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TVA COAL-GASIFICATION

COMMERCIAL DEMONSTRATION PLANT PROJECT

VOLUME 6

PLANT BASED ON

TEXACO GASIFIER

FINAL REPORT

November 1, 1980

Foster Wheeler Energy Corporation

110 South Orange Avenue, Livingston, New Jersey

PROCESS PLANTS DIVISION

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SECTION 1.0

INTRODUCTION

TVA Coal Gasification Study
Texaco Gasifier

INTRODUCTION

The baseline of a coal gasification plant producing medium Btu gas, based upon the Texaco gasification process is documented in this report.

The coal gasification plant consists of four identical modules, each with a capacity of approximately 4,800 tons of coal per day dry basis as delivered to the gasifiers. The entire plant (four modules) produces 1,195.0 Million Standard Cubic Feet per day of gas with a GHV value of approximately 285 Btu/SCF for a total heating value of about 341 billion Btu/day.

The plant location is the rural site of Murphy Hill, located along the Tennessee River, some 30 miles east of Huntsville, Alabama. Section 1 provides more detailed site information.

The desired product gas is a clean, medium-Btu gas suitable for pipeline distribution. The coal used for processing and for auxiliary boilers is a Kentucky No. 9 coal. The product gas specifications and the coal characteristics are listed in Section 2.

The site is accessible by barge and road, with the plant receiving coal primarily by barge. About 5 percent of plant needs are delivered by truck. The site will not be served by rail. The coal receiving facilities are sized to handle the entire needs of the plant.

Water needed for cooling and for process consumption will be drawn from the Tennessee River and will be treated by the plant water treatment facility. The plant will use closed loop cooling. Electricity will be furnished by TVA at the plant boundary.

The plant will be designed to meet all Federal, State, and local standards and guidelines.

A description of the plant by major sections is included as well as flow diagrams, stream balances and lists of major equipment. A key plot plan is presented in Section 5.

2.1 Choice of Processing Sequence

Process selection for the main processing units and support systems for the plant is determined by the characteristics of the Texaco gasification process and the results of specific studies carried out in Task 1. These studies considered the following questions:

- o Acid gas removal
- o Oxygen purity
- o Coal washing
- o Sulfur recovery

Support facilities studies include:

- o Equipment Drives
- o Gas Storage and Spares
- o Gas Delivery Pressure
- o Effects of Scale
- o Effects of Load Change

It was concluded that the conceptual design of the coal gasification plant should be based on unwashed coal, 98 volume % oxygen, and production of sulfur by-product in the form of prilled elemental sulfur. The Selexol process was picked to remove acid gas from raw coal gas.

The general processing sequence for the plant based on the Texaco gasifier reflects the characteristics of the gasifier. Pulverized coal is gasified under super atmospheric pressure with oxygen. Gasification occurs at high temperature (about 2500°F), and the gas produced is rich in carbon monoxide and hydrogen. Because of the high gasification temperature, the raw gas contains only small amounts of methane and essentially no oil, tar or phenols. As a result, the main processing units downstream of the gasification section consist only of gas cooling and acid gas removal.

Foster Wheeler established capacity factors to be used in the conceptual design of the various plant sections with the exception of gasification which is based on information supplied by the Texaco Development Corporation. The capacity factors, which were defined as the ratio of design capacity to normal material balance, reflected expected variations in coal feed analyses. In addition, Foster Wheeler selected spare trains and/or back-up systems to achieve an expected on-stream factor of about 90% for a module. The capacity factors are given in Foster Wheeler's supplement to TVA's Design Criteria. On-stream factor considerations are given in the discussion in Section 3.6 Volume 2 Study Assessments and Process Selection.

2.1 Choice of Processing Sequence (cont'd)

Process selection depends upon economics, experience with the process application and upon the characteristics of the Texaco gasifier. In addition to the selection of the process units, there is also the problem of selection of the process configuration involving the arrangement of units, number of trains, multiple part-capacity equipment items all integrated with the optimum plant capacity. Some configuration limitations are due to the state of development of the gasifier, some to equipment size and scale limitations as well as product demand variation and high risk, high maintenance items.

Block Flow Diagram

Drawing No. 54099-4-50-35-1 is a block flow diagram illustrating a coal conversion MBG plant using the Texaco gasifier. As shown in the diagram, coal, air, and water are the only raw materials entering the plant. Medium Btu gas is the only product leaving the plant together with by-products of sulfur, carbon dioxide and slag.

The accompanying Process Block Flow Diagram provides an overview of the main processing units selected for preparing medium Btu gas based on incorporating Texaco's gasification reactor. A brief review of the schematic which traces the flow of raw materials into finished product is furnished below, as well as a more detailed description of each individual unit.

2.1 Choice of Processing Sequence (Cont'd)

Raw coal is received from barges and is transported to coal storage piles. The coal is crushed, pulverized, slurried and fed to the gasifier, where it is reacted with oxygen from the air separation plant. The gasifier product gas is cooled and scrubbed free of solids, after which the acid gas components, CO_2, H_2S and COS, are removed in the Selexol unit. Slag emanating from the gasifier is removed to a slag disposal area; waste water generated from various processing units is treated by steam stripping. The hydrogen sulfide removed in the acid gas treating step is further processed to recover saleable sulfur, in prilled form. The resulting clean medium Btu gas is sent to the distribution system.

Support facilities common to these various units include: utilities waste water treating, flare/incinceration, and cooling tower.

2.2 General Description of Flow

Section 100 - Coal Receipt and Handling

Coal is delivered by barge to the plant as essentially 3" x 0 material. Coal is unloaded from the barges, broken to remove oversize pieces, and transferred to live storage or dead storage as required. Provision is made for receipt of about 5% of the coal by truck. During normal operation of plant, coal is reclaimed from live storage and delivered to a coal crusher which reduces the size to ½" x 0 as required for Section 300.

Section 200 - Air Separation Plant

Oxygen as required for gasification in the Texaco gasifier is produced as a 98% by volume oxygen stream from the air separation plants. The Texaco gasification process requires approximately 4,424 tons per day of oxygen to gasify 4,800 TPD of Kentucky Number 9 coal per module. The coal feed is expressed on a dry basis.

Principal components of the air separation plant are:

- Air compression to a pressure of approximately 75 psig
- Low temperature air fractionation
- Oxygen compression to a pressure of about 980 psig for the Texaco gasifiers

Liquid oxygen storage (24 hour consumption in one module) and high pressure gaseous oxygen storage (15 minutes consumption in one module) are provided as back-up supply of oxygen during short term outages of the air separation plant. Storage is provided in order to insure the required 90% operating factor for the plant.

The air separation plant produces nitrogen which is used for inert gas blanketing, instrument service, purges and other miscellaneous services. Liquid nitrogen storage of 250 tons is provided as a back-up nitrogen supply. Liquid nitrogen vaporization rate of 30 tons per hour has been used to meet the estimated plant needs with a delivery pressure of 100 psig.

Section 300 - Coal Gasification

Section 300 includes all of the equipment specified by the Texaco Development Corporation for the Texaco coal gasification process. Sized coal ½" x 0 is delivered to a coal feed bin included in Section 300. The coal is then pulverized in a rod mill using a wet grinding technique. The discharge from the mill is then fed to a slurry makeup system which

produces a coal/water slurry of proper consistency for pumping to the gasifiers. Coal fines and dirty water streams recovered downstream of the gasification system are recycled to the mill in order to minimize any carbon losses from the plant.

The coal/water slurry is pumped into the gasifier where it is gasified at high temperatures. With oxygen, the gasifier operating pressure is 750 psig which meets the final product gas requirements of 600 psig at battery limits without further compression. The gasifier effluent, which contains molten ash and the hot product gas, flows through a cooling section which generates 900 psig steam. Slag is discharged from the bottom of the gasification unit through a lock hopper system and discharged as a wet product to battery limits.

The partially cooled gas next flows through a three-stage scrubbing system for carbon removal. The scrubbed gas of a temperature of approximately 286°F then flows to a COS hydrolysis unit which is not included in the scope of Texaco's supply. The gas from the hydrolysis system is returned to the Texaco unit, Section 300, at a temperature of about 330°F and is then cooled to a final temperature of 110°F. The gas stream at this point contains less than 1 ppm by weight of carbon and flows to the sulfur removal system.

Various water streams, including water condensed from the gas, is collected and processed to clarify the water for the use in the process. A waste stream of about 300 gpm per module is sent to Section 700 for waste treatment. Recovered carbon is recycled to the wet coal grinding system.

Section 400 - Acid Gas Removal

The raw medium Btu gas from Section 300 contains sulfur compounds which must be removed. The bulk of the sulfur from the coal is as hydrogen sulfide with a smaller portion as carbonyl sulfide. COS is hydrolyzed in a catalytic reactor at a temperature of about 330°F. This reduces the COS content to about 13 ppm volume. Allied's Selexol process has been picked as suitable for removal of the H_2S for this particular application. This process uses a solvent consisting of dimethyl ether of polyethylene glycol (DMPEG), can be designed to provide a high degree of selectivity between hydrogen sulfide and carbon dioxide, and also has dehydration capabilities thus allowing the gas to meet the moisture specification of 7 lbs/MMSCF without further drying. This process is a physical absorption process and the relatively high partial pressure of H_2S is a factor in making this process attractive for the present plant design.

Carbon dioxide removal is also required in addition to H_2S removal in order to meet the GHV requirement of 285 Btu's per standard cubic foot in the purified product gas. Accordingly, design capacity has been provided in the Selexol unit to remove the required amount of CO_2.

The purified gas from the Selexol unit is delivered directly to battery limits at about 600 psig. No further treatment nor compression is required to meet the specifications for this plant.

Section 500 - Treated Gas Compression

This section is not required for this process.

Section 600 - Sulfur Recovery

In accordance with the Task I recommendation, sulfur compounds in the acid gas stream are converted to elemental sulfur using a Claus process followed by a Beavon tail gas treating unit. The hydrogen sulfide concentration in the acid gas stream from the Selexol unit is about 18.5%. Accordingly, a split flow variation of the Claus process is used to obtain over 95% conversion of H_2S to elemental sulfur. The low H_2S concentration in the acid gas requires that the Claus plant be provided with supplemental fuel. Product gas is used for this purpose.

In order to limit the sulfur emissions from the Sulfur Recovery Section, the Beavon sulfur recovery process is used to treat the tail gas. Overall sulfur recovery is increased to about 99.9% which meets sulfur recovery unit emission standards of 200 ppm or less of sulfur compounds in treated tail gas.

Molten elemental sulfur produced in the Claus and Beavon units is converted to solid prills in a Chemsource sulfur prilling process. In this operation molten sulfur is sprayed into a circulating stream of water. Solid prills of uniform size are produced and then separated from the water stream. Dewatered prills are sent to storage for eventual shipment from the site.

Section 700 - Sour Water Stripping

The water condensed during cooling of the gas stream from the Texaco gasifiers is contaminated with small amounts of sulfites, cyanides, thiocynates, formates, ammonia and solids. While much of the water is recycled, a portion must be withdrawn from the system for waste water treatment. The waste water is treated with iron sulfate and lime, is clarified, filtered, and then flows through an ammonia stripper, which removes the ammonia stream for disposal. The water from the ammonia stripper is neutralized and then flows to a biological oxidation clarifier before final

discharge to sewer.

Section 800 - Ash and Slag Handling

In the Texaco gasifier approximately 100% of the coal ash is converted to an inert slag. This material is discharged through equipment provided in Section 300. The slag discharge screens in Section 300 discharge on to conveyor and the material is then conveyed to a 56 hour slag pile before final discharge to the long-term slag storage pile. Fines accumulated in the screens' sumps are recycled to the coal pulverizers.

Section 1200 - Utility Area

The utility Area includes:

- o Raw water storage and treatment
- o Potable water treatment
- o BFW and condensate treatment
- o Steam generation
- o Plant and instrument air inert gas

Raw water is taken from the river, filtered and softened. This water is used for cooling tower makeup and for process water makeup as well as for feed for boiler feed water treatment. A portion of the softened water is further treated by chlorination to provide potable water.

Softened water is treated by ion exchange to provide water of satisfactory quality for use as boiler feed water in the high pressure steam systems. Recovered condensate is treated in an ion exchange system to "polish" the water for reuse in steam generation.

The Texaco coal gasification waste heat boilers normally generate adequate steam for operation of the plant. Foster Wheeler coal fired fluidized bed boilers are supplied for startup purposes. The high pressure steam generated in the Texaco waste heat boilers is saturated and must be superheated before prior use. A coal fired fluidized bed boiler superheater is provided for this purpose. Sulfur dioxide emissions are controlled in the Foster Wheeler fluid bed boilers by the addition of limestone which captures sulfur dioxide produced during combustion. The spent limestone is sent to long-term solid waste storage.

Plant and instrument air systems are based on the use of nitrogen produced as the byproduct in the Air Separation section.

Section 1300 - Cooling Water System

Cooling water used in process heat exchangers and exhaust steam condensing systems is cooled in mechanical draft cooling towers. Blowdown from the cooling water is treated for recovery of chromates and then sent to Waste Water Treatment.

Section 1400 - Flare and Incineration

Flares are provided to handle startup and emergency disposal of gas. An incinerator is provided to handle disposal of any combustible wastes or gases which can not be flared.

Section 1500 - Waste Water Treatment

Waste water collected in the plant based on the Texaco gasifiers is comprised of cooling tower blowdown, water treatment and steam generation blowdowns, and sanitary treatment effluent. In addition, water runoff from coal storage piles and long-term solid waste storage piles is added to the waste water.

The treatment system provided for waste water includes API separator, air floatation, surge basin and activated sludge biological oxidation systems and final holding ponds. Water from these final ponds is discharged to the river.

Section 2000 - General Facilities

General facilities for the coal gasification plant include:

- Long-term solid waste storage
- Byproducts and chemicals storage
- Power, lighting and communications
- Roads and fences
- Firewater systems
- Sewage plant
- Interconnecting piping

Storage of solid wastes accumulated over a 20 year period is provided. The major byproduct storage for the plant other than waste solids is elemental sulfur prills. Chemicals storage includes water chemicals, solvents and

limestone. The water system is based on drawing water from the river. The raw water storage tank serves as fire water reservoir as described in Section 1200.

Section 2100 - Buildings

Buildings are provided as required in TVA's Design Criteria, Section 1, Paragraph 1.3.

Section 2200 - Dock Facilities

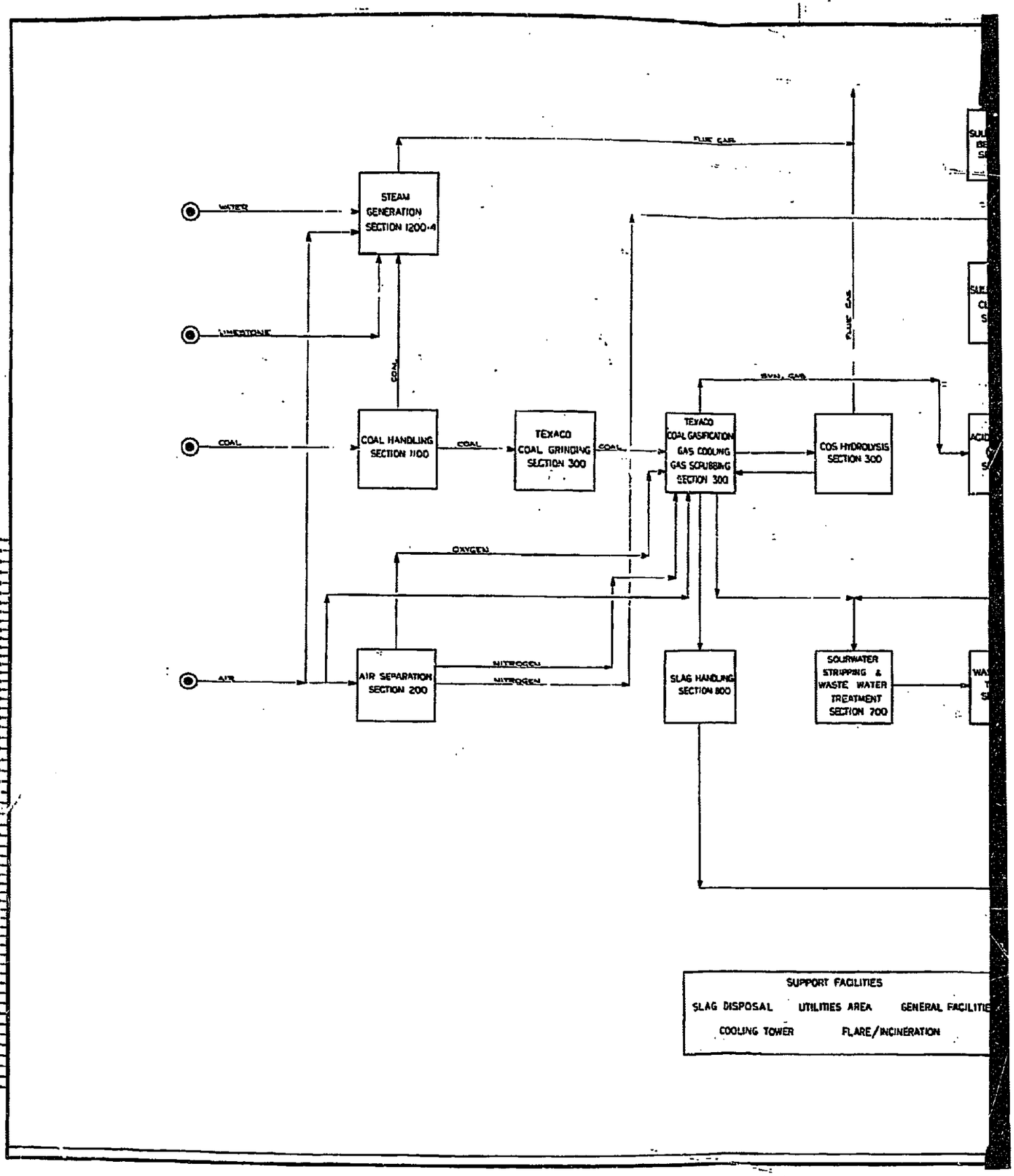
Dock facilities are provided to receive and handle barges delivering coal and barges handling sulfur shipments.

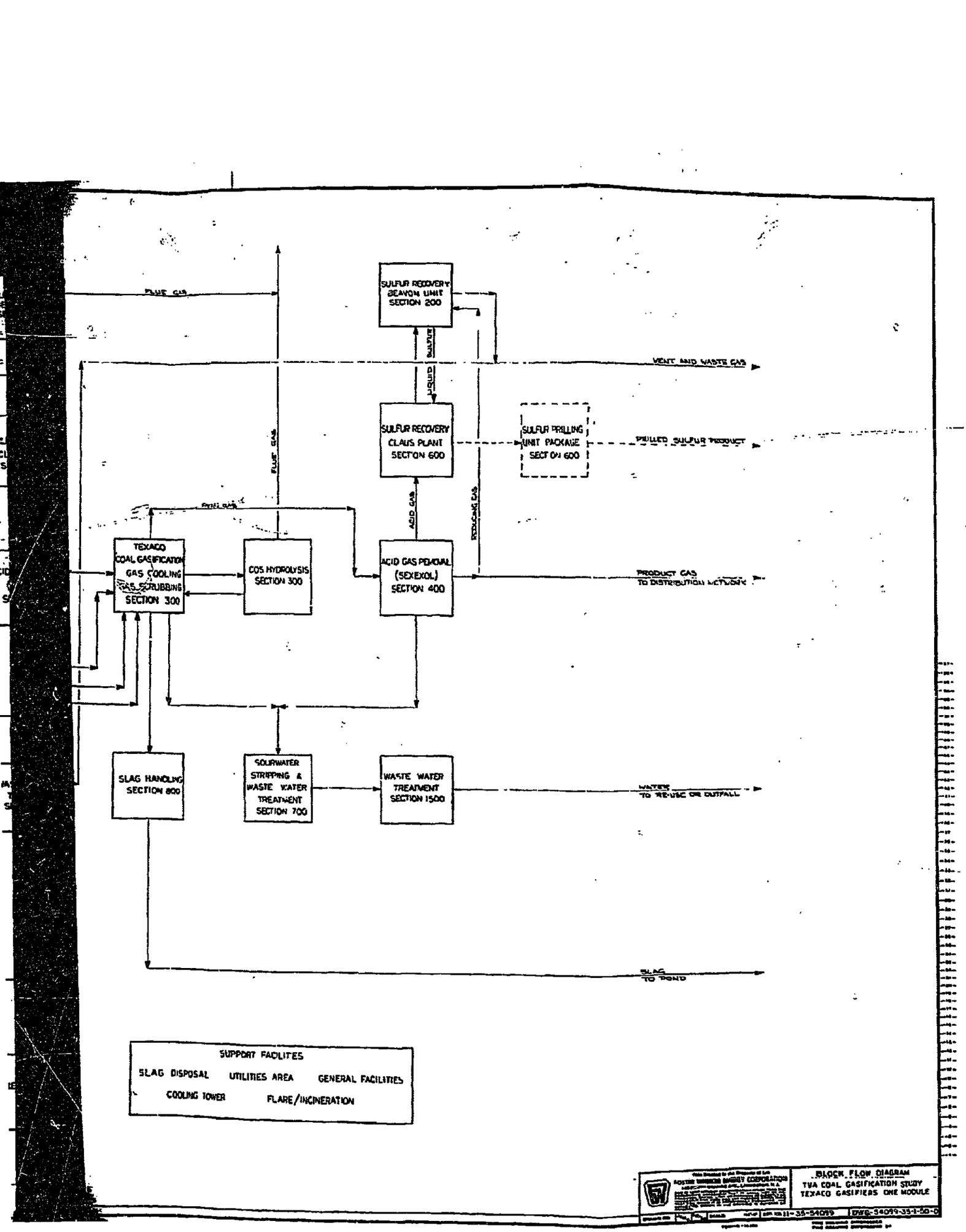
2.3 NOMINAL CAPACITIES OF PROCESSING UNITS

Nominal Capacities of Processing Units

	Process Unit	Nominal Capacity Units	1 Module	4 Modules
100	Coal Handling and Preparation	TPD	5,642.5	22,570
200	Air Separation Oxygen Production	TPD	4,424	17,696
300	Coal Gasification	TPD	5,000	20,000
400	Acid Gas Removal Gas Processed	MMSCFD	324.7	1,298.8
500	Product Gas Compressor	MMSCFD	-	-
600	Sulfur Recovery	LTPD	196	784
700	Sour Water Stripping	GPM	500	2,000
800	Ash Handling	TPD	750	3,000
900	Phenol Recovery	TPD	-	-
1000	Ammonia Recovery	TPD	-	-
1200	Utilities Area			
	Raw Water Treatment	GPM		24,400
	Potable Water Treatment	GPM		300
	BFW Treatment	GPM		2,240
	Condensate Treatment	GPM		7,600
	Steam Generation	TPD		34,858
	Flue Gas Cleaning	MMSCFD	-	-
1300	Cooling Water System			
	Cooling Water Circulation	GPM	175,000	700,000
	Blow Down Treatment	GPM		4,000
1400	Flare	MMBTU/HR	2,000	8,000
1500	Waste Water Treatment	GPM		4,320

2.4 BLOCK FLOW DIAGRAM


FLUE GAS
STEAM GENERATION SECTION 1200-4
WATER
LIMESTONE
COAL
COAL HANDLING SECTION 1100
COAL
TEXACO COAL GRINDING SECTION 300
COAL
TEXACO COAL GASIFICATION GAS COOLING GAS SCRUBBING SECTION 300
SYN. GAS
COS HYDROLYSIS SECTION 300
OXYGEN
AIR
AIR SEPARATION SECTION 200
NITROGEN
NITROGEN
SLAG HANDLING SECTION 800
SOURWATER STRIPPING & WASTE WATER TREATMENT SECTION 700
SUPPORT FACILITIES
SLAG DISPOSAL
UTILITIES AREA
COOLING TOWER
FLARE/INCINERATION


FLUE GAS
SULFUR RECOVERY BEAVON UNIT SECTION 200
SULFUR
LIQUID
VENT AND WASTE GAS
SULFUR RECOVERY CLAUS PLANT SECTION 600
SULFUR PRILLING UNIT PACKAGE SECTION 600
PRILLED SULFUR PRODUCT
FLUE GAS
ACID GAS
REDUCING GAS
FLUE GAS
TEXACO COAL GASIFICATION GAS COOLING GAS SCRUBBING SECTION 300
COS HYDROLYSIS SECTION 300
ACID GAS REMOVAL (SEXEXOL) SECTION 400
PRODUCT GAS TO DISTRIBUTION NETWORK
SLAG HANDLING SECTION 800
SOURWATER STRIPPING & WASTE WATER TREATMENT SECTION 700
WASTE WATER TREATMENT SECTION 1500
WATER TO RE-USE OR OUTFALL
SLAG TO POND
SUPPORT FACILITIES
SLAG DISPOSAL
UTILITIES AREA
GENERAL FACILITIES
COOLING TOWER
FLARE/INCINERATION
BLOCK FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
TEXACO GASIFIERS ONE MODULE
DWG-34099-351-30-0

TVA Coal Gasification Study
Texaco Gasifier

SECTION DESCRIPTION

3.1 SECTION 100-COAL PREPARATION

A. Reference Material:

• Process Flowsheet	FWEC Dwg. No. 54099-35-1-50-1
• Elevation Drawing	FWEC Dwg. No. 54099-35-1-01-1
• Equipment List	

B. Description of Flow

The unit is designed to receive and store coal, and transport it to four (4) coal gasification modules.

3" x 0" coal (8" maximum lump) is received in 1500 ton barges, and removed by barge unloader 35-UD101. Coal is then conveyed to unloader surge bin 35-TK101. Prior to entering the surge bin, tramp iron is removed by unloader magnetic separator 35-S101. Then the coal is conveyed from the surge bin to sampling station 35-SS101 and 35-SS102. Incoming inventory will be determined by sampling station feed weigh scales 25-WS101 and 35-WS102.

Coal will also be received by trucks, dumping into truck receiving hopper 35-TK102 in 25 ton batches. Coal is then conveyed directly to sampling station 35-SS101 and 35-SS102. Prior to sampling, tramp iron is removed by truck receiving magnetic separator 35-S102. Incoming inventory in this case will be determined by truck weigh scale 35-WS103.

Upon sampling, all coal drops to vibrating screens 35-SN101, 35-SN102, 35-SN103 and 35-SN104, where oversized lumps (+6") are conveyed directly to loadout and 90 day open dead storage. Unders (-6") are conveyed either to dead storage or enclosed live storage in storage silos 35-TK103, 35-TK104, 35-TK105 and 35-TK106. Incoming inventory to dead storage is determined by load-out weigh scale 35-WS104. Incoming inventory to live storage is determined by silo feed weigh scale 35-WS105.

Live storage reclaimation is handled by silo discharge feeders 35-FD104A-G, 35-FD105A-G, 35-FD106A-G and 35-FD107A-G, and the coal is conveyed to coal feed crushers 35-SR101, 35-SR102, 35-SR103 and 35-SR104. Dead storage reclaimation is done by a front-end loader dumping coal into dead storage reclaim hoppers 35-TK107 and 35-TK108, then conveying to the coal feed crushers.

The crushers break the coal down to 1/2" x 0" particle size and discharges it to the gasifier feed conveyors 35-CR117A/B. The gasifier feed conveyors will transport the material to the overhead bunker fill conveyors 35-CR118A/B feeding the coal feed bins or to the steam generator transfer conveyors 35-CR120A/B, which conveys the material onto the steam generator fill conveyors 35-CR119A/B.

All equipment from the gasifier feed conveyors to the storage bunkers are provided with one operating and one spare train.

Limestone Storage

Limestone will be delivered to the plant site by barge, then loaded into trucks. The trucks will be equipped with pneumatic unloaders for unloading into the 5000 ton limestone storage silo. Limestone will be removed from the silo using vibrating bin bottom 35-BV101 and will be fed into a pneumatic transport line by 2 rotary feeders 35-FD110A/B leading the material to the steam generator limestone storage bunkers. The pneumatic transport line will be equipped with silencers before and after pneumatic transport blowers 35-B101A/B for noise suppression.

Barge Unloading System

A power winch system for barge pulling has been contemplated and included in Item UD-101, of the equipment list for Section 100, Coal Preparation. The barge puller is designed to move a line of coal laden barges, already moved, and eventually, a single barge only during the actual coal unloading operation of that barge.

Considering the scale of the Key Plot Plan, 1 in. = 400 ft., the barge puller is not shown. It does not appear on the Process Flow Diagrams of Section 100, either, as it is an ancillary device which does not serve to clarify the movement and treatment of the product, coal, the principal purpose of the Process Flow Diagrams.

The cost of the barge puller is included as part of the hardware costs of equipment Item UD-101, for each of the coal gasification plants.

The foregoing comments apply as well to the barge cleanout system which consists of a small front end loader and a single bucket crane which loads the residual coal into a barge dedicated to the plant site for cleanout service. When it becomes full, the dedicated barge is moved into the unloading line and is then replaced by another of the empty barges.

Movement of single barges, other than those operated by the power winch, is effected by means of a 750 hp switch boat for which pricing provisions have been made in our estimate of plant costs.

