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FUEL GAS DEMONSTRATION PLANT PROGRAM

SMALL-SCALE INDUSTRIAL PROJECT

MECHANICAL DESIGN

PHASE I VOLUME 1

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Prepared for the

U.S. DEPARTMENT OF ENERGY

Assistant Secretary for Energy Technology
Office of Fossil Fuels

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Industrial Fuel Gas Demonstration Plant Program

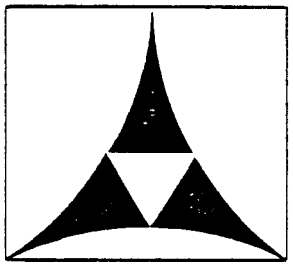
TASK III REPORT

DEMONSTRATION PLANT MECHANICAL DESIGN

VOLUME I

OVERALL PLANT DESCRIPTION

Prepared For
The Department of Energy
Under Contract ET-77-C-01-2582



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DEMONSTRATION PLANT MECHANICAL DESIGN

REPORT VOLUMES

Volume I	Overall Plant Description
Volume II	Air Separation
Volume III	Coal/Coke Treating & Feed Coal/Coke Handling Dock Facilities
Volume IV	Gasification Gas Cooling and Scrubbing Ash Treatment
Volume V	Gas Compression Gas Treating
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OVERALL PLANT DESCRIPTION

Volume I

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Section 1.0

INTRODUCTION

1.1 Project Description

The United States Department of Energy (DOE) awarded a contract to Memphis Light, Gas and Water Division (MLGW) which requires MLGW to perform process analysis, design, procurement, construction, testing, operation, and evaluation of a plant which will demonstrate the feasibility of converting high sulfur bituminous coal to industrial fuel gas with a heating value of 300 ± 30 Btu per standard cubic foot (SCF). The demonstration plant is to be based on the U-Gas process, with its product gas to be used in commercial applications in Memphis, Tennessee.

In order to perform this work, MLGW has established an industrial team, which includes:

MLGW - Memphis Light, Gas and Water Division, Memphis, Tenn.
The prime contractor and distributor of the industrial fuel gas.

FWEC - Foster Wheeler Energy Corporation, Livingston, N.J.
The engineer-construction manager.

IGT - Institute of Gas Technology, Chicago, Illinois.
The process developer.

DRC - Delta Refining Company, Memphis, Tenn.
To provide operating experience.

The contract specifies that the work is to be conducted in three phases. The Phases are:

Phase I - Program Development and Conceptual Design
Phase II - Demonstration Plant Final Design, Procurement and Construction
Phase III - Demonstration Plant Operation

Under Task III of Phase I a Mechanical Design and Cost Estimate for the Demonstration Plant was completed. The output of this Task, in addition to the cost estimate, is comprised of the following items:

a. Drawings/Flowsheets
b. Equipment List
c. Procurement Requisitions
d. Instrumentation Data
e. Plot Plans
f. Building Sketches

This report, entitled "Demonstration Plant Mechanical Design", is intended to provide all engineering information necessary for the preliminary design of the plant. This report, which should be used in conjunction with the Task II report "Demonstration Plant Process Design" includes information on all plant units shown on Table 1.

This Task III report is provided in twelve volumes as shown on Page i.

This is Volume I, Overall Plant Description. Combined with the other volumes comprising the Demonstration Plant Mechanical Design Report and the Process Design (Task II) Report, the material meets the requirements for deliverables No. 17, 19, 21 and 24; as specified within Appendix A - Statement of Work.

