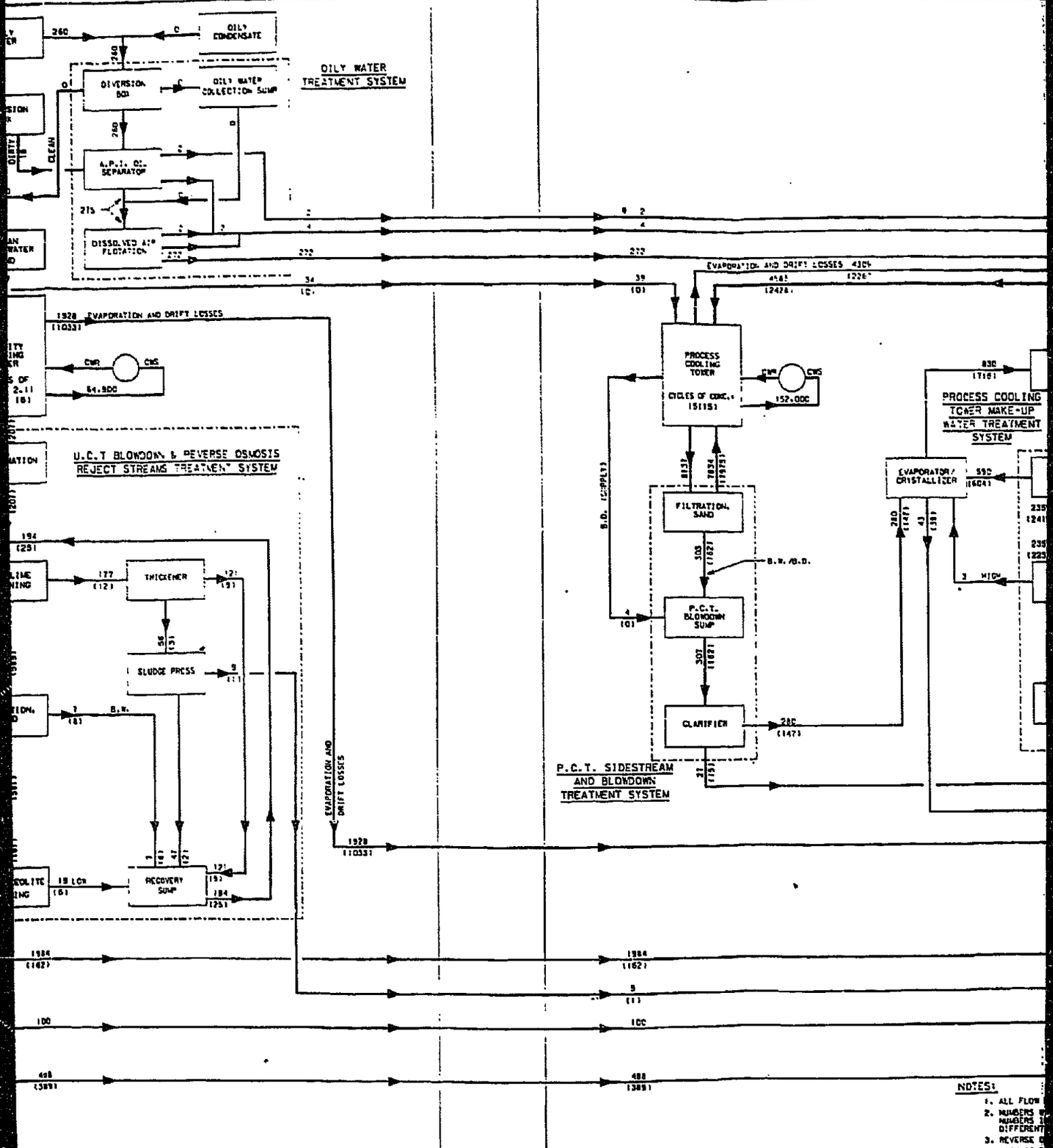

BIGHORN RIVER WATER
STORAGE POND
POTABLE WATER TREATMENT SYSTEM
CHLORINATION
FILTRATION, SAND
FILTRATION, ACT. CARBON
REVERSE OSMOSIS
REJECT
DECARBONATOR
RECOVERY SUMP
SLUDGE PRESS
THICKENER
RAW WATER
POTABLE WATER STORAGE TANK
CONDENSATE TREATMENT SYSTEM
CONDENSATE POLISHER
CONDENSATE FILTER/SOFTENER
CHLORINATION
COLD COND. FROM POWER PLANT
VACUUM CONDENSATE
PROCESS WATER FROM O2 PLANT AND METHANATION
FLASHED AND L.P. CONDENSATE
POTENT. OILY L.P. COND.
HOT CONDENSATE STORAGE TANK
COLD CONDENSATE STORAGE TANK
FIREWATER
600 # DEAERATOR
POTABLE WATER DISTRIBUTION
LANDFILL
100 # DEAERATOR
LOW
HIGH

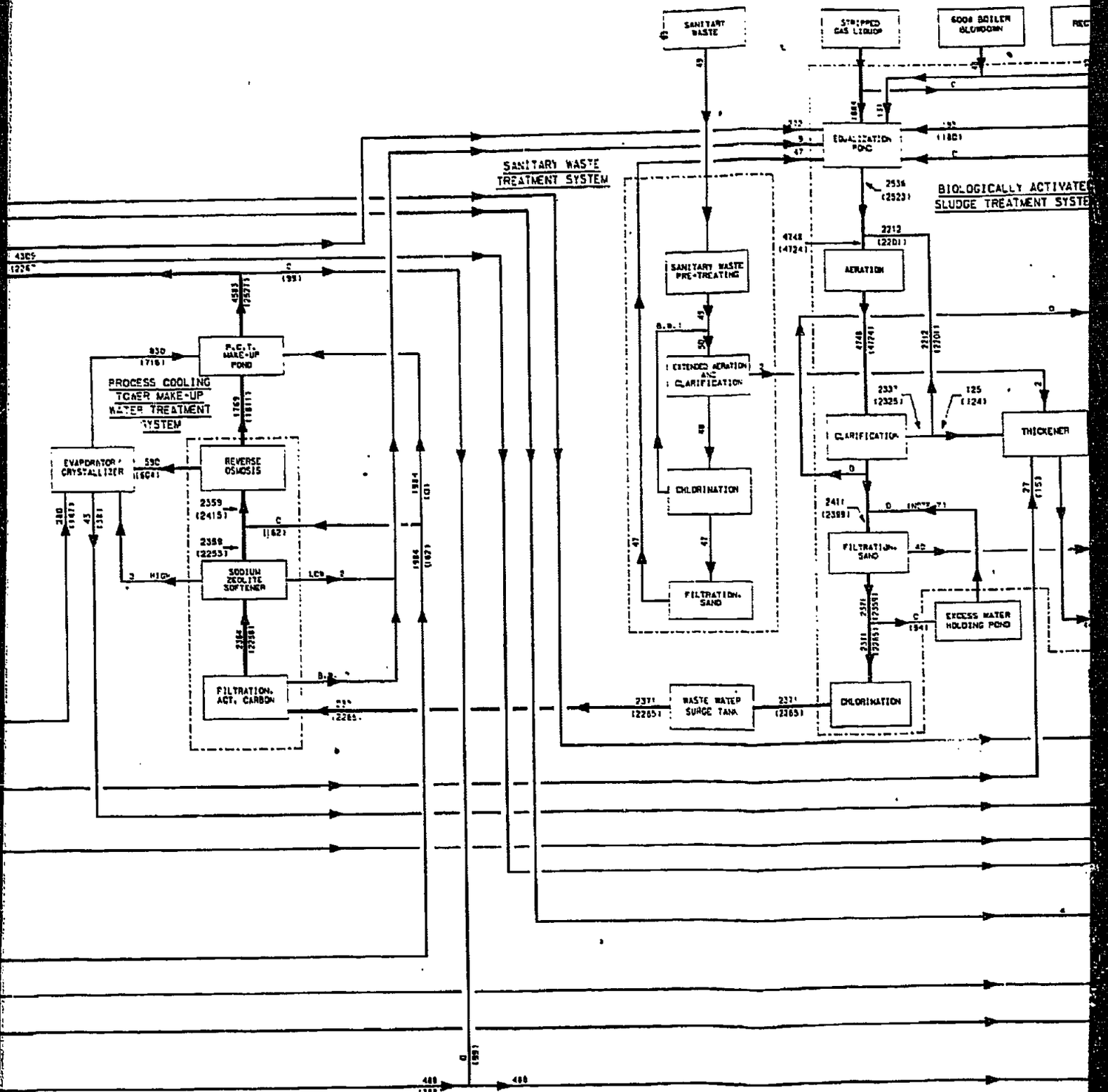

RAW WATER
PRE-TREATMENT SYSTEM
COLD LIME SOFTENING
THICKENER
GRAVITY FILTRATION, SAND
SLUDGE PRESS
CLEAR WELL
B.F.W.
TREATMENT
SYSTEM
FILTRATION, ACT. CARBON
REVERSE OSMOSIS
REJECT 372
SODIUM ZEOLITE SOFTENING
DEMINERAL, CATION/ANION
DEMINERAL, MIXED BED
DEMINER. WATER STORAGE TANK
LANDFILL
100 # DEAERATOR
COAL/ASH HANDLING
1,800 # DEAERATOR
1500# BOILER BLOWDOWN
STORM WATER
OILY WATER
OILY CONDENSATE
DIVERSION BOX
OILY WATER COLLECTION SUMP
A.P.I. OIL SEPARATOR
DISSOLVED AIR FLOTATION
CLEAN STORM WATER POND
UTILITY COOLING TOWER
CYCLES OF CONC. = 2.11
(5)
1928 EVAPORATION AND DRIFT LOSSES
(1035)
64,900
CHLORINATION
U.C.T BLOWDOWN & REVERSE OSMOSIS
REJECT STREAMS TREATMENT SYSTEM
WARM LIME SOFTENING
THICKENER
SLUDGE PRESS
FILTRATION, SAND
SODIUM ZEOLITE SOFTENING
RECOVERY SUMP



NOTES:

1. ALL FLOW
2. NUMBERS W
   NUMBERS I
   DIFFERENT
3. REVERSE O
4. HIGH IS F
5. B.W. IS F
6. B.D. IS F
7. DURING WI
   WATER HO

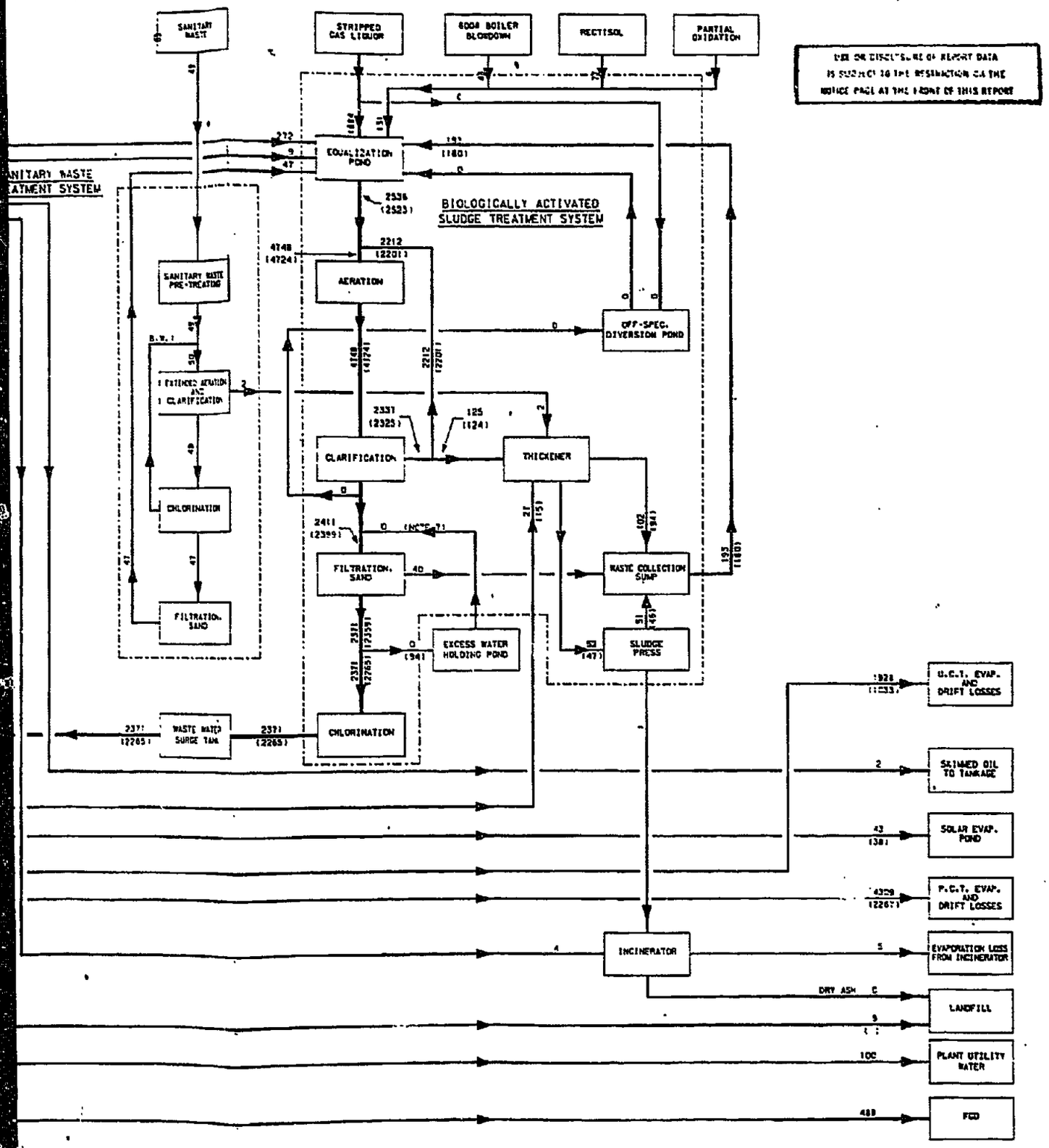
DRAWING NO.	REV.	FRAME
1835704-00-R-102	1	2 OF 2



NOTES:

1. ALL FLOW RATES IN GALLONS PER MINUTE.
2. NUMBERS WITHOUT PARENTHESES ARE FOR SUMMERTIME CASE; NUMBERS INSIDE PARENTHESES ARE FOR WINTERTIME CASE IF DIFFERENT FROM SUMMERTIME CASE.
3. REVERSE OSMOSIS INCLUDES MICRON FILTRATION.
4. HIGH IS FOR HIGH TDS WASTE. LOW IS FOR LOW TDS WASTE.
5. B.W. IS FOR BACKWASH.
6. B.D. IS FOR BLOWDOWN.
7. DURING WINTER, 180 GPM OF WATER IS STORED IN THE EXCESS WATER HOLDING POND FOR 10 DAYS FOR LATER USAGE.

FLUOR



FLUOR

R. WHITE
C.C. ABATAY
W.O. BELMITO
R. McCARTHY
R. LANG

BLOCK FLOW DIAGRAM
PLANT WATER BALANCE
CASE: WESTMORELAND COAL - 40% FINES - SNG
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE

835704-00-R-102

MICROFILM FRAME 1 OF 2

1

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6.1.8.2 (Continued)

boundaries and is accomplished by treatment and recycle of plant water streams as shown on the drawing. The plant water usage scheme achieves conservation of water and protection of the environment.

The water leaving the plant is in the form of evaporative losses from the cooling towers, waste water solar evaporation pond, and the waste treat ment sludge incinerator. The balance of the losses occur from small amounts of water to ash handling for dust control and to landfill disposal with dewatered sludge.

Raw water pumped into the plant flows to two major destinations, Boiler Feed Water (BFW) Treatment and Utility Cooling Tower Makeup. Low quantity uses include Potable Water, Firewater, and Flue Gas Desulfurization. The requirement for cooling water free of organic contamination in the Oxygen Production Unit is the reason for treated raw water make-up to the Utility Cooling Tower. Utility cooling water makeup is supplemented by clean storm water and blowdown from the 1500 psig boilers.

BFW Treatment supplies demineralized makeup water to supplement the polished condensate returning to feed the 1500 psig boilers and supplement the softened plant condensate streams feeding the 600 psig waste heat boilers in the plant. The unit also sends softened water to the 100 psig plant boilers. Waste water from reverse osmosis (RO) equipment in the BFW and Condensate Treatment and Potable Water Units joins the Utility Cooling Tower blowdown for treatment and is recycled to the Process Cooling Tower. Backflush regeneration of the filters and softeners in the above units is recycled directly to the Raw Water Treatment stream or the Utility Cooling Tower as makeup. The water with highest total dissolved solids (TDS) is used for Ash Handling dust control.

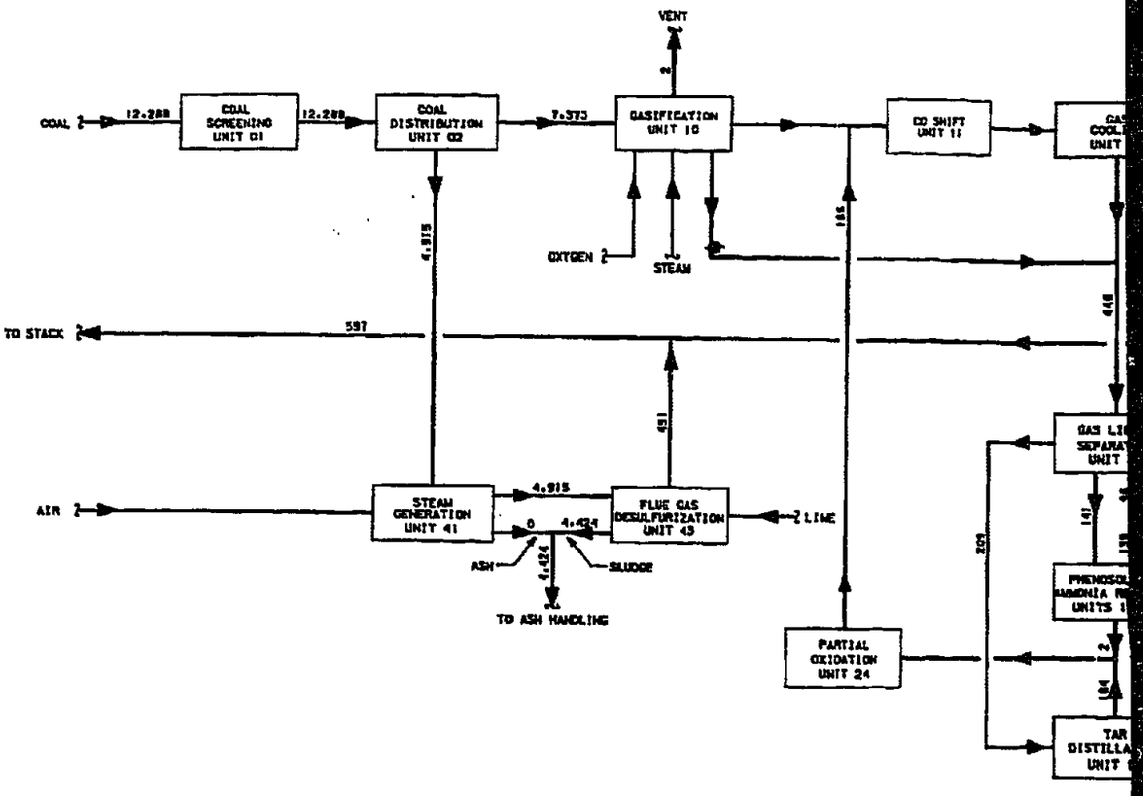
6.1.8.2 (Continued)

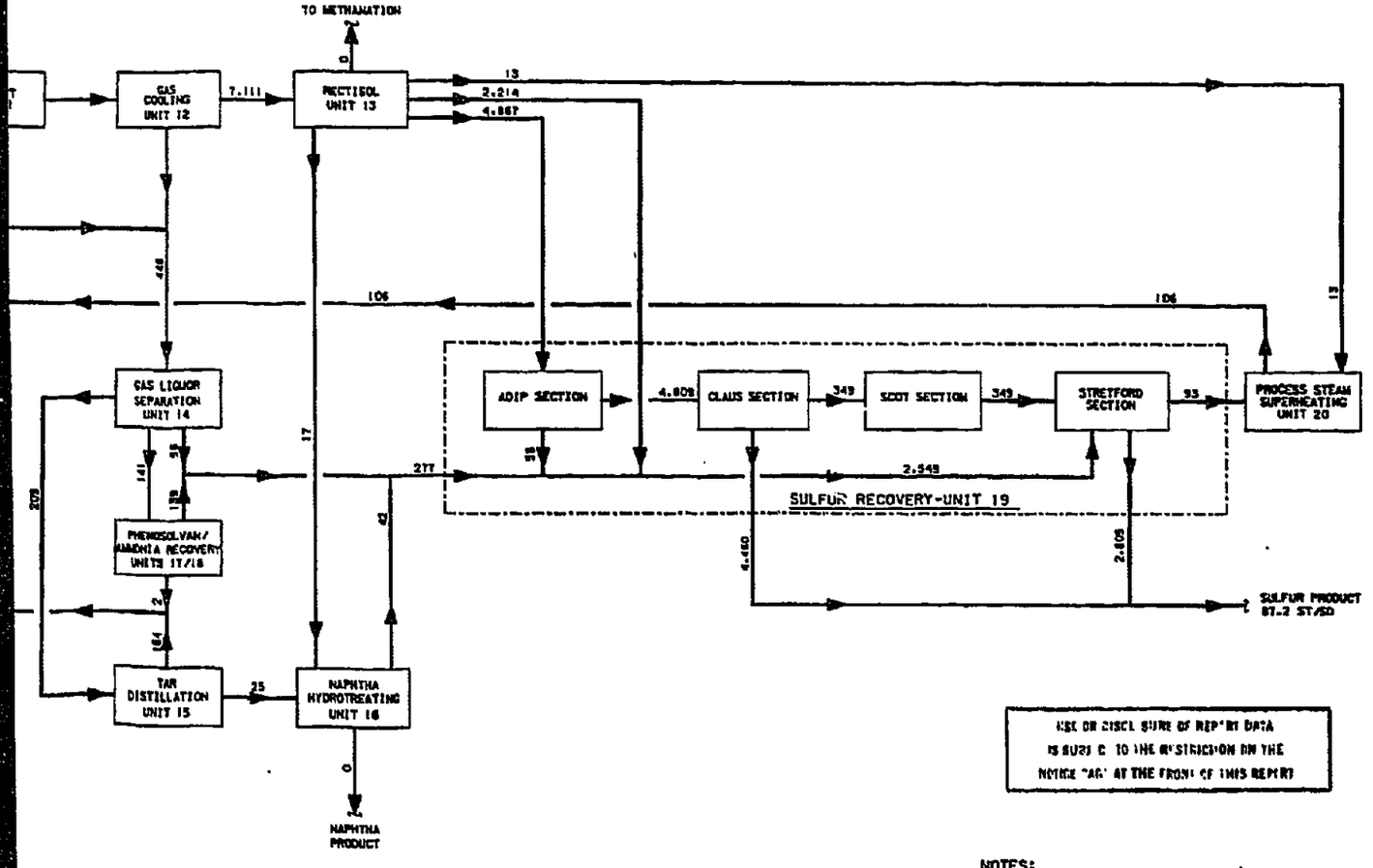
The large volume of makeup to the Process Cooling Tower is composed of biologically treated process waste water. This technologically advanced scheme accomplishes recycle of a very large stream of otherwise environmentally undesirable water without offplot disposal. The waste water consists of treated oily water, treated sanitary waste, plant wasteheat boiler blowdown, process water from POX and Rectisol, and stripped gas liquor from Ammonia Recovery. Organic wastes are reduced by biological treatment. The clarified water is treated by softening and RO before introduction into the Process Cooling Tower (PCT) makeup pond. High solids waste streams from the purification equipment in the PCT makeup treatment system and the PCT side stream treatment system are concentrated in an evaporator. The condensed water from the evaporator returns to the Process Cooling Tower, while the brine is pumped to the solar evaporation pond for crystallization by solar energy.

