3.6 SECTION 600 - SULFUR RECOVERY PLANT

BEAVON UNIT

A. Reference Material:

. Process Flow Diagram: FWEC Dwg. No. 54099-27-1-50-8

. Equipment List

. Material Balance

B. Description of Flow

Essentially all the sulfur compounds contained in the tail gas flowing from the Sulfur Recovery Claus Plant (Section 600) to the Beavon Unit are converted by hydrogenation to hydrogen sulfide in the Beavon Reactor, R-620. Product reducing gas from Secion 400 serves to reduce the sulfur oxides to H_2S.

The tail gas to the Reactor (27-15-R-620) is preheated in the Reactor Effluent Exchanger, 27-15-E-620, reduced, then cooled in the Reactor Effluent Cooler, E-621. Boiler feedwater is the coolant on the shell side of the Reactor Effluent Cooler. Tail gas from the Beavon Unit flows to the bottom of the H_2S Absorber (27-15-T-620). Most of the H_2S contained in the tail gas is absorbed by the Stretford solution, which circulates countercurrent to the gas entering the Absorber. Clean gas is vented to atmosphere from the top of the Absorber. The Stretford solution leaving the bottom flows to the Oxidizer Pit, 27-15-X-620. The absorbed sulfur, mostly H_2S, is oxidized to elemental sulfur, as is reduced Stretford solution, by air admitted by the Aerator, 27-15-M-620. Vent gases (air) leaving the Oxidizer Pit are released to atmosphere. The resulting

B. Description of Flow (cont'd)

frothy solution is circulated by the Solution Circulation Pump, P-620A/B, to the H_2S Absorber. A portion of the circulating stream is filtered in the Sulfur Filter, F-620, to recover elemental sulfur. Filtrate enters the Recovered Solution Drum (27-15-D-620) and also is recycled to the top of the H_2S Absorber by P-621A/B.

Liquid sulfur flows to the Sulfur Pit (X-601) in the Claus Plant (Section 600). A small portion of the recycled solution is purged to Wastewater Treating (Section 1500) or to drums. Makeup Stretford solution, stored in drums, is pumped intermittently as an aqueous solution to the top of the H_2S Absorber to replace purged solution. It may be necessary to direct vent gas, normally no flow, from Waste Water Treating (Section 1500) to the Beavon Unit for reduction of sulfur compounds.

BEAVON

FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA COAL GASIFICATION
LOCATION: ALABAMA
PLANT TYPE: B.&.W.GASIEIERS

SECTION NAME: SULFUR RECOVERY-UNIT
REF. DWG.: 54099-27-1-50-8
CONTRACT NO.: 11-27-54099 REV.:

SECTION NO.: 600
PAGE NO.: 1
DATE:

STREAM NUMBER		27 603		27	27 404	27 620	27 621
STREAM DESCRIPTION		Tail Gas from Claus Unit		Vent Gas from Waste Water Trtg	Product Reducing Gas	Absorber Solution Purge	Makeup Absorber Solution
COMPONENTS	(MW)	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR
HYDROGEN	2.016	0			21.000		
CARBON MONOXIDE	28.011	0.153			43.302		
CARBON DIOXIDE	44.011	289.269			2.730		
METHANE	16.043						
NITROGEN	28.013	975.62			2.331		
OXYGEN	32.000	0			0.00672		
HYDROGEN SULFIDE	34.080	10.82			0.00210		
CARBONYL SULFIDE	60.075	0.703			0.00042		
AMMONIA	17.031						
HYDROGEN CYANIDE	27.026						
CHLORIDES	35.453						
SULFUR	32.066	2.81					
CARBON DISULFIDE	76.143	0.60					
SULFUR DIOXIDE	64.066	5.41					
ARGON	39.944						
MERCAPTANS							
TOTAL DRY GAS		1,285.385		Normally 0	69.37224		
WATER	18.016	540.188					
TOTAL WET GAS		1,825.573		Normally 0	69.37224		
		LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR
TOTAL STREAM LBS/HR		50,865			1,441	260	260
SOLIDS LBS/HR							
COAL							
ASH							
CARBON							
TOTAL SOLIDS						252	252
WATER LIQUID							
TOTAL STREAM TEMPERATURE, °F		280			100		
MMSCFD DRY GAS							
DRY GAS GHV (BTU/SCF)							

BEAVON UNIT

FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA COAL GASIFICATION
LOCATION: ....ALABAMA.....
PLANT TYPE: ....B & W GASIFIERS.....

SECTION NAME: Sulfur Recovery.....
REF. DWG.: 54099-27-1-50-8.....
CONTRACT NO.: 11-27-54099 REV.: .....

SECTION NO.: 600.....
PAGE NO.: .....2.....
DATE: .....

STREAM NUMBER		27 622	27 623	27 624			
STREAM DESCRIPTION		Vent Gas from Beavon Unit	Sulfur to Claus Plant Sulfur Pit	Vent From Oxidizer Pit			
COMPONENTS	(MW)	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR
HYDROGEN	2.016	2.402					
CARBON MONOXIDE	28.011						
CARBON DIOXIDE	44.011	336.759					
METHANE	16.043						
NITROGEN	28.014	1,075.025		177.75			
OXYGEN	32.000			47.30			
HYDROGEN SULFIDE	34.080	9ppmv					
CARBONYL SULFIDE	60.076	190ppmv					
AMMONIA	17.031						
HYDROGEN CYANIDE	27.026						
CHLORIDES	35.453						
SULFUR	32.066		Liquid 20.93				
CARBON DISULFIDE	76.143						
SULFUR DIOXIDE	64.066						
ARGON	39.944						
MERCAPTANS							
TOTAL DRY GAS		1,414.187	Liquid 20.93	225.05			
WATER	18.016	83.058		15.54			
TOTAL WET GAS		1,497.245	Liquid 20.93	240.59			
		LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR
TOTAL STREAM LBS/HR		46,439	671	6,773 Air Sat'd w/H2O			
SOLIDS LBS/HR							
COAL							
ASH							
CARBON							
TOTAL SOLIDS							
WATER LIQUID							
TOTAL STREAM							
TEMPERATURE °F		95	275	100			
MMSCFD DRY GAS							
DRY GAS GROSS BTU/SCF							

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54099
SECTION: 600

EQUIPMENT LIST

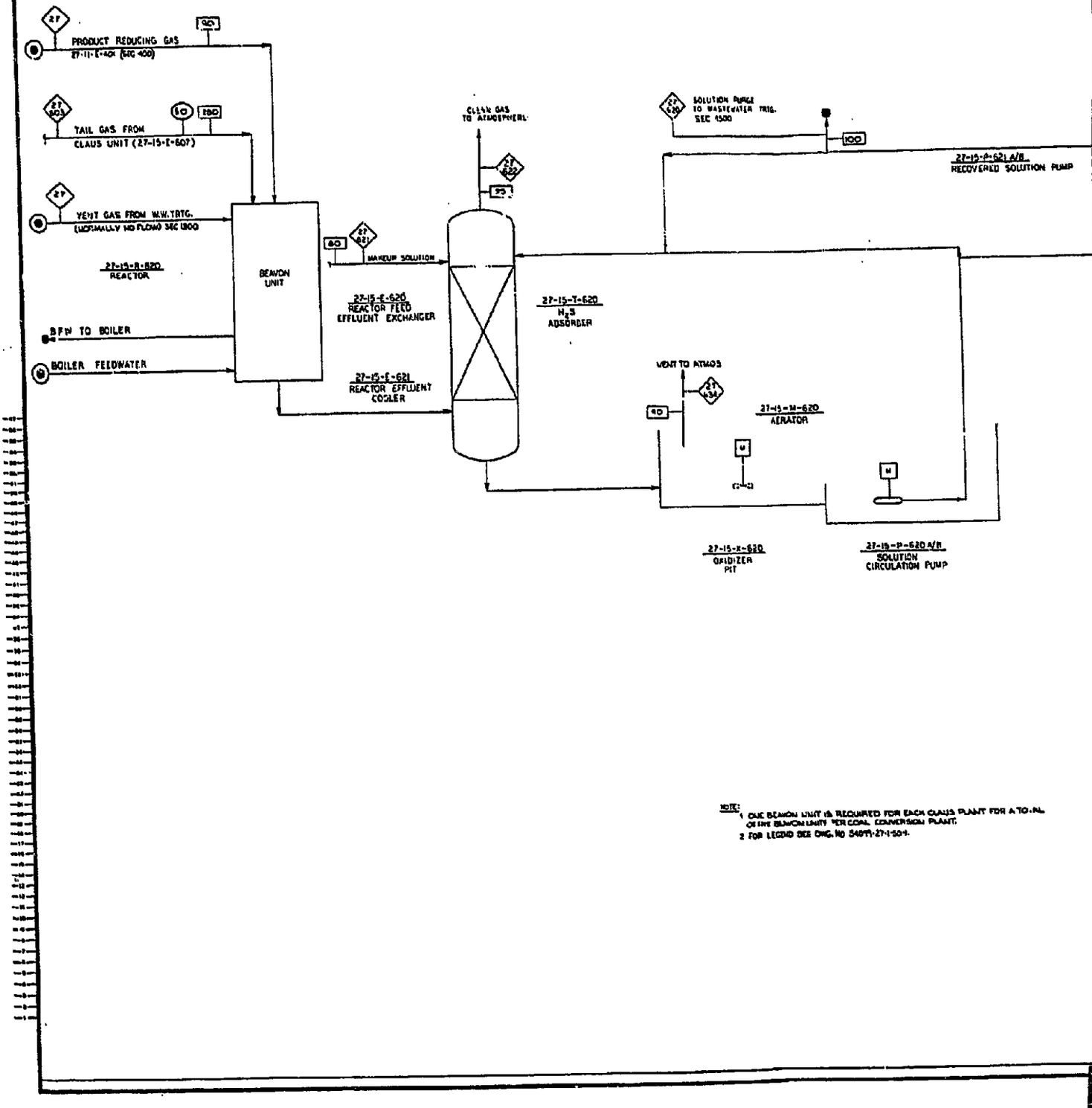
NAME OF UNIT: SULFUR RECOVERY-TAIL GAS UNIT

PAGE 1 OF 1

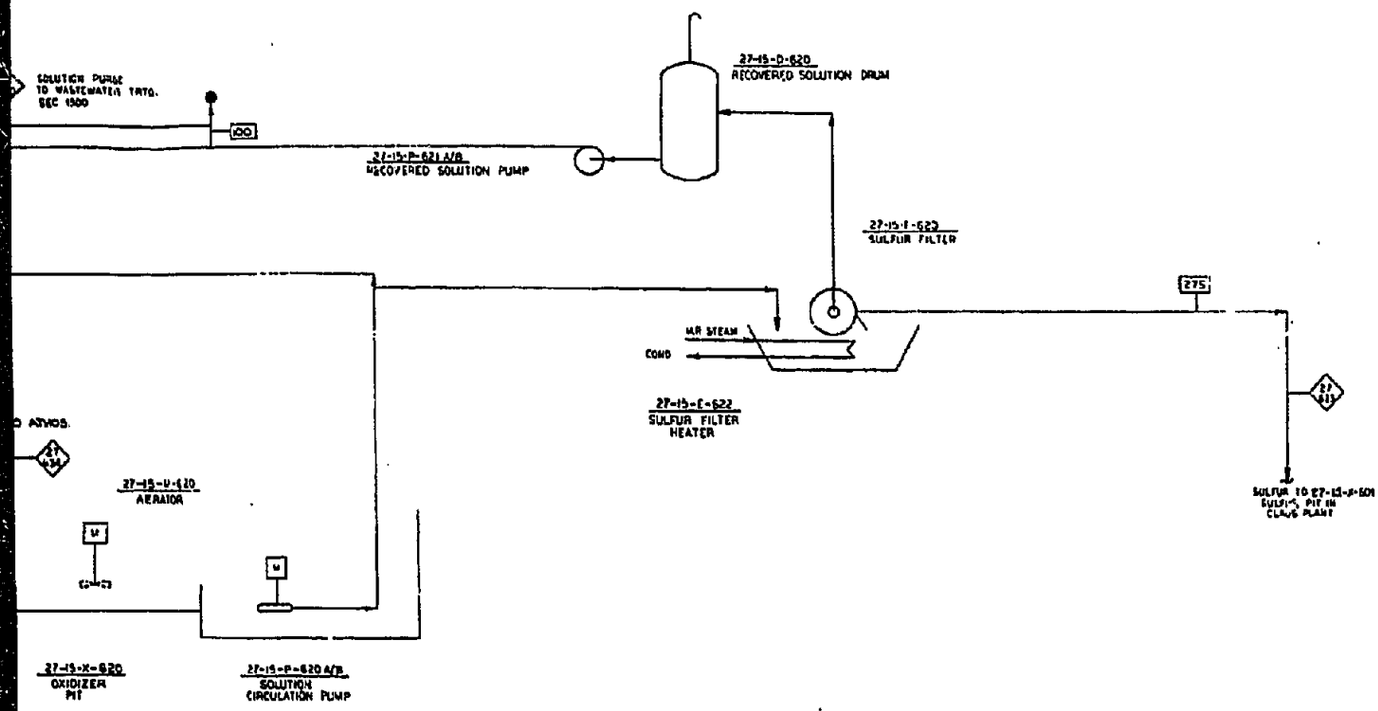
CLIENT: TVA (COAL GASIFICATION STUDY)
LOCATION: ALABAMA

REV'SION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	P. O. NO.	REV
DRUMS 27-15-	D-620	RECOVERED SOLUTION DRUM				
27-15-	E-620	REACTOR FEED-EFFLUENT EXCHANGER				
-	E-621	REACTOR EFFLUENT COOLER				
-	E-622	SULFUR FILTER HEATER				
-	F-620	SULFUR FILTER				
-	P-620A/B	SOLUTION CIRCULATION PUMP				
-	P-621A/B	RECOVERED SOLUTION PUMP				
-	R-620	REACTOR				
-	T-620	H_2S ABSORBER				
-	M-620	AERATOR				
-	X-620	OXIDIZER PIT				



NOTE:
1 ONE BEAVON UNIT IS REQUIRED FOR EACH CLAUS PLANT FOR A TOTAL OF FIVE BEAVON UNITS PER COAL CONVERSION PLANT.
2 FOR LEGEND SEE DWG. NO 540(1)-27-1-501.



NOTE:

1 ONE BEAVON UNIT IS REQUIRED FOR EACH CLAUS PLANT FOR A TOTAL OF FIVE BEAVON UNITS PER COAL CONVERSION PLANT.

2 FOR LEGEND SEE DWG. NO 341091-274-50-1

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTION 600
SULFUR RECOVERY BEAVON UNIT

DWG. NO. 9C091-274-50-3

TVA Coal Gasification Study
B&W Gasifier

SECTION DESCRIPTION

3.7 SECTION 700 - SOUR WATER STRIPPING

A. Reference Material:

. Process Flow Diagram FWEC Dwg. No. 54099-27-1-50-9

. Equipment List

. Material Balance

B. Description of Flow

In this section, sour water is treated for the removal of H_2S and NH_3 before discharging the water to Wastewater Treating, Section 1500.

Sour water from the bottom of the 1st Stg. Scrubber, 27-11-T-301, flows to the Stripper Feed Bottoms Exchanger, 27- 11-E-702, which preheats the feed to about 270°F while cooling the bottoms from the Sour Water Stripper. The preheated sour water leaving E-702 then combines with recycled Stripper overhead condensate from the Stripper Reflux Drum, 27-11-D-701, and enters the top of the Sour Water Stripper, 27-11-T-701.

Sour water is reboiled in the SWS Reboiler, 27-11-E-701, which uses L.P. (60 PSIG) steam. Sour Water Stripper overhead vapors are cooled and partially condensed in the Stripper Overhead Condenser, 27-11-E-704. The condensate and vapor flow by gravity to the Stripper Reflux Drum, 27-11-D-701. All of the condensate is combined with the feed and returned to the top of the Stripper. Acid gas leaving the Stripper Reflux Drum flows to the Claus Sulfur Plant (Section 600).

Stripped sour water from the bottom of the Stripper is cooled to about 200°F in the Stripper Feed Bottoms Exchanger, then cooled further to about 120°F in the SWS Bottoms Cooler, 27-11-E-703, using cooling water. Sour water leaving the cooler, E-703, is clarified in the Stripped Sour Water Clarifier, 27-11-CL-701. A char slurry leaves the bottom of the Clarifier and is pumped to the Slag Dewatering Bins in Section 800. Waste water overflowing the Clarifier flows to Wastewater Treatment (Section 1500), shown on FS 54099-27-1-50-18.

FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA COAL GASIFICATION
LOCATION: ALABAMA
PLANT TYPE: B & W GASIFIERS

SECTION NAME: SOUR WATER STRIPPING
REF. DWG.: 54099-27-1-50-9
CONTRACT NO.: 11-27-54099 REV.: .....
REBOILER PROVIDED

SECTION NO.: 700
PAGE NO.: 1
DATE: .....

STREAM NUMBER		27 312		27 701	27 702		
STREAM DESCRIPTION		Sour Water from Gas Scrubbing		SWS Offgas to Claus plant	Stripped & Clarified Sour water to Waste TRTG		
COMPONENTS	(MW)	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR
HYDROGEN	2.016						
CARBON MONOXIDE	28.011						
CARBON DIOXIDE	44.011						
METHANE	16.043						
NITROGEN	28.014						
OXYGEN	32.000						
HYDROGEN SULFIDE	34.080	0.64		0.607	0.033		
CARBONYL SULFIDE	60.075						
AMMONIA	17.031	0.165		0.013	0.152		
HYDROGEN CYANIDE	27.026						
CHLORIDES	35.453						
SULFUR	32.066						
CARBON DISULFIDE	76.143						
SULFUR DIOXIDE	64.066						
ARGON	39.944						
MERCAPTANS							
TOTAL DRY GAS		0.805		0.620	LIQUID		
WATER	18.016	15,541 Liquid		5.382	15,535.618		
TOTAL WET GAS				6.002	LIQUID		
		LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR
TOTAL STREAM LBS/HR		297,883		97.0	279,893		
SOLIDS LBS/HR							
COAL							
ASH		12,272					
CARBON		5,599					
TOTAL SOLIDS		17,871					
WATER LIQUID		279,987					
TOTAL STREAM							
TEMPERATURE, °F		205		140	120		
MMSCFD DRY GAS							
DRY GAS GHV (BTU/SCF)							

SINGLE TRAIN PER MODULE

EQUIPT FOR MODULE

FORM NO 135-904

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54099
SECTION 700

EQUIPMENT LIST

NAME OF UNIT: Sour Water Stripping

CLIENT: TVA (COAL GASIFICATION STUDY)

LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No/Module	REV.
DRUM 27-11-	D-701	STRIPPER REFLUX DRUM			1-100%	
EXCHANGERS 27-11-	E-701	SWS REBOILER			1-100%	
-	E-702	STRIPPER FEED-BOTTOMS EXCHANGER			1-100%	
-	E-703	SWS BOTTOMS COOLER			1-100%	
-	E-704	STRIPPER OVERHEAD CONDENSER			1-100%	
PUMPS 27-11-	P-701A/B	STRIPPED WATER PUMP			2-100%	
-	P-702A/B	STRIPPER RECYCLE PUMP			2-100%	
-	P-703A/B	CHAR SLURRY PUMP			2-100%	
TOWER 27-11-	T-701	SOUR WATER STRIPPER			1-100%	
CLARIFIER 27-11-	CL-701	STRIPPED SOUR WATER CLARIFIER			1-100%	

TVA Coal Gasification Study
B&W Gasifier

SECTION DESCRIPTION

3.8 SECTION 800-SLAG HANDLING

A. Reference Material:

- Process Flowsheet — FWEC Dwg. No. 54099-27-1-50-10 & 11
- Equipment List

B. Descripiton of Flow

Gasifiers

Section 800 is designed to receive a slag-water slurry from the gasification unit slag lock hoppers, hydraulically transport this slurry to the dewatering bins, recycle the used water and convey the solids to a slag surge pile.

A slag-water slurry is dumped from 16 slag lock hoppers to 16 slag transfer hoppers (27-TK118 thru 21-TK826) on sequential basis. When the first slag transfer hopper is full a signal is generated to activate the recirculating sluicewater pump 27-P806A/B which flushes the slag-water slurry into a sluiceway. The slag-water slurry follows the path of the sluiceway into slag sump 27-TK801A/B. At the mouth of the slag sump the slag-water slurry is passed through a sump grinder 27-SR801A/B to reduce oversized slag particles to prevent clogging of the slag pumps 27-P801A/B and 27-P802A/B at the base of the slag sump. The slag pumps remove the slurry from the slag sump and pumps it to the slag dewatering bins 27-TK802 thru 27-TK807. As soon as one dewatering bin is full it is isolated from the slurry feed and dewatering begins, meanwhile, the next sequential tank starts filling. When the dewatering bin is drained a valve at the bin outlet opens and the dewatered slag is discharged onto a conveyor system (27-CR801 and 27-CR802) which conveys the slag to a slag surge pile. Meanwhile, the water which was drained from the tank is sent to clarifiers 27-CL801 thru 27-CL803 where the overflow is drained to the sluicewater surge tanks 27-TK808 and 27-TK809 and the sludge is pumped back into the dewatering tank by underflow pumps 27-P803A/B thru 27-P805A/B.

All equipment in this system is provided on the basis of one operating and one spare except for tankage.

TVA Coal Gasification Study
B&W Gasifier
Steam Generators

Spent bed material is discharged from the spent bed coolers by rotary feeders 27-FD801A-G into a pneumatic conveying line which transports the material to storage silo 27-TK827. Air-spent bed separation is accomplished by filter-separator 27-F801. Spent bed material is then loaded into trucks and hauled to the slag storage pile.

Flyash from the steam generators is handled in the same manner, except a vacuum system is provided to minimize dusting problems. In addition, the outlet of flyash silo 27-TK828 is fitted with a flyash mixer/conditioner (27-M801) to minimize dusting while loading trucks. Again, the flyash is hauled to the slag storage pile.

FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA
LOCATION: MURPHY HILL, ALABAMA

SECTION NAME: B/W SLAG HANDLING
REF. DWG.: 54099-27-1-50-10 & 11
CONTRACT NO.: 11-27-54099 REV.: 0

SECTION NO.: 800

DATE: 6/30/80

EQUIPMENT SUMMARY

ITEM	DESCRIPTION	DEFINITION	DESIGN * TEMP. (°F)	DESIGN * PRESS. (PSIG)	CONSTRUCTION MATERIAL*
27-B801A/B	Pneumatic Transport Blowers (Spent Bed)				
27-802A/B	Pneumatic Transport Blowers (Flyash)				
27-CL801	Clarifier	50' Dia.			
27-CL802	Clarifier	50' Dia.			
27-CL803	Clarifier	50' Dia.			
27-CR801	Slag Transfer Conveyor	30" Belt, 250 TPH			
27-CR802	Slag Conveyor	30" Belt, 250 TPH			
27-F801	Filter-Separator (Spent Bed Silo)				
27-F802	Filter-Separator (Flyash Silo)				
27-FD801A-J	Spent Bed Discharge Feeders	3 TPH Each.			
27-M801	Flyash Mixer/Conditioner	100 TPH			
27-P801A/B	Slag Pumps	3270 GPM Each			
27-P802A/B	Slag Pumps	3270 GPM Each			
27-P803A/B	Underflow Pump and Spare	250 GPM Each			
27-P804A/B	Underflow Pump and Spare	250 GPM Each			
27-P805A/B	Underflow Pump and Spare	250 GPM Each			
27-P806A/B	Recirculating Sluice Water Pump and Spare	6540 GPM Each			
27-SL801	B801A/B Inlet Silencer				
27-SL802	B802A/B Outlet Silencer				
27-SR 801A/B	Sump Grinders	250 TPH Each			

* SHELL/TUBE WHERE APPLICABLE

FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA
LOCATION: MURPHY HILL, ALABAMA

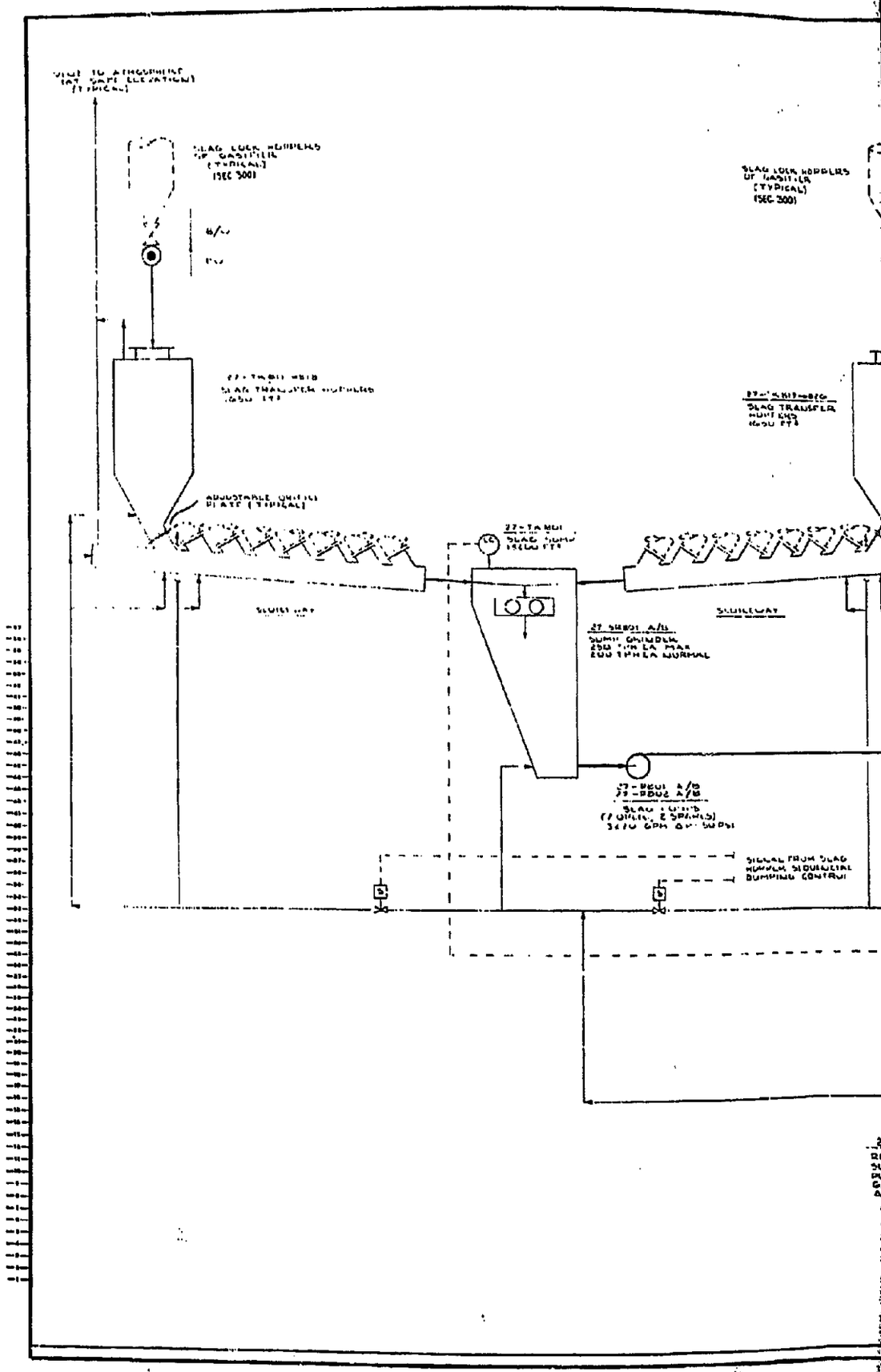
SECTION NAME: B/W SLAG HANDLING
REF. DWG.: 54099-27-1-50-10 & 11
CONTRACT NO.: 11-27-54099 REV.: 0

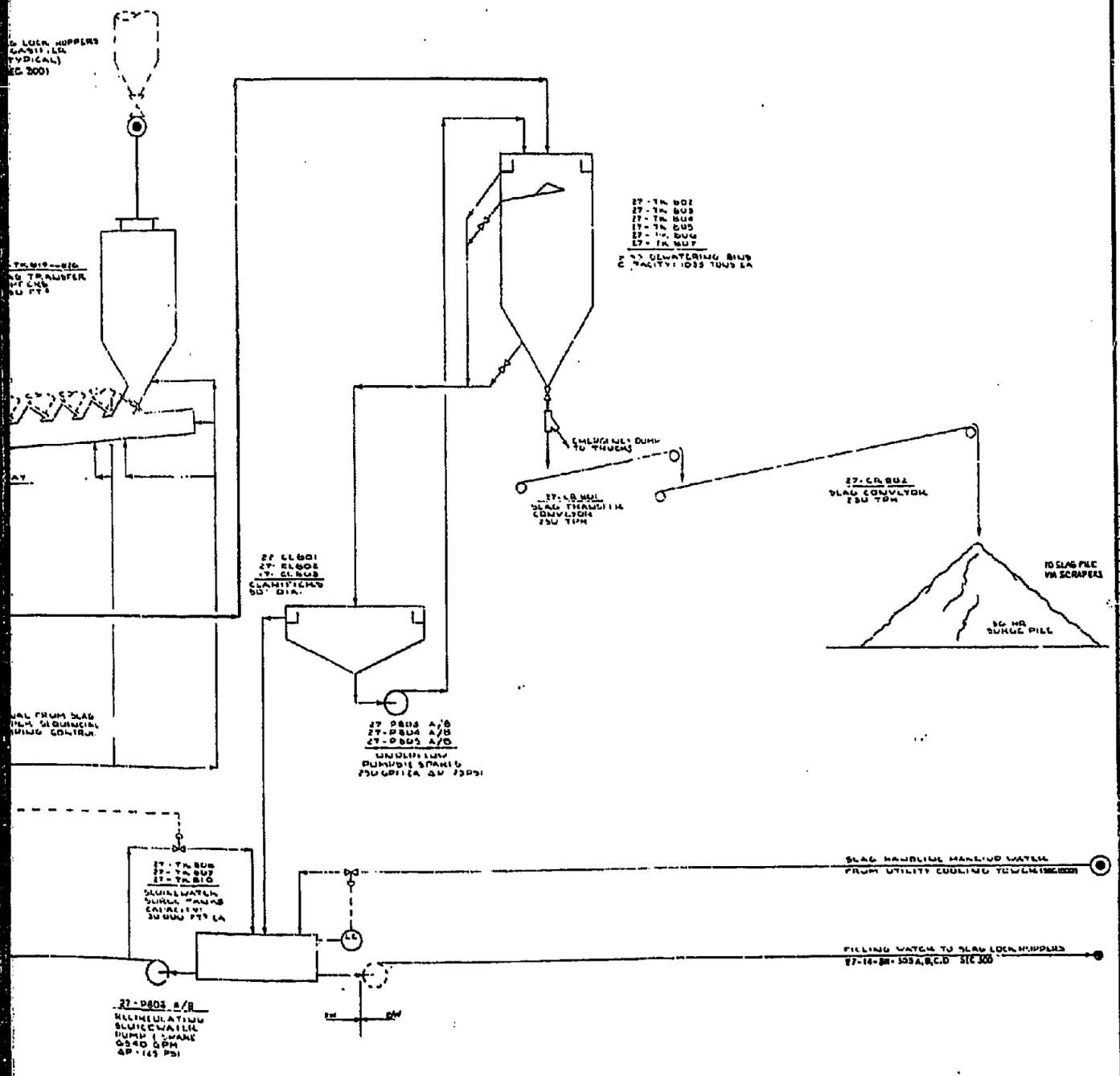
SECTION NO.: 800
PAGE NO.: 2 OF 2
DATE: 6/30/80

EQUIPMENT SUMMARY

ITEM	DESCRIPTION	DEFINITION	DESIGN * TEMP. (°F)	DESIGN * PRESS. (PSIG)	CONSTRUCTION MATERIAL*
27-TK801	Slag Sump	13,200 ft^3			
27-TK802	Slag Dewatering Bin	23,000 ft^3			
27-TK803	Slag Dewatering Bin	23,000 ft^3			
27-TK804	Slag Dewatering Bin	23,000 ft^3			
27-TK805	Slag Dewatering Bin	23,000 ft^3			
27-TK806	Slag Dewatering Bin	23,000 ft^3			
27-TK807	Slag Dewatering Bin	23,000 ft^3			
27-TK808	Sluice Water Surge Tank	30,000 ft^3			
27-TK809	Sluice Water Surge Tank	30,000 ft^3			
27-TK810	Sluice Water Surge Tank	30,000 ft^3			
27-TK811-818	Slag Transfer Hoppers	1,650 ft^3 Each			
27-TK819-826	Slag Transfer Hoppers	1,650 ft^3 Each			
27-TK827	Spent Bed Storage Silo	450 Tons			
27-TK828	Flyash Storage Silo	560 Tons			

* SHELL/TUBE WHERE APPLICABLE


SLAG LOCK HOPPERS OF GASIFIER (TYPICAL) (SEC 300)
SLAG LOCK HOPPERS OF GASIFIER (TYPICAL) (SEC 300)
SLAG TRANSFER HOPPERS
SLAG TRANSFER HOPPERS
ADJUSTABLE ORIFICE PLATE (TYPICAL)
SLUICEWAY
SLUICEWAY
SLAG PUMP
SUMP GRINDER
SLAG LOCK HOPPERS
SIGNAL FROM SLAG HOPPER SEQUENTIAL DUMPING CONTROL



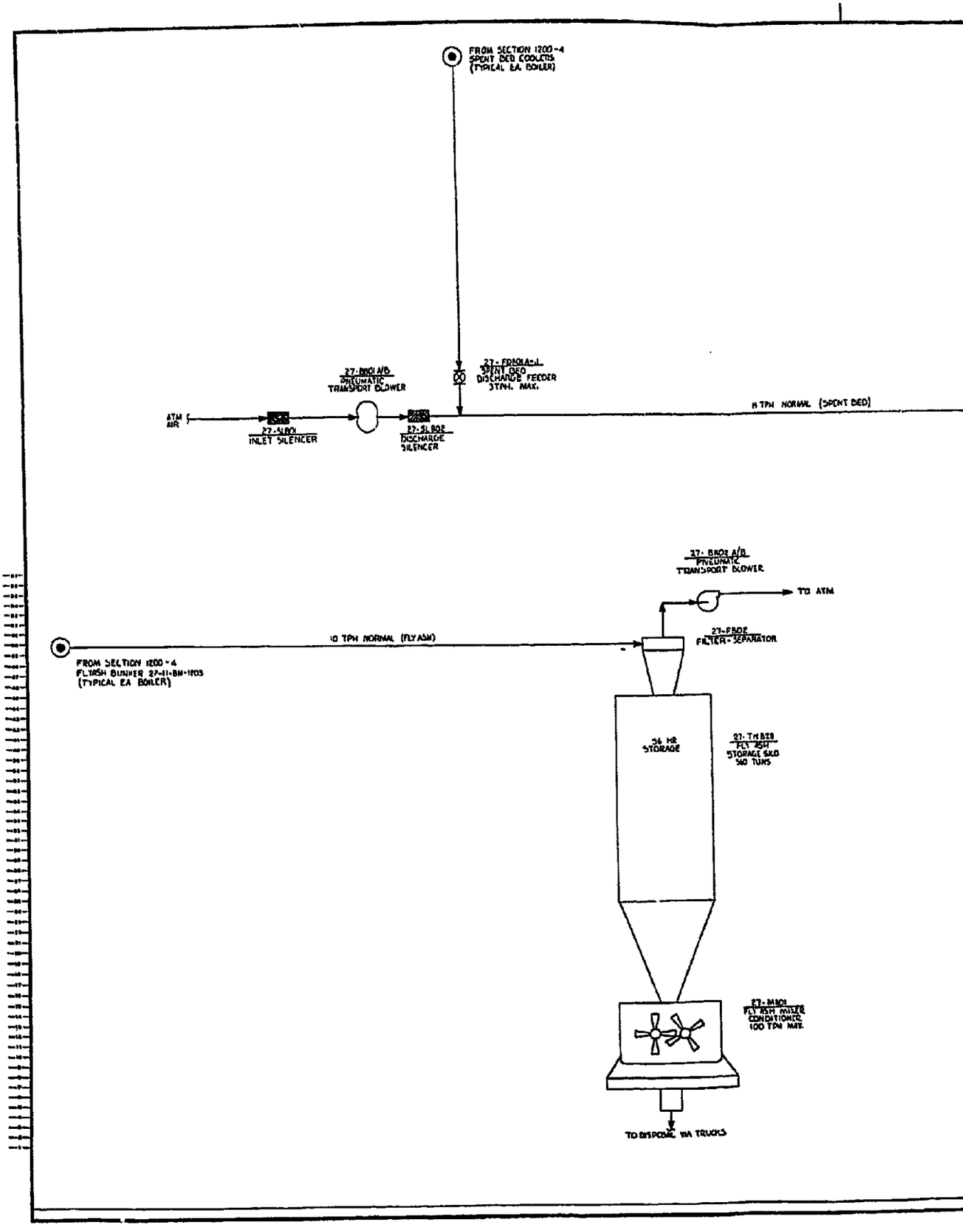
NOTES: 1) FOR LEGEND SEE DWG. Nº 84099-27-1-50-1

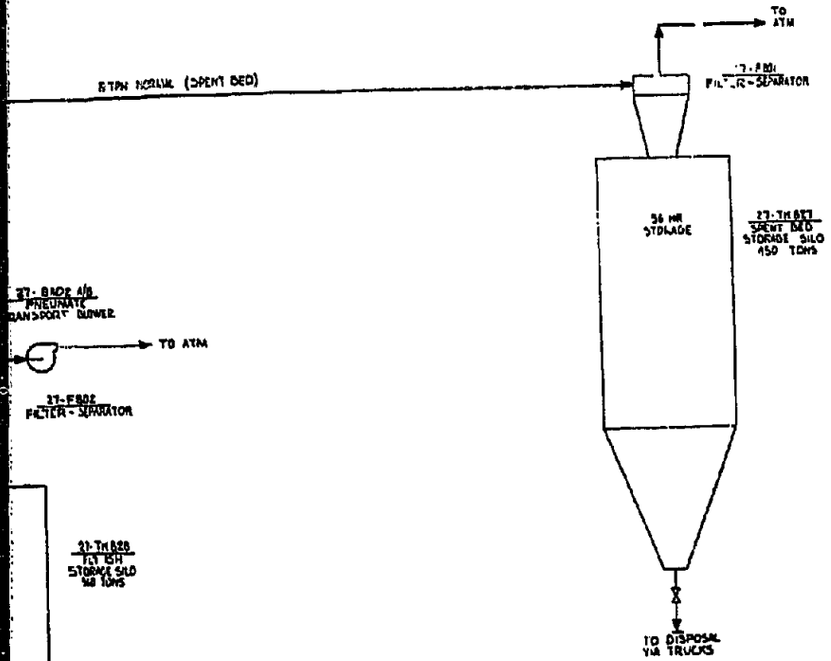
POWER SYSTEMS DIVISION OF THE BABCOCK & WILCOX COMPANY

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION COMMERCIAL DEMO PLANT
PLANT BASED ON B/W GASIFIER
SECTION 800 SLAG HANDLING
MURPHY HILL SITE - ALABAMA

DRAWING NO. 84099-27-1-50-10

A 6/30/80 INITIAL ISSUE


FROM SECTION 1200-4
SPENT BED COOLERS
(TYPICAL EA BOILER)
27-BIOLA/B
PNEUMATIC
TRANSPORT BLOWER
27-FIOOLA-J
SPENT BED
DISCHARGE FEEDER
3TPH. MAX.
8 TPH NORMAL (SPENT BED)
ATM
AIR
27-SL801
INLET SILENCER
27-SL802
DISCHARGE
SILENCER
27-BIO2 A/B
PNEUMATIC
TRANSPORT BLOWER
TO ATM
10 TPH NORMAL (FLY ASH)
27-FB02
FILTER-SEPARATOR
FROM SECTION 1200-4
FLYASH BUNKER 27-11-BN-1103
(TYPICAL EA BOILER)
36 HR
STORAGE
27-TNB28
FLY ASH
STORAGE SILO
560 TONS
27-M801
FLY ASH MIXER
CONDITIONER
100 TPH MAX.
TO DISPOSAL VIA TRUCKS



NOTE: FOR LEGEND SEE DWG. NO. 54099-27-1-50-1

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION COMMERCIAL DEMO PLANT
PLANT BASED ON BW GASIFIERS
SECTION 800 SLAG/ASH HANDLING
MURPHY HILL SITE ALABAMA
11-27-54099 DWG. NO. 54099-27-1-50-1

A	8-30-80	INITIAL ISSUE	CM	

TVA Coal Gasification Study
B&W Gasifiers

SECTION DESCRIPTION

3.9 SECTION 1200 - UTILITY AREA

1200-1 Raw Water Storage & Treatment

A. Reference Material

Process Flowsheet 54099-27-1-50-12

Equipment Summary List

B. Description of Flow

Raw water makeup entering the plant battery limits is of excellent quality. It is river water of the following approximate analyses in milligrams per liter:

Component	Concentration, Mg/liter Median	Maximum	Minimum
Silica (SiO_2)	5	6	3
Calcium (Ca)	19	23	15
Magnesium (Mg)	3.8	4.8	2.0
Sodium (Na)	5.3	24	1
Bicarbonate (HCO_3)	50	62	38
Sulfate (SO_4)	9.9	16	6.3
Chloride (Cl)	8	31	3
Nitrate (NO_3)	1.3	2.8	0
Dissolved Solids (180°C)	84	160	56
Hardness, as $CaCO_3$	62	76	49
pH (SU)	7.4	7.9	6.9
Color (PCU)	5	20	0
Iron	negligible		
Fluorides	negligible		

The Raw Water Storage Tank, TK-1208, also will serve as a reservoir of firewater. Therefore, it should always contain four hours of raw water storage at the peak usage of 4000 gpm per module x 4 modules, even though the normal makeup is about 100 gpm (since water is recovered from wastewater treating and used as cooling tower makeup).

Raw water, after treatment, will be used for cooling tower makeup, as emergency potable and service water, and influent to the demineralizer package provided in SEC 1200-3 to produce water for H.P. boiler feedwater treating. A single train of raw water treating is provided to serve all four modules.

Raw water is lifted from the river by P-1208A/B/C and pumped into TK-1208. Raw water is pumped from TK-1208 to the above-ground Clarifier-Softeners, CL-1201A/B, two units arranged in parallel. Sludge (mud, silt, etc.) will precipitate from the river water in these Clarifiers. Lime, alum and polyelectrolyte are added to the Clarifier feed-wells as required to reduce hardness to a low level and enhance flocculation of suspended solids. Sludge underflowing the Clarifiers is pumped to rotary vacuum or belt filters for concentration of solids. Polymer or lime are added in line in M-1201A/B to improve filtration rate. Filtrate is recycled to the Clarifiers. Concentrated solids are trucked to ash (slag) ponds.

Clarified water flows by gravity to Sandfilters, F-1202A/B, for polishing, reduction of suspended solids to a very low level (1-2ppm). The filters are backwashed periodically, approximately every 12 to 16 hours, for about five minutes. Backwash also is recycled to the Clarifiers.

Treated water leaving the Clarified Water Sandfilters, F-1202A/B, flows to SEC 1200-3, BFW Treating (Demineralization).