Table 1

AREA DESIGNATIONS
FOR DEMONSTRATION PLANT

Area No.	Title	Section No.
2230	Process Units	-
2231	Air Separation	310
2232	Coal/Coke Treating & Feed	320
2233	Coal Gasification	330
2234	Gas Cooling & Scrubbing	340
2235	Gas Compression (Raw/Recycle Gas)	350
2236	Gas Treating	360
2237	Sour Water Stripping	370
2238	Sulfur Recovery	380
2239	Tail Gas Treating	390
2222	Credit Generation	220
2240	Support Facilities	-
2241	Coal/Coke Handling	410
2242	Ash Treatment	420
2243	Utility Area Steam Generation Raw Water Storage BFW Treatment Plant Air	430
2244	Waste Water Treatment	440
2245	Cooling Tower	450
2246	Flare	460
2247	General Facilities Long Term Coal Storage Long Term Ash & Solid Waste Storage Interconnecting Piping Roads & Fences Firewater System Power & Lighting, & Communication Sewers	470
2248	Buildings	480
2249	Dock Facilities	490

Note: Section numbers shown on Drawings are the last two digits of the area number, followed by a zero (e.g. Section 310 is Air Separation Unit). Area numbers have been established for Cost Control Purposes in Phase II.

1.2 Plant Summary

The Industrial Fuel Gas Demonstration Plant produces a nominal 50 billion BTU/Day of product gas, which is equivalent in energy output to approximately a 10,000 barrel/day oil refinery. The product gas has a heating value of 300 ± 30 BTU/SCF. 45 billion BTU/Day of this gas is available as send-out gas to IFG customers. The remaining 5 billion BTU/Day of this gas is further processed to pipeline quality (950 BTU/SCF) and deposited in the Memphis natural gas distribution system to generate BTU credit. The BTU credit can be withdrawn and used to satisfy IFG customer demand when the U-Gas production facility is totally or partially down for maintenance. By the use of the credit generation system the demand of IFG customers can thus be assured.

Drawing 2202-1-50-00104 is the plant block flow diagram showing the process sequence and process related support facilities of this demonstration plant. Each process unit as well as each process related support facility is described briefly in the following summary.

Section 310, Air Separation Plant
Compresses intake air and separates it into oxygen and nitrogen. The oxygen is compressed and sent to the gasifiers. A small portion of the nitrogen is returned for plant use. Liquid oxygen and nitrogen can also be produced to keep their respective storage tanks filled in order to provide the necessary reserve for an outage of the air separation plant.

Section 320, Coal/Coke Treating and Feed
Coal is crushed from 2" x 0" to 1/4" x 0" and dried to 2.5% moisture in a dryer mill. The dried, sized coal is stored in a coal silo. Sized coke received by the plant is also dried by a separate dryer and stored in a coke silo. Coal or coke is conveyed to the gasifier feeding systems from either the coal or coke silo. Dual conveying systems are provided to fill the gasifier feeding systems with one serving as a spare. Each gasifier has its own feeding system. The gasifier feeding system is a multi-feed hopper system, each consisting of a receiving hopper, two lock hoppers and two injection hoppers. Each injection hopper feeds into three pneumatic injection lines which transports coal or coke into the gasifier.

Section 330, Coal Gasification
Contains the coal gasifiers where steam and oxygen react with the coal in a fluidized bed at about 1875°F and 75 psig to produce hot, raw gas (CO, CO_2 and H_2). Within the reaction zone of the fluidized bed is an ash-agglomerating zone. The ash agglomerates drop into a water quench. Fines carried over with the hot, raw gas are returned to the gasifier through external cyclones.

Section 340, Gas Cooling and Scrubbing
Cools the gas from 1875°F to 450°F. For purposes of heat recovery, the gas passes in sequence through a high pressure steam generator, high pressure steam superheater, another high pressure steam generator, and a boiler feedwater preheater. After heat recovery the raw gas is quenched to saturation and passes through scrubbers. In the scrubbers particulate matter is removed by scrubbing with water. Sections 330 and 340 are four parallel trains and the balance of the plant is one train. Sour water from the knock-out drum, containing dissolved NH_3 and H_2S passes through a sour water stripper in Section 370; the overhead from the stripper goes to sulfur recovery. The water effluent goes to waste water treatment. The slurry water from the scrubber goes through a slurry water stripper. The slurry water after being stripped is clarified and filtered. The filter cake is sent to the steam generator for use as fuel. The filtrate water effluent is sent to waste water treatment.