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

SECTION NAME: COAL PREPARATION
REF. DWG.: 54099-35-1-50-1
CONTRACT NO.: 11-35-54099 ; 0

SECTION NO.: 10
PAGE NO.: 1 OF 3
DATE: 6/30/80

EQUIPMENT SUMMARY

ITEM	DESCRIPTION	DEFINITION	DESIGN * TEMP. (°F)	DESIGN * PRESS. (PSIG)	CONSTRUCTION MATERIAL *
35-B101A/B	Pneumatic Transport Supply Blowers				
35-BV101	Vibrating Discharger	20 TPH			
35-CR101	Unloader Transfer Conveyor	Part of UD-101			
35-CR102	Surge Bin Feed Conveyor	84" Belt, 4,800 TPH			
35-CR103	Sampling Station Feed Conveyor	48" Belt, 1,600 TPH			
35-CR104	Sampling Station Feed Conveyor	48" Belt, 1,600 TPH			
35-CR105	Truck Receiving Transfer Conveyor	30" Belt, 125 TPH			
35-CR106	Oversize Coal Coll. Conveyor	30" Belt, 128 TPH			
35-CR107	Oversize Coal Transfer Conveyor	30" Belt, 128 TPH			
35-CR108	Screen Collecting Conveyor	48" Belt, 1,600 TPH			
35-CR109	Screen Collecting Conveyor	48" Belt, 1,600 TPH			
35-CR110	Dead Storage Load-Out Conveyor	66" Belt, 3,200 TPH			
35-CR111	Silo Fill Conveyor	66" Belt, 3,200 TPH			
35-CR112	Silo Fill Conveyor	66" Belt, 3,200 TPH			
35-CR113	Silo Fill Conveyor	66" Belt, 3,200 TPH			
35-CR114	Silo Feed Conveyor	66" Belt, 3,200 TPH			
35-CR115	Silo Disch. Collecting Conveyor	48" Belt, 1,250 TPH			
35-CR116	Reclaim Collecting Conveyor	48" Belt, 1,250 TPH			
35-CR117A/B	Gasifier Feed Conveyor	48" Belt, 1,250 TPH EA.			
35-CR118A/B	Overhead Bunker Fill Conveyor	48" Belt, 1,250 TPH EA.			
35-CR119A/B	Steam Generator Fill Conveyors	48" Belt, 1,250 TPH EA.			
35-CR120A/B	Stm. Gen. Transfer Feed Conveyors	48" Belt, 1,250 TPH EA.			
35-DC101	Coal Preparation Dust Coll. Sys.				
35-DP101	Dust Suppression System				
35-F101	Silo Vent Filter				
35-F102	Silo Vent Filter				
35-F103	Silo Vent Filter				
35-F104	Silo Vent Filter				

* SHELL/TUBE WHERE APPLICABLE

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

SECTION NAME: COAL PREPARATION
REF. DWG.: 54099-35-1-50-1
CONTRACT NO.: 11-35-54099 REV.: 0

SECTION NO.: 100
PAGE NO.: 2 OF 3
DATE: 6/30/80

EQUIPMENT SUMMARY

ITEM	DESCRIPTION	DEFINITION	DESIGN * TEMP. (°F)	DESIGN * PRESS. (PSIG)	CONSTRUCTION MATERIAL *
35-F105	Silo Filter Separator				
35-FD101	Unloader Surge Bin Feeder	84" x 120", 1,600 TPH			
35-FD102	Unloader Surge Bin Feeder	84" x 120", 1,600 TPH			
35-FD103	Truck Receiving Feeder	24" x 42", 125 TPH			
35-FD104A-G	Silo Discharge Feeder	30" Belt, 3 @ 417 TPH, 4 @ 313 TPH			
35-FD105A-G	Silo Discharge Feeder	30" Belt, 3 @ 417 TPH, 4 @ 313 TPH			
35-FD106A-G	Silo Discharge Feeder	30" Belt, 3 @ 417 TPH, 4 @ 313 TPH			
35-FD107A-G	Silo Discharge Feeder	30" Belt, 3 @ 417 TPH, 4 @ 313 TPH			
35-FD108	Reclaim Hopper Discharge Feeder	48" x 72", 1,250 TPH			
35-FD109	Reclaim Hopper Discharge Feeder	48" x 72", 1,250 TPH			
35-FD110A/B	Rotary Feeders	20 TPH EA.			
35-S101	Unloader Magnetic Separator	84"			
35-S102	Truck Receiving Magnetic Separator	30"			
35-S103	Dead Storage Reclaim Mag. Sep.	48"			
35-S104	Live Storage Reclaim Mag. Sep.	48"			
35-SL101	Silencer				
35-SL102	Silencer				
35-SN101	Vibrating Screen	8' x 20' Single Deck, 800 TPH			
35-SN102	Vibrating Screen	8' x 20' Single Deck, 800 TPH			
35-SN103	Vibrating Screen	8' x 20' Single Deck, 800 TPH			
35-SN104	Vibrating Screen	8' x 20' Single Deck, 800 TPH			
35-SR101	Coal Feed Crusher	44 x 93, 1,250 TPH			
35-SR102	Coal Feed Crusher	44 x 93, 1,250 TPH			

* SHELL/TUBE WHERE APPLICABLE

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

SECTION NAME: COAL PREPARATION
REF. DWG.: 54099-35-1-50-1
CONTRACT NO.: 11-35-54099 REV.: 0

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PAGE NO.: 3 OF 3
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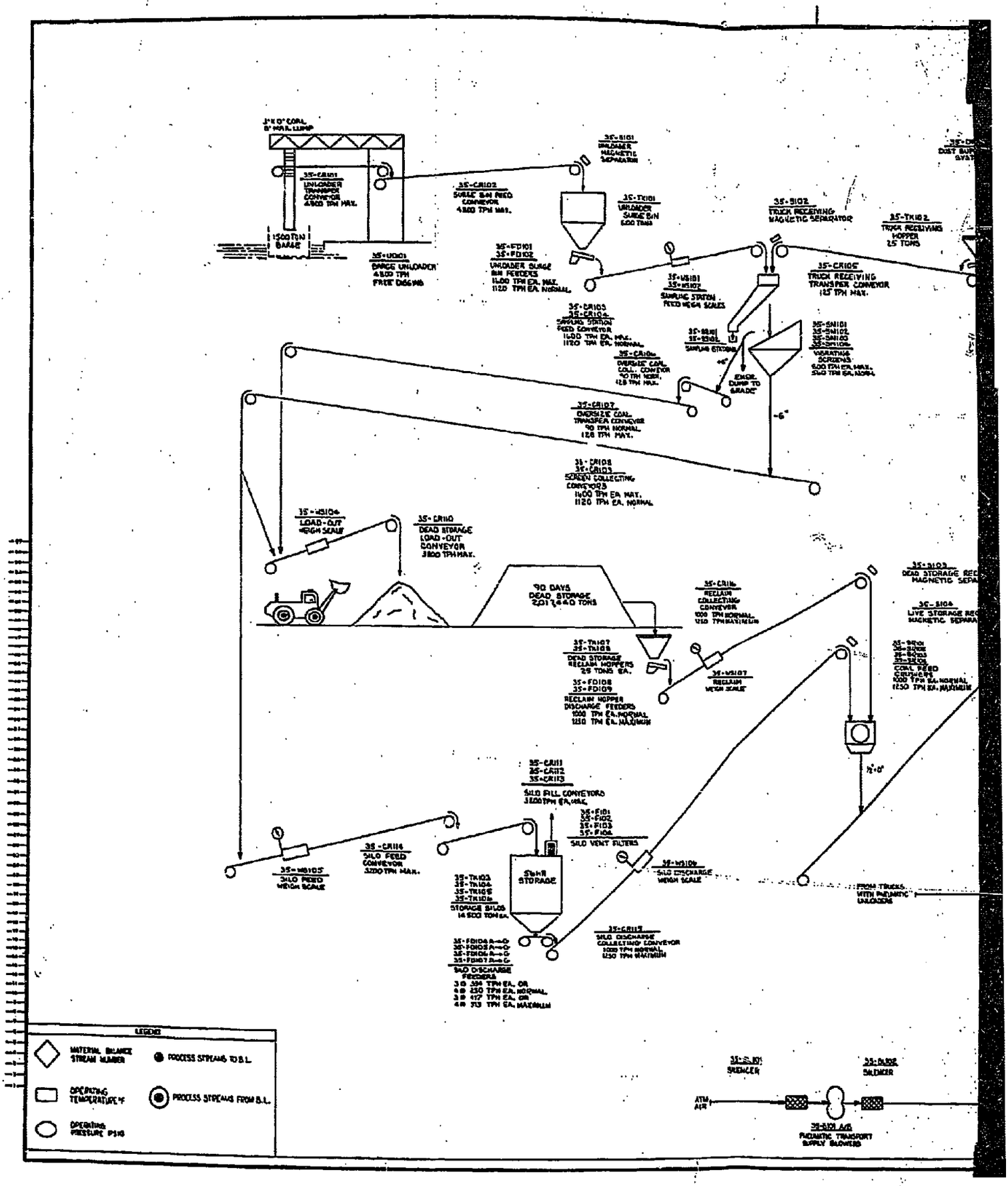
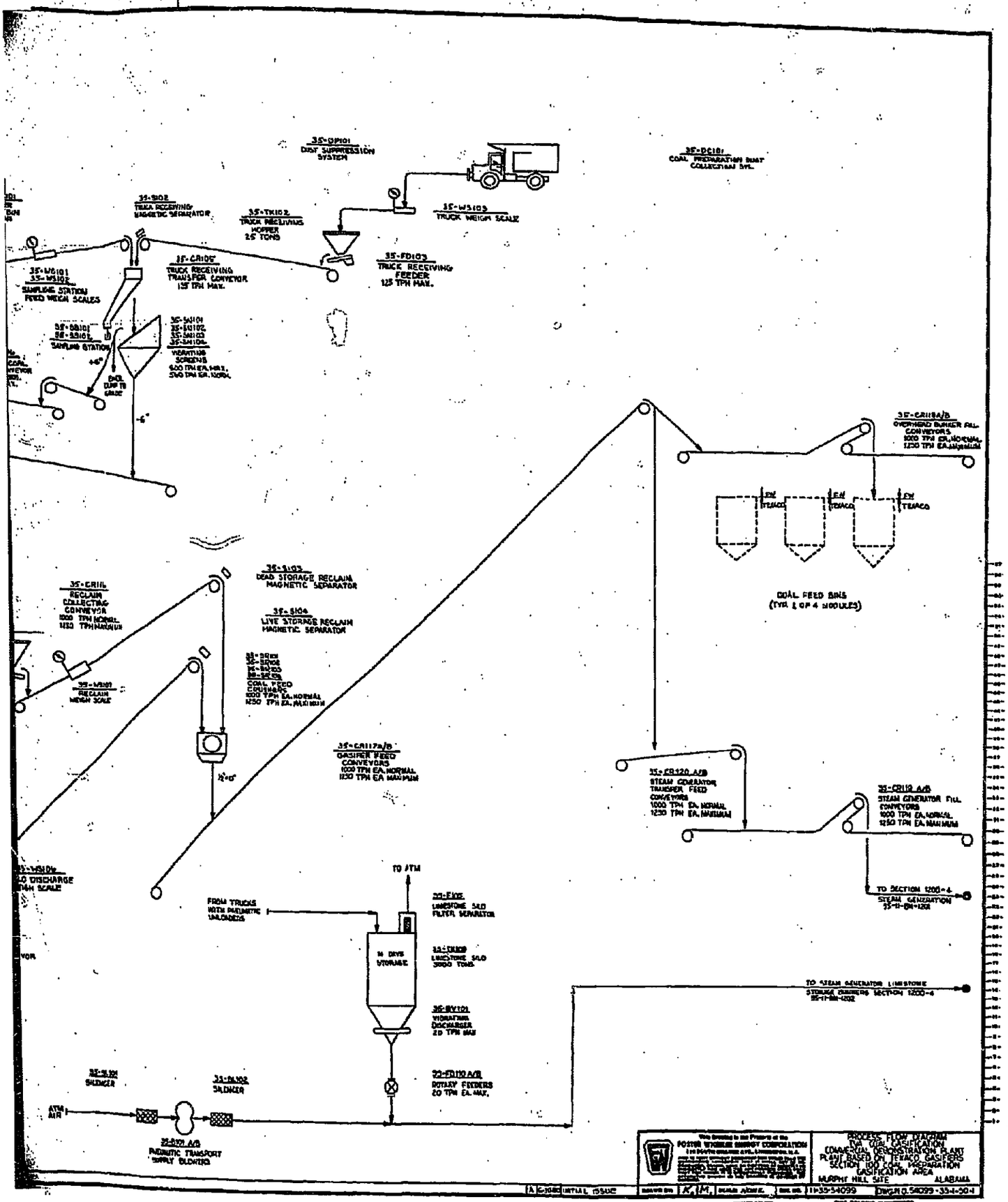
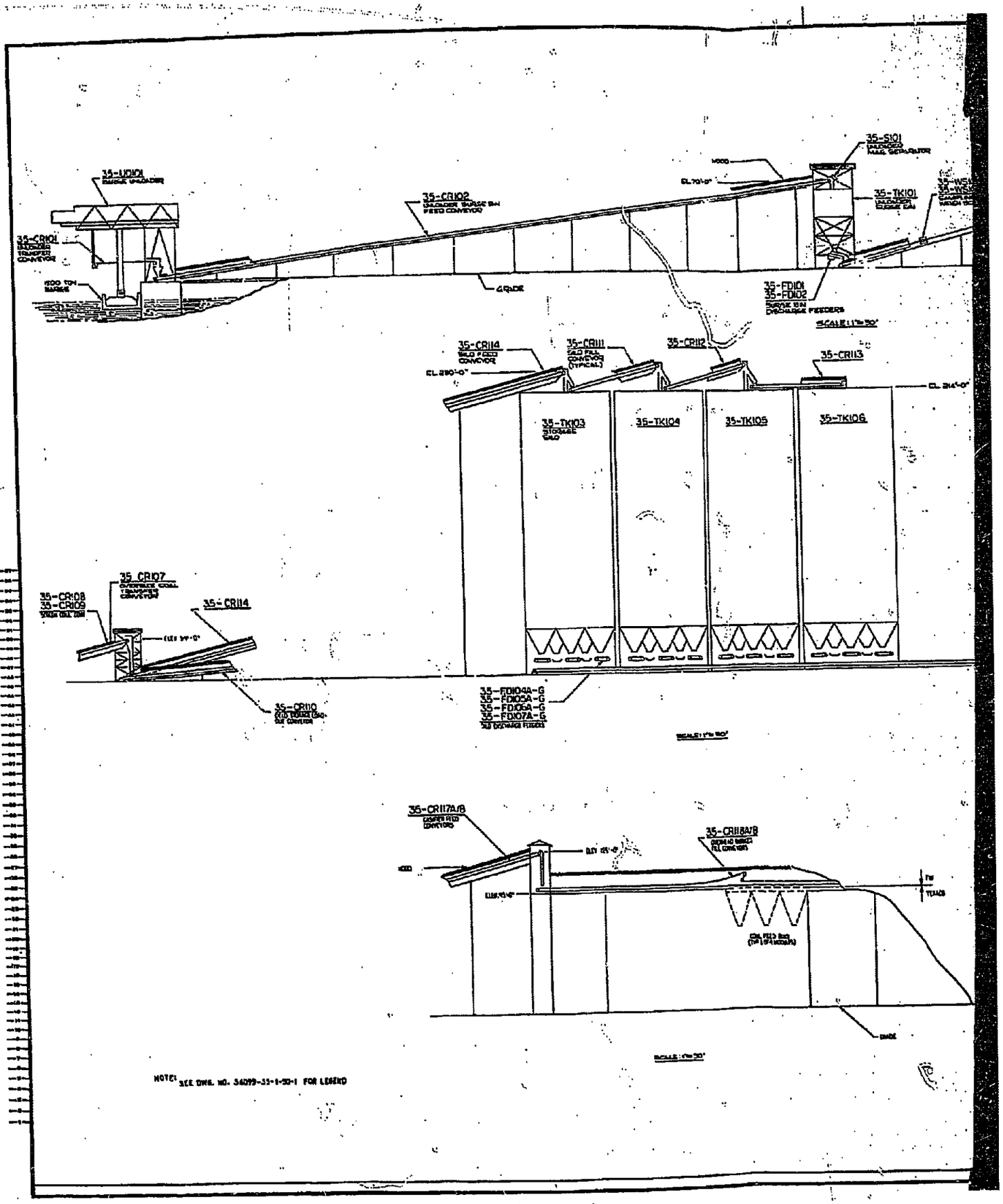
EQUIPMENT SUMMARY

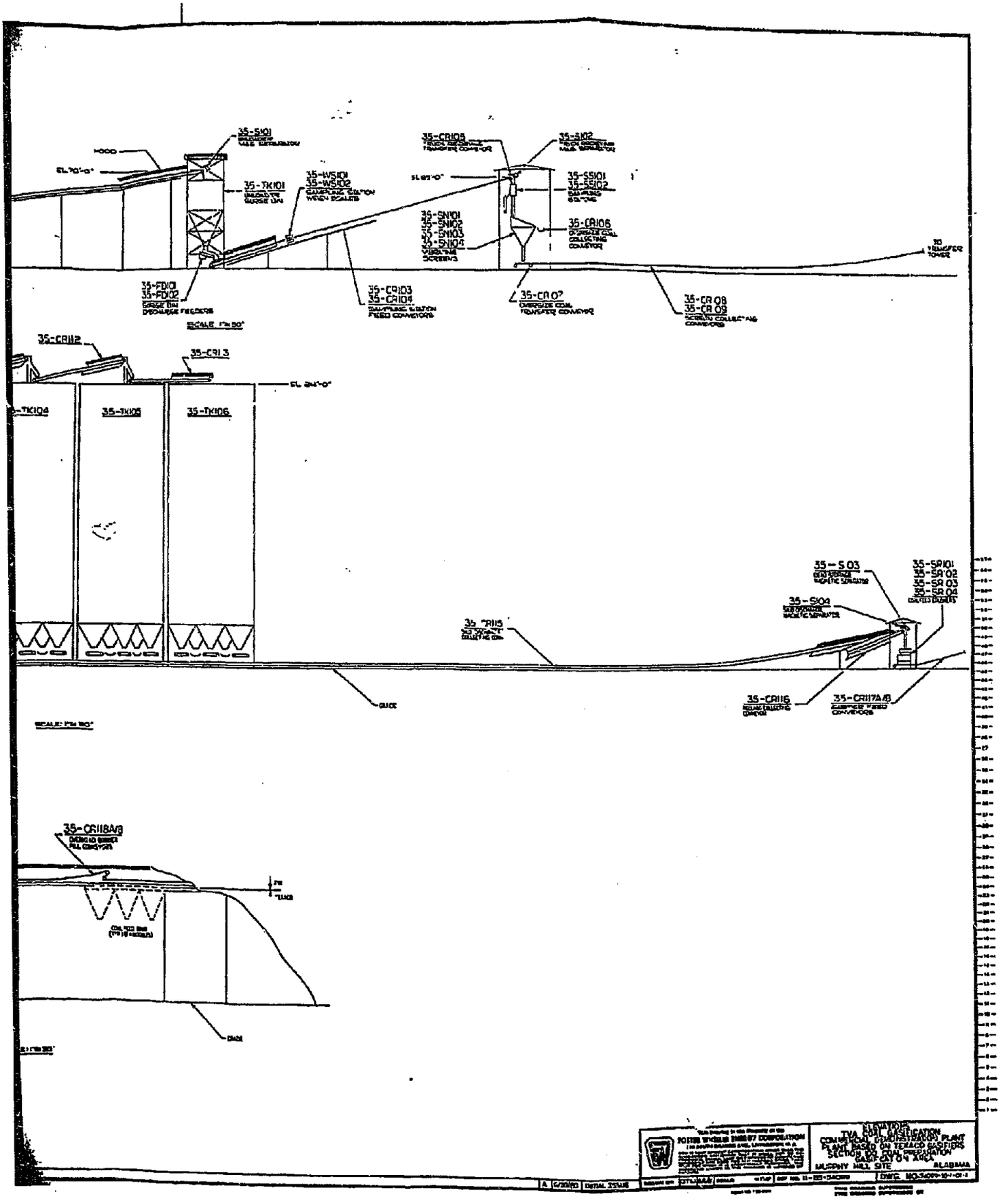
ITEM	DESCRIPTION	DEFINITION	DESIGN * TEMP. (°F)	DESIGN * PRESS. (PSIG)	CONSTRUCTION MATERIAL *
35-SR103	Coal Feed Crusher	44 x 93, 1,250 TPH			
35-SR104	Coal Feed Crusher	44 x 93, 1,250 TPH			
35-SS101	Sampling Station	2 - Stage, 1,600 TPH			
35-SS102	Sampling Station	2 - Stage, 1,600 TPH			
35-TK101	Unloader Surge Bin	600 Ton Capacity			
35-TK102	Truck Receiving Hopper	25 Ton Capacity			
35-TK103	Storage Silo	14,500 Ton Capacity			
35-TK104	Storage Silo	14,500 Ton Capacity			
35-TK105	Storage Silo	14,500 Ton Capacity			
35-TK106	Storage Silo	14,500 Ton Capacity			
35-TK107	Dead Storage Reclaim Hopper	25 Ton Capacity			
35-TK108	Dead Storage Recalim Hopper	25 Ton Capacity			
35-TK109	Limestone Silo	5,000 Ton Capacity			
35UD101	Barge Unloader	4,800 TPH			
35-WS101	Sampling Station Fd. Weigh Scale	48" W, 1,600 TPH			
35-WS102	Sampling Station Fd. Weigh Scale	48" W, 1,600 TPH			
35-WS103	Truck Weigh Scale	10' x 60'			
35-WS104	Load-Out Weigh Scale	66" W, 3,200 TPH			
35-WS105	Silo Feed Weigh Scale	66" W, 3,200 TPH			
35-WS106	Silo Discharge Weigh Scale	48" W, 1,168 TPH			
35-WS107	Reclaim Weigh Scale	48" W, 1,168 TPH			

* SHELL/TUBE WHERE APPLICABLE,


1"x 0" COAL
6" MAX. LUMP
35-CR101
UNLOADER TRANSFER CONVEYOR
4800 TPH MAX.
1500 TON BARGE
35-UD01
BARGE UNLOADER
4800 TPH
FREE DIGGING
35-CR102
SURGE BIN FEED CONVEYOR
4800 TPH MAX.
35-SI01
UNLOADER MAGNETIC SEPARATOR
35-TK101
UNLOADER SURGE BIN
500 TONS
35-FD101
35-FD102
UNLOADER SURGE BIN FEEDERS
1100 TPH EA. MAX.
1120 TPH EA. NORMAL
35-SI02
TRUCK RECEIVING MAGNETIC SEPARATOR
35-TK102
TRUCK RECEIVING HOPPER
25 TONS
35-CR105
TRUCK RECEIVING TRANSFER CONVEYOR
125 TPH MAX.
35-WS101
35-WS102
SAMPLING STATION FEED WEIGH SCALES
35-CR103
35-CR104
SAMPLING STATION BIN FEEDERS
1100 TPH EA. MAX.
1120 TPH EA. NORMAL
35-SA101
35-SA102
35-SA103
35-SA104
35-SA105
VIBRATING SCREENS
5000 TPH EA. MAX.
3360 TPH EA. NORM.
35-SR101
35-SR102
SAMPLE STATIONS
35-CR106
OVERSIZE COAL COLL. CONVEYOR
90 TPH NORM.
125 TPH MAX.
ENGR. DUMP TO GRADE
35-CR107
OVERSIZE COAL TRANSFER CONVEYOR
90 TPH NORMAL
125 TPH MAX.
35-CR108
35-CR109
SCREEN COLLECTING CONVEYORS
1400 TPH EA. MAX.
1120 TPH EA. NORMAL
35-WS104
LOAD-OUT WEIGH SCALE
35-CR110
DEAD STORAGE LOAD-OUT CONVEYOR
3800 TPH MAX.
90 DAYS
DEAD STORAGE
2,017,440 TONS
35-CR116
RECLAIM COLLECTING CONVEYOR
1000 TPH NORMAL
1250 TPH MAXIMUM
35-TK107
35-TK108
DEAD STORAGE RECLAIM HOPPERS
25 TONS EA.
35-FD108
35-FD109
RECLAIM HOPPER DISCHARGE FEEDERS
1000 TPH EA. NORMAL
1250 TPH EA. MAXIMUM
35-WS107
RECLAIM WEIGH SCALE
35-SI03
DEAD STORAGE REC MAGNETIC SEPA
35-SI04
LIVE STORAGE REC MAGNETIC SEPARA
35-SR101
35-SR102
35-SR103
35-SR104
COAL FEED CRUSHERS
1000 TPH EA. NORMAL
1250 TPH EA. MAXIMUM
35-CR111
35-CR112
35-CR113
SILO FILL CONVEYORS
3800TPH EA. MAX.
35-FI01
35-FI02
35-FI03
35-FI04
SILO VENT FILTERS
35-CR114
SILO FEED CONVEYOR
3200 TPH MAX.
35-WS105
SILO FEED WEIGH SCALE
35-TK103
35-TK104
35-TK105
35-TK106
STORAGE SILOS
14,500 TONS EA.
Stahl STORAGE
35-WS106
SILO DISCHARGE WEIGH SCALE
FROM TRUCKS WITH PNEUMATIC UNLOADERS
35-FD106 A-D
35-FD107 A-D
SILO DISCHARGE FEEDERS
3 @ 594 TPH EA. OR
4 @ 450 TPH EA. NORMAL
3 @ 417 TPH EA. OR
4 @ 313 TPH EA. MAXIMUM
35-CR115
SILO DISCHARGE COLLECTING CONVEYOR
1000 TPH NORMAL
1250 TPH MAXIMUM
LEGEND
MATERIAL BALANCE STREAM NUMBER
OPERATING TEMPERATURE °F
OPERATING PRESSURE PSIG
PROCESS STREAMS TO B.L.
PROCESS STREAMS FROM B.L.
35-S-101
SILENCER
35-SI02
SILENCER
ATM. AIR
35-BL01 A/B
PNEUMATIC TRANSPORT SUPPLY BLOWERS


35-DP101
DUST SUPPRESSION SYSTEM
35-DC101
COAL PREPARATION DUST COLLECTION SYS.
35-SI02
TRUCK RECEIVING MAGNETIC SEPARATOR
35-TK102
TRUCK RECEIVING HOPPER 25 TONS
35-WS103
TRUCK WEIGH SCALE
35-CR105
TRUCK RECEIVING TRANSFER CONVEYOR 125 TPH MAX.
35-FD103
TRUCK RECEIVING FEEDER 125 TPH MAX.
35-WS101
35-WS102
SAMPLING STATION FEED WEIGH SCALES
35-SB101
35-SB102
SAMPLING STATION
35-SA101
35-SA102
35-SA103
35-SA104
VIBRATING SCREENS 600 TPH EA. MIN. 540 TPH EA. NORMAL
DUST DUMP TO GRADE
+6"
-6"
35-CR118A/B
OVERHEAD BUNKER FILL CONVEYORS 1000 TPH EA. NORMAL 1250 TPH EA. MAXIMUM
EH TEXACO
EH TEXACO
EH TEXACO
COAL FEED BINS (TYP. 1 OF 4 MODULES)
35-SI03
DEAD STORAGE RECLAIM MAGNETIC SEPARATOR
35-SI04
LIVE STORAGE RECLAIM MAGNETIC SEPARATOR
35-CR111
RECLAIM COLLECTING CONVEYOR 1000 TPH NORMAL 1250 TPH MAXIMUM
35-WS101
RECLAIM WEIGH SCALE
35-SR101
35-SR102
35-SR103
35-SR104
COAL FEED CRUSHERS 1000 TPH EA. NORMAL 1250 TPH EA. MAXIMUM
½"-0"
35-CR117A/B
GASIFIER FEED CONVEYORS 1000 TPH EA. NORMAL 1250 TPH EA. MAXIMUM
35-CR120 A/B
STEAM GENERATOR TRANSFER FEED CONVEYORS 1000 TPH EA. NORMAL 1250 TPH EA. MAXIMUM
35-CR119 A/B
STEAM GENERATOR FILL CONVEYORS 1000 TPH EA. NORMAL 1250 TPH EA. MAXIMUM
TO SECTION 1200-4 STEAM GENERATION 35-11-BM-1201
TO ATM
FROM TRUCKS WITH PNEUMATIC UNLOADERS
35-FI05
LIMESTONE SILO FILTER SEPARATOR
35-TK108
LIMESTONE SILO 3000 TONS
N DAYS STORAGE
35-BV101
VIBRATING DISCHARGER 20 TPH MAX
TO STEAM GENERATOR LIMESTONE STORAGE HOPPERS SECTION 1200-4 35-11-BM-1202
35-SI01
SILENCER
35-SI02
SILENCER
ATM AIR
35-BW01 A/B
PNEUMATIC TRANSPORT SUPPLY BLOWERS
35-FD110 A/B
ROTARY FEEDERS 20 TPH EA. MAX.
POSTER WHEELER ENERGY CORPORATION
PROCESS FLOW DIAGRAM TVA COAL GASIFICATION COMMERCIAL DEMONSTRATION PLANT PLANT BASED ON TEXACO GASIFIERS SECTION 1200 COAL PREPARATION GASIFICATION AREA
MURPHY HILL SITE ALABAMA
A 6-1980 INITIAL ISSUE
K.M.
11-35-541099
DWG. NO. 541099-35-1-501


35-UD101
35-CR101
35-CR102
35-S101
35-TK101
35-FD101
35-FD102
35-CR114
35-CR111
35-CR112
35-CR113
35-TK103
35-TK104
35-TK105
35-TK106
35-CR107
35-CR108
35-CR109
35-CR110
35-FD104A-G
35-FD105A-G
35-FD106A-G
35-FD107A-G
35-CR117A/B
35-CR118A/B
NOTE: SEE DWG. NO. 34099-35-1-50-1 FOR LEGEND


35-SI01
HOOD
EL 70'-0"
35-TK101
35-WS101
35-WS102
35-CR105
35-SI02
35-SS101
35-SS102
35-SN101
35-SN102
35-SN103
35-SN104
35-CR106
TO TRANSFER TOWER
35-FD101
35-FD102
35-CR103
35-CR104
35-CR107
35-CR108
35-CR109
SCALE 1"=50'
35-CR112
35-C913
EL 614'-0"
35-TK104
35-TK105
35-TK106
35-S103
35-SR101
35-SR102
35-SR103
35-SR104
35-S104
35-CR115
35-CR116
35-CR117A/B
SCALE: 1"=50'
35-CR118A/B
ELEVATIONS
TVA COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
PLANT BASED ON TEXACO GASIFIERS
SECTION 100 COAL PREPARATION
EAST DYKE AREA
MURPHY HILL SITE
ALABAMA
A 6/20/80 INITIAL ISSUE

TVA coal Gasification Study
Texaco Gasifier

SECTION DESCRIPTION

3.2 SECTION 200 - AIR SEPARATION PLANT

A. Reference Material:

- Process Flowsheet FWEC Drwg No. 54099-35-1-50-2
- Equipment List
- Input/Output Major Stream Flows

B. Description of Flow

Filtered air is compressed to approximately 90 PSIG in Air Compressors (35-12-C-201A/B). Intercoolers, an aftercondenser, and K.O. Drum are provided. Condensate leaving the K.O. Drum flows to the cooling tower. One Air Compressor is motor driven and one turbine driven per air plant.

Some compressed air is fed to the gasifier during startup. Normally compressed air is fed only to the Cold Box Package (35-12-PG-201).

The Cold Box Package produces nitrogen containing about 10 ppmv O_2 and oxygen of about 98 vol % O_2 purity. Waste nitrogen is vented through the Waste Nitrogen Silencer (35-12-SL-201) to atmosphere. Oxygen gas leaving the Cold Box Package is compressed to a pressure of about 900 PSIG by the Oxygen Compressor (35-12-C-202A/B). Intercoolers will be provided by the compressor manufacturer. A fraction of the compressed oxygen is sent to the Gasification Section 300. A smaller fraction is boosted to about 3,000 PSIG by the O_2 Storage Feed Compressor and flows to the Gaseous Oxygen Storage Tanks (35-11-TK-20A/B/C/D). Stored oxygen is provided to insure continuity of a gasifier operation during shut down air plant outages.

The liquid oxygen product leaving the Cold Box Package (35-12-PG-201) enters the Liquid Oxygen Storage Tank (35-11-TK-201). When required, liquid oxygen is vaporized in the Liquid Oxygen Vaporation Package (35-11-PG-204), then combined with oxygen from the O_2 Storage Feed Compressors in both air plants (two air plants per module). The combined gaseous oxygen stream enters the Gaseous Oxygen Storage Tanks.

Liquid nitrogen leaves the Cold Box Package and enters the Liquid Nitrogen Storage Tank (35-11-TK-203). When required, liquid nitrogen is vaporized in the Nitrogen Vaporization Packages (35-11-PG-203A/B). Vaporized nitrogen from Nitrogen Package PG-203A is sent to the Gasifier in Section 300, while vaporized nitrogen from Nitrogen Vaporization Package PG-203B is used for Plant Instruments.

Gaseous nitrogen from the Cold Box Package, PG-201, enters the Plant Nitrogen Package (35-12-PG-202). Compressed nitrogen leaving the Knockout Drum at a pressure of about 585 PSIG is distributed to process users. A fraction of the compressed nitrogen utilized by plant instruments, the remainder used for purging, blanketing, coal system shutdown, coal treatment and coal feed system.

FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA COAL GASIFICATION
LOCATION: ALABAMA
PLANT TYPE: TEXACO GASIFIER

SECTION NAME: AIR SEPARATION PLANT
REF. DWG.: 54099-35-1-50-2
CONTRACT NO.: 11-35-54099 REV.:

SECTION NO.: 200
PAGE NO.: 1
DATE:

STREAM NUMBER		35 201	35 202	35 203	35 204	35 205	35 206
STREAM DESCRIPTION		Air Intake	Nitrogen	Oxygen	Oxygen	Condensate	Nitrogen
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						2,142.86
NITROGEN	28.014	42,984.76	40,841.9				
OXYGEN	32.000	11,518		11,518			
HYDROGEN SULFIDE	34.080						
CARBONYL SULFIDE	60.075						
AMMONIA	17.031						
HYDROGEN CYANIDE	27.026						
CHLORIDES	35.453						
SULFUR	32.066						
CARBON DISULFIDE	76.143						
SULFUR DIOXIDE	64.059						14.42
ARGON	39.944	511.79	273.93	223.44			
MERCAPTANS							
TOTAL DRY GAS		55,014.55	41,115.83	11,741.44			2,157.28
WATER	18.016	1,100.6					
TOTAL WET GAS		56,115.15					
		LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR
TOTAL STREAM LBS/HR		1,613,022.4	1,155,087	377,501			60,606
SOLIDS LBS/HR							
COAL							
ASH							
CARBON							
TOTAL SOLIDS						19,828.4	
WATER LIQUID							
TOTAL STREAM							
TEMPERATURE, °F		98		240			
MMSCFD DRY GAS							
DRY GAS GHV (BTU/SCF)							

TWO TRAINS PER MODULE (EXCEPT O_2 & N_2 STORAGE & VAPORIZATION)

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 200

TYPE OF UNIT: AIR SEPARATION PLANT

CLIENT TVA - COAL GASIFICATION STUDY

LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	NO/MODULE	REV
COMPRESSORS 35-12	C-201 A/B	AIR COMPRESSOR	2		2 - 50%	
	C-202 A/B	OXYGEN COMPRESSOR	2		2 - 50%	
	C-203 A/B	OXYGEN STORAGE FEED COMPRESSOR	2		2 - 50%	
DRUMS 35-12	D-201 A/B	AIR COMPRESSOR K.O. DRUM	2		2 - 50%	
EXCHANGERS 35-12	E-201 A/B	AIR COMPRESSOR INTERCOOLER	2		2 - 50%	
	E-202 A/B	AIR COMPRESSOR AFTER CONDENSER	2		2 - 50%	
	E-203 A/B	OXYGEN COMPRESSOR FIRST INTERCOOLER	2		2 - 50%	
	E-204 A/B	OXYGEN COMPRESSOR SECOND INTERCOOLER	2		2 - 50%	
	E-205 A/B	OXYGEN COMPRESSOR THIRD INTERCOOLER	2		2 - 50%	
	E-206 A/B	OXYGEN COMPRESSOR FIRST AFTERCOOLER	2		2 - 50%	
	E-207 A/B	OXYGEN COMPRESSOR SECOND AFTERCOOLER	2		2 - 50%	

FORM NO. 13

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 200

TYPE OF UNIT: AIR SEPARATION PLANT

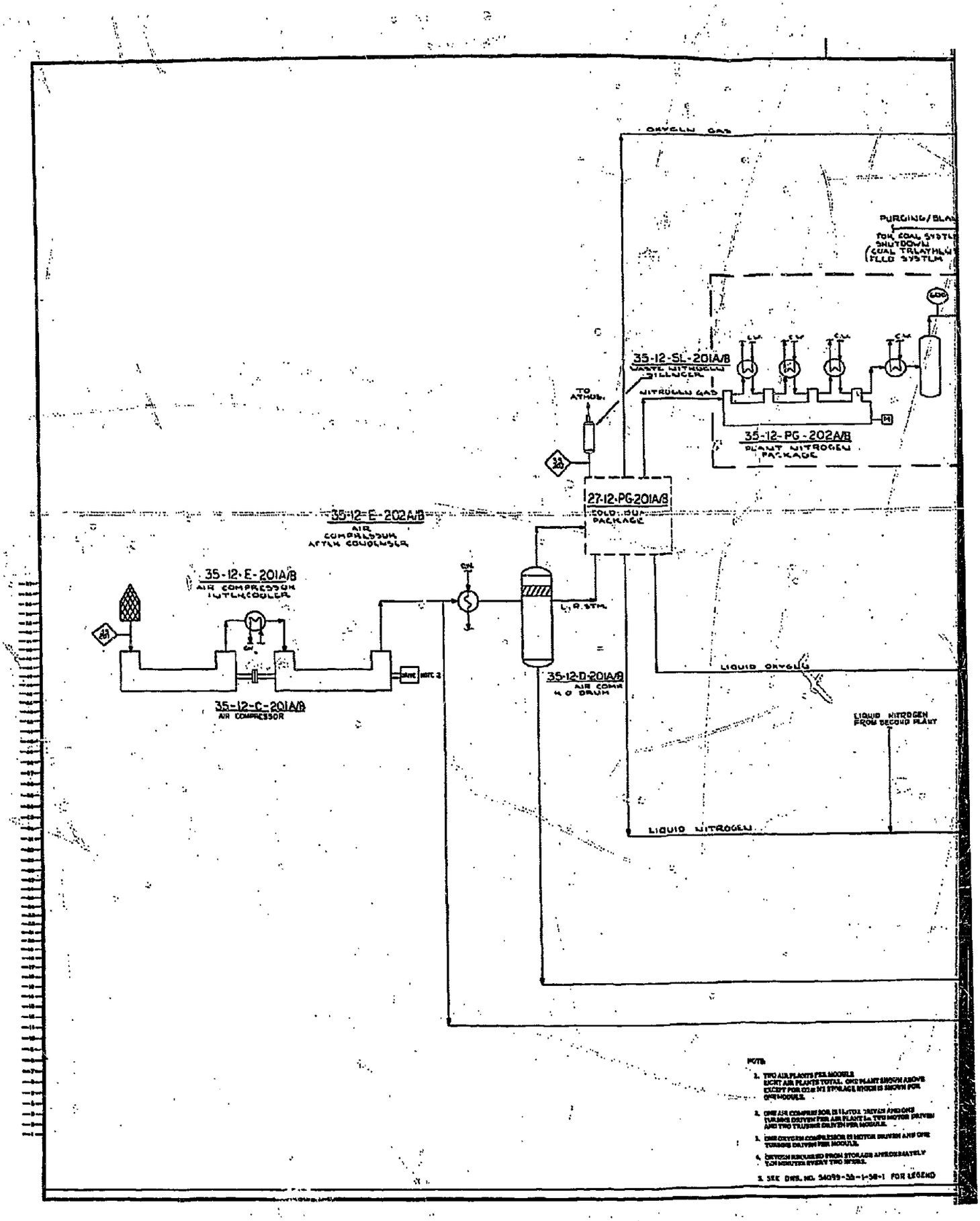
CLIENT: TVA - COAL GASIFICATION STUDY

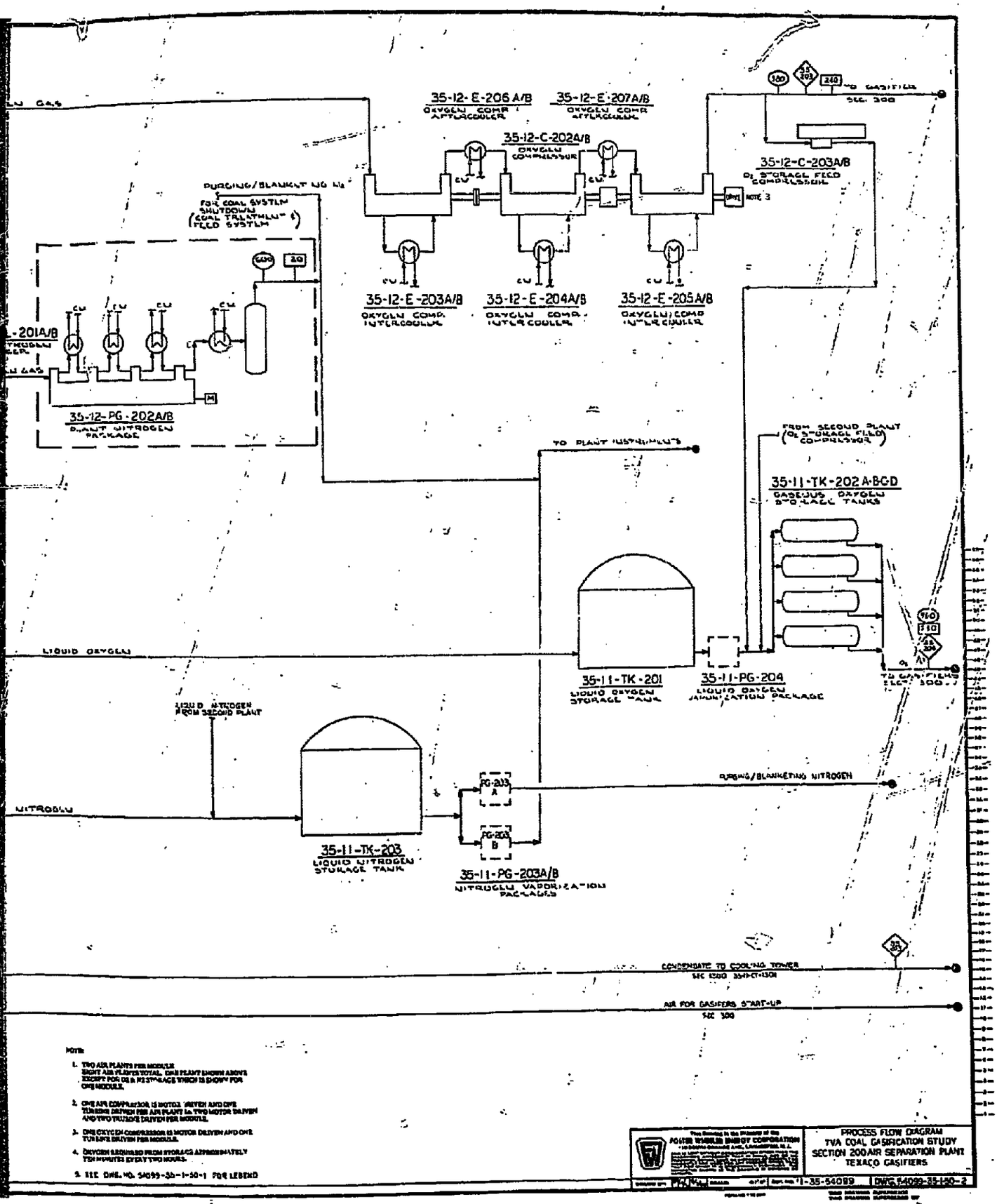
LOCATION: ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	NO/MODULE	REV
SILENCER						
35-12 —	SL-201	WASTE NITROGEN SILENCER	2		2 - 50%	
	A/B					
TANKS						
35-12 -	TK-201	LIQUID OXYGEN STORAGE TANK	2		1 - 100%	
—	TK-202	GASEOUS OXYGEN STORAGE TANK	2		4 - 25%	
	A/B/C/D					
—	TK-203	LIQUID NITROGEN STORAGE TANK	2		1 - 100%	
PACKAGE ITEMS						
35-12 —	PG-201	COLD BOX PACKAGE	2		2 - 50%	
	A/B					
—	PG-202	PLANT NITROGEN PACKAGE	2		2 - 50%	
	A/B					
—	PG-203	NITROGEN VAPORIZATION PACKAGE	2		2 - 50%	
	A/B					
—	PG-204	LIQUID OXYGEN VAPORIZATION PACKAGE	2		1 - 100%	

FORM NO. 135-66D


OXYGEN GAS
PURGING/BLA
FOR COAL SYSTE
SHUTDOWN
(COAL TRIATHLO
FLUID SYSTEM
35-12-SL-201A/B
WASTE NITROGEN
SILENCER
TO ATMOS.
NITROGEN GAS
35-12-PG-202A/B
PLANT NITROGEN
PACKAGE
27-12-PG-201A/B
COLD BOX
PACKAGE
35-12-E-202A/B
AIR
COMPRESSOR
AFTER COOLER
35-12-E-201A/B
AIR COMPRESSOR
INTERCOOLER
35-12-C-201A/B
AIR COMPRESSOR
35-12-D-201A/B
AIR COMP
H2O DRUM
L.P. STM.
LIQUID OXYGEN
LIQUID NITROGEN
FROM SECOND PLANT
LIQUID NITROGEN
NOTE 3
NOTES
1. TWO AIR PLANTS PER MODULE
EIGHT AIR PLANTS TOTAL. ONE PLANT SHOWN ABOVE
EXCEPT FOR COLD BOX STORAGE WHICH IS SHOWN FOR
ONE MODULE.
2. ONE AIR COMPRESSOR IS ELECTRIC DRIVEN AND ONE
TURBINE DRIVEN PER AIR PLANT i.e. TWO MOTOR DRIVEN
AND TWO TURBINE DRIVEN PER MODULE.
3. ONE OXYGEN COMPRESSOR IS MOTOR DRIVEN AND ONE
TURBINE DRIVEN PER MODULE.
4. OXYGEN REQUIRED FROM STORAGE APPROXIMATELY
7.5 MINUTES EVERY TWO HOURS.
5. SEE DWG. NO. 34099-35-1-38-1 FOR LEGEND



NOTE:

1. TWO AIR PLANTS PER MODULE EIGHT AIR PLANTS TOTAL. ONE PLANT SHOWN ABOVE EXCEPT FOR O2 & N2 STORAGE WHICH IS SHOWN FOR ONE MODULE.
2. ONE AIR COMPRESSOR IS MOTOR DRIVEN AND ONE TURBINE DRIVEN PER AIR PLANT i.e. TWO MOTOR DRIVEN AND TWO TURBINE DRIVEN PER MODULE.
3. ONE OXYGEN COMPRESSOR IS MOTOR DRIVEN AND ONE TURBINE DRIVEN PER MODULE.
4. OXYGEN REQUIRED FROM STORAGE APPROXIMATELY TEN MINUTES EVERY TWO HOURS.
5. SEE DWG. NO. 54099-35-1-50-1 FOR LEGEND

This Drawing is the Property of the FOSTER WHEELER ENERGY CORPORATION

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTION 200 AIR SEPARATION PLANT
TEXACO GASIFIERS

DWG. 54099-35-1-50-2

TVA Coal Gasification Study
Texaco Gasifier

SECTION DESCRIPTION

3.3 SECTION 300 - TEXACO GASIFICATION SYSTEM

A. Reference Material:

- Process Flowsheets — FWEC Dwg. No. 54099-35-4-50-3A
- Input/Output Major Stream Flows

B. Description of Flow

Sized coal (½" x 0) is delivered to a Coal Feed Bin. The Coal flows to the Belt Scale, and then to the Coal Feeding Belt, which conveys the coal (dry basis) at an average rate of 400,000 lbs/hr into a Mill. The Mill pulverizes the coal using wet grinding technique. Make-up water is continuously added to the Mill. Pulverized coal is discharged by gravity into the Mill Sump, where additional water is added. The coal slurry is pumped to a Slurry Make-up Tank. Coal/water slurry of proper consistency is produced in the Make-up Tank.

Coal fines and dirty water streams recovered downstream of the gasification system are recycled to the Mill in order to minimize any carbon losses from the plant. The slurry is pumped into the Slurry Mix Tank. When the tank is full, coal slurry is pumped into the Slurry Run Tank.

The coal slurry flows to the Gasifier where a controlled flow of oxygen from battery limit is introduced. The oxygen burns the coal to a synthetic gas containing largely H_2 and CO by the basic reaction:

$$C_x\ Hy + \tfrac{1}{2}\ O_2 = CO + \tfrac{1}{2}yH_2 + \text{Heat Evolved}$$

The process burner directs the products of combustion down into the gasifier.

The gasifier effluent, which contains molten ash and the hot product gas, flows through a Radiant Cooler, and then through a Convection Cooler, which generates 900 psig steam. The hot gas is scrubbed of soot and slag. The slag falls to the bottom of the radiant cooler and into the Lock Hopper. The Lock Hopper is operated on a 30 minute automatic cycle. The slag slurry leaving the hopper is screened to remove the larger sizes from the fines and water in Slag Screen. The slag is delivered to battery limits and the fines and water are collected in Startup Quench Water Sump. The fines are pumped to the battery limits for disposal by Sump Pump. The Sump Pump is also used to flush the slag hopper and to supply quench water during preheat of the gasifier.

The partially cooled gas flows through a Heat Exchanger, to heat the BFW to 375°F. The cooled gas next flows through a scrubbing system for carbon removal. The scrubbed gas of a temperature of approximately 280°F then flows to COS Hydrolysis Unit (FWEC Dwg. 54099-35-1-50-7) to reduce the COS concentration in the gas before entering the Acid Gas Removal Section. The gas from COS hydrolysis system is returned to Gasification Section. Most of the water vapor is condensed by first passing the syngas through coolers. All of the condensate is recirculated through the carbon scrubbing system. Syngas from the cooler flows to the Acid Gas Removal System, Section 400.

The carbon water from the gasifier and scrubbers is cooled in the Carbon Water Precooler before it enters the Clarifier. In the clarifier, carbon solids are concentrated and recycled to the wet coal grinding system. The overflow from the clarifier enters the Gray Water Drum, where the water is further clarified and sent to various process units within the Gasification Section. A waste stream is sent to the Section 700 for waste treatment.

FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA COAL GASIFICATION
LOCATION: ALABAMA
PLANT TYPE: TEXACO GASIFIER

SECTION NAME: COAL GRINDING
REF. DWG.: 54099-35-1-50-3A
CONTRACT NO.: 11-35-54099 REV.:

SECTION NO.: 300
PAGE NO.: 1 OF 3
DATE:

STREAM NUMBER		35 301		35 303	35 304		
STREAM DESCRIPTION		Raw Coal		Make-up Water	Lock Hopper Effluent		
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						
CARBONYL SULFIDE	60.075						
AMMONIA	17.031						
HYDROGEN CYANIDE	27.026						
CHLORIDES	35.453						
SULFUR	32.066						
CARBON DISULFIDE	76.143						
SULFUR DIOXIDE	64.059						
ARGON	39.944						
MERCAPTANS							
TOTAL DRY GAS							
WATER	18.016						
TOTAL WET GAS							
		LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR
TOTAL STREAM LBS/HR							
SOLIDS LBS/HR							
COAL		400,000					
ASH							
CARBON							
SOOT							
TOTAL SOLIDS		400,000					
WATER LIQUID							
TOTAL STREAM		400,000					
TEMPERATURE, °F							
MMSCFD DRY GAS							
DRY GAS GHV (BTU/SCF)							

FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA COAL GASIFICATION
LOCATION: ALABAMA
PLANT TYPE: TEXACO GASIFIER

SECTION NAME: GASIFICATION
REF. DWG.: 54099-35-1-50-3A
CONTRACT NO.: 11-35-54099 REV.:

SECTION NO.: 300
PAGE NO.: 2 of 3
DATE:

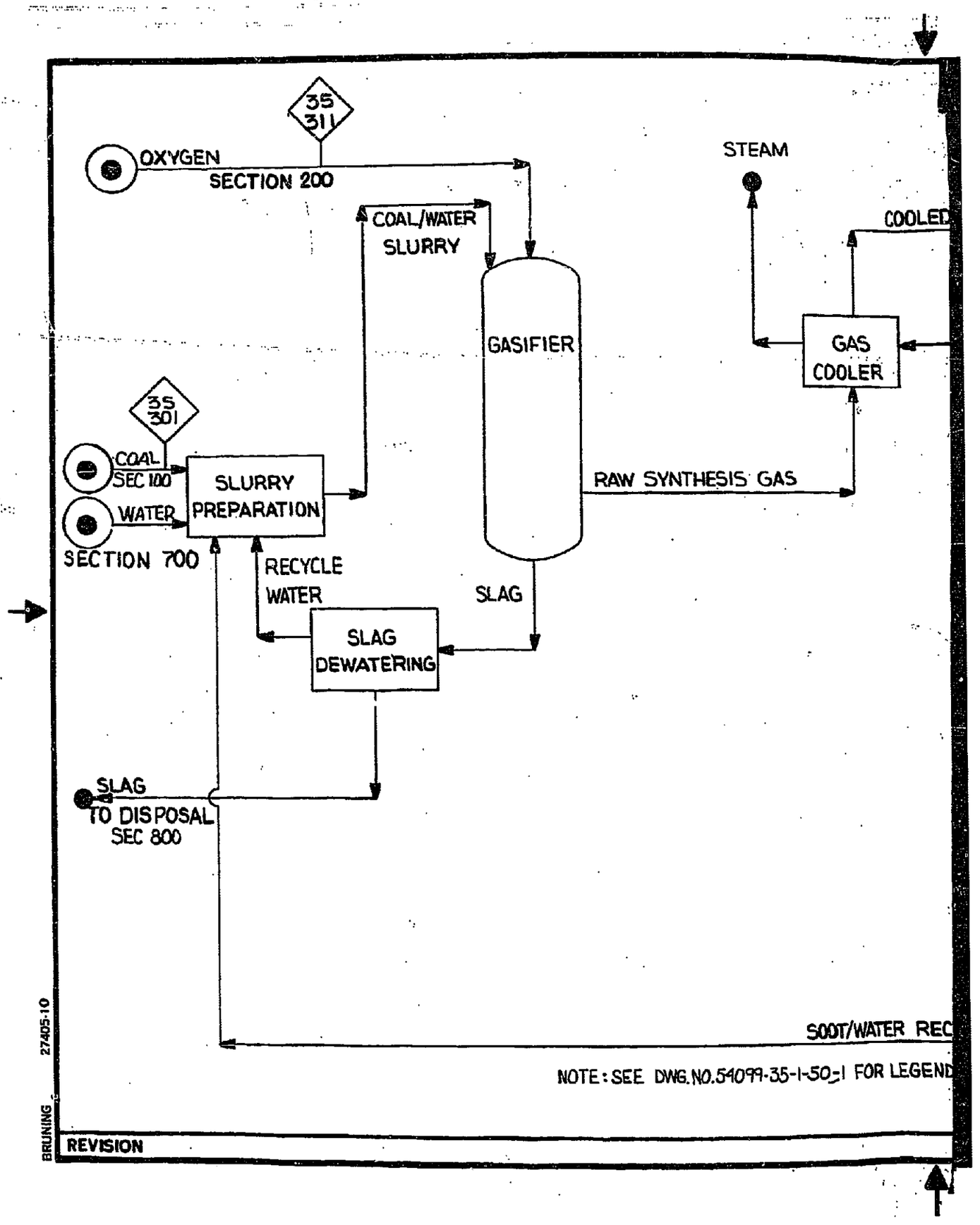
STREAM NUMBER		35 311				35 315	35 316
STREAM DESCRIPTION		Oxygen				SYN Gas	Flashed Gas
COMPONENTS	(MW)	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR
HYDROGEN	2.016					12,268.78	
CARBON MONOXIDE	28.011					16,380.06	
CARBON DIOXIDE	44.011					5,902.00	
METHANE	16.043					107.09	
NITROGEN	28.014					228.15	
OXYGEN	32.000	11,518					
HYDROGEN SULFIDE	34.080					524.24	FLOW
CARBONYL SULFIDE	60.076					1.6	
AMMONIA	17.031						
HYDROGEN CYANIDE	27.026						
CHLORIDES	36.453						INTERMITTENT
SULFUR	32.066						
CARBON DISULFIDE	76.143						
SULFUR DIOXIDE	64.059						
ARGON	39.944	223.44				223.44	
MERCAPTANS							
TOTAL DRY GAS						35,635.36	
WATER	18.016					49.25	
TOTAL WET GAS		11,741.44				35,684.61	
		LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR
TOTAL STREAM LBS/HR		377,501				778,102	
SOLIDS LBS/HR							
COAL							
ASH							
CARBON							
Soot							
TOTAL SOLIDS							
WATER LIQUID							
TOTAL STREAM							
TEMPERATURE, °F		240				100	
MMSCFD DRY GAS							
DRY GAS GHV (BTU/SCF)							

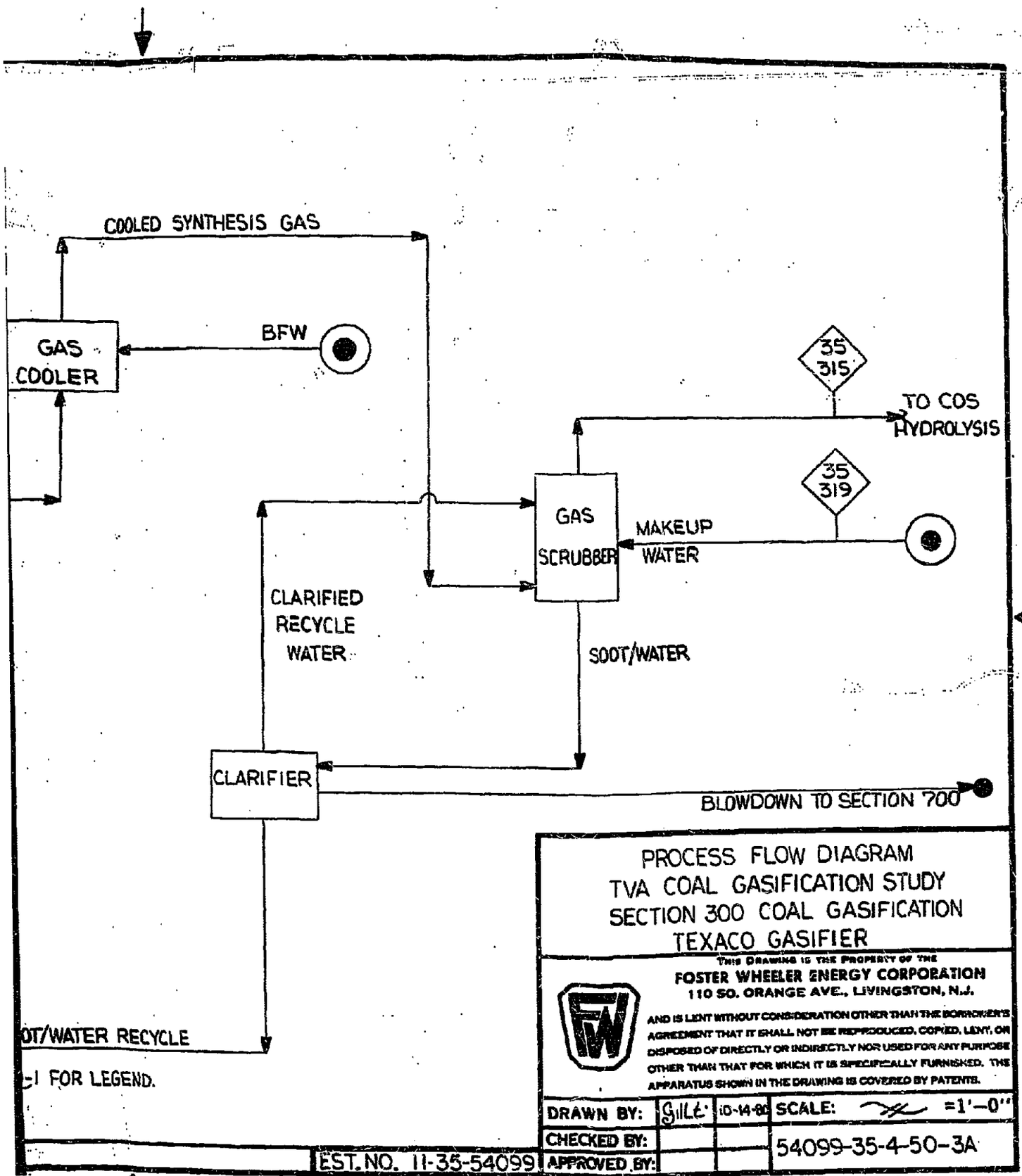
FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA COAL GASIFICATION
LOCATION: ALABAMA
PLANT TYPE: TEXACO GASIFIER

SECTION NAME: GASIFICATION
REF. DWG.: 54099-35-1-50-3A
CONTRACT NO.: 11-35-54099 REV.:

SECTION NO.: 300
PAGE NO.: 3 of 3
DATE:

STREAM NUMBER				35 319			
STREAM DESCRIPTION				Make-up Water			
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						
CARBONYL SULFIDE	60.075						
AMMONIA	17.031						
HYDROGEN CYANIDE	27.026						
CHLORIDES	35.453						
SULFUR	32.066						
CARBON DISULFIDE	76.143						
SULFUR DIOXIDE	64.059						
ARGON	39.944						
MERCAPTANS							
TOTAL DRY GAS							
WATER	18.016						
TOTAL WET GAS							
		LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR
TOTAL STREAM LBS/HR							
SOLIDS LBS/HR							
COAL							
ASH							
CARBON							
TOTAL SOLIDS							
WATER LIQUID				201,358.37			
TOTAL STREAM							
TEMPERATURE, °F				85			
MMSCFD DRY GAS							
DRY GAS GHV (BTU/SCF)							


35
311
OXYGEN
SECTION 200
STEAM
COAL/WATER
SLURRY
COOLED
GASIFIER
GAS
COOLER
35
301
COAL
SEC 100
WATER
SECTION 700
SLURRY
PREPARATION
RAW SYNTHESIS GAS
RECYCLE
WATER
SLAG
SLAG
DEWATERING
SLAG
TO DISPOSAL
SEC 800
SOOT/WATER REC
NOTE: SEE DWG. NO. 54099-35-1-50-1 FOR LEGEND
27405-10
BRUNING
REVISION


COOLED SYNTHESIS GAS
GAS COOLER
BFW
35 315
TO COS HYDROLYSIS
35 319
GAS SCRUBBER
MAKEUP WATER
CLARIFIED RECYCLE WATER
SOOT/WATER
CLARIFIER
BLOWDOWN TO SECTION 700
OT/WATER RECYCLE
-1 FOR LEGEND.
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTION 300 COAL GASIFICATION
TEXACO GASIFIER
THIS DRAWING IS THE PROPERTY OF THE
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SCALE: =1'-0"
CHECKED BY:
APPROVED BY:
54099-35-4-50-3A
EST. NO. 11-35-54099
FORM NO. 285-60-M

TVA Coal Gasification Study
Texaco Gasifier

SECTION DESCRIPTION

SECTION 300 - COS HYDROLYSIS

A. Reference Material:

- Process Flowsheet — FWEC Dwg. No. 54099-35-1-50-7
- Equipment Summary List

B. Description of Flow:

The scrubbed syngas downstream of the carbon scrubber flows to the COS Reactor Feed Preheater E-301. The gas is heated from 280 °F to 333 °F temperature to avoid pore condensation in the reactor.

The COS Reactor R-301, converts the bulk of COS in the raw gas to H_2S using the Haldor Topsoe CKA Catalyst. The conversion of COS to H_2S in the hydrolysis unit decreases the utility requirements and size of the Selexol unit. The raw gas leaving the reactor enters the syngas airfan cooler.

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 300

TYPE OF UNIT: COS HYDROLYSIS

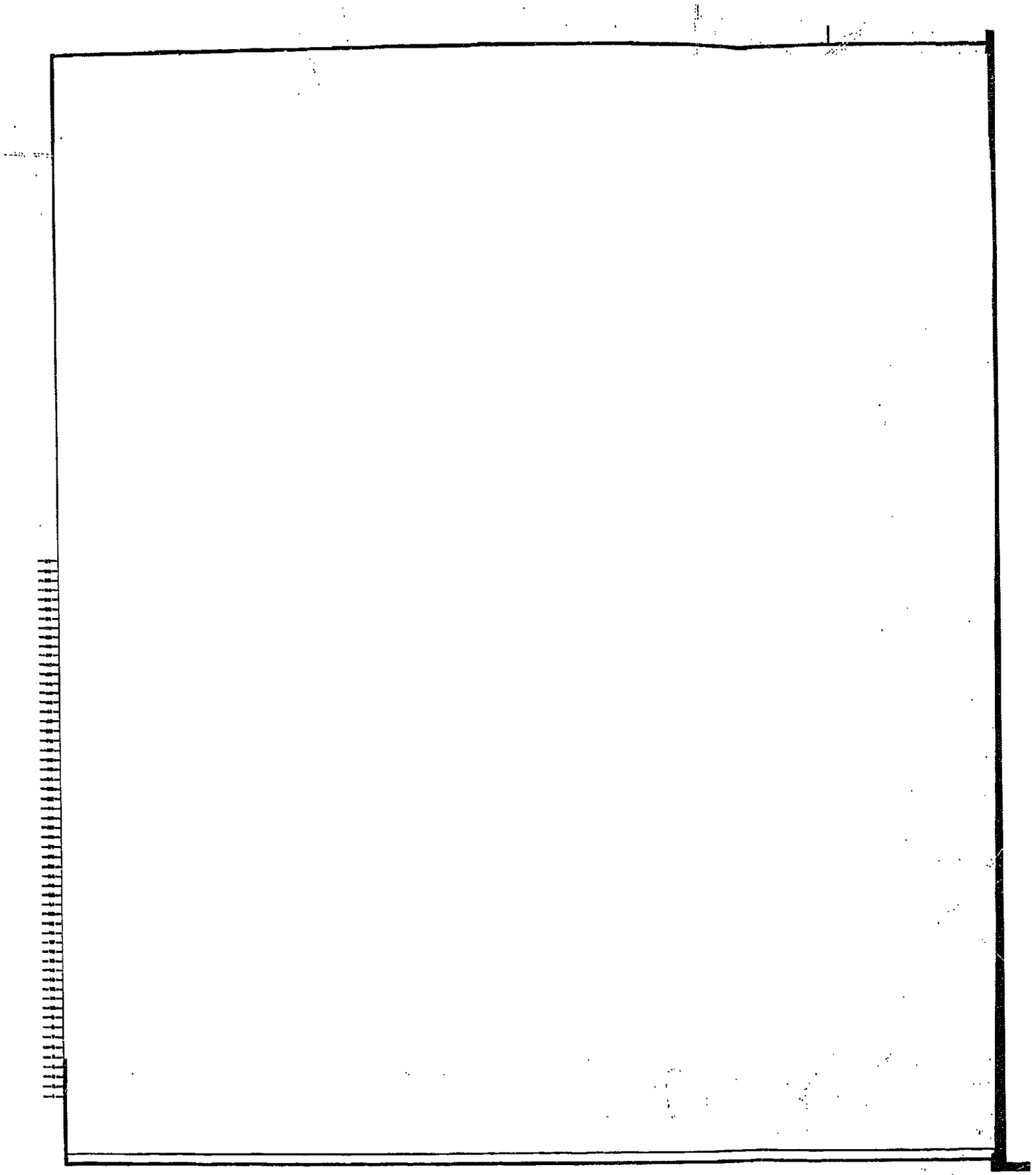
CLIENT TVA - COAL GASIFICATION STUDY

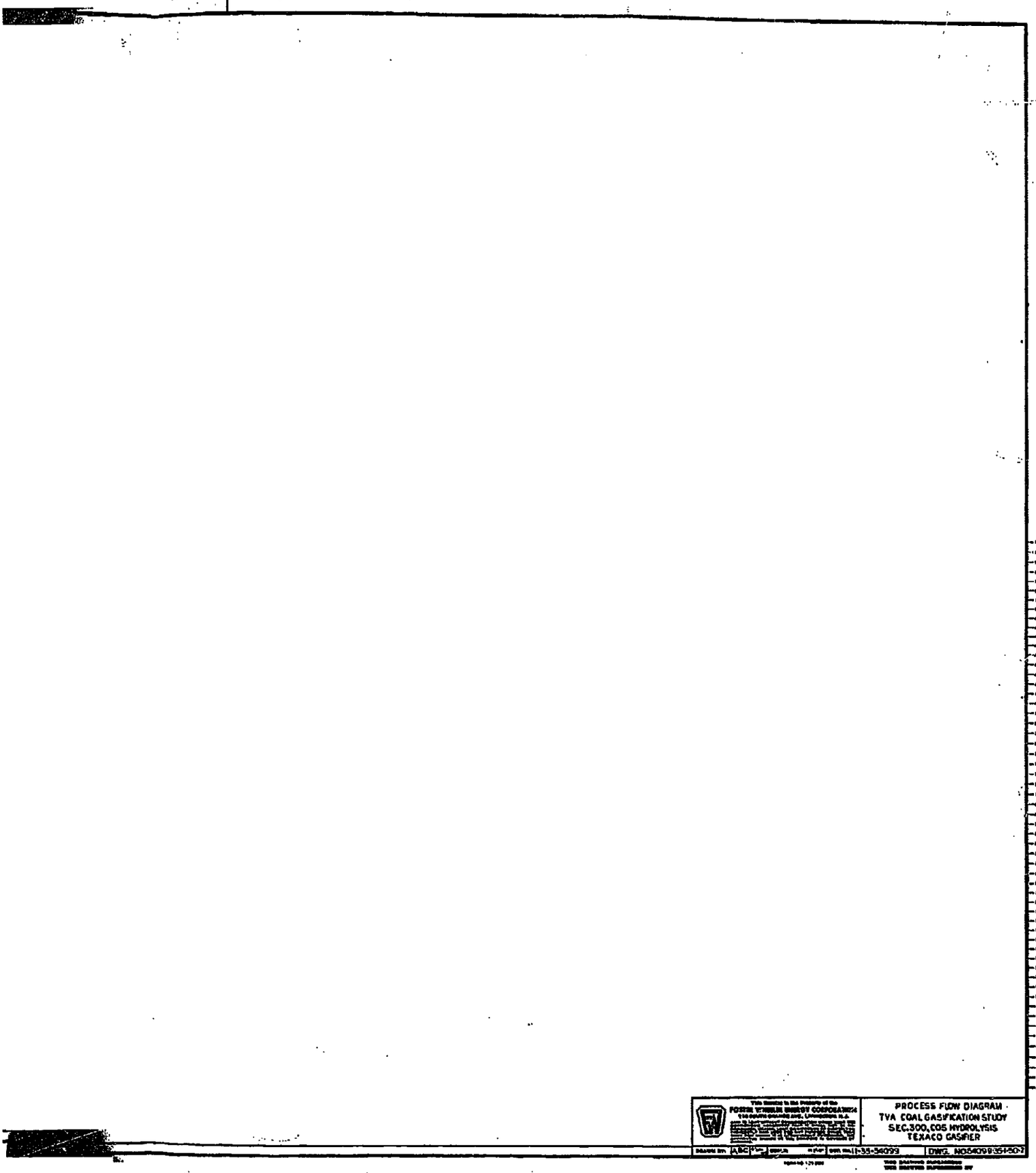
LOCATION

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	NO/MODULE	REV
EXCHANGER						
35-11-	E-301	COS REACTOR FEED PREHEATER	7		1-100%	
REACTOR						
35-11-	R-301	COS REACTOR	7		1-100%	

FORM NO. 135-66D





PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SEC.300, COS HYDROLYSIS
TEXACO GASIFIER

DWG. NO.5409835I-507

3.4 SECTION 400 - ACID GAS REMOVAL

A. Reference Material

Process Flow Diagram: FWEC Dwg. No. 54099-35-1-50-8
Equipment List
Input/Output Major Stream Flows

B. Description of Flow

The purpose of this section is to remove sulfur compounds from the raw gas. Raw gas from Gas Scrubbing (Section 300) combines with process recycle gas from the Recycle Gas Compressor (35-11-C-401) and is then cooled by heat exchange with product gas in the Feed-Product Gas Exchanger (35-11-E-401). Water condensed from the raw gas is separated in the H_2S Absorber K.O. Drum (35-11-D-401). Raw gas leaving the H_2S Absorber K.O. Drum (35-11-D-401) flows to the H_2S Absorber (35-11-T-401) where cold lean Selexol solvent physically absorbs H_2S, residual COS and some CO_2. Product gas leaving the top of the H_2S Absorber is heated in the Feed-Product Gas Eschanger (35-11-E-401). Most of the product gas flows to the Plant Battery Limit and the remainder to the Beavon Unit, Section 600, to be utilized as a reducing gas. The product gas contains less than 100 ppmv H_2S and less then 30 ppmv COS.