6.1.8.3 SULFUR BALANCE

Drawing No. 835704-00-4-104 shows the plant sulfur balance for the Westmoreland Coal - 40% Fines - SNG Case. Flow rates are given as pounds per hour of sulfur regardless of the form or compound the sulfur is in.

Sulfur enters the plant as a part of the coal. In Gasification most of the sulfur in the coal reacts to form hydrogen sulfide (H_2S). A very small portion of the H_2S is vented to the atmosphere in the lock gas vent, a portion is retained in the liquid, but most is contained in the gas. The selective Rectisol process removes the acid gases (carbon dioxide and sulfur containing gases) from the main process gas stream and separates the acid gases into three streams -a H_2S-rich stream, a H_2S-lean stream, and a CO_2-rich stream. The H_2S-rich stream is further concentrated in the ADIP section of Sulfur Recovery. The Claus section reacts and recovers molten sulfur from the H_2S-rich gas. The SCOT section converts sulfur compounds in the tailgas to H_2S. In the Stretford Section, molten


VENT
COAL
12,288
COAL SCREENING UNIT 01
12,288
COAL DISTRIBUTION UNIT 02
7,373
GASIFICATION UNIT 10
CO SHIFT UNIT 11
OXYGEN
STEAM
4,915
TO STACK
597
451
AIR
STEAM GENERATION UNIT 41
4,915
0
4,434
FLUE GAS DESULFURIZATION UNIT 43
LIME
ASH
SLUDGE
4,434
TO ASH HANDLING
PARTIAL OXIDATION UNIT 24



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

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

D.P.HALVERSON
C.P.ABATAY
W.O'BECHITO
R.McCARTHY 6-8-81
R.LANG

BLOCK FLOW DIAGRAM
SULFUR BALANCE
CASE: WESTMORELAND COAL-40% FINES-SNG
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-00-4-104 | 1

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6.1.8.3 (Continued)

sulfur is recovered from the Rectisol H_2S-lean gas, the ADIP and SCOT tailgases, and sulfur containing offgases from the liquid-processing units. Sulfur compounds in the Stretford vent gas and Rectisol CO_2-rich gas are converted to SO_2 in the Process Steam Superheating Unit, join the boiler flue gas and are vented to the atmosphere.

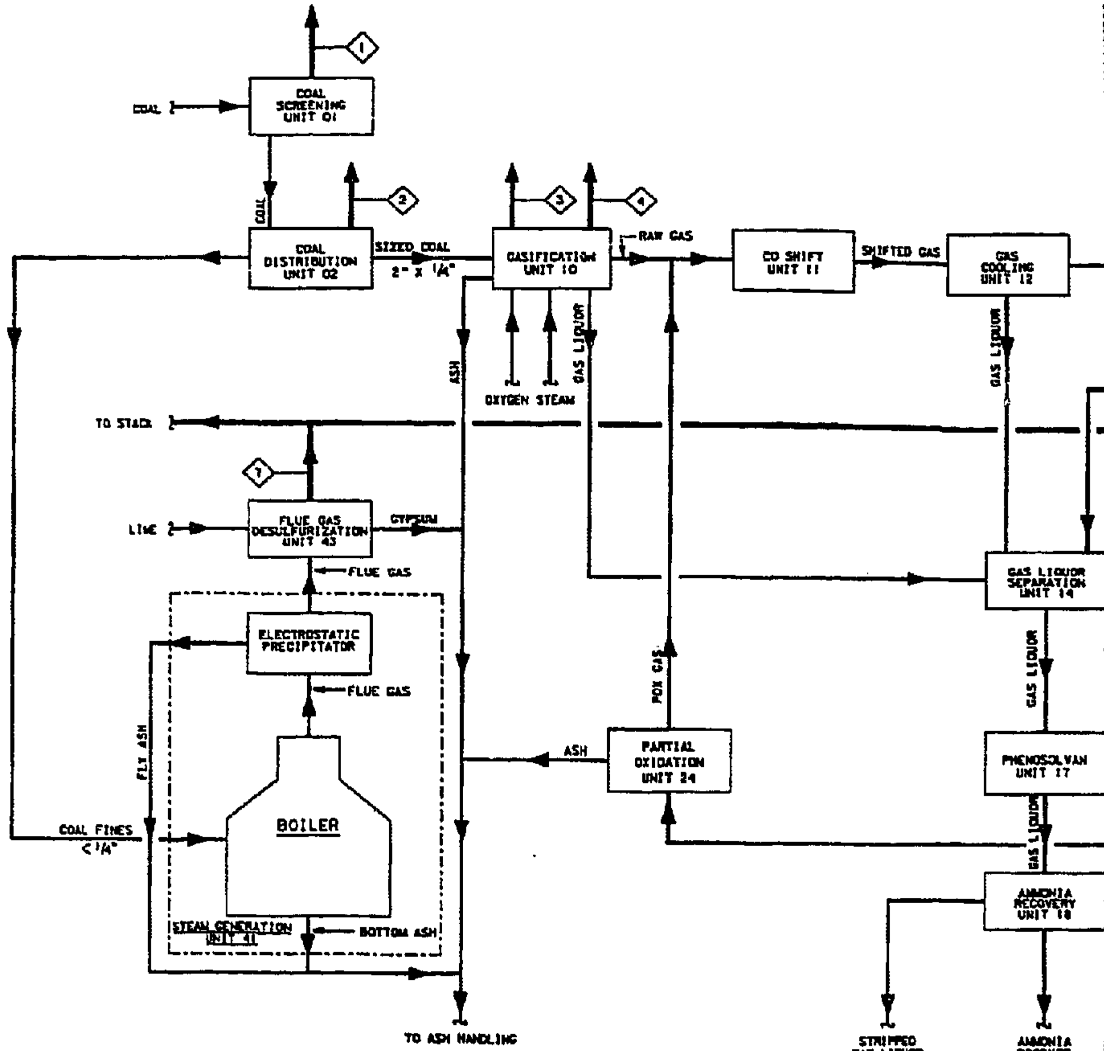
Sulfur that enters the boilers in the coal is oxidized to SO_2 and leaves in the flue gas. Ninety percent of the SO_2 in the flue gas is removed in the Flue Gas Desulfurization Unit and is oxidized to gypsum ($CaSO_4 \cdot 2H_2O$). The remaining SO_2 is vented to the atmosphere as a minor component of the flue gas.

6.1.8.4 AIR EMISSIONS

Drawing No. 835704-00-4-105 is the air emissions diagram for the Westmoreland Coal - 40% Fines - SNG Case. The drawing shows compositions, flow rates, and sources of streams that discharge to the atmosphere . Sources of emission are: coal handling, gasification, process heaters, coal-fired boilers, process steam superheater, and tankage. The diagram shows these sources in relation to the other process units and major process streams.

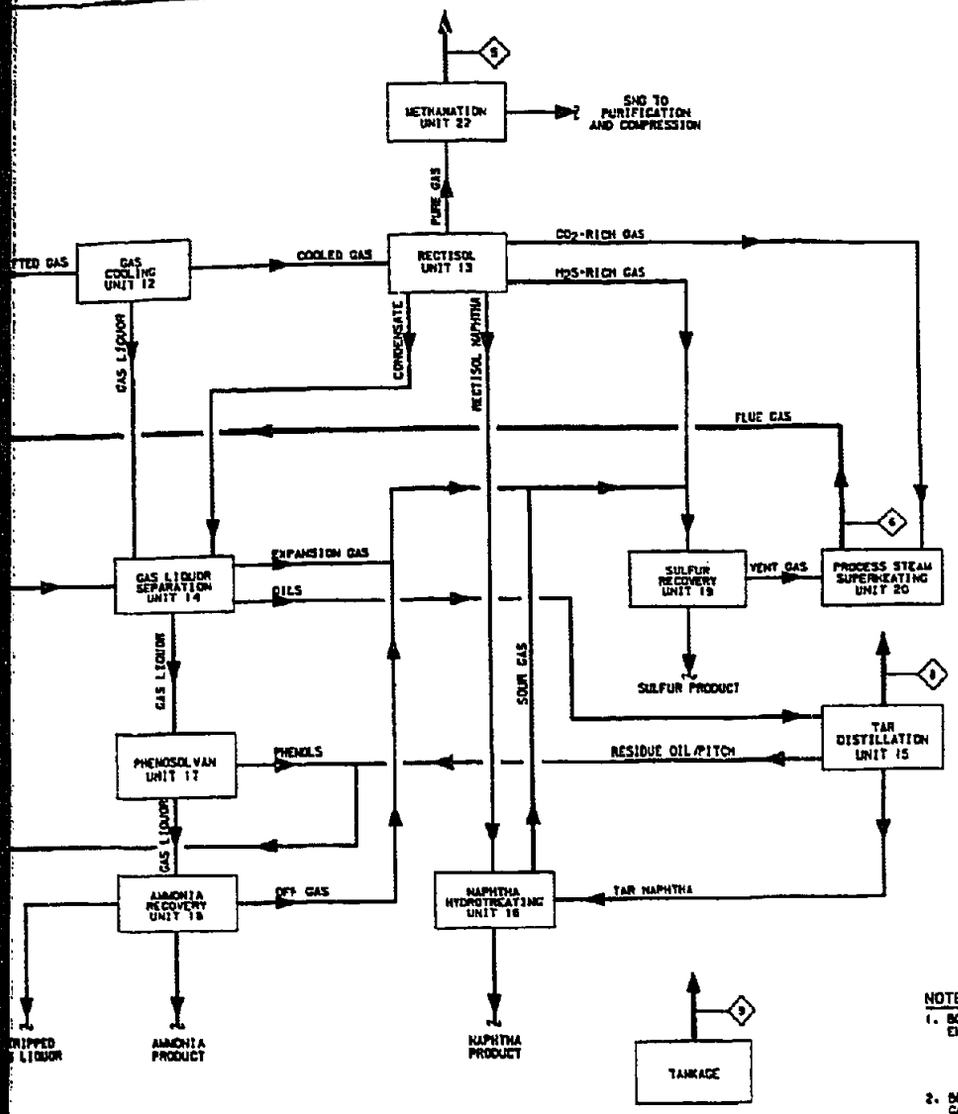
6.1.8.5 SOLID EFFLUENT

The solid effluent diagram for the Westmoreland Coal - 40% Fines - SNG Case (Drawing No. 835704-00-4-106) shows the sources of solid wastes that leave the plant battery limit. The major process steams and process units are shown for clarity. Several of the process units use catalysts that have resale value. The Sulfur Recovery catalyst has no resale value and is disposed of as landfill. The Raw Water Treating and Utility Cooling Water units produce sludges that are sent to landfill disposal. The Wastewater Treating sludge is incinerated prior to landfill disposal. The boiler



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	942	20.544	288.832	267	
N_2	LBS/HR			1		23.796	312.874	3.827.712	6.751	
CO_2	LBS/HR			263		4.970	950.730	1.112.320	1.410	
H_2O	LBS/HR			1		4.717	59.934	593.442	1.338	
SO_2	LBS/HR						211	(5) 983		
H_2S	LBS/HR			2						
COS	LBS/HR			TRACE						
NO_x	LBS/HR					22	225	2.584	8	
CO	LBS/HR			85		2	12	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		34.449	1.344.530	5.806.316	9.772	5
TOTAL FLOW	LBMOL/HR			19		1.253	36.748	203.430	355	
TEMPERATURE	°F	AMB.	AMB.			300	400	129	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 = 450 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: 468 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 12.2 MM BTU/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

DRAWN BY	D.P.HALVERSON
CHECKED BY	C.C.ABATAY
ENGINEERING MGR.	R.O'DELMITO
PROJECT MGR.	R.McCARTHY
APPROVED	R.LANG

BLOCK FLOW DIAGRAM
AIR EMISSIONS
CASE: WESTMORELAND COAL - 40% FINES - SNG

CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE	835704-00-4-105	1

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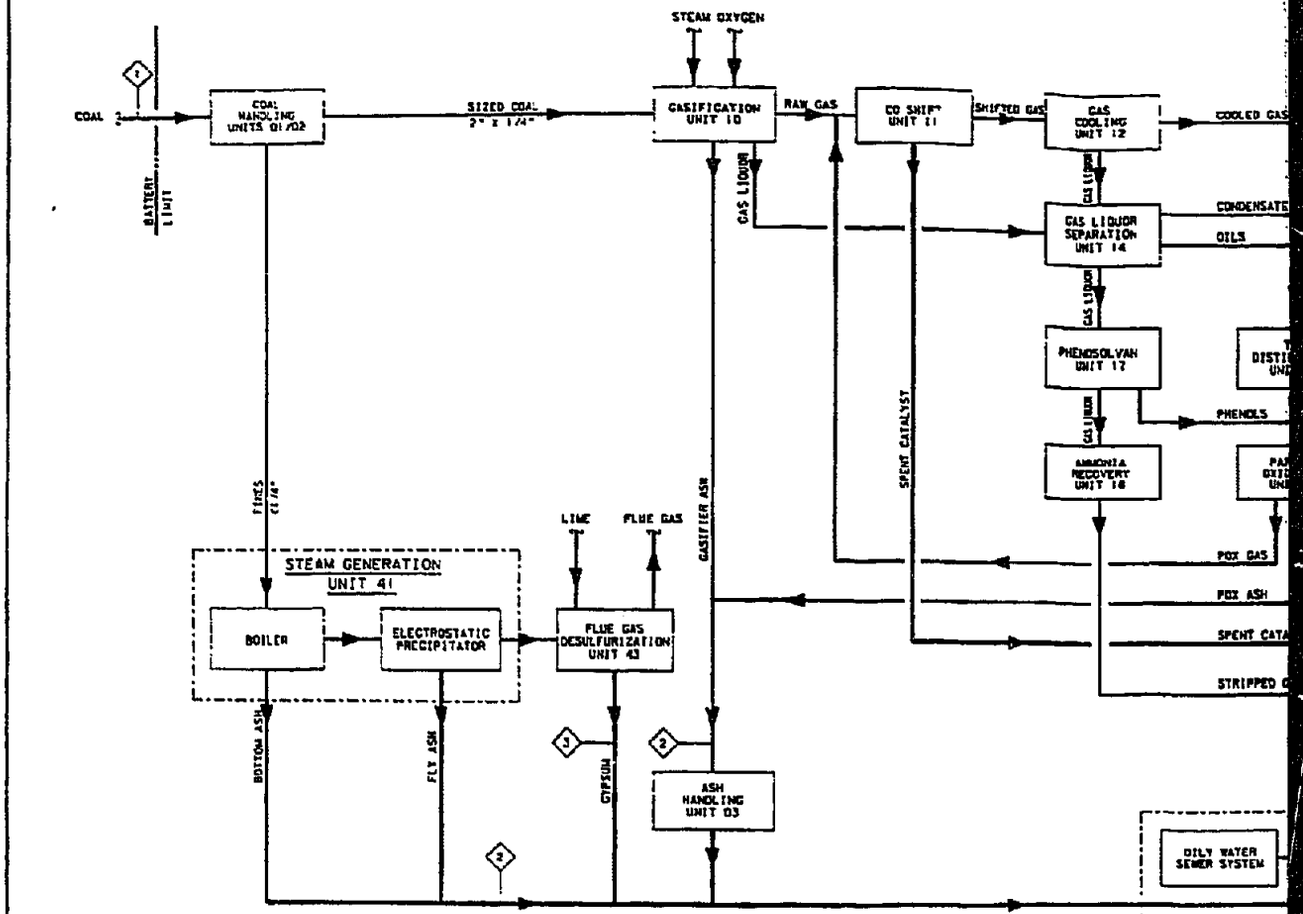
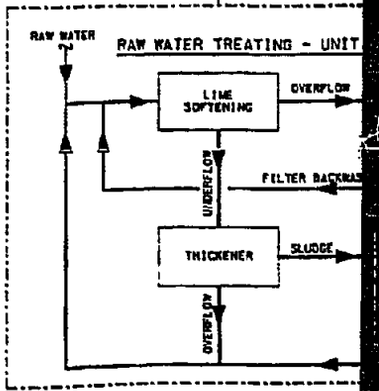


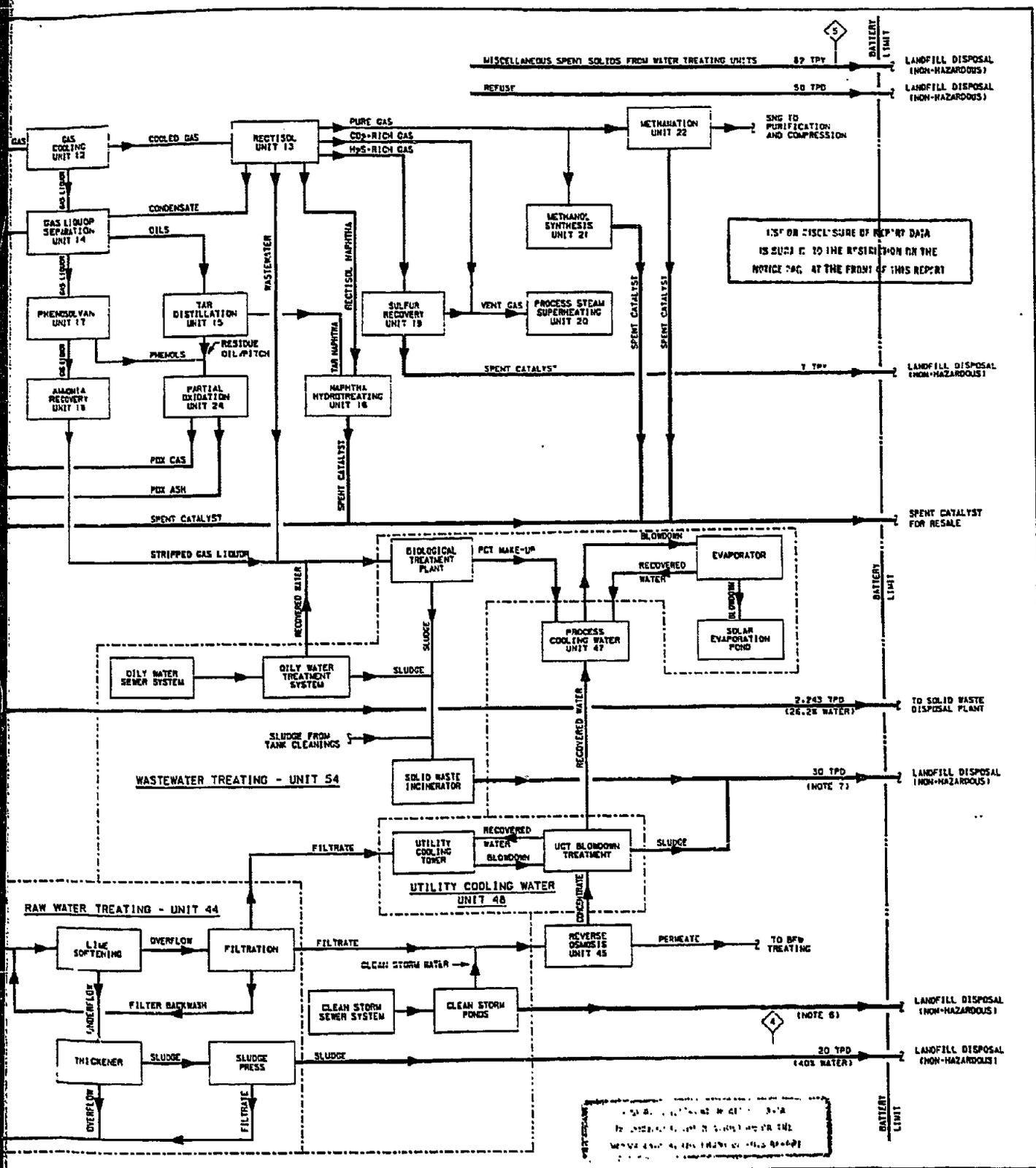
◇1 COAL (NOTE 7)		◇2 ASH (NOTES 2 - 4)		◇3 FGD GYPSUM (NOTE 5)		◇4 RAW WATER TREATMENT SLUDGE		◇5 WATER TREATING	
TRACE ELEMENTS	PPM	MINERAL ASH ANALYSIS	WT%		WT%		WT%		WT%
ANTIMONY	0.67	SiO_2	35.9	H_2O	23.0	$CaCO_3$	55.5	SPENT ACTIVATED CARBON	41.8
ARSENIC	1.77	Al_2O_3	19.2	$CaSO_4 \cdot 2H_2O$	75.0	$Mn(OH)_2$	0.9	SPENT ION EXCHANGE RESIN	58.1
BARIUM	181.60	Fe_2O_3	7.5	$CaCl_2$	0.5	H_2O	40.0		
BERYLLIUM	1.25	Na_2O	3.0	INERT SOLIDS	1.5	MISCELLANEOUS	3.6		
BORON	218.60	K_2O	0.18	$Co(OH)_2$	TRACE				
BROMINE	19.35	CaO	14.5	$Co(COOH)_2$	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	237.40								
LEAD	3.30								
LITHIUM	33.20								
MANGANESE	202.00								
MERCURY	0.08								
NICKEL	7.42								
SELENIUM	1.38								
SILVER	0.08								
STRONTIUM	497.02								
THALLIUM	0.23								
URANIUM	1.43								
VANADIUM	18.48								
ZINC	45.70								
ZIRCONIUM	128.00								



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.

NO.	REVISION DESCRIPTION



FLUOR

R. WHITE
G. C. ABATAY
W. O. DECKWITH
R. McCARTHY
R. LANG

BLOCK FLOW DIAGRAM
SOLID EFFLUENT
CASE: WESTMORELAND COAL - 40% FINES - SNG
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-00-4-106 | 1

001 33700106

6.1.8.5 (Continued)

ash, gasifier ash, and FGD gypsum are sent to the solid waste disposal plant. Additional wastes include spent solids from water treating and plant refuse.

