TVA / OGM / CG-81 / 9

TVA COAL-GASIFICATION

COMMERCIAL DEMONSTRATION PLANT PROJECT

VOLUME 1

PLANT BASED ON

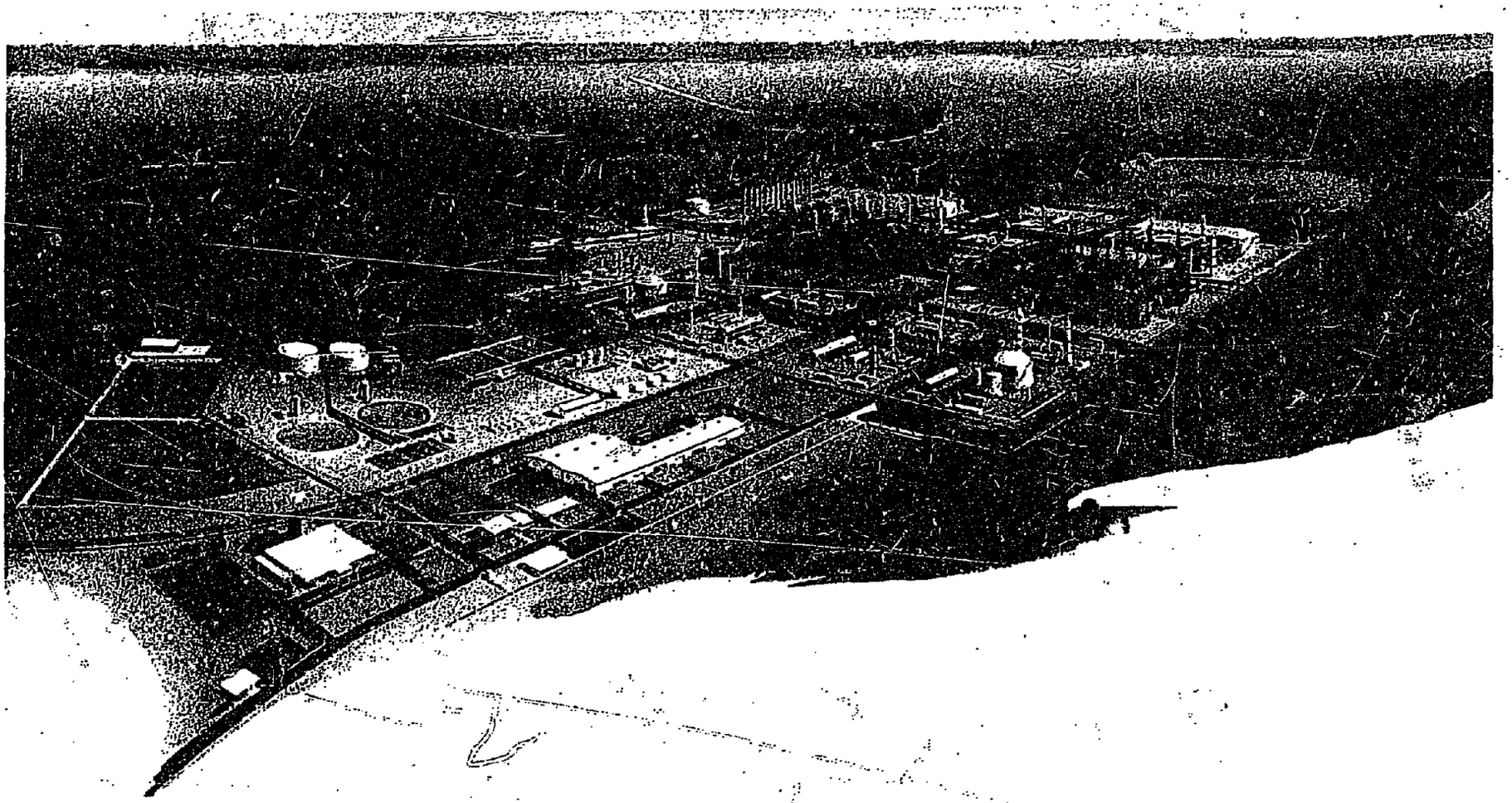
EXECUTIVE OVERVIEW (SUMMARY)

FINAL REPORT
November 1, 1980

Foster Wheeler Energy Corporation

110 South Orange Avenue, Livingston, New Jersey

PROCESS PLANTS DIVISION



CONCEPTUAL DESIGN
OF
TVA COAL GASIFICATION DEMONSTRATION PLANT
MURPHY HILL, ALABAMA
BY
FOSTER WHEELER ENERGY CORPORATION

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TVA COAL GASIFICATION COMMERCIAL DEMONSTRATION PLANT STUDY

Outline of Final Report

Volume 1	Executive Overview
Volume 2	Basis of Study, Assessments and Process Selection
Volume 3	Plant Based on Lurgi Dry Ash Gasifier
Volume 4	Plant Based on B & W Gasifier
Volume 5	Plant Based on K-T Gasifier
Volume 6	Plant Based on Texaco Gasifier
Volume 7	Plant Based on BGC/Lurgi Slagging Gasifier

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Volume I
Executive Overview

1.0 INTRODUCTION

SECTION 1.0
INTRODUCTION

TVA plans to build a coal gasification plant to demonstrate the operation of a commercial scale coal gasification facility producing a clean medium BTU gas (MBG) for use in various industrial applications in the TVA region. The project is intended to play a key role in effecting this nation's shift from oil and natural gas to coal, by demonstrating how to overcome the economic, technical and environmental problems associated with a large scale coal conversion facility. The facility is also intended to provide area industry with a secure source of clean fuel and feedstock, and assist in the development of national and regional resources.

The overall project plan consists of five phases, including:

Phase I - Conceptual Design, Environmental and Siting Studies

Phase II - Overall Plant Design and Environmental Statement

Phase III - First Module: Design, Construction and Start-Up

Phase IV - Subsequent Modules: Design, Construction and Start-Up

Phase V - Commercial Operation

In the Phase I efforts, Foster Wheeler Energy Corporation prepared conceptual designs, cost estimates, and trade-off studies of the following gasification systems:

1. Lurgi Dry Bottom
2. Koppers-Totzek
3. Babcock & Wilcox
4. British Gas Slagger
5. Texaco

The results of the Phase I studies will enable TVA to select the preferred gasification and processing schemes to be employed in the gasification plant.

2.0 SUMMARY OF RESULTS

SECTION 2.0
SUMMARY OF RESULTS

Table I presents the main comparison factors for each gasification plant case. The basis of design is 5000 T/D coal feed to the gasifiers in each module, and four (4) modules are included for each plant (20,000 T/D total). In the Lurgi and BGC cases, the coal feed is not dried and, therefore, the 20,000 T/D amount includes 9% moisture. In the K-T and B & W cases, the coal is pulverized and dried, so the 20,000 T/D feed includes only about 2% moisture. Therefore, a greater amount of as-received coal is required in order to deliver 20,000 T/D (4 modules) of coal feed to the K-T and B & W gasifiers.

The Texaco gasifiers use a water/coal slurry feed and the maximum input to each module is 4800 T/D on a dry basis. It was not possible to levelize the coal feed to 5000 T/D (dry basis) without adding more gasifiers. In any event, these variations do not have a significant effect on the investment or gas costs.

The plant investment costs summarized in Table I are in 1980 dollars. The indicated cost differences may not be significant because of the accuracy of the estimating procedures used. +30% -15%.

Estimated capital investment and product gas costs for the five gasification cases are compared on the following relative basis:

Case	Relative Total Capital Investment	Relative MBG Cost
BGC	1.00	1.06
Texaco	1.01	1.00
Babcock & Wilcox	1.02	1.05
Koppers Totzek	1.09	1.24
Lurgi Dry Ash	1.15	1.12

The relative product gas costs were based on an engineering-type levelized cost analysis with no credit given to by-products, except excess coal fines. Sensitivity of the estimated gas costs was determined for several operating parameters as summarized in Table II.

Specifications of the medium Btu fuel gas product (MBG) produced by the five commercial plant designs are summarized below. The heat recovery factor is a measure of the plant's overall efficiency calculated via the relationship:

$$HRF = \frac{\text{HHV Gas Product}}{\text{HHV Coal Feed \& Electric Power}} \times 100$$

Process		K-T	Texaco	B & W	Lurgi	BGC
MBG Composition Vol. %	H_2	29.02	37.51	30.27	44.9	26.8
	CO	64.33	50.04	62.41	19.3	61.1
	CO_2	4.49	10.73	3.93	24.1	4.8
	CH_4	0.10	0.32	0.00	10.6	6.4
	C_2 +	-	-	-	0.5	0.2
	N_2 + Ar	2.05	1.39	3.38	0.6	0.7
	H_2O	0.01	0.01	0.01	-	-
		100.00	100.00	100.00	100.0	100.0
Sulfur Content, ppmv		< 200	130	130	200	200
HHV, Btu/SCF		302	286	299	324	348
Delivered @ psig		600	610	600	600	600
^oF		120	92	120	120	120
Heat Recovery Factor		61.3	70.2	69.6	63.6	68.1

TABLE I

TVA COAL GASIFICATION PROJECT
COMPARISON OF COMMERCIAL PLANTS

GASIFIER TYPE	LURGI	BGC	K - T	B & W	TEXACO
Coal, Feed, TPD (1)					
Gasification	20,000	20,000	22,116	21,672	21,230
Boiler	5,260	2,350	1,820	888	1,340
Excess Fines	1,260	4,170			
Total	26,520	26,520	23,936	22,560	22,570
Oxygen, TPD @98%	9,000	9,400	17,624	16,800	17,696
Product Gas, MMSCFD	1,104	973	1,140	1,204	1,235
MMMBTU/D	358	338	344	360	353
HHV, BTU/SCF	324	348	302	299	286
By-Products					
Sulfur, LTPD	837	810	740	708	752
Ammonia, TPD	252	57	0	0	0
Phenols, TPD	103	81	0	0	0
Oil, BPD	1,500	1,830	0	0	0
Naphtha, BPD	2,275	1,351	0	0	0
Coal Fines, TPD (1)	1,260	4,170	0	0	0
Electric Power, MW	95	76	434	257	115
Raw Water, MGPM	14.6	15	16.9	16.0	24.4
Cat/Chem Cost MM$/Yr	12.7	12.6	13.6	3.2	5.8
Installed Plant Cost MM$ (1980)					
Processing	943.1	800.9	1,153.4	1,200.2	1,070.1
Offsites	670.8	595.2	348.1	234.2	351.5
Spare Parts	25.3	24.0	23.1	24.0	21.3
Site Prep	15.4	9.9	10.0	10.6	9.9
Contingency	284.4	214.5	230.4	220.0	216.7
Total	1,903.0	1,644.5	1,765.0	1,689.0	1,669.5
Total Investment MM$ (1980)	2,099.8	1,827.3	1,987.0	1,859.6	1,838.6

(1) As Received

TABLE II

SENSITIVITY ANALYSIS
VARIATIONS IN LEVELIZED GAS COST

ITEM	LURGI	B & W	BGC	K-T	TEXACO
Base Case	1.0	1.0	1.0	1.0	1.0
Coal Cost + 50%	1.22	1.20	1.22	1.19	1.22
Plant Cost + 25%	1.08	1.07	1.08	1.07	1.08
Operating Cost + 50%	1.11	1.13	1.11	1.15	1.11
Plant Service Factor @ 80%	1.06	1.06	1.06	1.06	1.06
70%	1.15	1.14	1.14	1.13	1.15
60%	1.26	1.25	1.25	1.23	1.26
By-Product Credit	0.86	0.96	0.87	0.97	0.96
Schedule @ + 1 year	1.09	1.08	1.08	1.08	1.08
- 1 year	0.93	0.92	0.92	0.92	0.92
Plant Life @ + 5 years	1.05	1.04	1.04	1.05	1.04
+ 10 years	1.09	1.09	1.09	1.10	1.08
Sulphur @ 1.0 ppm	1.01	1.02	1.01	1.02	1.02
Delivery Pressure @ 800 psig	1.01	1.02	1.01	1.01	1.00

3.0 DESCRIPTION OF ALTERNATES

SECTION 3.0
DESCRIPTION OF ALTERNATES

3.1 Block Flow Diagrams

Process Block Flow Diagrams are included in this section to describe the processing scheme for each alternate. Further details may be found in the separate volumes for each gasification system.

3.2 Coal Handling and Preparation

Docking facilities for 24 loaded coal barges will be provided along with a barge unloading unit of 5000 - 6000 T/H. Ninety (90) days of dead coal storage are planned, as well as fifty-six (56) hours of enclosed coal live silo storage which will be installed for the feed system to the preparation area.

Sized coal (1/8" x 2") is required for the Lurgi and British Gas gasifiers. This creates a supply of fines which are used in the boilers for steam generation, and a certain amount is available for outside sales. Pulverized coal is necessary for the operation of the entrained flow gasifiers, namely, K-T, B & W and Texaco. The K-T and B & W gasifiers also require dry coal.

3.3 Air Separation Plant

Standard plants to produce 98% pure oxygen are readily available to produce the required amount of oxidant. Liquid and gaseous oxygen storage are provided to insure a continuous supply of oxygen in case of an air plant failure. The nitrogen is used as a purge gas, as required, for in-plant use.

3.3 Air Separation Plant (cont'd)

The design capacities and number of air separation trains per module for the five alternate cases are:

Case	Lurgi	K-T	B & W	Texaco	BGC
No. of Trains	1	2	2	2	1
Train Capacity TPD 98% O$_2$	2350	2300	2200	2200	2500

3.4 Gasification

The number and type of gasifiers per module for each alternate are as follows:

Licensor	Type	Operating	Spare
Lurgi	Moving Fixed Bed	7	1
K-T	Entrained Flow	8	2
B & W	Entrained Flow	2	2
BGC	Moving Fixed Bed (Slagger)	6	2
Texaco	Entrained Flow	3	2

3.5 Slag and/or Ash Handling

Slag is produced in K-T, B & W, BGC and Texaco gasifiers while ash is made in the Lurgi and K-T systems. Standard water handling systems are readily available from vendors to the boiler industry. The slag and ash are inert materials which can be stored on site.

3.6 Acid Gas Removal

The Rectisol process is used for the Lurgi and BGC systems, and the Selexol process is proposed for the remaining alternates. Since Lurgi and BGC produce additional waste products, facilities are required for Gas Liquor Separation, Phenol Recovery and Ammonia Recovery.

3.7 Sulfur Recovery

In each case, primary sulfur recovery from acid gas streams was accomplished in standard Claus units. Tail gas from the Claus plants was further processed in Beavon Sulfur Recovery Units to minimize sulfur emissions vented to atmosphere. However, for the plant designs involving the Lurgi dry ash gasifier and the BGC slagging gasifier, the Claus unit tail gas is incinerated in the coal-fired steam generators which are equipped with Wellman Lord FGD units to recover sulfur dioxide. Recovered SO_2 is returned to the Claus plants for conversion to elemental sulfur. The sulfur product is prilled to make 700 - 800 T/D of solid product.

3.8 Gas Compression

The medium Btu gas must be compressed to 600 psig for delivery to the pipeline. The amount of compression depends on the gasifier pressure. The maximum amount is required for K-T, since this gasifier operates at atmospheric pressure, while no compression step is required for the high pressure Texaco gasifier.

The gasifier operating pressures are as follows:

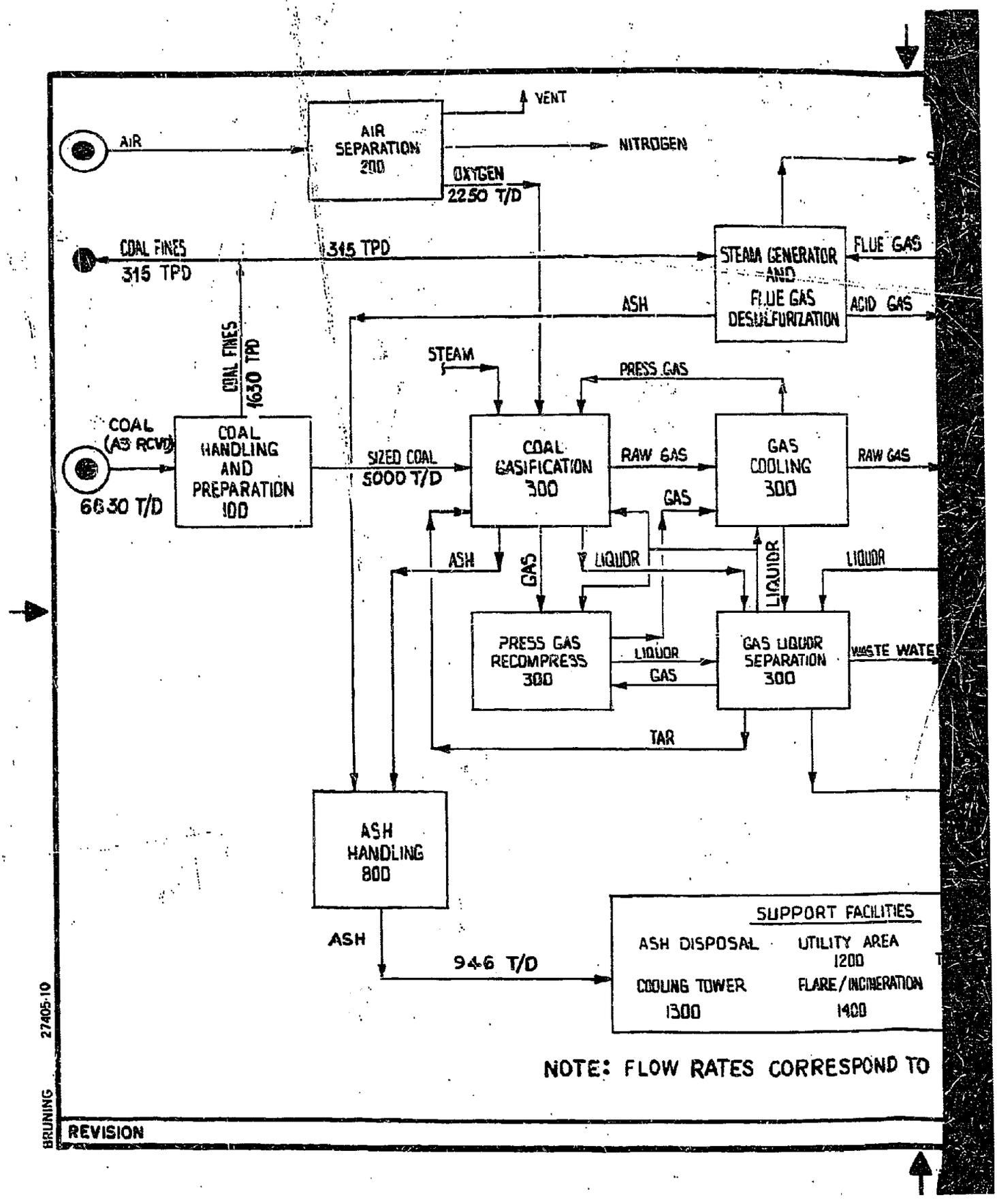
	Psig
Lurgi	450
K-T	0
B & W	225
BGC	450
Texaco	680

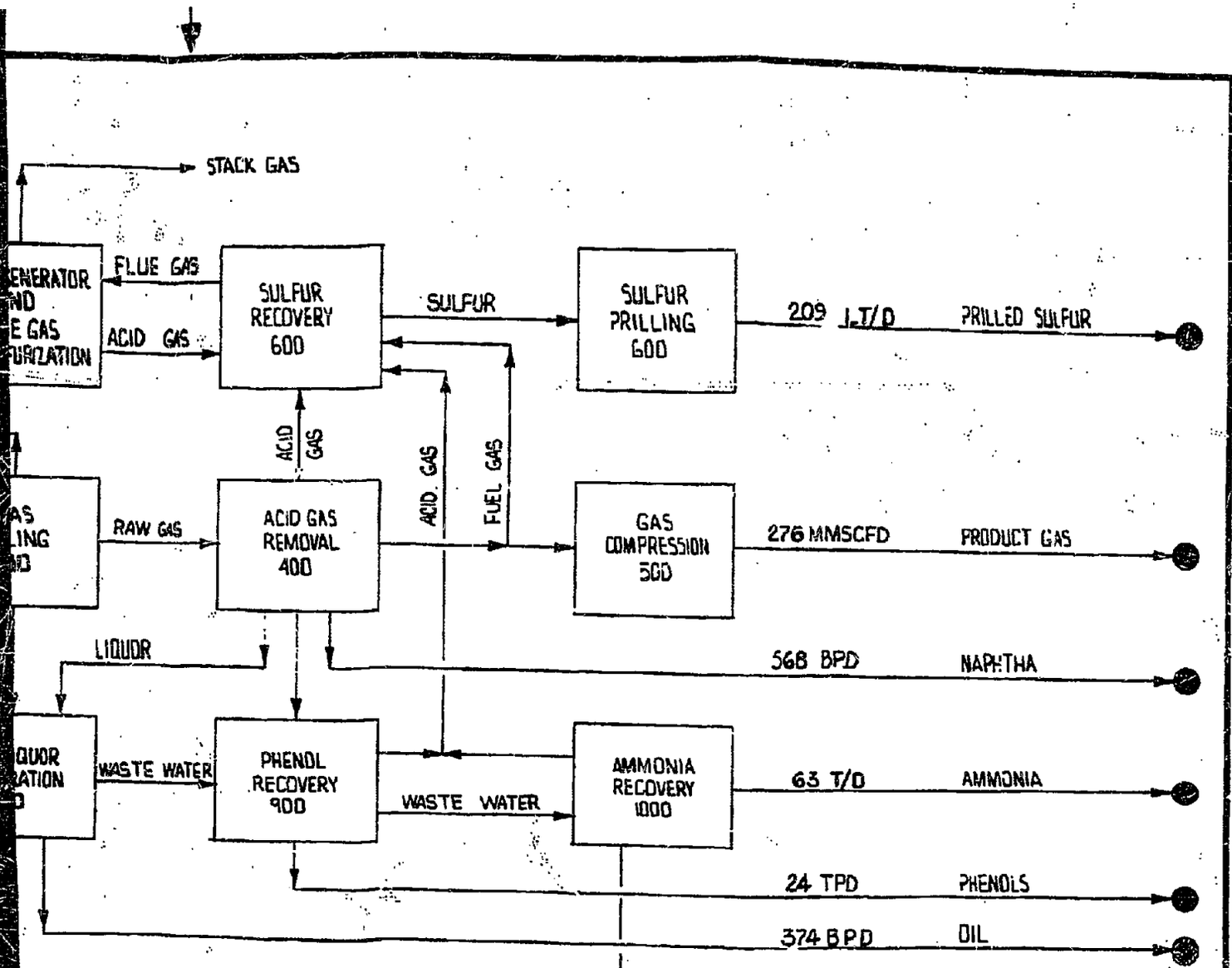
3.9 Support Facilities

The normal support facilities are required for each case. The sizes vary according to the utility loads.

3.9 Support Facilities (cont'd)

These facilities include steam generation, water treatment, cooling water, power, air, interconnecting piping, roads and fences, firewater, lighting and communications, sewers, waste water treatment, flare and incinerator, buildings and loading and unloading facilities.