ONE TRAIN PER ALL FOUR MODULES (PER PLANT)

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54099
SECTION: 1200-1

EQUIPMENT LIST

NAME OF UNIT: RAW WATER STORAGE & TREATMENT

CLIENT: TVA (COAL GASIFICATION STUDY)

LOCATION: ALABAMA

REVISION	1	2	3	4	5
DATE					
ORIGINAL					

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No/Plant	REV.
CLARIFIER 27-11-	CL-1201 A/B	CLARIFIER-SOFTENER			2- 50%	
FILTERS 27-11-	F-1202A/B	CLARIFIED WATER SANDFILTERS			2- 50%	
	F-1203A/B	SLUDGE FILTRATION SYSTEM			2-100%	
MIXER 27-11-	M-1201A/B	IN-LINE MIXER			2-100%	

ONE TRAIN PER ALL FOUR MODULES

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54099
SECTION: 1200-1

EQUIPMENT LIST

NAME OF UNIT: RAW WATER STORAGE & TREATMENT

CLIENT: TVA (COAL GASIFICATION STUDY)

LOCATION: ALABAMA

REVISION	1	2	3	4	5
DATE					
ORIGINAL					

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
TANKS						
27-11-	TK-1208	RAW WATER STORAGE TANK			1-100%	
-	TK-1209	SANDFILTER BACKWASH SUMP			1-100%	
PUMPS						
27-11-	P-1208A/B/C	RAW WATER LIFT PUMPS			3-50%	
-	P-1209A/B/C	FIREWATER PUMPS			3-50%	
-	P-1210A/B/C	CLARIFIER FEED PUMPS			3-50%	
-	P-1211A/B/C	CLARIFIER UNDERFLOW PUMP			3-50%	
-	P-1212A/B/C	BACKWASH PUMPS			3-50%	

ONE TRAIN PER ALL FOUR MODULES

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54099
SECTION: 1200-1

EQUIPMENT LIST

NAME OF UNIT: RAW WATER STORAGE & TREATMENT

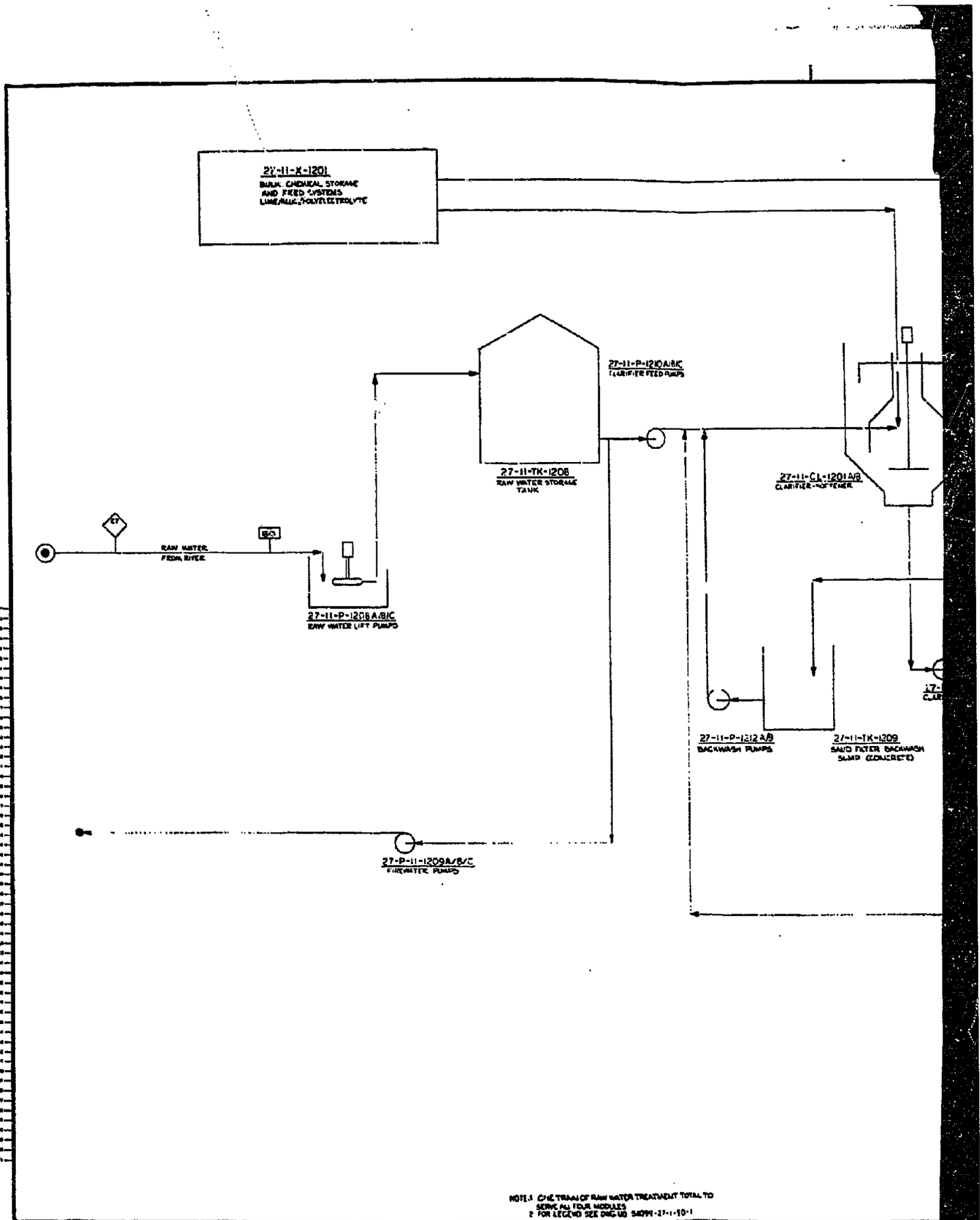
PAGE 3 OF 3

CLIENT: TVA (COAL GASIFICATION STUDY)

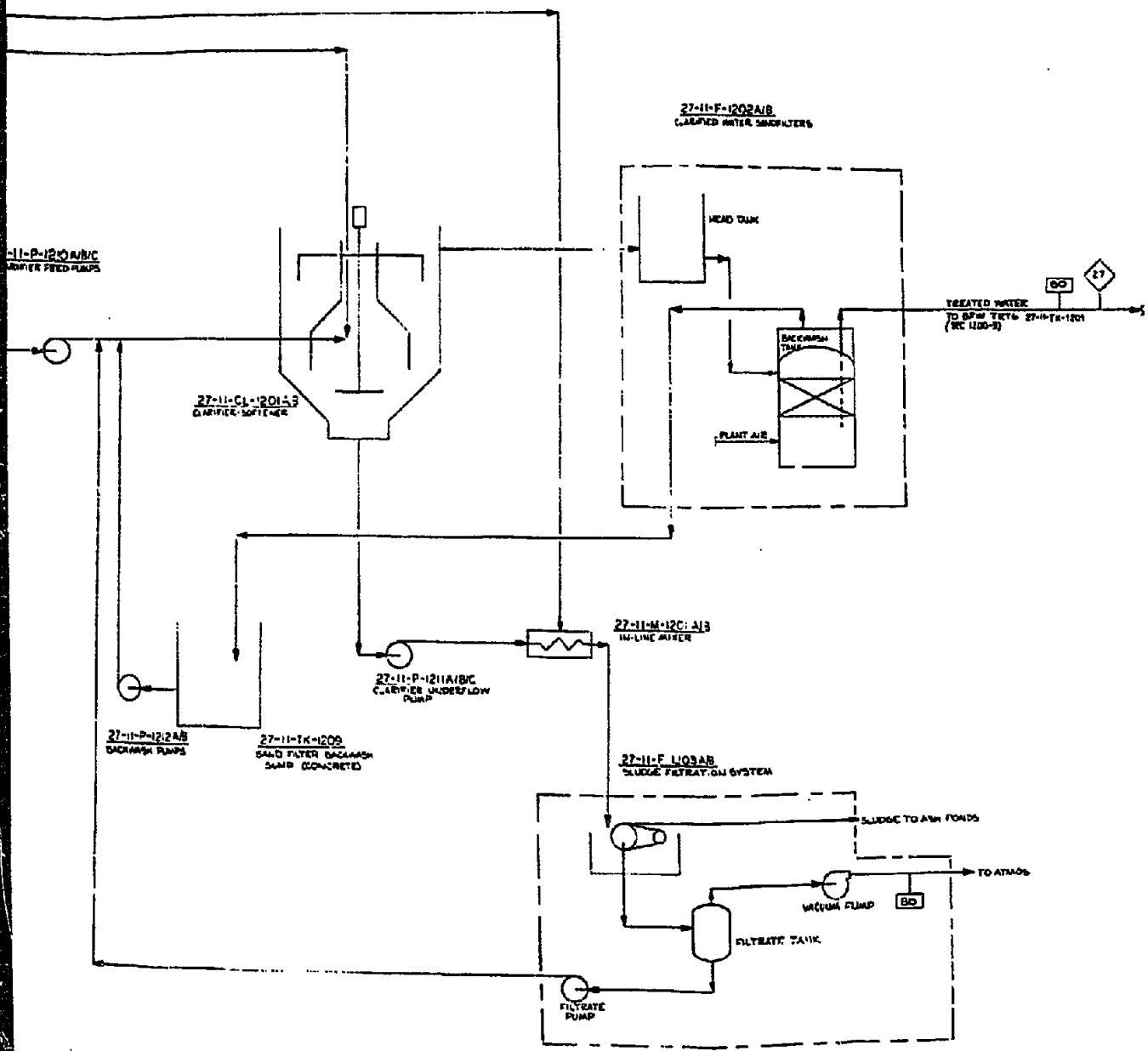
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No/Module	REV.
MISCELLANEOUS						
27-11-	X-1201	BULK CHEMICAL STORAGE AND FEED SYSTEMS			1-100%	



NOTE: 1 ONE TRAIN OF RAW WATER TREATMENT TOTAL TO SERVE ALL FOUR MODULES
2 FOR LEGEND SEE DWG NO 56099-27-11-10-1



PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SEC 1200-1 RAW WATER STORAGE & TREATMENT

11-27-54099 ORIGINAL 54099-27-1-50-12

TVA Coal Gasification Study
B&W Gasifers

1200-2 - Potable Water Storage & Condensate Treatment

A. Reference Material

Process Flowsheet 54099-27-1-50-13

Equipment Summary List

B. Description of Flow

Potable water extracted downstream of the Activated Carbon Filter in the Demineralization Unit (SEC 1200-3) is chlorinated to kill micro-organisms, then stored in the Potable Water Drum, D-1210.

Low pressure condensate, collected from the Condensate Flash Drum, H_2S Stripper Reboiler E-404, SWS Reboiler E-701, the proprietary Beavon Unit, building heating, steam tracings and various other miscellaneous and intermittent users, is flashed from 60 psig to the Deaerator DH-1201 (at ~5 psig), then cooled to about 165°F in the Condensate/Demin. Water Exchanger, E-1201, by exchanging heat with cold demineralized water. The latter stream feeds the Deaerator. Cooled condensate is stored in the Condensate Storage Tank, TK-1203.

Condensate recovery has been maximized in order to minimize raw water intake costs. Four hours of condensate hold-up is maintained to protect against possible leakage of a process stream into the condensate. Adequate hold-up permits condensate dumping until the source of the problem is located and a course of action is taken. Condensate from the Condensate Storage Tank, TK-1203, is pumped by Condensate Pumps, P-1203A/B, to the Deaerator, DH-1201. Condensate from turbine drives on the Air Compressor C-201A, Oxygen Compressor C-202, and the condensed portion from the turbine driving the Product Gas Compressor, C-501, also enter the Deaerator as does condensate from the shell side of BFW preheaters E-1205 and E-1206. The required deaeration steam is provided by L.P. steam from the 60 psig steam header and to a lesser extent by flashed steam from the Intermittent Blowdown Drum, D-1207.

Deaeration is required to prevent corrosion in the M.P. and H.P. boilers. The Deaerator, DH-1201, normally operates at 5 psig. Steam is used as the stripping medium and is vented to atmosphere, thereby removing gases entrained in BFW. Demineralized water make-up maintains the level in the deaerator storage drum.

Final oxygen control is maintained by chemical addition of hydrazine, an oxygen scavenger, directly to the deaerator. Amine is added in the form of morpholine to the boiler feedwater pump suction line to control corrosion of piping.

Deaerated BFW is pumped through preheater E-1205 which preheats M.P. condensate and feeds the M.P. condensate header. A sidestream is withdrawn upstream of E-1205 and boosted to a higher pressure by the BFW Booster Pump, P-1213A/B, thereby providing high pressure (935 psig) BFW. This stream is preheated in the H.P. Condensate Heater, E-1206, before entering the H.P. condensate header.

ONE POTABLE WATER DRUM FOR ALL FOUR MODULES
ONE TRAIN OF CONDENSATE TREATMENT FOR EACH MODULE

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54093
SECTION: 1200-2

EQUIPMENT LIST

NAME OF UNIT: POTABLE WATER & CONDENSATE TREATMENT

PAGE 1 OF 2

CLIENT: TVA (COAL GASIFICATION STUDY)
LOCATION: ALABAMA

REVISION	1	2	3	4	5
DATE					
ORIGINAL					

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No/Plant	REV.
DRUMS						
27-11-	D-1208	CONDENSATE FLASH DRUM			4-25%	
-	D-1210	POTABLE WATER DRUM			1-100%	
TANK						
27-11-	TK-1203	CONDENSATE STORAGE TANK			4- 25%	
EXCHANGERS						
27-11-	E-1201	CONDENSATE/DEMIN WATER EXCHANGER			4 -25%	
-	E-1205	M.P. CONDENSATE HEATER			4 -25%	
-	E-1206	H.P. CONDENSATE HEATER			4 -25%	
PUMPS						
27-11-	P-1203A/B	CONDENSATE PUMPS			8 -25%	
-	P-1205A/B	BFW PUMP			8 -25%	
-	P-1213A/B	BFW BOOSTER PUMP			8 -25%	
MISCELLANEOUS						
27-11-	X-1202	HYPOCHLORINATOR			1-100%	
27-11	-DH-1201	DEAERATOR			4 -25%	

ONE TRAIN OF CONDENSATE TREATMENT FOR EACH MODULE

FORM NO. 135-804

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54099
SECTION: 1200-2

EQUIPMENT LIST

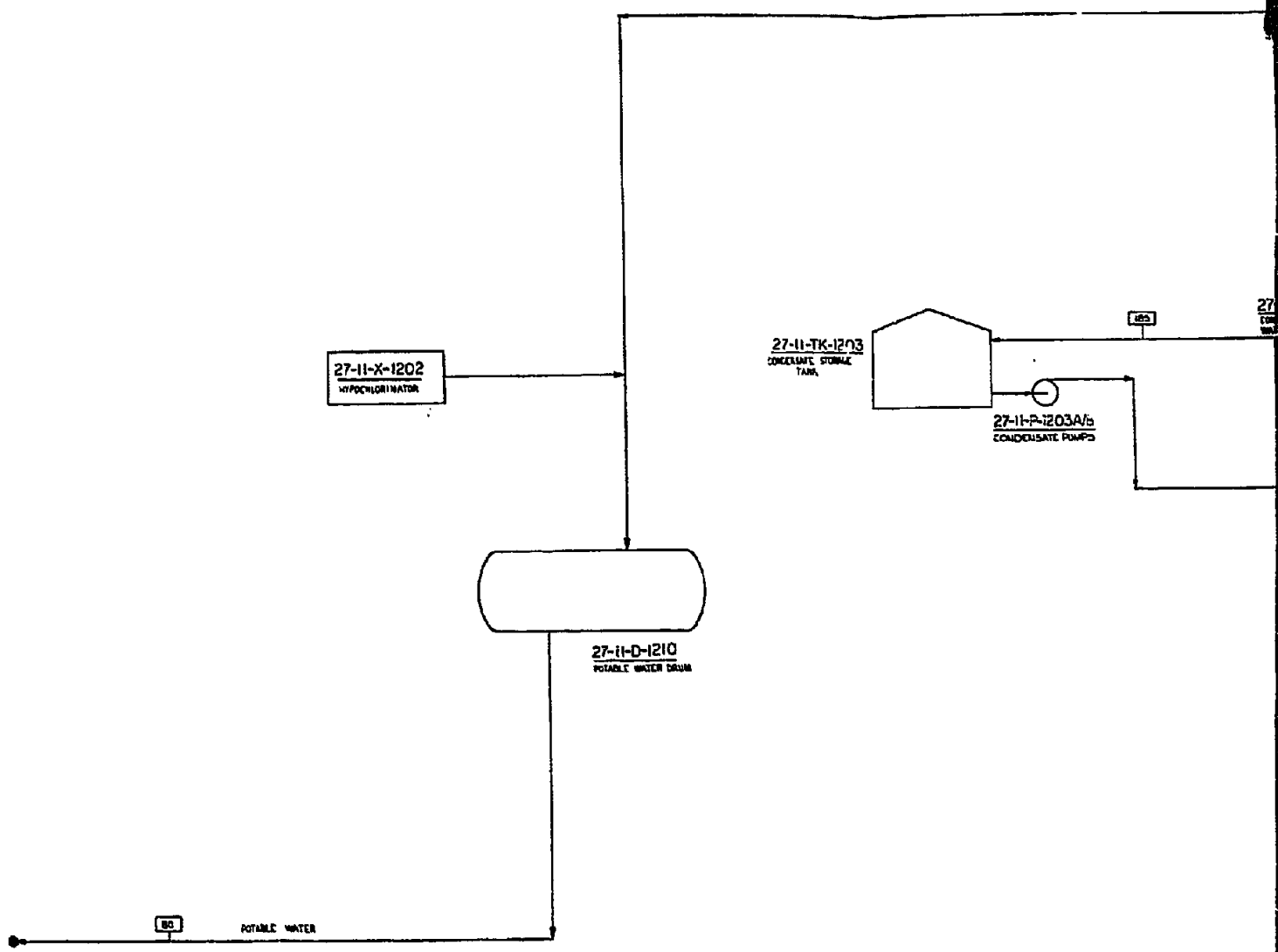
NAME OF UNIT: ~~CONDENSATE~~ POTABLE WATER & TREATMENT

PAGE 2 OF ~~3~~

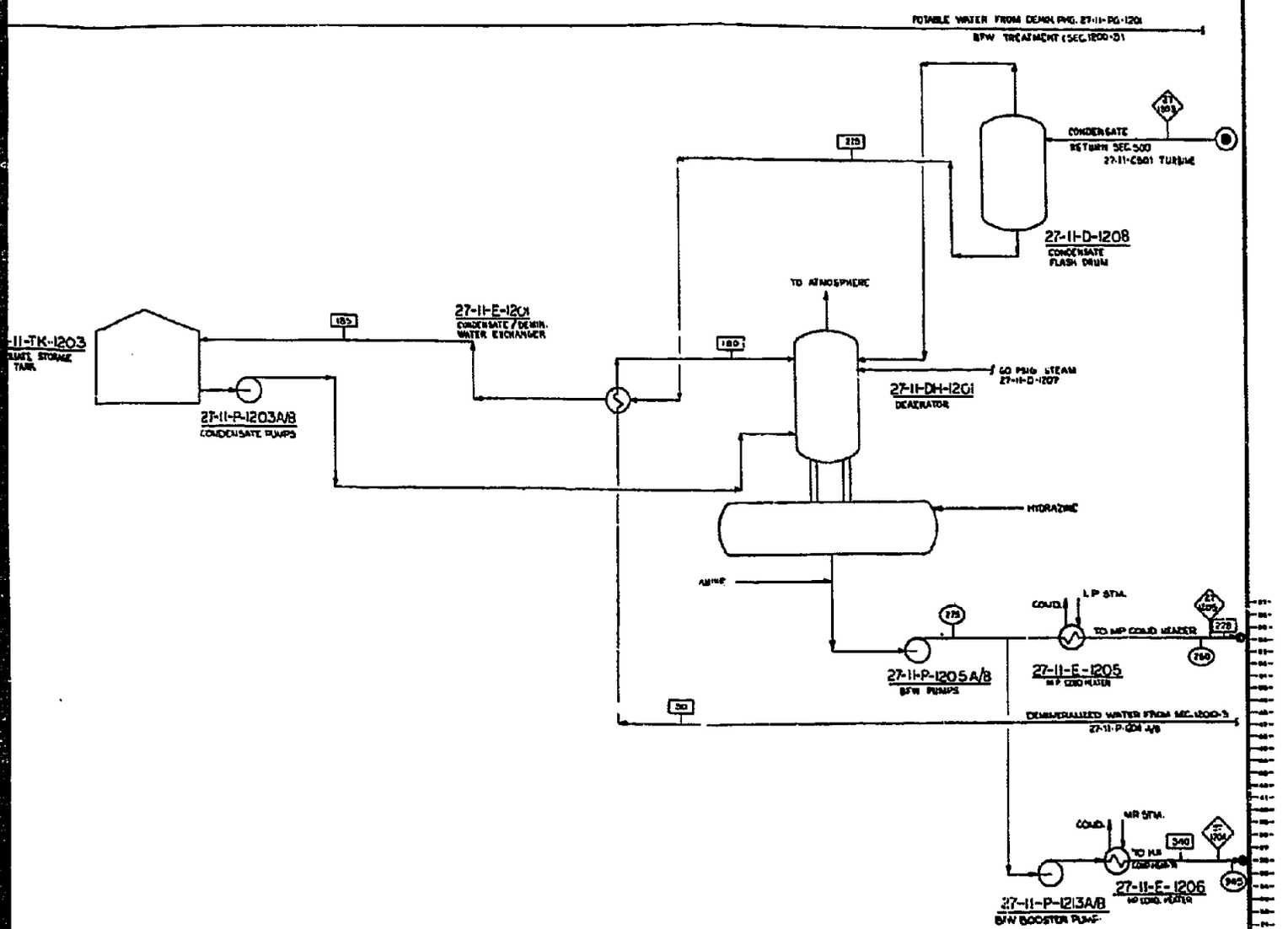
CLIENT: TVA COAL GASIFICATION STUDY
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Plant	REV.
PACKAGE ITEMS						
27-11-	PG-1202	AMINE INJECTION PACKAGE			4-25%	
-	PG-1203	HYDRAZINE INJECTION PACKAGE			4-25%	



NOTE: A SINGLE POTABLE WATER DRUM WILL SUFFICE TO SERVE ALL FOUR MODULES FOR CONDENSATE STORAGE AND TREATING PROVIDE A SEPARATE SYSTEM (AS SHOWN ABOVE) FOR EACH MODULE IE. FOUR TOTAL PER PLANT.
FOR LEGEND SEE DWG. NO 54099-27-1-50-1



OTABLE WATER DRUM WILL SUFFICE TO SERVE ALL
ER FOR CONDENSATE STORAGE AND TREATING PROVIDE
SYSTEM (AS SHOWN ABOVE) FOR EACH MODULE 1E,
PER PLANT.
SEE DWG. NO 54099-27-1-50-1

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTION 1200-2 POTABLE WATER STORAGE AND CONDENSATE TREATMENT

DWG. NO 54099-27-1-50-13

TVA Coal Gasification Study
B & W Gasifiers

1200-3 Boiler Feedwater Treatment

A. Reference Material:

- Process Flowsheet: 54099-27-1-50- 14
  54099-27-1-50-151

- Equipment Summary List:

B. Description of Flow

Treated river water at 75 - 80°F average, from Raw Water Treating, Sec 1200-1. is stored in TK-1201 (8 hour surge) then partly used as cooling tower and Gas Scrubbing (Sec 300) makeup. Most of the treated raw water undergoes additional treatment in a Demineralizer Package, PG-1201, to upgrade the water quality for use in the fluid bed boilers which generate high pressure superheated steam (935 psig/775°F). This demineralization system has an activated carbon filter to remove organic chlorides found in the river water in order to protect the downstream resin beds of the demineralizer. Cation exchangers (weak acid unit) reduce hardness and alkalinity; a degasifier removes carbon dioxide and reduces the load on the following mixed bed unit which removes silica and other anions. Demineralized undeaerated water is stored in the Demineralized Water Storage Tank, TK-1204, which provides about 8 hrs. hold-up. From this tank, the demineralized water is pumped through the Condensate/Demineralized Water Exchanger, E-1201, in Sec 1200-2.

Potable water is extracted downstream of the Demineralization Unit Activated Carbon Filter and flows to the Potable Water Drum, D-1210, in Sec 1200-2.

A Neutralization Tank, TK-1202, is provided to collect rinse and regenerant streams from the Demineralizer Package. These wash streams then are neutralized with 66° BE sulfuric acid or 50% caustic, as required. Wastes then are drained to the Clean Water Holding Basin, X-1506, located in the Wastewater Treatment Area, Sec 1500.