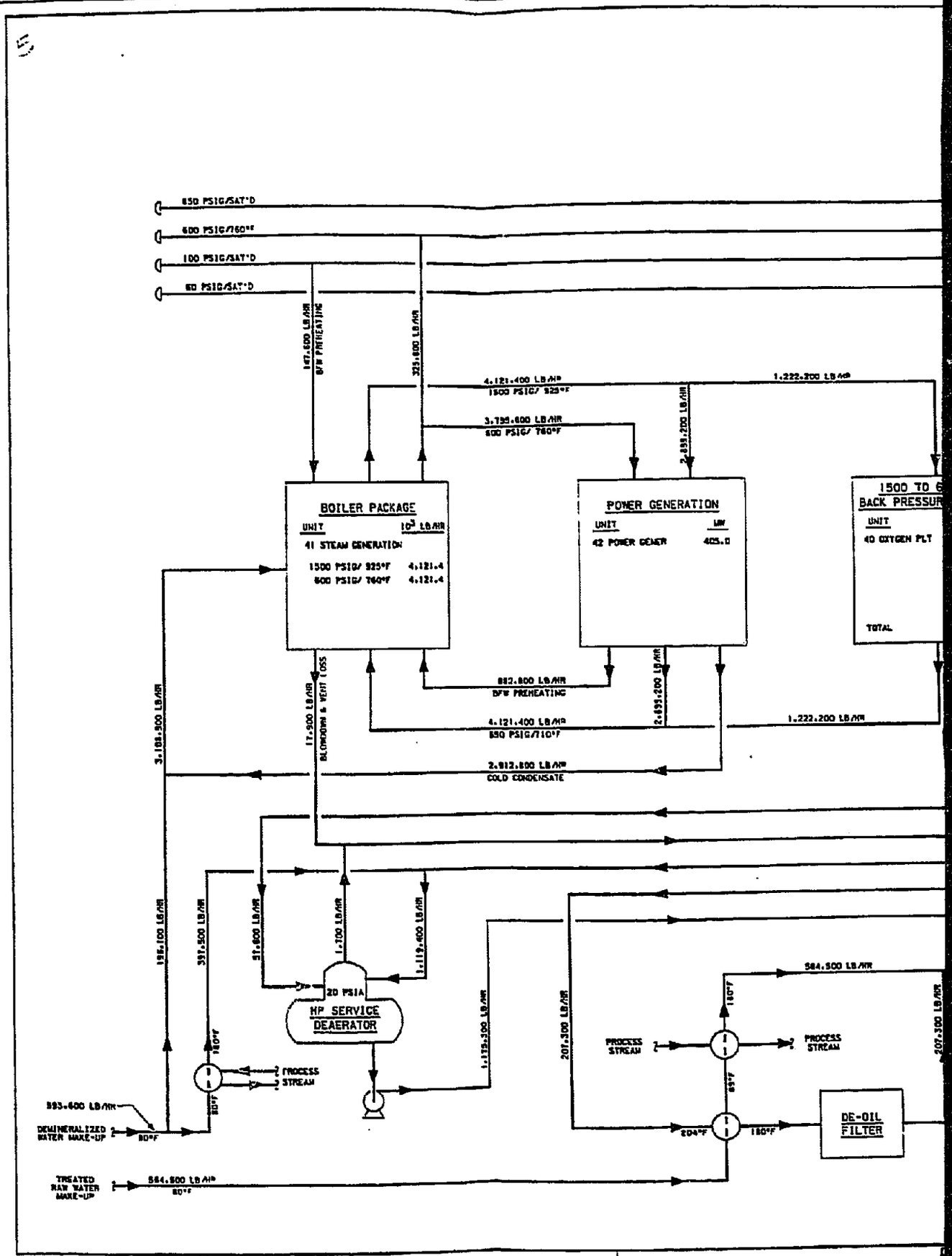
The flow rates and compositions of the solid effluents are given when known. The diagram also shows the trace element analysis of the coal and the mineral analysis of the ash.

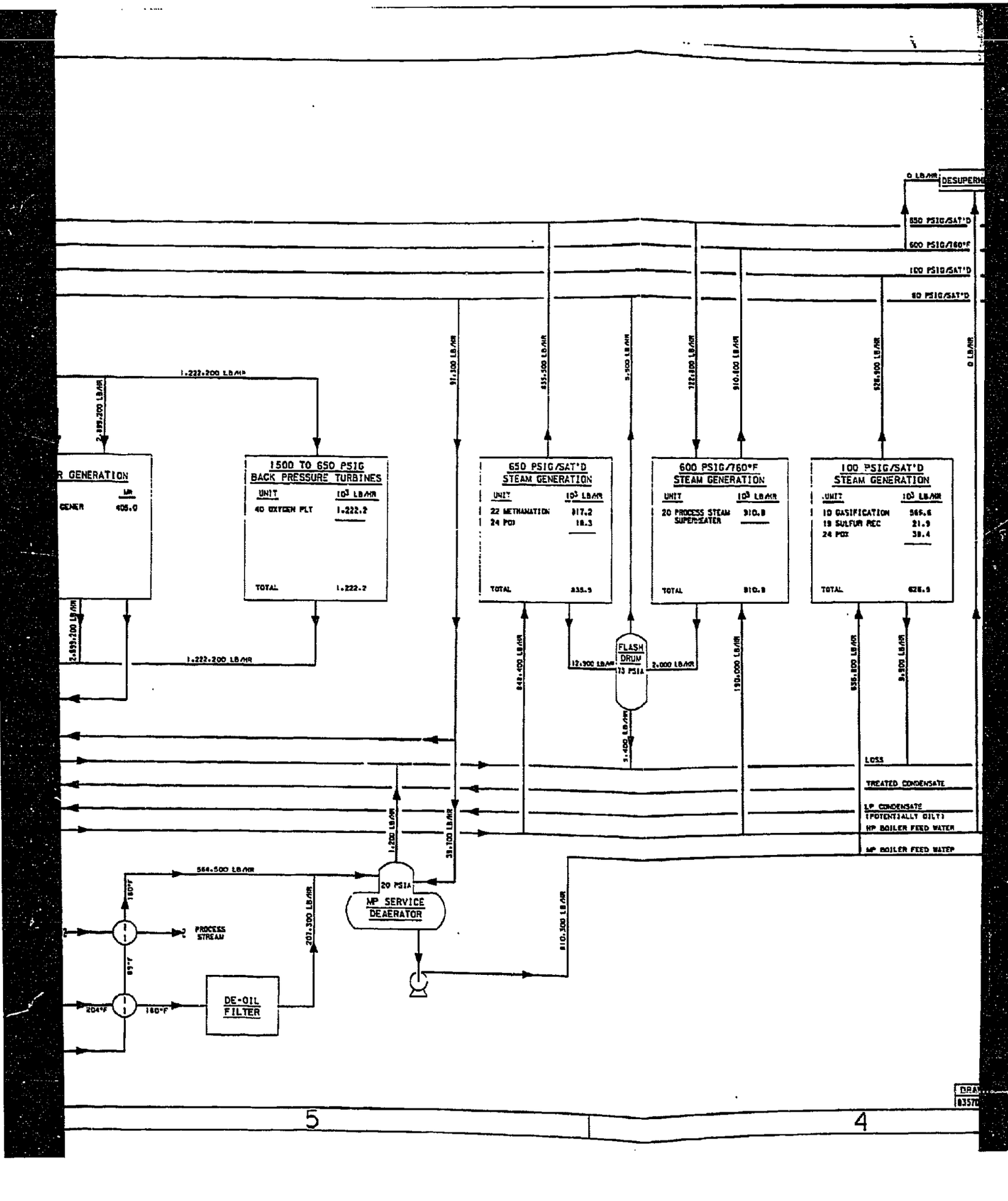
6.1.8.6 STEAM BALANCE

Drawing No. 835704-00-R-107 shows the plant steam balance for the Westmoreland Coal - 40% Fines - SNG Case. The steam balance shows the distribution of steam to and from the various steam producers and consumers in the plant. The steam producers and consumers are grouped according to pressure level and service. Each group occupies a block on the drawing and contains a list of the units which use this steam. Steam is generated at five different pressure levels and distributed throughout the process plant.

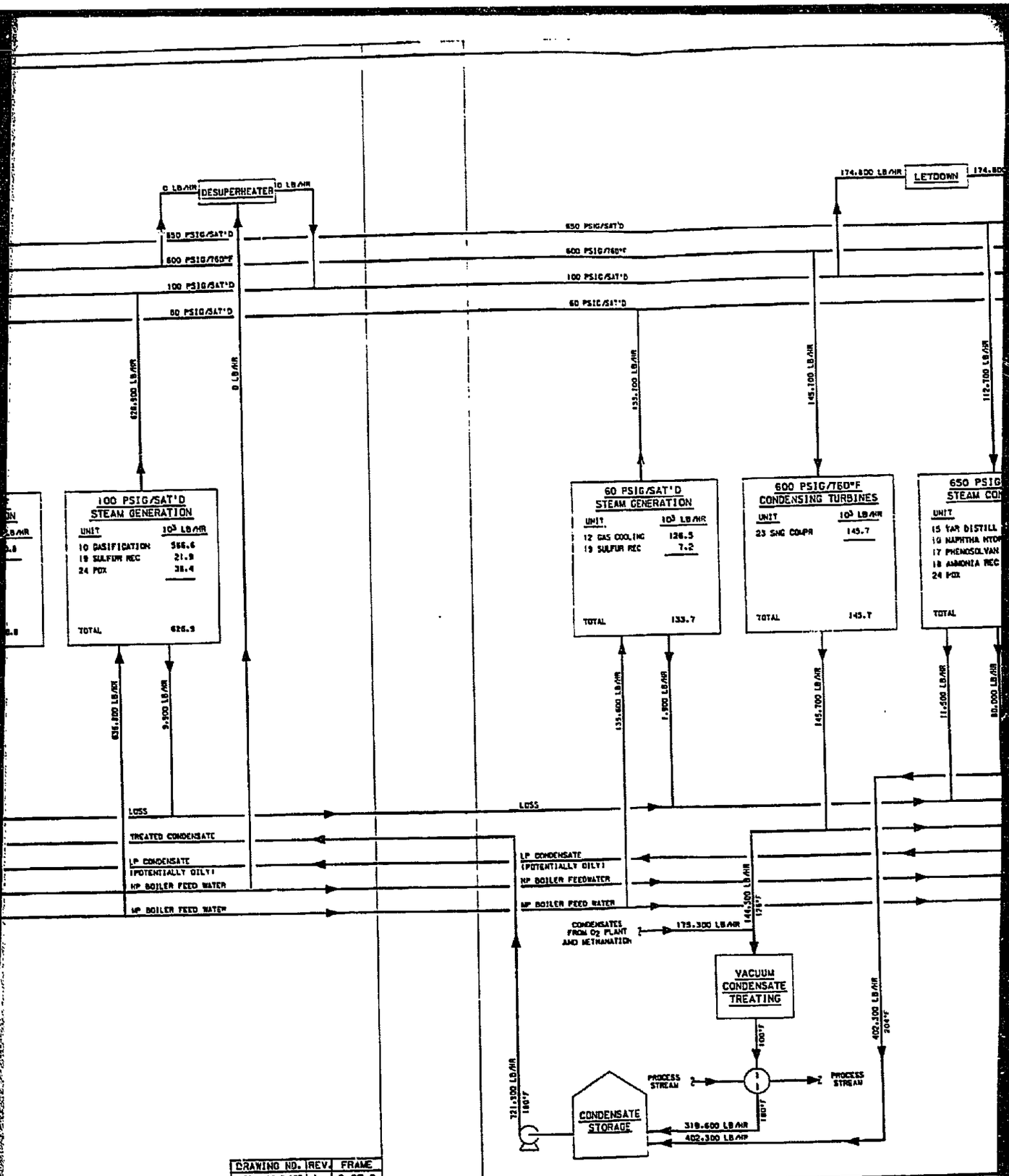
The steam balance also showns a general distribution of boiler feedwater and collection of returning condensates for reuse as boiler feedwater. Only the process deaerators are shown on the drawing. The boiler service deaerators are not shown but are included within the boiler plant.

Condensate and steam which are not returned to the plant for reuse are called losses. The losses are made up with demineralized water, treated raw water, and process condensates.

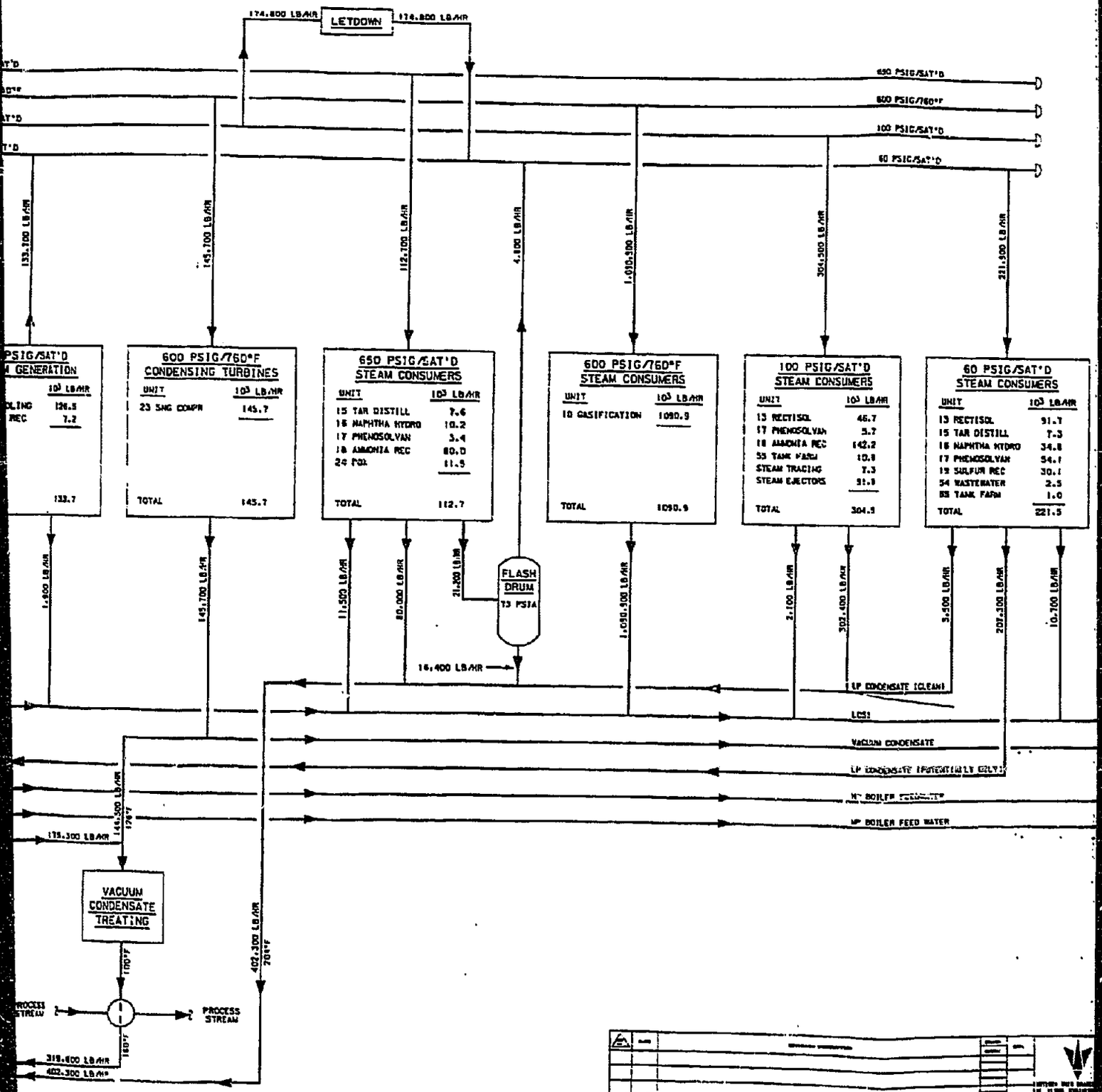

650 PSIG/SAT'D
600 PSIG/760°F
100 PSIG/SAT'D
60 PSIG/SAT'D
147,600 LB/HR
BFW PREHEATING
325,800 LB/HR
4,121,400 LB/HR
1500 PSIG/ 925°F
1,222,200 LB/HR
3,795,600 LB/HR
600 PSIG/ 760°F
2,893,200 LB/HR
BOILER PACKAGE
UNIT
10³ LB/HR
41 STEAM GENERATION
1500 PSIG/ 925°F 4,121.4
600 PSIG/ 760°F 4,121.4
POWER GENERATION
UNIT
MW
42 POWER GENER
405.0
1500 TO 6
BACK PRESSUR
UNIT
40 OXYGEN PLT
TOTAL
3,188,900 LB/HR
17,900 LB/HR
BLOWDOWN & VENT LOSS
882,800 LB/HR
BFW PREHEATING
2,493,200 LB/HR
4,121,400 LB/HR
650 PSIG/710°F
1,222,200 LB/HR
2,912,800 LB/HR
COLD CONDENSATE
195,100 LB/HR
337,500 LB/HR
51,800 LB/HR
1,700 LB/HR
1,119,400 LB/HR
20 PSIA
HP SERVICE
DEAERATOR
1,172,300 LB/HR
207,300 LB/HR
564,500 LB/HR
180°F
PROCESS
STREAM
PROCESS
STREAM
85°F
204°F
180°F
DE-OIL
FILTER
207,300 LB/HR
393,600 LB/HR
DEMINERALIZED
WATER MAKE-UP
80°F
80°F
PROCESS
STREAM
TREATED
RAW WATER
MAKE-UP
564,500 LB/HR
80°F


0 LB/HR
DESUPERH
850 PSIG/SAT'D
600 PSIG/760°F
100 PSIG/SAT'D
80 PSIG/SAT'D
1,222,200 LB/HR
2,899,200 LB/HR
91,300 LB/HR
835,500 LB/HR
9,500 LB/HR
322,800 LB/HR
810,800 LB/HR
628,900 LB/HR
0 LB/HR
R GENERATION
LB/HR
GENER 405.0
1500 TO 650 PSIG
BACK PRESSURE TURBINES
UNIT
10³ LB/HR
40 OXYGEN PLT 1,222.2
TOTAL 1,222.2
650 PSIG/SAT'D
STEAM GENERATION
UNIT
10³ LB/HR
22 METHANATION 817.2
24 POX 18.3
TOTAL 835.5
600 PSIG/760°F
STEAM GENERATION
UNIT
10³ LB/HR
20 PROCESS STEAM SUPERHEATER 810.8
TOTAL 810.8
100 PSIG/SAT'D
STEAM GENERATION
UNIT
10³ LB/HR
10 GASIFICATION 566.6
19 SULFUR REC 21.9
24 POX 38.4
TOTAL 626.9
2,899,200 LB/HR
1,222,200 LB/HR
848,400 LB/HR
12,900 LB/HR
FLASH DRUM
75 PSIA
2,000 LB/HR
3,400 LB/HR
190,000 LB/HR
636,800 LB/HR
9,500 LB/HR
LOSS
TREATED CONDENSATE
LP CONDENSATE (POTENTIALLY OILY)
HP BOILER FEED WATER
MP BOILER FEED WATER
1,220 LB/HR
39,700 LB/HR
564,500 LB/HR
20 PSIA
MP SERVICE DEAERATOR
180°F
PROCESS STREAM
85°F
204°F
180°F
DE-OIL FILTER
207,300 LB/HR
810,300 LB/HR

5 4

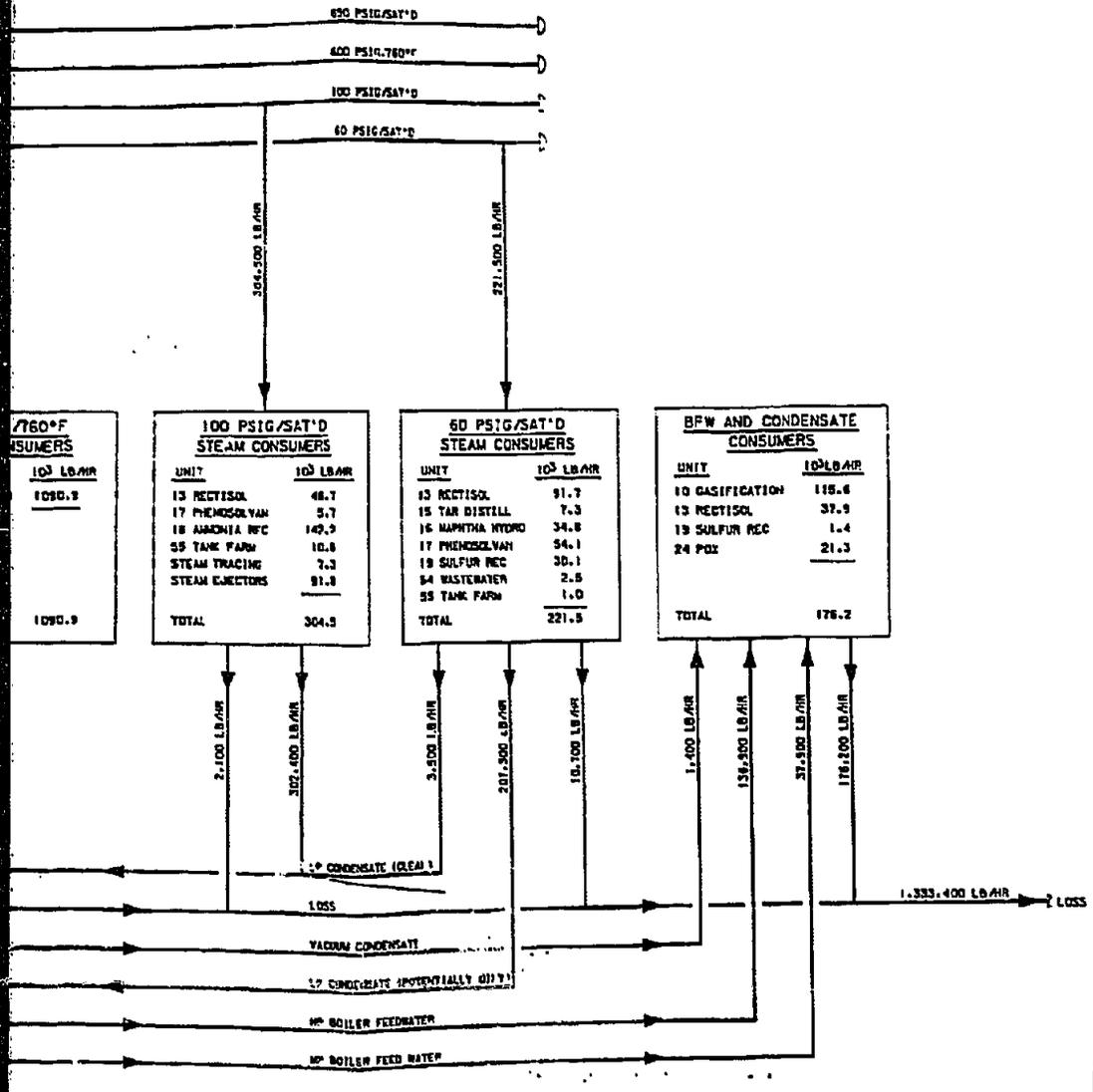


DRAWING NO.	REV.	FRAME
835704-00-B-107	1	2 OF 2


174,800 LB/HR
LETDOWN
174,800 LB/HR
650 PSIG/SAT'D
600 PSIG/760°F
100 PSIG/SAT'D
60 PSIG/SAT'D
133,700 LB/HR
145,700 LB/HR
112,700 LB/HR
4,100 LB/HR
1,010,300 LB/HR
304,300 LB/HR
221,500 LB/HR
PSIG/SAT'D
GENERATION
600 PSIG/760°F
CONDENSING TURBINES
UNIT
10³ LB/HR
23 SNG COMPR
145.7
TOTAL
145.7
650 PSIG/SAT'D
STEAM CONSUMERS
15 TAR DISTILL
7.6
16 NAPHTHA HYDRO
10.2
17 PHENOSOLVAN
3.4
18 AMMONIA REC
80.0
24 POX
11.5
TOTAL
112.7
600 PSIG/760°F
STEAM CONSUMERS
10 GASIFICATION
1090.9
TOTAL
1090.9
100 PSIG/SAT'D
STEAM CONSUMERS
13 RECTISOL
46.7
17 PHENOSOLVAN
5.7
18 AMMONIA REC
142.2
55 TANK FARM
10.8
STEAM TRACING
7.3
STEAM EJECTORS
91.8
TOTAL
304.5
60 PSIG/SAT'D
STEAM CONSUMERS
13 RECTISOL
91.7
15 TAR DISTILL
7.3
16 NAPHTHA HYDRO
34.8
17 PHENOSOLVAN
54.1
19 SULFUR REC
30.1
54 WASTEWATER
2.5
55 TANK FARM
1.0
TOTAL
221.5
1,900 LB/HR
145,700 LB/HR
11,500 LB/HR
80,000 LB/HR
21,300 LB/HR
FLASH DRUM
73 PSIA
1,090,900 LB/HR
2,100 LB/HR
302,400 LB/HR
3,500 LB/HR
207,300 LB/HR
10,700 LB/HR
16,400 LB/HR
LP CONDENSATE (CLEAN)
LCSI
VACUUM CONDENSATE
LP CONDENSATE (POTENTIALLY OILY)
HP BOILER FEEDWATER
MP BOILER FEED WATER
145,500 LB/HR
179,300 LB/HR
VACUUM CONDENSATE TREATING
402,300 LB/HR
PROCESS STREAM
PROCESS STREAM
319,600 LB/HR
402,300 LB/HR

3

2



NOTES:

1. THE TEMPERATURES, PRESSURES AND FLOW QUANTITIES ARE TO BE USED SOLELY FOR GENERAL INFORMATION.

FLUOR

D.P. HALVERSON
C.C. ABATAY
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R. LANG

BLOCK FLOW DIAGRAM
PLANT STEAM BALANCE
CASE: WESTMORELAND COAL - 40% FINES - SNG
CROW TRIBE OF INDIANS SYNFUELS FEASIBILITY STUDY

NONE

835704-00-R-107

MICROFILM FRAME NO. 1 OF 2

1

001 35700107

2

6.1.9 UTILITY SUMMARY

Table 6.1.9-1 indicates the utilities generated or consumed by each process or utility unit in the Westmoreland Coal - 40% Fines-SNG Case.