AIR
AIR SEPARATION 200
VENT
NITROGEN
OXYGEN 2250 T/D
COAL FINES 315 TPD
315 TPD
STEAM GENERATOR AND FLUE GAS DESULFURIZATION
FLUE GAS
ACID GAS
ASH
COAL FINES 1630 TPD
STEAM
PRESS GAS
COAL (AS RCVD)
6630 T/D
COAL HANDLING AND PREPARATION 100
SIZED COAL 5000 T/D
COAL GASIFICATION 300
RAW GAS
GAS COOLING 300
RAW GAS
GAS
ASH
GAS
LIQUOR
LIQUOR
LIQUOR
PRESS GAS RECOMPRESS 300
LIQUOR
GAS
GAS LIQUOR SEPARATION 300
WASTE WATE
TAR
ASH HANDLING 800
ASH
946 T/D
SUPPORT FACILITIES
ASH DISPOSAL
UTILITY AREA 1200
COOLING TOWER 1300
FLARE/INCINERATION 1400
NOTE: FLOW RATES CORRESPOND TO
BRUNING
27405-10
REVISION



PROCESS BLOCK FLOW DIAGRAM
TVA COAL GASIFICATION STUDY
LURGI DRY ASH GASIFIER

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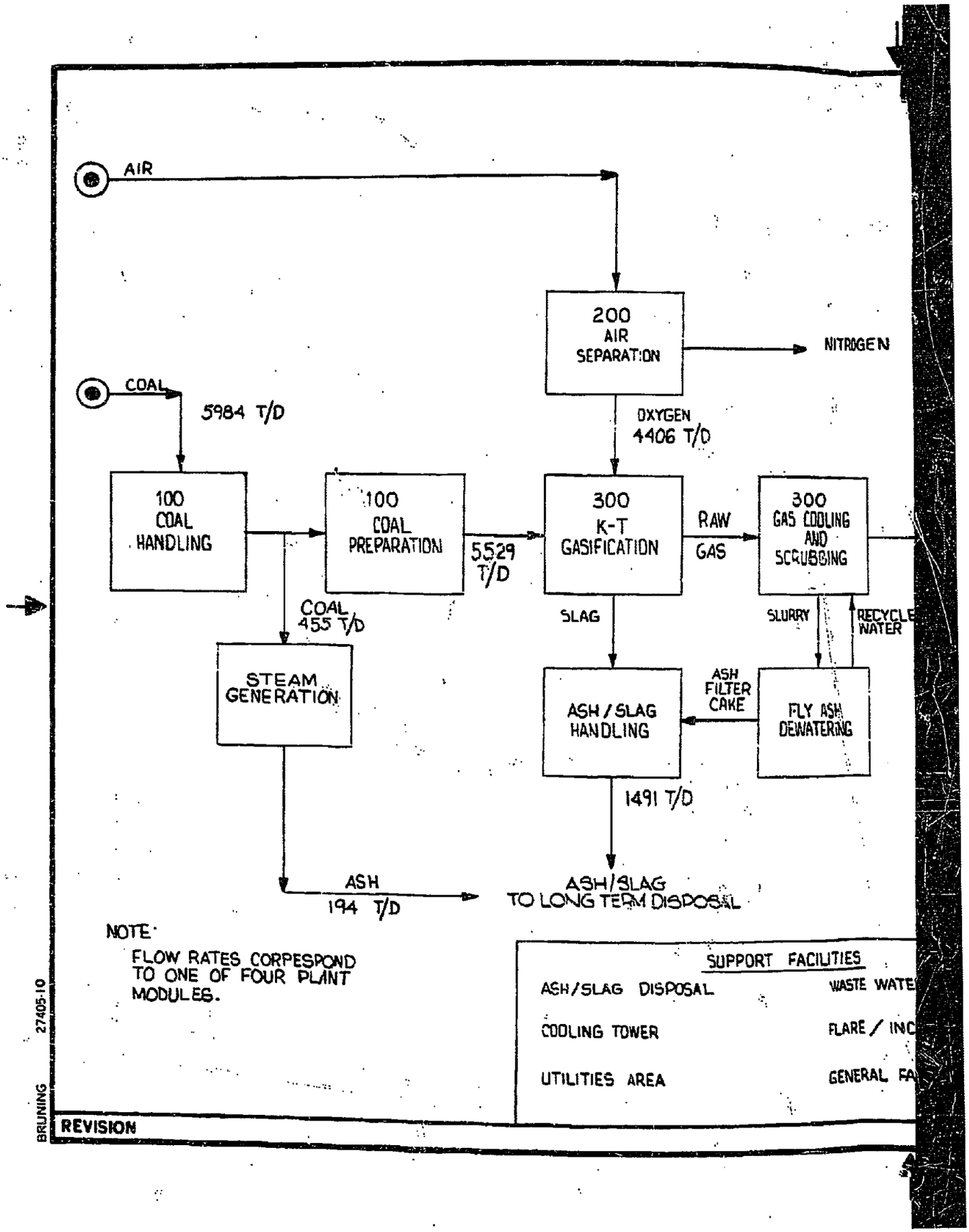
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200
AIR
SEPARATION
NITROGEN
COAL
5984 T/D
OXYGEN
4406 T/D
100
COAL
HANDLING
100
COAL
PREPARATION
5529
T/D
300
K-T
GASIFICATION
RAW
GAS
300
GAS COOLING
AND
SCRUBBING
COAL
455 T/D
SLAG
SLURRY
RECYCLE
WATER
STEAM
GENERATION
ASH
FILTER
CAKE
ASH / SLAG
HANDLING
FLY ASH
DEWATERING
1491 T/D
ASH
194 T/D
ASH/SLAG
TO LONG TERM DISPOSAL
NOTE:
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TO ONE OF FOUR PLANT
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SUPPORT FACILITIES
ASH/SLAG DISPOSAL
WASTE WATE
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FLARE / INC
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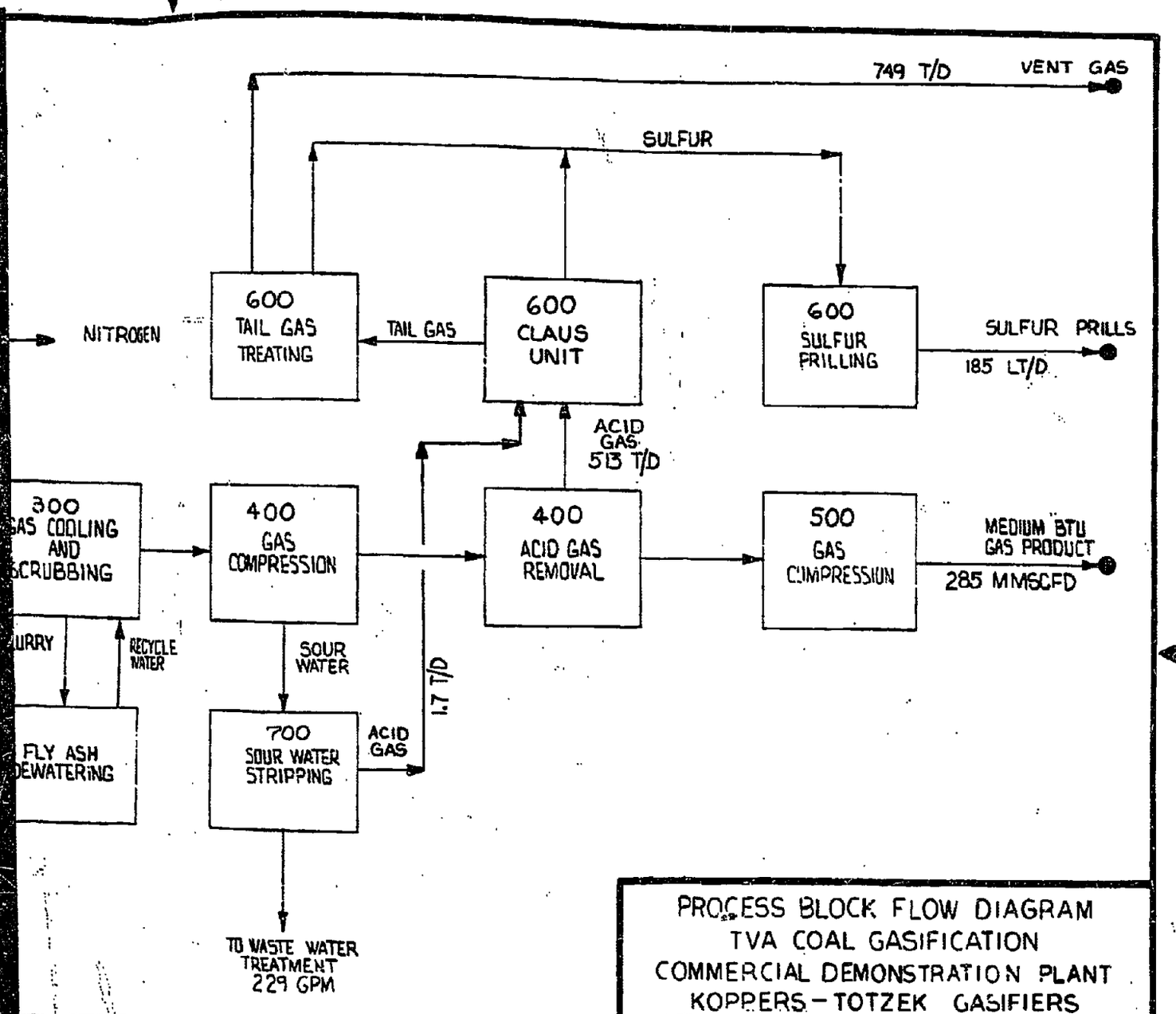

FACILITIES

WASTE WATER TREATING

FLARE / INCINERATION

GENERAL FACILITIES

PROCESS BLOCK FLOW DIAGRAM
TVA COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
KOPPERS – TOTZEK GASIFIERS

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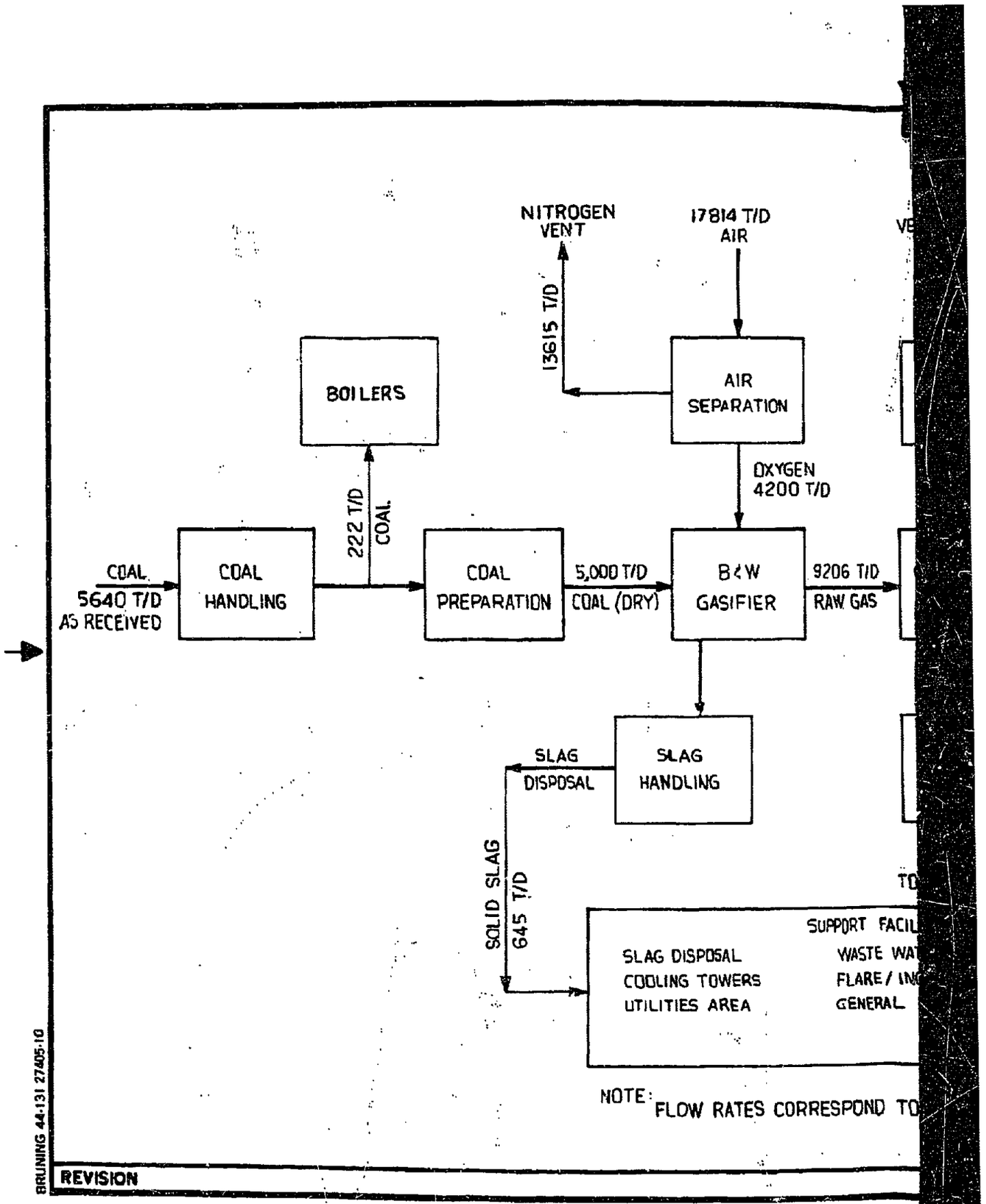
NITROGEN VENT
17814 T/D AIR
13615 T/D
BOILERS
AIR SEPARATION
OXYGEN 4200 T/D
222 T/D COAL
COAL 5640 T/D AS RECEIVED
COAL HANDLING
COAL PREPARATION
5,000 T/D COAL (DRY)
B&W GASIFIER
9206 T/D RAW GAS
SLAG DISPOSAL
SLAG HANDLING
SOLID SLAG 645 T/D
SLAG DISPOSAL
COOLING TOWERS
UTILITIES AREA
SUPPORT FACIL
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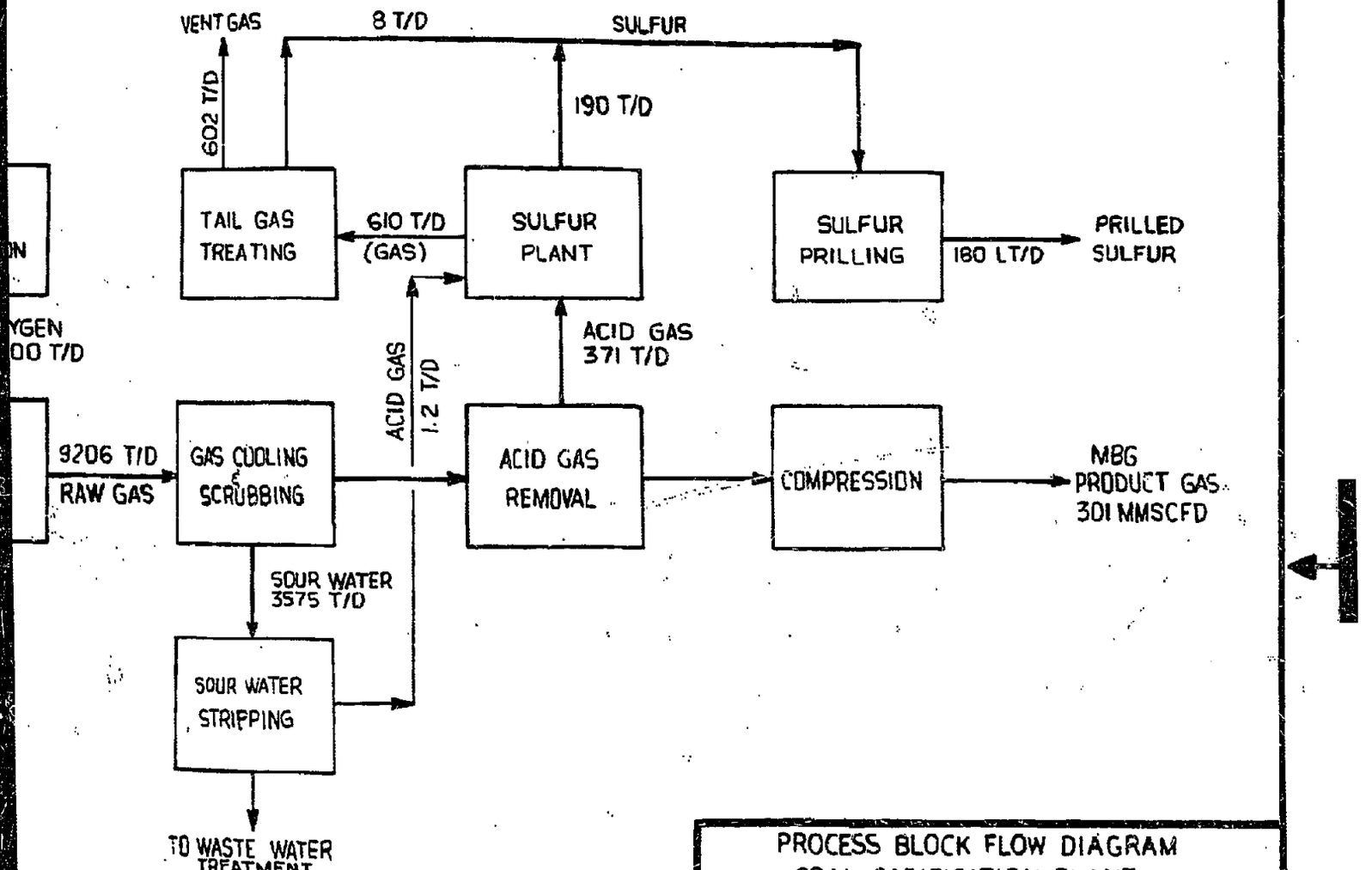

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COAL GASIFICATION PLANT
B&W GASIFIER
TVA PROJECT

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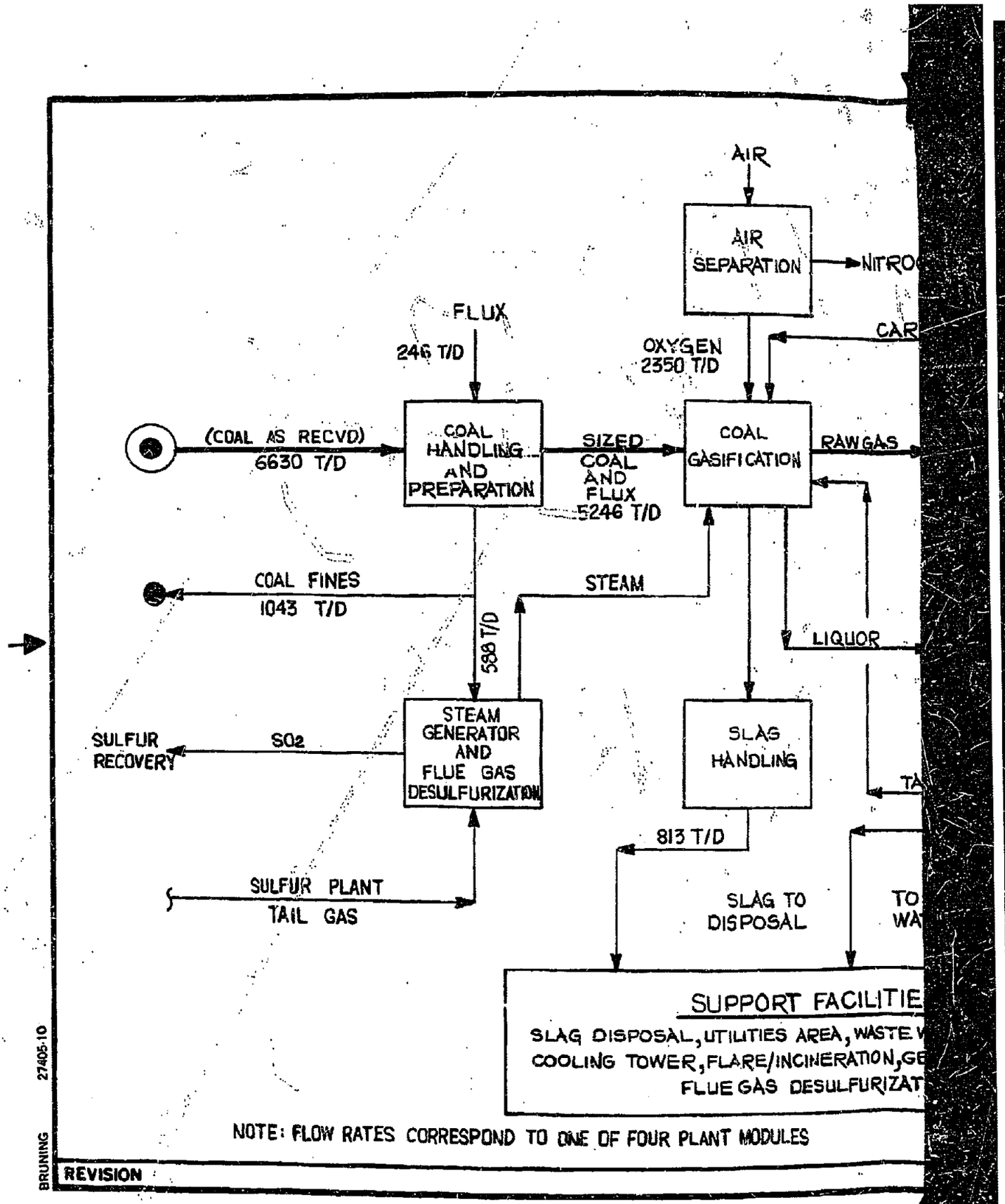
AIR
AIR SEPARATION
NITRO
FLUX
246 T/D
CAR
OXYGEN
2350 T/D
(COAL AS RECVD)
6630 T/D
COAL HANDLING AND PREPARATION
SIZED COAL AND FLUX
5246 T/D
COAL GASIFICATION
RAW GAS
COAL FINES
1043 T/D
STEAM
586 T/D
LIQUOR
STEAM GENERATOR AND FLUE GAS DESULFURIZATION
SULFUR RECOVERY
SO2
SLAG HANDLING
813 T/D
SULFUR PLANT TAIL GAS
SLAG TO DISPOSAL
SUPPORT FACILITIE
SLAG DISPOSAL, UTILITIES AREA, WASTE
COOLING TOWER, FLARE/INCINERATION, GE
FLUE GAS DESULFURIZAT
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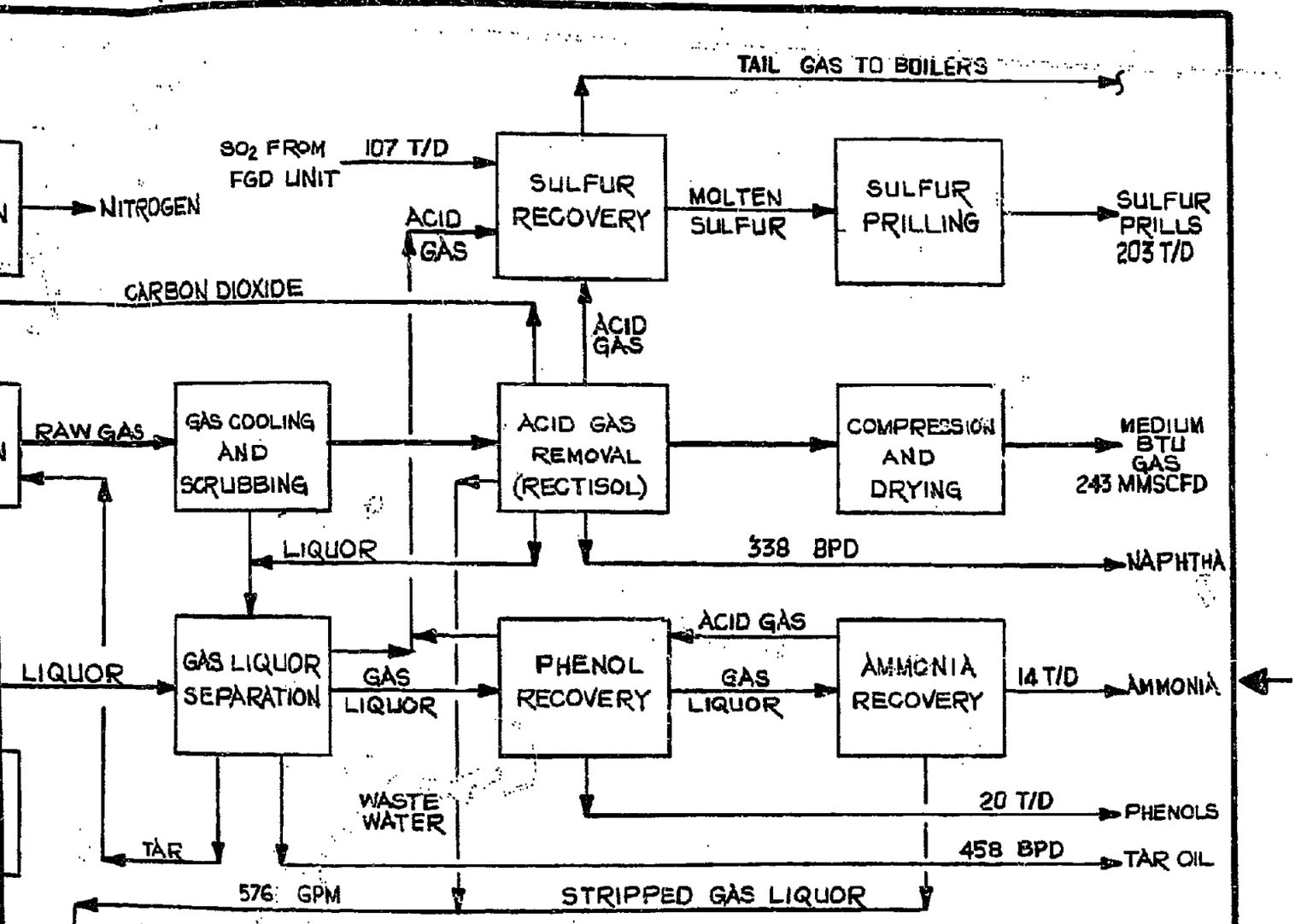

FACILITIES

REA, WASTE WATER TREATING
INERATION, GENERAL FACILITIES
ESULFURIZATION

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PROCESS BLOCK FLOW DIAGRAM
COAL GASIFICATION PLANT
BGC/LURGI SLAGGING GASIFIER
TVA PROJECT