The Selexol solvent leaving the bottom of the H_2S Absorber flows directly to the H_2S Flash Drum (35-11-D-402). Most of the absorbed CO_2 and sour gases are flashed, then compressed in the Recycle Gas Compressor (35-11-C-401), and then combined with the raw gas feed entering the Feed-Product Gas Exchanger. Make-up solvent is added to the H_2S stripper bottom. Fresh solvent is stored in a Solvent Storage Tank (35-11-TK-401).

Solvent leaving the bottom of the H_2S Flash Drum is pumped to the H_2S Stripper Preheater (35-11-E-402). The Stripper Preheater is heated with hot lean solvent pumped from the bottom of the H_2S Stripper (35-11-T-401). Preheated solvent enters the H_2S Stripper for removal of acid gases. Stripper bottoms are reboiled in the H_2S Stripper Reboiler (35-11-E-403) heated with 85 PSIG steam. Vapors leaving the H_2S Stripper overhead are condensed in the H_2S Stripper Condenser (35-11-E-404) then enters the Stripper Recycle Drum (D-403). Condensate is totally recycled back to the Stripper, while the Acid Gases flow to the Sulfur Recovery Claus Plant (Section 600). Hot lean solvent is pumped from the bottom of the H_2S Stripper and cooled in the H_2S Stripper Preheater as described earlier. The solvent is chilled in Selexol Refrigeration Package (35-11-PG-401), then enters the top of the H_2S Absorber.

FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA COAL GASIFIER
LOCATION: ALABAMA
PLANT TYPE: TEXACO GASIFIER

SECTION NAME: ACID GAS REMOVAL
REF. DWG.: 54099-35-1-50-8
CONTRACT NO.: 11-35-54099 REV.:

SECTION NO.: 400
PAGE NO.: 1
DATE:

STREAM NUMBER		35 401	35 402	35 403	35 404		
STREAM DESCRIPTION		SYN Gas	Product Gas	Acid Gas	Make-up Water		
COMPONENTS	(MW)	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR
HYDROGEN	2.016	12,268.78	12,267.81	1.15			
CARBON MONOXIDE	28.011	16,380.06	16,369.76	10.14			
CARBON DIOXIDE	44.011	5,902.00	3,604.0	2,297.48			
METHANE	16.043	107.09	106.72	0.33			
NITROGEN	28.014	228.15	228.15				
OXYGEN	32.000						
HYDROGEN SULFIDE	34.080	524.24	0.006	523.24			
CARBONYL SULFIDE	60.075	1.6	0.332	1.26			
AMMONIA	17.031						
HYDROGEN CYANIDE	27.026						
CHLORIDES	35.453						
SULFUR	32.066						
CARBON DISULFIDE	76.143						
SULFUR DIOXIDE	64.059						
ARGON	39.944	223.49	223.49				
MERCAPTANS							
TOTAL DRY GAS							
WATER	18.016	49.25	2.08	133.5			
TOTAL WET GAS		35,714.85	32,802.35	2,966.62			
		LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR
TOTAL STREAM LBS/HR		779,194	658,969	121,719			
SOLIDS LBS/HR							
COAL							
ASH							
CARBON							
TOTAL SOLIDS							
WATER LIQUID							
TOTAL STREAM							
TEMPERATURE, °F		110	92	110			
MMSCFD DRY GAS							
DRY GAS GHV (BTU/SCF)							

ONE TRAIN PER MODULE

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT NO. 11-35-54099	EQUIPMENT LIST	SECTION 400	TYPE OF UNIT ACID GAS REMOVAL (SELEXOL)	PAGE 1 OF 3

CLIENT TVA - COAL GASIFICATION STUDY)
LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD*	REQ'N. NO.	NO/MODULE	REV
COMPRESSOR 35-11	C-401	RECYCLE GAS COMPRESSOR			1 - 100%	
DRUMS 35-11	D-401	H_2S ABSORBER K.O. DRUM			1 - 100%	
	D-402	H_2S FLASH DRUM			1 - 100%	
	D-403	STRIPPER RECYCLE DRUM			1 - 100%	
EXCHANGERS 35-11	E-401	FEED PRODUCT GAS EXCHANGER			1 - 100%	
	E-402	H_2S STRIPPER PREHEATER			1 - 100%	
	E-403	H_2S STRIPPER REBOILER			1 - 100%	
	E-404	H_2S STRIPPER CONDENSER			1 - 100%	

FORM NO. 135-66D

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT NO. 11-35-54099	EQUIPMENT LIST	SECTION 400	TYPE OF UNIT ACID GAS REMOVAL (SELEXOL)	PAGE 2 OF 3

CLIENT TVA - COAL GASIFICATION STUDY | REVISION | ORIGINAL | 1 | 2 | 3 | 4 | 5

LOCATION ALABAMA | DATE

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	NO/MODULE	REV
PUMPS						
35-11 —	P-401A/B	LEAN SOLUTION PUMP			2 - 100%	
—	P-402A/B	H_2S STRIPPER RECYCLE PUMP			2 - 100%	
—	P-403A/B	SOLVENT SUMP PUMP			2 - 100%	
TANK						
35-11 —	TK-401	SOLVENT STORAGE TANK			1 - 100%	
	TK-402	SOLVENT SUMP			1 - 100%	

FORM NO. 135-660

ONE TRAIN PER MODULE

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT NO. 11-35-54099	EQUIPMENT LIST	SECTION 400	TYPE OF UNIT ACID GAS REMOVAL (SELEXOL)	PAGE 3 OF 3

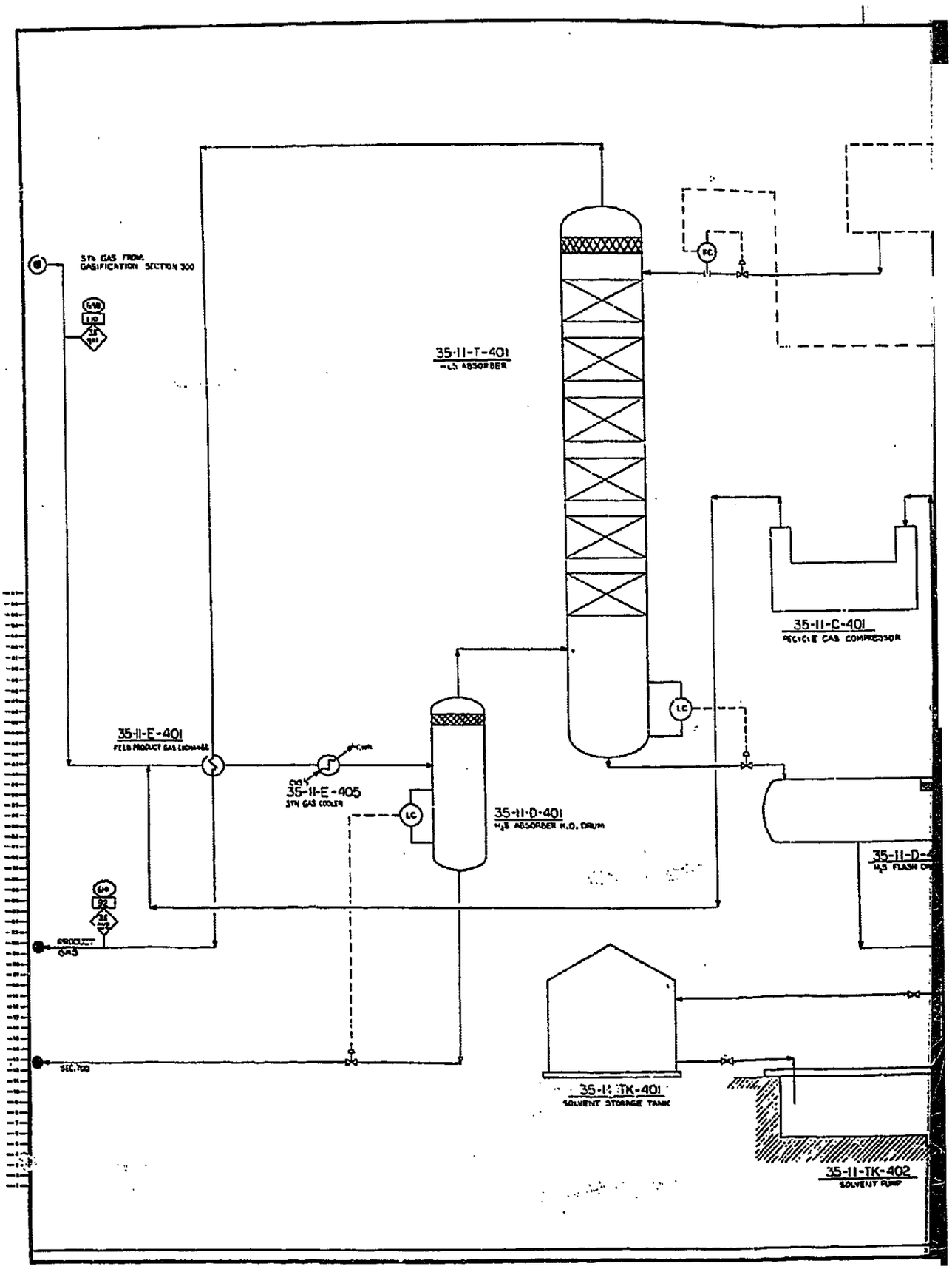
CLIENT TVA - COAL GASIFICATION STUDY

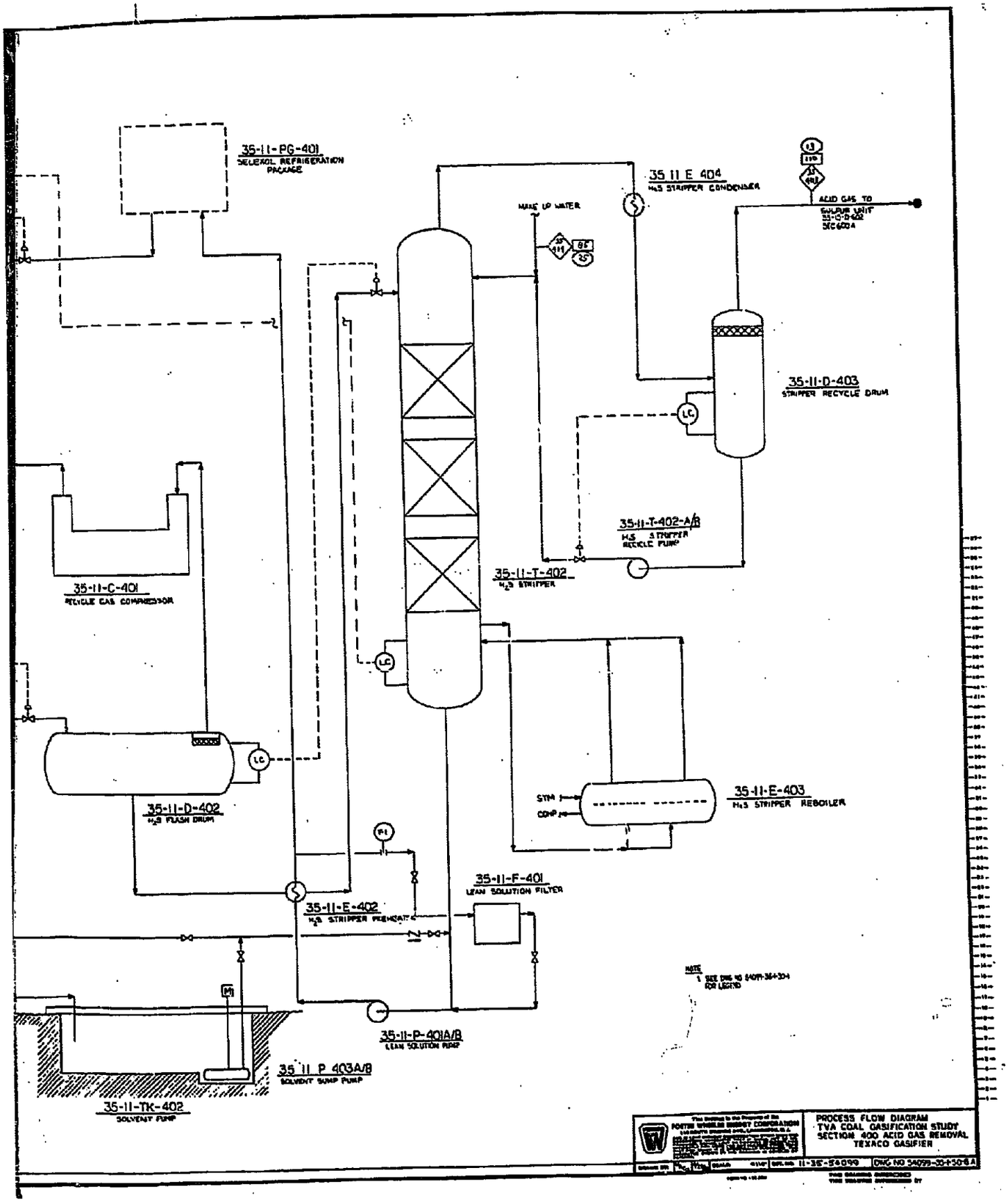
LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD*	REQ'N.NO.	NO/MODULE	REV
TOWERS						
35-11 —	T-401	H_2S ABSORBER			1 - 100%	
—	T-402	H_2S STRIPPER			1 - 100%	
FILTER						
35-11 —	F-401	LEAN SOLUTION FILTER			1 - 100%	
PACKAGE ITEM						
35-11 —	PG-401	SELEXOL REFRIGERATION PACKAGE			1 - 100%	

FORM NO. 135-66D


SYN GAS FROM GASIFICATION SECTION 300
35-11-T-401
H_2S ABSORBER
FC
35-11-C-401
RECYCLE GAS COMPRESSOR
LC
35-11-E-401
FEED PRODUCT GAS EXCHANGER
35-11-E-405
SYN GAS COOLER
LC
35-11-D-401
H_2S ABSORBER K.O. DRUM
35-11-D-
H_2S FLASH DR
PRODUCT
SEC. 700
35-11-TK-401
SOLVENT STORAGE TANK
35-11-TK-402
SOLVENT PUMP


35-11-PG-401
SELEXOL REFRIGERATION PACKAGE
35 11 E 404
H2S STRIPPER CONDENSER
MAKE UP WATER
ACID GAS TO SULFUR UNIT 35-11-D-402 SEC 6004
35-11-D-403
STRIPPER RECYCLE DRUM
35-11-T-402-A/B
H2S STRIPPER RECYCLE PUMP
35-11-T-402
H2S STRIPPER
35-11-C-401
RECYCLE GAS COMPRESSOR
35-11-D-402
H2S FLASH DRUM
STM
COND
35-11-E-403
H2S STRIPPER REBOILER
35-11-F-401
LEAN SOLUTION FILTER
35-11-E-402
H2S STRIPPER REHEATER
35-11-P-401A/B
LEAN SOLUTION PUMP
35 11 P 403A/B
SOLVENT SUMP PUMP
35-11-TK-402
SOLVENT PUMP
NOTE
1 SEE DWG NO 54099-30-1-30-1 FOR LEGEND
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTION 400 ACID GAS REMOVAL
TEXACO GASIFIER
DWG NO 54099-30-1-30-1 A

TVA Coal Gasification Study
Texaco Gasifier

SECTION DESCRIPTION

3.5 SECTION 600A - CLAUS SULFUR RECOVERY PLANT

A. Reference Material

Process Flowsheet FWEC Drawing No. 54099-35-1-50-9

Equipment List

Input/Output Major Stream Flows

B. Description of Flow

Acid gas from the Selexol Unit Stripper Recycle Drum flows through K.O. Drum and enters the Muffle Furnace (H-601). Hydrogen sulfide is partially (about one-third) oxidized to sulfur dioxide, utilizing air fed by the Process Air Blower (B-601). Medium pressure steam is generated in the Waste Heat Boiler (E-601) and is the major source of 150 psig steam for process use (refer to 54099-35-1-50-151).

Gases leaving the Waste Heat Boiler flow to a three stage Claus reactor system, consisting of R-601, 602, and 603, where sulfur dioxide reacts catalytically with the remaining hydrogen sulfide, producing elemental sulfur and water. The Claus Unit is about 96% efficient in removal of sulfur compounds from acid gas. Treated tail gas leaving the Claus Unit flows to the Beavon Unit (in series with the Claus Unit) for further reduction of sulfur compounds from the gas and recovery as elemental sulfur. Total normal sulfur production from Claus and Beavon Units combined is about 198 T/D per module.

Gas leaving each Claus Reactor (stage) is cooled below about 300°F to condense sulfur before entering the next stage or flowing to the Beavon Unit. A third Reactor Preheater, E-606, is provided for optimum operation in the third stage.

Liquified (condensed) sulfur flows to a Sulfur Pit, X-601, and may be stored in the Liquid Sulfur Storage Tank, TK-601A, for sale as a liquid product or prilled in the Sulfur Prilling Unit

Low pressure steam is generated during gas cooling to recover sulfur. Boiler blowdown streams will be used as cooling tower makeup as shown on 54099-35-1-50-151.

ONE TRAIN PER MODULE PLUS ONE SPARE TRAIN FOR ENTIRE PLANT

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 600

TYPE OF UNIT: SULFUR RECOVERY-CLAUS UNIT

CLIENT TVA - COAL GASIFICATION STUDY)

LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	NO/MODULE	REV
BLOWER 35-15	B-601	PROCESS AIR BLOWER	8		1 - 100%	
DRUMS 35-15	D-601	ACID GAS K.O. DRUM	8		1 - 100%	
—	D-602	BLOWDOWN DRUM	8		1 - 100%	
EXCHANGER 35-15	E-601	WASTE HEAT BOILER	8		1 - 100%	
—	E-602	1st SULFUR CONDENSER	8		1 - 100%	
—	E-603	SECOND REACTOR FEED HEATER	8		1 - 100%	
—	E-604	2ND SULFUR CONDENSER	8		1 - 100%	
—	E-605	3RD SULFUR CONDENSER	8		1 - 100%	
—	E-606	THIRD REACTOR FEED HEATER	8		1 - 100%	
—	E-607	FINAL SULFUR CONDENSER	8		1 - 100%	
—	E-608	SULFUR PIT HEATER	8		1 - 100%	
35-15	E-609	SULFUR TANK HEATER	8		1 - 100%	
—	E-610	AIR PREHEATER	8		1 - 100%	
—	E-611	ACID GAS PREHEATER				
35-15	H-601	MUFFLE FURNACE	8		1 - 100%	

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 600

TYPE OF UNIT: SULFUR RECOVERY-CLAUS UNIT

CLIENT: TVA - COAL GASIFICATION STUDY

LOCATION: ALABAMA

REVISION	1	2	3	4	5
DATE					
ORIGINAL					

CLASS	ITEM NO	DESCRIPTION	FD*	REQ'N.NO.	NO/MODULE	REV
PUMPS						
35-15 -	P-601	SULFUR TRANSFER PUMP	8		2 - 100%	
-	P-602	SULFUR LOADING PUMP	8		2 - 100%	
REACTORS						
35-15 -	R-601	FIRST REACTOR	8		1 - 100%	
-	R-602	SECOND REACTOR	8		1 - 100%	
-	R-603	THIRD REACTOR	8		1 - 100%	
TANKS						
35-15 -	TK-601	LIQUID SULFUR STORAGE TANK	8		1 - 100%	
-	X-601	SULFUR PIT	8		1 - 100%	

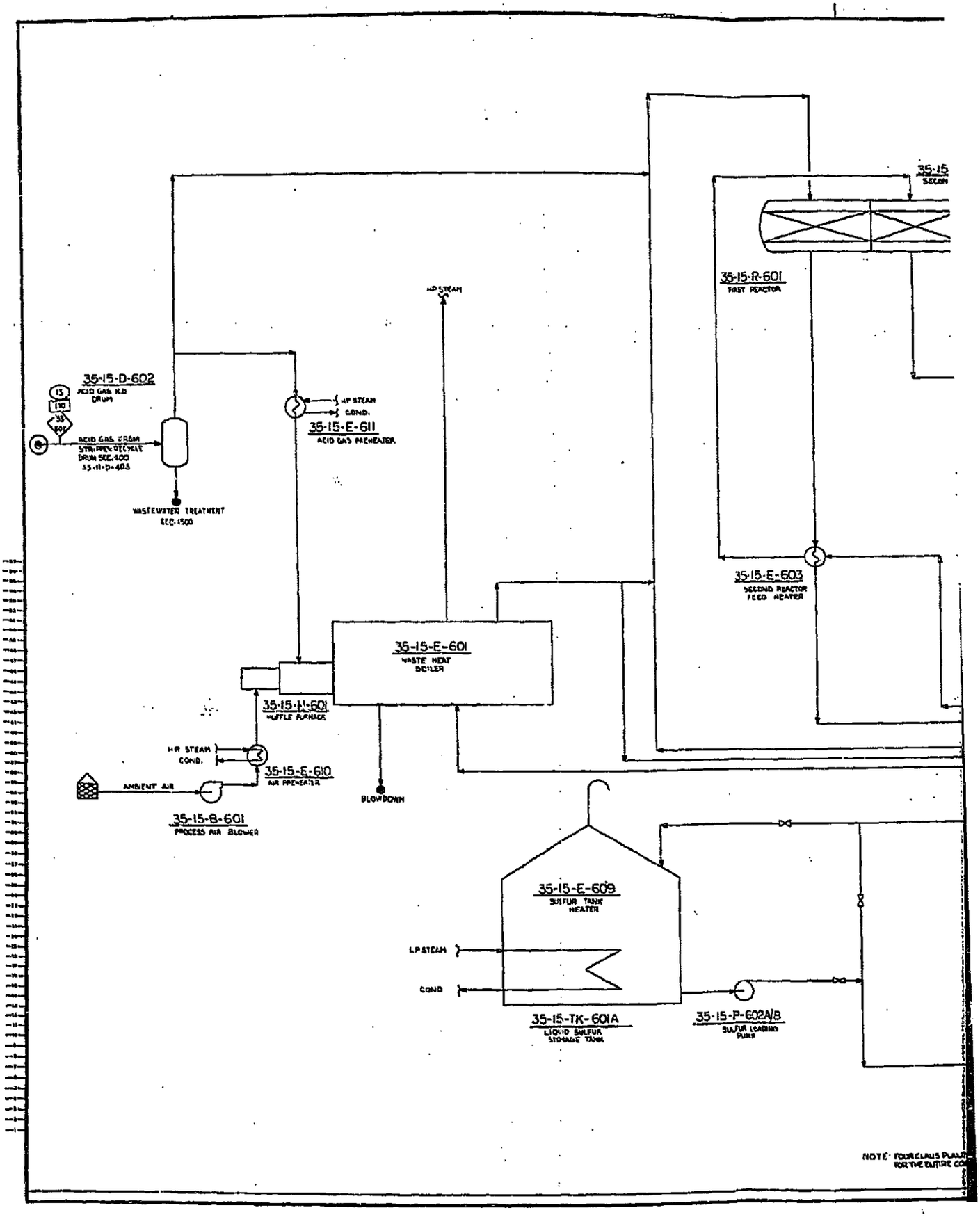
FORM NO. 135-66D

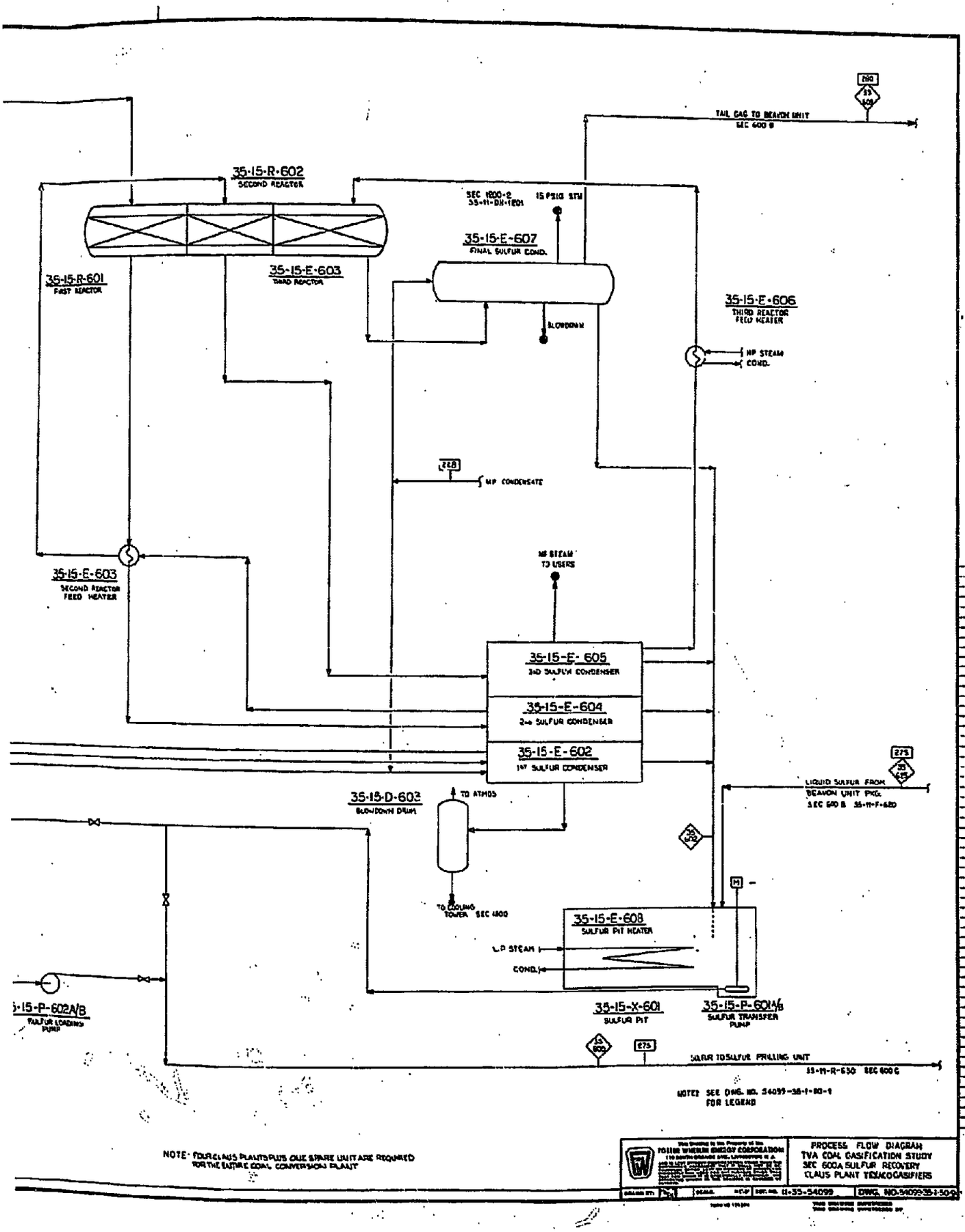
FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA COAL GASIFICATION
LOCATION: ALABAMA
PLANT TYPE: TEXACO GASIFIER

SECTION NAME: SULFUR RECOVERY-CLAUS PLANT
REF. DWG.: 54099-35-1-50-9
CONTRACT NO.: 11-35-54099 REV.: .....

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

STREAM NUMBER		35 601	35 602	35 603	35 604	35 625	35 605
STREAM DESCRIPTION		Acid Gas	Liq. Sulfur	Tail Gas	Air	Liq. Sulfur	Liq. Sulfur
COMPONENTS	(MW)	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR
HYDROGEN	2.016	1.15		0.73			
CARBON MONOXIDE	28.011	10.14		7.47			
CARBON DIOXIDE	44.011	2,297.48		2,312.89			
METHANE	16.043	0.33		0.03			
NITROGEN	28.014			1,090.13	1,044.66		
OXYGEN	32.000				276.86		
HYDROGEN SULFIDE	34.080	523.24		8.01			
CARBONYL SULFIDE	60.075	1.26		.48			
AMMONIA	17.031						
HYDROGEN CYANIDE	27.026						
CHLORIDES	35.453						
SULFUR	32.066		504.95	2.96		15.88	520.83
CARBON DISULFIDE	76.143			0.43			
SULFUR DIOXIDE	64.059			4.00			
ARGON	39.944						
MERCAPTANS							
TOTAL DRY GAS			504.95			15.88	520.83
WATER	18.016	133.5		714.93	32.05		
TOTAL WET GAS		2,966.62		4,142.06	1,353.57		
		LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR
TOTAL STREAM LBS/HR		121,719	16,191.73	146,108.56	38,702	509.2	16,700.93
SOLIDS LBS/HR							
COAL							
ASH							
CARBON							
TOTAL SOLIDS							
WATER LIQUID							
TOTAL STREAM							
TEMPERATURE, °F		110	275	280	400	275	275
MMSCFD DRY GAS							
DRY GAS GHV (BTU/SCF)							


35-15-D-602
ACID GAS K.O. DRUM
15
110
38
60F
ACID GAS FROM STRIPPER RECYCLE DRUM SEC. 400 35-11-D-403
WASTEWATER TREATMENT SEC. 1500
HP STEAM
COND.
35-15-E-611
ACID GAS PREHEATER
HP STEAM
35-15-R-601
FIRST REACTOR
35-15-E-603
SECOND REACTOR FEED HEATER
35-15-E-601
WASTE HEAT BOILER
35-15-H-601
MUFFLE FURNACE
LR STEAM
COND.
35-15-E-610
AIR PREHEATER
AMBIENT AIR
35-15-B-601
PROCESS AIR BLOWER
BLOWDOWN
35-15-E-609
SULFUR TANK HEATER
LP STEAM
COND
35-15-TK-601A
LIQUID SULFUR STORAGE TANK
35-15-P-602A/B
SULFUR LOADING PUMP


TAIL GAS TO BEAVON UNIT
SEC 600 B
35-15-R-602
SECOND REACTOR
SEC 1800-2
35-11-DH-1E01
15 PSIG STM
35-15-E-607
FINAL SULFUR COND.
35-15-R-601
FIRST REACTOR
35-15-E-603
THIRD REACTOR
BLOWDOWN
35-15-E-606
THIRD REACTOR
FEED HEATER
HP STEAM
COND.
MP CONDENSATE
35-15-E-603
SECOND REACTOR
FEED HEATER
MP STEAM
TO USERS
35-15-E-605
3rd SULFUR CONDENSER
35-15-E-604
2nd SULFUR CONDENSER
35-15-E-602
1st SULFUR CONDENSER
LIQUID SULFUR FROM
BEAVON UNIT PKG.
SEC 600 B 35-11-F-620
35-15-D-603
BLOWDOWN DRUM
TO ATMOS
TO COOLING
TOWER SEC 1800
35-15-E-608
SULFUR PIT HEATER
LP STEAM
COND.
35-15-P-602A/B
SULFUR LOADING
PUMP
35-15-X-601
SULFUR PIT
35-15-P-601A/B
SULFUR TRANSFER
PUMP
SULFUR TO SULFUR PRILLING UNIT
35-11-R-630 SEC 600 C
NOTE: SEE DWG. NO. 54099-35-1-80-1
FOR LEGEND
NOTE: FOUR CLAUS PLANTS PLUS ONE SPARE UNIT ARE REQUIRED
FOR THE FUTURE COAL CONVERSION PLANT
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SEC 600A SULFUR RECOVERY
CLAUS PLANT TEXACO GASIFIERS
DWG. NO. 54099-35-1-50-1

TVA Coal Gasification Study
Texaco Gasifier

SECTION DESCRIPTION

SECTION 600B- SULFUR RECOVERY BEAVON UNIT

A. Reference Material:

. Process Flow Diagram: FWEC Dwg. No. 54099-35-1-50-10

. Equipment List

. Input/Output Major Stream Flows

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 Section 400 serves to reduce the sulfur oxides to H_2S.

The tail gas to the Reactor (35-11-R-620) is preheated in the Reactor Effluent Exchanger, 35-11-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 (35-11-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, 35-11-X-620. The absorbed sulfur, mostly H_2S, is oxidized to elemental sulfur, as is reduced Stretford solution, by air admitted by the Aerator, 35-11-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 (35-11-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.