TABLE 6.1.9-1

BASE CASE: WESTMORELAND COAL - 40% F

UTILITY SUMMARY

UNIT NO.	NAME	STEAM (M lb/hr) 1500 lb 925°F	650 lb Sat'd	600 lb 760°F	100 lb Sat'd	60 lb Sat'd	Condensate (M lb/hr)	
01	Coal Screening							
02	Coal Distribution							
03	Ash Handling							
10	Coal Gasification			-1,090.9	+566.6			
11	CO Shift							
12	Gas Cooling					+126.5		
13	Rectisol				-46.7	-91.7	+138.4	
14	Gas Liquor Separation							
15	Tar Distillation		-7.6			-7.3	+14.9	
16	Naphtha Hydrotreating		-10.2			-34.8	+45.0	
17	Phensolvan		-3.4		-5.7	-54.1	+54.4	
18	Ammonia Recovery		-80.0		-142.2		+222.2	
19	Sulfur Recovery				+21.9	-22.9	-26.8	
20	Process Steam Superheating		-722.8	+910.8				
21	Methanol Synthesis		(+2.8)					
22	Methanation		+817.2					
23	SNG Compression and Purification			-145.7	-4.4		+150.1	
24	Partial Oxidation		+6.8		+38.4			
25	PSA Hydrogen Production							
40	Oxygen Production	-1,222.2	+1,222.2					
41	Steam Generation	+4,121.4	-4,121.4(1)	+4,121.4	-322.4	+180.3	-882.8	
42	Power Generation	-2,899.2	+2,899.2(1)	-3,795.6	-87.4		+3,883.0	
43	Flue Gas Desulfurization							
44	Raw Water Treating							
45	BFW and Condensate Treating					-92.5	-5,004.9	+
46	Air and 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	Wastewater Treating					-2.5	+2.5	
55	Tank Farm and Dispatch				-10.8	-1.0	+9.7	
56	Sanitary Sewer							
	Steam Tracing				-7.3		+7.3	
	Export							
Total (Process Units)		0	0	-325.8	+427.9	-84.3	651.8	-
Total (Utility Units)		0	0	+325.8	-427.9	+84.3	-1,985.2	-
TOTAL		0	0	0	0	0	-1,333.4	

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

Note: (1) 650 psig/710°F steam
(2) Include in Wastewater Treating (Unit 54)

TABLE 6.1.9-1

BASE CASE: WESTMORELAND COAL - 40% FINES - SNG

UTILITY SUMMARY

STEAM (M lb/hr) 600 lb 760°F	100 lb Sat'd	60 lb Sat'd	Condensate (M lb/hr)	BFW (M lb/hr)	Steam and Condensate Loss (M lb/hr)	Cooling Water (MM Btu/hr)	(GPM)	Electric Power (MW)	Fuel Gas (MM Btu/hr)
								-1.00	
								-0.10	
								-0.70	
-1,090.9	+566.6			-690.7	1,215.0	-8.27	-551	-2.40	-0.7
		+126.5		-128.4	1.9	-9.14	-609	-0.35	
	-46.7	-91.7	+138.4	-37.9	37.9	-204.40	-13,613	-22.90	+329.7
						-83.30	-5,548	-0.69	
		-7.3	+14.9			-3.60	-240	-0.19	-12.2
		-34.8	+45.0			-3.10	-206	-0.19	(-1.4)
	-5.7	-54.1	+54.4		8.8	-11.7	-779	-0.67	
	-142.2		+222.2			-122.6	-8,165	-0.48	-
	+21.9	-22.9	-26.8	-29.3	3.5	-43.4	-2,900	-3.00	-11.6
+910.8				-190.0	2.0			-2.08	-340.1
				(-2.9)	(0.1)	-1.2	-80	-0.07	+9.1
				-829.5	12.3	-4.4	-293	-4.50	(-43.0)
-145.7	-4.4		+150.1			-153.2	-10,200	-0.25	
	+38.4			-79.8	34.6	-6.98	-465	-0.17	-0.1
						-0.37	-25	-0.60	+30.4
						-156.3	-10,400	-11.30	
[1] +4,121.4	-322.4	+180.3	-882.8	-3,108.9	12.4			32.50	
[1] -3,795.6	-87.4		+3,883.0			-2,434.2	-162,300	+404.70	
								-5.70	
								-1.67	
		-92.5	-5,004.9	+5,094.5	2.9			-6.00	
						-6.5	-433	-3.40	
						+2,279.8	+151,974	-10.00	
						-974.5	64,907	-0.40	
								-0.03	
								-0.03	
								-0.02	
								-	
								-0.03	-2.0
		-2.5	+2.5					-6.20	-2.5
	-10.8	-1.0	+9.7		2.1	-1.1	-74	0.55	
								(2)	
	-7.3		+7.3						
								+283.16	
-325.8	+427.9	-84.3	651.8	-1,985.6	1,316.0	-656.0	-4,3674	-40.34	+4.5
+325.8	-427.9	+84.3	-1,985.2	-1,985.6	17.4	+656.0	+43,674	+323.50	-4.5
0	0	0	-1,333.4	0	+1333.4	0	0	+283.16	0

ncluded in totals.

6.1.10 CATALYSTS AND CHEMICAL SUMMARY

The catalysts and chemicals required for each unit in the Westmoreland Coal 40 percent Fines-SNG Case are shown in Table 6.1.10-1. Initial and annual requirements and costs are provided.

The initial charge was based on the larger of the following requirements: initial fill requirement or one month inventory. For chemicals used in several units throughout the plant (sulfuric acid, caustic, and lime), two week capacity storage is provided.

TABLE 6.1.10-1

BASE CASE: WESTMORELAND COAL - 40% FINES-SNG

CATALYST AND CHEMICAL SUMMARY

Unit	Item	Unit Cost	Initial Charge	Initial Cost, $	Annual Consumption	Annual Cost, $
03	Ash Handling					
	Flocculent	$0.80/lb	185 lb	150	2,200 lb	1,760
11	CO Shift Conversion					
	Sour Shift Catalyst	$340/ft.^{3}	4,055 ft.^{3}	1,378,700	4,055 ft.^{3}	1,378,700
13	Rectisol					
	Propylene	$0.20/lb	183,000 lb	36,600	258,200 lb	51,600
	Caustic	-	-	-	-	89,400
16	Naphtha Hydrotreating					
	Dimethyl Sulfide	$0.37/lb	3,800 lb	1,400	1,520 lb	560
	Confidential Catalyst	$1.50/lb	38,900 lb	58,400	13,000 lb	19,500
17	Phenosolvan					
	Isopropylether Solvent	$0.19/lb	918,875 lb	174,600	318,794 lb	60,600
	Gravel	$0.023/lb	62,509 lb	1,440	7,814 lb	180
	Sand	$0.018/lb	177,817 lb	3,200	22,227 lb	400
	Filtrilur	$0.375/lb	187,525 lb	70,300	23,441 lb	8,790

TABLE 6.1.10-1 (Continued)

BASE CASE: WESTMORELAND COAL - 40% FINES-SNG

CATALYST AND CHEMICAL SUMMARY

Unit	Item	Unit Cost	Initial Charge	Initial Cost, $	Annual Consumption	Annual Cost, $
18	Ammonia Recovery					
	Phosphonic Acid (100%)	$730/ton	213 ton	155,500	102 ton	74,500
	Sodium Hydroxide (50% soln.)	$290/ton	1,656 ton	480,200	552 ton	160,100
19	Sulfur Recovery					
	Diisopropanolamine	$1.15/lb	4,460 lb	5,130	2,200 lb	2,530
	Claus Catalyst	$0.48/lb	39,170 lb	18,800	13,100 lb	6,290
	Shell 634 Catalyst	$2.70/lb	17,660 lb	47,700	5,890 lb	15,900
	Citric Acid	$0.71/lb	8,600 lb	6,110	18,500 lb	13,100
	ADA	$5.95/lb	10,300 lb	61,300	22,000 lb	130,900
	Caustic (50%)	$145/ton	40 ton	5,800	(400 ton)	(58,000)
	Vanadium	$7.00/lb	6,900 lb	48,300	-	-
21	Methanol Synthesis					
	Synthesis Catalyst	$440/ft.^{3}	936 ft.^{3}	411,800	312 ft.^{3}	137,300

TABLE 6.1.10-1 (Continued)

BASE CASE: WESTMORELAND COAL - 40% FINES-SNG

CATALYST AND CHEMICAL SUMMARY

Unit	Item	Unit Cost	Initial Charge	Initial Cost, $	Annual Consumption	Annual Cost, $
22	Methanation					
	Synthesis Catalyst	$400/ft.^{3}	6,250 ft.^{3}	2,500,000	6,250 ft.^{3}	2,500,000
41	Steam Generation					
	Hydrazine Hydrate	$2.50/lb	347 lb	870	3,817 lb	9,540
	Sodium Phosphate	$925/ton	0.1 ton	90	1 ton	930
	Morpholine	$1.04/lb	7,157 lb	7,440	79,200 lb	82,400
43	Flue Gas Desulfurization					
	Lime (90% CaO)	$32/ton	772.3 ton	24,700	35,000 ton	1,120,000
	Formic Acid (90% Soln.)	$710/ton	50.2 ton	35,600	464.8 ton	330,000
	Anti Foulant (Nalco 7319)	$1.28/lb	250 lb	320	2,655 lb.	3,400
	HCL (30% Soln.)	$60/ton	103 ton	6,180	-	-

TABLE 6.1.10-1 (Continued)

BASE CASE: WESTMORELAND COAL - 40% FINES-SNG

CATALYST AND CHEMICAL SUMMARY

Unit	Item	Unit Cost	Initial Charge	Initial Cost, $	Annual Consumption	Annual Cost, $
44,45 & 49	Raw Water, BFW Treating and Potable Water					
	Polyelectrolyte	$1.00/lb	3,800 lb	3,800	45,400 lb	45,400
	Chlorine	$145.00/ton	26 ton	3,770	314 ton	45,400
	Quick Lime	$32.50/ton	97 ton	3,150	234 ton	7,610
	Soda Ash (Dense Bulk)	$86.00/ton	320 ton	27,500	12,100 ton	1,040,600
	Alum	$121.00/ton	25 ton	3,030	41 ton	4,960
	Hexametaphosphate	$765.00/ton	10 ton	7,650	12.1 ton	92,600
	Sulfuric Acid (93%)	$70.13/ton	300 ton	21,000	1,300 ton	91,200
	Caustic (50% Soln.)	$290/ton	400 ton	116,000	1,600 ton	464,000
	Activated Carbon	$1,500/ton	40.1 ton	60,200	20 ton	30,000
	Hydrazine Hydrate	$2.50/lb	172 lb	430	1,900 lb	4,750
	Morpholine	$1.04/lb	3,430 lb	3,570	37,970 lb	39,500
	Chelant (EDTA)	$0.48/lb	1,713 lb	820	18,960 lb	9,100
46	Air and Nitrogen System					
	Activated Alumina	$320/ton	3.6 ton	1,150	1 ton	320

TABLE 6.1.10-1 (Continued)

BASE CASE: WESTMORELAND COAL - 40% FINES-SNG

CATALYST AND CHEMICAL SUMMARY

Unit	Item	Unit Cost	Initial Charge	Initial Cost, $	Annual Consumption	Annual Cost, $
47	Process Cooling Water	$145/ton	35 ton	5,080	417 ton	60,500
	Chlorine	$70.13/ton	14 ton	980	4,580 ton	321,200
	Sulfuric Acid (93%)	$1.40/lb	8,950 lb	12,500	107,400 lb	150,400
	Inhibitor	$0.96/lb	3,560 lb	3,420	42,600 lb	40,900
	Dispersant	$2.75/lb	5,100 lb	14,000	24,600 lb	67,700
	Biocide	$1.48/lb	61,400 lb	90,900	160 lb	240
	Nalprep	$1500/ton	35.6 ton	53,400	17.8 ton	26,700
	Activated Carbon	$765/ton	4.4 ton	3,370	51.7 ton	39,600
	Hexametaphosphate					
48	Utility Cooling Water					
	Chlorine	$145/ton	24 ton	$ 3,480	285 ton	41,300
	Sulfuric Acid (93%)	$70.13/ton	222 ton	15,600	2,640 ton	185,100
	Inhibitor	$1.40/lb	4,230 lb	5,920	50,700 lb	71,000
	Dispersant	$0.96/lb	1,690 lb	1,620	20,300 lb	19,500
	Biocide	$2.75/lb	1,720 lb	4,730	8,900 lb	24,500
	Nalprep	$1.48/lb	21,900 lb	32,400	60 lb	90
	Poly-Electrolyte	$1.00/lb	1,330 lb	1,330	15,900 lb	15,900
	Quick Lime	$32.50/ton	34 ton	1,110	82 ton	2,670
	Soda Ash (Dense Bulk)	$86.00/ton	110 ton	9,460	4,240 ton	364,600

TABLE 6.1.10-1 (Continued)

BASE CASE: WESTMORELAND COAL - 40% FINES-SNG

CATALYST AND CHEMICAL SUMMARY

Unit	Item	Unit Cost	Initial Charge	Initial Cost, $	Annual Consumption	Annual Cost, $
54	Wastewater Treating	$290/ton	530 ton	153,700	11,900 ton	3,451,000
	Caustic (50%)	$70.13/ton	70 ton	4,910	1,700 ton	119,200
	Sulfuric Acid (93%)	$1.00/lb	210 lb	210	25,200 lb	25,200
	Poly-electrolyte	$730/ton	5 ton	3,650	56 ton	40,900
	Phospheric Acid (100%)					
55	Tank Farm and Dispatch					
	SNG Odorant (Ethyl/Amyl Mercaptan)	$1.00/lb	140 lb	$ 140	1,690 lb	1,690
	NaCl	$80/ton	20 tons	1,600	5,310 ton	424,800
		TOTAL		$6,216,210		$13,568,610

6.1.11 OPERATING MANPOWER

Table 6.1.11-1 lists the operating manpower for the plant. The units have been grouped into operating areas to assist in determining general supervision requirements.

The operation staff includes shift operators, shift foreman, superintendents and technical staff.

Included with operating manpower is Plant General personnel consisting of laboratory, fire and safety, security, inventory control/accounting and other general services.

Not included with operating manpower are maintenance manpower (described in Section 6.1.12) and plant staff of 20 positions. Plant staff includes the plant manager, area managers, staff accountants, personnel, process engineering and managers' secretaries.

TABLE 6.1.11-1
OPERATING MANPOWER
Base Case: Westmoreland Coal-40% Fines-SNG

Area	Unit No.	Description	Manpower Requirements: Supervision	Shift Operators	Total[1] Operating
1	01, 02, 03, 54, 56	Coal Screening, Coal Distribution, Ash Handling, Wastewater Treating, Sanitary Waste Treatment	2	7	30
2	10, 11, 12, 14	Coal Gasification, CO Shift, Gas Cooling, Gas Liquor Separation	3	12	51
3	13, 22, 23, 52	Rectisol, Methanation, SNG Purification and Compression, Fuel Gas	2	7	30
4	17, 18, 19, 20	Phenosolvan, Ammonia Recovery, Sulfur Recovery, Process Steam Superheating	2	7	30
5	15, 16, 21, 24	Tar Distillation, Naphtha Hydrotreating, Methanol Synthesis, Partial Oxidiation, PSA Hydrogen Production	1	5	21
6	40, 44, 45, 46 48, 49, 50, 51	Oxygen Production, Raw Water Treatment, BFW and Condensate Treatment, Air and Nitrogen Systems, Utility Cooling Water, Potable Water, Utility Water, Firewater	2	8	34
7	41, 42, 43	Steam Generation, Power Generation, Flue Gas Desulfurization	2	7	30
8	47, 53, 55, 57	Process Cooling Water, Flare, Tank Farm, Interconnecting Piping	2	5	22
Subtotal Operating			16	58	248.
General		Day Shift Only Operators, Laboratory, Fire & Safety, Security, Inventory Control/Accounting, General Services	Staff and Day Shift Only: 48	Shift Positions: 30	Total[1] General: 168.
Total Staff					416.

NOTE (1) Total includes four operators to fill each shift position.

6.1.12 MAINTENANCE MANPOWER

Annual maintenance costs have been estimated by applying a factor to the installed cost of each unit. This factor varies from four percent for units with high maintenance requirements (Gasification and Tar Distillation) to one percent for several utility/offsite units. The majority of the process units are set at three percent and the majority of the utility units are set at two percent.

For the Westmoreland Coal 40 percent Fines SNG Case, the annual maintenance cost is estimated at $36,100,000. This total cost is assumed to be 60 percent materials and 40 percent labor.

Using an average labor rate (including overheads) of $35,000 per annum for each maintenance staff position, the total maintenance manpower equals 413.

The maintenance staff includes maintenance personnel, laborers, craft foremen, plant engineering, purchasing and warehouse personnel.

6.2 BASE CASE PROCESS UNITS - ENGINEERING DATA

6.2.1 COAL SCREENING - UNIT 01

6.2.1.1 DESIGN BASIS

Purpose of Unit

The Coal Screening unit receives 2 inch and smaller sized coal from the mine by unit trains and stores the coal in a five day live storage pile. The unit screens the coal into coarse coal (2 inch x 1/4 inch) for gasifier feed and fines (less than 1/4 inch) for boiler feed.

Scope of Unit

The unit includes coal receiving, live storage, emergency storage, reclaiming, screening and conveying.

General Design Criteria

Crushed coal of 2 inch x 0 size from the mine is transported to the unit by railroad. Coal receiving is designed to receive coal based on five day per week mine operation. The coal is screened into two size fractions: 2 inch x 1/4 inch coal suitable for Lurgi gasifiers and the remaining 1/4 inch x 0 fines for feed to the boilers. Two 66 percent trains of screening are provided in the unit. The unit is designed based on 60 wt percent coarse coal and 40 wt percent fines. The unit conveys both fractions to the Coal Distribution unit which subsequently delivers them to the gasification and boiler facilities. The unit also provides 5 days covered live storage and 30 days buried emergency storage of feed coal. Associated conveying and reclaiming equipment are included in the unit. Dust collection equipment is provided to minimize particulate emissions, and surface water runoff is impounded. The facility is designed to minimize coal fines generation.

6.2.1.1 (Continued)

General Design Criteria

The unit is provided with sufficient standby capacity to be compatible with the overall plant stream factor of 332 days per year. All rotating equipment in the unit are motor driven. The entire unit is protected against fire hazard by appropriate automatic sprinkler systems.

Feedstock (Base Case: Westmoreland Coal - 40% Fines - SNG)

Crushed Coal from Mine

Feed Rate	18,000 ST/D @ 2 inch x 0 size

Westmoreland Coal Analysis (by Lurgi)

Proximate (As Rec'd.)	wt%	Ultimate (DAF)	wt%
Moisture	26.0	Carbon	75.98
Ash	7.4	Hydrogen	4.59
Volatiles	26.5	Nitrogen	1.09
Fixed Carbon	40.1	Sulfur	1.23
	100.0	Chlorine	0.03
		Oxygen	17.08
			100.00

Products (Screening Unit)

		Fraction
Coarse Coal to Gasifiers		
Production Rate	10,800 ST/D @ 2 x 1/4 inch size	60 wt%
Coal Fines to Boilers		
Production Rate	7,200 ST/D @ 1/4 x 0 inch size	40 wt%