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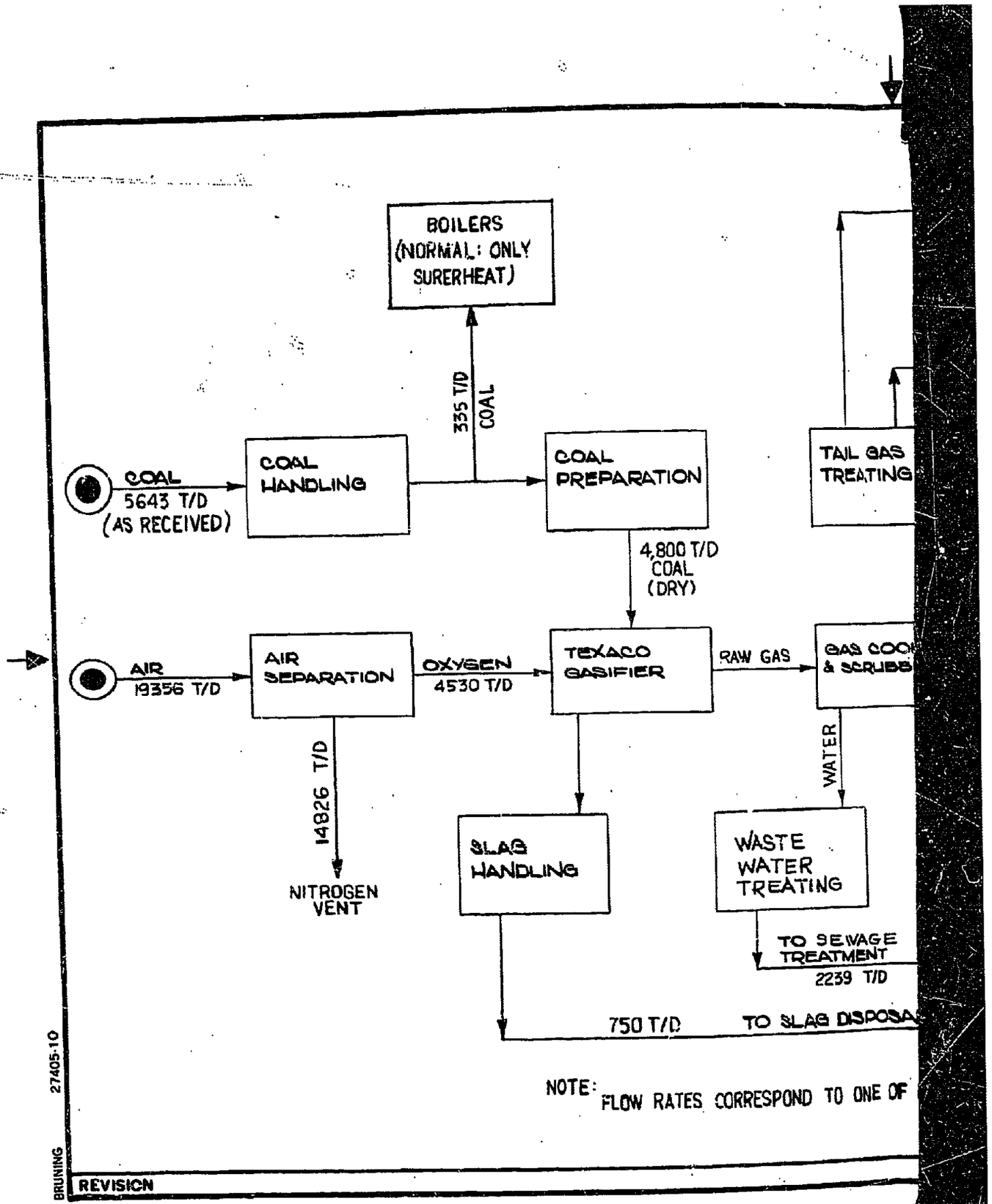
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(NORMAL: ONLY
SUPERHEAT)
335 T/D
COAL
COAL
5643 T/D
(AS RECEIVED)
COAL
HANDLING
COAL
PREPARATION
TAIL GAS
TREATING
4,800 T/D
COAL
(DRY)
AIR
19356 T/D
AIR
SEPARATION
OXYGEN
4530 T/D
TEXACO
GASIFIER
RAW GAS
GAS COOL
& SCRUBB
WATER
14826 T/D
NITROGEN
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SLAG
HANDLING
WASTE
WATER
TREATING
TO SEWAGE
TREATMENT
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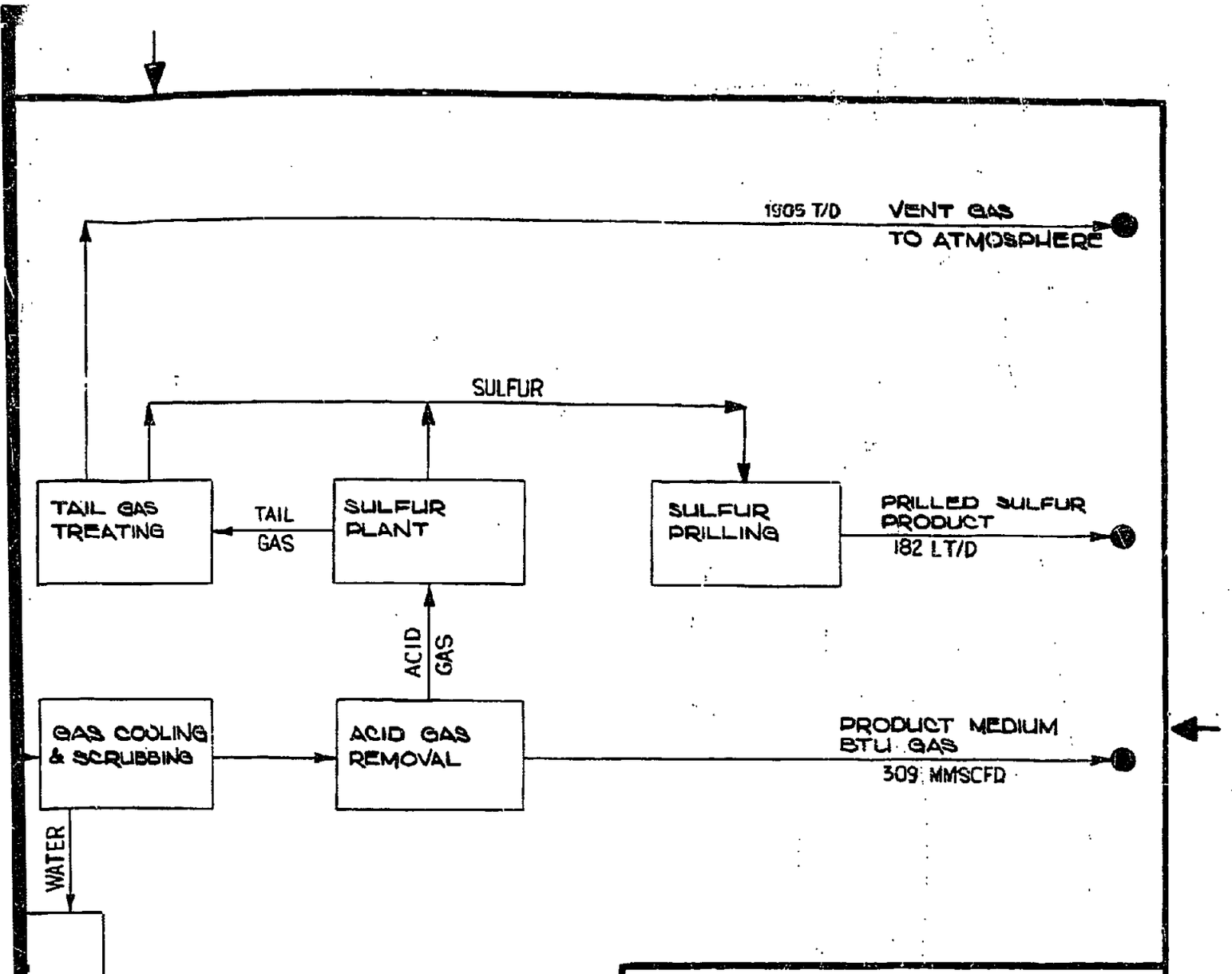

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COAL GASIFICATION PLANT
TEXACO GASIFIER
TVA PROJECT

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Section 4.0
OVERALL EVALUATIONS

4.1 The major advantages and disadvantages of each gasification system are listed below. It is understood that TVA will consider these factors in making their final selection.

4.2 Evaluation of the Lurgi Dry Ash Gasifier

The Lurgi dry ash gasifier is a moving bed gasifier operating at elevated pressures. Gasifier operation is controlled so that ash in the combustion zone is maintained at temperatures below the softening point of the ash.

4.2.1 Advantages

The major advantages of the Lurgi dry ash gasifier are:

4.2.1.1 The gasifier operates at pressures up to about 450 psig, thereby minimizing final compression to product gas delivery pressure.

4.2.1.2 The product gas has a high methane content resulting in a heating value significantly above 300 BTU/SCF HHV. High methane content is considered an advantage in a fuel gas operation. For synthesis gas production, however, the methane would require further conversion to hydrogen and carbon monoxide or withdrawal as fuel.

4.2.1.3 The Lurgi gasifier has a long history of successful commercial experience producing various types of synthesis gases and town gas. This experience is a significant advantage in relation to early installation in TVA's demonstration plant.

4.2.1.4 Operation with caking coals can be achieved by installation of a stirrer in the gasifier. This operation, however, has been proven to date only in pilot plant or small commercial gasifiers. Lurgi has advised that an extensive test on a large commercial Lurgi gasifier is being planned for 1981.

4.2.1.5 The gasifier has a high inventory of fuel which provides relatively stable operation.

4.2.1.6 Gasification involves a relatively low oxygen consumption, thereby reducing costs for air separation plants. Since oxygen is compressed rather than product gas, the low oxygen consumption is advantageous relative to compression costs.

4.2.2 Disadvantages

4.2.2.1 Gasification requires a large amount of steam injection into the gasifier to maintain temperatures below the ash softening point. This results in high energy consumption for steam production as well as added costs for treatment of large quantities of waste water. Steam

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4.2.2.1 (cont'd)
injected into the gasifier provides no other process function in a medium BTU fuel gas production plant where water gas shift of gas is not required. In other applications where shift is required, however, the gasifier steam would serve a further purpose of shifting carbon monoxide to carbon dioxide with resulting formation of hydrogen.

4.2.2.2 The gasifier produces significant quantities of tar, oil phenols, and ammonia from most coals. Although tar can be recycled to the gasifier with carryover dust, separation of these by-products involves significant capital and operating costs for separation units. These by-products may have little commercial value in a fuel gas operation because the quantities are small compared to typical petroleum or petrochemical plant production rates.

4.2.2.3 Gasification at temperatures below the ash softening point limits the rate of gasification. As a result, large gasification plants generally require many reactors to achieve required production rates. In recent years, however, larger Lurgi dry ash gasifiers have been developed having throughputs of about 30 tons of coal per hour.

4.2.2.4 The gasifier requires sized coal, usually 2" by 1/4" or 1/8". Although this avoids the cost of pulverizing and drying the coal, there is typically excess fines which cannot be used even for steam production. These fines must be disposed of or sold, usually at some loss.

4.2.2.5 The gasifier requires relatively high maintenance because of mechanical devices such as grates, stirrers, lock hopper valves, etc. SASOL, after many years of operation, has reported a gasifier availability of about 85%.

4.2.2.6 The raw gas contains a relatively low ratio of hydrogen sulfide to carbon dioxide. This results in difficulties in desulfurizing the gas so as to produce an acid gas containing a high concentration of hydrogen sulfide.

4.3 Evaluation of the Koppers-Totzek Gasifier

The Koppers-Totzek gasifier is an entrained upflow gasifier operating at atmospheric pressure.

4.3.1 Advantages

The major advantages of the Koppers-Totzek gasifier are:

4.3.1.1 The gasifier can handle essentially any type of coal including highly caking coals without pretreatment or without inclusion of any special mechanical devices. Since pulverized coal is required for the gasifier, the entire "as received" coal can be utilized.

4.3.1.2 The gasifier operates at high temperatures, thereby eliminating production of liquid by-products, phenols, and ammonia. Recovery of these by-products, which may have limited commercial value in an industrial fuel gas operation, is eliminated as well as the treatment of waste water generated by such recovery operations.

4.3.1.3 The gasifier utilizes atmospheric pressure equipment and requires little steam for gasification, leading to a relatively simple operation. Control of oxygen/coal ratio is very important, however, to maintain the high temperatures required for complete gasification.

4.3.1.4 The product gas has a relatively high ratio of hydrogen sulfide to carbon dioxide which permits extensive desulfurization of the gas while still producing an acid gas with high hydrogen sulfide concentration. This latter feature permits use of a conventional Claus sulfur recovery plant.

4.3.1.5 The Koppers-Totzek gasifier has extensive commercial plant operating experience, primarily, in production of synthesis gas for ammonia production. This is a significant advantage in relation to early installation in TVA's demonstration plant.

4.3.2 Disadvantages

The major disadvantages of the Koppers-Totzek gasifier are:

4.3.2.1 Possibly, the most important disadvantage in relation to production of high pressure medium BTU gas is the limitation to operation at atmospheric pressure. The weight flowrate of raw gas is about twice that of the oxygen feed to the gasifier. Compression of product gas from essentially atmospheric pressure to final delivery pressure of about 600 psig is a very large energy consumer relative to compression of oxygen which would be required for a pressurized gasifier. Gas compression results in added costs for heat exchangers, cooling water circulation, etc., in addition to the cost of the compressors.

4.3.2.2 Product gas contains essentially no methane or higher hydrocarbons because of the high gasification temperature. This is considered a disadvantage in a fuel gas operation although the heating value of the product gas complies without intentional carbon dioxide removal, with TVA's specification of 285 BTU/SCF HHV, minimum. In a synthesis gas operation, however, production of a low methane content gas would be considered an advantage.

4.3.2.3 Gasification involves a relatively high oxygen consumption, thereby necessitating installation of large air separation plants.

4.3.2.4 Although the gasifier can utilize the entire "as received" coal in pulverized form without discard of fines, production of dry pulverized coal involves significant capital and operating costs for mills, driers and fuel.

4.4 Evaluation of the Babcock-Wilcox Gasifier

The B & W gasifier is an entrained upflow gasifier operating at elevated pressure.

4.4.1 Advantages

The major advantages of the B & W Gasifier are:

4.4.1.1 The gasifier can handle essentially any type of coal including highly caking coals without pretreatment or without inclusion of any special mechanical devices. Since pulverized coal is required for the gasifier, the entire "as received" coal can be utilized.

4.4.1.2 The gasifier operates at high temperature, thereby eliminating production of liquid by-products, phenols, and ammonia. Recovery of these by-products, which may have limited commercial value in an industrial fuel gas operation, is eliminated as well as the treatment of waste water generated by such recovery operations.

4.4.1.3 The product gas has a relatively high ratio of hydrogen sulfide to carbon dioxide with Kentucky coal which permits extensive desulfurization of the gas while still producing an acid gas with high hydrogen sulfide concentration. The latter feature permits use of a conventional Claus sulfur recovery plant.

4.4.1.4 The gasifier operates at a pressure of about 200 psig, thereby eliminating a significant portion of raw gas compression relative to operation at atmospheric pressure. Since the weight flow-rate of oxygen is only about 50% of that of raw gas, reduction in gas compression requirements represents important capital and operating cost savings.

4.4.2 Disadvantages

The major disadvantages of the B & W gasifier are:

4.4.2.1 Product gas contains essentially no methane or higher hydrocarbons because of the high gasification temperature. This is considered a disadvantage in a fuel gas operation although the heating value of the product gas complies, without intentional carbon dioxide removal, with TVA's specification of 285 BTU/SCF HHV, minimum. In a synthesis gas operation, however, production of a low methane content gas would be considered an advantage.

4.4.2.2 Gasification involves a relatively high oxygen consumption, thereby necessitating installation of large air separation plants.

4.4.2.3 Although the gasifier can utilize the entire "as received" coal in pulverized form without discard of fines, production of dry pulverized coal involves significant capital and operating costs for mills, driers, and fuel.

4.4.2.4 Although the B & W gasifier was operated by DuPont for a brief period on a large scale during the 1950's, there is no recent pilot plant or demonstration plant experience and no commercial plant experience. This is an important consideration relative to the timing of installation in TVA's demonstration plant. There are no known plans for installation and operation of B & W gasifiers in the near future although some projects in the planning stage are considering B & W gasifiers.

4.5 Evaluation of the BGC/Lurgi Slagging Gasifier

The BGC/Lurgi slagging gasifier is a moving bed gasifier operating at elevated pressures. Gasifier operation is controlled so that ash in the combustion zone is melted and removed from the gasifier as slag.

4.5.1 Advantages

The major advantages of the BGC/Lurgi slagging gasifier are:

4.5.1.1 The gasifier operates at pressures up to about 450 psig, thereby minimizing final compression to product gas delivery pressure.

4.5.1.2 The product gas has a high methane content resulting in a heating value significantly above 300 BTU/SCF HHV. High methane content is considered an advantage in a fuel gas operation. For synthesis gas production, however, the methane would require further conversion to hydrogen and carbon monoxide or withdrawal as fuel.

4.5.1.3 Operation with caking coals can be achieved by installation of a stirrer in the gasifier. This operation has been tested in the Westfield plant where a Lurgi gasifier was modified for slagging operation.

4.5.1.4 The gasifier has a high inventory of fuel which provides relatively stable operation.

4.5.1.5 Gasification involves a relatively low oxygen consumption, only slightly higher than that required for dry ash operation. Since oxygen is compressed rather than product gas, the low oxygen consumption is advantageous relative to compression costs.

4.5.1.6 Steam injection into the gasifier is substantially reduced compared to dry ash operation since temperatures in the combustion zone can exceed the ash softening temperature. This reduces costs for steam production and waste water treatment. In applications where water gas shift is required, however, it may be necessary to add steam for this purpose.

4.5.1.7 Gasification rates in the slagging gasifier are high relative to the dry ash mode because of increased operating temperature. Throughput rates of up to four times the dry ash rates, have been reported in the literature.

4.5.1.8 The raw gas contains a relatively high ratio of hydrogen sulfide to carbon dioxide because of low steam usage and high temperatures in the gasifier relative to the dry ash operation. This simplifies production of an acid gas from gas desulfurization which has a high hydrogen sulfide concentration.

4.5.2 Disadvantages

The major disadvantages of the BGC/Lurgi slagging gasifier are:

4.5.2.1 The gasifier produces significant quantities of tar, oil, phenols, and ammonia from most coals. Although tar and oil can be recycled to the gasifier with the carryover dust or by injection into tuyeres, separation of these by-products involves significant capital and operating costs for separation units. These by-products may have little commercial value in a fuel gas operation because the quantities are small compared to typical petroleum or petrochemical plant production rates.

4.5.2.2 The gasifier requires sized coal, usually 2" by 1/4" or by 1/8". Although this avoids the cost of pulverizing and drying the coal, there is typically excess fines which cannot be used even for steam production. These fines must be disposed of or sold, usually at loss.

4.5.2.3 The gasifier requires relatively high maintenance because of stirrers and lock hopper valves. Conditions in the slagging zone are particularly severe.

4.5.2.4 The gasifier has been tested in a modified Lurgi gasifier at Westfield and short term tests under slagging conditions have been completed successfully. There is, however, at present no commercial plant operating experience. This is an important consideration in terms of the timing of installation in TVA's demonstration plant, that is the first module scheduled for operation in 1985 or later modules scheduled for operation in 1986 - 1988.

4.6 Evaluation of the Texaco Gasifier

The Texaco gasifier is an entrained downflow gasifier operating at elevated pressure.

4.6.1 Advantages

The major advantages of the Texaco gasifier are:

4.6.1.1 The gasifier can handle essentially any type of coal, including highly caking coals without pretreatment or without inclusion of any special mechanical devices. Since pulverized coal is required for the gasifier, the entire "as received" coal can be utilized.

4.6.1.2 The gasifier operates at high temperature, thereby eliminating production of liquid by-products, phenols, and all but small amounts of ammonia. Recovery of these by-products, which may have limited commercial value in an industrial fuel gas operation, is eliminated as well as the treatment of waste water generated by such recovery operations.

4.6.1.3 Control of the coal feed rate to the gasifier, which is particularly important in entrained flow gasifiers, is achieved by wet grinding of coal to produce a coal slurry which is pumped to the gasifier. Lock hoppers are not required and drying of coal is eliminated.

4.6.1.4 Although no commercial units are in operation, the Texaco coal gasifier has been operated successfully in pilot plants and in a demonstration plant constructed in Germany. The experience gained from these operations, together with Texaco's extensive background in high temperature, high pressure oil partial oxidation plants, which in many respects resemble the coal gasification process, should minimize the technical uncertainties in designing commercial scale gasifiers.

4.6.1.5 The Texaco gasifier can operate at pressures up to at least about 900 psig. This capability permits elimination of all gas compression in the proposed TVA demonstration plant, leaving only oxygen compression. Since the weight flowrate of oxygen is only about 50% of that of raw gas, elimination of gas compression represents significant capital and operating cost savings.

4.6.2 Disadvantages

The major disadvantages of the Texaco gasifier are:

4.6.2.1 Although use of a water slurry coal feed provides precise control of coal feedrate, the steam concentration in the gasifier must be at least that corresponding to the water in the coal feed. This produces a relatively low hydrogen sulfide to carbon dioxide ratio in the product gas which complicates production of

4.6.2.1 (cont'd)

an acid gas from desulfurization having a high hydrogen sulfide content. In the baseline conceptual design, it was also necessary to remove some carbon dioxide from the gas to meet TVA's product gas heating value specification. The presence of a high concentration of steam in the gasifier effluent, however, would be useful in operation where water gas shift is required.

Operation of the Texaco gasifier improves with higher coal slurry concentration, i.e., lower oxygen requirement, less CO_2 production, increased product gas heating value. It is important that good coal grinding be achieved to obtain the maximum coal slurry concentration, although additives may be used to improve the slurry quality of a poor coal grind.

4.6.2.2 The product has a low methane content. This is considered a disadvantage in a fuel gas operation. In a synthesis gas operation, however, low methane content would be considered an advantage.

4.6.2.3 Gasification involves a relatively high oxygen consumption, thereby necessitating the installation of large air separation plants.

4.6.2.4 Although pilot plant and demonstration plant operations have been successful, and extensive experience is available concerning oil partial oxidation, there is at present no commercial operation with the Texaco gasifier. This is an important consideration in the timing of installation in TVA's demonstration plant.. It should be noted, however, that TVA's Muscle Shoals project is expected to be in operation in 1981, which sould provide valuable additional experience at a relatively early date.

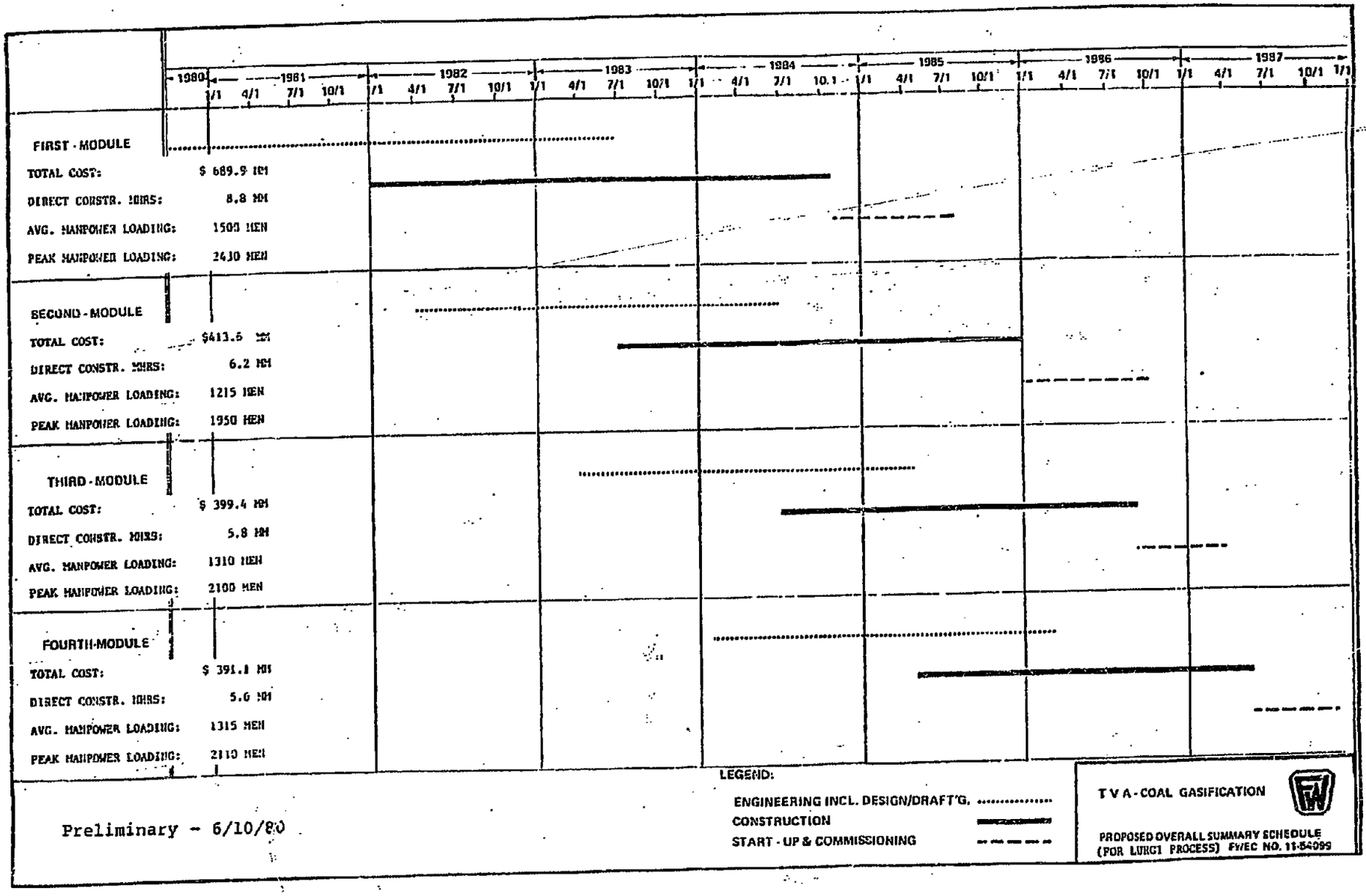
SECTION 5.0
SCHEDULES

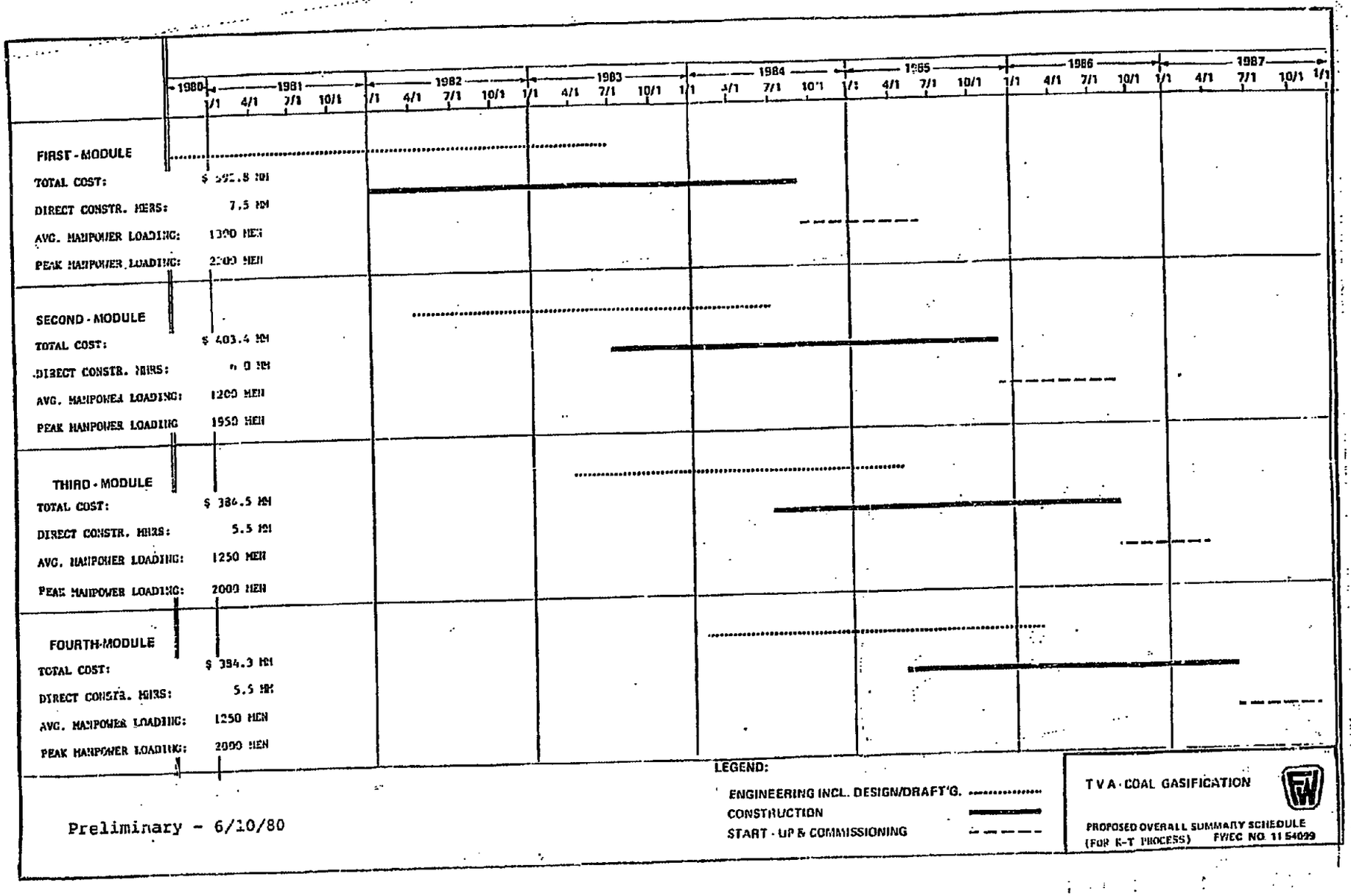
Summary schedules are included here for each case and each module. These were prepared, using our normal experience factors. Slightly longer times are given for the Lurgi case, to accommodate the additional investment cost.