FOSTER WHEELER ENERGY CORPORATION
CUSTOMER: TVA COAL GASIFICATION
LOCATION: ALABAMA
PLANT TYPE: TEXACO GASIFIER

SECTION NAME: SULFUR RECOVERY-BEAVON UNIT
REF. DWG.: 54099-35-1-50-10
CONTRACT NO.: 11-35-54099 REV.:

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

STREAM NUMBER		35 621	35 622	35 623	35 624	35 625	35 626
STREAM DESCRIPTION		Tail Gas	Product Reducing Gas	Air	Clean Gas	Sulfur	Vent From Oxidizer Pit
COMPONENTS	(MW)	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR	MOL/HR
HYDROGEN	2.016	0.73	95.17		18.2		
CARBON MONOXIDE	28.011	7.47	126.97		1.98		
CARBON DIOXIDE	44.011	2,312.89	27.22		2179.63		
METHANE	16.043	0.02	0.82				
NITROGEN	28.014	1,090.13	3.51	942.36	2077.69		
OXYGEN	32.000			250.56			
HYDROGEN SULFIDE	34.080	8.01			9 ppmv		
CARBONYL SULFIDE	60.075	.48			190 ppmv		
AMMONIA	17.031						
HYDROGEN CYANIDE	27.026						
CHLORIDES	35.453						
SULFUR	32.066	2.96				LIQ. 15.88	
CARBON DISULFIDE	76.143	.43					
SULFUR DIOXIDE	64.059	4.0					
ARGON	39.944						
MERCAPTANS							
TOTAL DRY GAS			253.7	1,192.92	4277.5	LIQ. 15.88	
WATER	18.016	714.93	0.016	37.07	251.3		
TOTAL WET GAS		4,142.06	253.716	1,229.99	4528.8	LIQ. 15.88	
		LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR	LBS/HR
TOTAL STREAM LBS/HR		14,610.86	5,059	35,085	158,751.66	509.2	
SOLIDS LBS/HR							
COAL							
ASH							
CARBON							
TOTAL SOLIDS							
WATER LIQUID							
TOTAL STREAM							
TEMPERATURE, °F			100	60	95	275	
MMSCFD DRY GAS							
DRY GAS GHV (BTU/SCF)							

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 600

TYPE OF UNIT: SULFUR RECOVERY-BEAVON UNIT

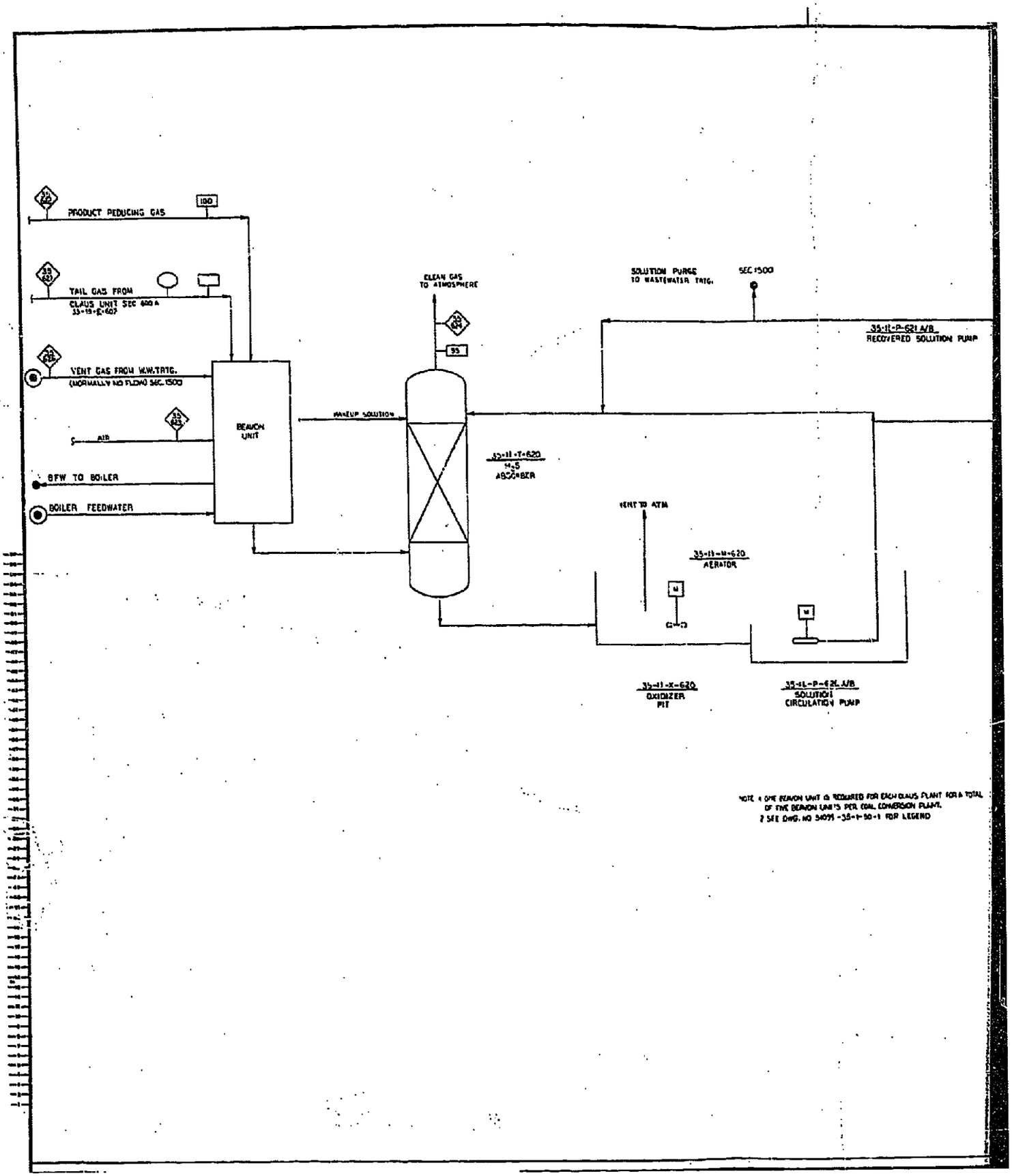
CLIENT TVA - COAL GASIFICATION STUDY

LOCATION ALABAMA

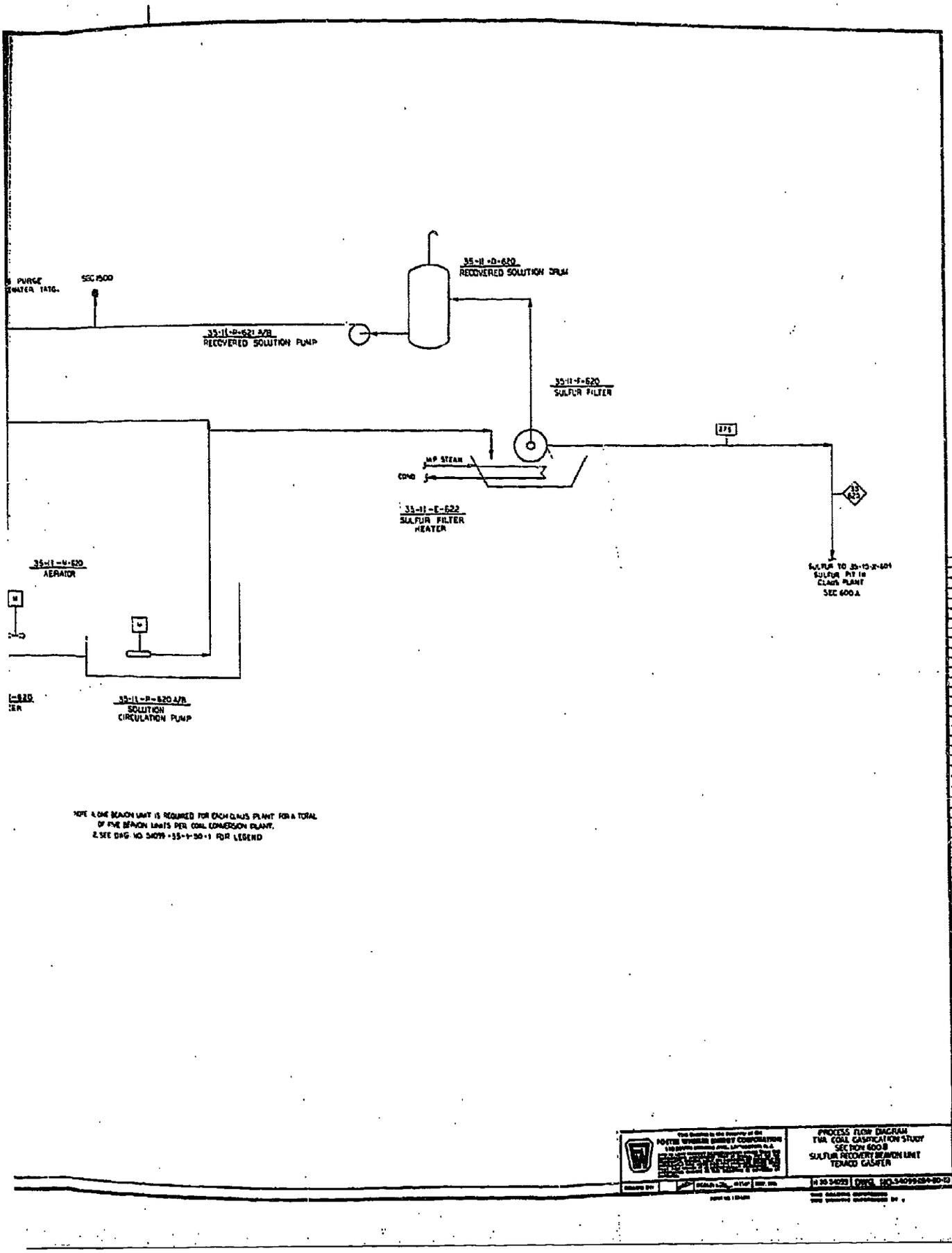
REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	NO/MODULE	REV
DRUM 35-11 —	D-620	RECOVERED SOLUTION DRUM	10		1 - 100%	
FILTER 35-11 —	F-620	SULFUR FILTER	10		1 - 100%	
EXCHANGERS 35-11 —	E-620	REACTOR FEED EFFLUENT EXCHANGER	10		1 - 100%	
—	E-621	REACTOR EFFLUENT COOLER	10		1 - 100%	
—	E-622	SULFUR FILTER HEATER	10		1 - 100%	
MIXER 35-11 —	M-620	AERATOR	10		1 - 100%	
PUMPS 35-11 —	P-620	SOLUTION CIRCULATION PUMP	10		2 - 100%	
—	P-621	RECOVERED SOLUTION PUMP	10		2 - 100%	
TOWER 35-11 —	T-620	H_2S ABSORBER	10		1 - 100%	
REACTOR 35-11 —	R-620	REACTOR	10		1 - 100%	
TANK 35-11 —	X-620	OXIDIZER PIT	10		1 - 100%	

FORM NO. 135-66D



NOTE 1 ONE BEAVON UNIT IS REQUIRED FOR EACH CLAUS PLANT FOR A TOTAL OF FIVE BEAVON UNITS PER COAL CONVERSION PLANT.
2 SEE DWG. NO 34099-35-1-30-1 FOR LEGEND


PURGE WATER TATG.
SEE 1500
35-11-D-620
RECOVERED SOLUTION DRUM
35-11-P-621 A/B
RECOVERED SOLUTION PUMP
35-11-F-620
SULFUR FILTER
MP STEAM
COND
35-11-E-622
SULFUR FILTER HEATER
275
33 625
35-11-V-620
AERATOR
SULFUR TO 35-13-X-601 SULFUR PIT IN CLAUS PLANT SEE 600 A
35-11-P-620 A/B
SOLUTION CIRCULATION PUMP
NOTE 1. ONE BEAVON UNIT IS REQUIRED FOR EACH CLAUS PLANT FOR A TOTAL OF FIVE BEAVON UNITS PER COAL CONVERSION PLANT.
2. SEE DWG. NO. 34099-35-V-50-1 FOR LEGEND
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTION 600 B
SULFUR RECOVERY BEAVON UNIT
TEXACO GASIFIER

TVA Coal Gasification Study
Texaco Gasifier

SECTION DESCRIPTION

SECTION 600C - SULFUR PRILLING UNIT

A. Reference Material

- Process Flowsheet — FWEC Dwg. No. 54099-35-1-50-11
- Equipment List

B. Description of Flow

The molten sulfur is fed to the top of Prilling Reactor, R-630, where it is distributed on a plate containing a number of nozzles.

Sulfur from the molten pool on the plate flows down through the nozzles into a short air space where surface tension causes the individual flow streams to break up and contract into spheres. The latter then drop into a pool of temperature controlled process water where the prills are completely solidified and cooled.

The process water enters the reactor through a series of inlet nozzles located along the straightside of the reactor. This provides precise water flow control and allows for control of the surface movement of the water.

A grizzly screen is located near the bottom of the Prilling Reactor to catch large pieces of sulfur which are swept away.

Sight glasses are provided on the reactor to observe both the nozzle plate and the bottom screen. Manways are located on the reactor to gain access to the grate and the nozzle plate.

From the reactor, the water slurry of cooled solid sulfur prills flows on to Dewatering Screen, F-630, which is located directly under the reactor. This screen separates the bulk of the water from the sulfur prills.

Water from F-630 flows by gravity into the Hotwell, TK-633. The Hotwell is a two-compartment vessel. The water enters the first compartment and overflows a weir before entering the second compartment. This will allow any sulfur fines in the water to settle in the first compartment. Any solids trapped in TK-633 can be pumped out, using the Slurry Pump, P-630A/B.

Make-up water flow to the system is controlled by the level in the Hotwell. The Hotwell Pump, P-631A/B pumps the water from the Hotwell to the Cooling Tower, CT-630, which is packaged type cooling tower. The temperature of the water from the tower is controlled by on/off control of the fan motor. The water from the water cooler drains to the Cold Well, TK-631, and is pumped from the Cold Well to the prill reactor by the Cold Well Pump, P-632A/B.

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 600

TYPE OF UNIT SULFUR PRILLING

CLIENT TVA - COAL GASIFICATION STUDY

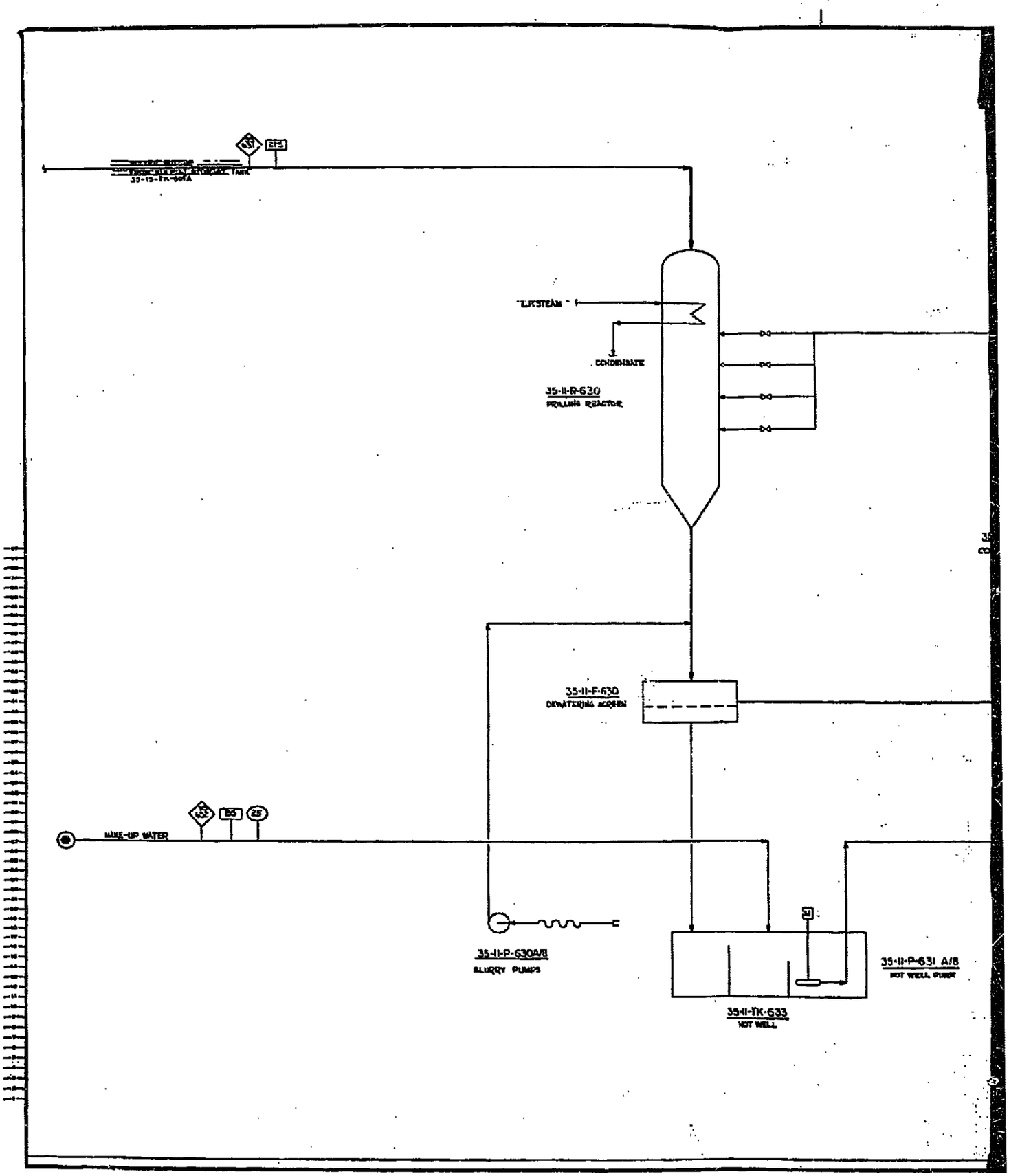
LOCATION ALABAMA

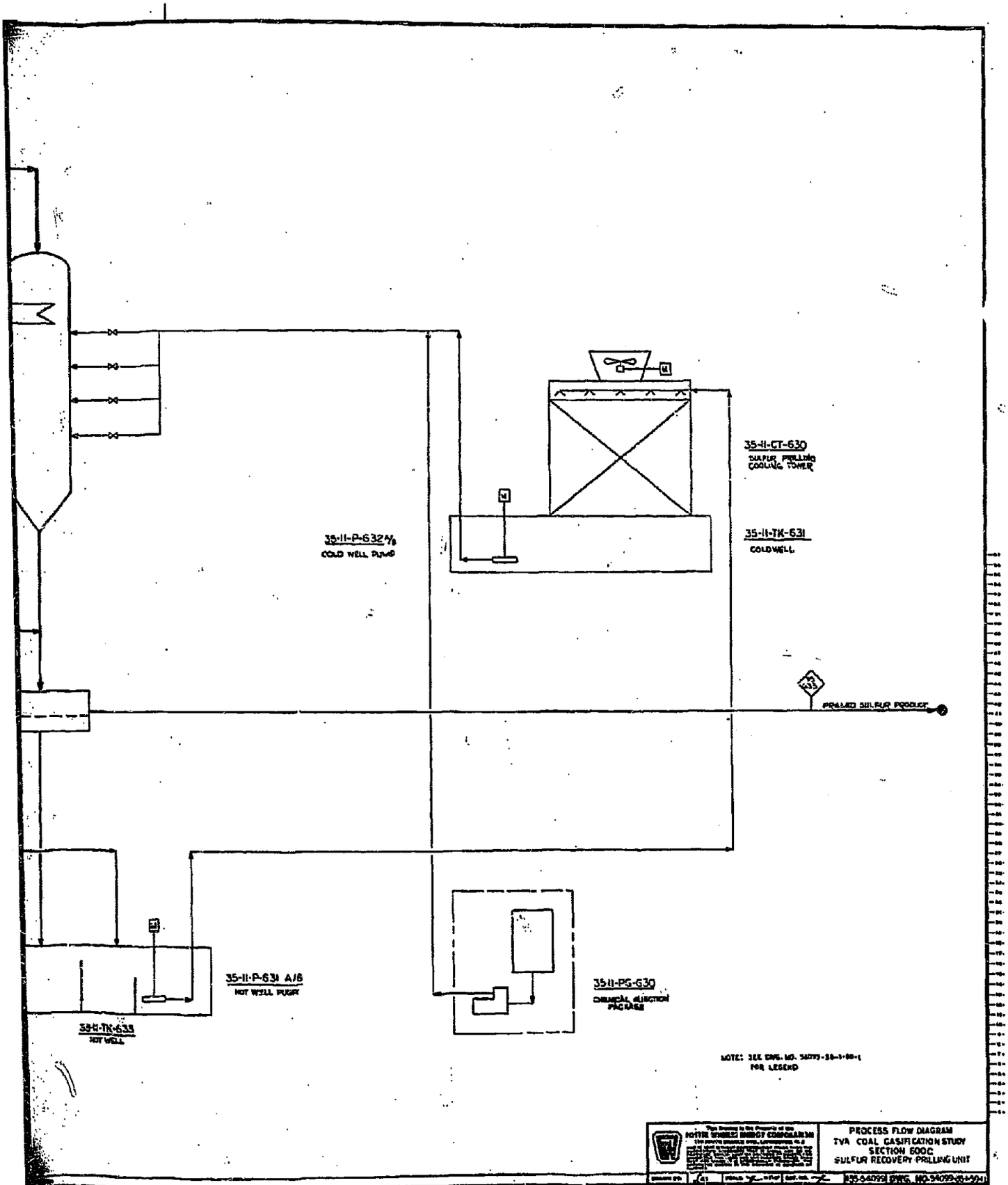
REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	NO/MODULE	REV
SCREEN						
35-11 —	F-630	DEWATERING SCREEN	10		1 - 100%	
PUMPS						
35-11 —	P-630	SLURRY PUMP	10		2 - 100%	
—	P-631	HOT WELL PUMP	10		2 - 100%	
—	P-632	COLD WELL PUMP	10		2 - 100%	
REACTOR						
35-11 —	R-630	PRILLING REACTOR	10		1 - 100%	
COOLING TOWER						
35-11 —	CT-630	SULFUR PRILLING COOLING TOWER	10		1 - 100%	
TANKS						
35-11 —	TK-630	HOT WELL	10		1 - 100%	
—	TK-631	COLD WELL	10		1 - 100%	
PACKAGE ITEMS						
35-11 —	PG-630	CHEMICAL INJECTION PACKAGE	10		1 - 100%	

FORM NO. 135-66D

p


215
LP STEAM
CONDENSATE
35-II-R-630
POLLING REACTOR
35-II-F-630
DEWATERING SCREEN
MAKE-UP WATER
35-II-P-630A/B
SLURRY PUMPS
35-II-TK-633
HOT WELL
35-II-P-631 A/B
HOT WELL PUMP


35-II-CT-630
SULFUR PRILLING COOLING TOWER
35-II-TK-631
COLD WELL
35-II-P-632 A/B
COLD WELL PUMP
PRILLED SULFUR PRODUCT
35-II-P-631 A/B
HOT WELL PUMP
35-II-TK-633
HOT WELL
35II-PG-630
CHEMICAL INJECTION PACKAGE
NOTE: SEE DWG. NO. 56777-35-1-00-1 FOR LEGEND
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTION 600C
SULFUR RECOVERY PRILLING UNIT
DWG. NO. 94099-35-1-601

TVA Coal Gasification Study
Texaco Gasifier

SECTION DESCRIPTION

3.6 SECTION 700 - SOUR WATER STRIPPER & WASTE WATER TREATMENT

A. Reference Material:

- Process Flow sheet — FWEC Dwg. No. 54099-35-4-50-12A

B. Description of Flow:

The process flow for the Blowdown Wastewater Treatment section is described below.

Blowdown from the clarifier in Section 300 is flashed and stripped with steam. The overhead vapors are partially condensed and the condensate is returned to Section 300. The non-condensibles are water scrubbed in the Neutralization Unit. The flashed liquid is sent to the Chemical Mix Reaction Unit where most of the impurities are chemically precipitated. Any vapor formed in the reactor is sent to the neutralization system, while the reacted wastewater flows to clarification. From the clarifier, the sludge, after dewatering, is sent to landfill. The clarified water is then steam stripped. Stripped vapor is sent to boiler fire box, and the stripper bottom liquid is neutralized.

After neutralization, the liquor flows to Aeration and Biological Oxidation. The digested sludge from biological oxidation is filtered and then disposed of as landfill. The clean water from the biox system is used as cooling tower make-up water.

TVA Coal Gasification Study
Texaco Gasifier

SECTION DESCRIPTION

3.7 SECTION 800-SLAG HANDLING

A. Reference Material:

- Process Flowsheet — FWEC Dwg. No. 54099-35-1-50-13
- Equipment List

B. Description of Flow

Slag

This unit is designed to receive slag from any or all of twenty (20) Texaco Gasification Units, and mechanically transport the slag to an on-site landfill area.

Slag from each gasifier is dewatered by a screen and discharged to one of the slag transfer conveyors 35-CR805A/B. It is then conveyed to a slag conveyor 35-CR806, and transferred to a 56 hour slag pile at the onsite landfill area.

Slag is also captured in the grinding section of each module by a clarifier screen. This slag is dumped onto a clarifier screen transfer conveyor 35-CR801A/B, 35-CR802A/B, 35-803A/B or 35-CR804A/B. It is then transferred to the slag tranfer conveyors and conveyed to the landfill.

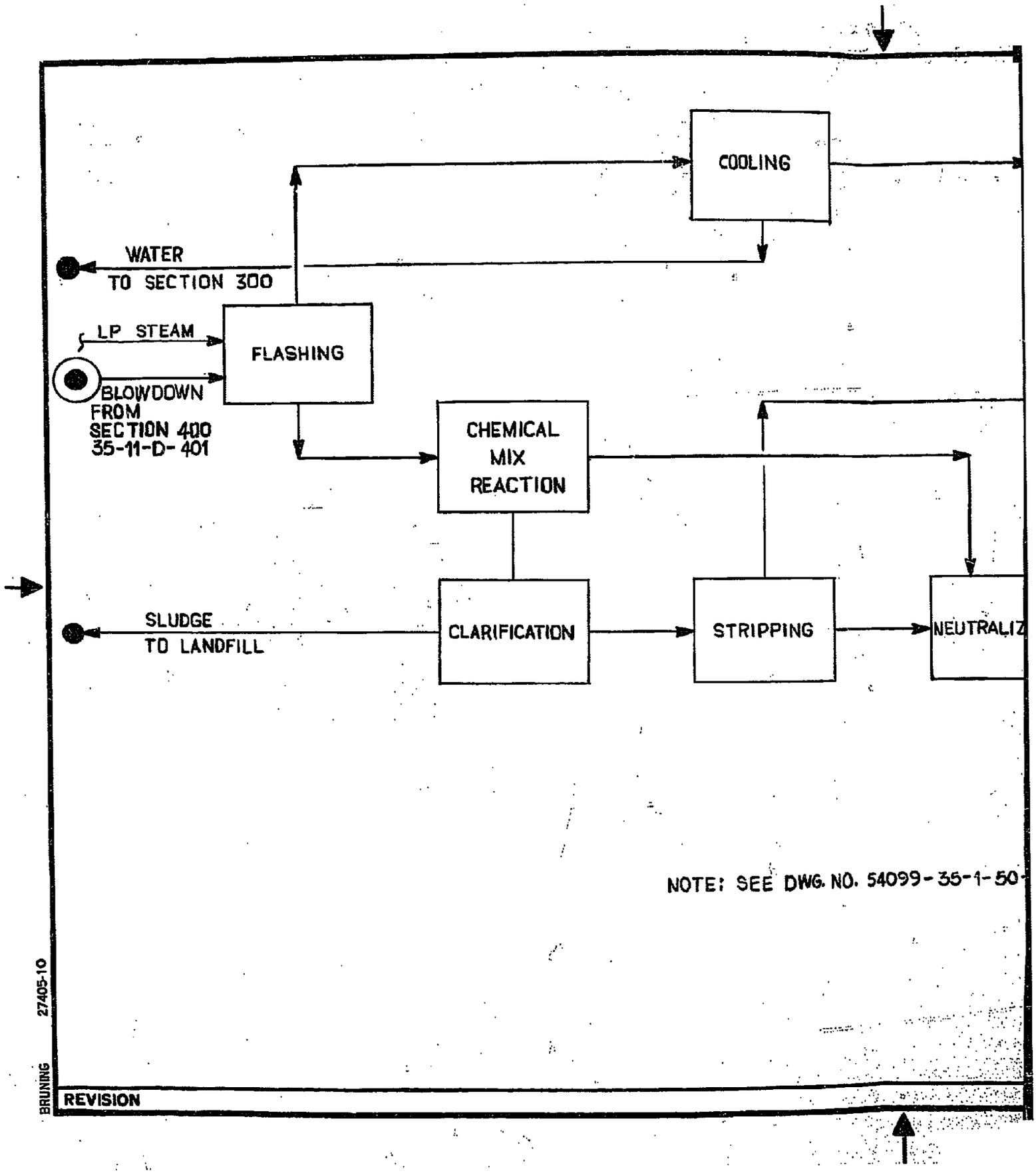
Spent Bed

Spent bed from the spent bed coolers in section 1200 is fed into a pneumatic transport line by rotary feeders 35-FD801A-J. The material is then conveyed up to the filter separator 35-F801 by pneumatic transport blowers 35-B801A/B. The pneumatic transport line will be equipped with silencers before and after the pneumatic transport blowers 35-B801A/B for noise suppression.

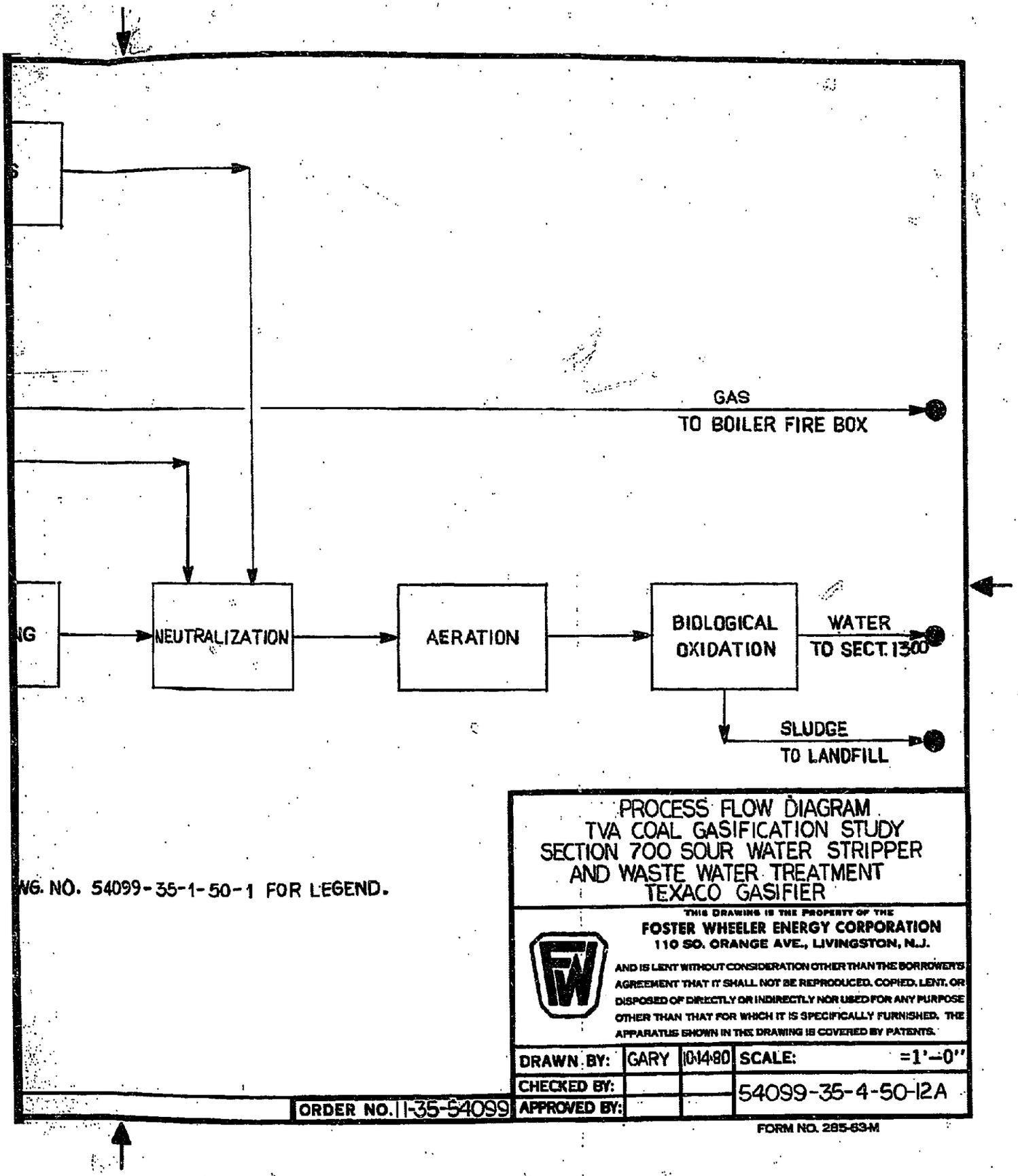
The filter separator will remove the forced air from the material and discharge it into the atmosphere. Meanwhile, the spent bed falls into the spent bed storage silo 35-TK801. Later, the material will be removed from the silo and brought to the disposal site by trucks.