1 TRAIN PER MODULE

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT 11-27-54099 SECTION: 1200-3	EQUIPMENT LIST	NAME OF UNIT: BFW TREATMENT	PAGE 1 OF 2

CLIENT: TVA (COAL GASIFICATION STUDY)

LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
PACKAGE ITEM						
27-11-	PG-1201	DEMINERALIZER PACKAGE			1-100%	
EXCHANGERS						
27-11-	E-1202	TREATED WATER TANK HEATER			1-100%	
-	E-1203	WATER BACKWASH HEATER			1-100%	
-	E-1204	CAUSTIC STORAGE DRUM HEATER			1-100%	
DRUMS						
27-11-	D-1201	SULFURIC ACID STORAGE DRUM			1-100%	
-	D-1202	CAUSTIC STORAGE DRUM			1-100%	

1 TRAIN PER MODULE

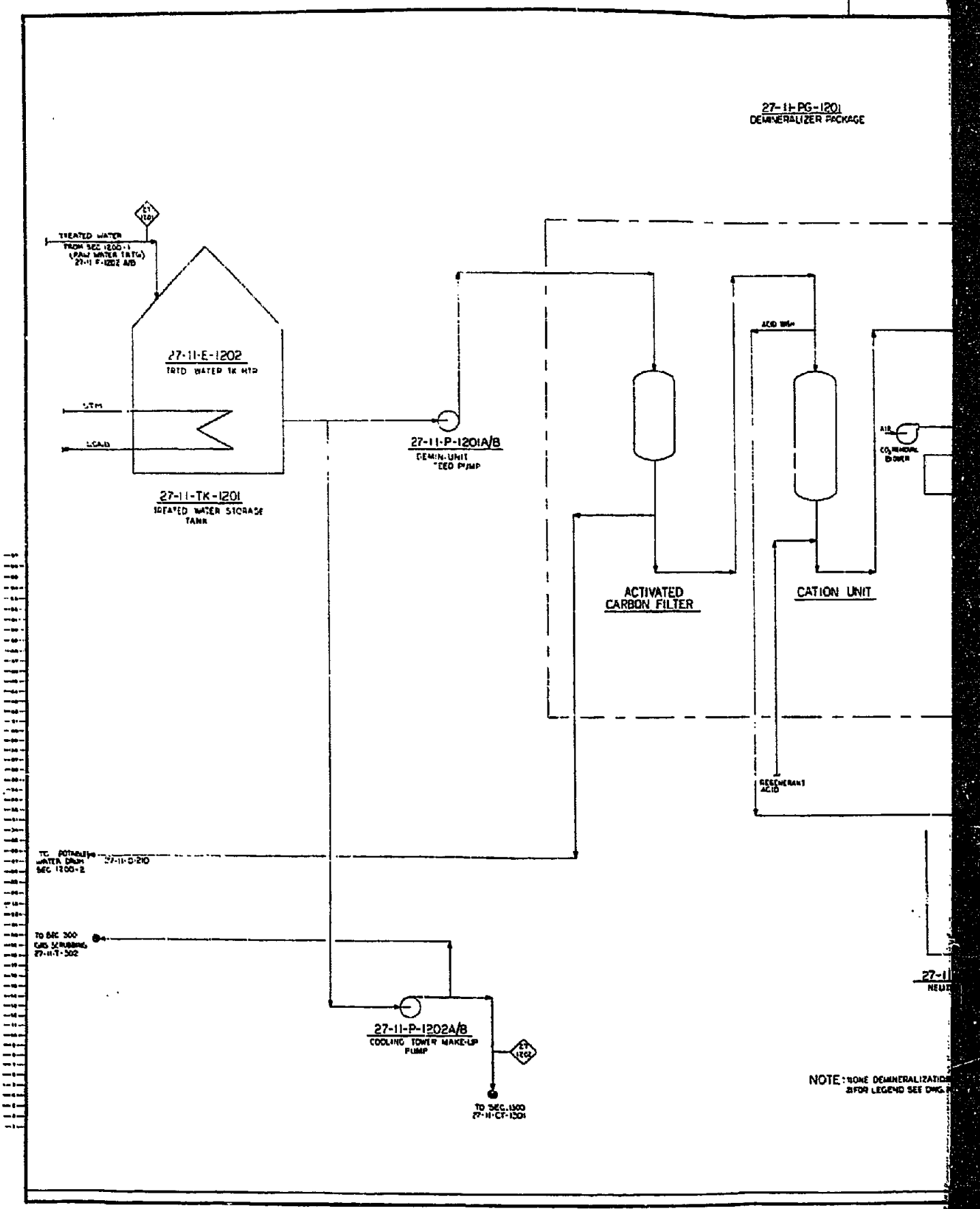
FORM NO. 135-904

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT: 11-27-54099 SECTION: 1200-3	EQUIPMENT LIST	NAME OF UNIT: BFW TREATMENT	PAGE 2 OF 2

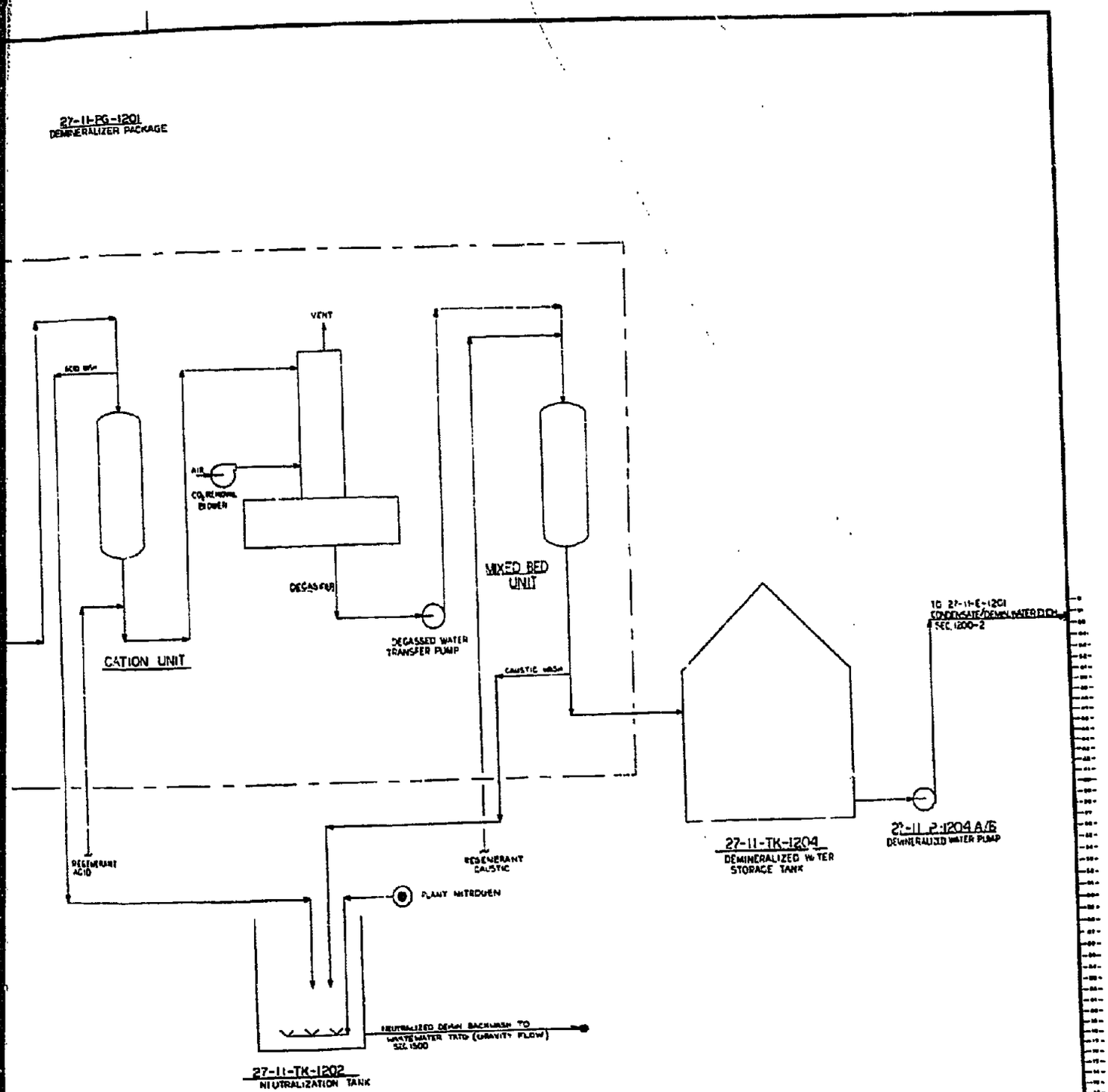
CLIENT: TVA (COAL GASIFICATION STUDY)
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
TANKS						
27-11-	TK-1201	TREATED WATER STORAGE TANK			1-100%	
-	TK-1202	NEUTRALIZATION TANK			1-100%	
-	TK-1204	DEMINERALIZED WATER STORAGE TANK			1-100%	
PUMPS						
27-11-	P-1201A/B	DEMIN UNIT FEED PUMP			2-100%	
-	P-1202A/B	COOLING TOWER MAKEUP PUMP			2-100%	
-	P-1204A/B	DEMINERALIZED WATER PUMP			2-100%	
-	P-1206	REGENERATION ACID PUMP			1-100%	
-	P-1207	REGENERATION CAUSTIC PUMP			1-100%	
-	P-1208	NEUTRALIZATION ADJUST ACID PUMP			1-100%	
-	P-1209	NEUTRALIZATION ADJUST CAUSTIC PUMP			1-100%	


27-11-PG-1201
DEMINERALIZER PACKAGE
TREATED WATER
FROM SEC 1200-1
(RAW WATER TRTD)
27-11-P-1202 A/B
27-11-E-1202
TRTD WATER HTR
STM
COND
27-11-TK-1201
TREATED WATER STORAGE TANK
27-11-P-1201A/B
DEMIN. UNIT FEED PUMP
ACTIVATED CARBON FILTER
CATION UNIT
AIR
REGENERANT ACID
TO POTABLE WATER DRUM SEC 1200-2
27-11-D-1210
TO SEC 300 GAS SCRUBBING 27-11-T-302
27-11-P-1202A/B
COOLING TOWER MAKE-UP PUMP
TO SEC. 1300
27-11-CT-1301
NOTE: 1 ONE DEMINERALIZATION
2 FOR LEGEND SEE DWG.

27-11-PG-1201
DEMINERALIZER PACKAGE



NOTE: ONE DEMINERALIZATION UNIT REQD PER MODULE
#FOR LEGEND SEE DWG No 54099-27-1-50-1

FOSTER WHEELER ENERGY CORPORATION	PROCESS FLOW DIAGRAM TVA COAL GASSIFICATION STUDY SEC. 1200-3 BFW TREATMENT
DRAWN BY: AC | APP'D: | SCALE: | REV: | SUP. NO.	11-27-54099 | DWG. 54099-27-1-50-1

TVA Coal Gasification Study
B&W Gasifiers

Section Description

Section 1200-4 - Steam Generation and Distribution

A. Reference Material

Process Flowsheet	FWEC Drawing No. 54099-27-1-50-15
Steam Balance Summary	FWEC Drawing No. 54099-27-1-50-151
Equipment Summary List	

B. Description of Flow

Flow of steam generation and distribution may be followed on the Plant Steam, Condensate and Boiler Feedwater Balance Diagram, Drawing No. 54099-27-1-50-151.

High pressure superheated steam is generated primarily through waste heat recovery in E-301 during Gas Cooling in Section 300 with additional high pressure steam being generated in the H.P. Steam Generators, SG-1201A & B. Sufficient steam generation capacity is available with the two fluid bed boilers to assure an adequate supply of steam to shut down the plant under power outage conditions.

The steam header system consists of three steam levels:

High Pressure (H.P.)	935 psig, 775°F
Medium Pressure (M.P.)	250 psig sat'd, 406°F
Low Pressure (L.P.)	60 psig sat'd, 308°F

Most of the high pressure steam is condensed or expanded through turbines driving the Air Compressor, C-201A; the Oxygen Compressor, C-202; and the Product Gas Compressor, C-501. A small amount of H.P. steam is required for preheat in the Claus Sulfur Recovery Plant. A significant portion of the steam utilized to drive the Product Gas Compressor is extracted at 250 psig (medium pressure level) through the turbine running this compressor. Condensate from H.P. steam users is returned to the deaerator.

Medium pressure steam is generated in the Gasification section in the M.P. Steam Drum, D-302, and also extracted from the Product Gas Compressor turbine. M.P. steam is utilized principally in the Acid Gas Removal (Selexol) Refrigeration Compressor, PG-402, and to a lesser extent in the Gasification section Char Eductor, J-302, as preheat for H.P. condensate in E-1205 and to preheat the gas entering COS hydrolysis (in Raw Gas Heater, E-407).

Low pressure steam results from the Refrigeration Compressor, PG-402, turbine exhaust, flashed boiler blowdown in the Continuous Blowdown Drum, D-1206, and a small quantity from flashed H.P. condensate in the Condensate Flash Drum. The major consumers of L.P. steam are the Selexol Reboiler (H_2S Stripper), E-404, Sour Water Stripper Reboiler, E-701, M.P. Condensate Heater, E-1205, preheating M.P. condensate, and Deaerator, DH-1201, deaerating H.P. and M.P. boiler feedwaters. Also the Beavon Tail Gas Treating Unit (Sec 600) and steam tracing and miscellaneous items utilize L.P. steam.

Boiler blowdown from the Continuous Blowdown Drum, D-1206, is directed to the Cooling Tower as cooling tower makeup. D-1206 receives continuous condensate streams from H.P. steam generation (Sec 1200-4) and the Gasification M.P. Steam Drum, D-302, and from Blowdown Drum, D-603 (which receives blowdown from the Claus Plant Sulfur Condensers). Intermittent blowdown from the H.P. Steam Generators, SG-1201A/B, an aqueous sludge, is flashed to the Intermittent Blowdown Drum, D-1207. Vapor vents to the Deaerator. The small stream from the drum is sent to the Wastewater Treating Section and treated together with the Dirty Water streams. This sludge will settle out with lime sludge in the Clarifier. CL-1501. It is pumped to the Sludge Pond for settling and storage.

L.P. condensate flows to the Condensate Storage Tank, TK-1203. Condensate is polished in a Mixed Bed Polishing Unit, then pumped to the Deaerator for subsequent use as boiler feedwater (M.P. and H.P.). A BFW Booster Pump, P-1213A/B, is provided in series with the M.P. BFW Pump, P-1205A/B, to pump a portion of the deaerated condensate to the H. P. Level (side stream).

Process flowsheet 54099-27-1-50-15 shows both the Fluid Bed Boilers, 27-11-SG-1201A/B and the Flue Gas Generators, 27-11-PG-1201A/B. Additional flue gas is produced in the generators to provide sufficient hot gas for drying the coal required for Gasification in Sec. 300A. Limestone is injected into both the Flue Gas Generators and Steam Generators to reduce the sulfur emission. Approximately 90% of the sulfur in the coal is converted to calcium sulfite, recovered as ash, and discharged to the Slag Pond.

1 TRAIN PER MODULE

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT 11-27-54099 SECTION: 1200-4	EQUIPMENT LIST	NAME OF UNIT STEAM GENERATION	PAGE 1 OF 4

CLIENT: TVA (COAL GASIFICATION STUDY)
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
BLOWER						
27-11-	B-1201A/B	BOILER AIR BLOWERS			2-100%	
-	B-1202A/B	GENERATOR AIR BLOWER			2-50%	
-	B-1203A/B	TEMPERING AIR BLOWER			2-50%	
BUNKERS						
27-11-	BN-1201	COAL BUNKER			1-100%	
-	BN-1202	LIMESTONE BUNKER			1-100%	
-	BN-1203	ASH BUNKER			1-100%	
-	BN-1204A/B	LIMESTONE BIN			2-50%	
-	BN-1205A/B	COAL BIN			2-50%	
DRUMS						
27-11-	D-1206	CONTINUOUS BLOWDOWN DRUM			1-100%	
-	D-1207	INTERMITTENT BLOWDOWN DRUM			1-100%	

1 TRAIN PER MODULE

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT. 11-27-54099 SECTION: 1200-4	EQUIPMENT LIST	NAME OF UNIT STEAM GENERATION	PAGE 2 OF 4

CLIENT: TVA (COAL GASIFICATION STUDY)
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	NO./Module	REV.
CONVEYORS 27-11-	CR-1201	COAL CONVEYOR			1-100%	
-	CR-1202	LIMESTONE CONVEYOR			1-100%	
-	CR-1203 A/B	ASH COOLER-CONVEYOR			2-100%	
-	CR-1204 A/B	LIMESTONE BIN CONVEYOR			2-50%	
-	CR-1205 A/B	COAL BIN CONVEYOR			2-50%	
EJECTORS 27-11-	J-1201 A/B	LIMESTONE EJECTORS			2-100%	
-	J-1202	ASH EJECTOR			1-100%	

1 TRAIN PER MODULE

FORM NO. 135-804

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT: 11-27-54099 SECTION: 1200-4	EQUIPMENT LIST	NAME OF UNIT: STEAM GENERATION	PAGE 3 OF 4

CLIENT: TVA (COAL GASIFICATION STUDY)

LOCATION: ALABAMA

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	REVISION / DATE / ORIGINAL: No./Module	1	2	3	4	5	REV.
FEEDERS											
27-11-	FD-1201A/B	COAL FEEDERS			2-100%						
-	FD-1202A/B	LIMESTONE FEEDERS			2-100%						
-	FD-1203A/B	LIMESTONE BIN FEEDER			2-50%						
-	FD-1204A/B	COAL BIN FEEDER			2-50%						
PACKAGE/ITEM											
27-11-	PG-1201	PHOSPHATE ADDITION PACKAGE			1-100%						
-	PG-1204A/B	FLUE GAS GENERATOR			2-50%						

1 TRAIN PER MODULE

FORM NO. 135-90-

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54099
SECTION: 1200-4

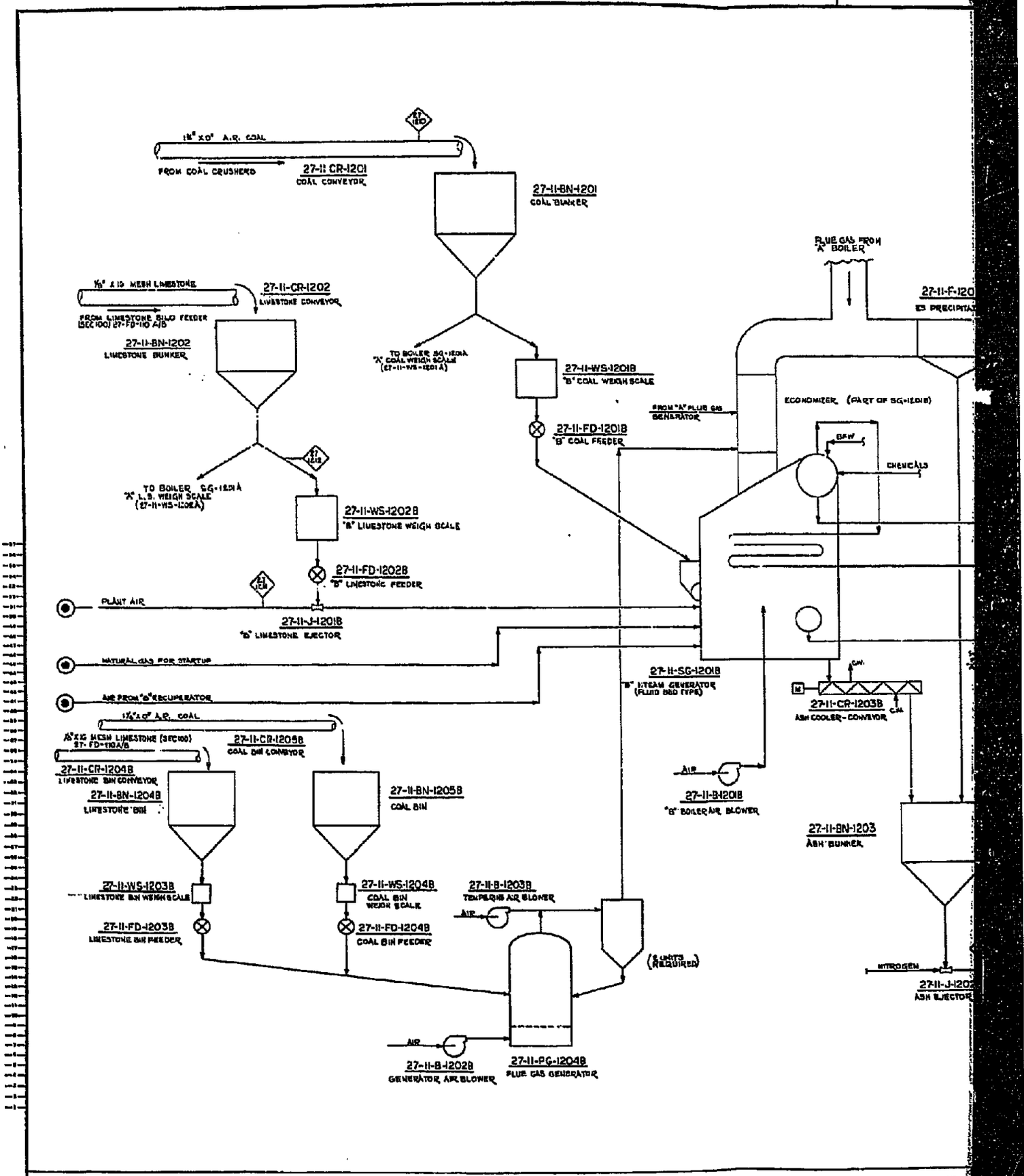
EQUIPMENT LIST

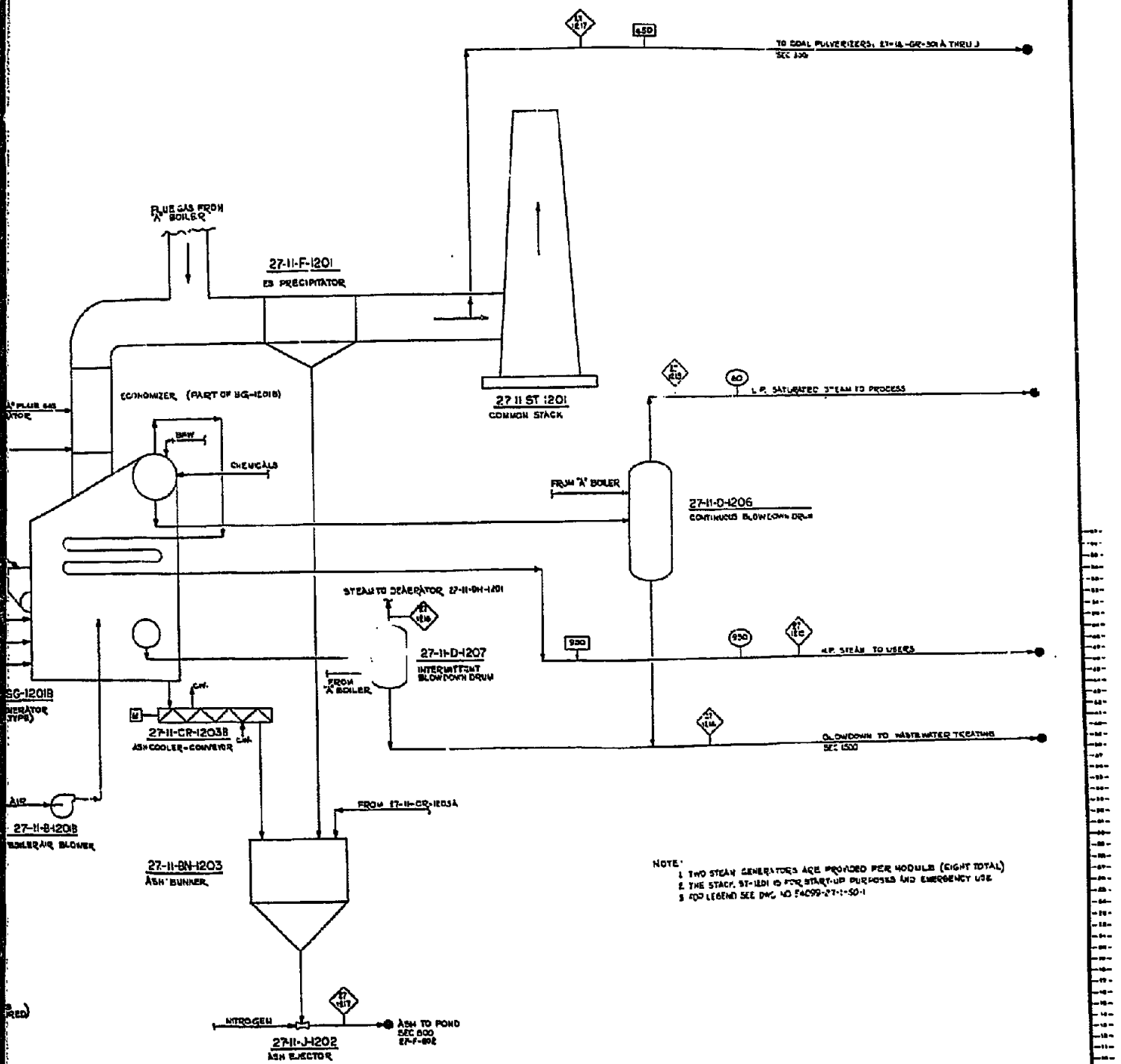
NAME OF UNIT: STEAM GENERATION

CLIENT: TVA (COAL GASIFICATION STUDY)
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
STEAM GENERATORS						
27-11-	SG-1201A/B	FLUID BED BOILERS (STEAM GENERATORS)			2-100%	
STACK						
27-11-	ST-1201	COMMON STACK			1-100%	
FILTER (Pptr)						
27-11-	F-1201	ELECTROSTATIC PRECIPITATOR			1-100%	
WEIGH SCALES						
27-11-	WS-1201A/B	COAL WEIGH SCALES			2-100%	
-	WS-1202A/B	LIMESTONE WEIGH SCALES			2-100%	
-	WS-1203A/B	LIMESTONE BIN WEIGH SCALE			2-50%	
-	WS-1204A/B	COAL BIN WEIGH SCALE			2-50%	