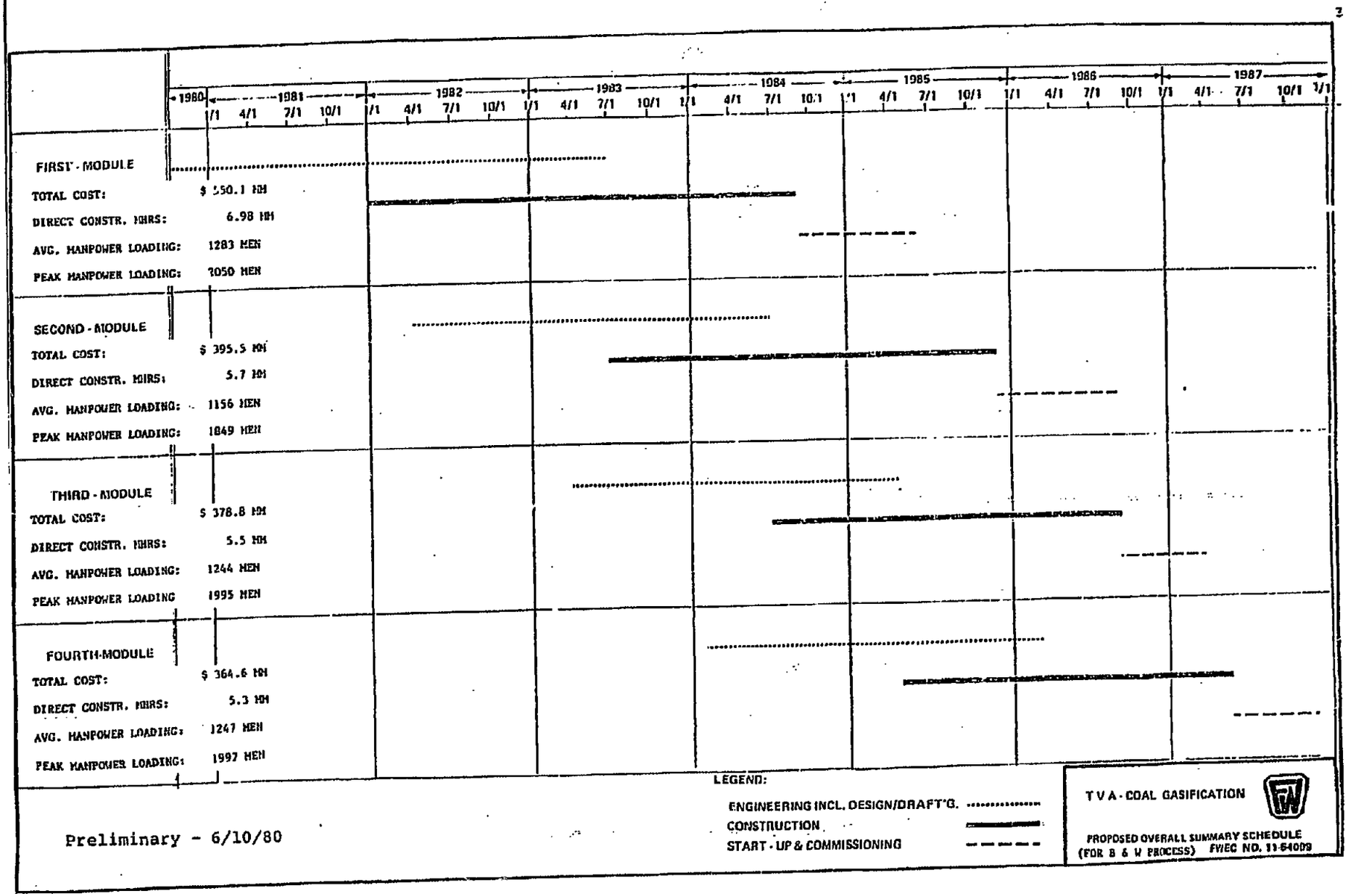
SUMMARY

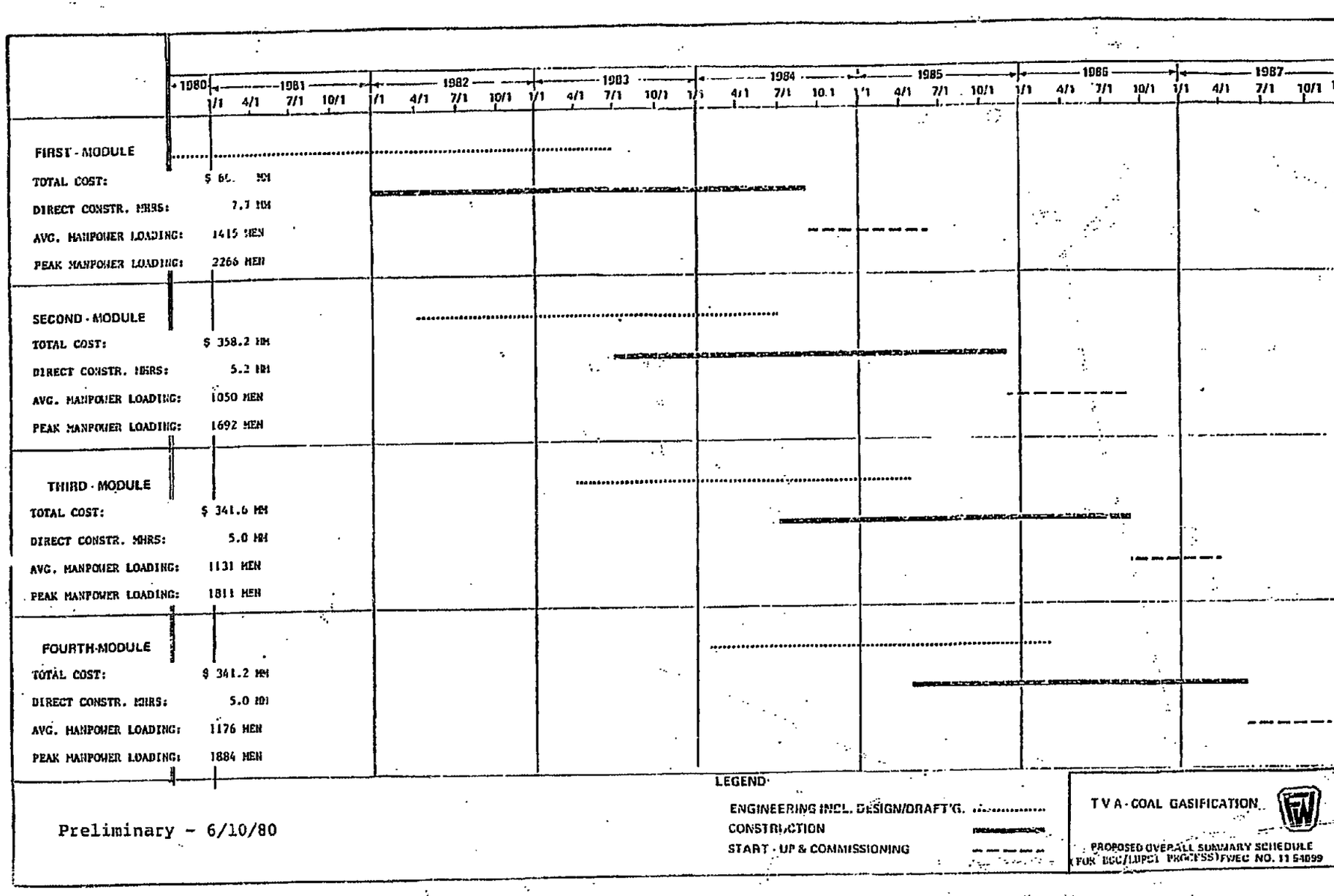
TVA COMPLETION - SCHEDULE

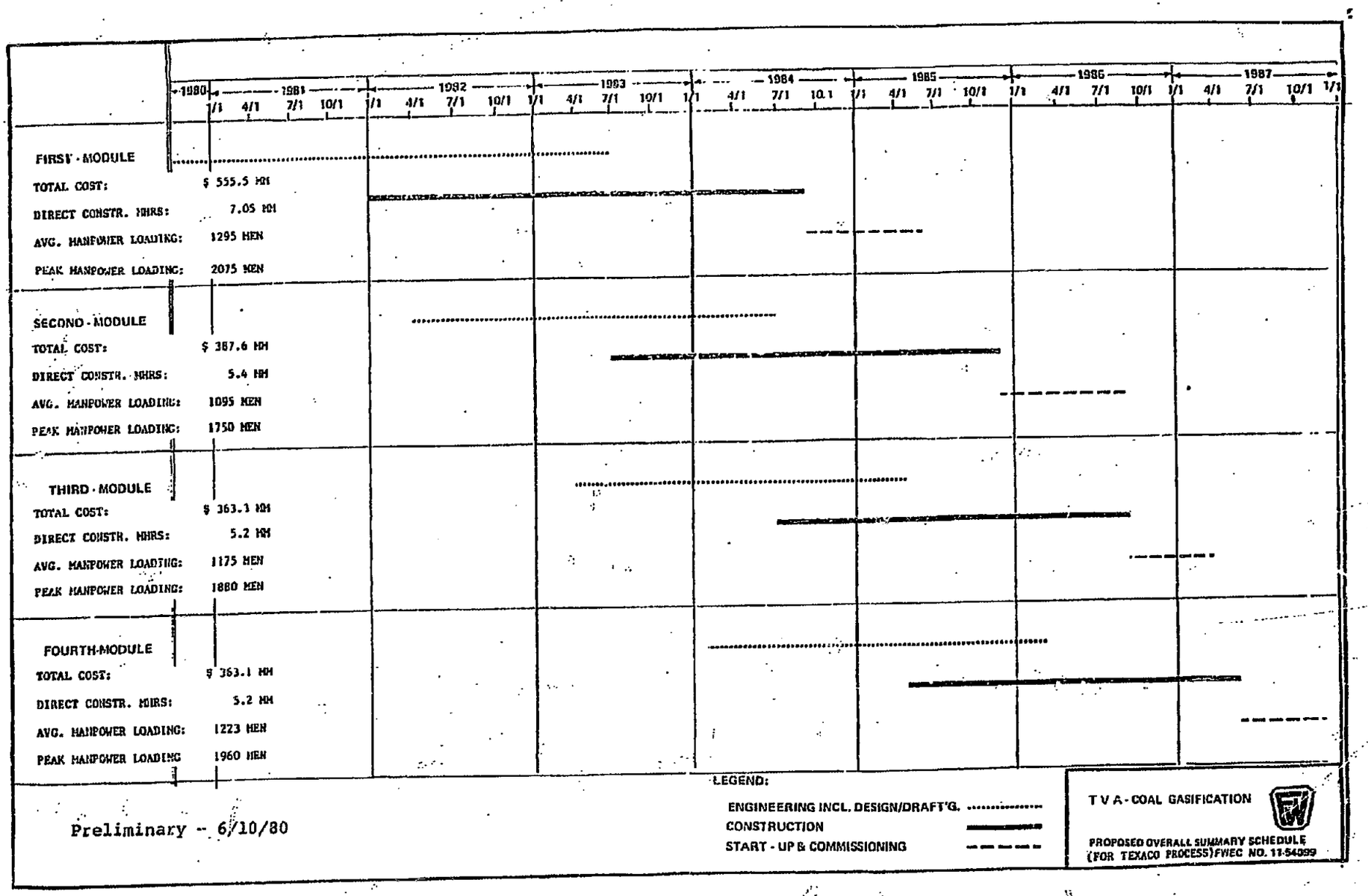
Process	1st Module	2nd Module	3rd Module	4th Module
I. LURGI				
Mechanical Completion	10.30.84	12.30.85	8.30.86	5.30.87
Start-Up and Commissioning Completion	7.30.85	9.30.86	3.30.87	11.30.87
II. K-T:				
Mechanical Completion	8.30.84	11.30.85	8.30.86	5.30.87
Start-up and Commissioning Completion	5.30.84	8.30.86	3.30.87	11.30.87
III. B & W:				
Mechanical Completion	8.30.84	11.30.85	8.30.86	5.30.87
Start-Up and Commissioning Completion	5.30.84	8.30.86	3.30.87	11.30.87
IV. TEXACO:				
Mechanical Completion	8.30.84	11.30.85	8.30.86	5.30.87
Start-Up and Commissioning Completion	5.30.84	8.30.86	3.30.87	11.30.87
V. SLAGGER (BSC/LURGI):				
Mechanical Completion	8.30.84	11.30.85	8.30.86	5.30.87
Start-Up and Commissioning Completion	5.30.84	8.30.86	3.30.87	11.30.87


1980
1981
1982
1983
1984
1985
1986
1987
1/1 4/1 7/1 10/1
FIRST-MODULE
TOTAL COST: $ 689.9 MM
DIRECT CONSTR. MHRS: 8.8 MM
AVG. MANPOWER LOADING: 1500 MEN
PEAK MANPOWER LOADING: 2430 MEN
SECOND-MODULE
TOTAL COST: $413.6 MM
DIRECT CONSTR. MHRS: 6.2 MM
AVG. MANPOWER LOADING: 1215 MEN
PEAK MANPOWER LOADING: 1950 MEN
THIRD-MODULE
TOTAL COST: $ 399.4 MM
DIRECT CONSTR. MHRS: 5.8 MM
AVG. MANPOWER LOADING: 1310 MEN
PEAK MANPOWER LOADING: 2100 MEN
FOURTH-MODULE
TOTAL COST: $ 391.1 MM
DIRECT CONSTR. MHRS: 5.6 MM
AVG. MANPOWER LOADING: 1315 MEN
PEAK MANPOWER LOADING: 2110 MEN
LEGEND:
ENGINEERING INCL. DESIGN/DRAFT'G.
CONSTRUCTION
START-UP & COMMISSIONING
Preliminary - 6/10/80
TVA-COAL GASIFICATION
PROPOSED OVERALL SUMMARY SCHEDULE
(FOR LURGI PROCESS) FWEC NO. 11-84099


1980
1981
1982
1983
1984
1985
1986
1987
1/1 4/1 7/1 10/1
FIRST - MODULE
TOTAL COST: $ 592.8 MM
DIRECT CONSTR. HRS: 7.5 MM
AVG. MANPOWER LOADING: 1300 MEN
PEAK MANPOWER LOADING: 2500 MEN
SECOND - MODULE
TOTAL COST: $ 403.4 MM
DIRECT CONSTR. HRS: 5.0 MM
AVG. MANPOWER LOADING: 1200 MEN
PEAK MANPOWER LOADING 1950 MEN
THIRD - MODULE
TOTAL COST: $ 384.5 MM
DIRECT CONSTR. HRS: 5.5 MM
AVG. MANPOWER LOADING: 1250 MEN
PEAK MANPOWER LOADING: 2000 MEN
FOURTH-MODULE
TOTAL COST: $ 394.3 MM
DIRECT CONSTR. HRS: 5.5 MM
AVG. MANPOWER LOADING: 1250 MEN
PEAK MANPOWER LOADING: 2000 MEN
LEGEND:
ENGINEERING INCL. DESIGN/DRAFT'G.
CONSTRUCTION
START - UP & COMMISSIONING
TVA - COAL GASIFICATION
PROPOSED OVERALL SUMMARY SCHEDULE
(FOR K-T PROCESS) FWEC NO. 11 54029
Preliminary - 6/10/80


1980
1981
1982
1983
1984
1985
1986
1987
1/1 4/1 7/1 10/1
FIRST - MODULE
TOTAL COST: $ 550.1 MM
DIRECT CONSTR. MHRS: 6.98 MM
AVG. MANPOWER LOADING: 1283 MEN
PEAK MANPOWER LOADING: 2050 MEN
SECOND - MODULE
TOTAL COST: $ 395.5 MM
DIRECT CONSTR. MHRS: 5.7 MM
AVG. MANPOWER LOADING: 1156 MEN
PEAK MANPOWER LOADING: 1849 MEN
THIRD - MODULE
TOTAL COST: $ 378.8 MM
DIRECT CONSTR. MHRS: 5.5 MM
AVG. MANPOWER LOADING: 1244 MEN
PEAK MANPOWER LOADING 1995 MEN
FOURTH-MODULE
TOTAL COST: $ 364.6 MM
DIRECT CONSTR. MHRS: 5.3 MM
AVG. MANPOWER LOADING: 1247 MEN
PEAK MANPOWER LOADING: 1997 MEN
LEGEND:
ENGINEERING INCL. DESIGN/DRAFT'G.
CONSTRUCTION
START - UP & COMMISSIONING
Preliminary - 6/10/80
TVA - COAL GASIFICATION
PROPOSED OVERALL SUMMARY SCHEDULE
(FOR B & W PROCESS) FWEC NO. 11-64009


1980
1981
1982
1983
1984
1985
1986
1987
1/1 4/1 7/1 10/1
FIRST - MODULE
TOTAL COST: $ 6[illegible] MM
DIRECT CONSTR. MHRS: 7.7 MM
AVG. MANPOWER LOADING: 1415 MEN
PEAK MANPOWER LOADING: 2266 MEN
SECOND - MODULE
TOTAL COST: $ 358.2 MM
DIRECT CONSTR. MHRS: 5.2 MM
AVG. MANPOWER LOADING: 1050 MEN
PEAK MANPOWER LOADING: 1692 MEN
THIRD - MODULE
TOTAL COST: $ 341.6 MM
DIRECT CONSTR. MHRS: 5.0 MM
AVG. MANPOWER LOADING: 1131 MEN
PEAK MANPOWER LOADING: 1811 MEN
FOURTH-MODULE
TOTAL COST: $ 341.2 MM
DIRECT CONSTR. MHRS: 5.0 MM
AVG. MANPOWER LOADING: 1176 MEN
PEAK MANPOWER LOADING: 1884 MEN
LEGEND
ENGINEERING INCL. DESIGN/DRAFT'G.
CONSTRUCTION
START - UP & COMMISSIONING
TVA - COAL GASIFICATION
PROPOSED OVERALL SUMMARY SCHEDULE
(FOR BCC/LUPCI PROCESS) FWEC NO. 11 54099
Preliminary - 6/10/80


1980
1981
1982
1983
1984
1985
1986
1987
1/1 4/1 7/1 10/1
FIRST - MODULE
TOTAL COST: $ 555.5 MM
DIRECT CONSTR. MHRS: 7.05 MM
AVG. MANPOWER LOADING: 1295 MEN
PEAK MANPOWER LOADING: 2075 MEN
SECOND - MODULE
TOTAL COST: $ 387.6 MM
DIRECT CONSTR. MHRS: 5.4 MM
AVG. MANPOWER LOADING: 1095 MEN
PEAK MANPOWER LOADING: 1750 MEN
THIRD - MODULE
TOTAL COST: $ 363.1 MM
DIRECT CONSTR. MHRS: 5.2 MM
AVG. MANPOWER LOADING: 1175 MEN
PEAK MANPOWER LOADING: 1880 MEN
FOURTH-MODULE
TOTAL COST: $ 363.1 MM
DIRECT CONSTR. MHRS: 5.2 MM
AVG. MANPOWER LOADING: 1223 MEN
PEAK MANPOWER LOADING 1960 MEN
LEGEND:
ENGINEERING INCL. DESIGN/DRAFT'G.
CONSTRUCTION
START - UP & COMMISSIONING
Preliminary -- 6/10/80
TVA - COAL GASIFICATION
PROPOSED OVERALL SUMMARY SCHEDULE
(FOR TEXACO PROCESS) FWEC NO. 11-54099

6.0 KEY PLOT PLANS & ELEVATIONS

SECTION 6.0

KEY PLOT PLANS & ELEVATIONS

Because of the "fast track" nature of this project, Foster Wheeler expended as much time as possible studying the development of the Murphy Hill site. Key plot plans and elevations were prepared for each case. However, further work is necessary to optimize land usage, grading requirements and plot arrangements. One such departure in plot arrangment is discussed in a succeeding section.

The appropriate land area usage required* for each process is shown in the following table:

	Acres			
	Lurgi	B & W	K-T	Texaco
Coal Storage	55	55	55	55
Process and Support Facilities	223	143	186	116
Ash Slag Storage	287	197	168	135
Required TOTALS	565	395	409	306
As-drawn TOTALS**	586	416	499	349

The "as drawn" totals represent the approximate net values within the normal fenced areas as actually shown on the attached Key Plot Plans.

* The coal storage and the ash/slag areas represent fairly good estimates of the land area that will be required. The areas shown for Process and Support Facilities are only an approximate indication of the land area required within the latitude provided for the present study. These latter values were obtained by measuring the resulting gross area occupied on the Key Plot Plan for each licensed coal gasification process.

** The greater values for TOTALS "as-drawn" versus "required" represent, for the most part, a more generous indication of land usage on the Key Plot Plan for the coal and, especially, for the ash/slag areas.

6.1 Commentary on Key Plot Plans

The development of the Key Plot Plan requires the optimization of all facilities from the standpoint of accommodating the process streams, minimizing piping sizes and lengths, consolidating common facilities, access to coal storage and ash deposit areas, minimizing changes in the topography of the site, minimizing visual intrusions into the environment, etc.

Upon examination of the Key Plot Plan for the Lurgi (non-slagging), Babcock-Wilcox, Koppers-Totzek and Texaco systems, it will be observed that the physical relationship between the coal pile, ash/slag storage and the constructed plant facilities, is essentially the same. The principal differences between the various Key Plot Plans occur in the extent of the ash/slag pile and in the arrangement of the essential facilities internal to the constructed plant.

Some of the differences in arrangement of such facilities were made to illustrate possible variations in layout and to stimulate further commentary for the objective of the eventual refinement of the layout for the final Key Plot Plan.

A major concern which has been voiced, relates to the efficient and safe operation of the Air Separation Plant (Section 200). The two major aspects of concern are:

A. The possibility of hydrocarbon vapors contaminating the air supply and in becoming concentrated in the air separation process providing a basis for an explosive mixture.

6.1 (continued)

B. Fugitive dust from coal or ash, from sources in close proximity, can affect the dust loading of the filters at the air intake manifold of the air compressors, whereby the efficient operation of the compressor would be adversely affected.

Potential impact of these two problems may be assessed from the following considerations:

6.1.1 Hydrocarbon Vapors

The Lurgi (non-slagging) gasification plant is the only one which produces hydrocarbons in significant quantity as a byproduct. As presently shown on Drawing 54099-1-01-4, the Air Plant (Section 200) is in excess of 350 feet from the nearest major source of hydrocarbons, the Phenol Recovery Plant (Section 950). Ammonia, another source of potentially dangerous vapors, is recovered in Section 900 which is also more than 350 feet away. As presently shown, the far extremity of the Air Plant is well in excess of 1000 feet from either the Phenol or Ammonia Recovery Plant.

Based on the foregoing, it seems perfectly reasonable to assume that the precise location of the air intake to the air compressors of the Air Plant, can easily be 600 - 700 feet (or more) from potential sources of dangerous vapors generated in the Coal Gasification Plant.

6.1.2 Fugitive Dust

All gasification systems are so arranged that the long term storage coal pile and especially the ash/slag storage areas appear, generally, to surround the plant facilties and especially the Air Plant of the Lurgi (dry ash) and Koppers-Totzek systems.

Fugitive dust could also originate from coal and limestone conveying and transfer to steam generation (Section 1200) which is, in all systems, contiguous to the Air Separation Plant. Additionally, coal is conveyed and transferred to bunkers serving the various gasifiers or to equipment which prepares coal for feeding to the gasifiers.

The improbability of fugitive dust emanating from the foregoing sources is supported by the following:

Coal Pile

The expanse of inactive coal in long term storage would be compacted and chemically sealed to render it unlikely to experience oxidation or spontaneous combustion. As a consequence, the coal pile would become essentially, dust free. During unloading for storage or withdrawing for gasification, we would provide dust suppression water/chemical spraying at the "active" working portions of the coal pile.