Flyash

Flyash from baghouses will be drawn into filter separator 35-F802 by flyash centrifugal blower 35-B802. The air will be discharged to the atmosphere and the flyash will drop into the flyash storage silo 35-TK802. Flyash will be removed from the silo by flyash mixer conditioner 35-M801 which will also blend the flyash with water to create a uniform dust free mixture for clean disposal. The flyash/water mixture will be brought to the disposal site by trucks.


COOLING
WATER
TO SECTION 300
LP STEAM
FLASHING
BLOWDOWN
FROM
SECTION 400
35-11-D-401
CHEMICAL
MIX
REACTION
SLUDGE
TO LANDFILL
CLARIFICATION
STRIPPING
NEUTRALIZ
NOTE: SEE DWG. NO. 54099-35-1-50
27405-10
BRUNING
REVISION

p



WG. NO. 54099-35-1-50-1 FOR LEGEND.

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTION 700 SOUR WATER STRIPPER
AND WASTE WATER TREATMENT
TEXACO GASIFIER

DRAWN BY:	GARY	10-14-80	SCALE: =1'-0"
CHECKED BY:			54099-35-4-50-12A
APPROVED BY:			

ORDER NO. 1-35-54099

FORM NO. 285-63-M

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

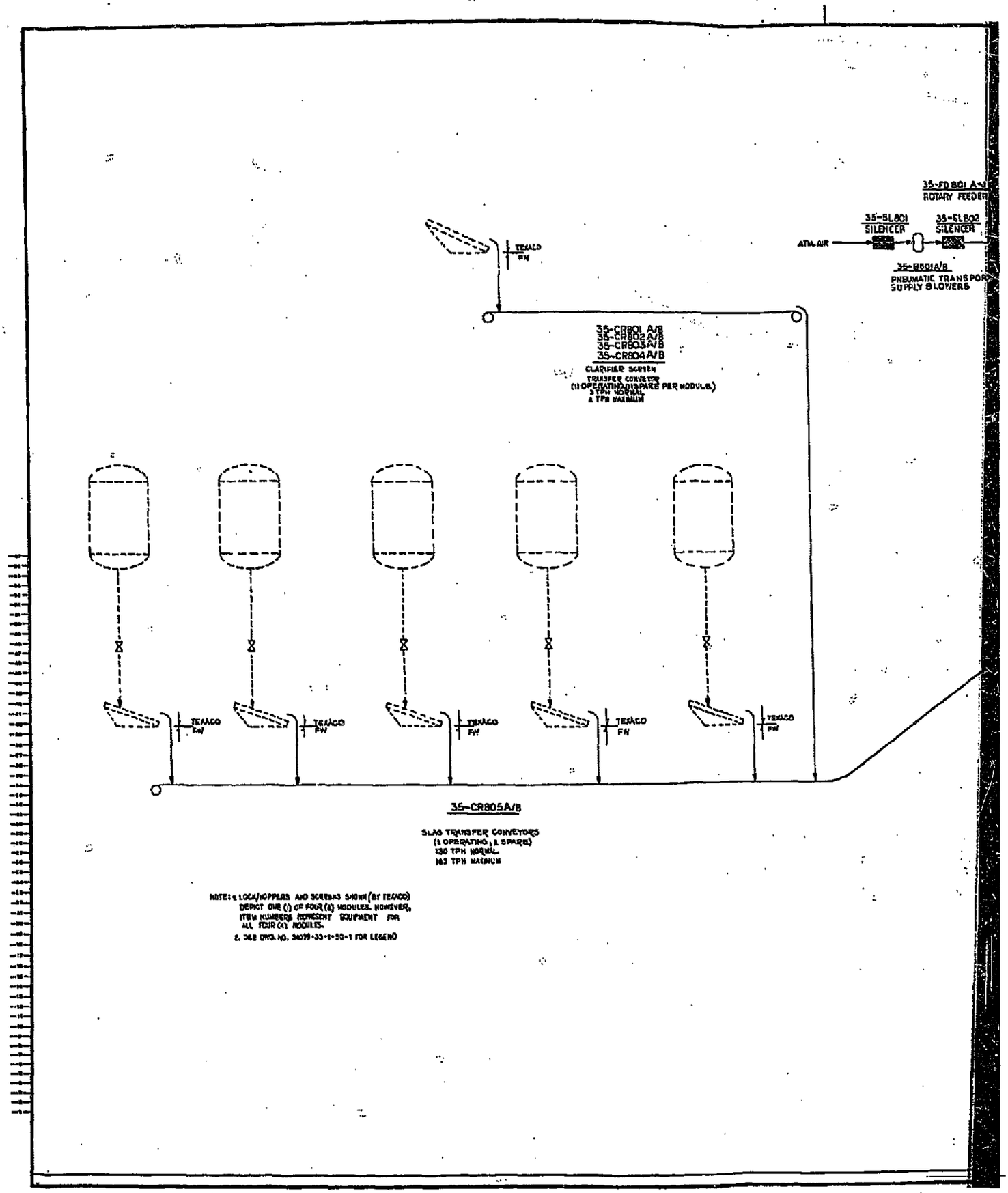
SECTION NAME: SLAG HANDLING
REF. DWG.: 54099-35-1-50-10
CONTRACT NO.: 11-35-54099 REV.: 0

SECTION NO.: 800
PAGE NO.: 1 OF 1
DATE: 6/30/80

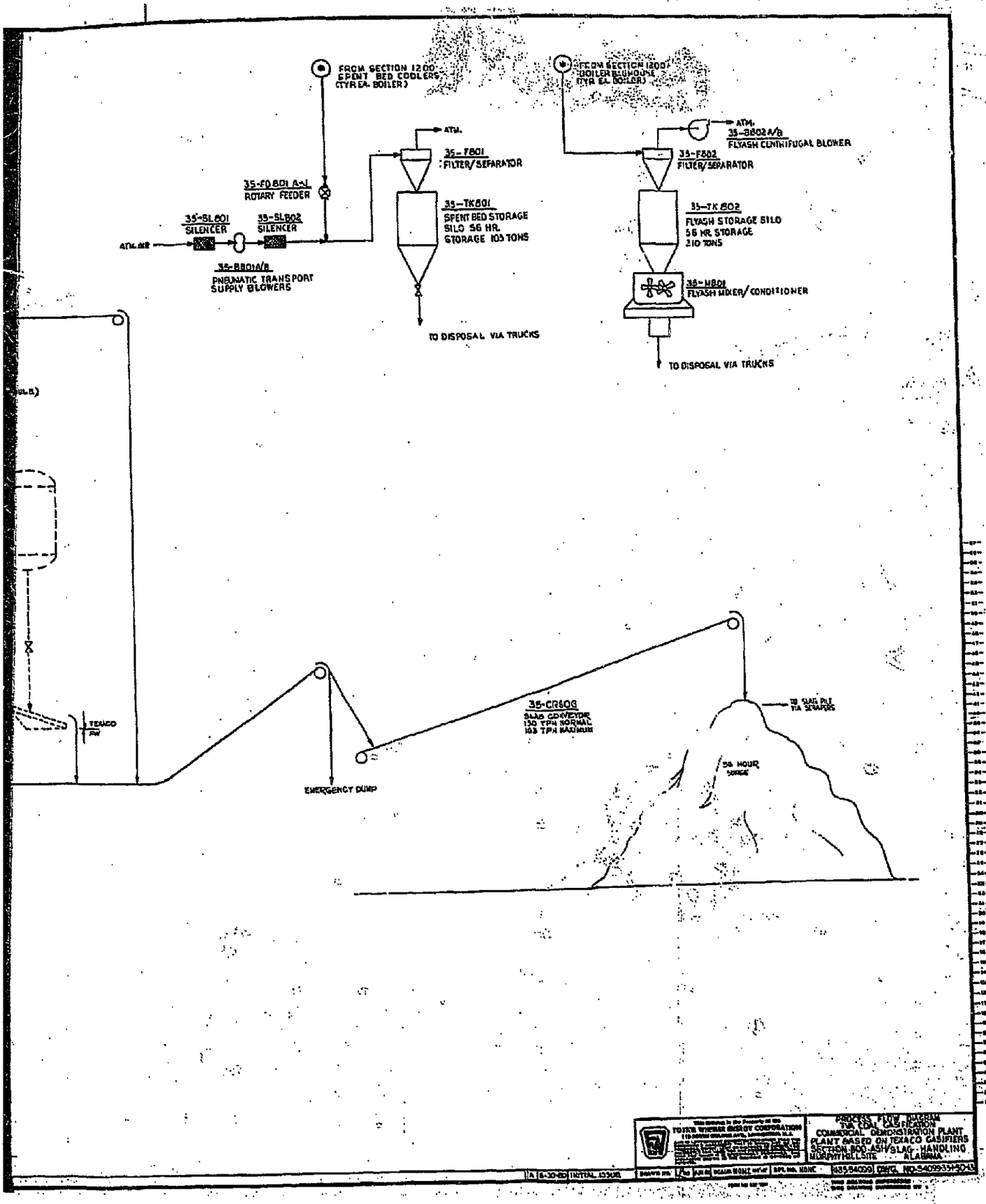
EQUIPMENT SUMMARY

ITEM	DESCRIPTION	DEFINITION	DESIGN * TEMP. (°F)	DESIGN * PRESS. (PSIG)	CONSTRUCTION MATERIAL*
35-B801A/B	Pneumatic Transport Supply Blowers				
35-B802A/B	Flyash Centrifugal Blower				
35-CR801A/B	Clarifier Screen Transfer Con.	24" Belt, 4 TPH			
35-CR802A/B	Clarifier Screen Transfer Con.	24" Belt, 4 TPH			
35-CR803A/B	Clarifier Screen Transfer Con.	24" Belt, 4 TPH			
35-CR804A/B	Clarifier Screen Transfer Con.	24" Belt, 4 TPH			
35-CR805A/B	Slag Transfer Conveyor	30" Belt, 163 TPH			
35-CR106	Slag Conveyor	30" Belt, 163 TPH			
35-F801	Filter/Separator				
35-F802	Filter/Separator				
35-FD801A	Rotary Feeder				
35-FD801B	Rotary Feeder				
35-FD801C	Rotary Feeder				
35-FD801D	Rotary Feeder				
35-FD801E	Rotary Feeder				
35-FD801F	Rotary Feeder				
35-FD801G	Rotary Feeder				
35-FD801H	Rotary Feeder				
35-FD801I	Rotary Feeder				
35-FD801J	Rotary Feeder				
35-M801	Flyash Mixer Conditioner				
35-SL801	Silencer				
35-SL802	Silencer				
35-TK801	Spent Bed Storage Silo	105 Tons			
35-TK802	Flyash Storage Silo	210 Tons			

* SHELL/TUBE WHERE APPLICABLE


35-FD 801 A-1
ROTARY FEEDER
35-SL801
SILENCER
35-SL802
SILENCER
ATM. AIR
35-BB01A/B
PNEUMATIC TRANSPORT
SUPPLY BLOWERS
TEXACO
FW
35-CR801 A/B
35-CR802 A/B
35-CR803 A/B
35-CR804 A/B
CLARIFIER SCREEN
TRANSFER CONVEYOR
(1 OPERATING, 1 SPARE PER MODULE)
3 TPH NORMAL
4 TPH MAXIMUM
35-CR805A/B
SLAG TRANSFER CONVEYORS
(1 OPERATING, 1 SPARE)
130 TPH NORMAL
163 TPH MAXIMUM
NOTE: 1. LOCK/HOPPERS AND SCREENS SHOWN (BY TEXACO)
DEPICT ONE (1) OF FOUR (4) MODULES. HOWEVER,
ITEM NUMBERS REPRESENT EQUIPMENT FOR
ALL FOUR (4) MODULES.
2. SEE DWG. NO. 34099-33-1-50-1 FOR LEGEND

p


FROM SECTION 1200 SPENT BED COOLERS (TYP EA. BOILER)
FROM SECTION 1200 BOILER BLOWDOWN (TYP EA. BOILER)
ATM.
35-B802 A/B
FLYASH CENTRIFUGAL BLOWER
35-F801
FILTER/SEPARATOR
35-F802
FILTER/SEPARATOR
35-FD801 A-L
ROTARY FEEDER
35-TK801
SPENT BED STORAGE SILO 56 HR. STORAGE 103 TONS
35-TK802
FLYASH STORAGE SILO 56 HR. STORAGE 210 TONS
35-SL801
SILENCER
35-SL802
SILENCER
ATM. AIR
35-B801A/B
PNEUMATIC TRANSPORT SUPPLY BLOWERS
35-MB01
FLYASH MIXER/CONDITIONER
TO DISPOSAL VIA TRUCKS
TO DISPOSAL VIA TRUCKS
TEXACO PW
EMERGENCY DUMP
35-CR806
SLAG CONVEYOR
130 TPH NORMAL
163 TPH MAXIMUM
TO SLAG PILE VIA SCRAPERS
56 HOUR SURGE
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
PLANT BASED ON TEXACO GASIFIERS
SECTION 800-ASH/SLAG HANDLING
MURPHY HILL SITE ALABAMA
A 6-30-80 INITIAL ISSUE
835-54009 DWG. NO. 5409931-8045

TVA Coal Gasification Study
Texaco Gasifiers

SECTION DESCRIPTION

3.8 Section 1200 Utility Area

Section 1200-1 Raw Water Storage & Treatment

A. Reference Material

Process Flowsheet FWEC Drawing No. 54099-35-1-50-14

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
Disolved 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 (1-2 ppm). 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).

1 TRAIN PER ALL 4 MODULES (PER PLANT)

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 1200-1

TYPE OF UNIT RAW WATER STORAGE/TREATMENT

PAGE 1 OF 3

CLIENT TVA (COAL GASIFICATION STUDY)

LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FOB	REQ'N.NO.	No/Plant	REV
CLARIFIER						
35-11 -	CL-1201 A/B	CLARIFIER-SOFTENER	14		2-50%	
FILTERS						
35-11 -	F-1202 A/B	CLARIFIED WATER SANDFILTERS	14		2-50%	
35-11 -	F-1203 A/B	SLUDGE FILTERATION SYSTEM	14		2-100%	
MIXER						
35-11 -	M-1201 A/B	IN-LINE MIXER	14		2-100%	

FORM NO. 135-66D

1 TRAIN PER ALL 4 MODULES (PER PLANT)

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 1200-1

TYPE OF UNIT RAW WATER STORAGE/TREATMENT

CLIENT TVA (COAL GASIFICATION STUDY)

LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	No./Plant	REV
TANKS						
35-11-	TK-1208	RAW WATER STORAGE TANK	14		1-100%	
35-11-	TK-1209	SANDFILTER BACKWASH SUMP	14		1-100%	
PUMPS						
35-11-	P-1208 A/B/C	RAW WATER LIFT PUMPS	14		3-50%	
-	P-1209 A/B/C	FIREWATER PUMPS	14		3-50%	
-	P-1210 A/B/C	CLARIFIER FEED PUMPS	14		3-50%	
-	P-1211 A/B/C	CLARIFIER UNDERFLOW PUMP	14		3-50%	
-	P-1212 A/B/C	BACKWASH PUMPS	14		3-50%	

FORM NO. 135-660

ONE TRAIN PER ALL FOUR MODULES (PER PLANT)

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT NO. 11-35-54099	EQUIPMENT LIST	SECTION 1200-1	TYPE 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	FD	EQ'N.NO.	No/Plant	REV
MISCELLANEOUS						
35-11-	X-1201	BULK CHEMICAL STORAGE AND FEED SYSTEMS	14		1-100%	

FORM NO. 135-66D

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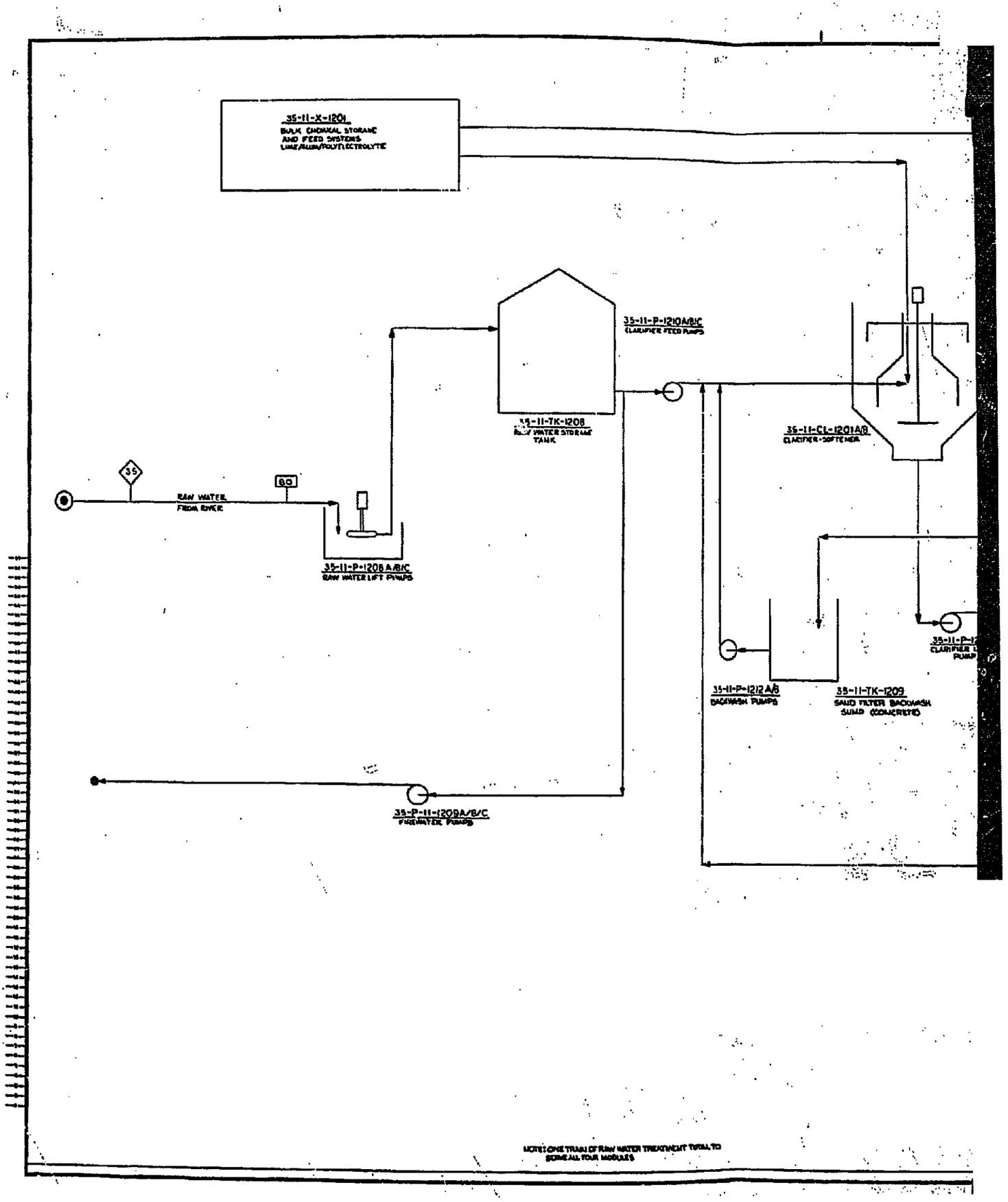
35-11-X-1201
BULK CHEMICAL STORAGE AND FEED SYSTEMS LIME/ALUM/POLYELECTROLYTE
35-11-P-1210A/B/C
CLARIFIER FEED PUMPS
35-11-TK-1208
RAW WATER STORAGE TANK
35-11-CL-1201A/B
CLARIFIER-SOFTENER
35
60
RAW WATER FROM RIVER
35-11-P-1208A/B/C
RAW WATER LIFT PUMPS
35-11-P-1212A/B
BACKWASH PUMPS
35-11-TK-1209
SAND FILTER BACKWASH SUMP (CONCRETE)
35-P-11-1209A/B/C
FIREWATER PUMPS
NOTE: ONE TRAIN OF RAW WATER TREATMENT TYPICAL TO SERVE ALL FOUR MODULES

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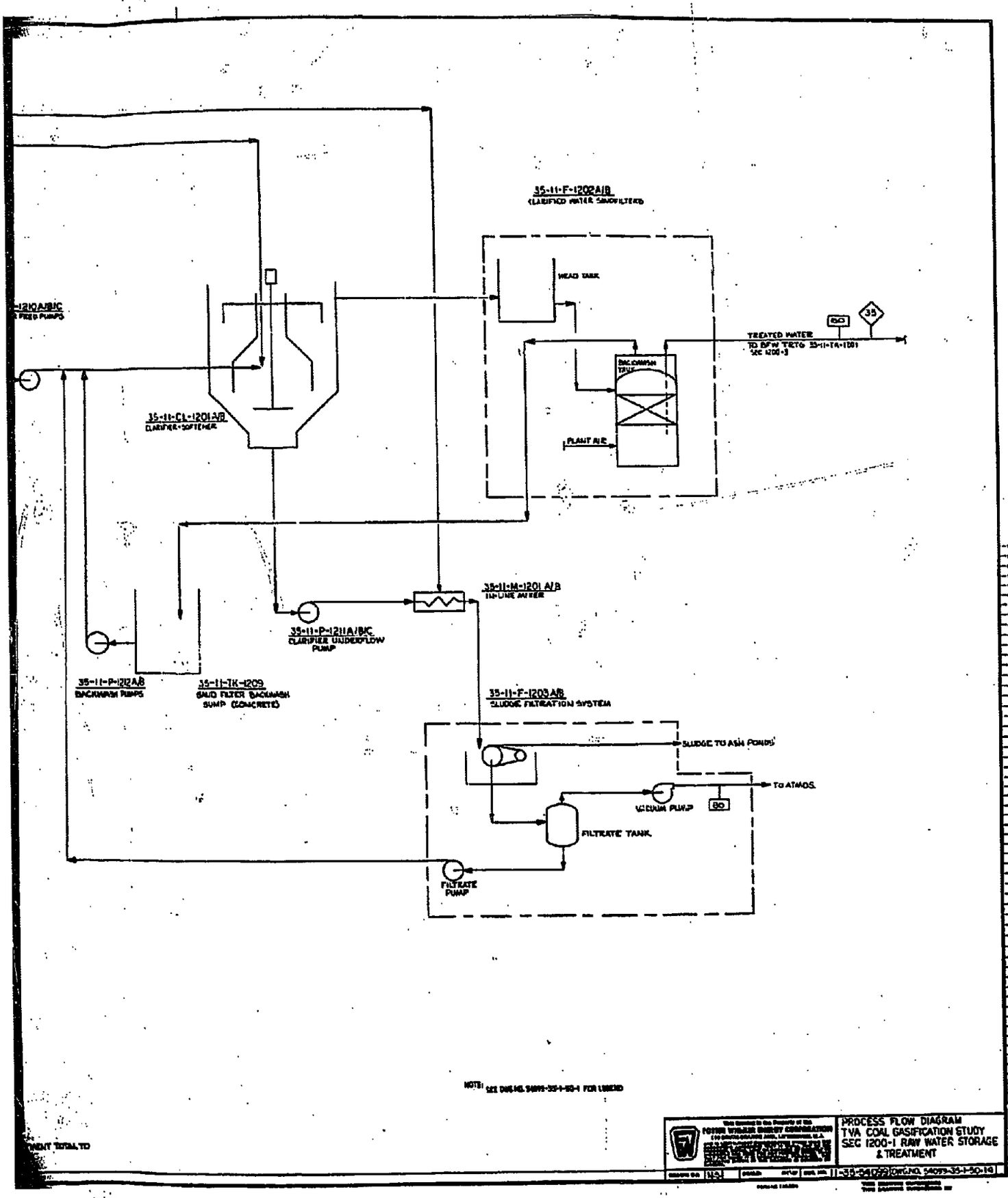
35-11-F-1202A/B
(CLARIFIED WATER SAND FILTERS)
HEAD TANK
TREATED WATER
TO BFW TRTG 35-11-TA-1201
SEC 1200-2
60
35
BACKWASH
TRUCK
PLANT AIR
35-11-CA-1201-A/B
CLARIFIER-SOFTENER
35-11-M-1201 A/B
IN-LINE MIXER
35-11-P-1211A/B/C
CLARIFIER UNDERFLOW
PUMP
35-11-P-1212A/B
BACKWASH PUMPS
35-11-TK-1209
SAND FILTER BACKWASH
SUMP (CONCRETE)
35-11-F-1203 A/B
SLUDGE FILTRATION SYSTEM
SLUDGE TO ASH POND
TO ATMOS.
VACUUM PUMP
80
FILTRATE TANK
FILTRATE
PUMP
NOTE: SEE DWG NO. 54099-35-1-50-1 FOR LEGEND
POWER SYSTEMS ENGINEERING, INC.
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SEC 1200-1 RAW WATER STORAGE
& TREATMENT
11-35-54099 ORIG. NO. 54099-35-1-50-1

TVA Coal Gasification Study
Texaco Gasifiers

SECTION DESCRIPTION

3.8 SECTION 1200-2 - POTABLE WATER STORAGE & CONDENSATE TREATMENT

A. Reference Material

- Process Flowsheet 54099-35-1-50-15
- 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.

Medium pressure condensate and high pressure condensate collected from the various continuous users and various other miscellaneous intermittent users are flashed to 50 psig steam for process users. The low pressure condensate is then cooled to about 274°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 further flashed in the Condensate Storage Tank, TK-1203 to 15 psig steam.

Condensate and steam recovery have 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-1203 A/B, to the Deaerator, DH-1201. Condensate from turbine drives on the Air Compressor, C-201, and Oxygen Compressor, C-202, enter the Deaerator as does condensate from the shell side of BFW preheater, E-1206. The required deaeration steam is provided by L.P. steam from the 50 psig steam header, M.P. steam from the 85 psig steam header, and to a lesser extent by flashed steam from the Condensate Storage Tank, TK-1203.

Deaeration is required to prevent corrosion in the various steam generation systems. 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 makeup 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 to the MP condensate header. A sidestream is withdrawn 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 HP condensate header.

ONE POTABLE WATER DRUM FOR ALL 4 MODULES
ONE TRAIN OF CONDENSATE TREATMENT FOR EACH MODULE

FORM NO. 135-904

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-35-54099
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						
35-11-	D-1208	CONDENSATE FLASH DRUM	15		4-25%	
35-11-	D-1210	POTABLE WATER DRUM	15		1-100%	
TANK						
35-11-	TK-1203	CONDENSATE STORAGE TANK	15		4-25%	
EXCHANGERS						
35-11-	E-1201	CONDENSATE/DEMIN WATER EXCHANGER	15		4-25%	
-	E-1205	H. P. CONDENSATE HEATER	15		4-25%	
PUMPS						
35-11-	P-1203 A/B	CONDENSATE PUMPS	15		8-25%	
-	P-1205 A/B	BFW PUMP	15		8 - 25%	
-	P-1213 A/B	BFW BOOSTER PUMP	15		8-25%	
	P-1214 A/B/C/D	TURBINE CONDENSATE PUMPS	15		16 - 100%	
MISC.						
5-11 -	X-1202	HYPOCHLORINATOR	15		1-100%	
-	DH-1201	DEAERATOR	15		4-25%	

FORM NO. 135-904

ONE TRAIN OF CONDENSATE FOR EACH MODULE

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT: 11-35-54099
SECTION: 1200-2

EQUIPMENT LIST

NAME OF UNIT: ~~CONDENSATE~~ POTABLE WATER & 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./Plant	REV.
PACKAGE ITEMS						
35-11-	PG-1202	AMINE INJECTION PACKAGE	15		4-25%	
-	PG-1203	HYDRAZEINE INJECTION PACKAGE	15		4-25%	

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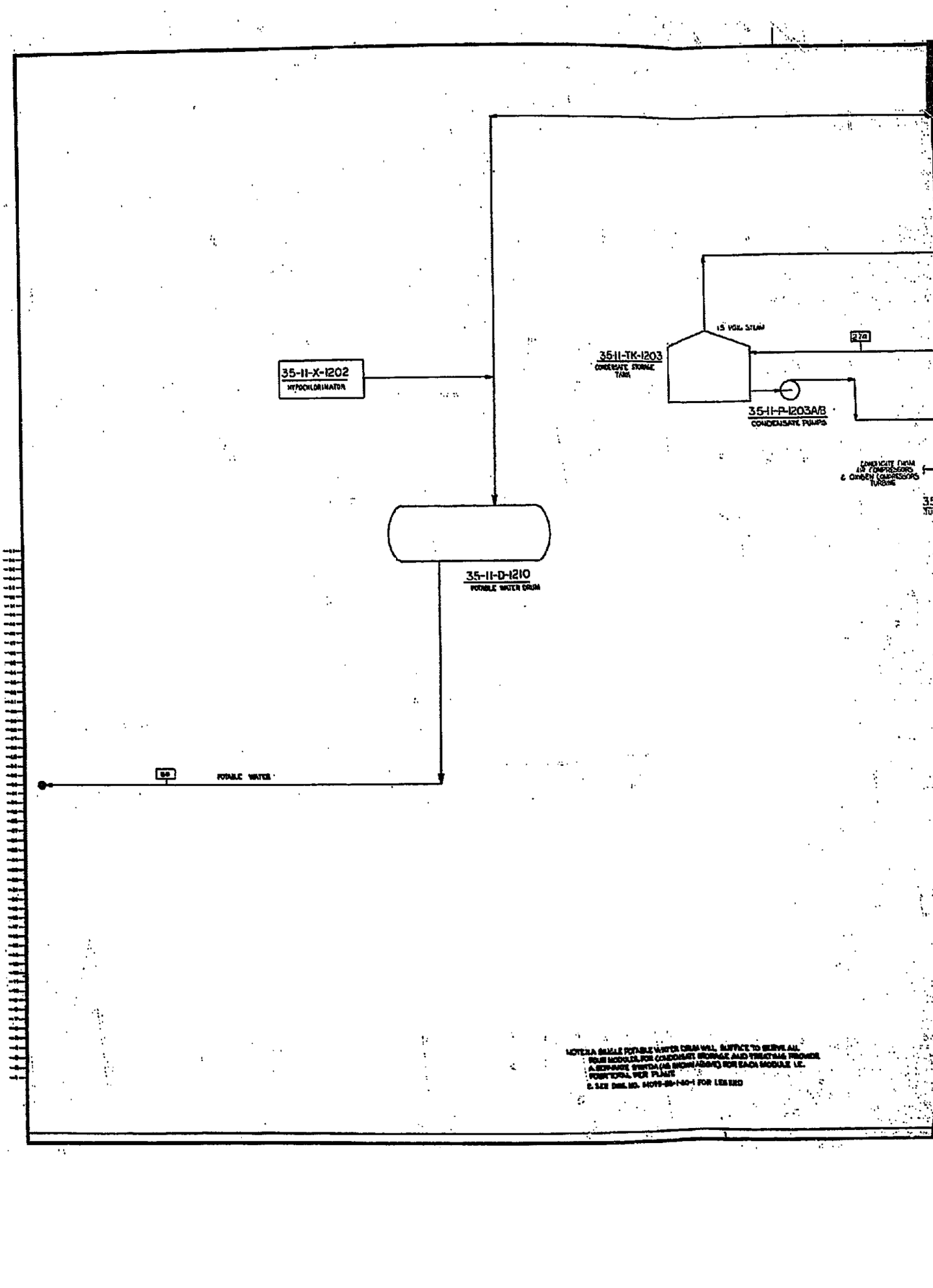
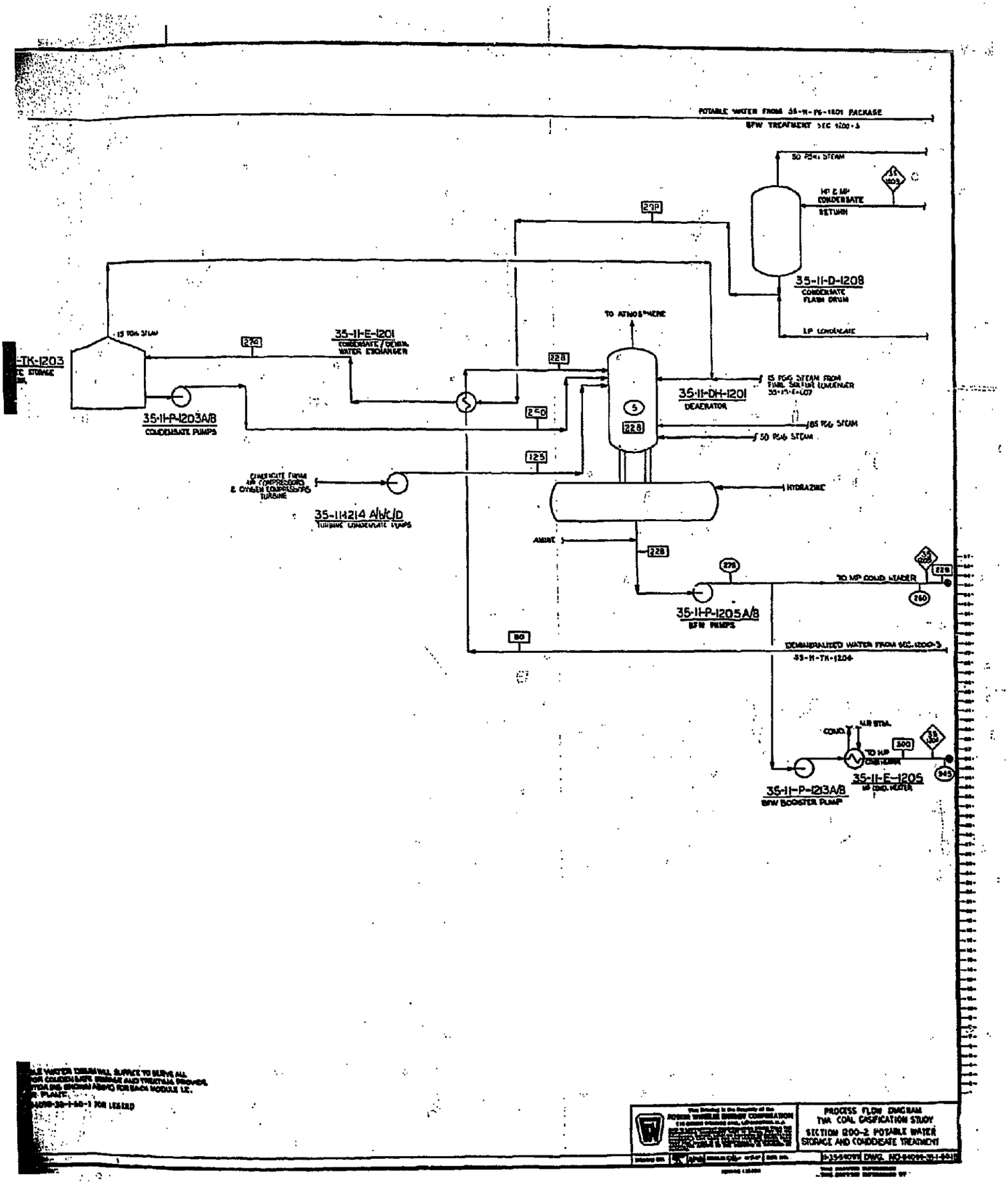

35-11-X-1202
HYPOCHLORINATOR
35-11-TK-1203
CONDENSATE STORAGE TANK
35-11-P-1203A/B
CONDENSATE PUMPS
35-11-D-1210
POTABLE WATER DRUM
POTABLE WATER
NOTES:A SMALL POTABLE WATER DRUM WILL SUFFICE TO SERVE ALL
FOUR MODULES FOR CONDENSATE STORAGE AND TREATING PROPOSE
A SEPARATE SYSTEM (AS SHOWN ABOVE) FOR EACH MODULE I.E.
FOUR SYSTEMS PER PLANT
SEE DWG. NO. 34099-35-1-50-1 FOR LEGEND


POTABLE WATER FROM 35-H-PK-1201 PACKAGE
BFW TREATMENT SEC 1200-3
50 PSIG STEAM
HP & MP CONDENSATE RETURN
35-11-D-1208
CONDENSATE FLASH DRUM
LP CONDENSATE
TO ATMOSPHERE
15 PSIG STEAM
35-11-E-1201
CONDENSATE / DEMIN. WATER EXCHANGER
-TK-1203
35-11-P-1203A/B
CONDENSATE PUMPS
35-11-DH-1201
DEAERATOR
15 PSIG STEAM FROM FINAL SULFUR CONDENSER
85 PSIG STEAM
50 PSIG STEAM
CONDENSATE FROM AIR COMPRESSORS & OXYGEN COMPRESSORS TURBINE
35-11-14 A/B/C/D
TURBINE CONDENSATE PUMPS
HYDRAZINE
AMINE
TO MP COND. HEADER
35-11-P-1205A/B
BFW PUMPS
DEMINERALIZED WATER FROM SEC. 1200-3
35-H-TK-1204
COND.
AUX STM.
TO MP CONDENSER
35-11-E-1205
MP COND. HEATER
35-11-P-1213A/B
BFW BOOSTER PUMP
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTION 200-2 POTABLE WATER STORAGE AND CONDENSATE TREATMENT

TVA Coal Gasification Study
Texaco Gasifiers

SECTION DESCRIPTION

3.8 SECTION 1200-3 BOILER FEEDWATER TREATMENT

A. Reference Material:

. Process Flowsheet: 54099-35-1-50- 16
54099-35-1-50-151

. 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.