1/8" X 0" A.R. COAL
FROM COAL CRUSHERS
27-11-CR-1201
COAL CONVEYOR
27-11-BN-1201
COAL BUNKER
1/8" X 10 MESH LIMESTONE
27-11-CR-1202
LIMESTONE CONVEYOR
FROM LIMESTONE BULD FEEDER (SEC 100) 27-FD-110 A/B
27-11-BN-1202
LIMESTONE BUNKER
TO BOILER SG-1201A "A" COAL WEIGH SCALE (27-11-WS-1201A)
27-11-WS-1201B
"B" COAL WEIGH SCALE
27-11-FD-1201B
"B" COAL FEEDER
TO BOILER SG-1201A "A" L.S. WEIGH SCALE (27-11-WS-1202A)
27-11-WS-1202B
"B" LIMESTONE WEIGH SCALE
27-11-FD-1202B
"B" LIMESTONE FEEDER
PLANT AIR
27-11-J-1201B
"B" LIMESTONE EJECTOR
NATURAL GAS FOR STARTUP
AIR FROM "B" RECUPERATOR
1/8"x0" A.R. COAL
8"X10 MESH LIMESTONE (SEC 100) 27-FD-110A/B
27-11-CR-1203B
COAL BIN CONVEYOR
27-11-CR-1204B
LIMESTONE BIN CONVEYOR
27-11-BN-1204B
LIMESTONE BIN
27-11-BN-1205B
COAL BIN
27-11-WS-1203B
LIMESTONE BIN WEIGH SCALE
27-11-WS-1204B
COAL BIN WEIGH SCALE
27-11-FD-1203B
LIMESTONE BIN FEEDER
27-11-FD-1204B
COAL BIN FEEDER
27-11-B-1203B
TEMPERING AIR BLOWER
(2 UNITS REQUIRED)
27-11-B-1202B
GENERATOR AIR BLOWER
27-11-FG-1204B
FLUE GAS GENERATOR
FLUE GAS FROM "A" BOILER
ECONOMIZER (PART OF SG-1201B)
FROM "A" FLUE GAS GENERATOR
BFW
CHEMICALS
27-11-SG-1201B
"B" STEAM GENERATOR (FLUID BED TYPE)
27-11-CR-1203B
ASH COOLER-CONVEYOR
27-11-B-1201B
"B" BOILER AIR BLOWER
27-11-BN-1203
ASH BUNKER
NITROGEN
27-11-J-1202
ASH EJECTOR



NOTE:
1. TWO STEAM GENERATORS ARE PROVIDED PER MODULE (EIGHT TOTAL)
2. THE STACK, ST-1201 IS FOR START-UP PURPOSES AND EMERGENCY USE
3. FOR LEGEND SEE DWG. NO. FW099-27-1-50-1

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SEC 1200-4 STEAM GENERATION
FLUIDIZED BED BOILER

FW 11-27-54099

TVA Coal Gasification Study
B & W Gasifiers

SECTION DESCRIPTION

3.10 SECTION 1300 - COOLING WATER SYSTEM

A. Reference Material:

. Process Flowsheet: 54099-27-1-50- 16
54099-27-1-50-161

. Equipment Summary List:

B. Description of Flow

The cooling water system consists of a mechanical draft cooling tower, cooling water circulation pumps, chemical addition, blowdown pumps, chromate recovery (if economical), chromate destruct, and settler/thickener packages.

Cooling water at 88°F is pumped by Cooling Water Circulating Pumps, P-1301, A/B/C from Cooling Tower, CT-1301 to the supply header. From the supply header it flows through the distribution system to users and then, into the return header at an average temperature of 103°F. From the return header, it flows back into Cooling Tower, CT-1301, thus completing a closed-loop cycle.

Chemical feeding equipment associated with the cooling water system includes facilities for the addition of chlorine, corrosion inhibitor, dispersant and sulfuric acid. A cooling water monitoring system provides for automatic and continuous sensing of circulating water quality and sends resulting output signals to chemical additives pumps, provided as part of the cooling tower package, and a cooling bleed valve for maintaining non-scaling, minimum corrosion conditions. Gaseous chlorine from cylinders is fed directly into the cooling tower basin by means of an eductor, with water supplied by a tap off the circulating pumps discharge as motive fluid.

To control pH and total dissolved solids content of the cooling water, a bleed stream is pumped by the Cooling Tower Blowdown Pump, P-1302 A/B, to Chromate Recovery, X-1504, then to Chromate Destruct Package, X-1505, located in the Wastewater Treatment Section. The effluent stream from Chrome Destruct is fed to a Settler/Thickener Package, part of

X-1505, from which clarified overflow is sent to a Treated C. T. Effluent Tank, TK-1503, then discharged to the outfall. Thickened underflow sludge is pumped to an offsite area for eventual landfill.

The primary source of make-up cooling water is treated river water from the Treated Water Storage Tank, TK-1201, in Section 1200-3. Makeup is also available as intermittently flowing streams from Wastewater Treatment, Sec 1500, and other sections (Sec 200, etc.)

Cooling water users are shown on Dwg. No. 54099-1-50-161.

1 TRAIN PER MODULE

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54099
SECTION: 1300

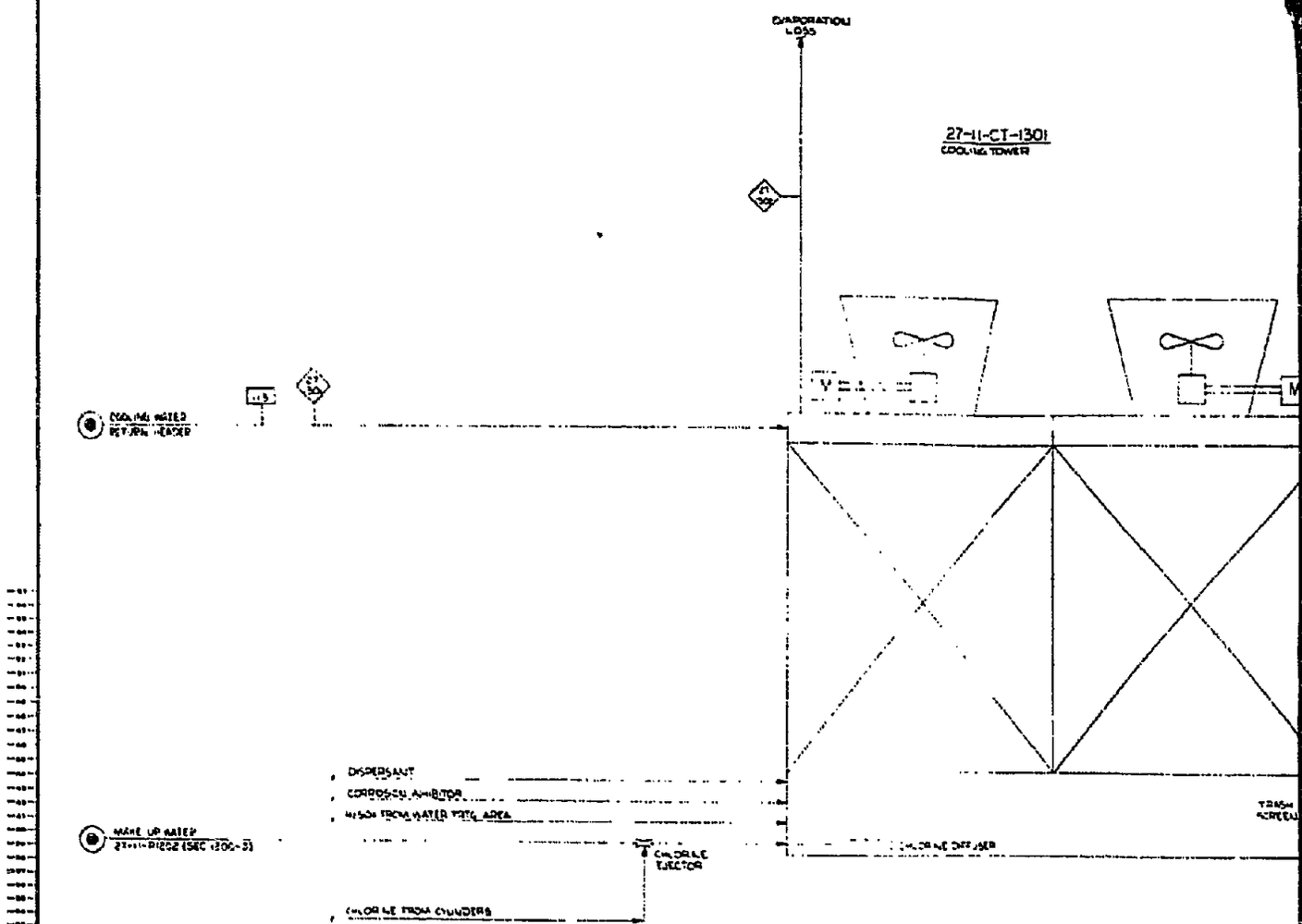
EQUIPMENT LIST

NAME OF UNIT: COOLING WATER SYSTEM

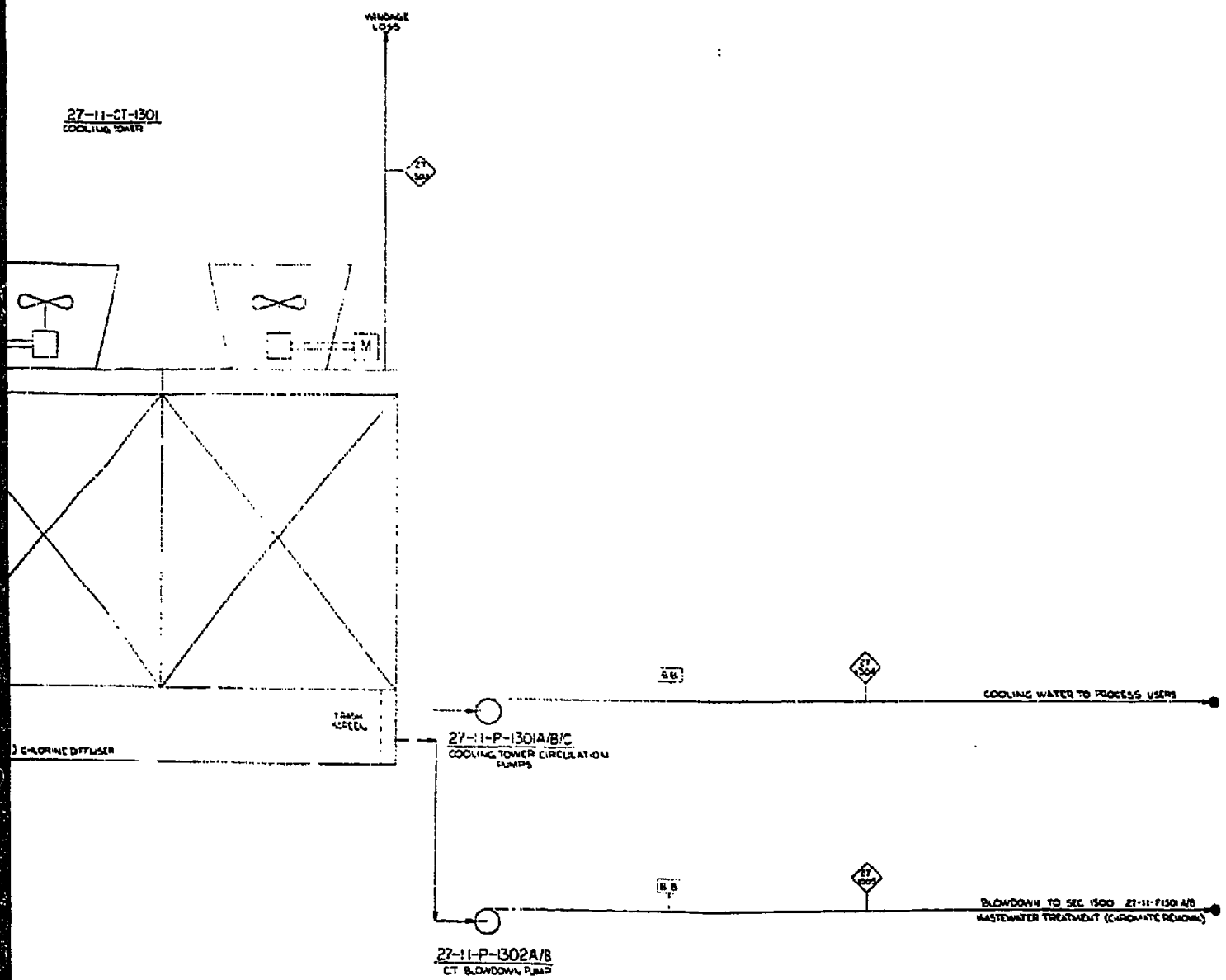
CLIENT: TVA (COAL GASIFICATION STUDY)
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
COOLING TOWER 27-11-	CT-1301	COOLING TOWER PACKAGE			1-100%	
PUMPS 27-11-	P-1301A/B/C	COOLING TOWER CIRCULATION PUMPS			3-50%	
-	P-1302A/B	COOLING TOWER BLOWDOWN PUMP			2-100%	



NOTE 1 ONE COOLING TOWER REQUIRED PER MODULE
2. FOR LEGEND SEE DWG NO 34099-27-1-50-1



POSTER WHEELER ENERGY CORPORATION

FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SEC 1300 COOLING WATER SYSTEM

DWG NO. 34099-27-F-501-K

TVA Coal Gasification Study
B & W Gasifiers

SECTION DESCRIPTION

3.11 SECTION 1400 - FLARE SYSTEM

A. Reference Material:

- Process Flowsheet: FWEC Dwg. No. 54099-27-1-50-17
- Equipment Summary List:

B. Description of Flow

The function of the flare system is to provide for safe burning of combustible vapors released from process equipment during plant startup, shutdown or during operating upsets.

Flare (K.O.) Seal Drum,D-1401, receives the discharge from vents and safety valves in the various process units connected to a single main flare header. Water collected in the Flare Seal Drum,D-1401, is drained intermittently to Waste Water Treating, Section 1500. Vapors from the Flare (K.O.) Seal Drum are burned in Elevated Flare, FL-1401. The Flare Seal Drum is provided with a steam coil to prevent water freezing in cold weather. Elevated Flare, FL-1401, includes the following features:

- Facilities for smokeless burning of hydrocarbons.
- An air seal, located underneath the flare tip to prevent oxygen back-diffusion into the system.
- A flame front generator for igniting pilots.
- Facilities are provided for automatic nitrogen injection into the flare knockout drum to compensate for the system "contraction" after a hot blow.

As part of the flare package, a Pilot Gas K.O. Drum is provided in the pilot gas line to separate all liquid droplets from the gas. Similarly, a Steam Separator removes entrained mist and bulk condensate from the steam line.

An incinerator or ground flare, H-1401, is provided to combust raw gas during startup. Incinerator air is blown by B-1401 A/B,

one operating blower and one 100% spare, through the air preheater, E-1401, and into the incinerator combustion chamber. Flue gases are vented to a stack provided by the incinerator vendor.

1 TRAIN PER MODULE

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54099
SECTION: 1400

EQUIPMENT LIST

NAME OF UNIT: FLARE & INCINERATOR

CLIENT: TVA (COAL GASIFICATION STUDY)
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
DRUM 27-11-	D-1401	FLARE SEAL DRUM			1-100%	
FLARE 27-11-	FL-1401	FLARE STACK UNIT			1-100%	
EXCHANGER 27-11-	E-1401	INCINERATOR AIR PREHEATER			1-100%	
-	E-1402	SEAL DRUM HEATER			1-100%	
FURNACE 27-11-	H-1401	INCINERATOR			1-100%	