6.1.2 (continued)

Ash/Slag

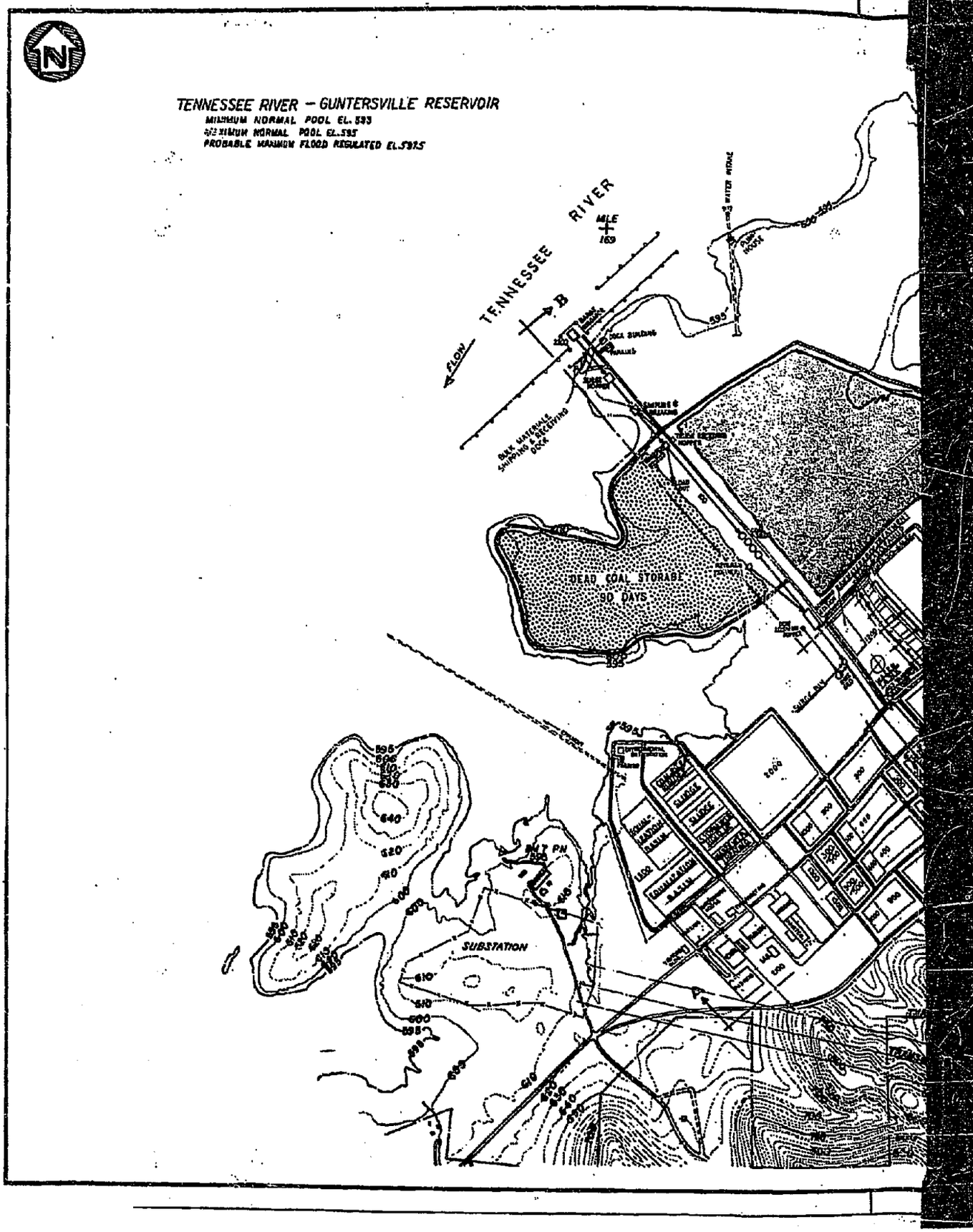
All systems for the removal of dry flyash and spent bed materials to the long term storage pile would be provided with dust suppression by water or chemical sprays. Other slag/ash removal systems involve wet or damp materials which would not, initially, constitute a source of dust. In any event, dust suppression by means of water/chemical spraying equipment should be provided. As stated in the Foster Wheeler reports, Technical Description, Part 2, under Section 2000 - General Facilities, ash/slag will be treated to render it chemically and mechanically stable and hospitable to the growth of plant life. As the growth of vegetation takes hold, the ash/slag pile will be no different than other terrain around the plant and, therefore, would not be an extraordinary source of fugitive dust.

Coal & Limestone Conveying & Transfer Systems

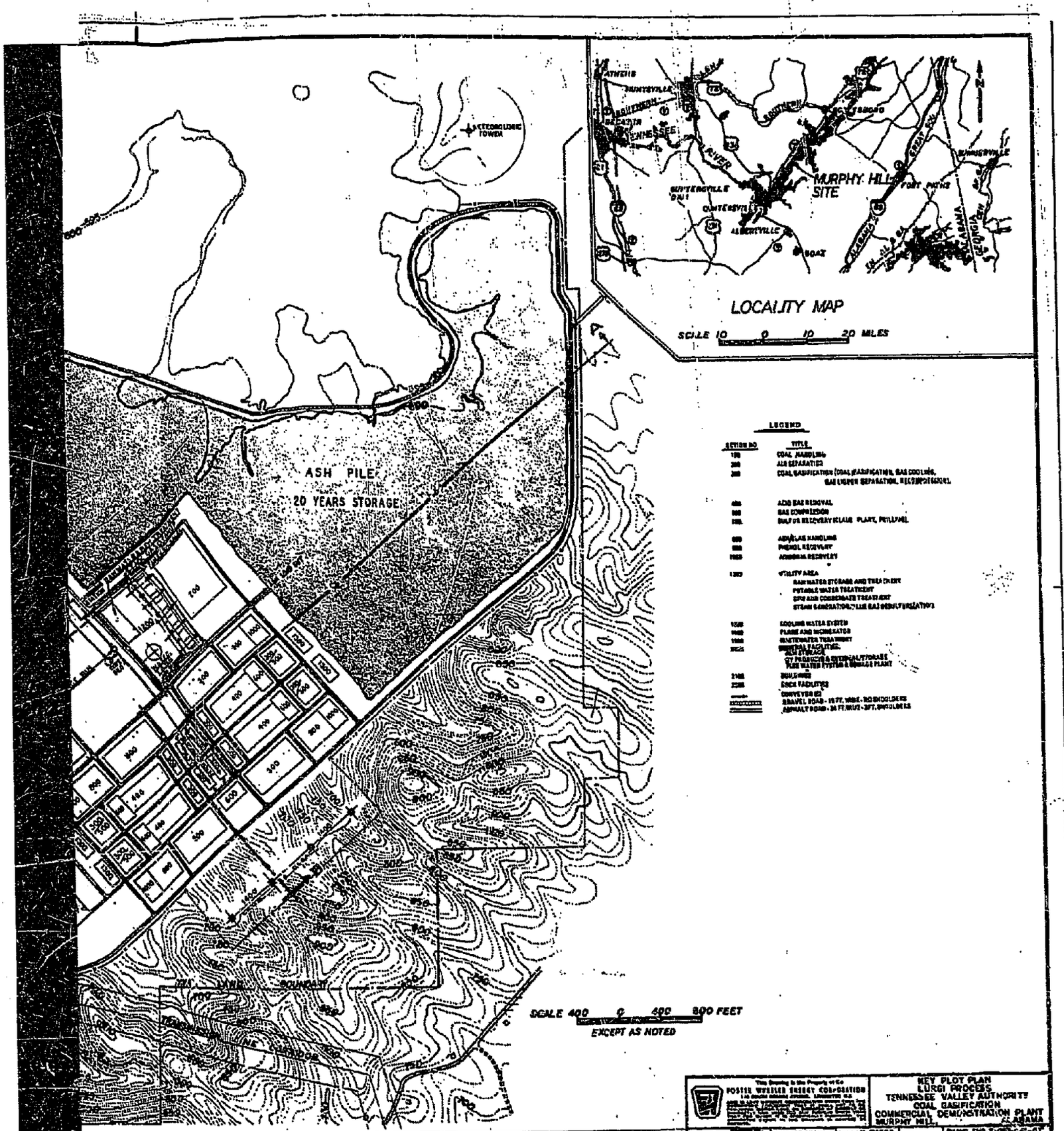
Considering the nature of the proposed plant for the gasification of coal, all coal and limestone conveyors would be designed to operate inside of completely enclosed galleries (for conveyors) or buildings (at transfer stations). Additionally, vacuum extraction ducts at various stations, where dust could be generated, would be provided to aid in the control and containment of any dust arising during materials conveying and transfer.

6.1.3 Conclusion

In consideration of the various design features which are recommended for incorporation in the plants, it is Foster Wheeler's opinion that a design for a safe and efficient Air Separation Plant would result. An optimum design, considering the entire Key Plot Plan, is a task appropriately left for the next phase of this project.


TENNESSEE RIVER – GUNTERSVILLE RESERVOIR
MINIMUM NORMAL POOL EL. 593
MAXIMUM NORMAL POOL EL. 595
PROBABLE MAXIMUM FLOOD REGULATED EL. 597.5
TENNESSEE RIVER
MILE 169
FLOW
B
DEAD COAL STORABLE 90 DAYS
SUBSTATION
595
600
610
620
640

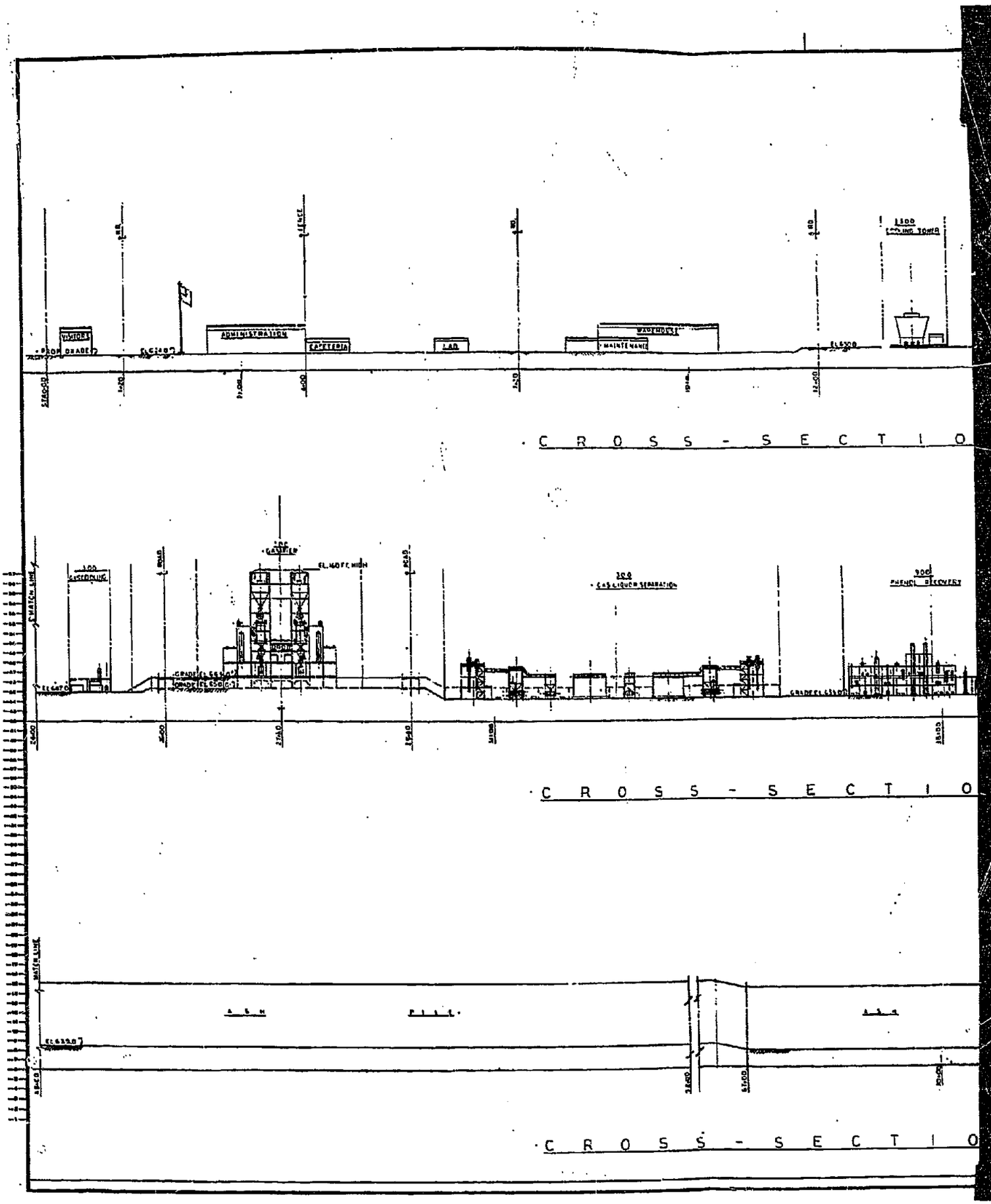
p



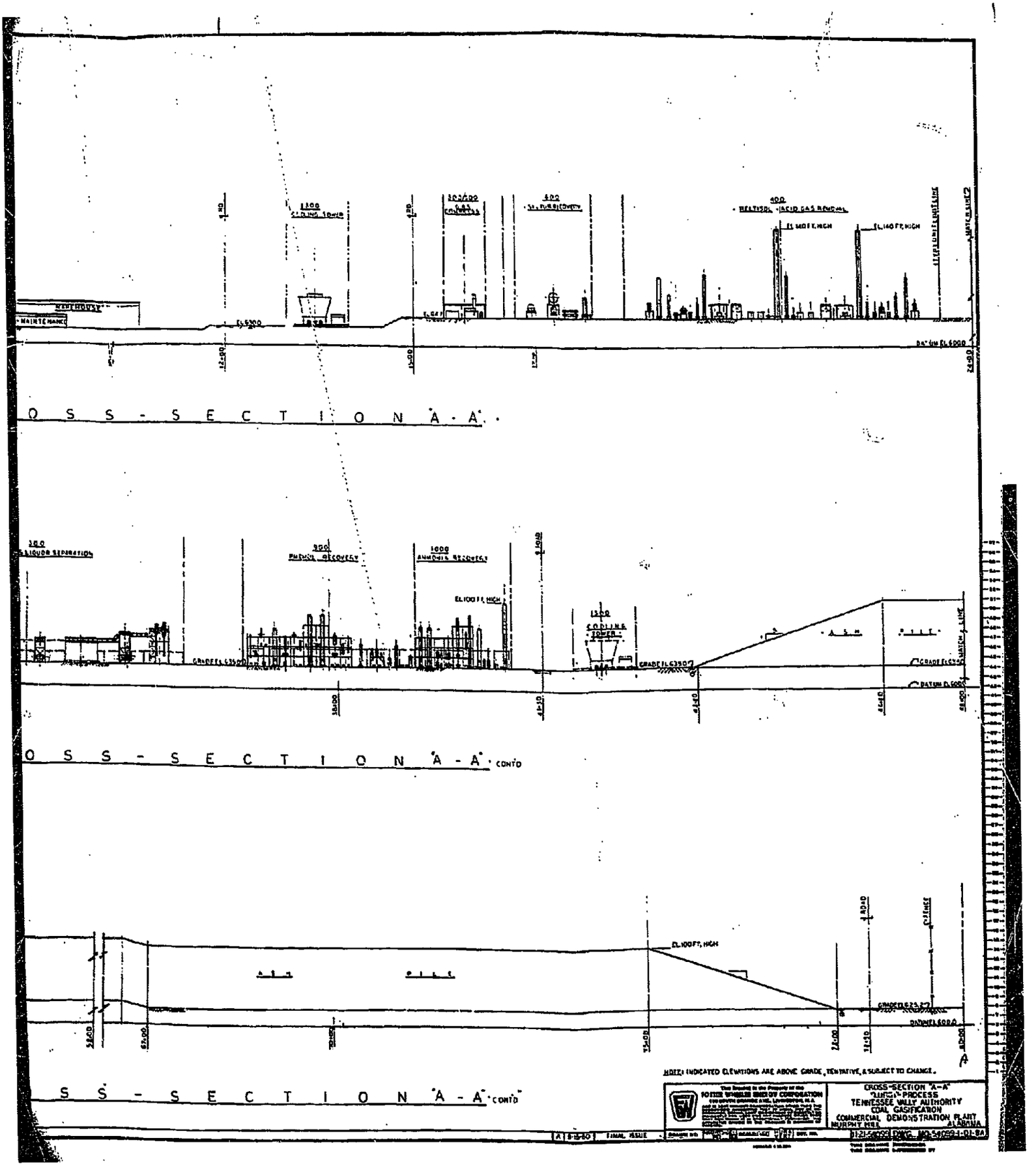
POSTER WHEELER ENERGY CORPORATION

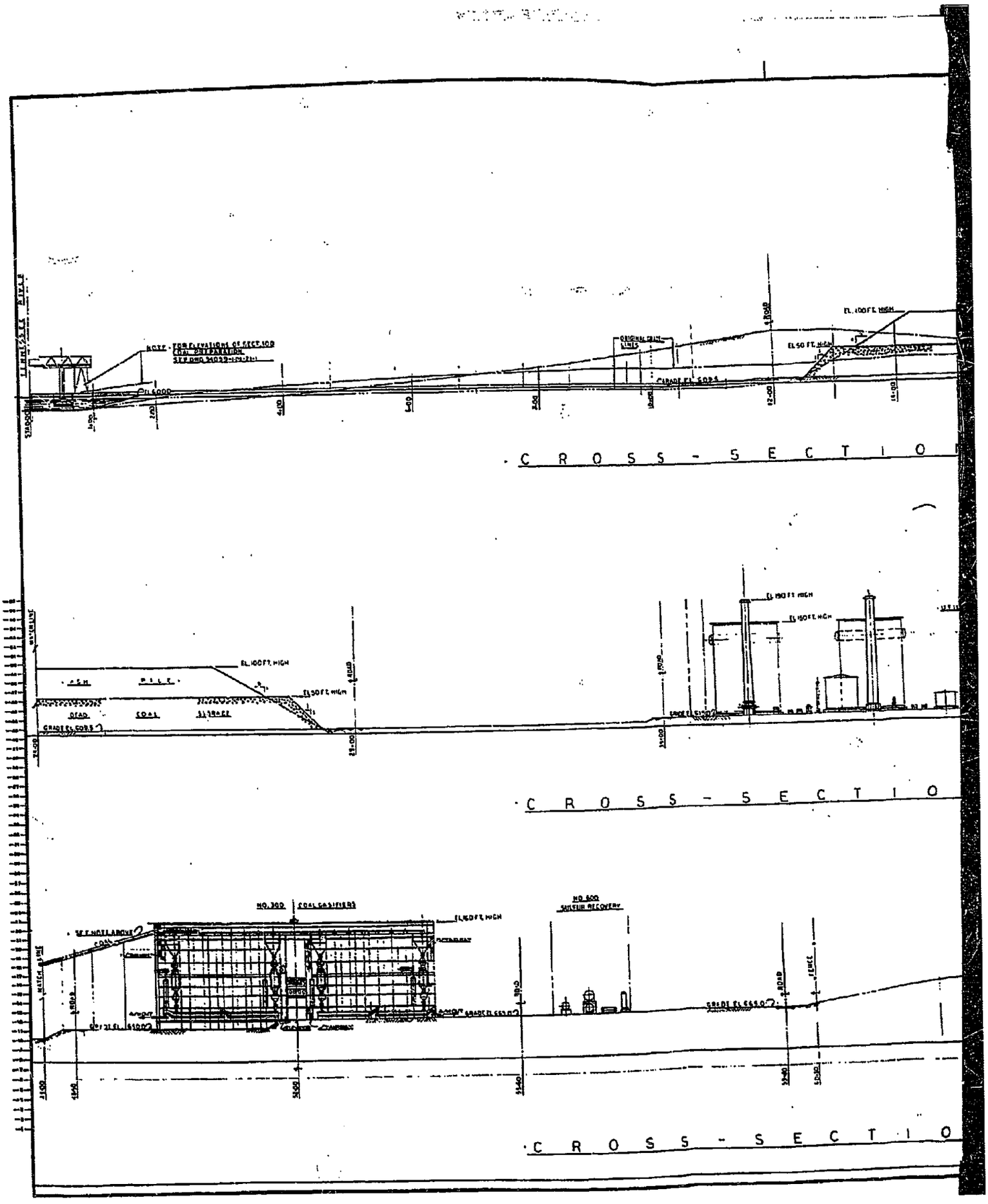
KEY PLOT PLAN
LURGI PROCESS
TENNESSEE VALLEY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MURPHY HILL, ALABAMA

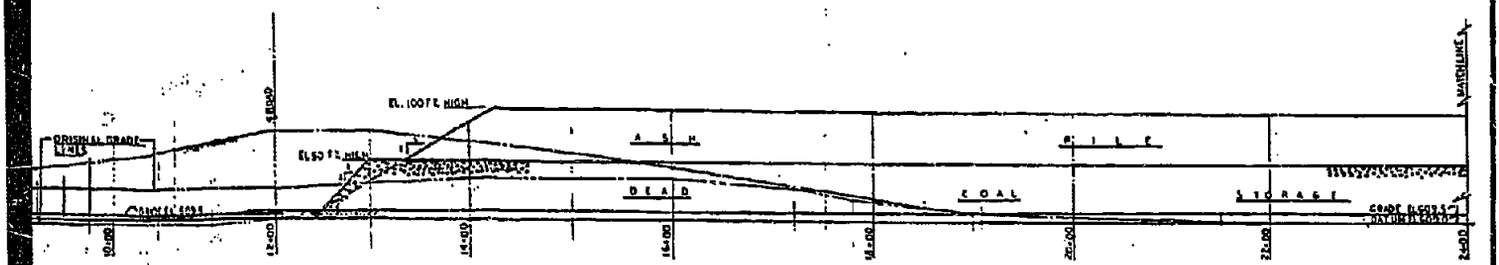
C 5-10-80 FINAL ISSUE | B 4-8-80 REVISED FOR CLIENTS AC | A MAY-1-80 CLIENT COMMENTS


VISITORS
ADMINISTRATION
CAFETERIA
LAB
WAREHOUSE
MAINTENANCE
1300
COOLING TOWER
C R O S S - S E C T I O
100
CASTORING
200
GASIFIER
EL. 1605 FT. HIGH
300
GAS LIQUOR SEPARATION
900
PHENOL RECOVERY
C R O S S - S E C T I O
C R O S S - S E C T I O

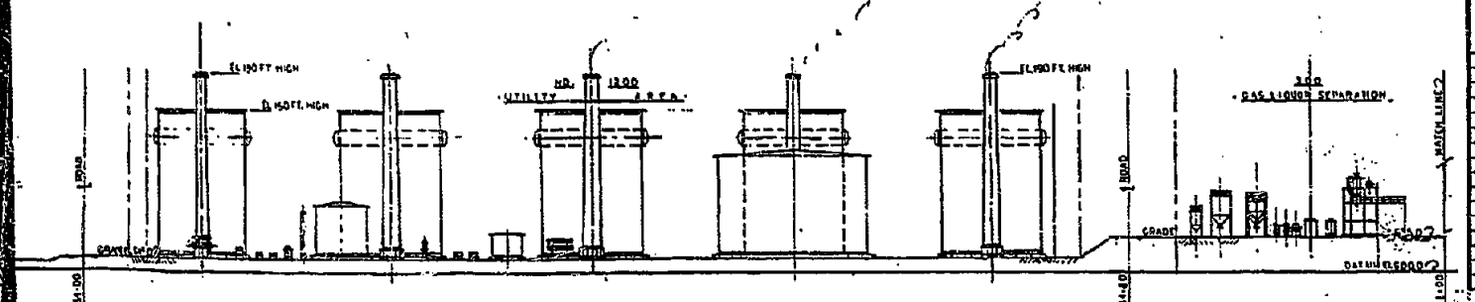
p


O S S - S E C T I O N A - A
O S S - S E C T I O N A - A CONT'D
S S - S E C T I O N A - A CONT'D
NOTE: INDICATED ELEVATIONS ARE ABOVE GRADE, TENTATIVE, & SUBJECT TO CHANGE.
CROSS-SECTION "A-A"
"LURGI"-PROCESS
TENNESSEE VALLY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MURPHY, NEB.
ALABAMA
FINAL ISSUE

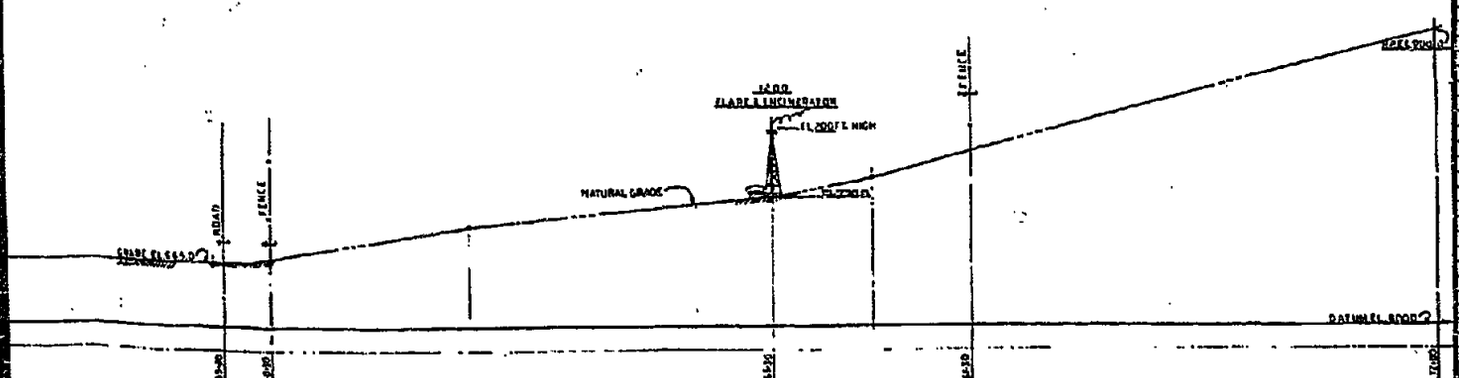

EL. 100 FT. HIGH
EL 50 FT. HIGH
ORIGINAL GRADE LINES
GRADE EL. 50.0
C R O S S - S E C T I O
EL 150 FT HIGH
EL 100 FT. HIGH
EL 100 FT. HIGH
EL 50 FT. HIGH
GRADE EL 50.0
C R O S S - S E C T I O
NO. 300 COAL GASIFIERS
EL 100 FT. HIGH
NO. 500 SULFUR RECOVERY
GRADE EL 65.0
FENCE
C R O S S - S E C T I O



S S - S E C T I O N B - B"



S S - S E C T I O N B - B" CONTD.