FORM NO. 135-904

1 TRAIN PER MODULE

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT 11-35-54099
SECTION: 1200-3

EQUIPMENT LIST

NAME OF UNIT: BFW 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.
PACKAGE ITEM						
35-11-	PG-1201	DEMINERALIZER PACKAGE	16		1-100%	
EXCHANGERS						
35-11-	E-1202	TREATED WATER TANK HEATER	16		1-100%	
-	E-1203	WATER BACKWASH HEATER	16		1-100%	
-	E-1204	CAUSTIC STORAGE DRUM HEATER	16		1-100%	
DRUMS						
35-11-	D-1201	SULFURIC ACID STORAGE DRUM	16		1-100%	
-	D-1202	CAUSTIC STORAGE DRUM	16		1-100%	

FORM NO. 135-904

1 TRAIN PER MODULE

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT 11-35-54099
SECTION 1200-3

EQUIPMENT LIST

NAME OF UNIT: BFW TREATMENT

CLIENT: TVA (COAL GASIFICATION STUDY)

LOCATION: ALABAMA

REVISION DATE	1	2	3	4	5
ORIGINAL					

CLASS	ITEM NO.	DESCRIPTION	EFD	REQ'N. NO.	No./Module	REV.
TANKS						
35-11-	TK-1201	TREATED WATER STORAGE TANK	16		1-100%	
-	TK-1202	NEUTRALIZATION TANK	16		1-100%	
-	TK-1204	DEMINERALIZED WATER STORAGE TANK	16		1-100%	
PUMPS						
35-11-	P-1201 A/B	DEMIN UNIT FEED PUMP	16		2-100%	
-	P-1202 A/B	COOLING TOWER MAKEUP PUMP	16		2-100%	
-	P-1204 A/B	DEMINERALIZED WATER PUMP	16		2-100%	
-	P-1206	REGENERATION ACID PUMP	16		1-100%	
-	P-1207	REGENERATION CAUSTIC PUMP	16		1-100%	
-	P-1208	NEUTRALIZATION ADJUST ACID PUMP	16		1-100%	
-	P-1209	NEUTRALIZATION ADJUST CAUSTIC PUMP	16		1-100%	

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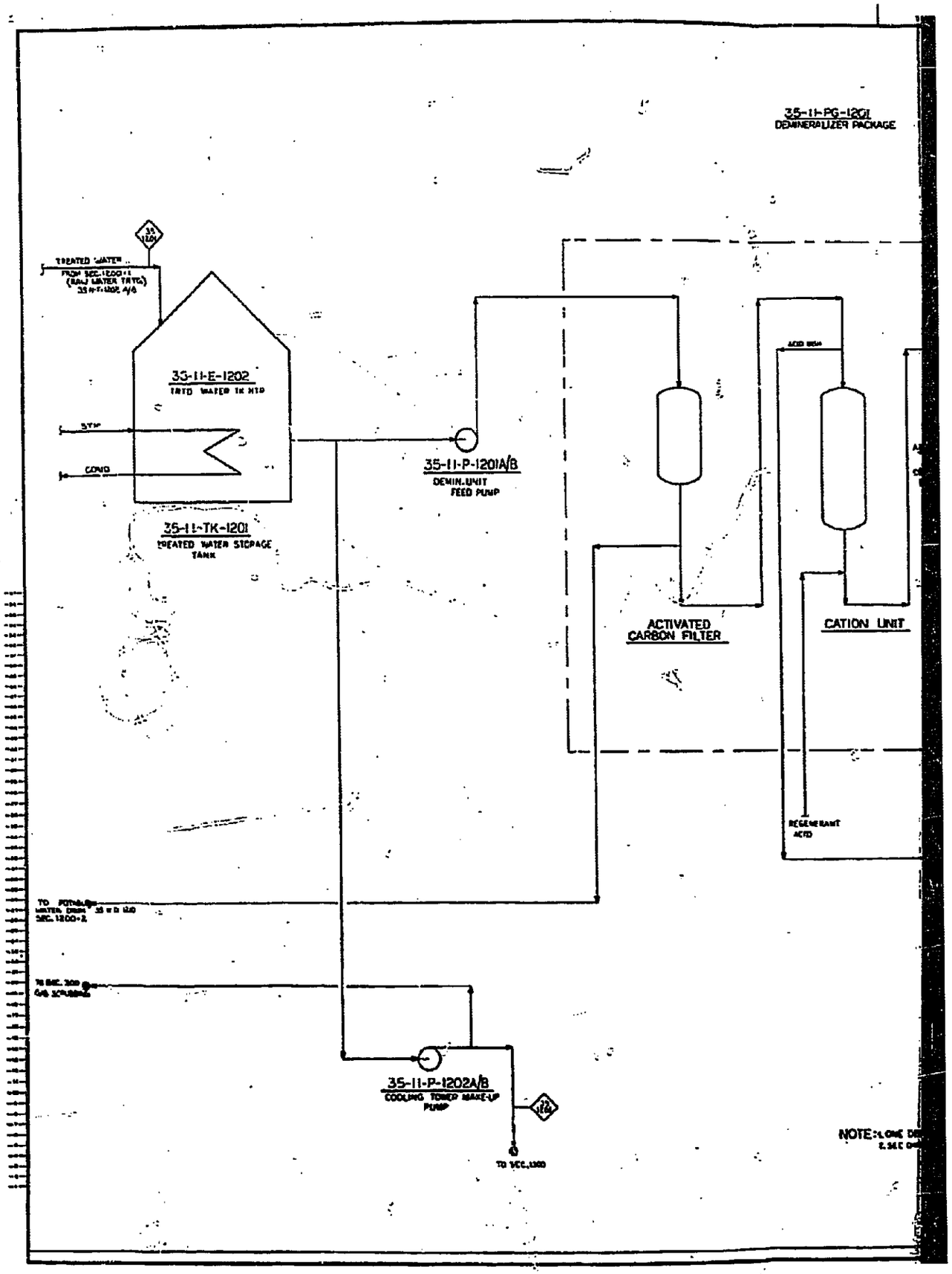
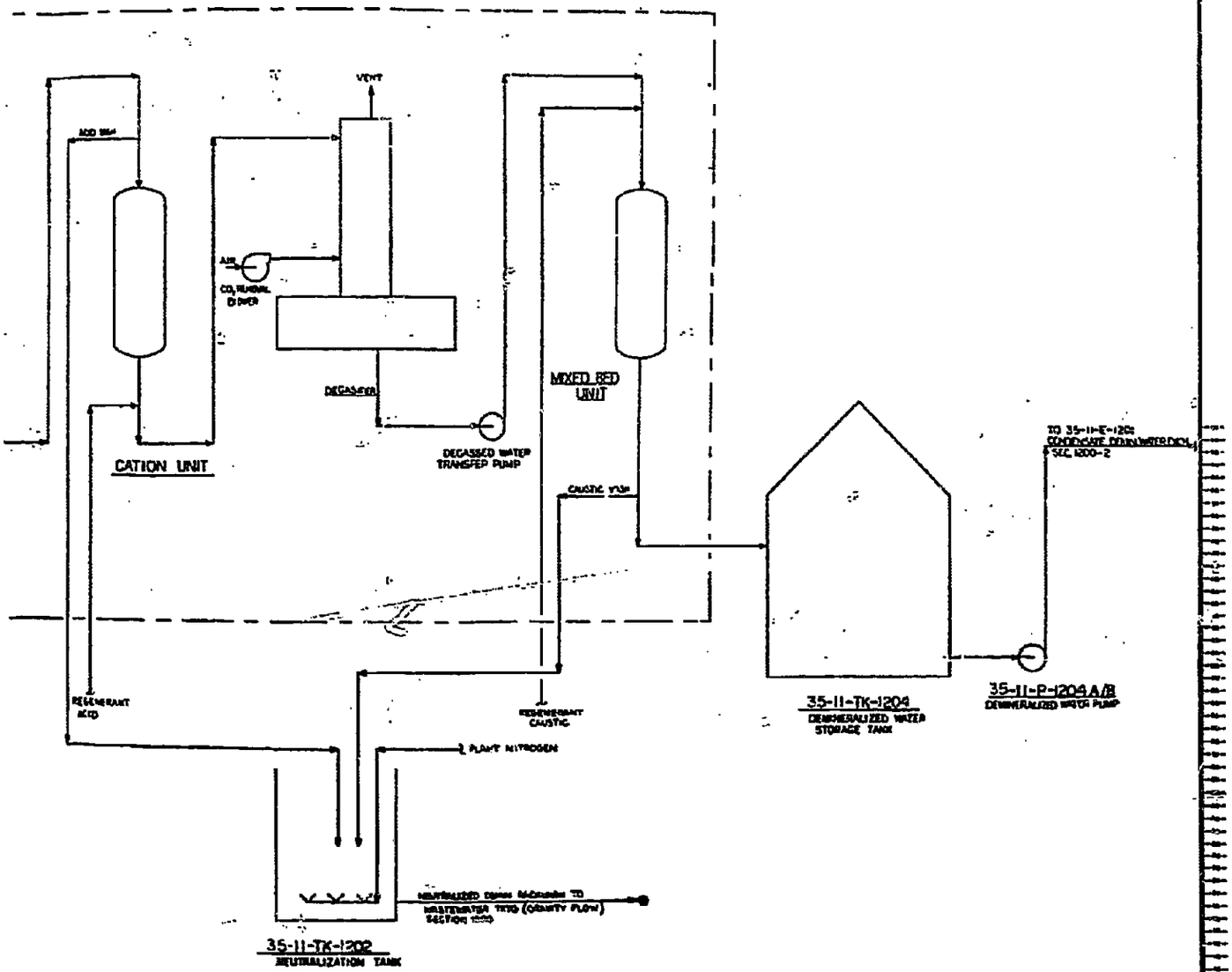

35-11-PG-1201
DEMINERALIZER PACKAGE
TREATED WATER
33-11-E-1202
STM
COND
35-11-TK-1201
TREATED WATER STORAGE TANK
35-11-P-1201A/B
DEMIN. UNIT FEED PUMP
ACTIVATED CARBON FILTER
CATION UNIT
REGENERANT ACID
TO POTABLE WATER DRUM
35-11-P-1202A/B
COOLING TOWER MAKE-UP PUMP
TO 33C,1300

35-11-PG-1201
DEMINERALIZER PACKAGE



NOTE: 1. ONE DEMINERALIZATION UNIT DESTILPER MODULE

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SEC. 1200-3 BFW TREATMENT

TVA Coal Gasification Study
Texaco Gasifier

SECTION DESCRIPTION

3.8 SECTION 1200-4 - STEAM GENERATION AND DISTRIBUTION

A. Reference Material

. Process Flowsheets	FWEC Dwg. No. 54099-35-1-50-17
. Steam Balance Summary	FWEC Dwg. No. 54099-35-1-50-151
. Equipment Summary List	

B. Description of Flow

Flow of steam generation and distribution may be followed on the Plant Stream, Condensate and Boiler Feed Water Diagram, Drawing No. 54099-35-1-50-151.

The Steam Header System consists of four steam levels

High Pressure (H.P.)	900 psig, 1000°F
Medium Pressure (M.P.)	150 psig, 365°F
Low Pressure (L.P.)	85 psig, 460°F
Low Pressure (L.P.)	50 psig, 298°F

High pressure saturated steam is generated through waste heat recovery in the Radiant Cooler, E-313 and Convection Cooler, E-314. Most of high pressure steam is condensed or expanded through turbines driving Air Compressor, C-201, and the Oxygen Compressor, C-202. A small amount of H.P. steam is required for preheat in the Clause Sulfur Recovery Plant. Condensate from H.P. steam users is returned to the deaerator.

Medium pressure steam is generated in Clause Plant Section in the Waste Heat Boiler, E-601. Medium pressure steam is utilized principally in the Gasification Section 300.

85 psig steam is extracted from the oxygen compressor turbine. It is utilized principally in the H_2S Stripper Reboiler, E-403, in Acid Gas Removal Section 400. Other consumers of 85 psig steam are the H.P. Condensate Heater, E-1205, and Deaerator, DH-1201. Also the Beavon Tail Gas Treating Unit, steam tracing and miscellaneous items utilize 85 psig steam.

50 psig steam is generated by flashing medium and high pressure steam condensate into Condensate Flash Drum, D-1208. Waste Heat Boiler, SG-1203, upstream of the Fluid Bed Boiler Superheater, SG-1202, also generates 50 psig steam by recovering heat from flue gas. Consumers of the 50 psig steam are: Deaerator, DH-1201, the Flash Drum, D-701, and Ammonia Stripper, T-701 in Section 700, Tail Gas Treating Unit and Sulfur Prilling Unit. Blowdown from various steam generating equipment is directed to the cooling tower as cooling tower makeup. L.P. condensate flows to the Condensate Storage Tank, TK-1203 and flashes to 15 psig steam. Final Sulfur Condenser, E-607, also generates 15 psig steam. Deaerator, DH-1201, utilizes all of the 15 psig steam generated within the plant. The condensate from the storage tank is pumped to the deaerator for subsequent use as boiler feed water. A BFW Booster Pump, P-1213, is provided in series with the M.P. BFW Pump, P-1205, to pump a portion of the deaerated condensate to the H.P. level.

Process flowsheet 54099-35-1-17 shows the Steam Generator, SG-1201, and the Fluid Bed Boiler Superheater, SG-1202. The Steam Generator is used during the plant startup. The Fluid Bed Boiler Superheater superheats the 900 psig saturated steam produced in the Gasifier. Limestone is injected into both the Steam Generator and Fluid Bed Boiler 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

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 1200-4

TYPE OF UNIT STEAM GENERATION

CLIENT TVA (COAL GASIFICATION STUDY)

LOCATION ALABAMA

REVISION DATE	ORIGINAL	1	2	3	4	5

CLASS	ITEM NO	DESCRIPTION	FD*	REQ'N.NO.	No./Module		REV
BLOWER 35-11 -	B-1201	BOILER AIR BLOWER	17			ONE FOR ENTIRE PLANT	
-	B-1202	SUPERHEATER AIR BLOWER	17		1-100%		
BUNKERS 35-11 -	BN-1201	COAL BUNKER	17		1-100%		
-	BN-1202	LIMESTONE BUNKER	17		1-100%		
-	BN-1203	ASH BUNKER	17		1-100%		
DRUMS 35-11 -	D-1206	CONTINUOUS BLOWDOWN DRUM	17			ONE FOR ENTIRE PLANT	
-	D-1207	INTERMITTENT BLOWDOWN DRUM	17			ONE FOR THE ENTIRE PLANT	

FORM NO. 135-66D

1 TRAIN PER MODULE

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 1200-4

TYPE OF UNIT STEAM GENERATION

CLIENT TVA (COAL GASIFICATION STUDY)

LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N. NO.	No./Module	REV
CONVEYORS						
35-11-	CR-1201	COAL CONVEYOR	17		1-100%	
-	CR-1202	LIMESTONE CONVEYOR	17		1-100%	
	CR-1203	ASH COOLER-CONVEYOR	17		ONE FOR ENTIRE PLANT	
-	CR-1204	SUPERHEATER ASH COOLER CONVEYOR	17		1-100%	
EJECTORS						
35-11-	J-1201	LIMESTONE EJECTOR	17		ONE FOR THE ENTIRE PLANT.	
-	J -1202	ASH EJECTOR	17		ONE FOR THE ENTIRE PLANT	
	J-1203	SUPERHEATER LIMESTONE EJECTOR	17		1-100%	

1 TRAIN PER MODULE

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT NO. 11-35-54099	EQUIPMENT LIST	SECTION 1200-4	TYPE OF UNIT STEAM GENERATION	PAGE 3 OF 4

CLIENT TVA (COAL GASIFICATION STUDY)

LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N. NO.	No./Module		REV
FEEDERS							
35-11-	FD-1201	COAL FEEDER	17		1	ONE FOR ENTIRE PLANT	
	FD-1202	SUPERHEATER COALFEEDER	17		1-100%		
	FD-1203	SUPERHEATER LIMESTONE FEEDER	17		1-100%		
	FD-1204	LIMESTONE FEEDER	17		1	ONE FOR ENTIRE PLANT	

FORM NO. 135-66D

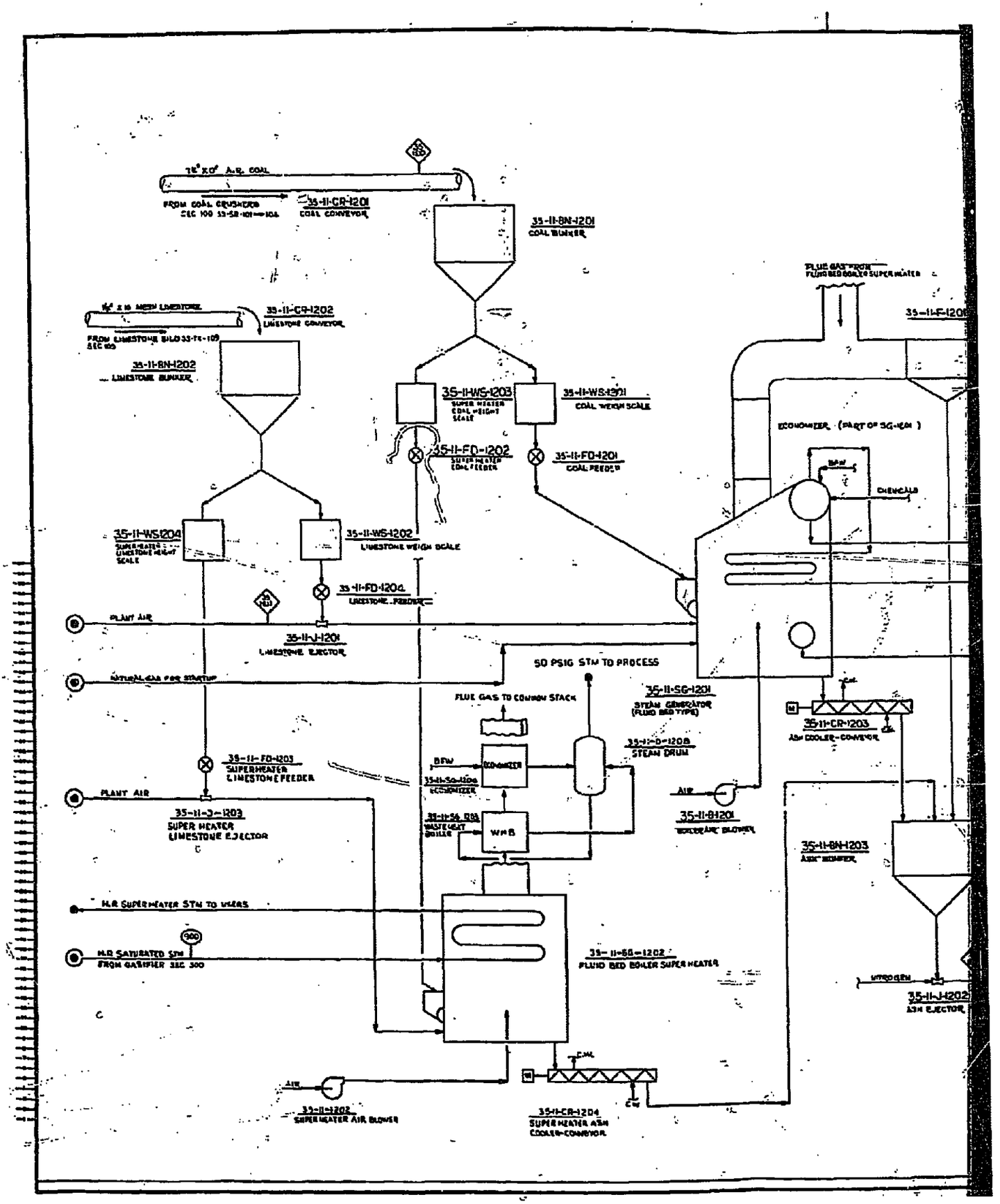
1 TRAIN PER MODULE

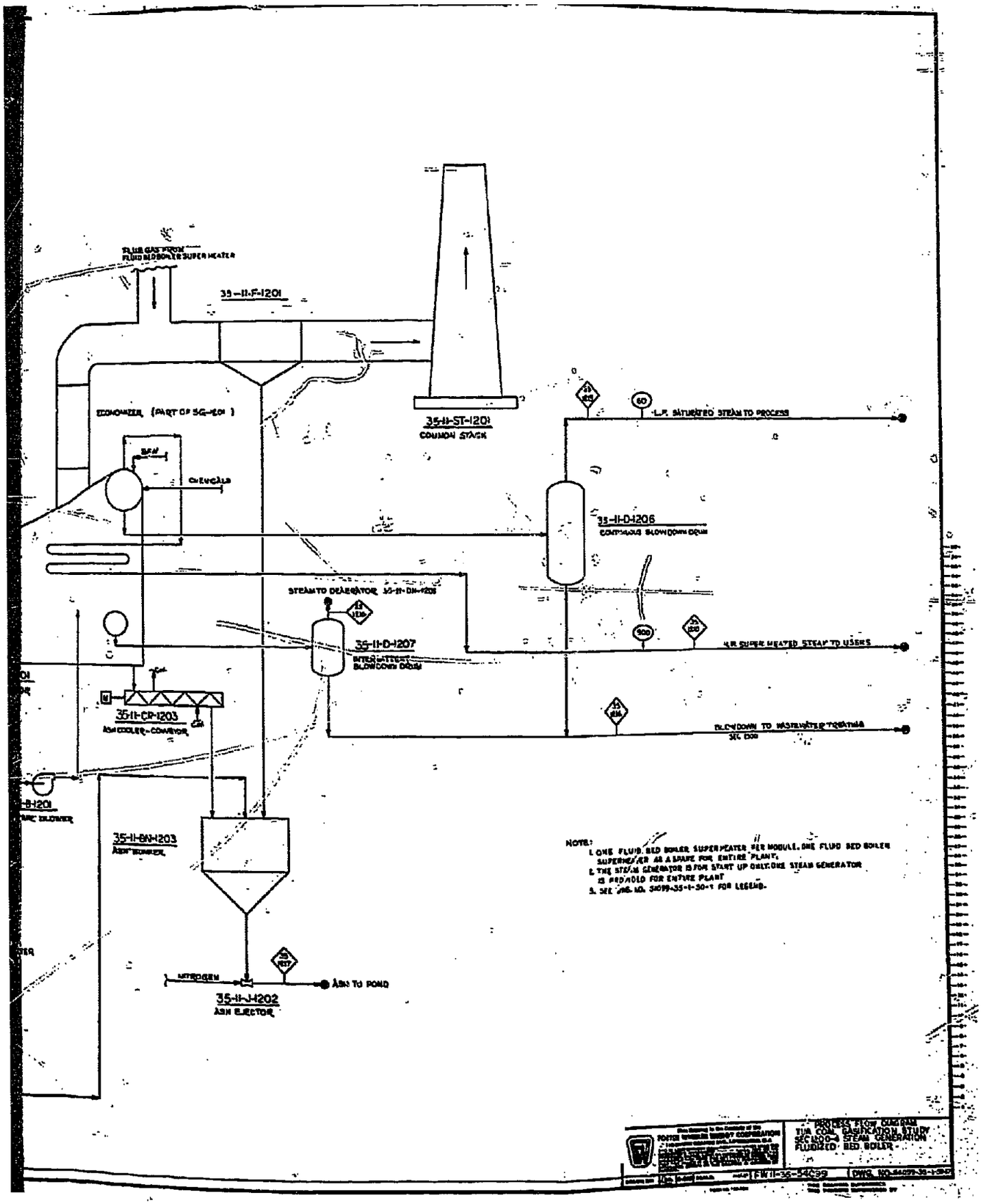
FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION | CONTRACT NO. 11-35-54099 | EQUIPMENT LIST | SECTION 1200-4 | TYPE OF UNIT STEAM GENERATION | PAGE 4 OF 4

CLIENT TVA (COAL GASIFICATION) | LOCATION ALABAMA | REVISION | DATE | ORIGINAL | 1 | 2 | 3 | 4 | 5

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	No./Module		REV
STEAM GENERATORS							
35-11-	SG-1201	STEAM GENERATOR	17			ONE FOR ENTIRE PLANT	
35-11-	SG-1202	FLUID BED BOILER SUPERHEATER	17		1-100%		
	SG-1203	ECONOMIZER	17		1-100%		
	SG-1204	WASTE HEAT BOILER	17		1-100%		
STACK							
35-11-	ST-1201	COMMON STACK	17		1-100%		
FILTER (Pptr)							
35-11-	F-1201	ELECTROSTATIC PRECIPITATOR	17		1-100%		
WEIGH SCALES							
35-11-	WS-1201	COAL WEIGH SCALE	17			ONE FOR ENTIRE PLANT	
-	WS-1202	LIMESTONE WEIGH SCALE	17			ONE FOR ENTIRE PLANT	
-	WS-1203	SUPERHEATER COAL WEIGH SCALE	17		1-100%		
-	WS-1204	SUPERHEATER LIMESTONE WEIGH SCALE	17		1-100%		

FORM NO. 135-66D


FROM COAL CRUSHER SEC 100
35-11-CR-1201 COAL CONVEYOR
35-11-BN-1201 COAL BUNKER
FROM LIMESTONE SILO SEC 100
35-11-CR-1202 LIMESTONE CONVEYOR
35-11-BN-1202 LIMESTONE BUNKER
35-11-WS-1203 SUPER HEATER COAL WEIGHT SCALE
35-11-WS-1201 COAL WEIGH SCALE
35-11-FD-1202 SUPER HEATER COAL FEEDER
35-11-FD-1201 COAL FEEDER
35-11-WS-1204 SUPER HEATER LIMESTONE WEIGHT SCALE
35-11-WS-1202 LIMESTONE WEIGH SCALE
35-11-FD-1204 LIMESTONE FEEDER
PLANT AIR
35-11-J-1201 LIMESTONE EJECTOR
NATURAL GAS FOR STARTUP
50 PSIG STM TO PROCESS
FLUE GAS TO COMMON STACK
35-11-SG-1201 STEAM GENERATOR (FLUID BED TYPE)
35-11-D-1208 STEAM DRUM
35-11-FD-1203 SUPERHEATER LIMESTONE FEEDER
BFW
35-11-SG-1206 ECONOMIZER
35-11-SG-1205 WASTE HEAT BOILER
WHB
PLANT AIR
35-11-J-1203 SUPER HEATER LIMESTONE EJECTOR
AIR
35-11-B1201 BOILER AIR BLOWER
35-11-CR-1203 ASH COOLER-CONVEYOR
35-11-BN-1203 ASH BUNKER
H.R SUPERHEATER STM TO WGAS
H.R SATURATED STM FROM GASIFIER SEC 300
35-11-SG-1202 FLUID BED BOILER SUPER HEATER
NITROGEN
35-11-J-1202 ASH EJECTOR
AIR
35-11-1202 SUPERHEATER AIR BLOWER
35-11-CR-1204 SUPER HEATER ASH COOLER-CONVEYOR
FLUE GAS FROM FLUID BED BOILER SUPERHEATER
35-11-F-1201
ECONOMIZER (PART OF SG-1201)
BFW
CHEMICALS


FLUE GAS FROM FLUID BED BOILER SUPER HEATER
35-11-F-1201
ECONOMIZER (PART OF SG-E01)
35-11-ST-1201
COMMON STACK
L.P. SATURATED STEAM TO PROCESS
35-11-D-1206
STEAM TO DEAERATOR
35-11-D-1207
H.P. SUPER HEATED STEAM TO USERS
35-11-CR-1203
BLOWDOWN TO WASTEWATER TREATING
35-11-BN-1203
NITROGEN
ASH TO POND
35-11-J-1202
ASH EJECTOR
NOTE:
1. ONE FLUID BED BOILER SUPERHEATER PER MODULE. ONE FLUID BED BOILER SUPERHEATER AS A SPARE FOR ENTIRE PLANT.
2. THE STEAM GENERATOR IS FOR START UP ONLY. ONE STEAM GENERATOR IS PROVIDED FOR ENTIRE PLANT
3. SEE DWG. NO. 34099-35-1-30-1 FOR LEGEND.
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTION-4 STEAM GENERATION
FLUIDIZED BED BOILER
FW 11-35-54C99

TVA Coal Gasification Study
Texaco Gasifiers

SECTION DESCRIPTION

3.9 SECTION 1300 - COOLING WATER SYSTEM

A. Reference Material:

. Process Flowsheet: 54099-35-1-50- 18
54099-35-1-50-161

. 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. 54099-35-1-50-161.