Section 350, Gas Compression
Scrubbed gas is cooled, compressed to sufficiently high pressure and cooled again to go through gas treating and deliver the gas at 150 psig to the industrial fuel gas distribution header.

Section 360, Gas Treating
Receives the cooled gas from gas compression in Section 350. It then passes to a Selexol unit where H_2S and COS are removed to meet the product gas sulfur specification, and enough CO_2 is removed to obtain a constant heating value product gas. The product gas is then sent to Section 470 where it will be odorized and metered before being discharged to the industrial fuel gas distribution system.

Section 370, Sour Water Stripping
Receives sour water from Sections 340, 350 and 360. The major portions of ammonia and hydrogen sulfide are removed by means of steam stripping.

Section 380, Sulfur Recovery
Receives sour gas from Section 370 and acid gas from Section 360. It converts the sulfur compound in three catalytic stages of a Claus type sulfur recovery unit to achieve 96% sulfur recovery. Sulfur goes through condensers, seal pit and rundown pit, and storage tank before being loaded into tank trucks.

Section 390, Tail Gas Treating
Receives the tail gas from Section 380. It then goes to a Beavon unit package where remaining sulfur is converted to H_2S, and then removed in a Stretford Unit. The tail gas is reheated to achieve satisfactory buoyancy and discharged to the atmosphere.

Section 220, Credit Generation
Treats from 10% to 30% of the product gas from Section 360 to produce pipeline quality gas which will be deposited into the Memphis pipeline gas distribution system to generate a reserve of credit. This reserve which can be withdrawn during U-gas plant outage. Pipeline gas withdrawn from the Memphis pipeline gas distribution system will be adjusted to the U-gas heating value prior to its distribution to the U-gas customers.

Section 410, Coal/Coke Handling
Receives the incoming washed coal (2" x 0") from barges and transports it to a 14 day live coal storage pile. From there coal is transported to Section 320.

Section 420, Ash Treatment
Receives the agglomerated quenched ash slurry from the gasifiers (Section 330) and conveys it hydraulically to the dewatering bins. The dewatered ash is then discharged into trucks for disposal to the ash pile. The water from the dewatering bins is collected in the clarifier where clean water overflows into a sump tank while the underflow is pumped back to the dewatering bins. The clean water is then recycled to the gasifiers. A startup pump is provided for initial transport of slurry to the dewatering bins when the gasifier pressure is too low for conveying.

The non-process sections to support the process and to provide utilities to the process include the following functions:

Section 430, Utility Area which includes:
Steam Generation
Raw Water Storage
BFW Treatment

Section 440, Waste Water Treatment

Section 450, Cooling Tower

Section 460, Flare

Section 470, General Facilities which include:
Long Term Coal Storage for 90 days
Long Term Ash & Solid Waste Storage
Interconnecting Piping
Roads and Fences
Firewater System
Power, Lighting, and Communication
Sewers
Odorization and Metering Station

Drawing No. 2203-1-01-4701 is the Key Plot Plan for the Demonstration Plant. The site, which comprises approximately 134 acres, is located next to the T. H. Allen Steam Generating Station in Shelby County, Tennessee.

An in-depth discussion of the site selection and description can be found in the following separate documents:

a. "Site Evaluation and Selection Report" February 1979.

b. Environmental Analysis Report August 1979.

All sections of the plant are shown on the Key Plot Plan.

Section 2.0

DEMONSTRATION PLANT DESIGN BASIS

This Design Basis, initially issued March 4, 1979 forms the foundation for process and mechanical engineering of the Demonstration Plant. Included in the Basis of Design are the plant capacity, coal analysis, product gas specifications, unit material balance around the gasifiers, design parameters for various plant areas.

2.1 DESIGN CRITERIA

This plant is designed to gasify coal and produce a clean medium BTU Industrial Fuel Gas (IFG). Sulfur in the coal is recovered and bright liquid sulfur produced.

The plant is designed for a net IFG production of 50×10^9 BTU/day. Subsequent references to the Plant Material Balance (PMB) refer to operation at this rate. Net plant production includes any gas withdrawn to Credit Generation, but not fuel gas consumed within the plant.