1 TRAIN PER MODULE

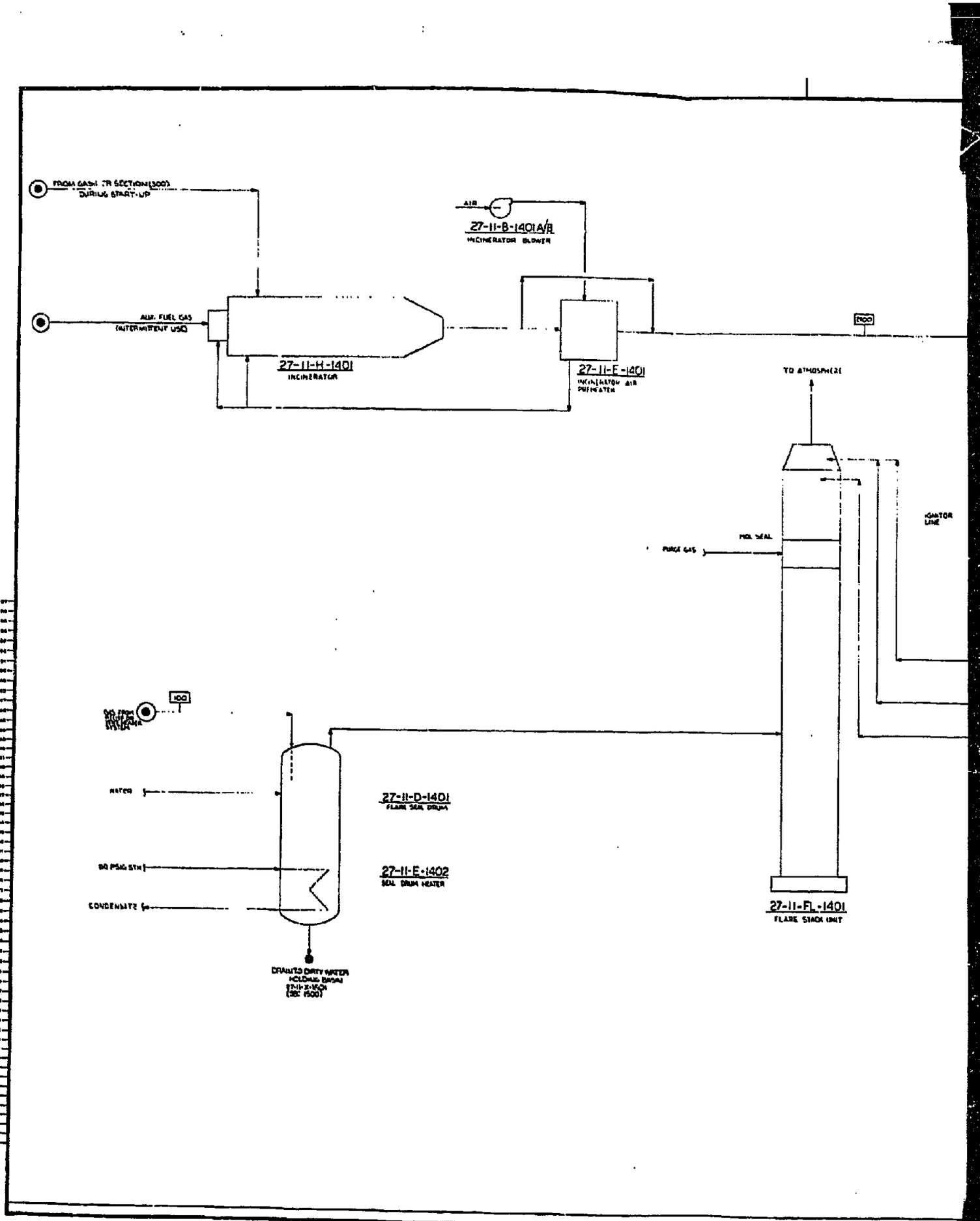
FORM NO. 135-904

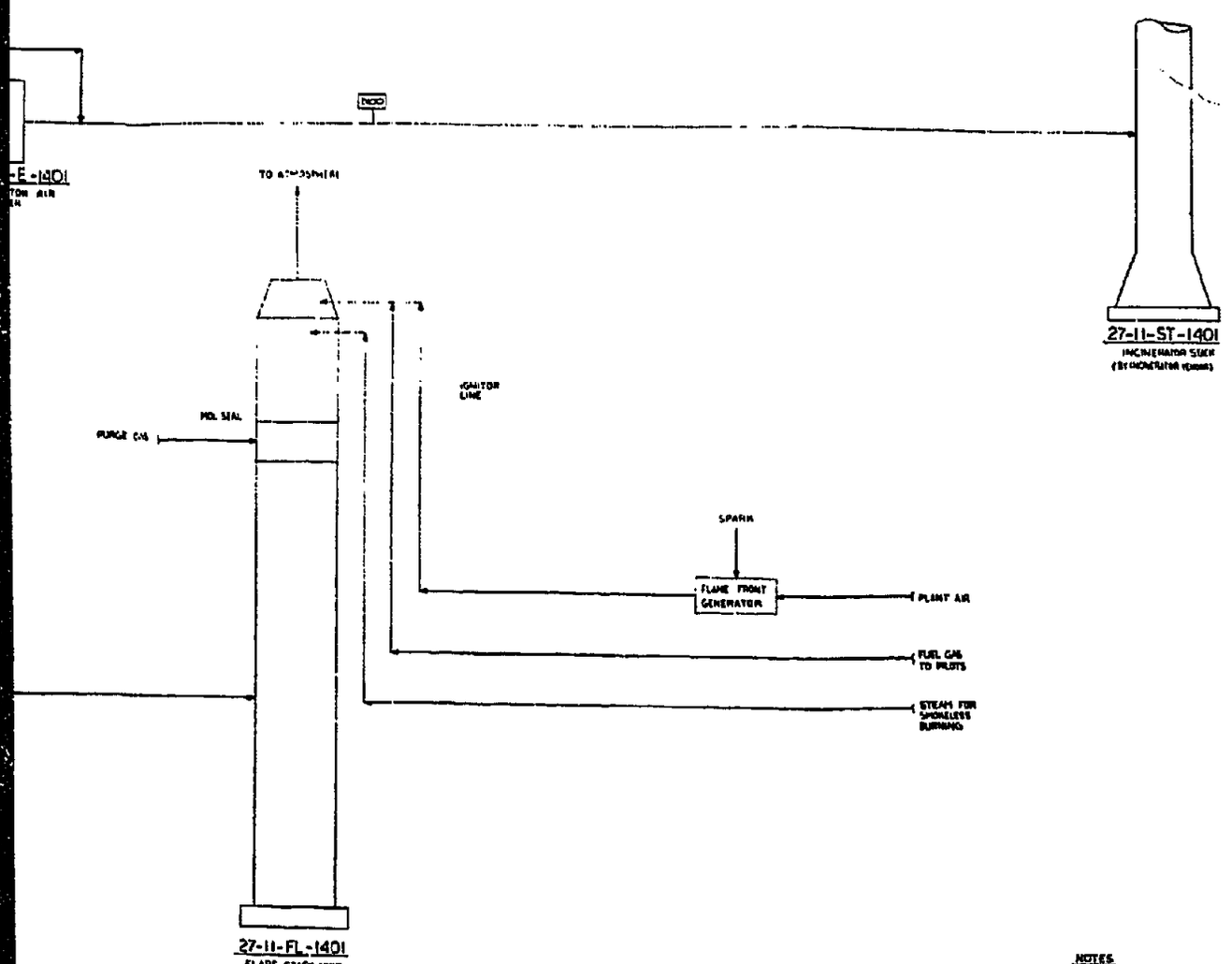
FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT: 11-27-54099 SECTION: 1400	EQUIPMENT LIST	NAME OF UNIT: FLARE & INCINERATOR	PAGE 2 OF 2

CLIENT: TVA (COAL GASIFICATION STUDY)
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
INCINERATOR STACK						
27-11-	ST-1401	INCINERATOR STACK			1-100%	
BLOWER						
27-11-	B-1401A/B	INCINERATOR BLOWER			2-100%	


FROM GASH. TR SECTION(300)
DURING START-UP
AIR
27-11-B-1401A/B
INCINERATOR BLOWER
AIR, FUEL GAS
(INTERMITTENT USE)
27-11-H-1401
INCINERATOR
27-11-E-1401
INCINERATOR AIR
PREHEATER
TO ATMOSPHERE
PURGE GAS
100
WATER
27-11-D-1401
FLARE SEAL DRUM
50 PSIG STM
27-11-E-1402
SEAL DRUM HEATER
CONDENSATE
27-11-FL-1401
FLARE STACK UNIT



NOTES.
1. ONE TRAIN PER MODULE
FLARE AND INCINERATOR
2. FOR LEGEND SEE DWG. NO. 54099-27-1-50-1

FOSTER WHEELER ENERGY CORPORATION

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTIONED FLARE & INCINERATOR

EW 11-27-54099

DWG. NO. 54099-27-1-51-1

TVA Coal Gasification Study
B & W Gasifier Alternate

SECTION DESCRIPTION

3.12 SECTION 1500 - WASTE WATER TREATMENT

A. Reference Material:

. Process Flowsheet: FWEC Dwg. No. 54099-27-1-50-18

. Equipment Summary List:

B. Description of Flow

Wastewaters will be generated from several sources in the plant. The type and degree of treatment and the ultimate disposal of these wastewaters will depend on the source of the wastewater and on the type and concentration of pollutants in the water. The wastewaters and their sources are:

1. Stormwater falling on, and drained from the area inside the limits of processing units (ISBL);
2. Ash Pile Leachate from stormwater falling on piles of ash;
3. Rinse and Neutralization Water from regeneration of the Demineralizer in Sec. 1200-3;
4. Spent service water (deck washings, flushing, etc.)
5. Stormwater falling on, and drained from the coal piles; Coal Pile Runoff
6. Process wastewater consisting of stripped sour water from Sec 700;
7. Cooling tower blowdown;
8. Sanitary wastewater generated by plant personnel.

The treatment and disposal of these wastewater streams are described below:

Clean Water Streams - ISBL Stormwater,
Ash Pile Leachate and Rinse
and Neutralization Waters

The above clean water streams are collected in the Clean Water Holding Basin, 27-11-X-1506 for analyses before pumping these waters to the cooling tower (as makeup) or discharging to the outfall depending upon dissolved solids level.

ISBL stormwater is collected from process units and may require lifting to the holding basin depending on the plant terrain. Ash pile leachate is an intermittent stream which drains from piles of ash during a rainfall. Rinse and neutralization waters are obtained during regeneration of the Demineralizer. The latter unit reduces the dissolved solids level to permit the use of water as BFW makeup to the H.P. Steam Generators.

Dirty Water Streams - Coal Pile Runoff,
Service Water and
Stripped Sour Water

The above streams are described in the Preliminary Report on Emissions and Effluents. They are relatively low in organics (BOD, COD) but do contain a significant amount of dissolved solids. Cyanides may be present in the stripped sour water stream, although analyses or estimated cyanide level have not been determined. If cyanides are present, these will be destroyed rather easily by the relatively inexpensive ozonation-UV system.

Coal pile leachate (runoff), spent service water from deck washings, etc. and stripped sour water from which hydrogen sulfide and ammonia have been removed to a low level in the Sour Water Stripper, then clarified (in Sec 700) to remove most of the suspended solids, are collected in the Dirty Water Holding Basin, 27-11-X-1501. A continuous discharge is pumped to the Neutralization Basin, TK-1501, into which hydrated lime is fed by gravity from a large storage bin mounted above the basin. The lime adjusts the PH to approximately 8.5. The wastewater then flows by gravity to an Aerating Basin, X-1502, where fixed aerators aerate and mix the incoming stream oxidizing inorganic ionic materials, thereby causing them to form insoluble hydroxides. The aerated stream flows by gravity to the rectangular clarifier with traveling arm siphon sludge removal, CL-1501, where the insoluble precipitate settles from the water.

The 20 wt.% solids precipitate slurry is pumped to a disposal pond. Decant from the pond is returned by gravity to the clarifier. Sludge is removed periodically from the pond for disposal to landfill.

It may be necessary to recarbonate the clarified stream to remove excess lime. This could be accomplished using the CO_2 rich gas stream emitted

from the Beavon Unit absorber. The clarified-recarbonated stream then would enter an ozonation-UV package system for destruction of cyanides. Since oxygen is available from the Air Separation Plant, Sec. 200, ozone could be generated simply by providing an ozone generator. Ozone would contact the aqueous stream in an Ozone Contactor.

Treated wastewater is pumped to the Treated Wastewater Basin, X-1503, for analyses, then pumped to the Cooling Tower as makeup or discharged to the outfall.

Cooling Tower Blowdown

Cooling Tower blowdown contains chromium and zinc which must be reduced to very low levels before this aqueous stream, high in dissolved solids, can be discharged.

A chrome recovery system, X-1504 is shown on drwg. 54099-27-1-50-18, preceded by a sandfilter to remove suspended solids and prevent fouling of ion-exchange resins in the recovery system. A moving bed ion exchange system could reduce chromium and zinc levels to less than 1 ppm each. The recovery system would be followed by a Chrome Destruct Unit, X-1505, which would precipitate residual chromium and zinc as insoluble hydroxides, thereby reducing these metals to undetectable levels.

The cost effectiveness of a recovery system must be studied i.e. whether the value of recovered materials would pay out the capital cost in a reasonable period of time. If not cost effective, the recovery system will be omitted and all the chrome and zinc in the C.T. blowdown destroyed.

Treated cooling tower blowdown is held in a day tank, TK-1503, for analyses before being pumped to the outfall.

Sanitary Wastewater

Sanitary wastewater from toilets, showers and wash basins will be sent to a package biological unit to reduce BOD and destroy microorganisms. The treated wastewater will be discharged.

1 TRAIN FOR EACH MODULE

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-27-54099
SECTION: 1500

EQUIPMENT LIST

NAME OF UNIT: WASTEWATER TREATMENT

CLIENT: TVA (COAL GASIFICATION STUDY)
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
FILTER						
11-27-	F-1501 A/B	COOLING TOWER BLOWDOWN SANDFILTER			2-100%	
TANKS						
27-11-	TK-1501	NEUTRALIZATION BASIN			1-100%	
-	TK-1502	LIME STORAGE TANK			1-100%	
-	TK-1503	TREATED C.T. EFFLUENT TANK			1-100%	
-	TK-1504	BACKWASH SUMP			1-100%	
CLARIFIER						
27-11-	CL-1501	LIME TREATMENT CLARIFIER			1-100%	

1 TRAIN FOR EACH MODULE

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT: 11-27-54099 SECTION: 1500	EQUIPMENT LIST	NAME OF UNIT: WASTEWATER TREATMENT	PAGE 2 OF 3

CLIENT: TVA (COAL GASIFICATION STUDY)

LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
AERATOR						
27-11-	M-1501 A/B	DIRTY WATER AERATOR			2-100%	
PUMPS						
27-11-	1501A/B	DIRTY WATER LIFT PUMP			2-100%	
-	1502A/B	TREATED WASTEWATER PUMP			2-100%	
-	1503A/B	CLARIFIER SLUDGE PUMP			2-100%	
-	1504A/B	OUTFALL TRANSFER PUMP			2-100%	
-	1505A/B	TREATED C.T. EFFLUENT PUMP			2-100%	
-	1506A/B	BACKWASH SUMP PUMP			2-100%	
-	1507A/B	CLEAN WATER DISCHARGE PUMP			2-100%	

1 TRAIN FOR EACH MODULE

FORM NO. 135-904

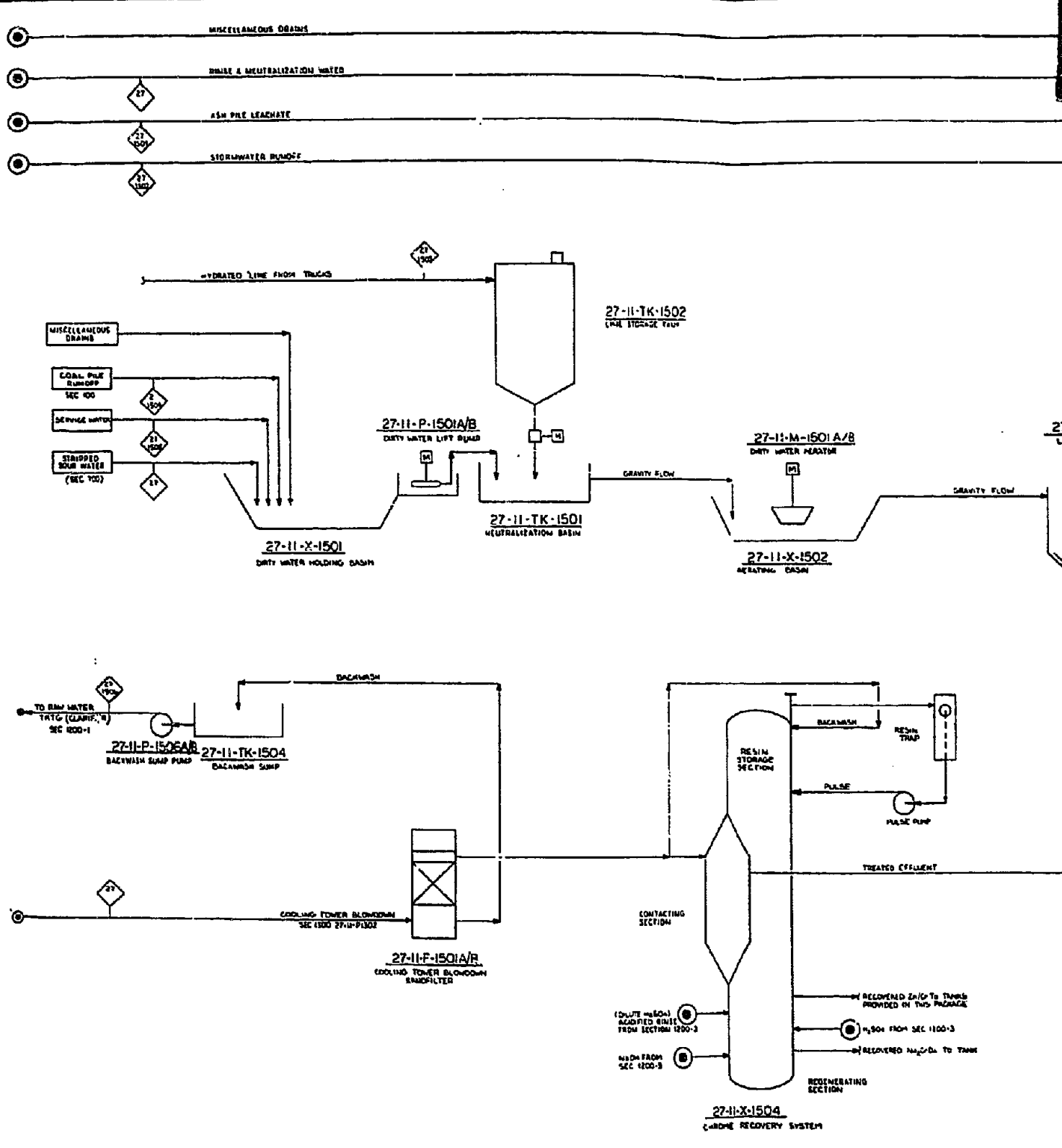
FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT: 11-27-54039 SECTION: 1500	EQUIPMENT LIST	NAME OF UNIT: WASTEWATER TREATMENT	PAGE 3 OF 3

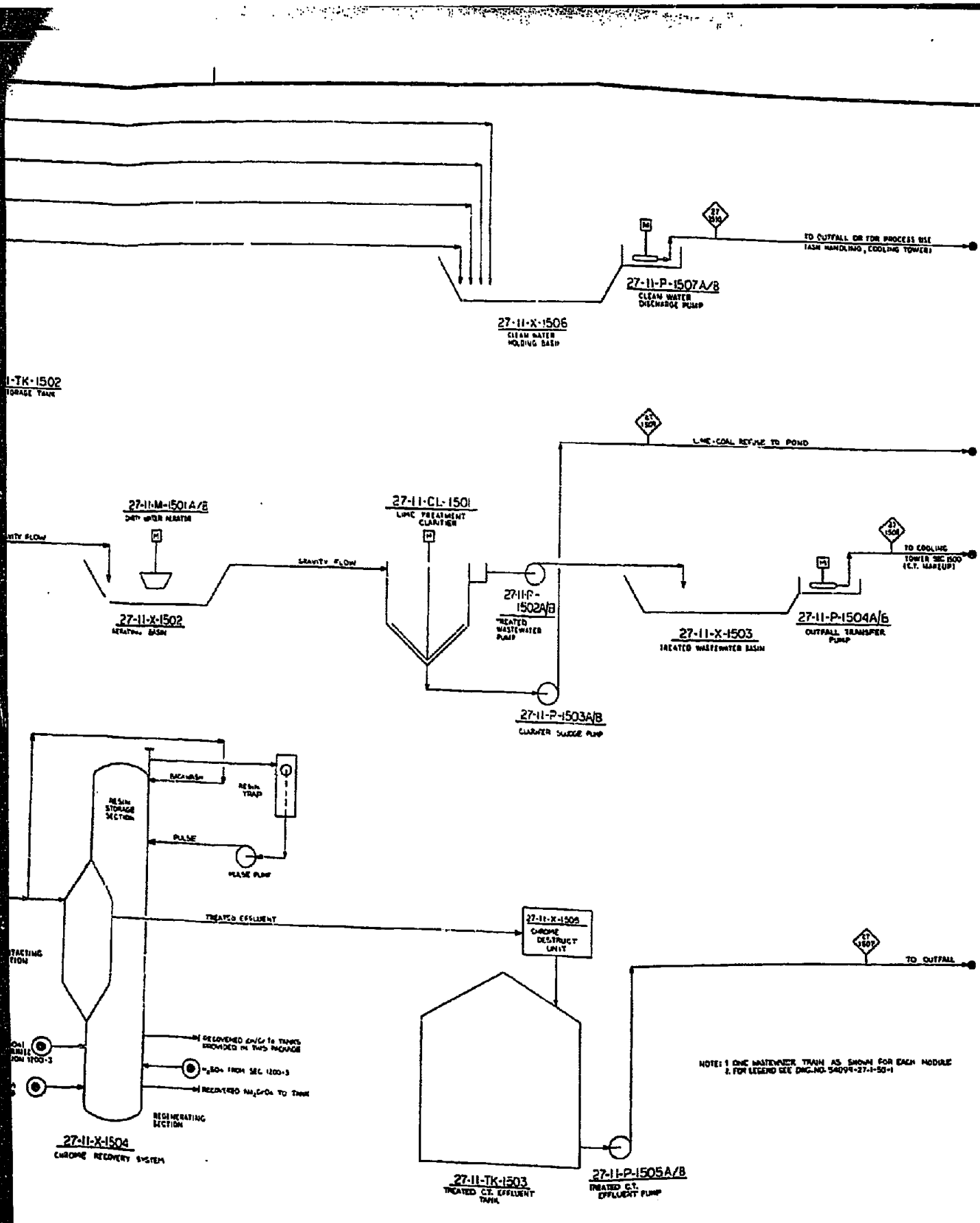
CLIENT: TVA (COAL GASIFICATION STUDY)

LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
MISCELLANEOUS						
27-11-	X-1501	DIRTY WATER HOLDING BASIN			1-100%	
-	X-1502	AERATING BASIN			1-100%	
-	X-1503	TREATED WASTEWATER BASIN			1-100%	
-	X-1504	CHROME RECOVERY SYSTEM			1-100%	
-	X-1505	CHROME DESTRUCT UNIT			1-100%	
-	X-1506	CLEAN WATER HOLDING BASIN			1-100%	


MISCELLANEOUS DRAINS
RINSE & NEUTRALIZATION WATER
ASH PILE LEACHATE
STORMWATER RUNOFF
HYDRATED LIME FROM TRUCKS
27-11-TK-1502
LIME STORAGE TANK
MISCELLANEOUS DRAINS
COAL PILE RUNOFF
SEC 100
SEEPAGE WATER
STRIPPED SOUR WATER
(SEC 700)
27-11-P-1501A/B
DIRTY WATER LIFT PUMP
27-11-M-1501 A/B
DIRTY WATER AERATOR
GRAVITY FLOW
GRAVITY FLOW
27-11-X-1501
DIRTY WATER HOLDING BASIN
27-11-TK-1501
NEUTRALIZATION BASIN
27-11-X-1502
AERATING BASIN
BACKWASH
TO RAW WATER TNTG (CLARIF. B)
SEC 1200-1
27-11-P-1505A/B
BACKWASH SUMP PUMP
27-11-TK-1504
BACKWASH SUMP
BACKWASH
RESIN TRAP
RESIN STORAGE SECTION
PULSE
PULSE PUMP
TREATED EFFLUENT
COOLING TOWER BLOWDOWN
SEC 1300 27-11-P1302
27-11-F-1501A/B
COOLING TOWER BLOWDOWN SANDFILTER
CONTACTING SECTION
RECOVERED Zn/Cr TO TANKS PROVIDED IN THIS PACKAGE
H_2SO_4 FROM SEC 1200-3
RECOVERED Na_2CrO_4 TO TANK
(DILUTE H_2SO_4) ACIDIFIED RINSE FROM SECTION 1200-3
NaOH FROM SEC 1200-3
REGENERATING SECTION
27-11-X-1504
CHROME RECOVERY SYSTEM



POSTER WHEELER ENERGY CORPORATION

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SEC-1500 WASTEWATER TREATMENT

27-54099 | DWG. 54099-27-1-50-1B

K. Cooling Water System

The cooling towers and water circulating pumps are shown, at present, at the extremity of each of four gasification modules and adjacent to the air separation plant to minimize piping costs and pumping losses. As the cooling towers are situated, there is some, minimal, diffusion of cooling tower plumes over either the process areas or the buildings. As the reader may be aware, the prevailing wind in summer is to the south when the cooling towers would be operating at or near full capacity. In the winter months, the prevailing wind direction is to the north.

During summer operation, under windy conditions, cooling towers at the N.E. perimeter of the process areas would experience wind velocities which are flowing over the ash pile. The presence of the ash pile upstream of the cooling towers is not considered to have any measurable adverse impact on performance. This position appears to be confirmed by the results of tests on a tower-spoil hill configuration which duplicates, in almost every respect, the proposed design. Reference is made to the report: "Hydrothermal Modelling of Browns Ferry Nuclear Plant Cooling Towers" by S.C. Jain and J.F. Kennedy, Report No. 219, Iowa Institute of Hydraulic Research, April, 1979. The report, sponsored by TVA Water Systems Development Branch, makes the following statement in regard to the spoil hill upstream of the cooling towers.