Utility Requirements

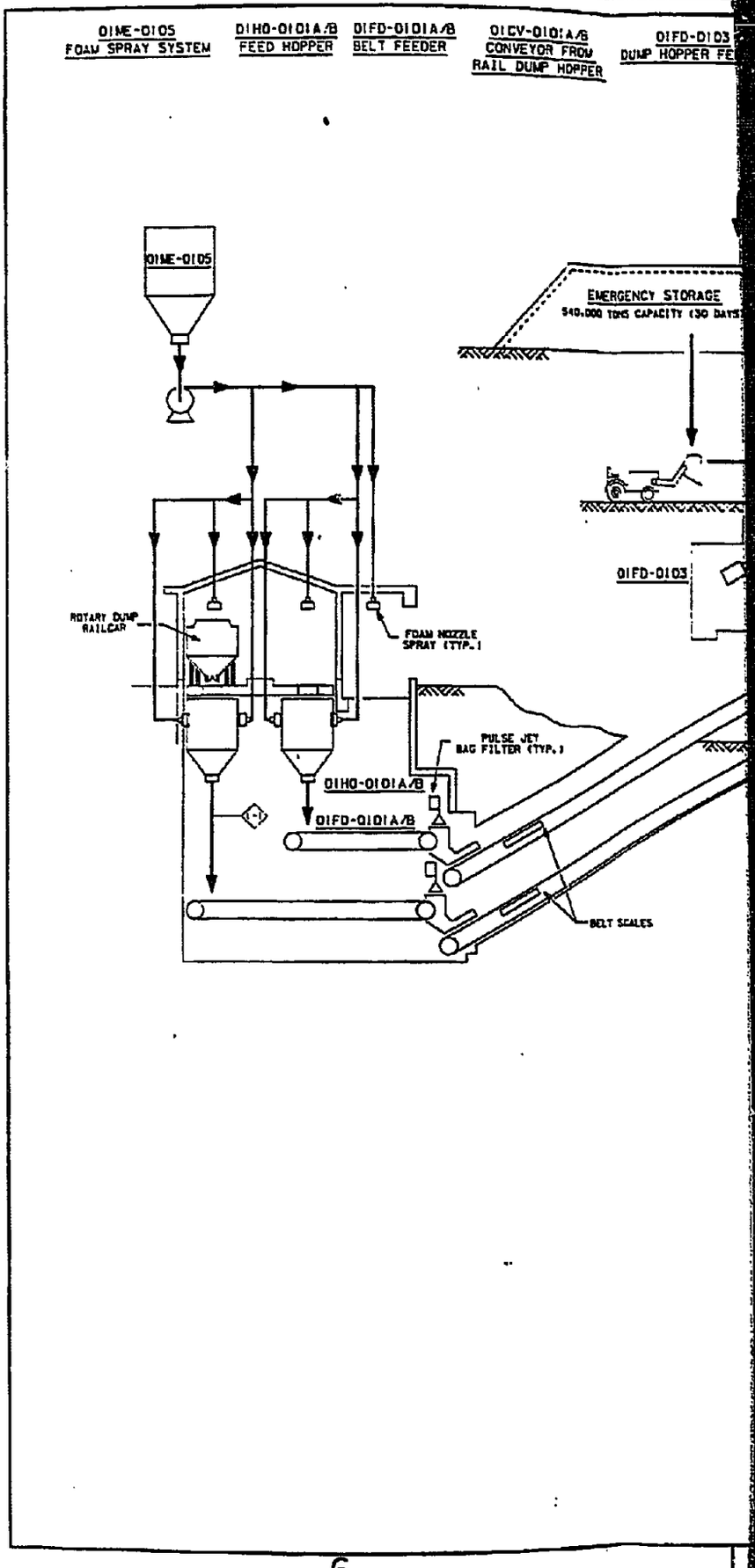
Electric Power	1,000 kW

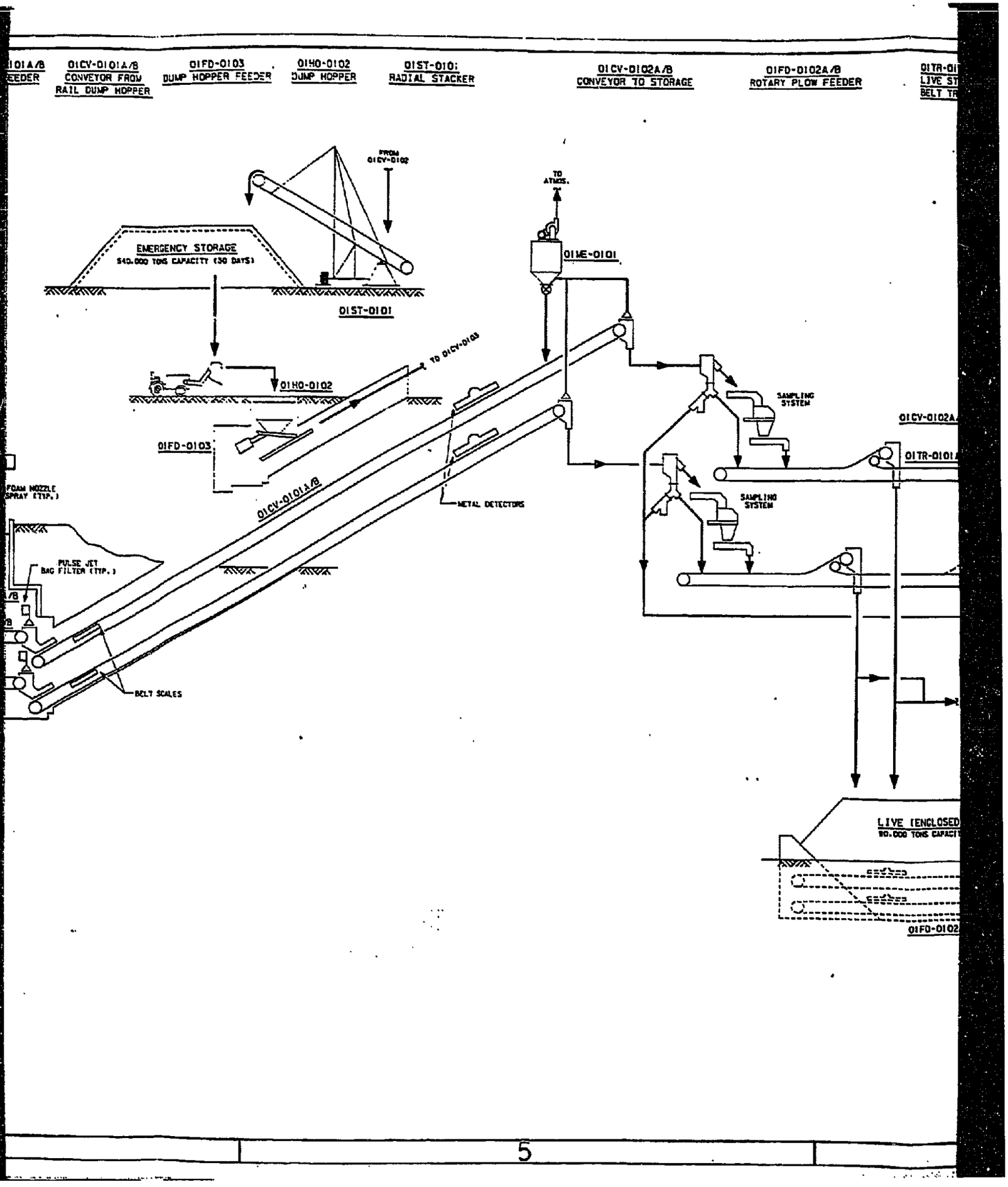
6.2.1.2 PROCESS DESCRIPTION

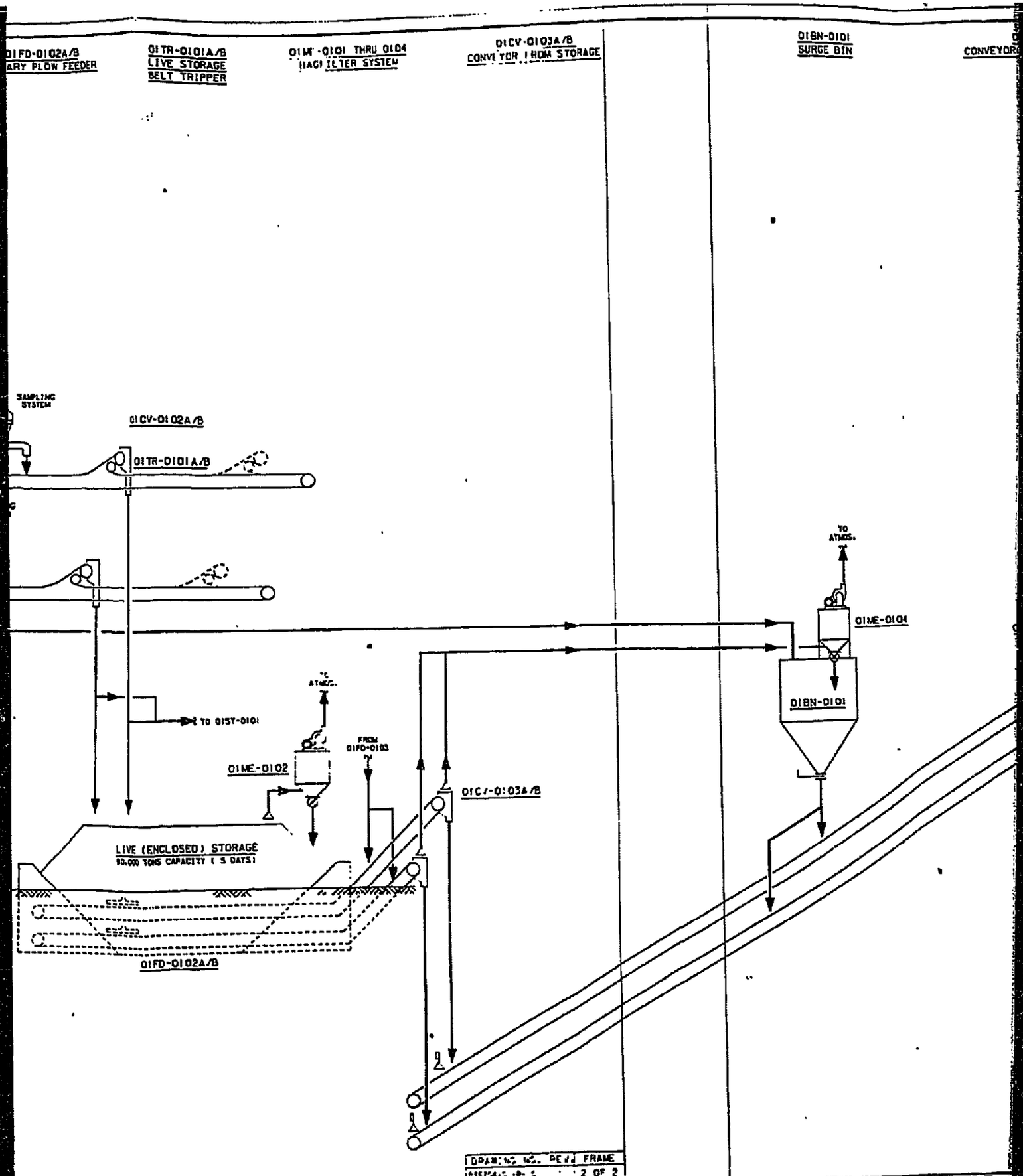
Drawing No. 835704-01-R-101 is the process flow sketch for the Coal Screening Unit. Material balance for the unit (Table 6.2.1-1) follows the process flow sketch. The plot plan is shown on Drawing No. 835740-01-4-050. The equipment list is included as Table 6.2.1-2.

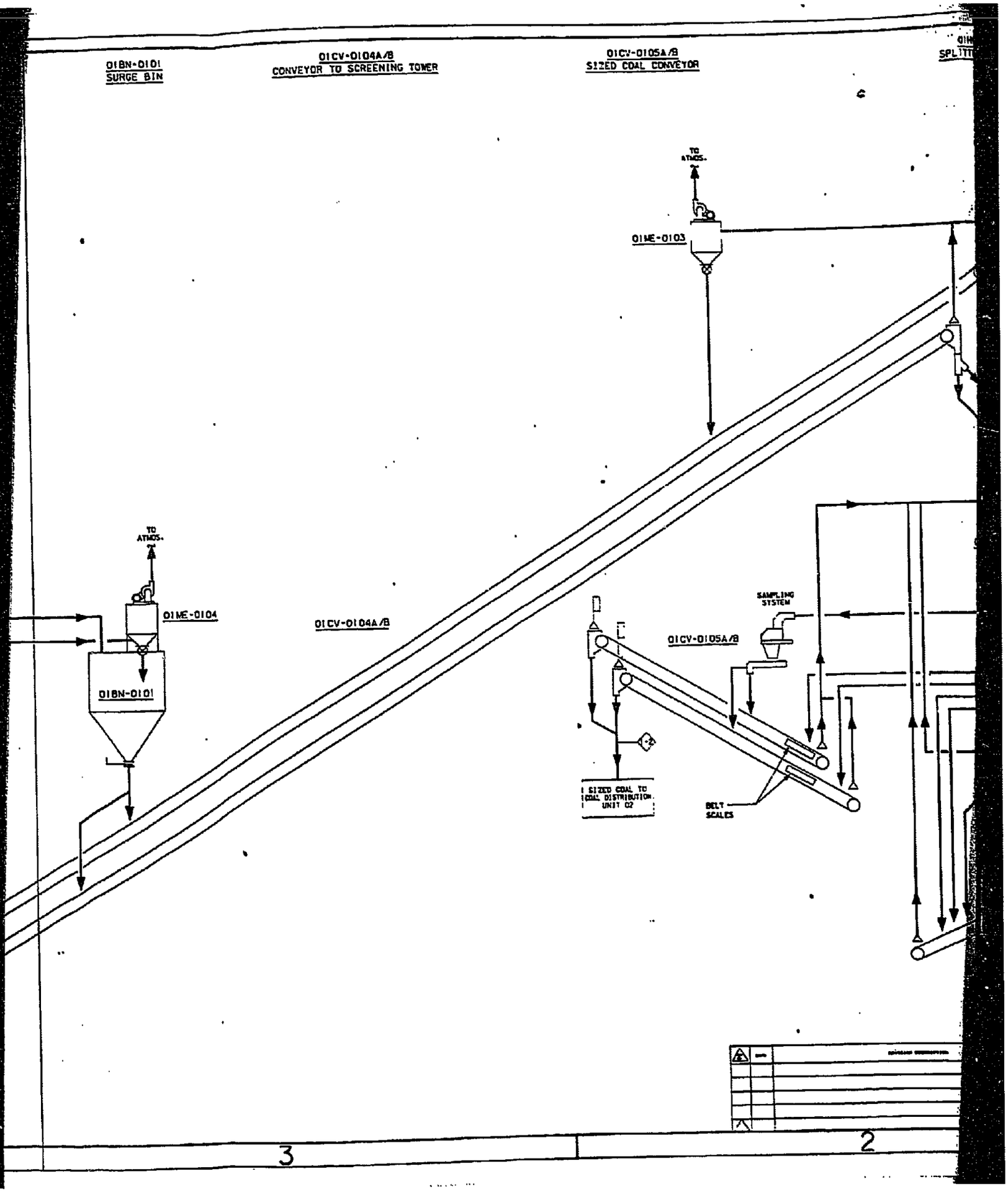
Crushed coal of 2 inch x 0 size is delivered to the plant site by railcars. Coal unloading portion of the unit operates 24 hours per day, five days a week which corresponds to the mine operating schedule. Coal is conveyed from the coal receiving building to either live or emergency storage. Enclosed live storage capacity for normal plant consumption for five days and buried emergency storage for consumption for 30 days are provided within the unit. Coal is reclaimed from storage and transferred to the screening surge bin. The surge bin provides temporary storage of the coal prior to being conveyed to the screening tower. In the screening tower, adjustable vibrating screens classify the feed coal into a 2 inch x 1/4 inch size fraction and a 1/4 inch x 0 size fraction. The two sized materials leave the unit battery limit by separate conveyors to the Coal Distribution Unit 02. Coal samplers are provided in the screening tower for sampling coarse and fine coal.

Coal dust emissions from the unit are kept to a minimum by several bag-house filter systems provided in the storage buildings and all coal transfer points. All conveyors and bag filters are protected against fire hazard by appropriate automatic sprinkler systems.


01ME-0105
FOAM SPRAY SYSTEM
01HO-0101A/B
FEED HOPPER
01FD-0101A/B
BELT FEEDER
01CV-0101A/B
CONVEYOR FROM
RAIL DUMP HOPPER
01FD-0103
DUMP HOPPER FE
01ME-0105
EMERGENCY STORAGE
540,000 TONS CAPACITY (30 DAYS
01FD-0103
ROTARY DUMP
RAILCAR
FOAM NOZZLE
SPRAY (TYP.)
PULSE JET
BAG FILTER (TYP.)
01HO-0101A/B
01FD-0101A/B
BELT SCALES


01ICV-0101A/B
CONVEYOR FROM
RAIL DUMP HOPPER
01FD-0103
DUMP HOPPER FEEDER
01HO-0102
DUMP HOPPER
01ST-0101
RADIAL STACKER
01CV-0102A/B
CONVEYOR TO STORAGE
01FD-0102A/B
ROTARY PLOW FEEDER
FROM 01CV-0102
EMERGENCY STORAGE
540,000 TONS CAPACITY (30 DAYS)
01ST-0101
TO ATMOS.
01ME-0101
TO 01CV-0103
01HO-0102
01FD-0103
01CV-0101A/B
FOAM NOZZLE SPRAY (TYP.)
PULSE JET BAG FILTER (TYP.)
METAL DETECTORS
BELT SCALES
SAMPLING SYSTEM
SAMPLING SYSTEM
01CV-0102A
01TR-0101A
LIVE (ENCLOSED
80,000 TONS CAPACI
01FD-0102


01FD-0102A/B
ARY PLOW FEEDER
01TR-0101A/B
LIVE STORAGE
BELT TRIPPER
01ME-0101 THRU 0104
BAG FILTER SYSTEM
01CV-0103A/B
CONVEYOR FROM STORAGE
01BN-0101
SURGE BIN
CONVEYOR
SAMPLING SYSTEM
01CV-0102A/B
01TR-0101A/B
TO ATMOS.
01ME-0104
01BN-0101
TO 01ST-0101
TO ATMOS.
FROM 01FD-0103
01ME-0102
01CV-0103A/B
LIVE (ENCLOSED) STORAGE
80,000 TONS CAPACITY (5 DAYS)
01FD-0102A/B
DRAWING NO. REV. FRAME
2 OF 2


01BN-0101
SURGE BIN
01CV-0104A/B
CONVEYOR TO SCREENING TOWER
01CV-0105A/B
SIZED COAL CONVEYOR
SPLITT
TO ATMOS.
01ME-0103
TO ATMOS.
01ME-0104
01CV-0104A/B
01BN-0101
01CV-0105A/B
SAMPLING SYSTEM
SIZED COAL TO COAL DISTRIBUTION UNIT 02
BELT SCALES

3

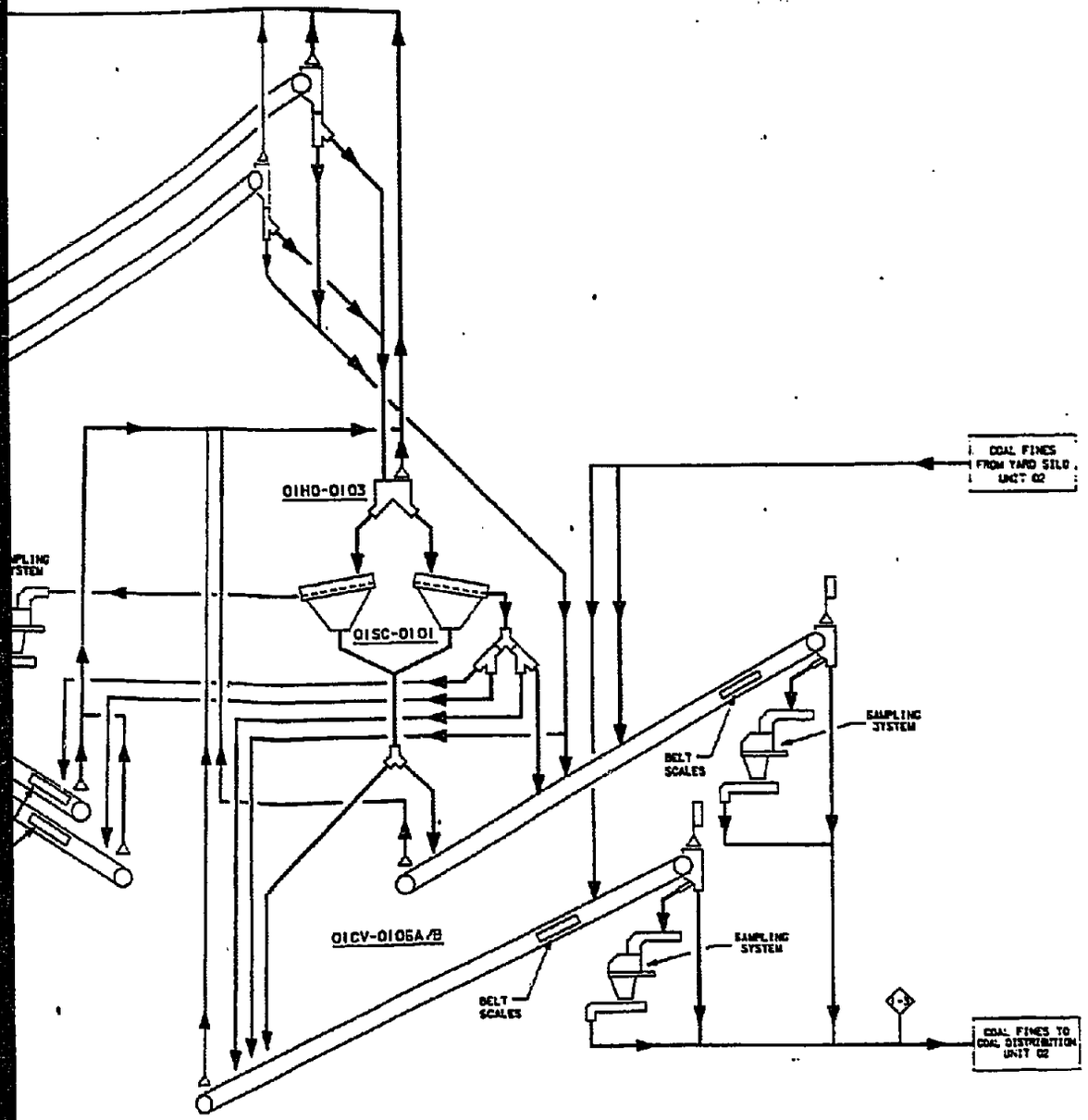
2

01HO-0103
SPLITTER HOPPER

01SC-0101
ADJUSTABLE VIBRATING SCREEN

01CV-0106A/B
COAL FINES CONVEYOR

SEE DISCUSSION OF WEIGHT DATA IN SECTION 2.4 OF THE MAIN BODY OF THE REPORT



NOTE:

FLOW QUANTITIES REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.