2.1.2 By-products

The plant is designed to produce only IFG and sulfur. No other by-products were considered in the Phase I demonstration plant design.

2.1.3 Service Factor and Sparing

The plant is designed for operation at a 90% on-stream factor, excluding credit generation.

Sufficient spare equipment is provided to allow the plant to achieve the 90% factor. This includes, but is not limited to, rotating equipment; large centrifugal compressors may have spare rotors only. A distinction was made between equipment items with installed spares and items for which plot space is left vacant for a possible spare, to be installed if found necessary during Phase II or later.

2.1.4 Turndown

The plant is designed to operate at a net IFG production of 15×10^9 BTU/day through the Credit Generation System. The product gas specifications to the IFG pipeline was maintained at all levels of operation between 100% and 33-1/3% of the Plant Material Balance.

2.1.5 Coal, Coke and Ash Analysis

The plant is designed to operate on the representative coal given below. Other coals may be used in the plant in the future. The coal feed rate will then be adjusted to fit the capactiies of the various units in the plant.

2.1.5.1 Coal Type of Coal - Washed Kentucky No. 9

Ultimate	As Received 2" x 0" Wt. %	As Dried ¼" x 0" Wt. %	MF Wt. %	MAF Wt. %
Moisture	11.0	2.50	-	-
Ash	12.0	13.15	13.48	-
Carbon	61.1	66.93	68.64	79.36
Hydrogen	4.3	4.71	4.83	5.58
Nitrogen	1.0	1.10	1.12	1.30
Chlorine	0.2	0.22	0.25	0.26
Sulfur	3.5*	3.83	3.93	4.54
Oxygen	6.9	7.56	7.75	8.96
	100.0	100.00	100.00	100.00
Proximate				
Moisture	11.0	2.50	-	-
Ash	12.0	13.15	13.48	-
Volatiles	35.4	38.78	39.78	45.97
Fixed Carbon	41.6	45.57	46.74	54.03
	100.0	100.00	100.00	100.00
HHV Btu/lb.	11,157	12,222	12,536	14,490
Bulk Density LB/CF	42	44.4	-	-
FSI	4-6	4-6	-	-
Hardgrove	58	60	-	-

* Note: Minimum Sulfur content of coal on an "As Received" basis is 2.8% which is equivalent to 3.63% on an MAF basis.

APPROXIMATE COAL SIZE

a. Coal As Received From Mine 2" x 0"

Retained	Microns	Cum. wt%
+ 2"	50,800	2.56
+ 1½	38,100	9.84
+ 1¼	32,000	12.79
+ 1	25,400	19.90
+ 3/4	19,000	28.56
+ ½	12,700	40.94
+ ¼	6,700	59.18
+ 1/8	3,175	72.32
+ 10 Mesh	2,000	78.50
+ 100 "	149	96.20
- 100	--	100.0

APPROXIMATE COAL SIZE

b. Coal Feed to Gasifier

Retained	Microns	Cum. wt%
+ ½"	6,350	1.8
+ 4 Mesh	4,760	12.4
+6	3,360	32.1
+ 12	1,680	58.6
+ 40	420	84.4
+ 70	210	90.8
+ 140	105	94.2
+ 200	74	95.1
+ 270	53	96.5
- 270	--	100.0

* Specification + ½" ≤ 2% - 100 Mesh ≤ 10%

2.1.5.2 Coke

(Typical of Bethlehem Coke Breeze)

Ultimate	As Received Wt. %	As Dried Wt. %	MF Wt. %
Moisture	15.00	2.5	-
Ash	9.29	10.7	11.0
Carbon	73.52	84.3	86.5
Hydrogen	0.35	0.4	0.4
Nitrogen	0.53	0.6	0.6
Sulfur	0.70	0.8	0.8
Oxygen	0.61	0.7	0.7
	100.00	100.0	100.0
Proximate			
Moisture	15.0	2.5	-
Ash	9.3	10.7	11.0
Volatiles	2.6	3.0	3.1
Fixed Carbon	73.1	83.8	85.9
	100.0	100.0	100.0
Bulk Density, Lb/CF	48	50	-
HHV, BTU/lb.	10,958	12,569	12,891
Hardgrove	45		

Note:

Coke has been obtainable in the proper size range of ¼" x 0" for feed to the gasifier. This size range does not require coke crushing and availability should be good as long as steel is produced.