1 TRAIN PER MODULE

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT NO. 11-35-54099	EQUIPMENT LIST	SECTION 1300	TYPE OF UNIT COOLING WATER SYSTEM	PAGE 1 OF 1

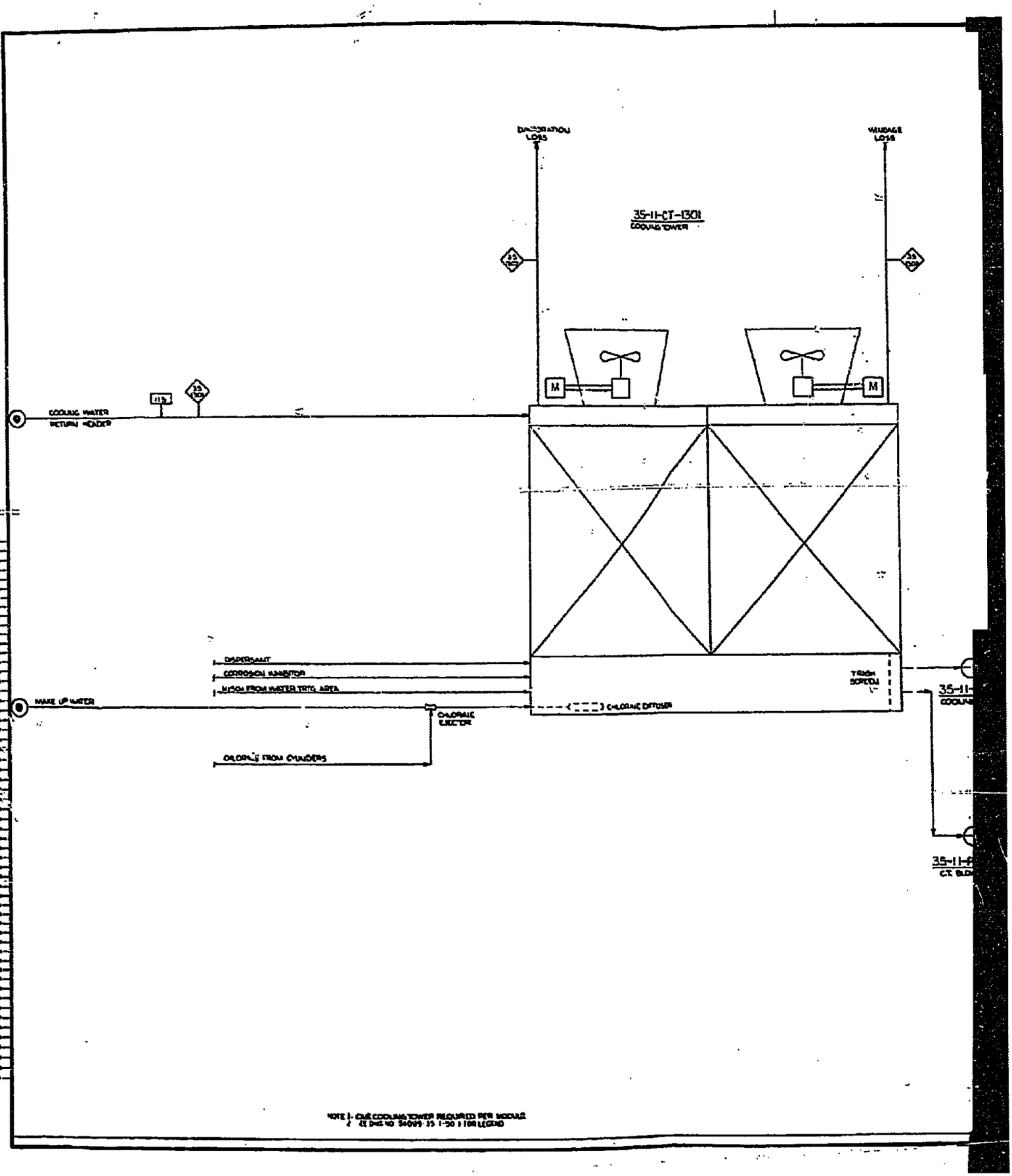
CLIENT TVA (COAL GASIFICATION STUDY)

LOCATION ALABAMA

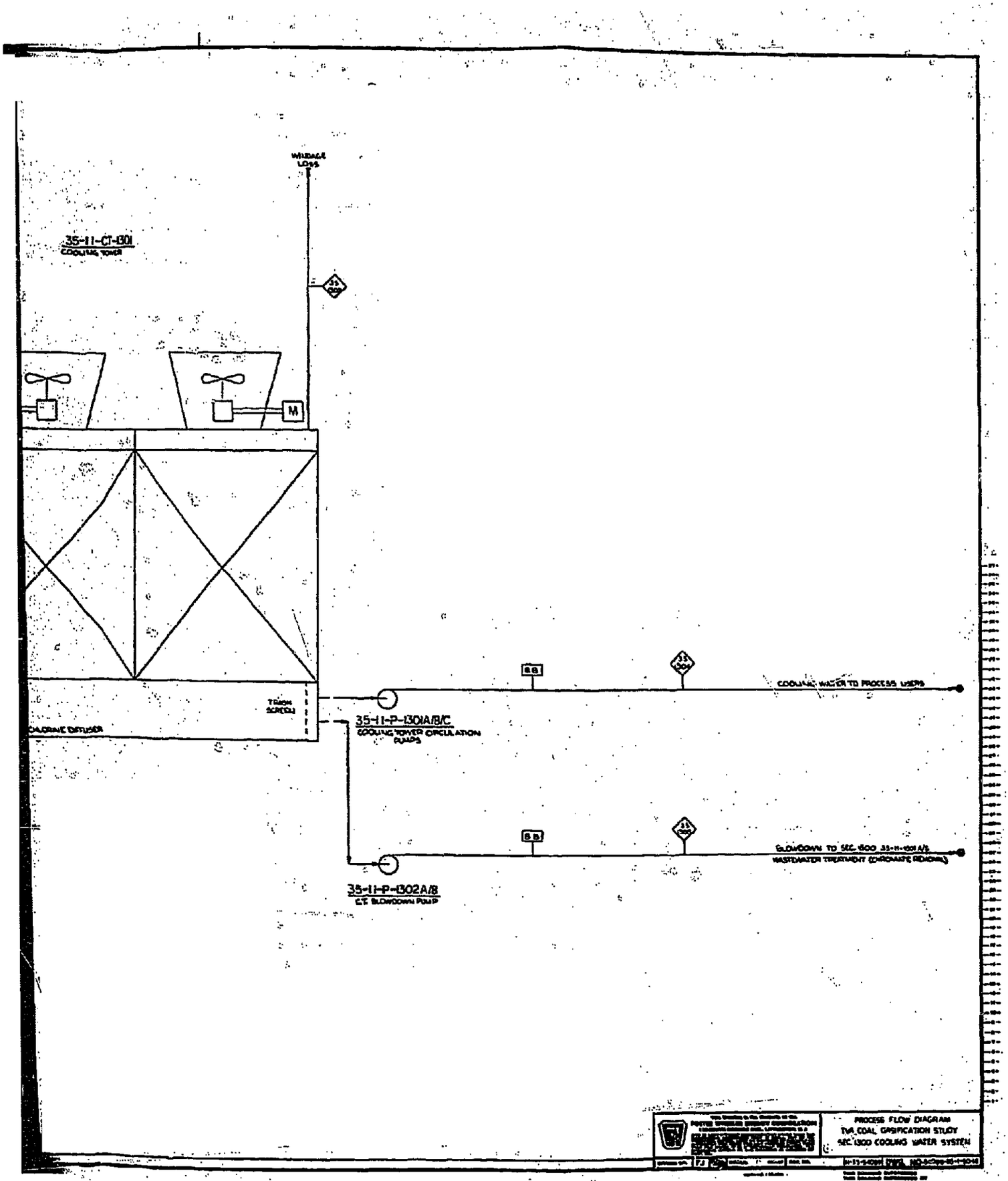
REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD*	REQ'N.NO.	No./Module	REV
COOLING TOWER						
35-11-	CT-1301	COOLING TOWER PACKAGE	18		1-100%	
PUMPS						
35-11-	P-1301 A/B/C	COOLING TOWER CIRCLATION PUMPS	18		3-50 %	
35-11-	P-1302 A/B	COOLING TOWER BLOWDOWN PUMP	18		2-100%	

FORM NO. 135-66D



NOTE 1- ONE COOLING TOWER REQUIRED PER MODULE
2 SEE DWG NO 34099-35 1-50 1 FOR LEGEND


WINDAGE LOSS
35-11-CT-1301
COOLING TOWER
M
TRASH SCREEN
CHLORINE DIFFUSER
35-11-P-1301A/B/C
COOLING TOWER CIRCULATION PUMPS
COOLING WATER TO PROCESS USERS
35-11-P-1302A/B
CT BLOWDOWN PUMP
BLOWDOWN TO SEC. 1500 35-11-1501A/B
WASTEWATER TREATMENT (CHROMATE REMOVAL)
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SEC 1300 COOLING WATER SYSTEM

TVA Coal Gasification Study
Texaco Gasifiers

SECTION DESCRIPTION

3.10 SECTION 1400 - FLARE SYSTEM

A. Reference Material:

- Process Flowsheet: FWEC Dwg. No. 54099-35-1-50-19
- 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

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT NO. 11-35-54099	EQUIPMENT LIST	SECTION 1400	TYPE OF UNIT FLARE & INCINERATOR	PAGE 1 OF 2

CLIENT TVA (COAL GASIFICATION STUDY)	REVISION	ORIGINAL	1	2	3	4	5
LOCATION ALABAMA	DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	No./Module	REV
DRUM						
35-11-	D-1401	FLARE SEAL DRUM	19		1-100%	
FLARE						
35-11-	FL-1401	FLARE STACK UNIT	19		1-100%	
EXCHANGER						
35-11-	E-1401	INCINERATOR AIR PREHEATER	19		1-100%	
-	E-1402	SEAL DRUM HEATER	19		1-100%	
FURNACE						
35-11-	H-1401	INCINERATOR	19		1-100%	

FORM NO. 135-66D

1 TRAIN PER MODULE

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 1400

TYPE OF UNIT FLARE & INCINERATOR

PAGE 2 OF 2

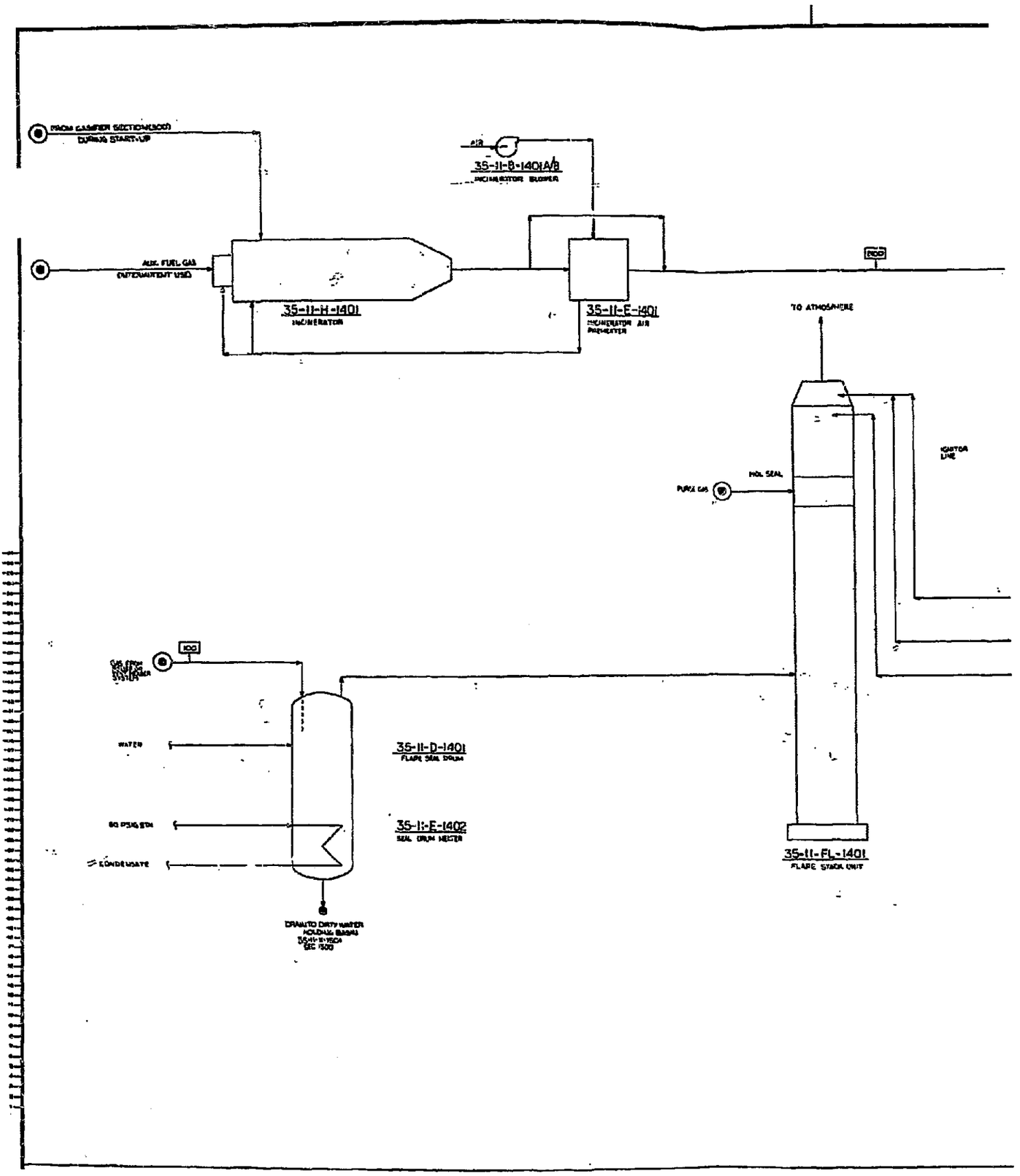
CLIENT TVA (COAL GASIFICATION STUDY)

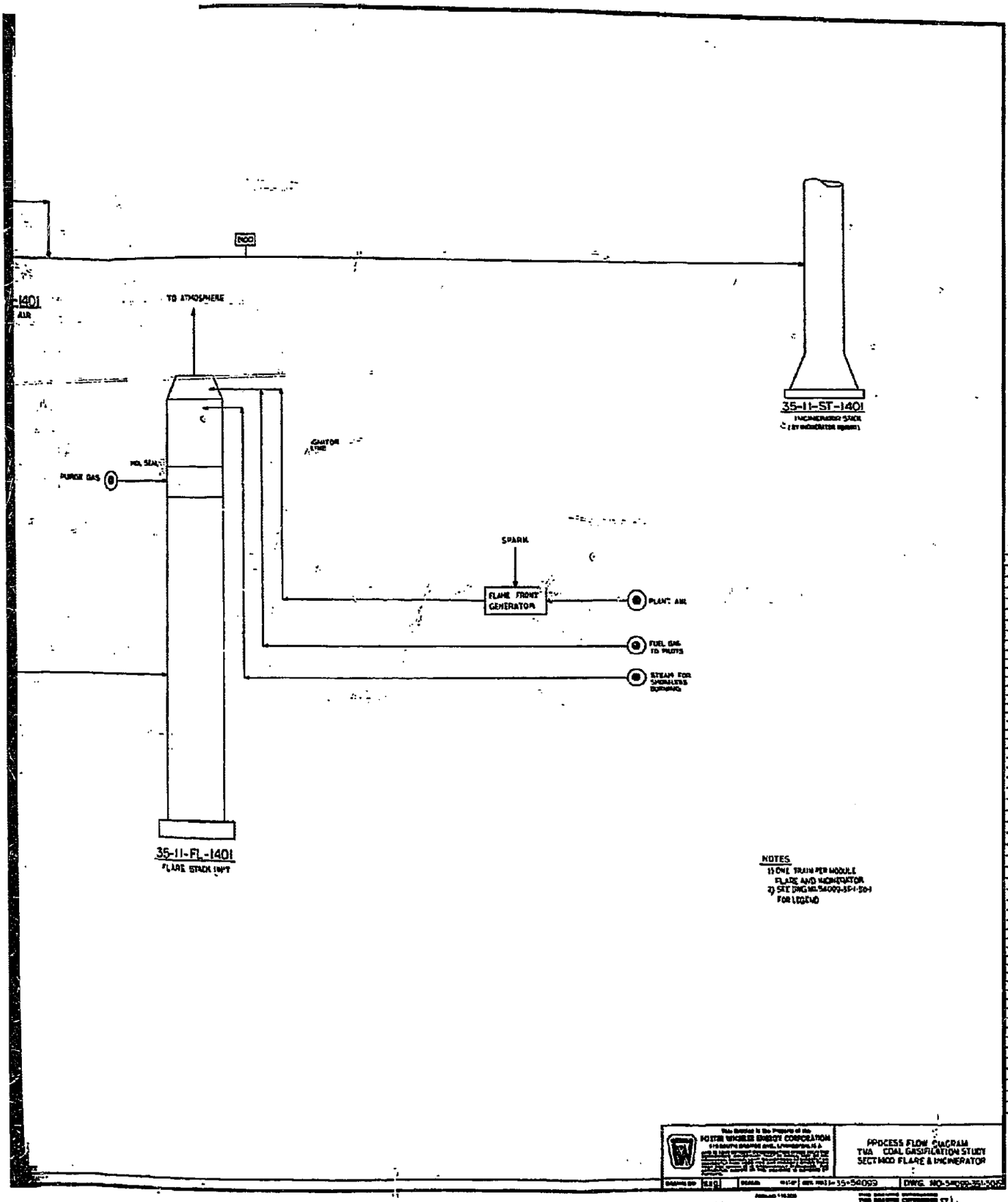
LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N NO.	No./Module	REV
INCINERATOR STACK						
35-11-	ST-1401	INCINERATOR STACK	19		1-100%	
BLOWER						
35-11-	B-1401 A/B	INCINERATOR BLOWER	19		2-100%	

FORM NO. 135-66D


FROM GASIFIER SECTION (1300)
DURING START-UP
AIR
35-11-B-1401A/B
INCINERATOR BLOWER
AUX. FUEL GAS
(MAINTENANCE USE)
35-11-H-1401
INCINERATOR
35-11-E-1401
INCINERATION AIR
PREHEATER
1500
TO ATMOSPHERE
PURGE GAS
INCINERATOR
LINE
100
WATER
35-11-D-1401
FLARE SEAL DRUM
80 PSIG STM
35-11-E-1402
SEAL DRUM HEATER
CONDENSATE
35-11-FL-1401
FLARE STACK UNIT
DRAIN TO DIRTY WATER



NOTES
1) ONE TRAIN PER MODULE FLARE AND INCINERATOR
2) SEE DWG. NO. 54009-351-SD-1 FOR LEGEND

POSTER WHEELER ENERGY CORPORATION

PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
SECTIONAL FLARE & INCINERATOR

DWG. NO. 54009-351-SD-5

TVA Coal Gasification Study
Texaco Gasifier Alternate

SECTION DESCRIPTION

3.11 SECTION 1500 - WASTE WATER TREATMENT

A. Reference Material:

. Process Flowsheet: FWEC Dwg. No. 54099-35-1-50-20

. 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. Cooling tower blowdown;
7. 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, 35-11-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

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. are collected in the Dirty Water Holding Basin, 35-11-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. 54099-35-1-50-20, 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

FOSTER WHEELER ENERGY CORP.
PROCESS PLANTS DIVISION

CONTRACT NO. 11-35-54099

EQUIPMENT LIST

SECTION 1500

TYPE OF UNIT WASTEWATER TREATMENT

CLIENT TVA (COAL GASIFICATION STUDY)

LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N NO.	No./Module	REV
FILTER						
35-11-	F-1501 A/B	COOLING TOWER BLOWDOWN SANDFILTER	20		2-100%	
TANKS						
35-11-	TK-1501	NEUTRALIZATION BASIN	20		1-100%	
-	TK-1502	LIME STORAGE TANK	20		1-100%	
-	TK-1503					
-	TK-1504	BACKWASH SUMP	20		1-100%	
CLARIFIER						
35-11-	CL-1501	LIME TREATMENT CLARIFIER	20		1-100%	

FORM NO. 135-66D

1 TRAIN FOR EACH MODULE

FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT NO. 11-35-54099	EQUIPMENT LIST	SECTION 1500	TYPE OF UNIT WASTEWATER TREATMENT	PAGE 2 OF 3

CLIENT TVA (COAL GASIFICATION STUDY) | REVISION | ORIGINAL | 1 | 2 | 3 | 4 | 5

LOCATION ALABAMA | DATE

CLASS	ITEM NO	DESCRIPTION	FD#	REQ'N.NO.	No./Module	REV
AERATOR						
35-11-	M-1501 A/B	DIRTY WATER AERATOR	20		2-100%	
PUMPS						
35-11-	1501A/B	DIRTY WATER LIFT PUMP	20		2-100%	
-	1502A/B	TREATED WASTEWATER PUMP	20		2-100%	
-	1503A/B	CLARIFIER SLUDGE PUMP	20		2-100%	
-	1504A/B	OUTFALL TRANSFER PUMP	20		2-100%	
-	1505A/B	TREATED C.T. EFFLUENT PUMP	20		2-100%	
-	1506A/B	BACKWASH SUMP PUMP	20		2-100%	
-	1507A/B	CLEAN WATER DISCHARGE PUMP	20		2-100%	

FORM NO. 135-66D

1 TRAIN FOR EACH MODULE

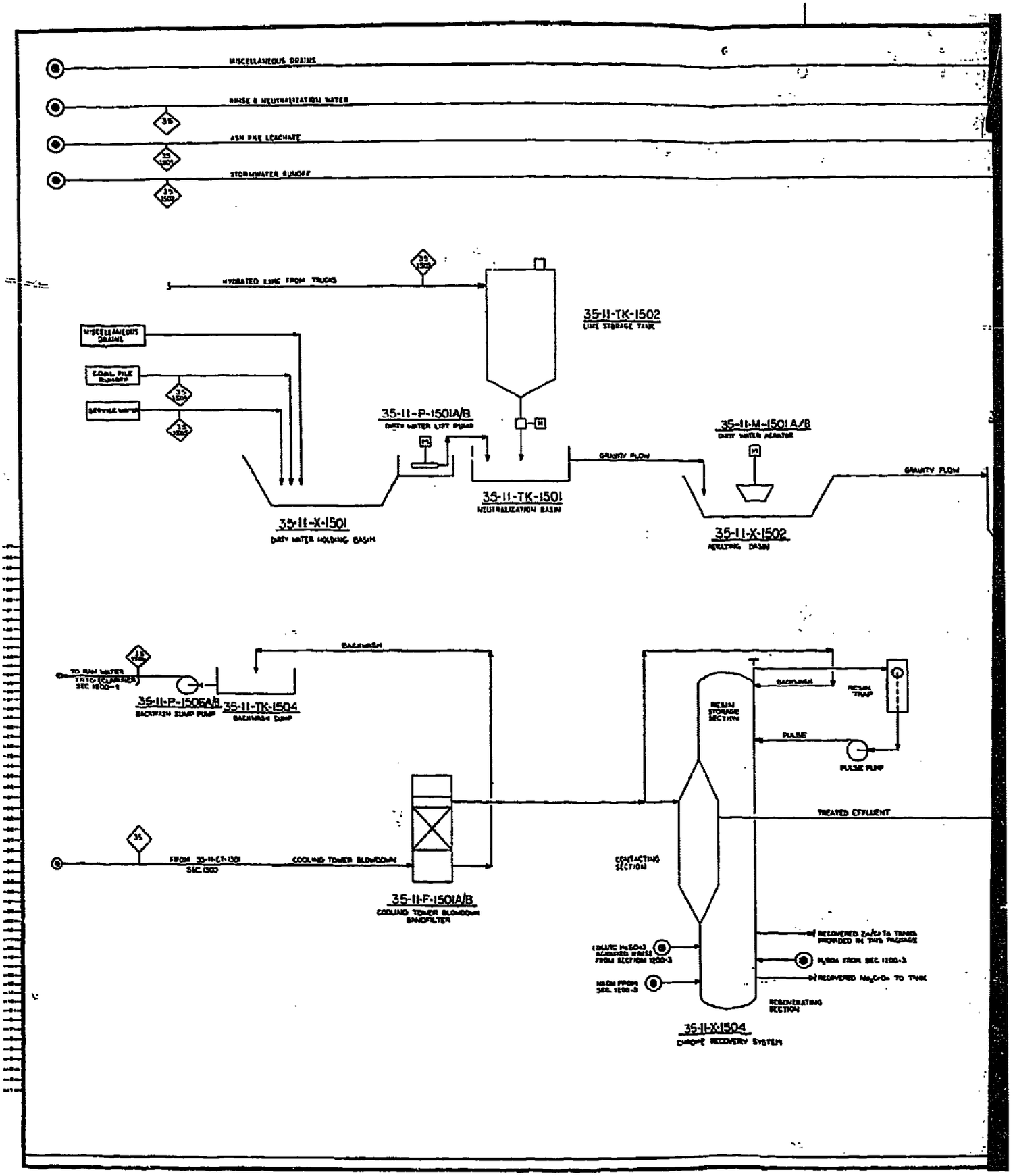
FOSTER WHEELER ENERGY CORP. PROCESS PLANTS DIVISION	CONTRACT NO. 11-35-54099	EQUIPMENT LIST	SECTION 1500	TYPE OF UNIT WASTEWATER TREATMENT	PAGE 3 OF 3

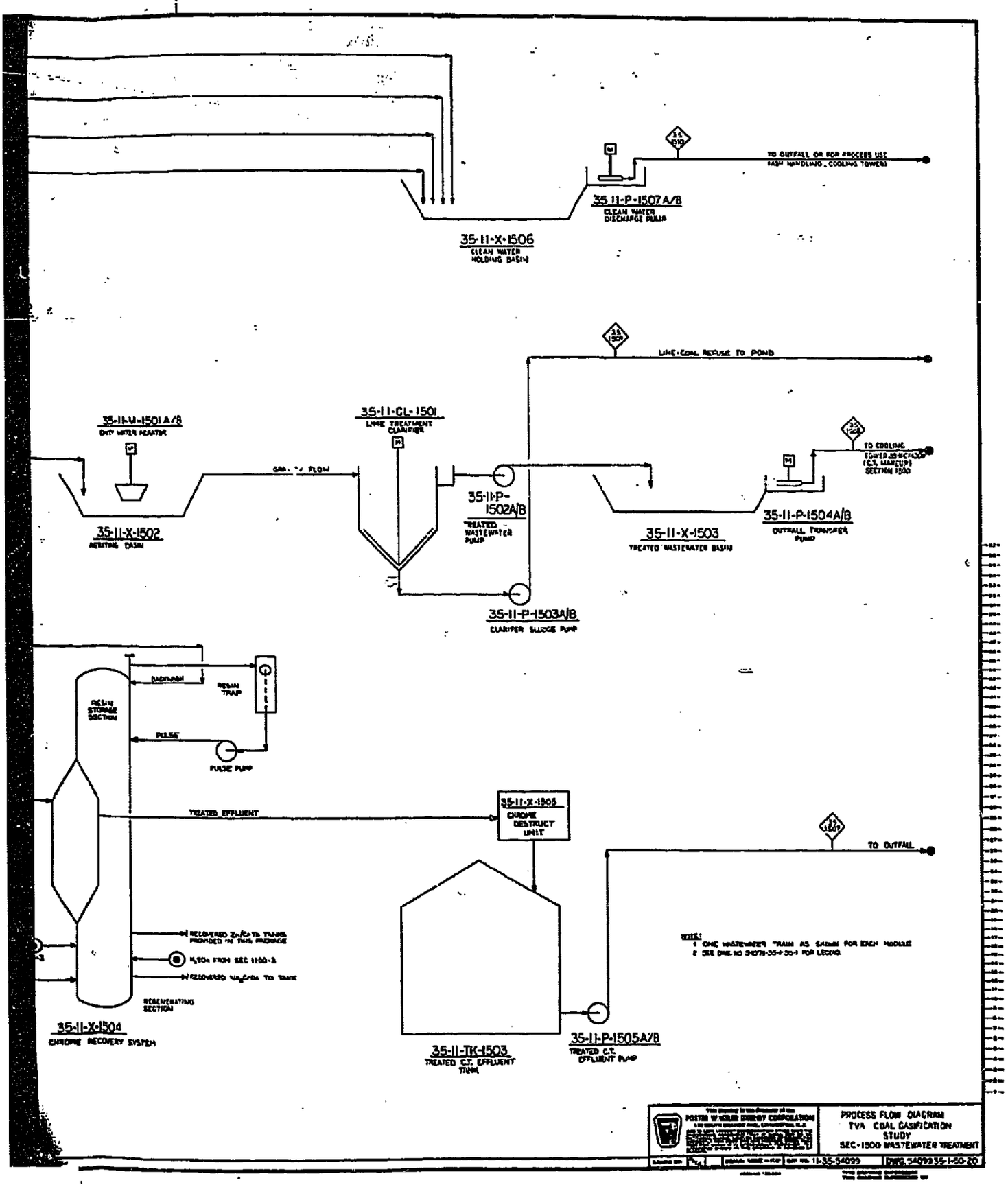
CLIENT TVA (COAL GASEFICATION STUDY)
LOCATION ALABAMA

REVISION	ORIGINAL	1	2	3	4	5
DATE						

CLASS	ITEM NO	DESCRIPTION	FOR	REQ'N NO.	No./Module	REV
MISCELLANEOUS						
35- 11-	X-1501	DIRTY WATER HOLDING	20		1-100%	
-	X-1502	AERATING BASIN	20		1-100%	
-	X-1503	TREATED WASTEWATER BASIN	20		1-100%	
-	X-1504	CHROME RECOVERY SYSTEM	20		1-100%	
-	X-1505	CHROME DESTRUCT UNIT	20		1-100%	
-	X-1506	CLEAN WATER HOLDING BASIN	20		1-100%	

FORM NO. 135-66D


MISCELLANEOUS DRAINS
RINSE & NEUTRALIZATION WATER
ASH PILE LEACHATE
STORMWATER RUNOFF
HYDRATED LIME FROM TRUCKS
35-11-TK-1502
LIME STORAGE TANK
MISCELLANEOUS DRAINS
COAL PILE RUNOFF
35-11-P-1501A/B
DIRTY WATER LIFT PUMP
35-11-M-1501A/B
DIRTY WATER AERATOR
GRAVITY FLOW
GRAVITY FLOW
35-11-TK-1501
NEUTRALIZATION BASIN
35-11-X-1501
DIRTY WATER HOLDING BASIN
35-11-X-1502
AERATING BASIN
BACKWASH
TO RAW WATER INTO CLARIFIER SEC 1600-1
35-11-P-1505A/B
BACKWASH SUMP PUMP
35-11-TK-1504
BACKWASH SUMP
BACKWASH
RESIN TRAP
RESIN STORAGE SECTION
PULSE
PULSE PUMP
TREATED EFFLUENT
FROM 35-11-CT-1501 SEC 1500
COOLING TOWER BLOWDOWN
CONTACTING SECTION
35-11-F-1501A/B
COOLING TOWER BLOWDOWN SANDFILTER
RECOVERED Zn/Cr TO TANKS PROVIDED IN THIS PACKAGE
RECOVERED Mg2CrO4 TO TANK
REGENERATING SECTION
35-11-X-1504
CHROME RECOVERY SYSTEM


35-11-X-1506
CLEAN WATER HOLDING BASIN
35-11-P-1507A/B
CLEAN WATER DISCHARGE PUMP
TO OUTFALL OR FOR PROCESS USE
LIME-COAL REFUSE TO POND
35-11-M-1501A/B
35-11-CL-1501
LIME TREATMENT CLARIFIER
35-11-P-1502A/B
TREATED WASTEWATER PUMP
35-11-X-1502
AERATING BASIN
35-11-X-1503
TREATED WASTEWATER BASIN
35-11-P-1504A/B
OUTFALL TRANSFER PUMP
35-11-P-1503A/B
CLARIFIER SLUDGE PUMP
RESIN STORAGE SECTION
DIAPHRAM
RESIN TRAP
PULSE
PULSE PUMP
TREATED EFFLUENT
35-11-X-1505
CHROME DESTRUCT UNIT
TO OUTFALL
RECOVERED Zn/Fe TO TANKS PROVIDED IN TANK FARMAGE
H2SO4 FROM SEC 1550-3
RECOVERED NaOH/Fe(OH)3 TO TANK
REGENERATING SECTION
35-11-X-1504
CHROME RECOVERY SYSTEM
35-11-TK-1503
TREATED C.T. EFFLUENT TANK
35-11-P-1505A/B
TREATED C.T. EFFLUENT PUMP
NOTES:
1 ONE WASTEWATER TRAIN AS SHOWN FOR EACH MODULE
2 SEE DWG. NO 240Y9-35-1-20-1 FOR LEGEND
POSTER WHEELER ENERGY CORPORATION
PROCESS FLOW DIAGRAM
TVA COAL GASIFICATION
STUDY
SEC-1500 WASTEWATER TREATMENT
DWG. 5409935-1-50-20

TVA Coal Gasification Study
Texaco Gasifiers

SECTION DESCRIPTION

3.12 SECTION 2000 - GENERAL FACILITIES

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

Ash and Slag 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 slope 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 from the Texaco gasifiers and flyash and spent bed materials from auxiliary fluidized bed superheaters, are expected to have a chemical compositon and resulting physical properties resembling irregularly shaped glass beads. The foregoing may render the slag possolanic when reacted with lime in the presence of moisture. In any event, either the slag in its natural state, or with the addition of lime, would be hospitable to supporting root systems for plant growth. Ultimately, such vegetation would be an effective means for stabilizing both the surface of the slag pile as well as the perimeter.

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. A relatively high iron oxide content in the ash/slag would indicate an acidic leachate. In any event, none of the chemical constituents of the ash indicated in the Design Criteria appear as toxic materials which could leach into water ultimately destined for consumption by humans, fish or animals. Elsewhere, it has been reported, however, that flyash normally contains a variety of toxic elements in trace amounts which could leach into the soil and, ultimately, into 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 ash. The presence of toxic elements and the possible attenuating properties of the soil from the proposed plant site of Murphy Hill should be determined.

By-products and Chemicals Storage

A 14-day supply of limestone for the fluidized bed steam superheaters is provided.

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.

A variety of 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 indicated in the succeeding section 2. Plant Requirements.

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)
- U.S. Bureau of Mines
- 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 30 MVA, 138/13.8 KV intertie with the TVA power grid will be provided to supply power.

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 power 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 on the following basis:

  Motors 250 HP to 5,000 HP; 416 V, 3 phase, 3 wire

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

  Motors below ½ HP; single phase, 2 wire

  Lighting & Instrument branch circuit; 120 V, single phase.

5. Electrical Equipment

In general, electrical equipment and wiring materials are furnished as required by Article 500 of 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)

In non-hazardous locations, equipment enclosures are dictated by dust and moisture or corrosive conditions of the location. The minimum enclosure for electrical apparatus is NEMA, Type 1.

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 416 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. All rigid conduit will be hot-dipped galvanized steel or PVC (polyvinyl chloride).

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 Considerations (TVA Design Criteria).

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

Road and fence lighting will be provided, using mercury vapor lighting fixtures mounted on poles and incandescent fixtures for fence lighting whenever road/fence layout does not allow the use of a combined lighting system.

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
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SECTION DESCRIPTION

3.13 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 accord 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