FLUOR

DRAWN	R. WHITE
DESIGNED	R.C. ABATAY
CHECKED	R. O'BELMITO
ENGINEER	R. McCARTHY
PROJECT MANAGER	R. LANG

PROCESS FLOW DIAGRAM
COAL SCREENING
UNIT 01

CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE

835704-01-R-101 — 1

MICROFILM FRAME 1 OF 2

003 3570110101

2

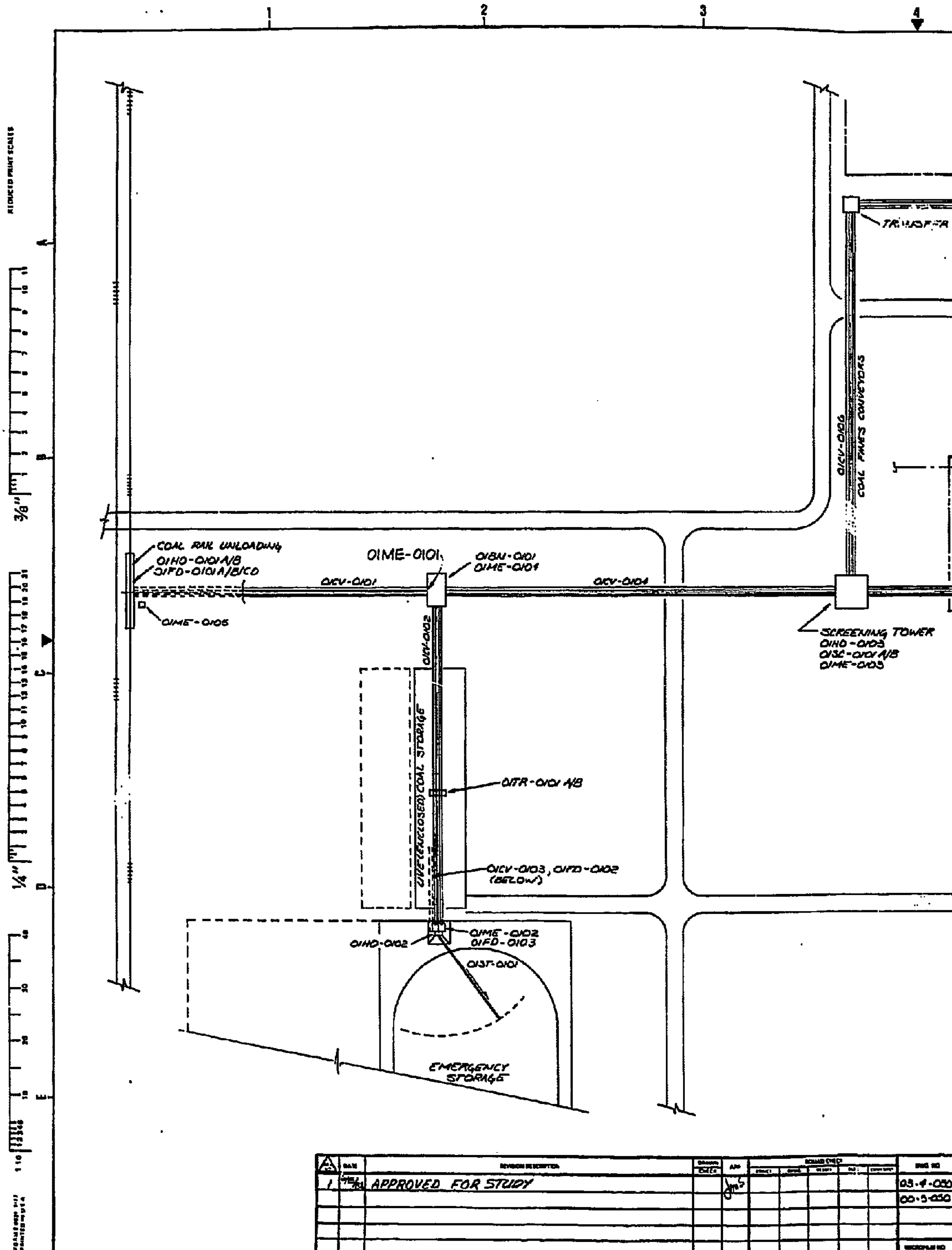
TABLE 6.2.1-1

MATERIAL BALANCE

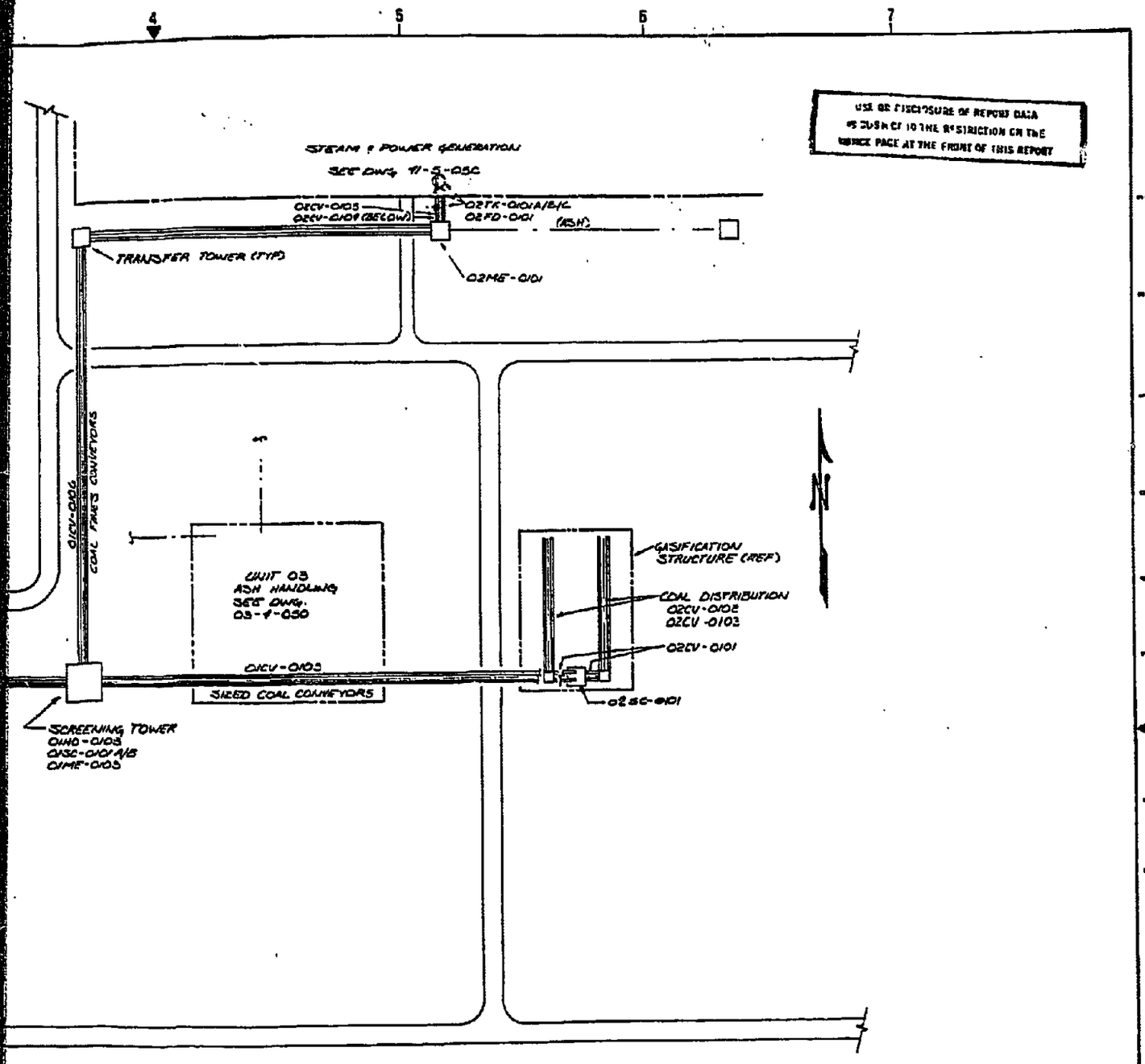
COAL SCREENING - UNIT 01

Stream Number	1-1	1-2	1-3
Stream Name	Total Coal Feed	Sized Coal To Gasification	Coal Fines To Boilers
DAF Coal, lb/hr	999,000	599,400	399,600
Moisture, lb/hr	390,000	234,000	156,000
Ash, lb/hr	111,000	66,600	44,400
Total, lb/hr	1,500,000	900,000	600,000
ST/SD	18,000	10,800	7,200

NOTE: Flow quantities 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.



COAL RAIL UNLOADING
01HO-0101A/B
01FD-0101A/B/C/D
01ME-0105
01ME-0101
01BM-0101
01ME-0101
01CV-0101
01CV-0104
01CV-0102
TRANSFER TO
01CV-0106
COAL FINES CONVEYORS
SCREENING TOWER
01HO-0103
01SC-0101A/B
01ME-0103
01TR-0101 A/B
01CV-0103, 01FD-0102
(BELOW)
01ME-0102
01FD-0103
01HO-0102
01ST-0101
EMERGENCY
STORAGE
REDUCED PRINT SCALES
3/8"
1/4"
APPROVED FOR STUDY
03-4-030
00-5-030



DWG NO	
03-1-050	PLOT PLAN - UNIT 03
00-1-050	SITE #1 PLOT PLAN

FLUOR

R MILLER
E. MOESTL
CONJT
SMETS
R LAIN

PLOT PLAN - UNITS 01 & 02
COAL HANDLING
CROW TRIBE OF INDIANS MONTANA

SCALE 1" = 100'
835704-01-4-050
REVISION 1

TABLE 6.2.1-2

EQUIPMENT LIST

COAL SCREENING - UNIT 01

Item No.	Equipment Name	Number Required Operating	Spare
01CV-0101 A/B	Conveyor from Rail Dump Hopper	1	1
01CV-0102 A/B	Conveyor to Storage	1	1
01CV-0103 A/B	Conveyor from Storage	1	1
01CV-0104 A/B	Conveyor to Screening Tower	1	1
01CV-0105 A/B	Sized Coal Conveyor	1	1
01CV-0106 A/B	Coal Fines Conveyor	1	1
01SC-0101	Adjustable Vibrating Screens	1	1
01FD-0101 A/B	Belt Feeders	2	2
01FD-0102 A/B	Live Storage Plow Feeder	1	1
01FD-0103	Dump Pit Hopper Belt Feeder	1	0
01HO-0101 A/B	Railcar Rotary Dump Feed Hopper	1	1
01HO-0102	Emergency Storage Dump Hopper	1	0
01HO-0103	Splitter Hopper to Screen	1	0
01BN-0101	Surge Bin to Screening	1	0

TABLE 6.2.1-2 (Continued)

EQUIPMENT LIST

COAL SCREENING - UNIT 01

Item No.	Equipment Name	Number Required	
		Operating	Spare
01TR-0101 A/B	Live Storage Belt Tripper	1	1
01ST-0101	Radial Stacker to Emergency Storage	1	0
01ME-0101 thru 0104	Bag Filter System	1	0
01ME-0105	Foam Spray System	1	0

NOTE: Other miscellaneous equipment include sampling systems, front end loader from emergency storage, metal detectors and belt scales.

6.2.2 COAL DISTRIBUTION - UNIT 02

6.2.2.1 DESIGN BASIS

Purpose of Unit

The unit receives sized coal and fines from the Coal Screening Unit 01 and distributes them respectively to the Coal Gasification and Steam Generation units.

Scope of Unit

The unit includes distribution of the two coal fractions to the appropriate user units.

General Design Criteria

The unit consists of two separate conveying systems, one each for the sized coal and the fines. A 100 percent spare capacity is provided in both systems. The unit stream factor is compatible with the overall plant stream factor of 332 days per year. One day storage of coal fines and transfer equipment to boiler structure are provided within the unit. The coarse coal conveying equipment is designed to minimize generation of coal fines. The facility conforms to local environmental regulations regarding dust emissions. The system conforms to conveyor equipment manufacture association standards. All rotating equipment in the unit are motor driven. The conveyors are protected against fire hazard by appropriate automatic sprinkler systems.

Feedstock

Coarse Coal

Feed Rate 10,800 ST/D @ 2 inch x 1/4 inch size

6.2.2.1 (Continued)

Coal Fines

Feed Rate 7,200 ST/D @ 1/4 inch x 0 size

Products

Coarse Coal to Gasifiers

10,800 ST/D @ 2 inch x 1/4 inch size

Coal Fines to Boilers

7,200 ST/D @ 1/4 inch x 0 size

Utility Requirements

Electric Power 1000 kW

6.2.2.2 PROCESS DESCRIPTION

Drawing No. 835704-02-4-101 is the process flow sketch for this unit. The coal feed rates are given in Table 6.2.2-1. The equipment list follows as Table 6.2.2-2.

The Coal Distribution unit receives sized coal (2 inch x 1/4 inch) and fines (1/4 inch x 0) from the Screening Unit 01 by separate conveyors.

Gasifier Coal

Gasifier Transfer Conveyors (01CV-0105 A/B) deliver sized coal via a belt weigher onto the covered Distribution Conveyors which run atop the gasifier structure along the two parallel rows of gasifiers. Each of the two Transfer Conveyors and two Distribution Conveyors is capable of handling the entire coal feed rate to the gasifiers, thus ensuring uninterrupted coal supply in the event of breakdown of any of the conveyors. The four Gasifier Tripper feed conveyors transfer the coal from any of the four distribution conveyors to the individual gasifier bunkers located above the coal feed locks.

6.2.2.2 (Continued)

Boiler Coal

The fine coal (1/4 inch x 0) from the Screening unit is delivered to the Fines Conveyor or, in the event of boiler or conveyor disorder, to the yard silos in Unit 02. One day boiler coal consumption capacity is provided in the yard silos. Coal from the silos may be transferred to the fines conveyor from the bottom via vibrating feeders. The fines conveyor delivers the coal to the surge hoppers located on top of the boiler structure in Unit 41. Emissions from the transfer points are controlled by a bag filter system.

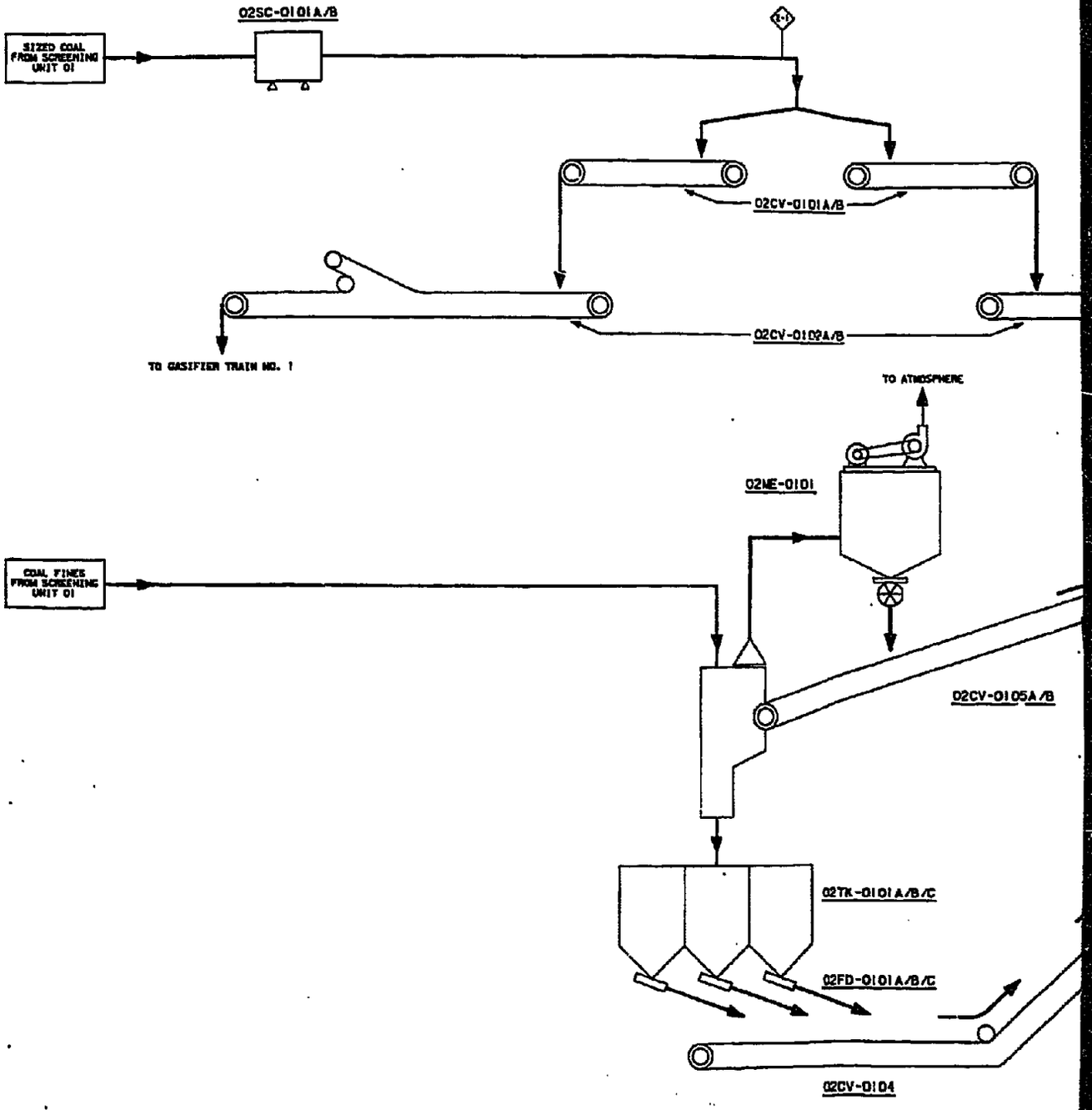
02SC-0101A/B
GASIFIER COAL BELT WEIGHER

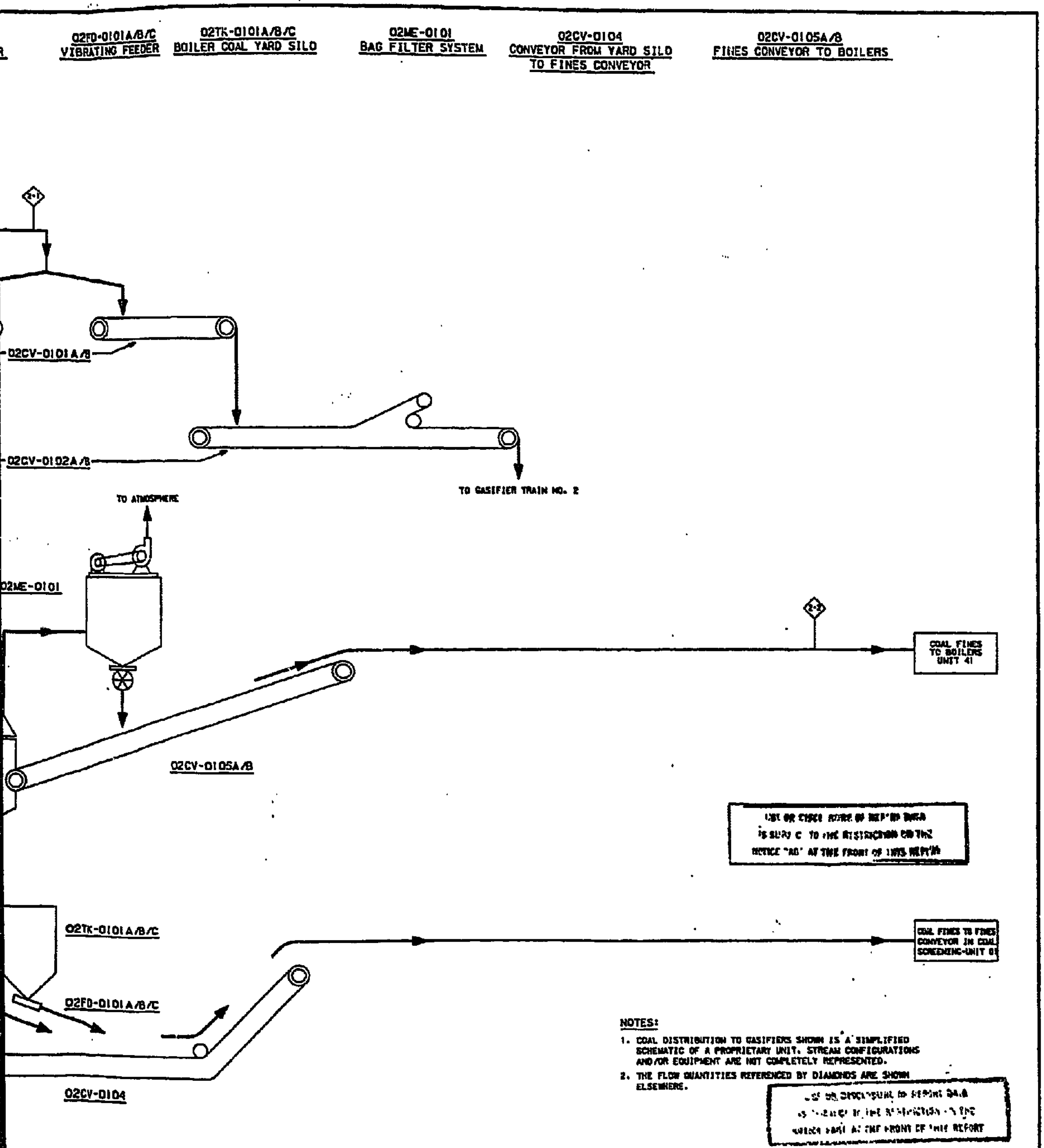
02CV-0101A/B
GASIFIER DISTRIBUTION CONVEYOR

02CV-0102A/B
GASIFIER TRIPPER FEED CONVEYOR

02FD-0101A/B/C
VIBRATING FEEDER

02TK-0101A
BOILER COAL YA




02FD-0101A/B/C
VIBRATING FEEDER
02TK-0101A/B/C
BOILER COAL YARD SILO
02ME-0101
BAG FILTER SYSTEM
02CV-0104
CONVEYOR FROM YARD SILO TO FINES CONVEYOR
02CV-0105A/B
FINES CONVEYOR TO BOILERS
02CV-0101A/B
02CV-0102A/B
TO GASIFIER TRAIN NO. 2
TO ATMOSPHERE
02ME-0101
COAL FINES TO BOILERS UNIT 41
02CV-0105A/B
02TK-0101A/B/C
COAL FINES TO FINES CONVEYOR IN COAL SCREENING-UNIT 01
02FD-0101A/B/C
02CV-0104
NOTES:
1. COAL DISTRIBUTION TO GASIFIERS SHOWN IS A SIMPLIFIED SCHEMATIC OF A PROPRIETARY UNIT. STREAM CONFIGURATIONS AND/OR EQUIPMENT ARE NOT COMPLETELY REPRESENTED.
2. THE FLOW QUANTITIES REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.

FLUOR

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

PROCESS FLOW DIAGRAM
COAL DISTRIBUTION
UNIT 02

CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-02-4-101 | 1

TABLE 6.2.2-1

MATERIAL BALANCE

COAL DISTRIBUTION - UNIT 02

Stream Number	2-1	2-2
Stream Name	Sized Coal To Gasification	Coal Fines To Boilers
DAF Coal, lb/hr	599,400	399,600
Moisture, lb/hr	234,000	156,000
Ash, lb/hr	66,600	44,400
Total, lb/hr	900,000	600,000
ST/SD	10,800	7,200

NOTE: Flow quantities 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 6.2.2-2

EQUIPMENT LIST

COAL DISTRIBUTION - UNIT 02

Items No.	Equipment Name	Number Required Operating	Spare
02CV-0101 A/B(1)	Gasifier Distribution Conveyor	2	2
02CV-0102 A/B(1)	Gasifier Tripper Feed Conveyor	2	2
02SC-0101 A/B	Gasifier Coal Belt Weigher	1	1
02TK-0101 A/B/C	Boiler Coal Yard Silo	0	3
02FD-0101 A/B/C	Coal Yard Silo Vibrating Feeder	0	3
02CV-0104	Conveyor from Yard Silo to Fines Conveyor	0	1
02CV-0105 A/B	Fines Conveyor to Boilers	1	1
02ME-0101	Bag Filter System	1	0

Note (1) Train No. 2 equipment numbers which are not shown are the the same as indicated above except the train designation is 02 instead of 01.

Example:	Train No. 1	Train No. 2
	02CV-0101 A/B	02CV-0201 A/B

6.2.3 ASH HANDLING - UNIT 03

6.2.3.1 DESIGN BASIS

Purpose of Unit

The Ash Handling unit receives coal ash from the Coal Gasification, POX and Steam Generation units and sludge from Flue Gas Desulfurization unit, dewaters wet ash as necessary and transports the ash/sludge to plant battery limits for disposal.

Scope of Unit

The unit includes ash collection, dewatering, surge storage, and transportation to plant battery limits.

General Design Criteria

Gasifier Ash

The gasifier ash handling is by the wet slurry method. The slurry is approximately 5 percent wt. solids, with a maximum, for design, solids content of 15 percent wt. Each gasifier has a dedicated sluiceway directly underneath the ash lock. Each sluiceway is suitably sloped and lined. Six exit sluiceways (four operating and two spare) receive the slurry from all fourteen gasifiers and deliver it to the ash dewatering plant. The small quantity of POX ash (about 0.25 T/D) is also transported by a single sluiceway to the dewatering plant. The dewatering plant consists of six desliming screens (four operating and two spare), two coarse ash conveyors and fine ash dewatering trains complete with cyclones, cone thickeners, screens and ash conveyor.

6.2.3.1 (Continued)

Boiler Ash

Boiler ash consists of bottom ash and fly ash (electrostatic precipitator ash). Each boiler is equipped with a dedicated bottom ash collection, wet transport and dewatering system. One operating train (and a spare train) of pneumatic transport and conditioning system are provided for the fly ash.

FGD Sludge

A single train conveying system delivers the sludge from the FGD unit to the collecting conveyor.

Ash Storage/Disposal

A single train conveyor system (with a spare) collects the gasifier and boiler ash and FGD sludge and transports this material to the stockpile where five days covered storage is provided. A single train reclaiming and conveyor system (with a spare) transfers the solid waste from the stockpile to the plant battery limits for disposal by others.

Sufficient spare capacity is included for all equipment in critical service. The onstream factor for the unit is compatible with the overall plant stream factor of 332 days per year. All rotating equipment in the unit are motor driven. Particulate pollutants generated from the conveyance and handling of ash conform to applicable environmental regulations. Winterization to -30°F is considered in the plant design. Fire protection in the conveying system is provided by automatic sprinklers.

6.2.3.1 (Continued)

Ash Handling Design Capacities

	Tons per day (dry)		
	Average	Max	Moisture, wt%
Gasifier Ash	827	1730	32.8
Boiler Ash	531	620	15
FGD Sludge	293	293	23
Aggregate Ash to Solid Waste Disposal	1656		26.2

Utility Requirements

Electric Power	700 kW
Raw Water Makeup	83 gpm

6.2.3.2 PROCESS DESCRIPTION

The process flow sketch for the Ash Handling unit is presented on Drawing No. 835704-03-4-101. Material balance for the unit is shown in Table 6.2.3-1. The plot plan is shown on Drawing No. 835704-03-4-050. The equipment list is given in Table 6.2.3-2.

Ash is produced at three locations: Coal gasification, boilers, and Partial Oxidation. The flue gas desulfurization (FGD) system produces gypsum sludge which is disposed of with the ash.