NOTE: INDICATED ELEVATIONS ARE ABOVE GRADE, TENTATIVE, AND SUBJECT TO CHANGE.

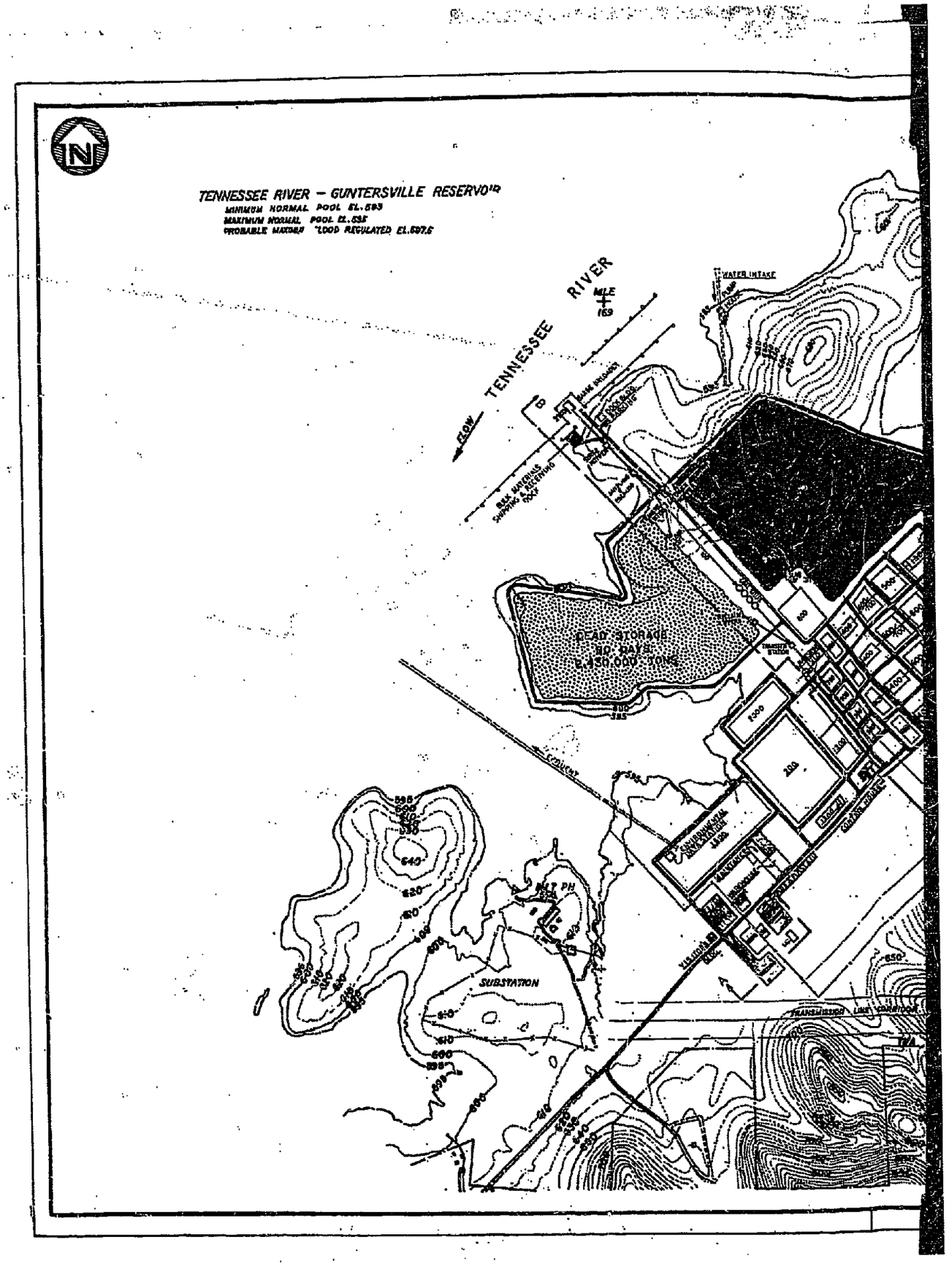
S S - S E C T I O N B - B" CONTD.

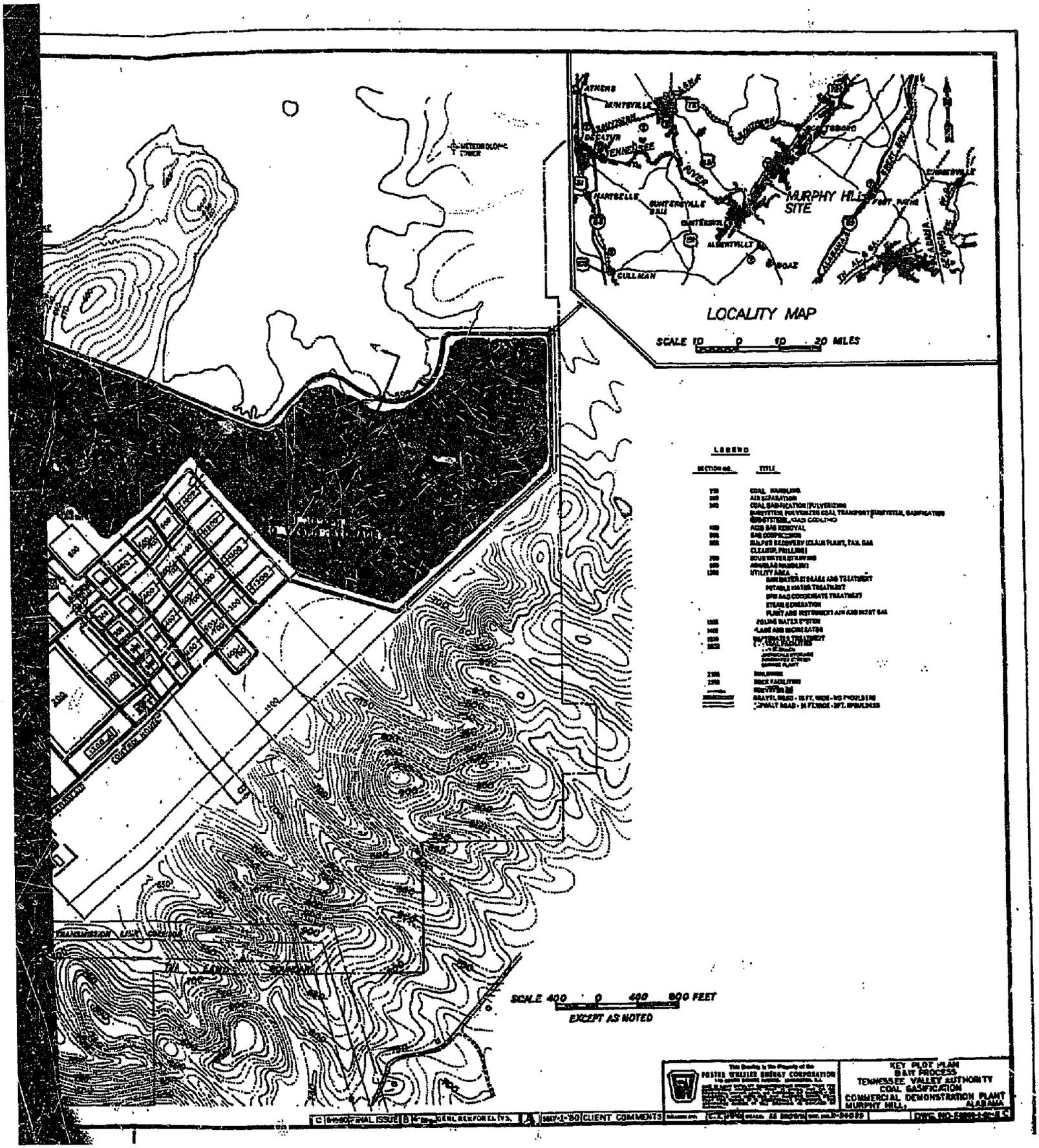
A	8-15-80	FINAL ISSUE	

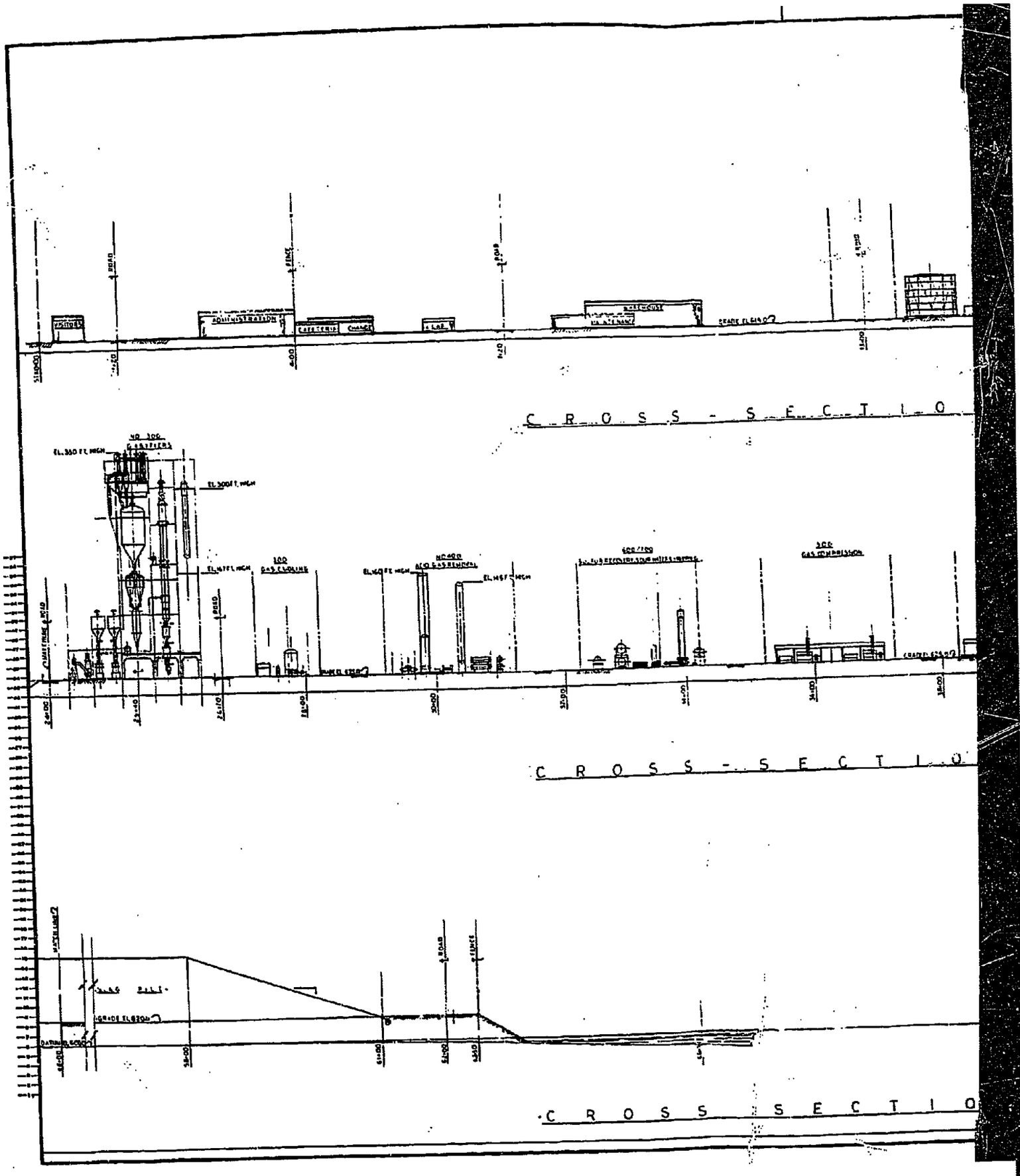
FOSTER WHEELER ENERGY CORPORATION

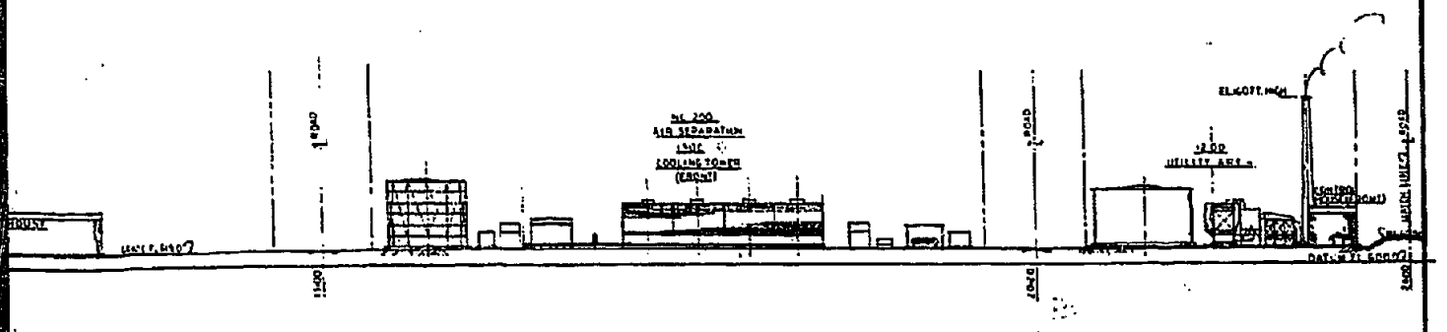
CROSS-SECTION "B-B"
"LURGI" PROCESS
TENNESSEE VALLEY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MURPHY HILL ALABAMA

DWG. NO. 540591-1-131-HA

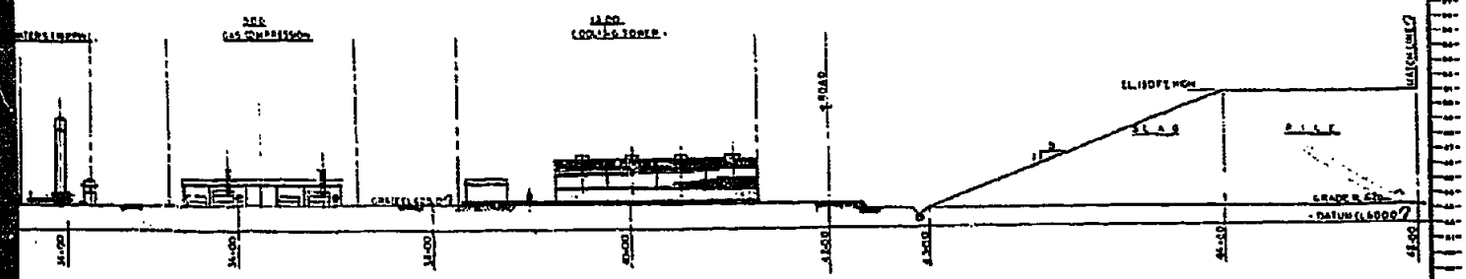

TENNESSEE RIVER – GUNTERSVILLE RESERVOIR
MINIMUM NORMAL POOL EL. 593
MAXIMUM NORMAL POOL EL. 635
PROBABLE MAXIMUM FLOOD REGULATED EL. 697.6
TENNESSEE RIVER
MILE 169
FLOW
WATER INTAKE
BANK STABILIZATION
BULK MATERIALS SHIPPING FACILITY
DEAD STORAGE
90 DAYS
2,430,000 TONS
SUBSTATION
TRANSMISSION LINE CORRIDOR
TVA


METEOROLOGICAL TOWER
ATHENS
DECATUR
TENNESSEE RIVER
HARTSELLE
GUNTERSVILLE DAM
GUNTERSVILLE
ALBERTVILLE
CULLMAN
BOAZ
MURPHY HILL SITE
CHEROKEE
FORT PAYNE
ALABAMA
GEORGIA
LOCALITY MAP
SCALE 10 0 10 20 MILES
LEGEND
SECTION NO.
TITLE
COAL HANDLING
AIR SEPARATION
COAL PREPARATION (PULVERIZING)
GASIFIERS, POLYMERIZER, COAL TRANSPORT, CRYSTAL, GASIFICATION
GAS COOLING
ACID GAS REMOVAL
GAS COMPRESSING
SULFUR RECOVERY (CLAUS PLANT, TAIL GAS CLEANUP, PHILLIPS)
SOLVENT REJUVENATING
AMMONIA HANDLING
UTILITY AREA
RAW WATER STORAGE AND TREATMENT
POTABLE WATER TREATMENT
SPW AND CONDENSATE TREATMENT
STEAM GENERATION
PLANT AND INSTRUMENT AIR AND INERT GAS
COOLING WATER SYSTEM
ASH AND SLAG REMOVAL
WASTE WATER TREATMENT
ADMINISTRATION BUILDING
SHOP FACILITIES
GRAVEL ROAD - 22 FT. WIDE - NO SHOULDERS
ASPHALT ROAD - 24 FT. WIDE - 8 FT. SHOULDERS
SCALE 400 0 400 800 FEET
EXCEPT AS NOTED
C FINAL ISSUE
B GEN. REVISIONS
A MAY-1-80 CLIENT COMMENTS
KEY PLOT PLAN
B&W PROCESS
TENNESSEE VALLEY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MURPHY HILL, ALABAMA


C R O S S - S E C T I O
C R O S S - S E C T I O
C R O S S S E C T I O



S - S E C T I O N "A - A"



S - S E C T I O N "A - A" CONT'D

S S E C T I O N A - A CONT'D

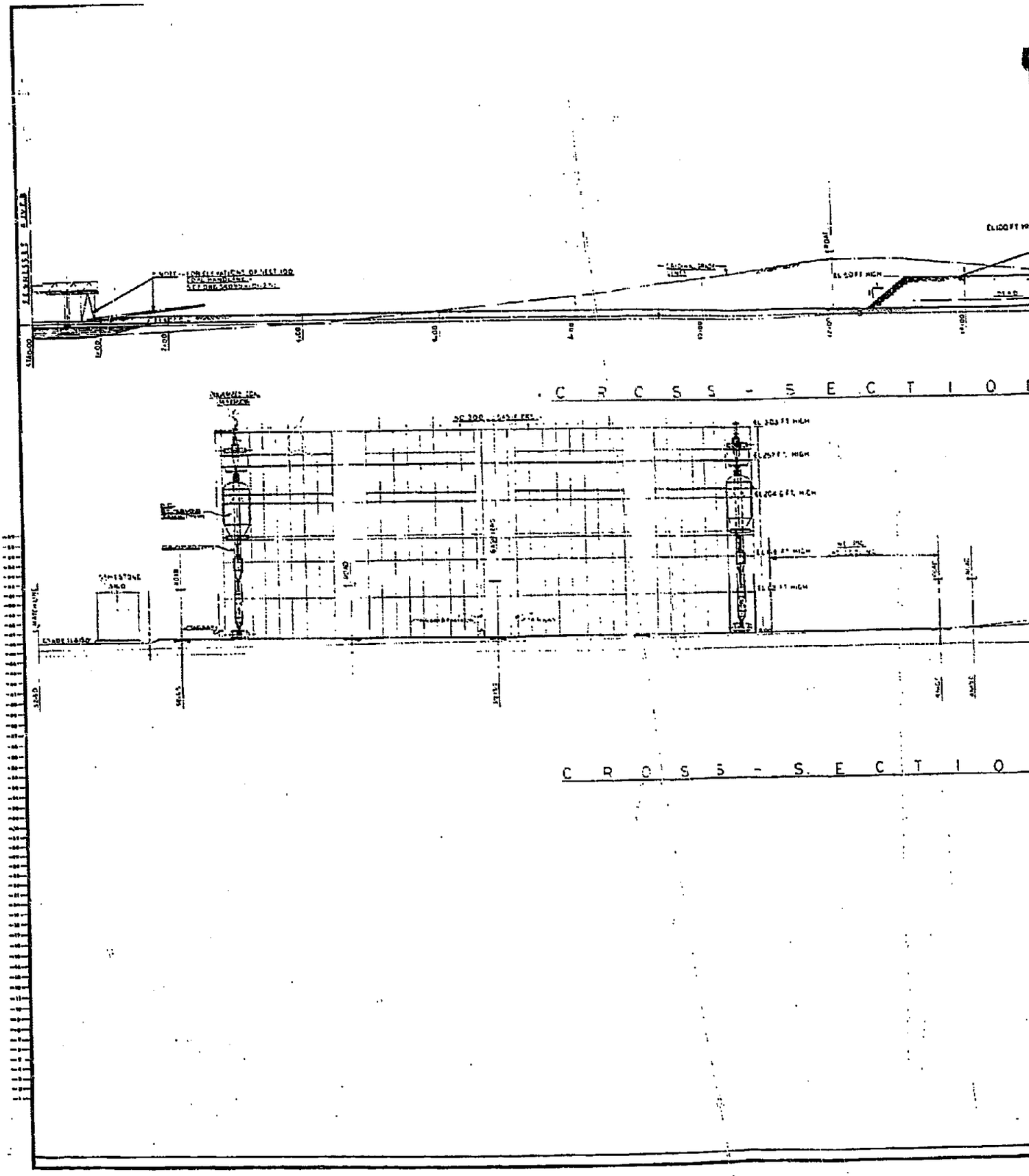
NOTE: INDICATED ELEVATIONS ARE ABOVE GRADE, TENTATIVE AND SUBJECT TO CHANGE.

POSTER WHEELER ENERGY CORPORATION

CROSS-SECTION "A-A"
U-GAS PROCESS
TENNESSEE VALLEY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MURPHY HILL ALABAMA