> "The influence of the spoil hill on $\bar{R}$ (the recirculation ratio of effluent air stream into the intake louvers) is insignificant, amounting to no more than +1%"

(Foregoing appears on p. 25, VI. Summary of Results)

L. ELEVATION VIEWS

I. Terrain

Considering the rocky nature of the subsoil, based on extensive boring and seismic depth of rock determination, the plant areas have been terraced in order to minimize costly cutting and filling of excavated materials. The terraces shown are substantially those which form the basis of the cost estimates. As will be evident from the drawings, every effort has been made to limit differences in elevation to 15 feet. Wherever a greater difference in elevation occurs, a roadway for access of fire fighting equipment has been provided at the higher elevation, paralleling the main service road below.

II. Process Units

The structures, towers and other equipment shown are representative of the type of equipment for a particular process. Where fairly detailed information on both the size and quantity of equipment was available, as an example the gasifier reactors and ancillaries, the elevation views shown are substantially an accurate pictorial representation.

TVA Coal Gasification Study
B&W Gasifier

SECTION DESCRIPTION

3.13 SECTION 2000 - GENERAL FACILITIES

This section describes long-term ash storage, by-products and chemicals storage, firewater system, sewage plant, power, lighting and communications.

Ash Storage

An irregular area, generally N.E. of the operating plant facilities, is to be cleared and rough graded for deposition of ash and other spent solids related to the combustion processes. The perimeter of the ash pile is designed with a vertical to horizontal slop 1:3 to provide for a reasonable margin of design for stability. Should it be required, an additional margin of stability of the perimeter embankment can be provided by employing earth and rock fill material from the site.

Slag and flyash from the B&W gasifiers and spent bed materials and flyash from the fluidized bed boilers, contain a significant proportion of materials which would behave as flyash. Such compounds, in the presence of moisture and an alkaline agent (limestone), would undergo pozzolanic activity to form, in many respects, a stable, cementitious compound.

The Design Criteria (Section 4.3) of TVA, for base-case design, stipulates no lining under ash, sludge and water containment ponds. The present design, which is dry storage, does not include any lining. The reader should be alerted to the possibility of leachate from the slag and ash pile finding its way into Guntersville Reservoir. This possibility would become less likely if the ash undergoes pozzolanic activity, inasmuch as the permeability of the ash by moisture would be reduced. A further concern is the possibility of toxic materials which could leach into the ground and, eventually, into Guntersville Reservoir. The ash analysis, Section 2.1.4 of the Design Criteria, indicates compounds which are largely inert and non-toxic. It is known, however, that trace quantities of the heavy metals may be found in flyash. Leachate from the flyash, in particular, could be a source of unacceptable pollution of Guntersville Reservoir.

None of the foregoing comments are to be construed as definitive statements of fact and should, therefore, be verified by suitable testing immediately following startup of the plant to verify the chemical and physical behavior of the mixture of slag, ash and spent bed materials. Additionally, the presence of toxic elements and the attenuating properties of the cementified pile and soil from the proposed plant site of Murphy Hill should be determined.

By-products and Chemicals Storage

A 14-day supply of lime and limestone is kept on hand for the fluidized bed boilers and treatment of effluents.

Some dozen solvents, catalysts and other chemicals are stored either as a periodic replacement charge or as a continuing, expendable requirement. Such solvents, catalysts and chemicals are listed in the succeeding section 2. Plant Requirements.

Sulfur is converted into a solid form in a prilling operation at the sulfur recovery unit serving each module of the gasification plant. The solid prills are then transported to a storage bin of 30 days production capacity prior to removal from the plant site.

Firewater System

A 10-inch underground looped piping network will be provided to supply firewater to all areas of the plant. Hydrants are located at approximately 300-foot intervals. In the Process Area, 25 percent of the hydrants will be provided with monitor nozzles capable of directing water coverage on equipment in minimal response time.

The source of firewater is an allowance in the Raw Water Storage Tank. Three (3) 2000 gpm pumps -- one diesel-driven and two motor-driven -- supply water to the piping grid. A fourth 300 gpm capacity jockey pump provides pressurization of the system at all times. Should loss of pressure occur due to fire, the main pump(s) are sequentially started automatically. Pump discharge pressure is 150 psig. This assures firewater supply demands to remote hydrants at 80 to 100 psig.

Sewage System

Several sewer systems will be provided. These include a clean rain runoff system, an oily water system to handle rain runoff from areas of oily contamination, systems to handle rain runoff from coal pile and ash storage areas and sanitary sewer collecting wastes from all building sanitary facilities. All these systems direct flow to the waste treatment facilities for treatment.

Power, Lighting and Communications

1. General

   The electrical facilities for the Coal Gasification Complex will be a complete installation, including power supply from a TVA power substation, lighting, communications, fire alarm and aircraft warning systems.

2. Standards, Codes and Regulations

The design, materials,equipment and installation of the electrical facilities will be in accordance with Foster Wheeler's Engineering Standard 70A1, the latest edition of the codes and regulations contained therein, and including the following:

- Section 1.4.3 Electrical Design Considerations (TVA Design Criteria)
- FAA Regulations
- FCC Regulations

3. Area Classification

All areas within limits are classified in accordance with the National Electrical Code, Article 500.

4. Power Distribution

A dual 138/13.8 KV intertie with the TVA power grid will be provided, including 2 transformers, each rated to supply the total plant load.

The overall design basis for the proposed electrical system is one of high reliability to minimize interruption of operation. Key features of the design are as follows:

- Dual feeders from the TVA system.
- Secondary-selective double-ended substation load centers are provided as required to supply medium and low voltage process loads.
- Double radial feeders are run to each load center.
- Outdoor/indoor bus duct is furnished from the outdoor transformers to the indoor 5 KV or 480 KV switchgears.
- All switchgear and motor control centers are indoors.
- Electric power is distributed to power consumers rated on the following basis:

  Motors 250 HP to 5,000 HP; 4,000 V, 3 phase, 3 wire

  Motors ½ to 200 HP; 460 V, 3 phase, 3 wire

  Motors below ½ HP; single phase, 2 wire, 115 V

  Lighting & instrument branch circuit; 120 V, single phase

5. Electrical Equipment

In general, electrical equipment and wiring materials are furnished as required by the National Electrical Code and Section 1.4.3 Electrical Design Considerations (TVA Design Criteria), and to conform to the following standards, where applicable:

- National Electrical Manufacturer's Association (NEMA)
- American National Standards Institute (ANSI)
- Underwriter Laboratories (UL)

6. Motor Control Equipment

The 4000 V motors up to 2000 HP are magnetic contactor-type control with current limiting fuses. Two-high units are furnished. Motors greater than 2000 HP are controlled by switchgear-type circuit breakers. The 460 V motors are controlled by a combination circuit breaker and magnetic contactor.

7. Wiring Method

Both 13.8 KV and 4,160 V distribution will be in underground conduits. Within process unit limits where overhead pipe racks or supports are available, wiring for 480 V and less will be in overhead conduit.

8. Lighting

Lighting for process areas is provided in accordance with FW Engineering Standard 70A1 and all applicable standards referred to in Section 1.4.3 Electrical Design Consdierations (TVA Design Criteria).

Aviation obstruction lighting will be provided in accordance with the FAA requirements for the site.

Road and equipment lighting will be provided, using mercury vapor lighting fixtures mounted on poles.

9. Communications

Telephone Company system: An empty conduit system will be provided for the local telephone company to furnish and install telephone service to the plant.

Two-way Communication: A two-way FM radio communication system will be provided for plant operation.

10. Fire Alarm System

The fire alarm system design is based on utilization of the telephone system for fire alert throughout the plant. Telephone-type relays will be provided to actuate fire signal devices in areas required for personal safety.

TVA Coal Gasification Study
B&W Gasifier

SECTION DESCRIPTION

3.14 SECTION 2100 - BUILDINGS

Buildings for the Coal Gasification complex will be provided in accordance with the building list tabulated below. This indicates the nominal building dimensions and designates the basic materials of construction. The buildings will be in accordance with standard industry design. The envisioned scope of supply includes necessary foundations, structural framing, sheathing, roofing, insulation, plumbing, heating and ventilating, along with electrical power and lighting circuitry. All design and construction will be completely in accordance with applicable local and state codes.

Allowance is provided for building furnishings. This includes office furnishings for the administration building and other office areas for personnel, tools and shop equipment to sufficiently outfit the various craft shops in the maintenance building to conduct normal maintenance of plant equipment, laboratory equipment for sampling and analyzing process streams, change house lockers and facilities for personnel convenience.

Service	Dimensions (ft)	Area (ft^2)	Construction Material
Administration		25,600	Masonry
Maintenance			
Shop	75 x 280	21,000	Pre-fab Metal
Offices	48 x 100	4,800	Masonry
Warehouse	200 x 240	48,000	Pre-fab Metal
Laboratory	50 x 100	5,000	Masonry
Firehouse/First Aid	50 x 90	4,500	Pre-fab Metal
Gate/Change House	80 x 125	10,000	Pre-fab Metal
Process Control	60 x 100	6,000	Masonry
Water Treatment	100 x 200	20,000	Pre-fab Metal
Electrical Substations (size varies 10 required)			Masonry

SECTION 4.0

PLANT REQUIREMENTS

TVA Coal Gasification
B&W Gasifier

4.1 SUMMARY OF FEEDS AND PRODUCTS

Coal Feed Rate TPD, as Rec'd.	
Gasification	21,672
Boiler Pit	888
Excess Fines	0
Total	22,560
Oxygen Feed, 98%, TPD	16,800
Product Gas	
MMSCFD	1,204.1
HHV BTU/SCF	298.7
MMM BTU/DAY	359.7
Composition, MOL%	
H_2	30.27
CO	62.41
CH_4	0.00
N_2+ Ar	3.38
CO_2	3.93
H_2O	0.01
C_2	-
Byproducts	
Sulfur LTPD	708.0
Ammonia, TPD	-
Phenols, TPD	-
Oil, BPD	-
Naphtha, BPD	-
Purchased	
Electric Power, MW	256.7
Raw Water, MGPM	16.0

OVERALL MATERIAL & ENERGY BALANCE

Input	Tons/Day	MMBTU/HR
Coal To Coal Handling	5,640	5,161.3
Air	28,618	12.0
Water	23,696	39.5
Limestone	77	-
Power	-	219.0
Total In	58,031	5,431.8

Output		
Product Gas	8,249	3,764.7
Sulfur	198	65.2
Slag	646	20.0
Cooling Tower Evap.	15,960	1,290.0
Cooling Tower Losses	6,420	18.7
Air Plant Waste Gas	12,764	9.0
Vent Gases	11,958	20.2
Water Losses	1,520	2.5
Miscellaneous	316	241.5
Total Out	58,031	5,431.8

TVA Coal Gasification Study
B&W Gasifiers

Section Description

4.2 STEAM BALANCE

A. Reference Material

Process Flowsheet	FWEC Drawing No. 54099-27-1-50-15
Steam Balance Summary	FWEC Drawing No. 54099-27-1-50-151

B. Description of Flow

Flow of steam generation and distribution may be followed on the Plant Steam, Condensate and Boiler Feedwater Balance Diagram, Drawing No. 54099-27-1-50-151.

High pressure superheated steam is generated primarily through waste heat recovery in E-301 during Gas Cooling in Section 300 with additional high pressure steam being generated in the H.P. Steam Generators, SG-1201A & B. Sufficient steam generation capacity is available with the two fluid bed boilers to assure an adequate supply of steam to shut down the plant under power outage conditions.

The steam header system consists of three steam levels:

High Pressure (H.P.)	935 psig, 775°F
Medium Pressure (M.P.)	250 psig sat'd, 406°F
Low Pressure (L.P.)	60 psig sat'd, 308°F

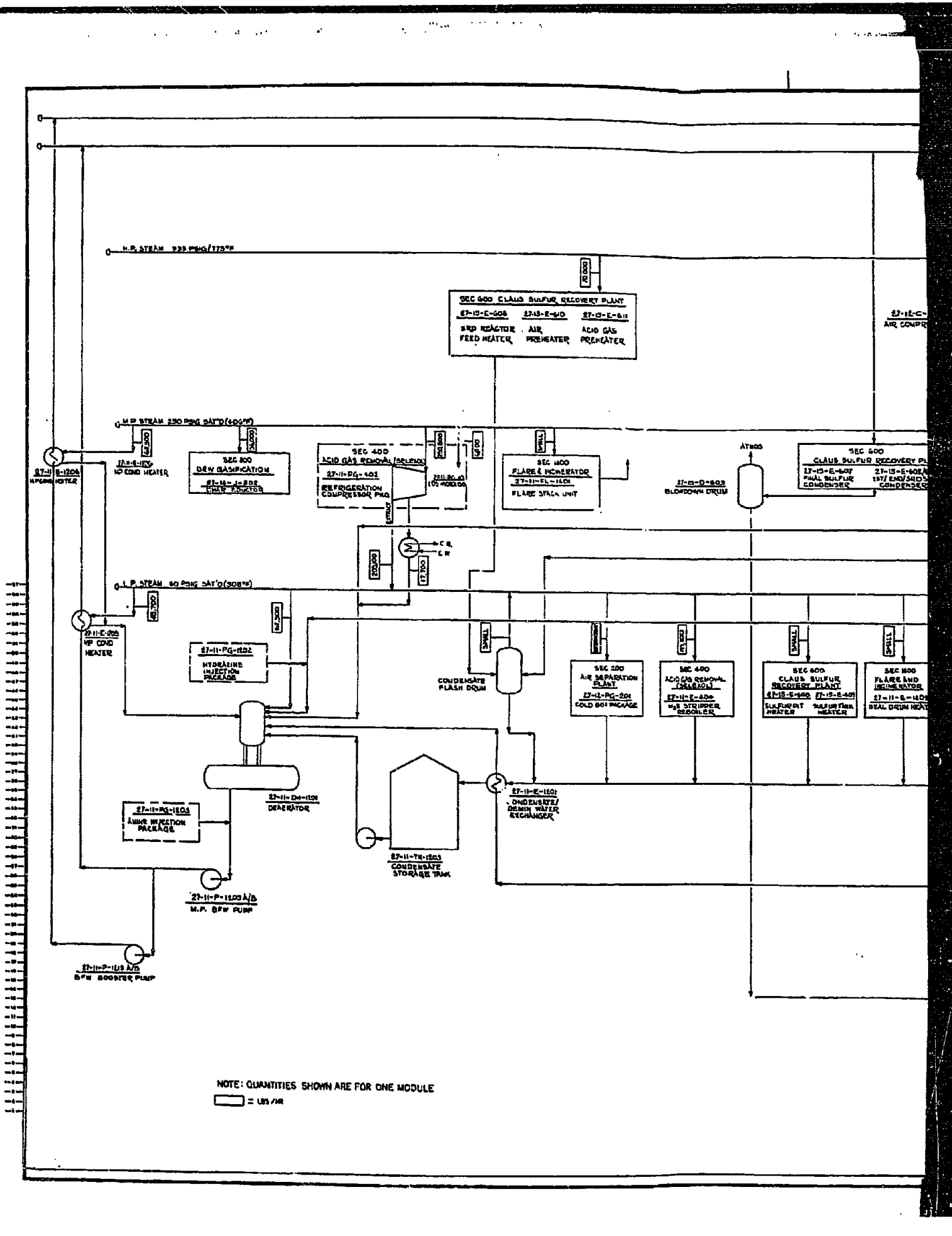
Most of the high pressure steam is condensed or expanded through turbines driving the Air Compressor, C-201A; the Oxygen Compressor, C-202; and the Product Gas Compressor, C-501. A small amount of H.P. steam is required for preheat in the Claus Sulfur Recovery Plant. A significant portion of the steam utilized to drive the Product Gas Compressor is extracted at 253 psig (medium pressure level) through the turbine running this compressor. Condensate from H.P. steam users is returned to the deaerator.

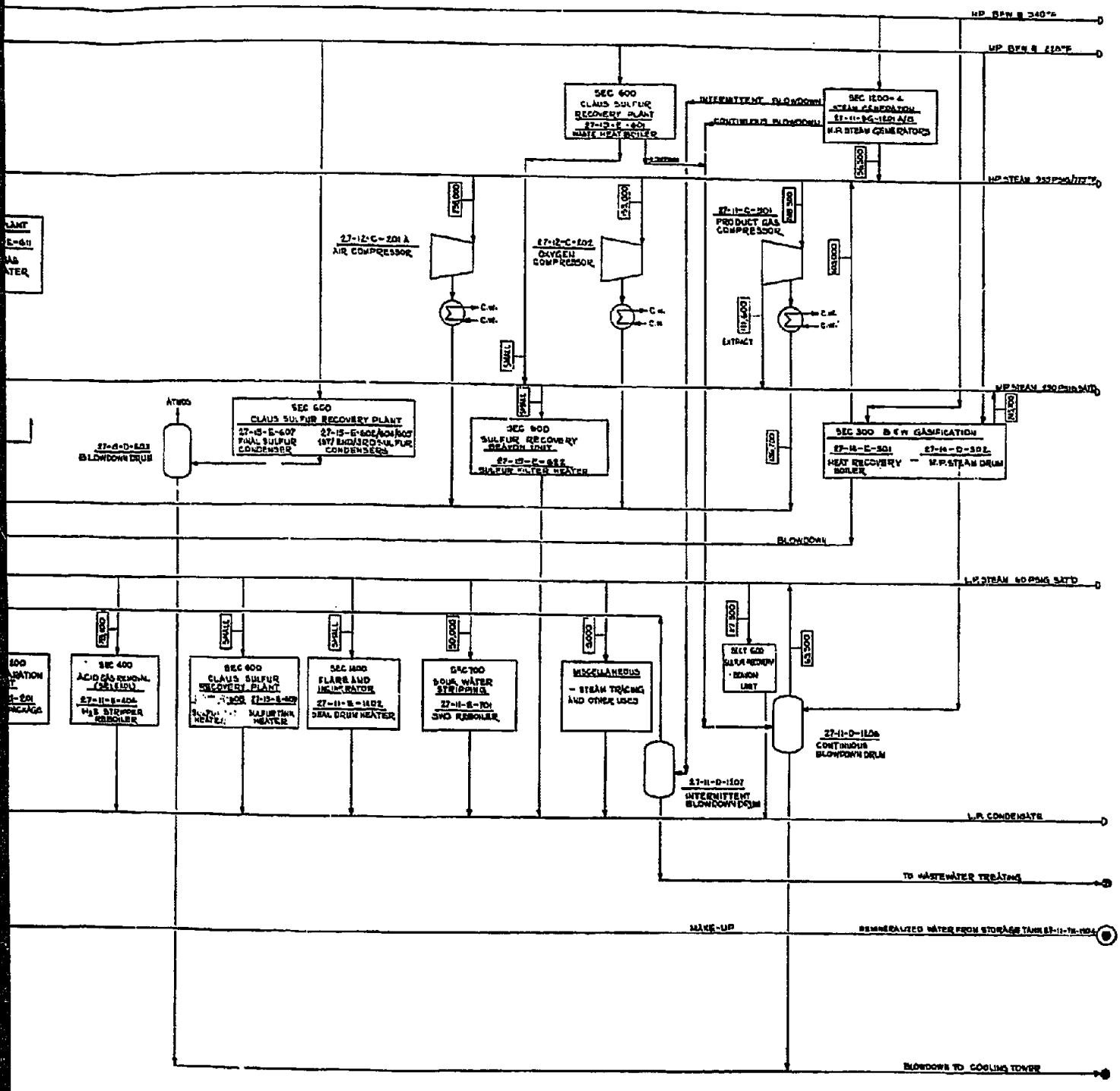
Medium pressure steam is generated in the Gasification section in the M.P. Steam Drum, D-302, and also extracted from the Product Gas Compressor turbine. M.P. steam is utilized principally in the Acid Gas Removal (Selexol) Refrigeration Compressor, PG-402, and to a lesser extent in the Gasification section Char Eductor, J-302, as preheat for H.P. condensate in E-1205 and to preheat the gas entering COS hydrolysis (in Raw Gas Heater, E-407).

Low pressure steam results from the Refrigeration Compressor, PG-402, turbine exhaust, flashed boiler blowdown in the Continuous Blowdown Drum, D-1206, and a small quantity from flashed H.P. condensate in the Condensate Flash Drum. The major consumers of L.P. steam are the Selexol Reboiler (H_2S Stripper), E-404, Sour Water Stripper Reboiler, E-701, M.P. Condensate Heater, E-1205, preheating M.P. condensate, and Deaerator, DH-1201, deaerating H.P. and M.P. boiler feedwaters. Also the Beavon Tail Gas Treating Unit (Sec 600) and steam tracing and miscellaneous items utilize L.P. steam.

Boiler blowdown from the Continuous Blowdown Drum, D-1206, is directed to the Cooling Tower as cooling tower makeup. D-1206 receives continuous condensate streams from H.P. steam generation (Sec 1200-4) and the Gasification M.P. Steam Drum, D-302, and from Blowdown Drum, D-603 (which receives blowdown from the Claus Plant Sulfur Condensers). Intermittent blowdown from the H.P. Steam Generators, SG-1201A/B, an aqueous sludge, is flashed to the Intermittent Blowdown Drum, D-1207. Vapor vents to the Deaerator. The small stream from the drum is sent to the Wastewater Treating Section and treated together with the Dirty Water streams. This sludge will settle out with lime sludge in the Clarifier, CL-1501. It is pumped to the Sludge Pond for settling and storage.

L.P. condensate flows to the Condensate Storage Tank, TK-1203. Condensate is polished in a Mixed Bed Polishing Unit, then pumped to the Deaerator for subsequent use as boiler feedwater (M.P. and H.P.). A BFW Booster Pump, P-1213A/B, is provided in series with the M.P. BFW Pump, P-1205A/B, to pump a portion of the deaerated condensate to the H. P. Level (side stream).