Gasifier Ash

The gasifier ash from the Lurgi coal gasification process is obtained in a fused form as abrasive angular particles. The ash is discharged from the ash locks below each gasifier. Sufficient water is added on discharge for

6.2.3.2 (Continued)

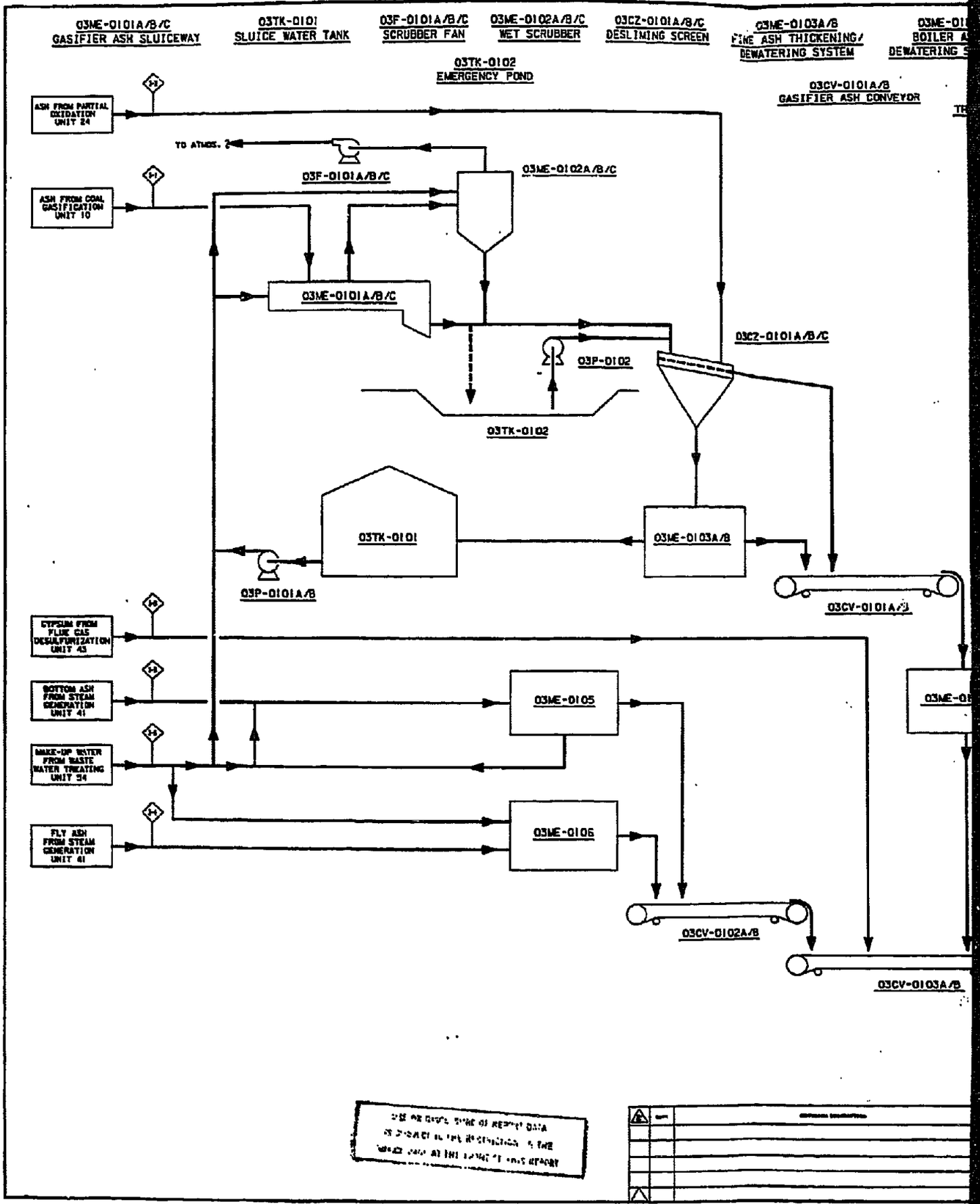
quenching and the ash slurry is transported by sluiceways. Steam generated from cooling of the hot ash along with other vapors is vented from the sluiceways through a scrubber. The slurry is separated by desliming screens into water and ash. The water is clarified; fine ash is recovered in a series of thickeners and the water is recycled to the sluiceway. Makeup water from the Waste Water Treating unit is added as required. The fine ash recovered in thickener underflow joins the coarse ash overflow from the desliming screen and is conveyed to the ash collection area. A small quantity of ash is also discharged from the Partial Oxidation unit. This ash is conveyed batch wise to the gasifier ash system.

Boiler Ash

Boiler ash is generated in two forms: bottom ash from the pulverized coal-fired steam boiler and fly ash from the boiler flue gas electrostatic precipitators. The bottom ash is quenched upon discharge from the boiler and transported to the dewatering system by jet pumps. In the dewatering system, the water is separated from the ash cake and recycled. The fly ash from the electrostatic precipitators is pneumatically transported to the fly ash conditioner where water is added to prevent dusting. The bottom ash cake, fly ash, and the FGD sludge are collected and transferred by a common conveyor to the ash collection area.

Ash Disposal

Two parallel collecting conveyors receive the gasifier ash, boiler ash, and FGD sludge and transport this material to an overland ash conveyor which discharges to the ash stockpile. Covered storage capacity for ash production for five days normal plant operation is provided within the unit. Reclaim conveyors transfer the ash from the stockpile to plant battery limit for disposal to the offsite ash disposal facility.


03ME-0101A/B/C
GASIFIER ASH SLUICEWAY
03TK-0101
SLUICE WATER TANK
03F-0101A/B/C
SCRUBBER FAN
03ME-0102A/B/C
WET SCRUBBER
03CZ-0101A/B/C
DESLIMING SCREEN
03ME-0103A/B
FINE ASH THICKENING/
DEWATERING SYSTEM
03TK-0102
EMERGENCY POND
03CV-0101A/B
GASIFIER ASH CONVEYOR
ASH FROM PARTIAL OXIDATION UNIT 24
TO ATMOS. 2
03F-0101A/B/C
03ME-0102A/B/C
ASH FROM COAL GASIFICATION UNIT 10
03ME-0101A/B/C
03CZ-0101A/B/C
03P-0102
03TK-0102
03TK-0101
03ME-0103A/B
03P-0101A/B
03CV-0101A/B
GYPSUM FROM FLUE GAS DESULFURIZATION UNIT 43
BOTTOM ASH FROM STEAM GENERATION UNIT 41
03ME-0105
MAKE-UP WATER FROM WASTE WATER TREATING UNIT 34
FLY ASH FROM STEAM GENERATION UNIT 41
03ME-0106
03CV-0102A/B
03CV-0103A/B

03ME-0103A/B
FINE ASH THICKENING/ DEWATERING SYSTEM

03ME-0105
BOILER ASH DEWATERING SYSTEM

03ME-0106
FLY ASH CONDITIONING SYSTEM

03ME-0104A/B
ASH SAMPLER

03CV-0104A/B
OVERLAND ASH CONVEYOR

03CV-0106A/B
RECLAIM CONVEYOR

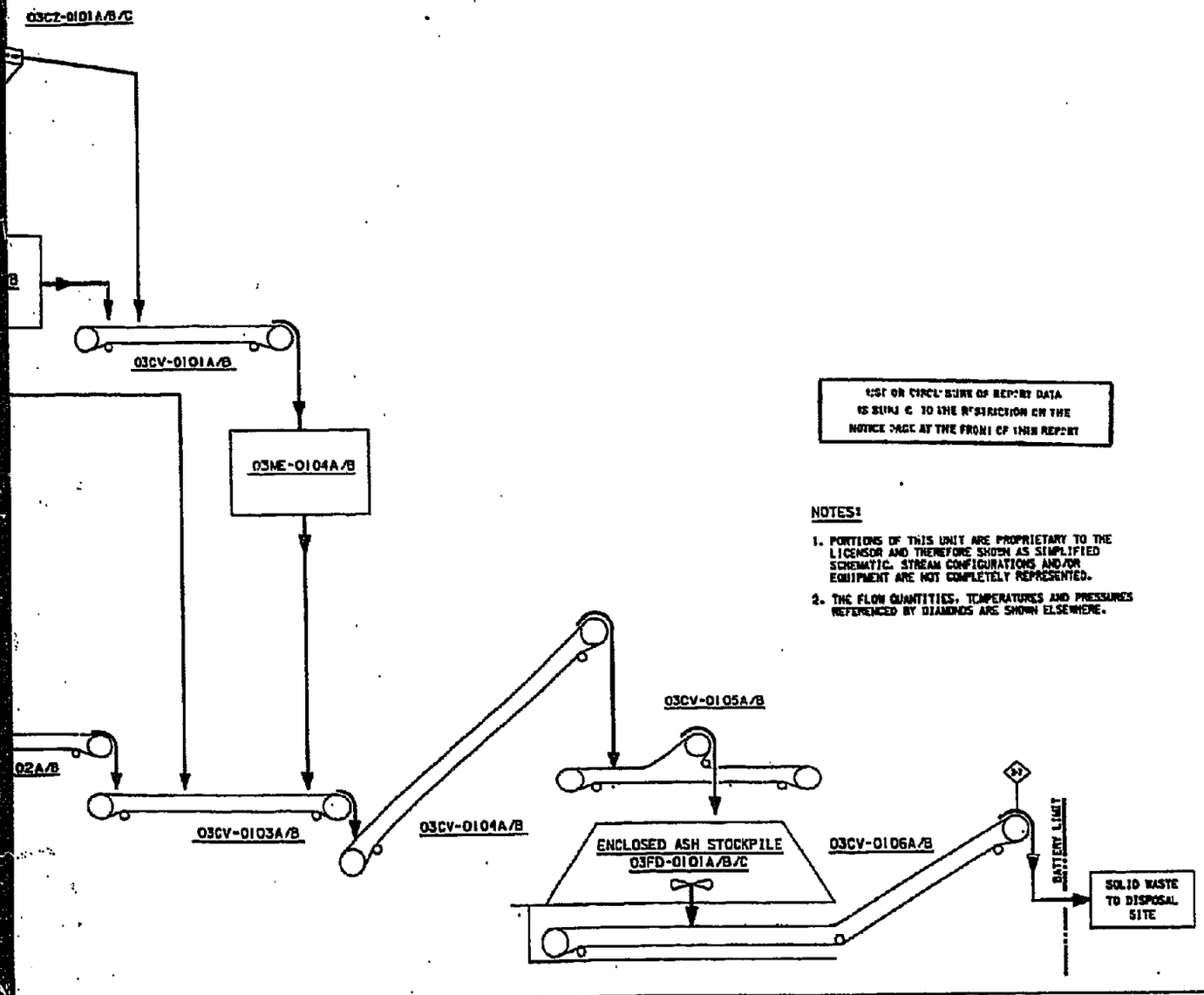
03CV-0101A/B
GASIFIER ASH CONVEYOR

03CV-0102A/B
BOILER ASH TRANSFER CONVEYOR

03CV-0103A/B
ASH COLLECTING CONVEYOR

03FD-0101A/B/C
FLOW FEEDER

03CV-0105A/B
TRIPPER CONVEYOR



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NOTES:

1. PORTIONS OF THIS UNIT ARE PROPRIETARY TO THE LICENSOR AND THEREFORE SHOWN AS SIMPLIFIED SCHEMATIC. STREAM CONFIGURATIONS AND/OR EQUIPMENT ARE NOT COMPLETELY REPRESENTED.
2. THE FLOW QUANTITIES, TEMPERATURES AND PRESSURES REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.

FLUOR

R. WHITE
C. C. ABATAY
W. D. MELMETO
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R. LANG

PROCESS FLOW DIAGRAM
ASH HANDLING
UNIT 03

CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-03-4-101 | 1

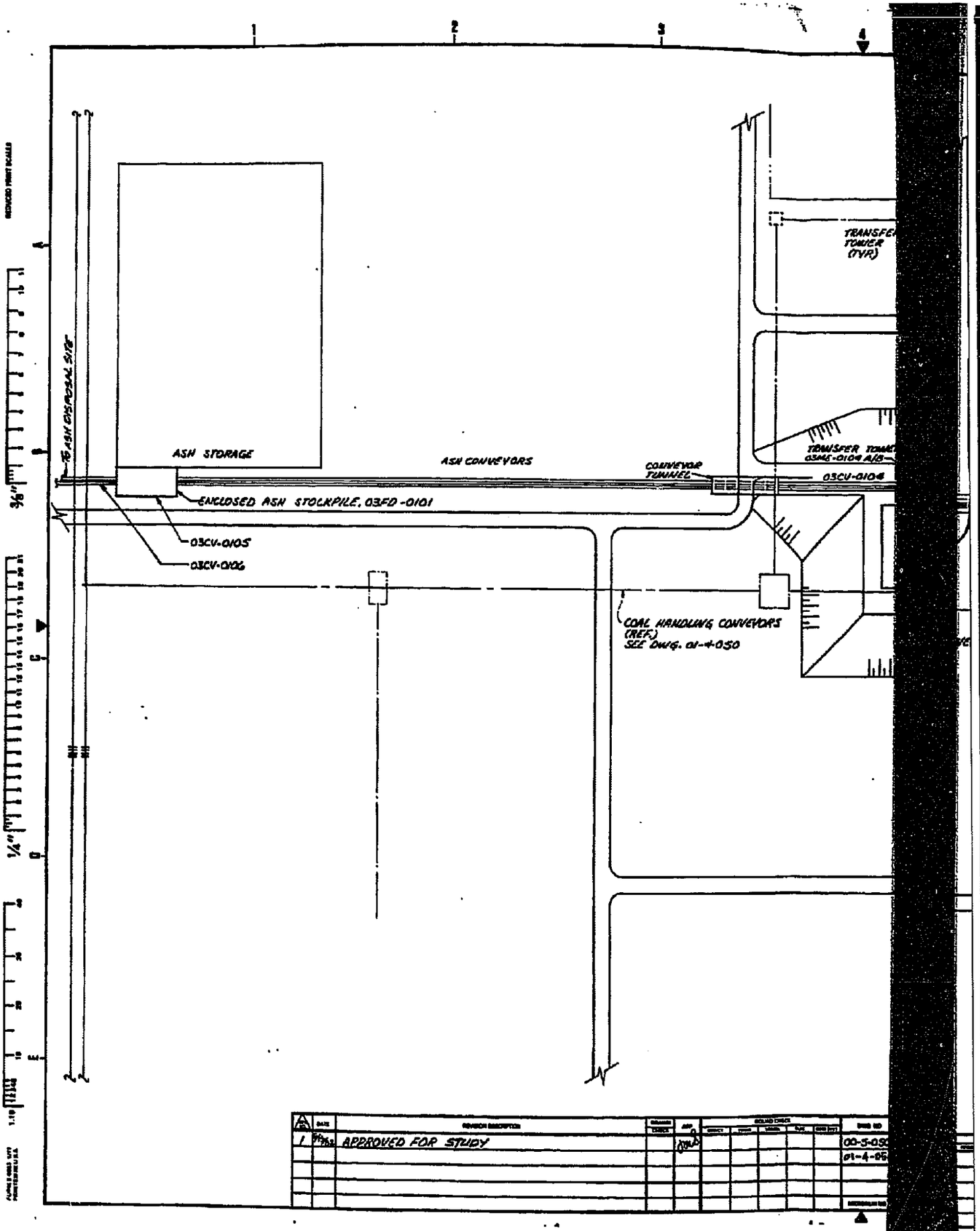
003 1357031 01

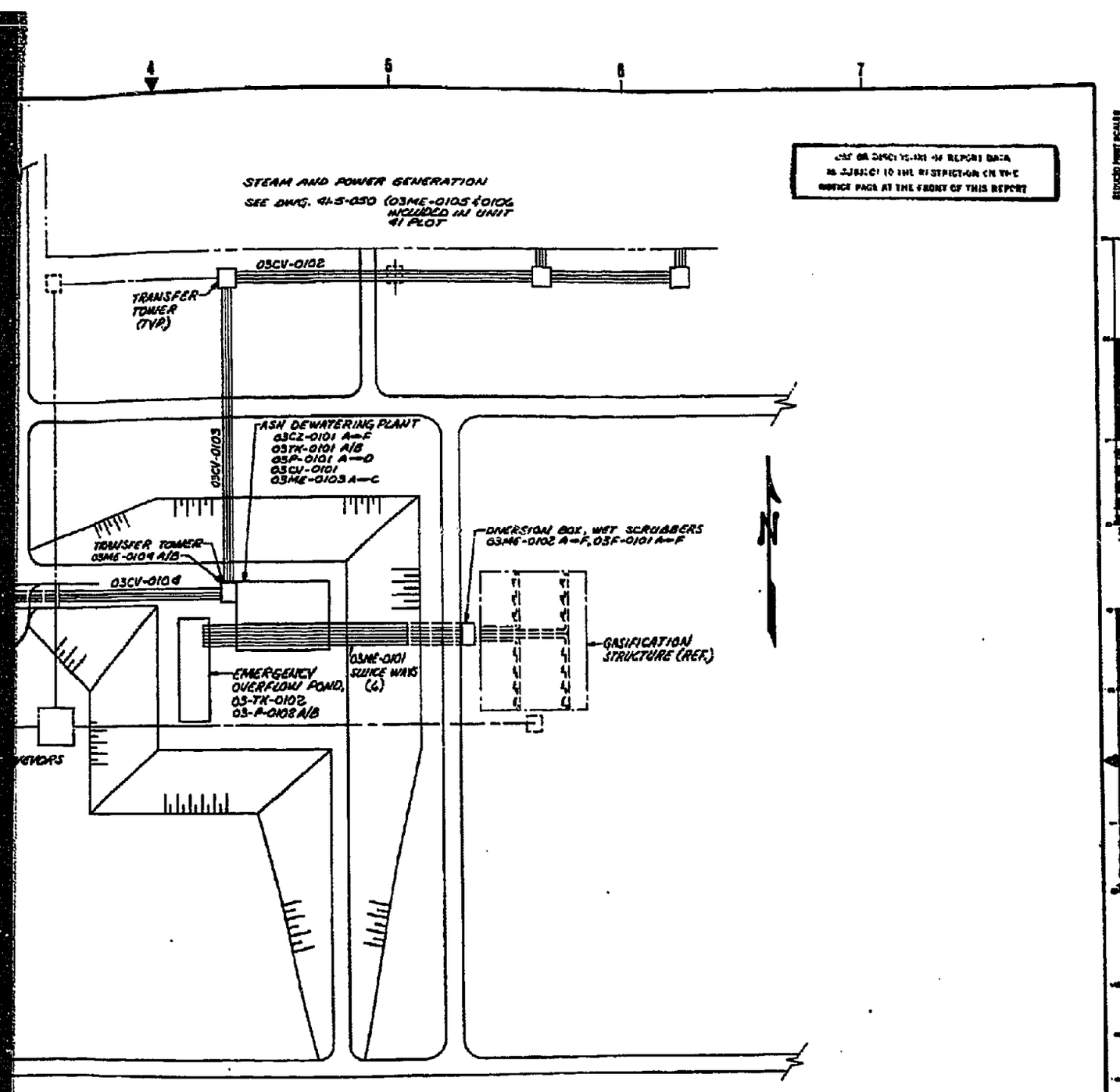
TABLE 6.2.3-1
MATERIAL BALANCE
ASH HANDLING - UNIT 03

Stream Number		3-1	3-2	3-3	3-4	3-5	3-6	3-7
Stream Name		Gasifier Ash (2)	POX Ash (2)	Boiler Bottom Ash (2)	Boiler Fly Ash (2)	Makeup Water	FGD Sludge	Solid Waste to Disposal
Dry Solids,	lb/hr	68,931	18	8,880	35,377	-	24,832	138,038
Water,	lb/hr					41,464	7,418	48,882
Sludge,	lb/hr					-	32,350	186,920
	ST/SD					-	387	2,243.04
Wt % Solids						-0-	77.0	73.8

NOTES: (1) Flow quantities 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) Only dry solids flows are shown.


1
2
3
4
ASH DISPOSAL SITE
ASH STORAGE
ASH CONVEYORS
CONVEYOR TUNNEL
03CV-0104
ENCLOSED ASH STOCKPILE, 03FD-0101
03CV-0105
03CV-0106
COAL HANDLING CONVEYORS (REF.) SEE DWG. 01-4-050
TRANSFER TOWER (TYP.)
APPROVED FOR STUDY
00-5-03
01-4-05



ALL EQUIPMENT SIZES AND LOCATIONS ARE APPROXIMATE.

00-S-050	SITE #1 PLOT PLAN	
01-4-050	PLOT PLAN UNIT 01	

FLUOR

J. PREDDI
E. MOERTL
T. CONTI
J. SAMETS
R. TANG

PLOT PLAN - UNIT 03
ASH HANDLING
CROW TRIBE OF INDIANS MONTANA

1" = 100'-0" | 835704-03-4-050 | 1

TABLE 6.2.3-2

EQUIPMENT LIST

ASH HANDLING - UNIT 03

Item No.	Equipment Name	Number Required Oper.	Spare
Ash Removal from Gasifiers			
03TK-0101 (3)	Sluice Water Tank	2	0
03TK-0102	Emergency Pond	1	0
03P-0101 A/B (3)	Sluiceway Water Pump	2	2
03ME-0101 A/B/C (3)	Sluiceway with Gates	4	2
03F-0101 A/B/C (3)	Scrubber Fan	4	2
03ME-0102 A/B/C (3)	Wet Scrubber	4	2
03P-0102	Emergency Pond Overflow Reclaim Pump	0	2
Ash Dewatering			
03CZ-0101 A/B/C (3)	Desliming Screen	4	2
03CV-0101 A/B	Gasifier Ash Conveyor	1	1
03ME-0103 A/B (3)	Fine Ash Thickening/Dewatering System (1)	2	1
03ME-0104 A/B	Ash Sampler	1	1
03ME-0105 (3)	Boiler Ash Dewatering System (2)	2	0
03ME-0106	Fly Ash Conditioning System	1	0
03CV-0102 A/B	Boiler Ash Transfer Conveyor	1	1

TABLE 6.2.3-2 (Continued)

EQUIPMENT LIST

ASH HANDLING - UNIT 03

Item No.	Equipment Name	Number Required Oper.	Spare
Ash Transport to Disposal			
03CV-0103 A/B	Ash Collecting Conveyor	1	1
03CV-0104 A/B	Overland Ash Conveyor	1	1
03CV-0105 A/B	Tripper Conveyor	1	1
03FD-0101 A/B/C (3)	Plow Feeder	4	2
03CV-0106 A/B	Reclaim Conveyor	1	1

NOTES:

(1) Includes dewatering screens, sedimentation pond and thickeners.

(2) Includes ash jet pumps, dewatering bins, settling tanks and water recycle system; critical equipment within the system are spared.

(3) Train No. 2 equipment numbers which are not shown are the same as indicated above except the train designation is 02 instead of 01.

Example:	Train No. 1	Train No. 2
	03TK-0101	03TK-0201

6.2.4 COAL GASIFICATION - UNIT 10

6.2.4.1 DESIGN BASIS

Purpose of Unit

The purpose of this unit is to convert coal into crude synthesis gas by partial combustion under pressure with oxygen and steam in moving bed Lurgi gasifiers.

Scope of Unit

The unit includes gasifiers, coal feed and ash discharge locks, waste heat boilers, dusty liquid separation, and lock gas recompression. The gasification unit is licensed by Lurgi Mineraloltechnik of Germany.

General Design Criteria

The unit consists of two trains of gasifiers, each train containing six operating and one spare gasifier (49,147 Nm^3/hr of dry raw gas per gasifier) and one lock gas recompression system. Additionally, all rotating equipment are spared sufficiently to ensure an overall plant onstream factor of 332 days per year. All rotating equipment in the unit are motor driven.