A 8-9-80 FINAL ISSUE

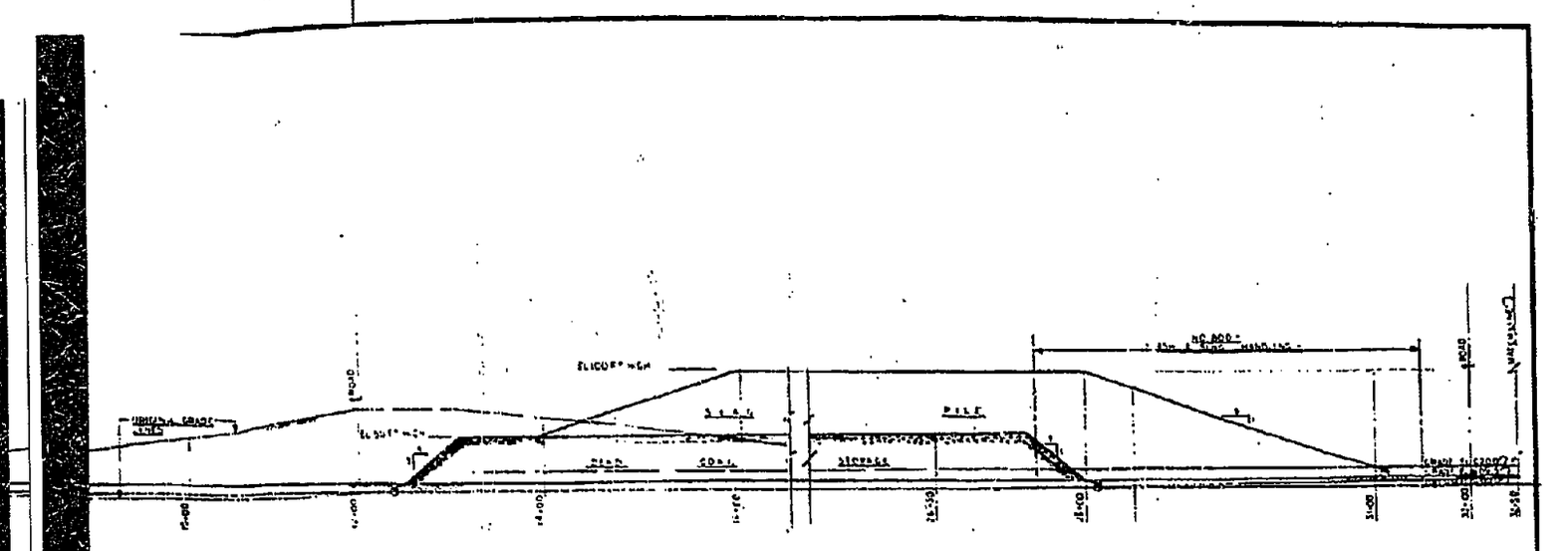
p



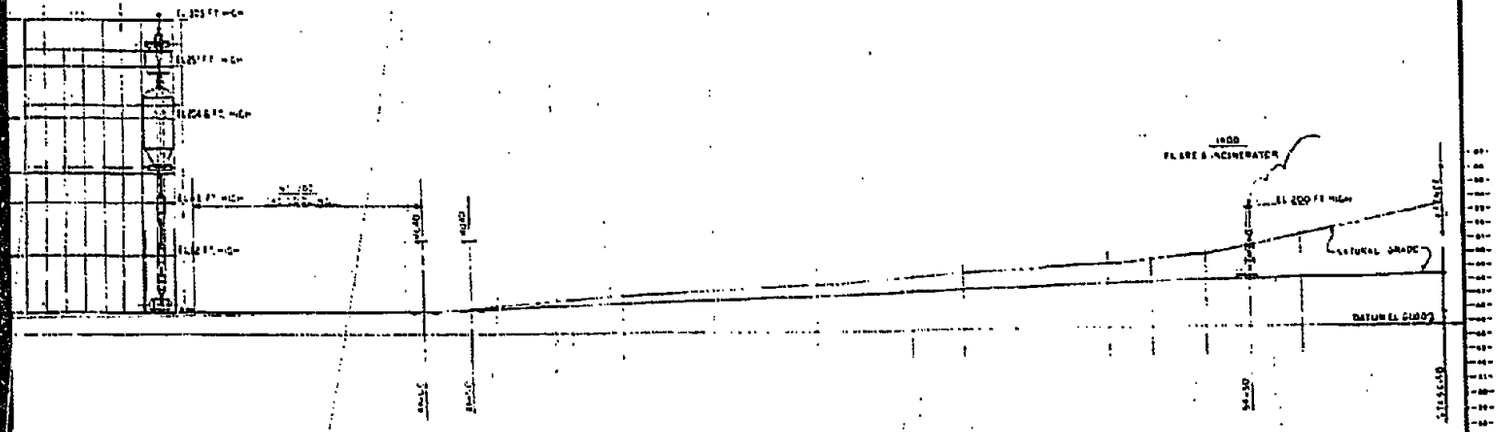
C R O S S - S E C T I O

C R O S S - S E C T I O

p



S S - S E C T I O N B - B



S S - S E C T I O N B - B CONTD

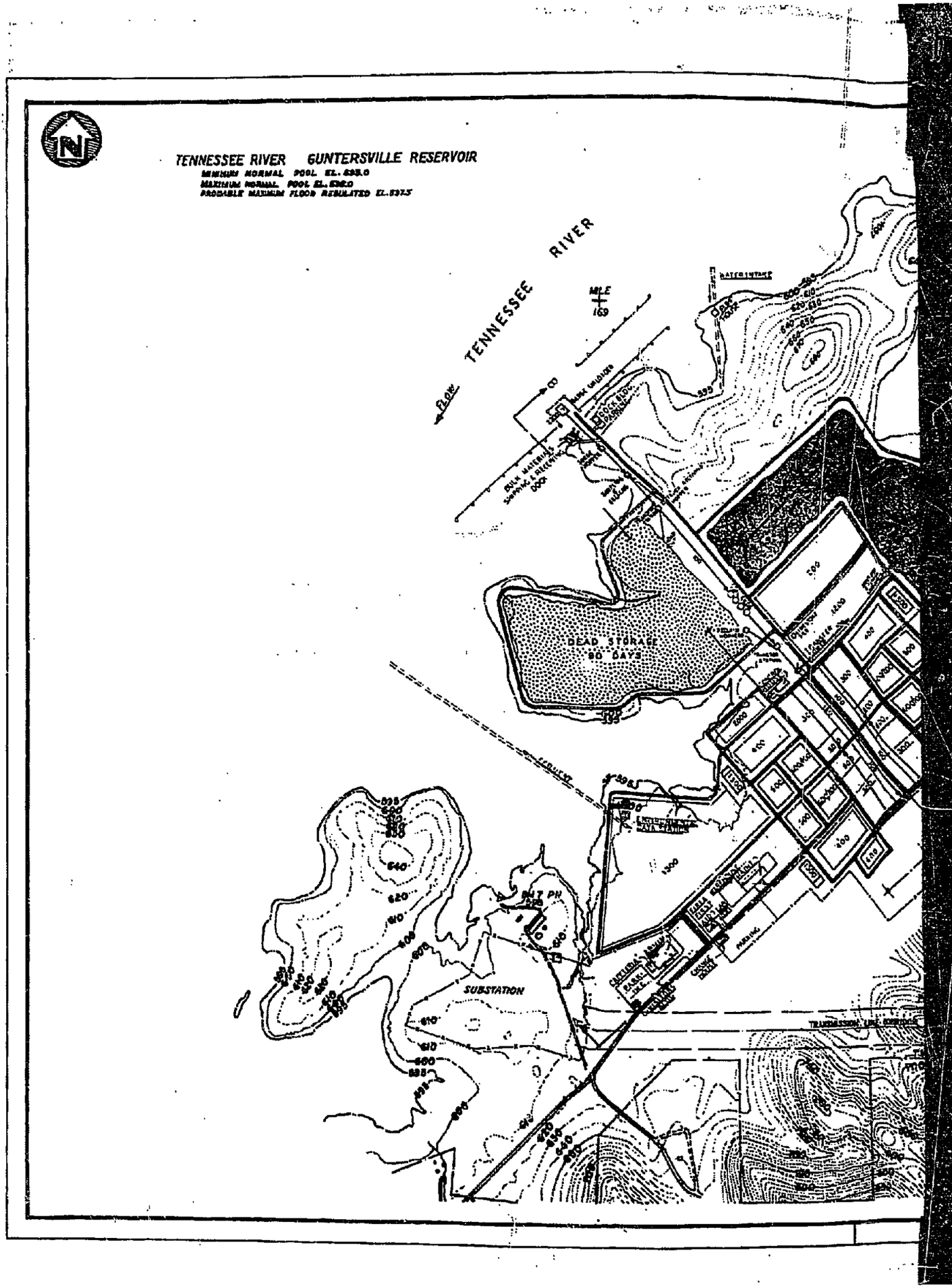
NOTE: INDICATED ELEVATIONS ARE ABOVE GRADE, TENTATIVE, AND SUBJECT TO CHANGE

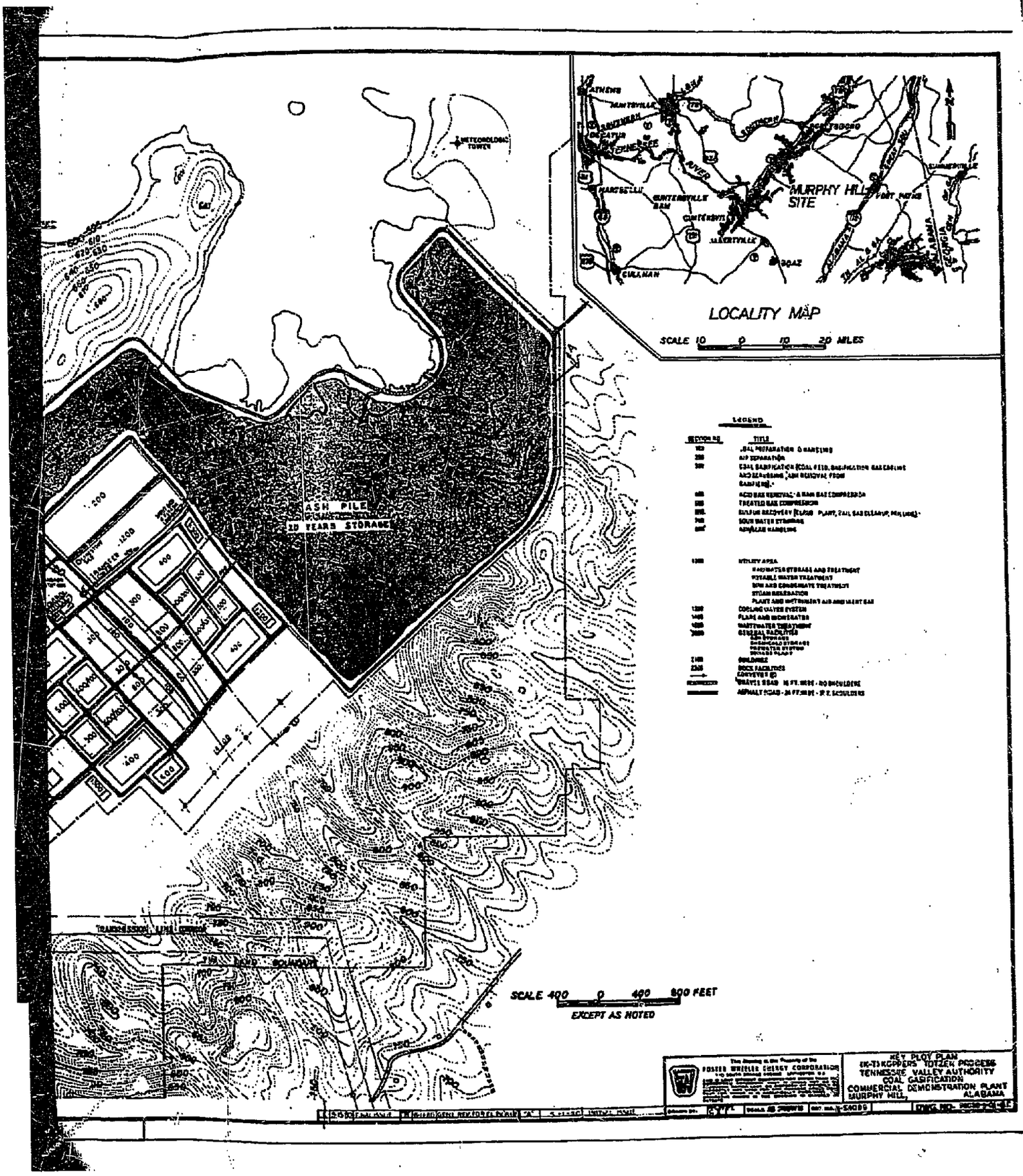
FOSTER WHEELER ENERGY CORPORATION

CROSS-SECTION B-B
"D.A.W." PROCESS
TENNESSEE VALLEY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MURPHY HILL
ALABAMA

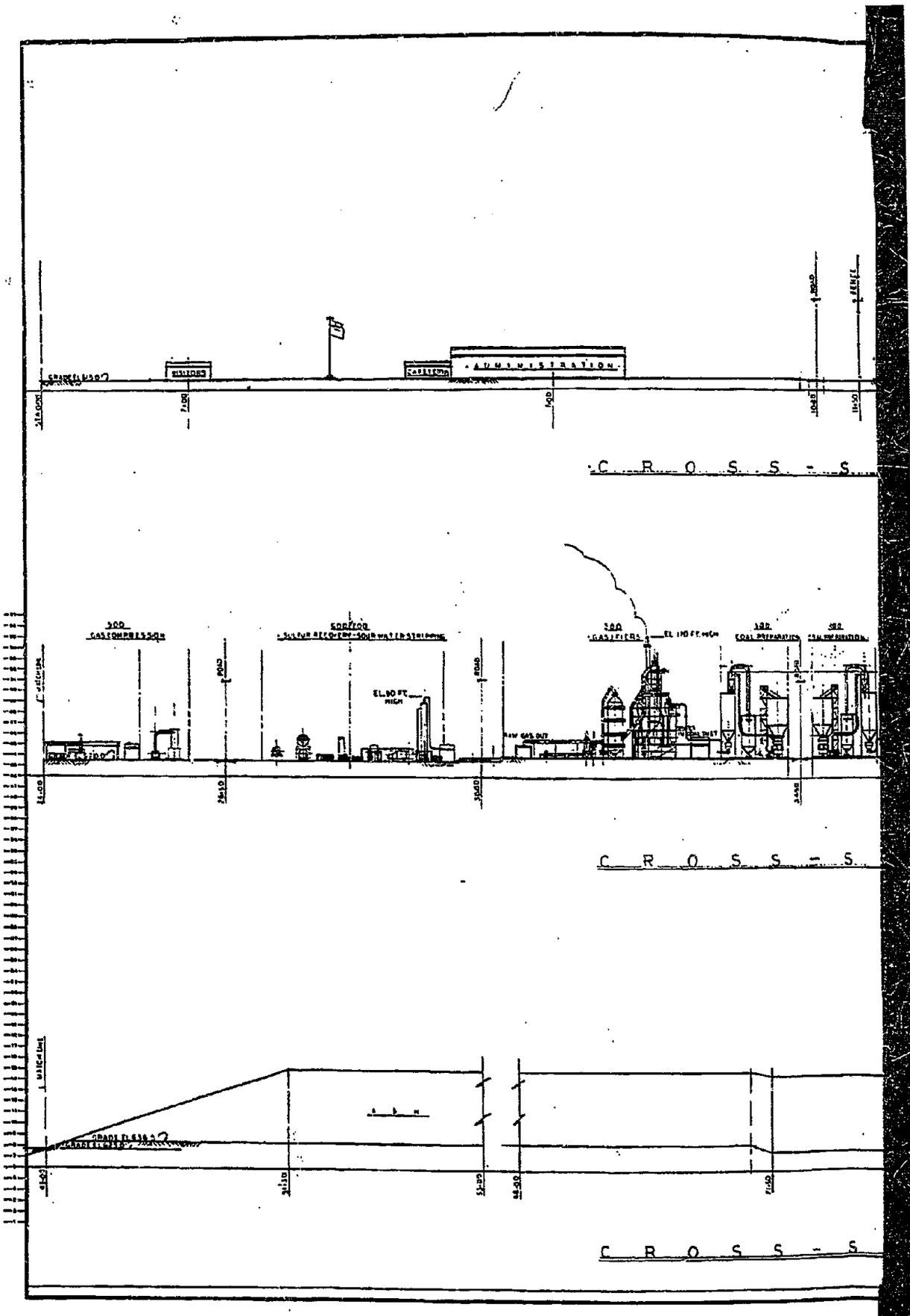
A 8-15-80 FINAL ISSUE

112/54099 DWG. NO. 54099-1-01-11A


TENNESSEE RIVER GUNTERSVILLE RESERVOIR
MINIMUM NORMAL POOL EL. 595.0
MAXIMUM NORMAL POOL EL. 595.0
PROBABLE MAXIMUM FLOOD REGULATED EL. 837.5
TENNESSEE RIVER
FLOW
MILE 169
DEAD STORAGE 90 DAYS
SUBSTATION
EFFLUENT


METEOROLOGIC TOWER
ASH PILE
10 YEARS STORAGE
MURPHY HILL SITE
LOCALITY MAP
SCALE 10 0 10 20 MILES
LEGEND
SCALE 400 0 400 800 FEET
EXCEPT AS NOTED
KEY PLOT PLAN
BI-TI KOPPERS TOTZEK PROCESS
TENNESSEE VALLEY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MURPHY HILL,
ALABAMA

p



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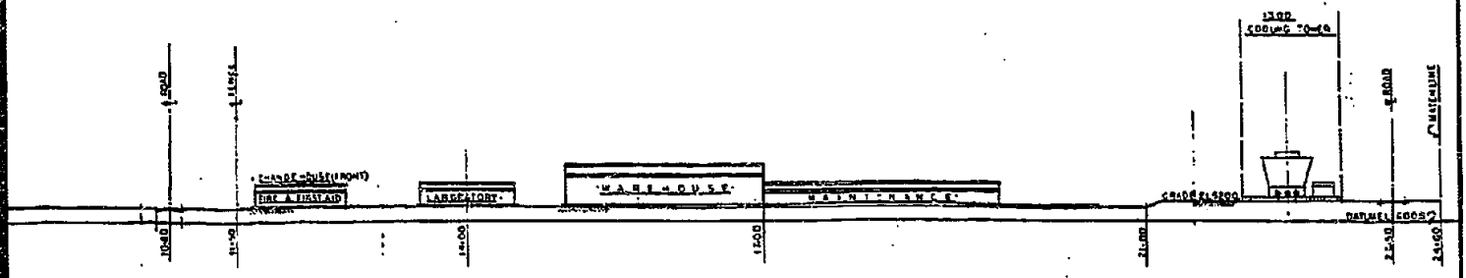
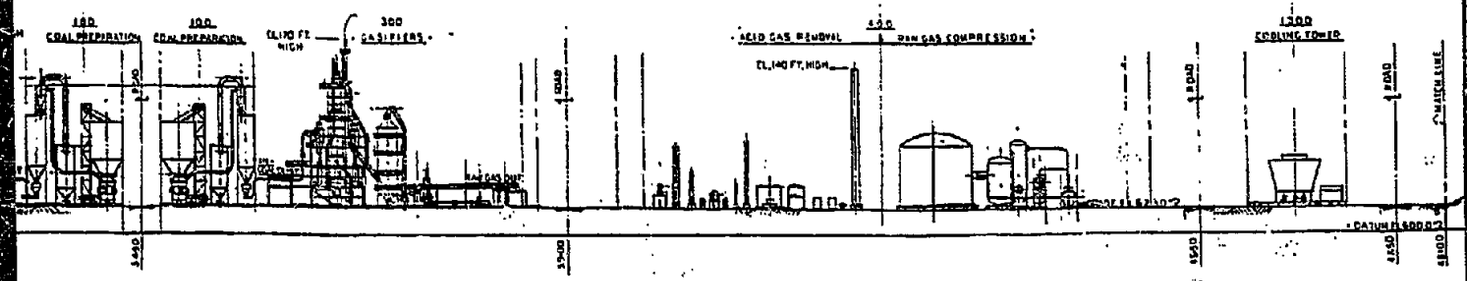
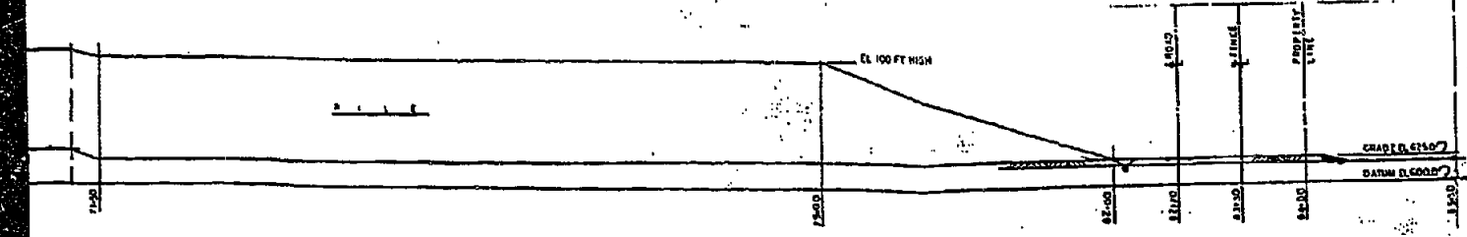


S S - S E C T I O N A - A



S S - S E C T I O N A - A CONTD.



S S - S E C T I O N A - A CONTD.

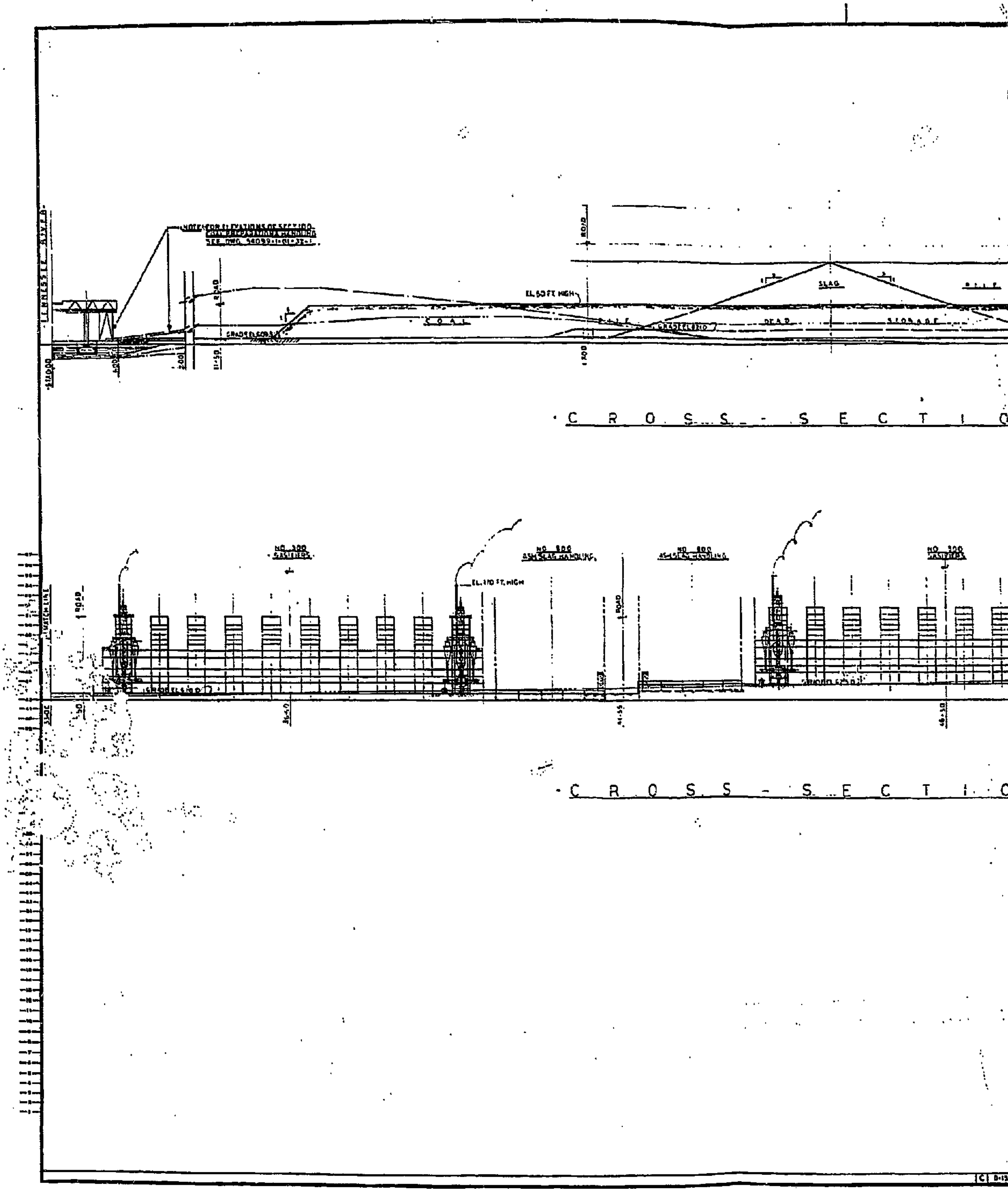
NOTE: INDICATED ELEVATIONS ARE ABOVE GRADE, TENTATIVE, AND SUBJECT TO CHANGE.

POSTER WHEELER ENERGY CORPORATION

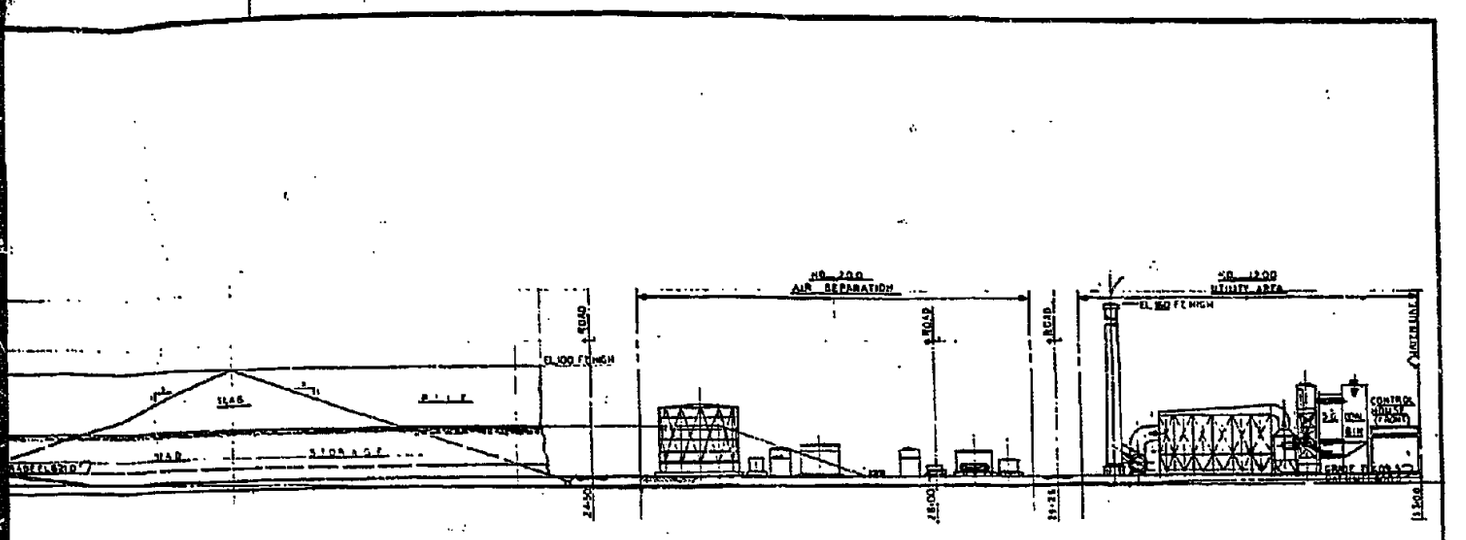
CROSS-SECTION "A-A"
(K-T) KOPPERS TOTZEK PROCESS
TENNESSEE VALLY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MURPHY HILL ALABAMA

A | 8-15-83 | FINAL ISSUE

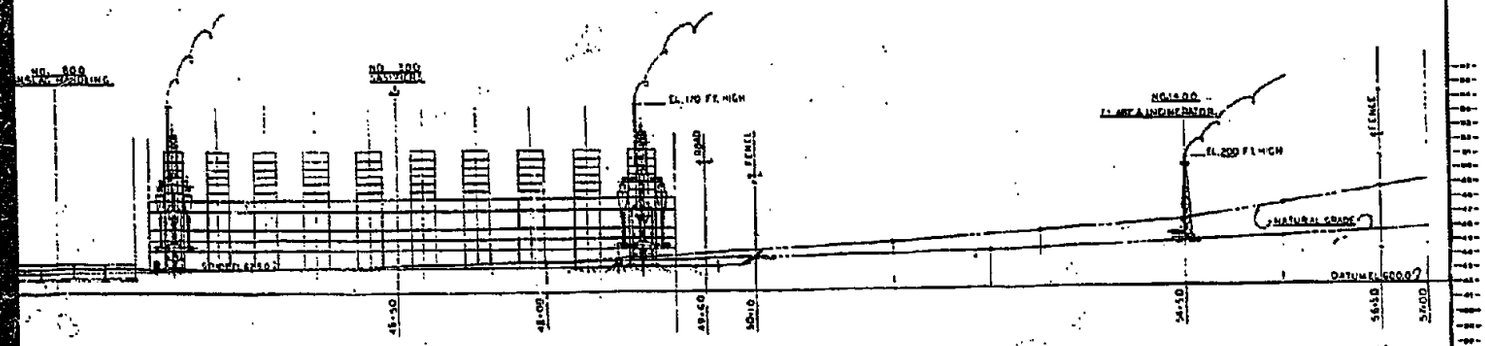
SCALE 1"=40'-0" | DWG. NO. 54099-01-A



SLAG
COAL
PILE
DEAD
STORAGE
ROAD
NO. 300 GASIFIERS
NO. 800 ASH-SLAG HANDLING
C R O S S - S E C T I O
C R O S S - S E C T I O