2.1.5.2 Typical Ash Analysis

Mineral Analysis of Ash	Percent Weight Ignited Basis
Silica, SiO_2	47.00
Alumina, Al_2O_3	22.21
Titania, TiO_2	1.03
Ferric Oxide, Fe_2O_3	19.75
Lime, CaO	3.00
Magnesia, MgO	1.02
Potassium Oxide, K_2O	2.55
Sodium Oxide, Na_2O	0.53
Sulfur Trioxide, SO	2.69
Phos. Pentoxide, P_2O_5	0.19
Strontium Oxide, SrO	0.00
Barium Oxide, BaO	0.01
Manganese Oxide, Mn_3O_4	0.00
Undetermined	0.02
	100.00

Alkalies as Na^2O, Dry Coal Basis	=	0.18
Silica Value	=	66.41
Base: Acid Ratio	=	0.38
T_{250} Temperature	=	2435°F

Fusion Temperature of Ash

	Reducing	Oxidizing
Initial Deformation	2055°F	2340°F
Softening, ST	2170°F	2515°F
Softening, HT	2285°F	2515°F
Fluid, FT	2405°F	2585°F

Additional Ash Properties

Bulk Density	lb/cf (dry)	76
	lb/cf (with 10% moisture)	75
Fluid Bed Density @ 3.3 ft/sec.		65
Complete Fluidization Velocity ft/sec		3.3
Apparent Density lb/cf		140

2.1.5.3 Typical Ash Analysis (Continued)

Screen Analysis

USS	% Carbon	% Ash	Wt.%
6	60.2	39.8	4.4
12	41.8	58.2	18.0
20	5.6	94.4	70.2
40	12.4	87.6	7.2
PAN	-	-	0.2
	-	-	100.0

2.1.6 Product Gas Specifications

The Product Industrial Fuel Gas shall meet the following specifications at the plant battery limit:

Pressure	150 psig
Temperature	80 - 120°F
Heating Value (HHV)	To be selected within allowable range of 270 to 330 BTU/SCF
Sulfur Content H_2S*	0.5 gr/100 SCF max
Total S	5 gr/100 SCF max
Water Dew Point at 150 psig	15°F max.

2.1.7 IGT Gasifier Heat and Material Balance

Feed Conditions to Gasification Section battery limit:

Steam	500°F 115 psig
Oxygen	(98% vol O_2, 2% N_2+A) 215°F 105 psig
Coal (See Section 2.2)	80°F 75 psig

The IGT Gasifier Heat and Material Balance is given on Figure 2-1 and Table 2-1. It is based on:

- Ash agglomerate composition of 85% ash.
- Fines loss of 3% of coal feed.
- Heat loss of 150,000 Btu/ton of dry coal.
- Product recycle gas of 0.1 lb/lb of coal.
- Gasifier operating at rated capacity.