6.2.4.1 (Continued)

Feedstock (Case: Westmoreland Coal - 40% Fines - SNG)

Coal

As received	900,000 lb/hr
DAF Coal	599,400 lb/hr

Coal Analysis (by Lurgi)

Proximate wt % (As Rec'd)		Ultimate wt % (DAF)	
Moisture	26.0	C	75.98
Ash	7.4	H	4.59
Fixed Carbon	40.1	O	17.08
Volatile Matter	26.5	N	1.09
	100.0	S	1.23
		Cl	0.03
			100.00

Calorific Value, HHV (DAF) 12,931.4 Btu/lb

Size Range: 1/4 inch x 2 inch

Oxygen: 222,018 lb/hr
(98.5% O_2 & 1.5% N_2 & Ar (as N_2)):
Battery Limit Conditions: 505 psia and 230°F

Superheated Steam 1,090,908 lb/hr
(From external sources: 550 psig/756°F)

Products

Crude Gas (including net lock gas)

Dry Gas	58,017.4 lb mol/hr
Moisture	28,582.7 lb mol/hr
Total Wet Gas	86,600.1 lb mol/hr

6.2.4.1 (Continued)

Total stream including hydrocarbon liquids 1,803,111 lb/hr

Battery Limit Conditions	Temperature	355°F
	Pressure	435 psia

Composition

Component	Dry Mol %
H_2	40.2
N_2/Ar (or N_2)	0.2
CO	15.9
CH_4	10.9
C_2+	0.8
CO_2	31.6
H_2S	0.4
COS	0.01
	100.00

Dusty Gas Liquor (Net quantity leaving unit)

Flow Rate	454,365 lb/hr	
Battery Limit Conditions	Temperature	350°F
	Pressure	350 psia

Utility Requirements

Steam (550 psig/756°F) from external sources	1,090,908 lb/hr
Steam produced (100 psig sat'd)	566,600 lb/hr
BFW to gasifier jacket (212°F)	115,600 lb/hr
Electric Power	2,400 kW
Cooling Water (Δ T = 30°F)	551 gpm
Fuel Gas (for the dedicated flare)	0.7 MM Btu/hr

6.2.4.2 PROCESS DESCRIPTION

The process flow sketch for the Gasification unit is presented on Drawing No. 835704-10-4-101. The unit material balance for the Base Case follows on Table 6.2.4-1. The plot plan is shown on Drawing No. 835704-10-4-050. The equipment list is given in Table 6.2.4-2.

The sized coal (2 inch x 1/4 inch) for gasifier feed is transported by the Coal Distribution unit to a coal bunker located at the top of each gasifier. Sequential operation of the coal lock upper and lower valves feeds the coal into the gasifier. The sequence of operation involves (1) depressurization of the coal lock by venting the lock gas to the gas recompression system; (2) loading the coal charge from the bunker into the coal lock; (3) repressurization of the coal lock chamber with lock gas taken as a slipstream from the cooled raw gas leaving the Gas Cooling unit; and (4) loading coal from the coal lock to the gasifier.

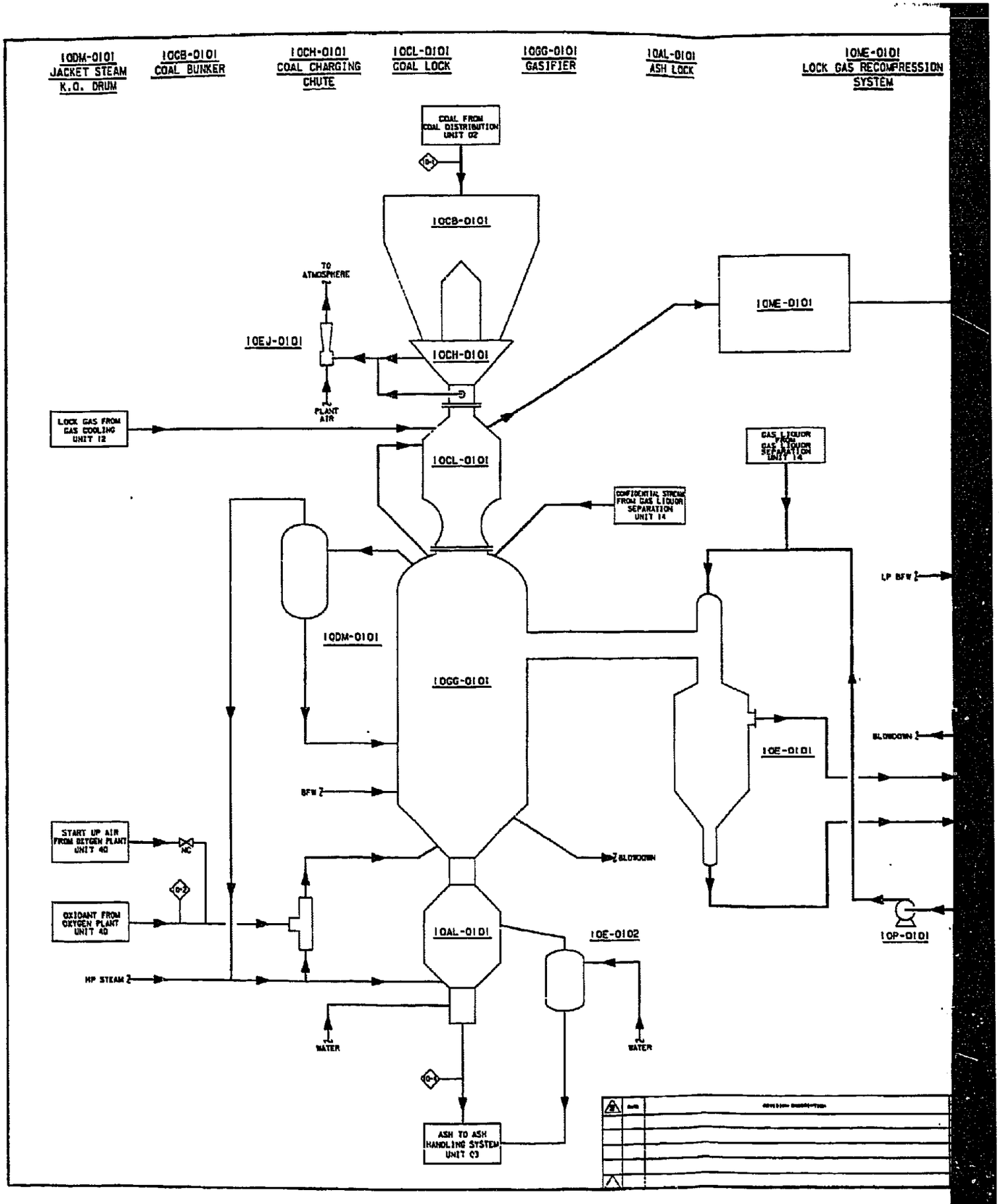
The coal bed moves down through the gasifier where the coal is dried, devolatilized, and gasified by the heat generated from the combustion of the residual coal char with oxygen in the presence of steam. The mixture of oxygen and superheated steam is fed near the bottom of the gasifier and passes up through the moving coal bed. A part of the steam required is supplied by steam generated in the water jacket of the gasifier.

Ash is collected at the bottom of the gasifier and is transferred to the ash lock by a rotating grate. The ash removal process is a sequential operation similar to the charging of the coal except steam is used to pressurize the ash lock chamber and the ash lock expansion condenser is used for depressurization. The ash is discharged through the ash chute after quenching with water into the ash handling system.

6.2.4.2 (Continued)

The hot crude gas from the gasifier is cooled in the wash-cooler by scrubbing with a recycle stream of dusty and recycle gas liquor. The dusty gas liquor is collected at the bottom of the waste heat boiler and the recycle gas liquor is pumped from the Gas Liquor Separation unit. The dust and heavy tar stripped from the hot crude gas in the wash-cooler flow to the liquid sump of the waste heat boiler. The crude gas from the wash-cooler is further cooled in the waste heat boiler where medium pressure steam is generated. The dusty gas liquor condensed in the waste heat boiler flows to the Gas Liquor Separation unit (14) for further processing.

A small amount of lock gas remains in the coal lock after depressurizing the coal lock. This residue (approximately two percent of the total) is exhausted to the atmosphere by the coal lock ejector using air as the motive fluid. The hot flare cooler and the hot flare separator, located downstream of the waste heat boiler, are utilized only during startup or emergency shutdown operations.

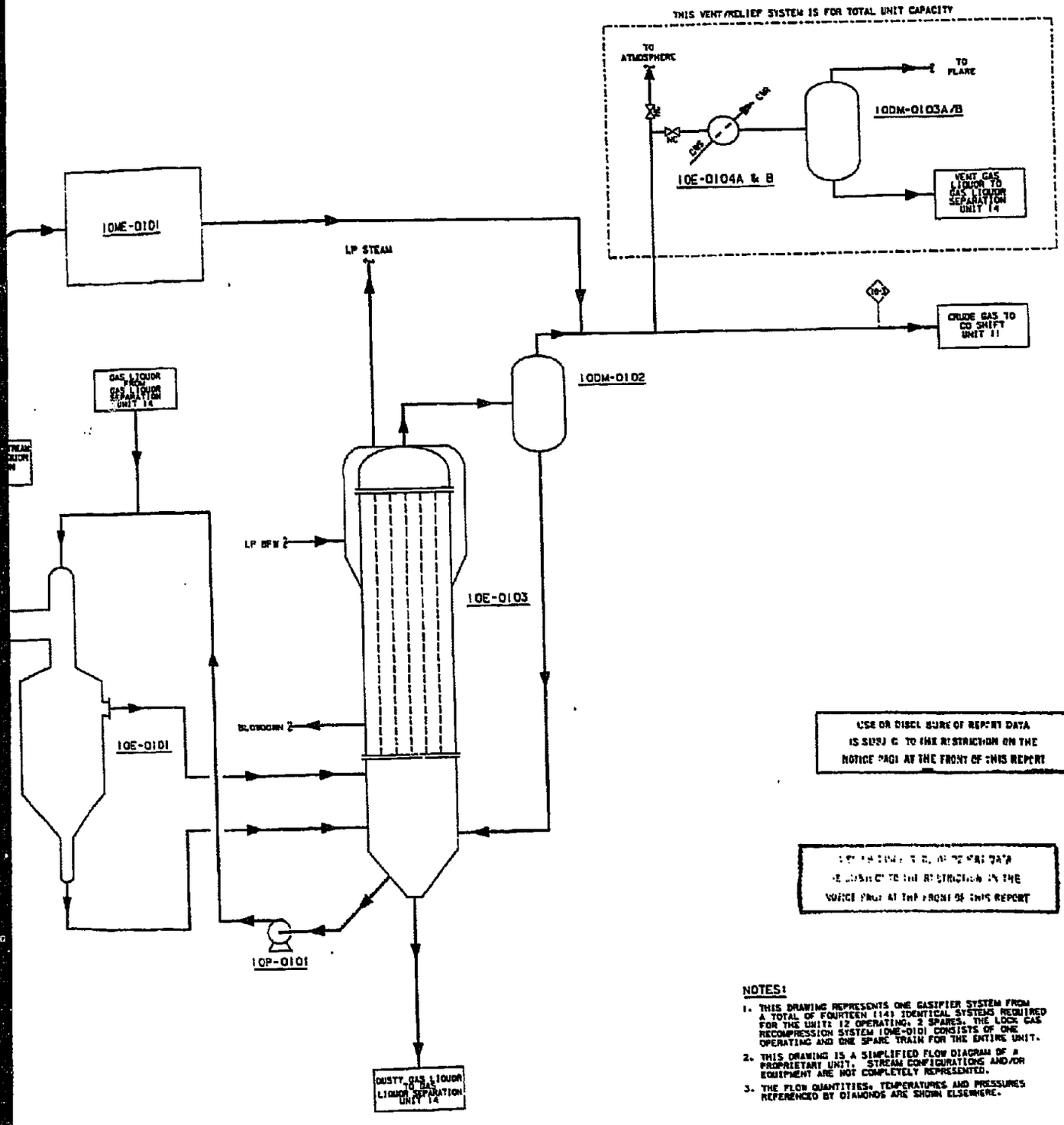

10DM-0101
JACKET STEAM K.O. DRUM
10CB-0101
COAL BUNKER
10CH-0101
COAL CHARGING CHUTE
10CL-0101
COAL LOCK
10GG-0101
GASIFIER
10AL-0101
ASH LOCK
10ME-0101
LOCK GAS RECOMPRESSION SYSTEM
COAL FROM COAL DISTRIBUTION UNIT 02
10CB-0101
TO ATMOSPHERE
10EJ-0101
10CH-0101
PLANT AIR
10ME-0101
LOCK GAS FROM GAS COOLING UNIT 12
10CL-0101
GAS LIQUOR FROM GAS LIQUOR SEPARATION UNIT 14
CONFIDENTIAL STREAM FROM GAS LIQUOR SEPARATION UNIT 14
LP BFW
10DM-0101
10GG-0101
10E-0101
BLOWDOWN
BFW
START UP AIR FROM OXYGEN PLANT UNIT 40
NC
OXIDANT FROM OXYGEN PLANT UNIT 40
10AL-0101
10E-0102
10P-0101
HP STEAM
WATER
WATER
ASH TO ASH HANDLING SYSTEM UNIT 03

-0101
LOCK

10ME-0101
LOCK GAS RECOMPRESSION SYSTEM

10DM-0102
LIQUID SEPARATOR

10DM-0103A/B
HOT FLARE SEPARATOR



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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 GASIFIER SYSTEM FROM A TOTAL OF FOURTEEN (14) IDENTICAL SYSTEMS REQUIRED FOR THE UNIT: 12 OPERATING, 2 SPARES. THE LOCK GAS RECOMPRESSION SYSTEM 10ME-0101 CONSISTS OF ONE OPERATING AND ONE SPARE TRAIN FOR THE ENTIRE UNIT.
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

DRAWN BY	R. WHITE
DESIGNED BY	C.G. ABAYAY
CHECKED BY	W.D'BELMITO
ENGINEERING MANAGER	R. McCARTHY 6-24-83
PROJECT MANAGER	R.L ANG

PROCESS FLOW DIAGRAM
COAL GASIFICATION
UNIT 10

CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE	1	835704-10-4-101	1

003 3571010I

TABLE 6.2.4-1

MATERIAL BALANCE

COAL GASIFICATION - UNIT 10

Stream Number	10-1	10-2		10-3	
Stream Name	Sized Coal Feed	Oxidant		Crude Gas	
Component		lb-mol/hr	Mol %	lb-mol/hr	Mol %
H_2				23,328.0	40.31
N_2		104.3	1.5	127.6	0.22
CO				9,257.0	15.96
CH_4				6,322.1	10.90
C_2H_4				72.4	0.12
C_2H_6				289.5	0.50
C_3H_6				36.2	0.06
C_3H_8				36.2	0.06
C_4H_8				9.0	0.02
C_4H_{10}				9.0	0.02
CO_2				18,311.3	31.56
H_2S				214.7	0.37
COS				4.4	0.01
O_2		6,847.2	98.5		
			100.0		100.0
Dry Gas, lb-mol/hr		6,951.5	100.0	58,017.4	66.99
H_2O lb-mol/hr		-0-	-0-	28,582.7	33.01
Wet Gas lb-mol/hr		6,951.5	100.0	86,600.1	100.0

TABLE 6.2.4-1 (Continued)

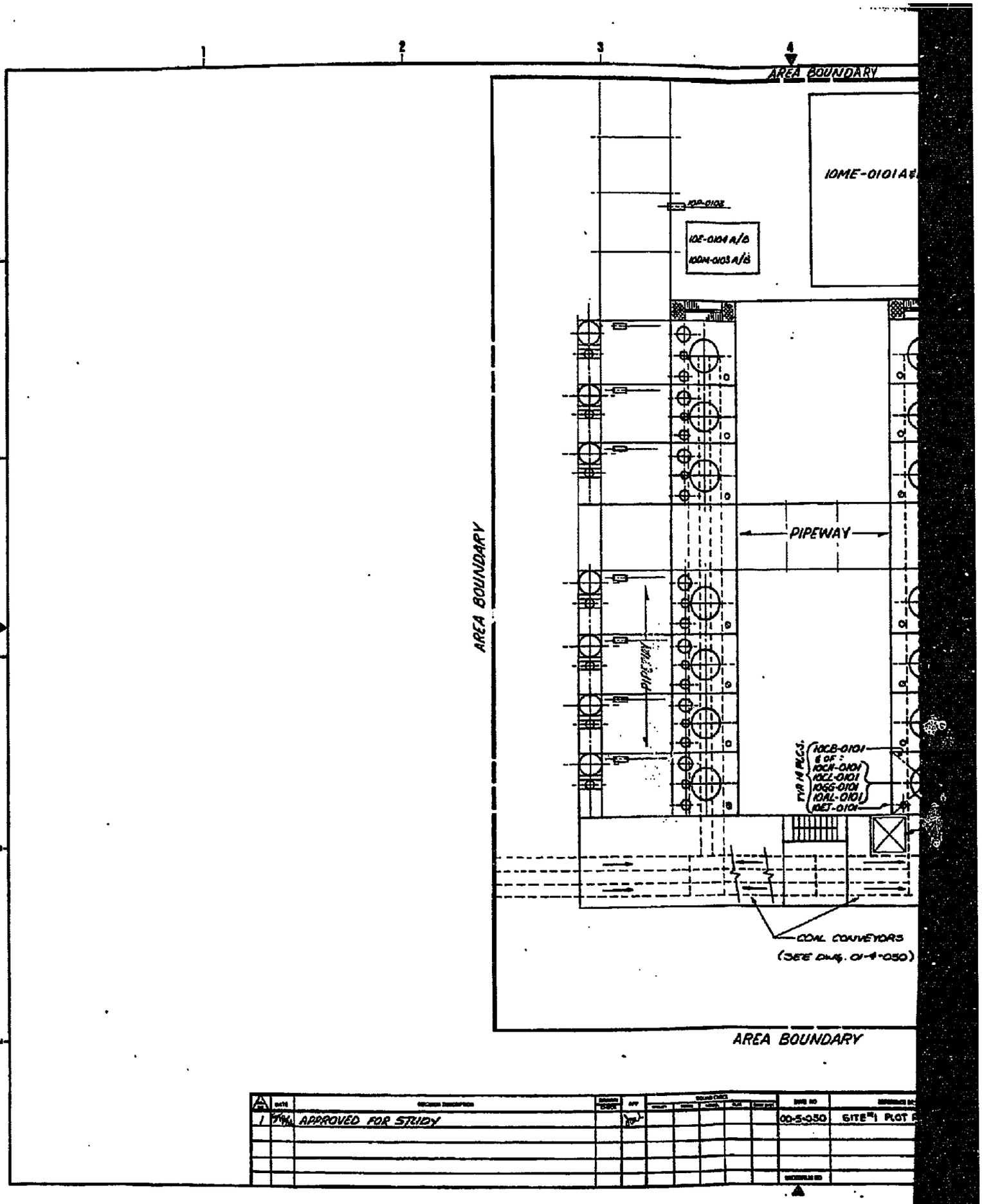
MATERIAL BALANCE

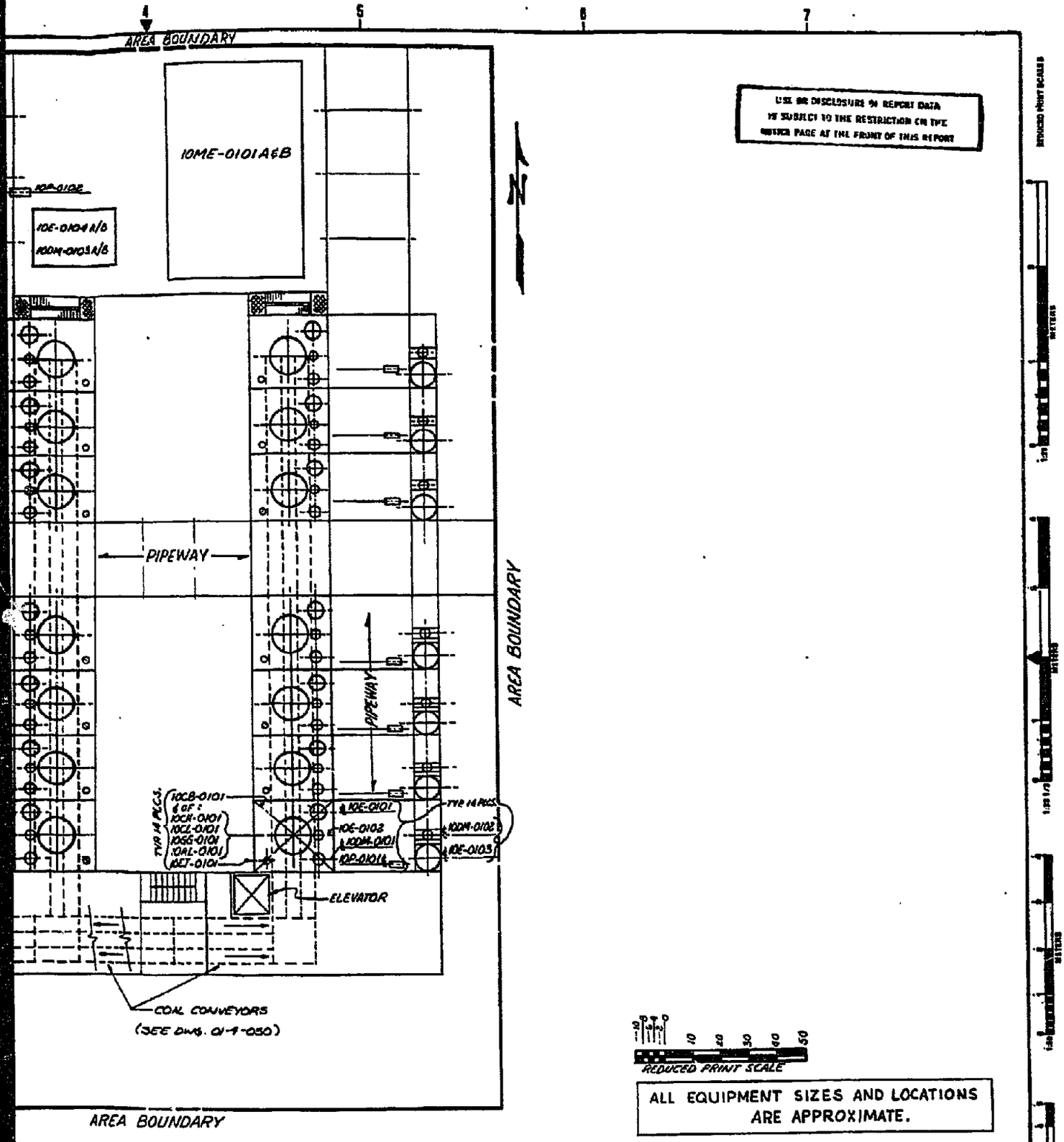
COAL GASIFICATION - UNIT 10

Stream Number		10-1	10-2		10-3		10-4
Stream Name		Sized Coal Feed	Oxidant		Crude Gas		Ash
Component			lb /hr	Mol %	lb /hr	Mol %	
Dry Gas,	lb/hr		222,018		1,239,695		
H_2O	lb/hr	234,000			514,946		
Tars	lb/hr				12,947		
Oils	lb/hr				16,843		
Naphtha	lb/hr				5,275		
Phenols	lb/hr				5,095		
Fatty Acids	lb/hr				1,139		
Org. Sulfur	lb/hr				213		
Ammonia	lb/hr				6,773		
HCl	lb/hr				185		
DAF coal	lb/hr	599,400					
Ash	lb/hr	66,600					68,931 *
TOTAL	lb/hr	900,00	222,018		1,803,111		68,931
Pressure, psia		Ambient	505		435		Ambient
Temperature, °F		Ambient	230		355		650

*includes unburnt carbon

NOTE: Flow quantities, pressure, and temperature shown are for the total unit on the 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
10ME-0101A/B
10E-0104 A/B
10GH-0103 A/B
PIPEWAY
PIPEWAY
AREA BOUNDARY
TYP 14 PLCS.
10CB-0101
& OF :
10CH-0101
10CL-0101
10GG-0101
10AL-0101
10ET-0101
COAL CONVEYORS
(SEE DWG. 01-1-050)
AREA BOUNDARY
1 APPROVED FOR STUDY
00-5-050
SITE 1 PLOT



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DWG NO	REFERENCE DRAWING
10-5-050	SITE PLOT PLAN

FLUOR

J.PARODI
E. MOERTL
T.CONTI
J.SMETS
R.LANG

PLOT PLAN - UNIT 10
GASIFICATION
CROW TRIBE OF INDIANS MONTANA

1" = 20'-0"

835704-10-4-050

1