S S - S E C T I O N B - B



S S - S E C T I O N B - B CONT'D

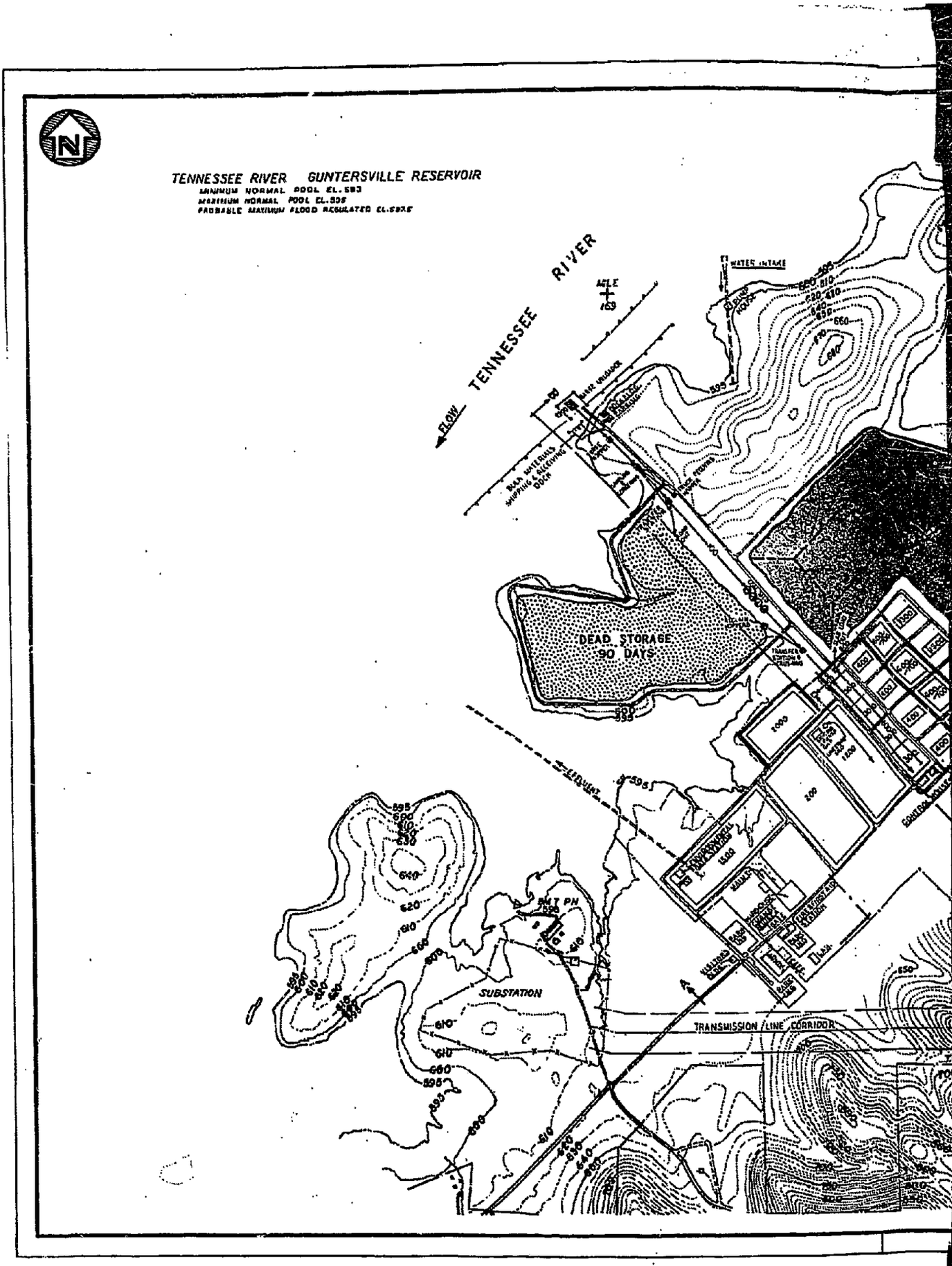
NOTE: UNLOCATED EL. DIMENSIONS ARE ABOVE GRADE, TENTATIVE, AND SUBJECT TO CHANGE

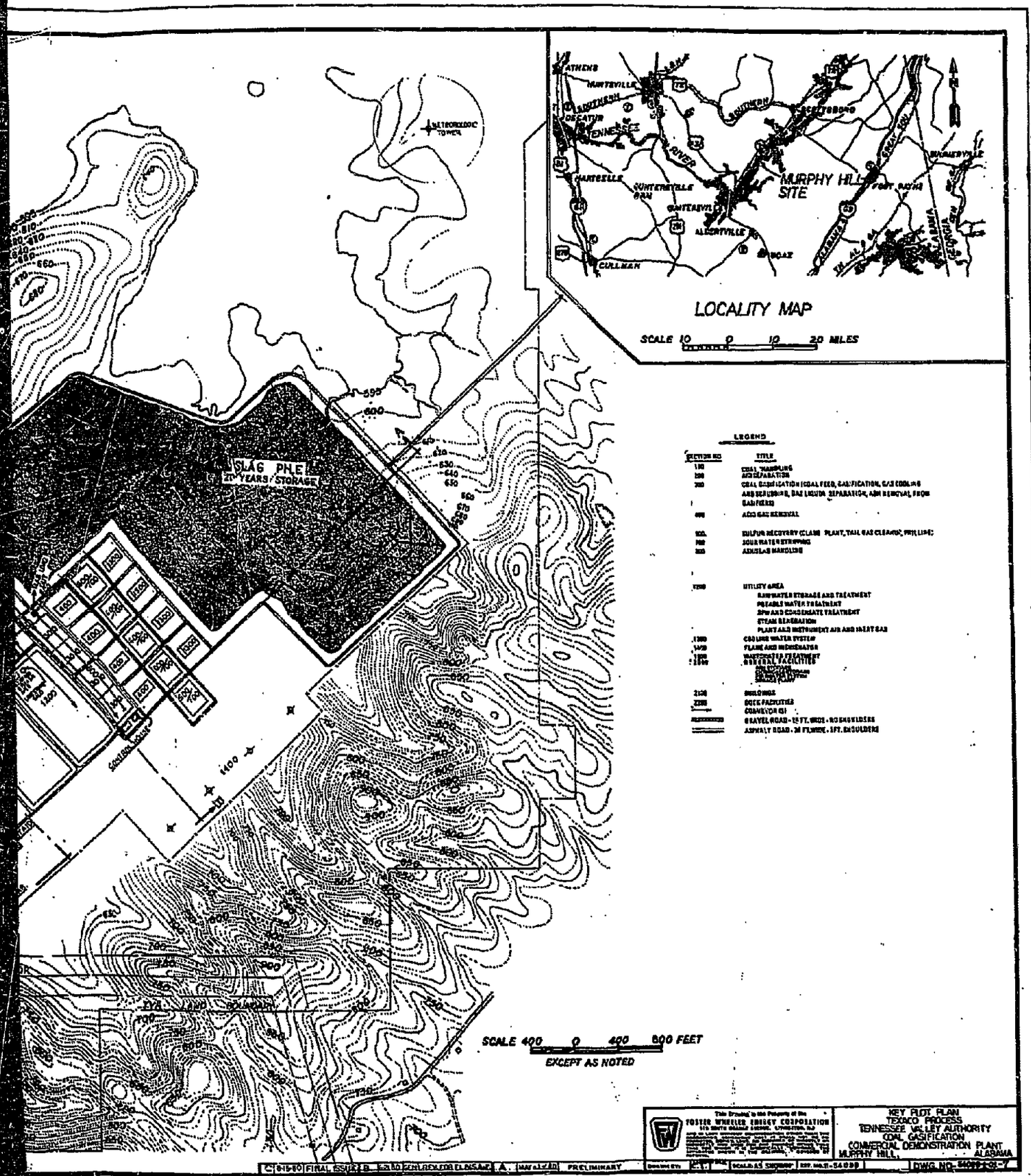
POSTER WHEELER ENERGY CORPORATION

CROSS-SECTION 'B-B'
(K-T) KOPPERS-TOTZEK PROCESS
TENNESSEE VALLEY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MUSCLE SHOALS ALABAMA

H-54099 DWG. NO. 54099-1-01-DC

C 9-15-80 FINAL ISSUE | B 6-27-80 SMALL REVISIONS | A 6-19-80 INITIAL ISSUE


TENNESSEE RIVER GUNTERSVILLE RESERVOIR
MINIMUM NORMAL POOL EL. 593
MAXIMUM NORMAL POOL EL. 595
PROBABLE MAXIMUM FLOOD REGULATED EL. 595.5
TENNESSEE RIVER
FLOW
WATER INTAKE
ACLE
169
RAW MATERIALS SHIPPING & RECEIVING DOCK
DEAD STORAGE 90 DAYS
EFFLUENT
SUBSTATION
TRANSMISSION LINE CORRIDOR



LEGEND

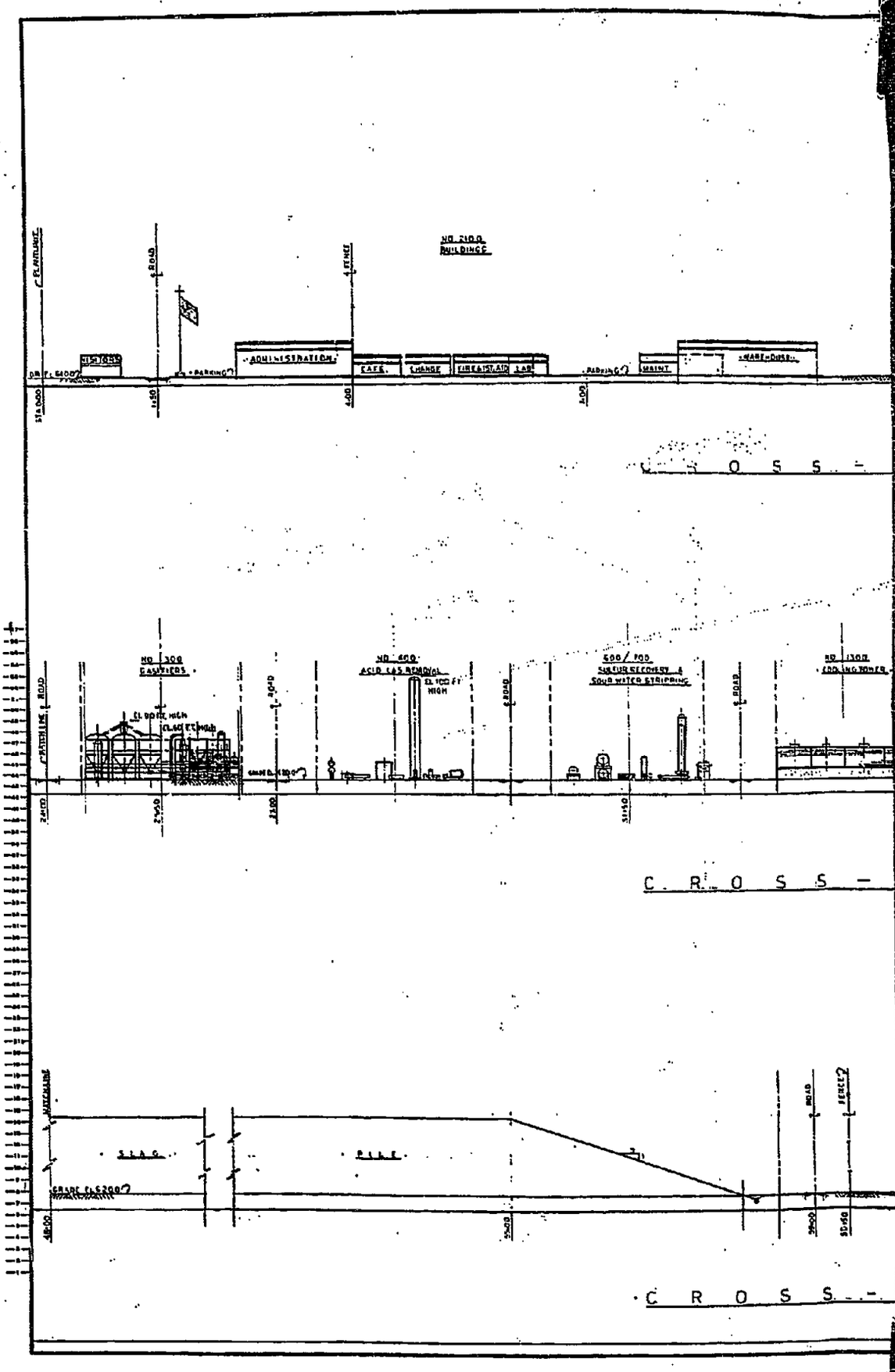
SECTION NO	TITLE
100	COAL HANDLING AND PREPARATION
200	COAL GASIFICATION (COAL FEED, GASIFICATION, GAS COOLING AND SCRUBBING, GAS LIQUOR SEPARATION, ASH REMOVAL FROM GASIFIERS)
400	ACID GAS REMOVAL
500	SULFUR RECOVERY CLAUS PLANT, TAIL GAS CLEANUP, PIPELINE
900	SOUR WATER STRIPPING
800	AMMONIA HANDLING
1100	UTILITY AREA RAW WATER STORAGE AND TREATMENT POTABLE WATER TREATMENT BFW AND CONDENSATE TREATMENT STEAM GENERATION PLANT AND INSTRUMENT AIR AND INERT GAS
1300	COOLING WATER SYSTEM
1400	FLARE AND INCINERATOR
1700	WASTEWATER TREATMENT
1800	SERVICE FACILITIES
2100	BUILDINGS
2200	DOCK FACILITIES
	CONVEYOR (S)
	GRAVEL ROAD - 25 FT. WIDE - NO SHOULDERS
	ASPHALT ROAD - 28 FT. WIDE - 3 FT. SHOULDERS

NO.	DATE	BY	REVISION
C	8-15-80	FINAL ISSUED	
B	5-30-80	CONCEPTUAL PLANT	
A	MAY 1980	PRELIMINARY	

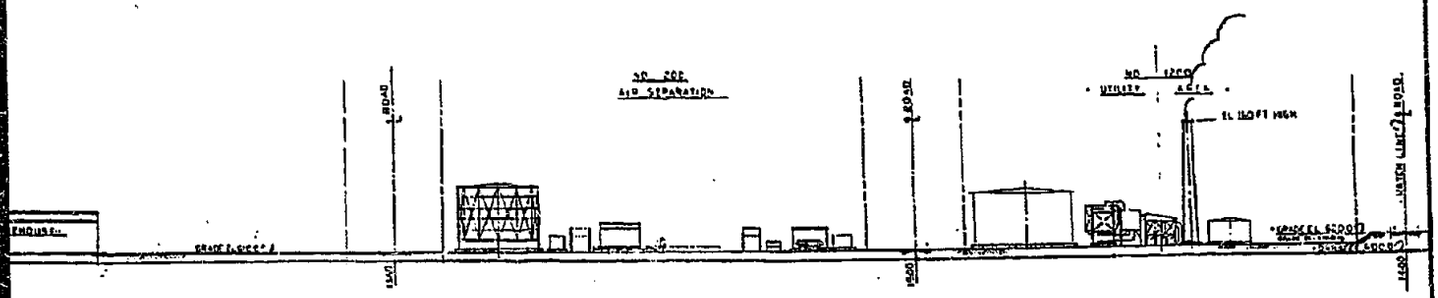
This Drawing is the Property of the FOSTER WHEELER ENERGY CORPORATION

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

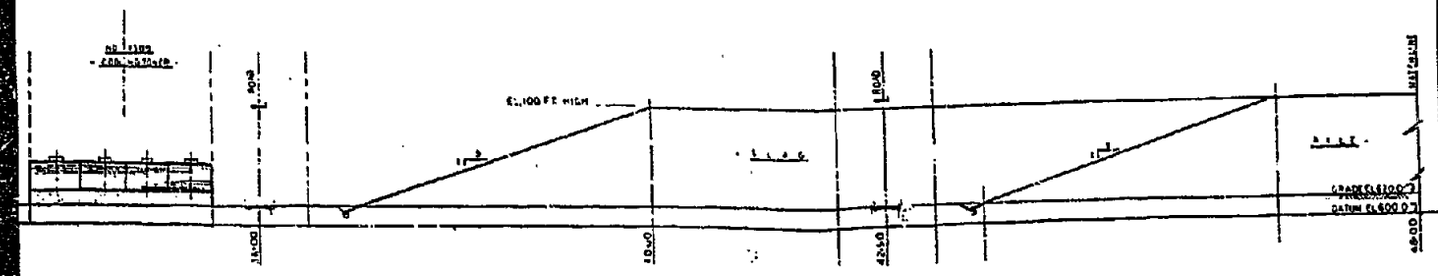
DWG. NO. 54099-C1-7


NO. 2100
BUILDINGS
ADMINISTRATION
CAFE
CHANGE
FIRE & 1ST AID
LAB
MAINT
STORE
CROSS -
NO. 300
GASIFIERS
NO. 600
ACID GAS REMOVAL
SULFUR RECOVERY &
SOUR WATER STRIPPING
NO. 1300
COOLING TOWERS
CROSS -
SLAG
PIPE
CROSS -

p



S S - S E C T I O N A - A



S S - S E C T I O N A - A - CONT'D

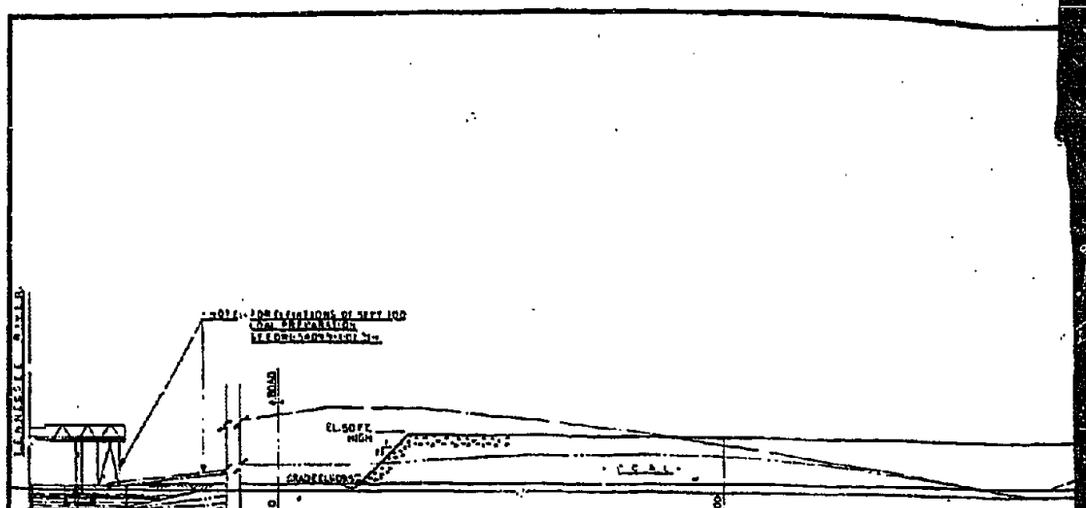
S S - S E C T I O N A - A - CONT'D

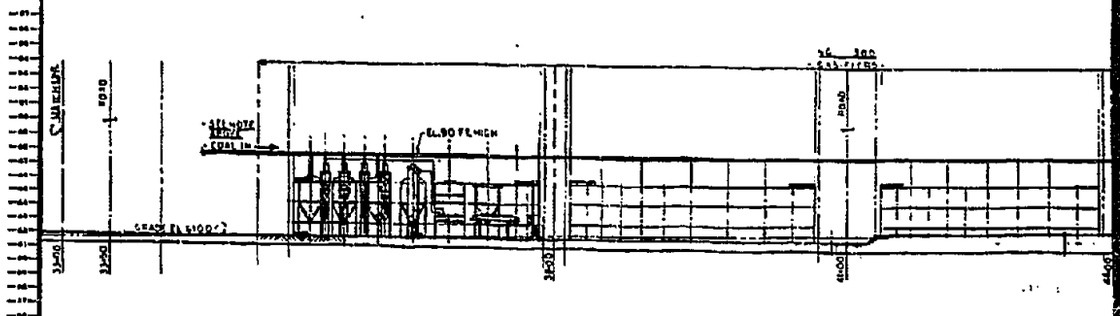
NOTE: INDICATED ELEVATIONS ARE ABOVE GRADE, TENTATIVE, AND SUBJECT TO CHANGE.

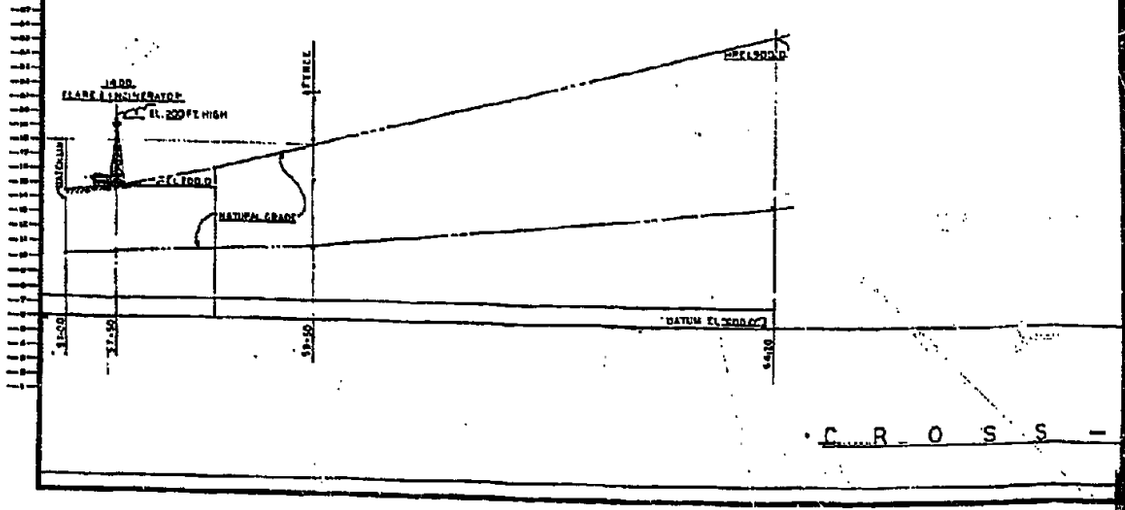
FOSTER WHEELER ENERGY CORPORATION

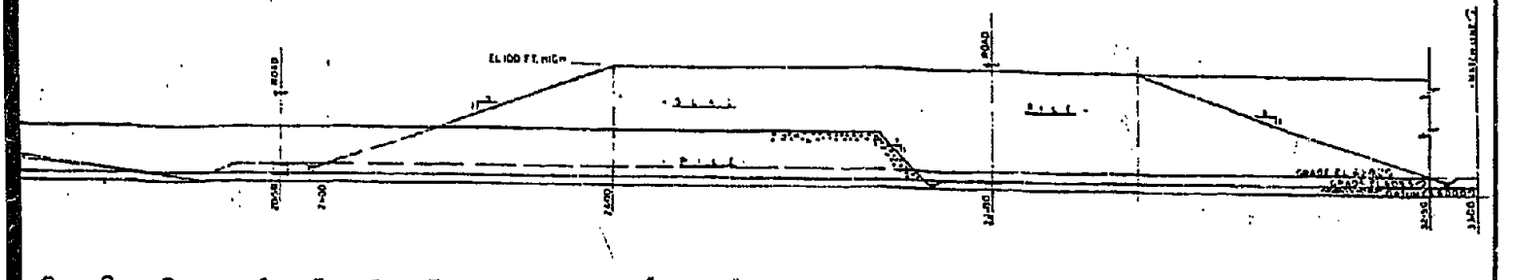
CROSS-SECTION "A-A"
TEXACO PROCESS
TENNESSEE VALLEY AUTHORITY
COAL GASIFICATION -
COMMERCIAL DEMONSTRATION PLANT
MURPHY HILL ALABAMA

A | 8-15-80 | FINAL ISSUE

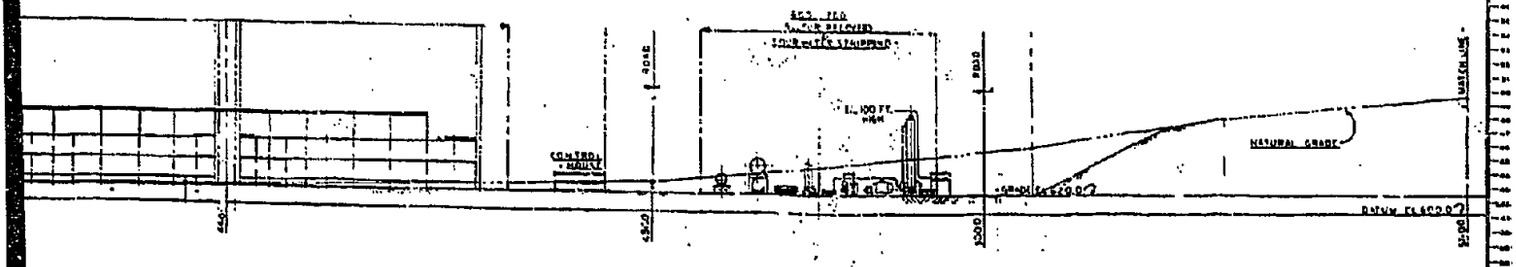

EL. 50 FT. HIGH
C R O S S -


EL. 90 FT. HIGH
C R O S S -


EL. 200 FT. HIGH
NATURAL GRADE
C R O S S -



O S S - S E C T I O N "B - B"



O S S - S E C T I O N "B - B" (CONT'D)

S S - S E C T I O N "B - B" CONT'D

NOTE: INDICATED ELEVATIONS ARE ABOVE GRADE, TENTATIVE, AND SUBJECT TO CHANGE.

A	8-15-80	FINAL ISSUE

FOSTER WHEELER ENERGY CORPORATION

CROSS SECTION "B-B"
TEXACO PROCESS
TENNESSEE VALLEY AUTHORITY
COAL GASIFICATION
COMMERCIAL DEMONSTRATION PLANT
MURPHY HILL, ALABAMA

1" = 50'-0" DWG. NO. S-4099-1-01-54