H.P. STEAM 935 PSIG/775°F
SEC 600 CLAUS SULFUR RECOVERY PLANT
27-13-E-608 SRP REACTOR FEED HEATER
27-13-E-610 AIR PREHEATER
27-13-E-611 ACID GAS PREHEATER
M.P. STEAM 230 PSIG SAT'D(406°F)
27-11-E-1204 M.P. COND HEATER
SEC 800 D&W GASIFICATION
SEC 400 ACID GAS REMOVAL (RELEXOL)
27-11-PG-401 REFRIGERATION COMPRESSOR PKG
SEC 400 FLARE & INCINERATOR
27-11-FL-1401 FLARE STACK UNIT
27-15-D-603 BLOWDOWN DRUM
SEC 600 CLAUS SULFUR RECOVERY PL
27-15-E-607 FINAL SULFUR CONDENSER
L.P. STEAM 50 PSIG SAT'D(308°F)
27-11-E-1205 HP COND HEATER
27-11-PG-1202 HYDRAZINE INJECTION PACKAGE
CONDENSATE FLASH DRUM
SEC 200 AIR SEPARATION PLANT
27-13-PG-201 COLD BOX PACKAGE
SEC 400 ACID GAS REMOVAL (SELEXOL)
27-11-E-404 H2S STRIPPER REBOILER
SEC 600 CLAUS SULFUR RECOVERY PLANT
27-13-E-609 SULFUR PIT HEATER
27-13-E-609 SULFUR TANK HEATER
SEC 800 FLARE AND INCINERATOR
27-11-E-1601 CONDENSATE/ DEMIN WATER EXCHANGER
27-11-DM-1201 DEAERATOR
27-11-PG-1203 AMINE INJECTION PACKAGE
27-11-TK-1203 CONDENSATE STORAGE TANK
27-11-P-1103 A/B M.P. BFW PUMP
27-11-P-1119 A/B BFW BOOSTER PUMP
NOTE: QUANTITIES SHOWN ARE FOR ONE MODULE
= LBS/HR



POWER SYSTEMS ENERGY CORPORATION

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
PLANT STEAM CONDENSATE & BOILER FEEDWATER SYSTEM BALANCE DIAGRAM

FW 11-27-54089 | DWG. NO. 5409 - 27-1-50-151

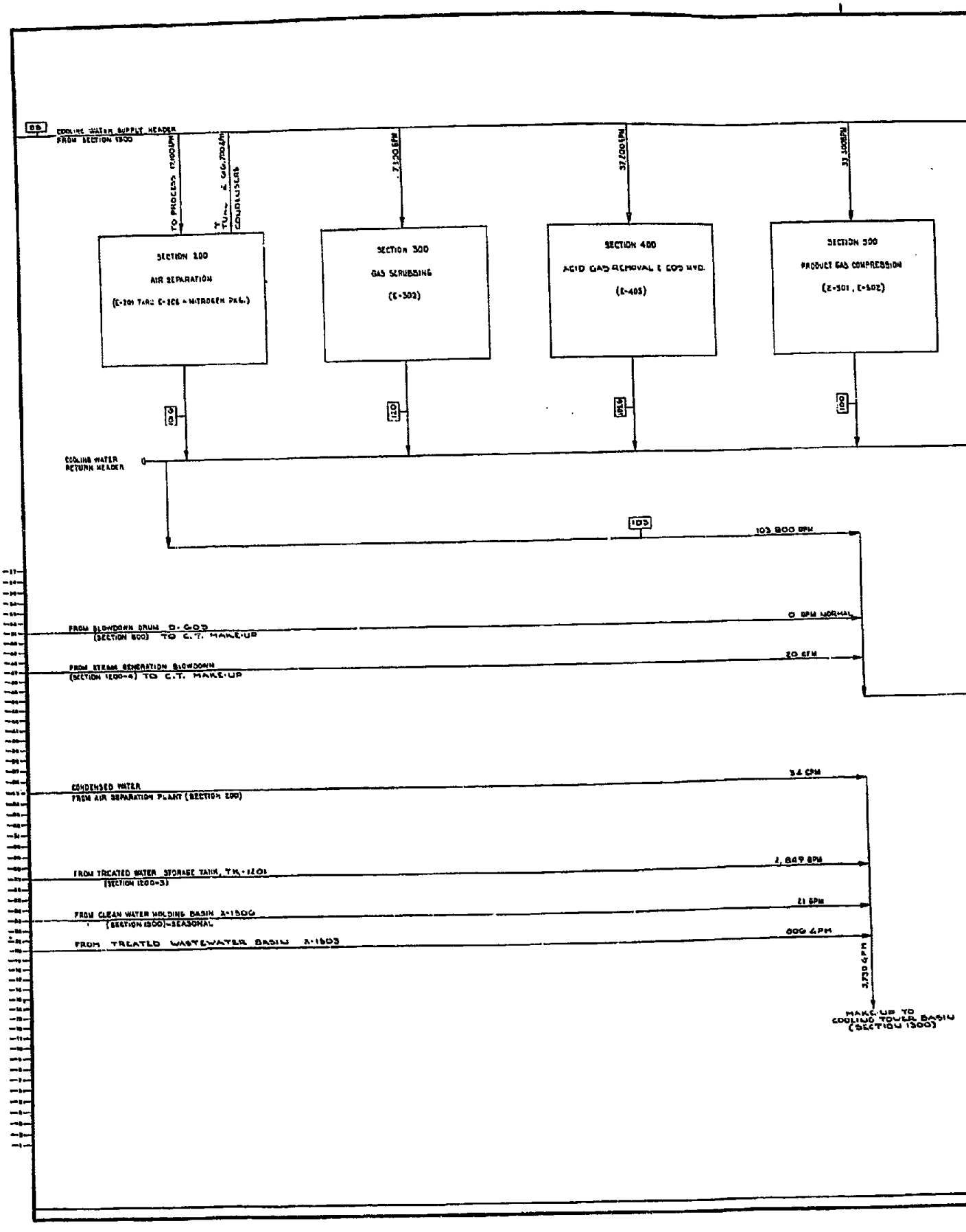
TVA Coal Gasification Study
B&W Gasifiers

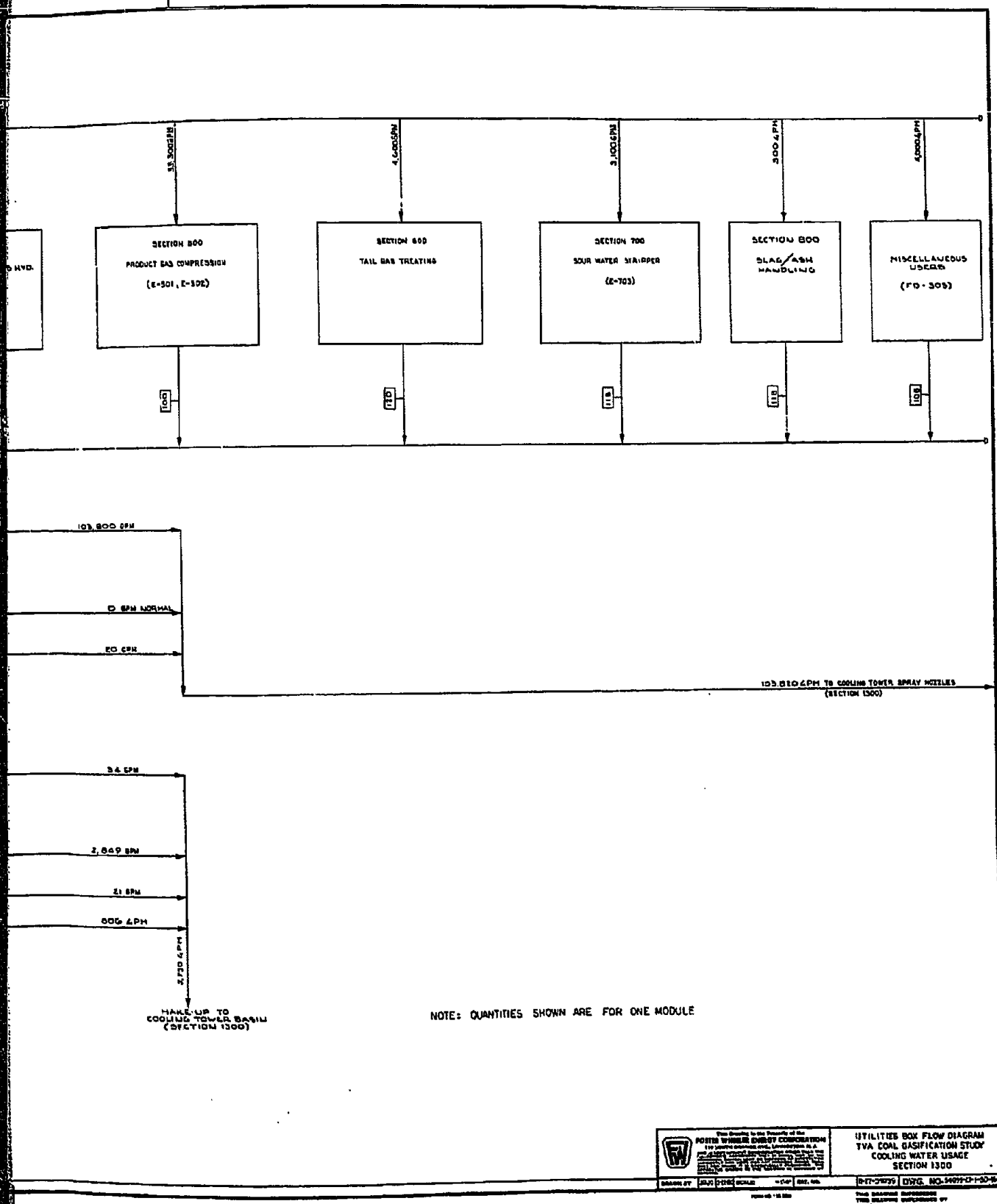
4.3 SECTION 1300 - COOLING WATER USAGE

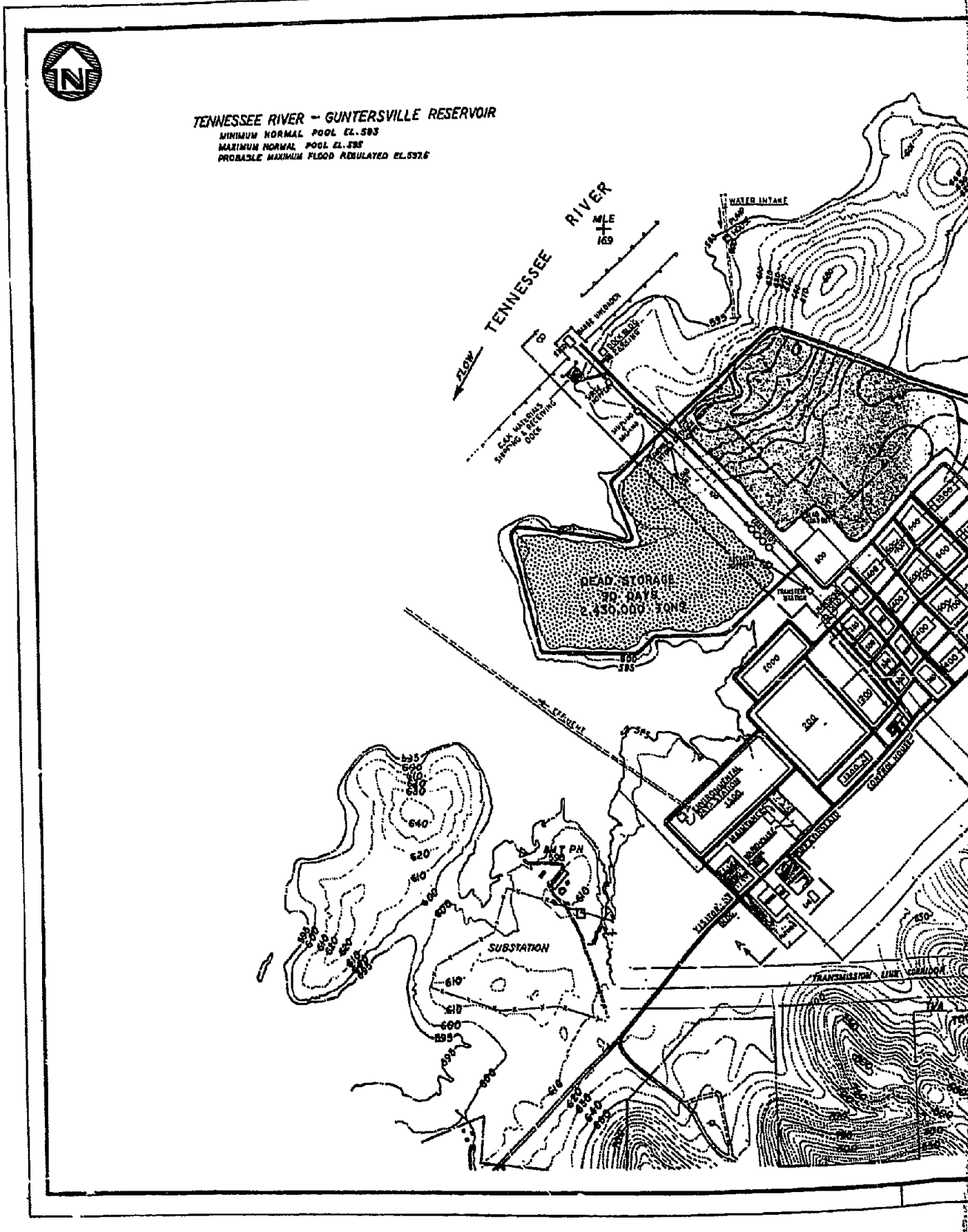
Utilities Box Flow Diagram

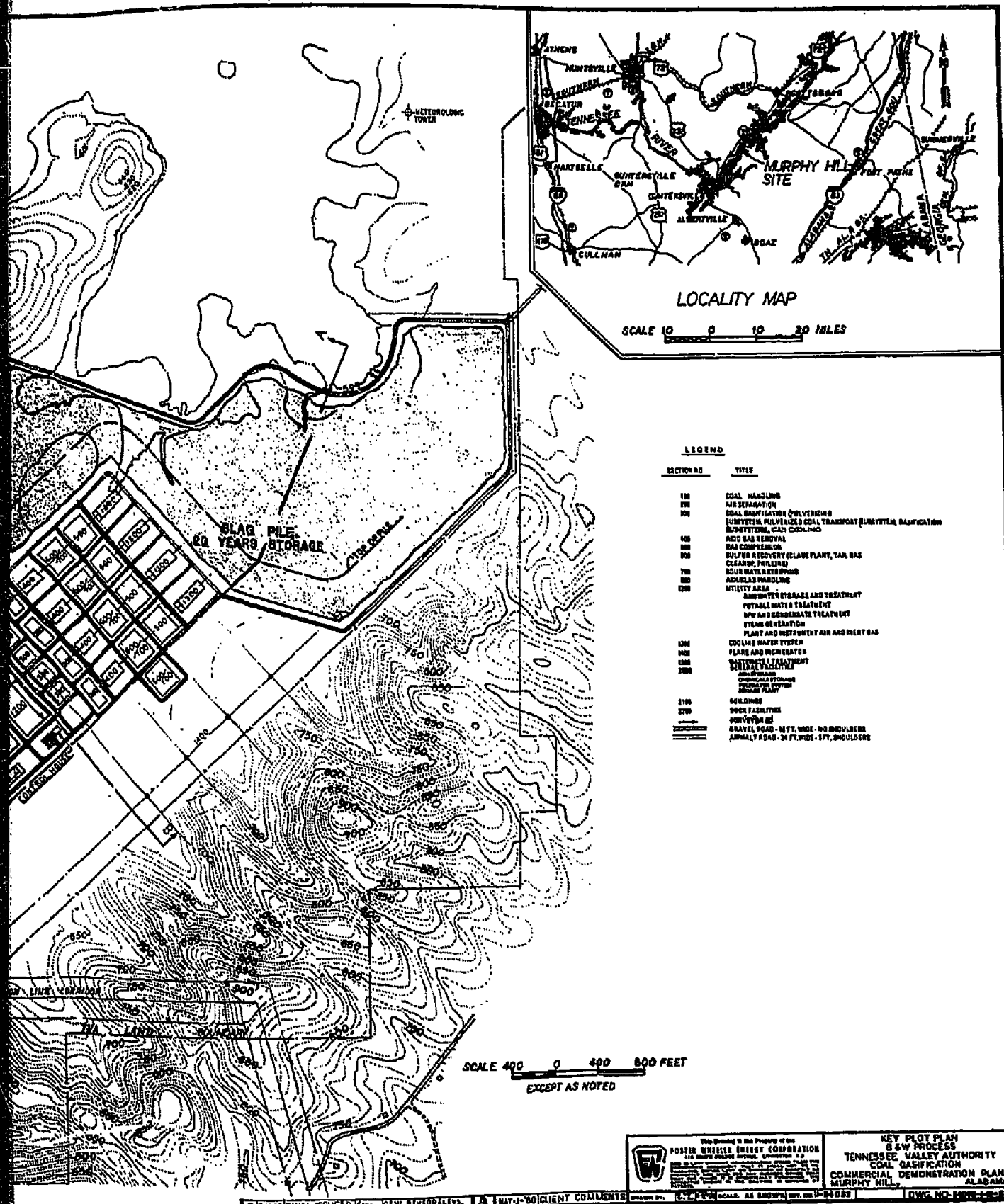
The cooling water users are indicated on dwg. no. 54099-27-1-50-161. Major users are the turbine condensers in Sec. 200, Air Separation, for Product Gas Compression, Sec. 500 and for the Refrigeration Compressor in Sec. 400, Acid Gas Removal.

The average temperature rise is shown for each section. The cooling water return header discharges at the cooling tower spray nozzles. The cooling tower makeup of 3,730 gpm compensates for evaporation and windage losses at the cooling tower and for cooling tower blowdown (550 gpm).


COOLING WATER SUPPLY HEADER FROM SECTION 1300
TO PROCESS 17,000 GPM
TO TUBE & SHELL CONDENSERS
7,100 GPM
37,000 GPM
33,300 GPM
SECTION 100
AIR SEPARATION
(E-201 THRU E-206 & NITROGEN PKG.)
SECTION 300
GAS SCRUBBING
(E-303)
SECTION 400
ACID GAS REMOVAL & COS HYD.
(E-405)
SECTION 500
PRODUCT GAS COMPRESSION
(E-501, E-502)
100
120
140
160
180
COOLING WATER RETURN HEADER
105
103,800 GPM
FROM BLOWDOWN DRUM D-603 (SECTION 600) TO C.T. MAKE-UP
0 GPM NORMAL
FROM STEAM GENERATION BLOWDOWN (SECTION 1200-6) TO C.T. MAKE-UP
20 GPM
CONDENSED WATER FROM AIR SEPARATION PLANT (SECTION 200)
34 GPM
FROM TREATED WATER STORAGE TANK, TK-1201 (SECTION 1200-3)
1,849 GPM
FROM CLEAN WATER HOLDING BASIN X-1500 (SECTION 1500)-SEASONAL
21 GPM
FROM TREATED WASTEWATER BASIN X-1503
806 GPM
3,730 GPM
MAKE-UP TO COOLING TOWER BASIN (SECTION 1300)


SECTION 800
PRODUCT GAS COMPRESSION
(E-501, E-502)
SECTION 600
TAIL GAS TREATING
SECTION 700
SOUR WATER STRIPPER
(E-703)
SECTION 800
SLAG/ASH HANDLING
MISCELLANEOUS USERS
(FD-305)
108
110
118
118
105
103,800 GPM
0 GPM NORMAL
20 GPM
103,810 GPM TO COOLING TOWER SPRAY NOZZLES (SECTION 1300)
34 GPM
2,869 GPM
21 GPM
606 GPM
2,730 GPM
MAKE-UP TO COOLING TOWER BASIN (SECTION 1300)
NOTE: QUANTITIES SHOWN ARE FOR ONE MODULE
UTILITIES BOX FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
COOLING WATER USAGE
SECTION 1300


TENNESSEE RIVER – GUNTERSVILLE RESERVOIR
MINIMUM NORMAL POOL EL. 595
MAXIMUM NORMAL POOL EL. 595
PROBABLE MAXIMUM FLOOD REGULATED EL. 597.6
TENNESSEE RIVER
MILE 169
FLOW
WATER INTAKE
DEAD STORAGE
90 DAYS
2,430,000 TONS
595
SUBSTATION
TRANSMISSION LINE CORRIDOR
TVA



C	8-31-80	FINAL ISSUE	B	6-[illegible]	GENL REVISIONS	A	MAY-1-80 CLIENT COMMENTS

This Drawing is the Property of the FOSTER WHEELER ENERGY CORPORATION

KEY PLOT PLAN
S & W PROCESS
TENNESSEE VALLEY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MURPHY HILL, ALABAMA

DRAWN BY: [illegible] SCALE: AS SHOWN DWG. NO. 11-24053

DWG. NO. [illegible]

TVA Coal Gasification Study

B&W Gasifiers

4.4 Power Requirements

Section	Name of Section	Power Usage, KW	
		One Module	Total Plant
100	Coal Preparation (Crushing, Feeding)	2,580	2,580
200	Air Separation	43,400	173,600
300	Gasification and Gas Scrubbing	2,600	10,400
400	Acid Gas Removal (Selexol)	2,230	8,920
500	Product Gas Compression (turbine drive)	100	400
600	Claus and Beavon Sulfur Recovery Units	1,100	4,400
700	Sour Water Stripping	100	400
800	Slag Handling	800	800
1200-1	Raw Water Treatment	800	800
1200-2	Condensate Treatment and Potable Water	350	1,100
1200-3	BFW Treatment	1,800	7,200
1200-4	Fluid Bed Boiler	1,275	5,100
1300	Cooling Water System	7,500	30,000
1400	Flare & Incinerator	250	1,000
1500	Wastewater Treatment	1,800	7,200
2000	General Facilities	300	1,200
2100	Buildings	200	800
2200	Dock Facilities	200	800
		57,385	256,700

TVA Coal Gasification Study
B&W Gasifiers

4.5 FUEL REQUIREMENTS - B&W GASIFIER SYSTEM

The fuel required to produce the medium Btu product gas and provide the required quantity of process steam is coal.

Approximately 5,000 T/D of dried coal (containing 2.0 wt % moisture), 5,418 T/D as-is coal, is fed to each gasifier module. In addition, the flue gas generator and steam generators, (2) in each module, will consume about 222 T/D of coal (as-is). There are no other normal fuel requirements.

4.6

TVA Coal Gasification Study
Babcock and Wilcox Gasifier
Catalysts and Chemicals

Plant Based Upon 4 Modules

Chemical	Usage Lbs/Yr.	1st Charge or Inventory Lbs	Unit Cost $/Lb	Annual Usage Cost $/Yr	1st Charge or Inventory $
Selexol Solvent	39,600	280,000	1.15	45,540	322,000
Stretford Chemical	370,000	53,000	0.105	38,850	5,600
Phosphate	10,000	5,000	0.25	2,500	1,250
Sulfuric Acid	1,200,000	160,000	0.05	60,000	8,000
Caustic	426,000	42,000	0.10	42,600	4,200
Amine	6,000	2,000	1.00	6,000	2,000
Hydrazine	200	200	2.60	520	520
Chlorine	100,000	10,000	0.12	12,000	1,200
Dispersant	40,000	3,000	0.54	21,600	1,620
Inhibitor	72,000	4,000	0.50	36,000	2,000
Activated Carbon	180,000	170,000	0.70	126,000	119,000
Polymer	142,000	12,000	2.00	284,000	24,000
Lime	79,391,000	6,900,000	0.02	1,597,800	138,000
Limestone	117,400,000	15,400,000	0.0065	763,000	100,000
Alum	711,000	62,000	0.08	56,880	4,960
Beavon Catalyst	10,800	18,000	1.00	10,800	18,000
Claus Catalyst	74,000	225,000	0.50	37,000	112,500
COS Hyd. Catalyst	27,000	81,400	1.80	48,600	146,520
				3,189,690	1,011,370