GASIFIER BALANCE

Basis: 1000 lb/hr Dry Coal Feed

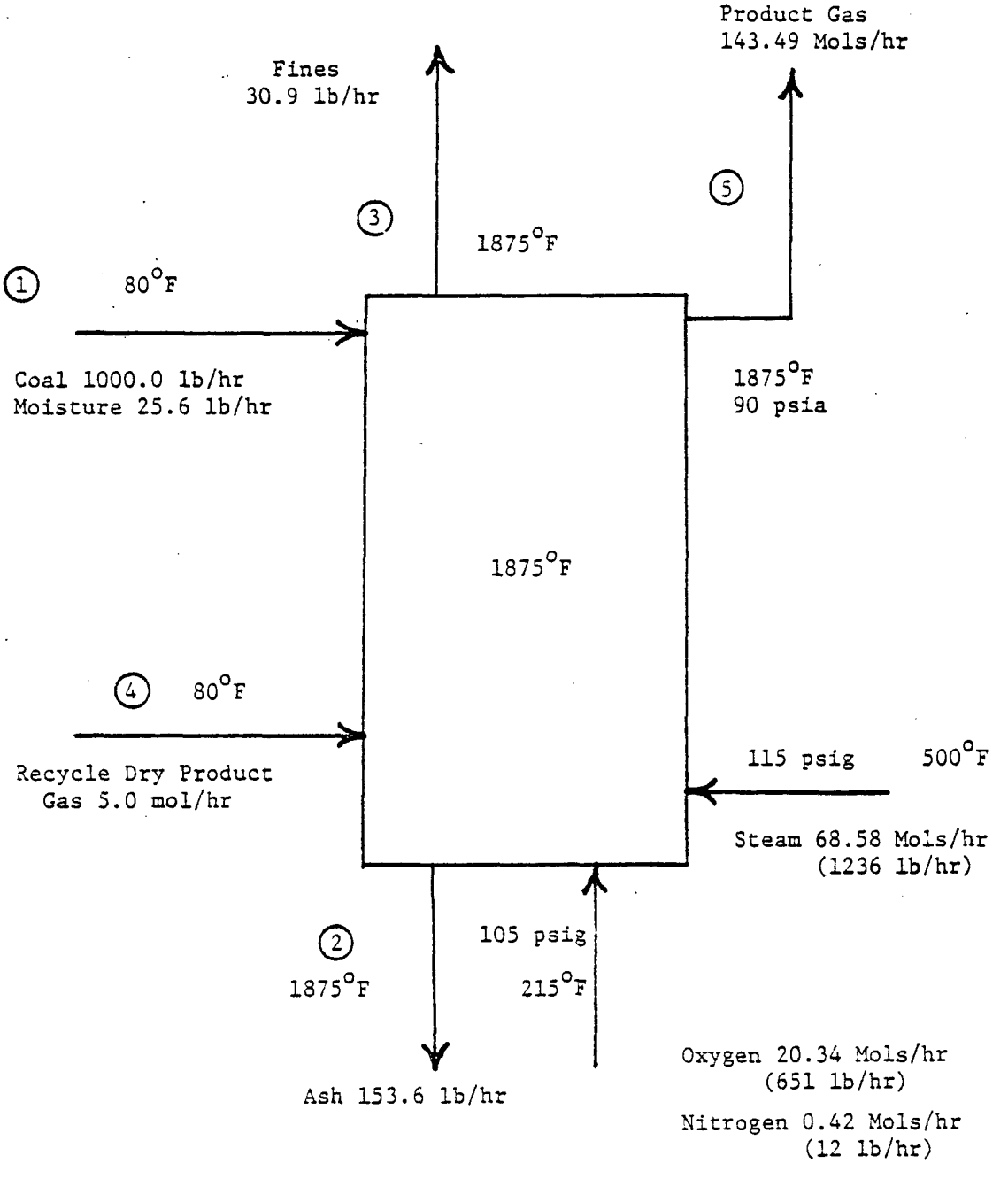


Figure 2-1

Table 2-1

GASIFIER BALANCE

Stream No.	① Coal Feed		② Residue		③ Fines	
Temp., °F	80		1875		1875	
	lbs/hr	wt %	lbs/hr	wt %	lbs/hr	wt %
C	686.4	68.64	21.5	13.99	23.5	75.98
H_2	48.3	4.83	0.0	0.01	0.1	0.25
O	77.5	7.75	-	-	-	-
N_2	11.2	1.12	0.5	0.35	0.2	0.71
S	39.3	3.93	1.0	0.65	0.4	1.36
Ash	137.3	13.73	130.6	85.00	6.7	21.70
Total	1000.00	100.00	153.6	100.00	30.9	100.00
Moisture	25.6					

Table 2-1 (cont.)

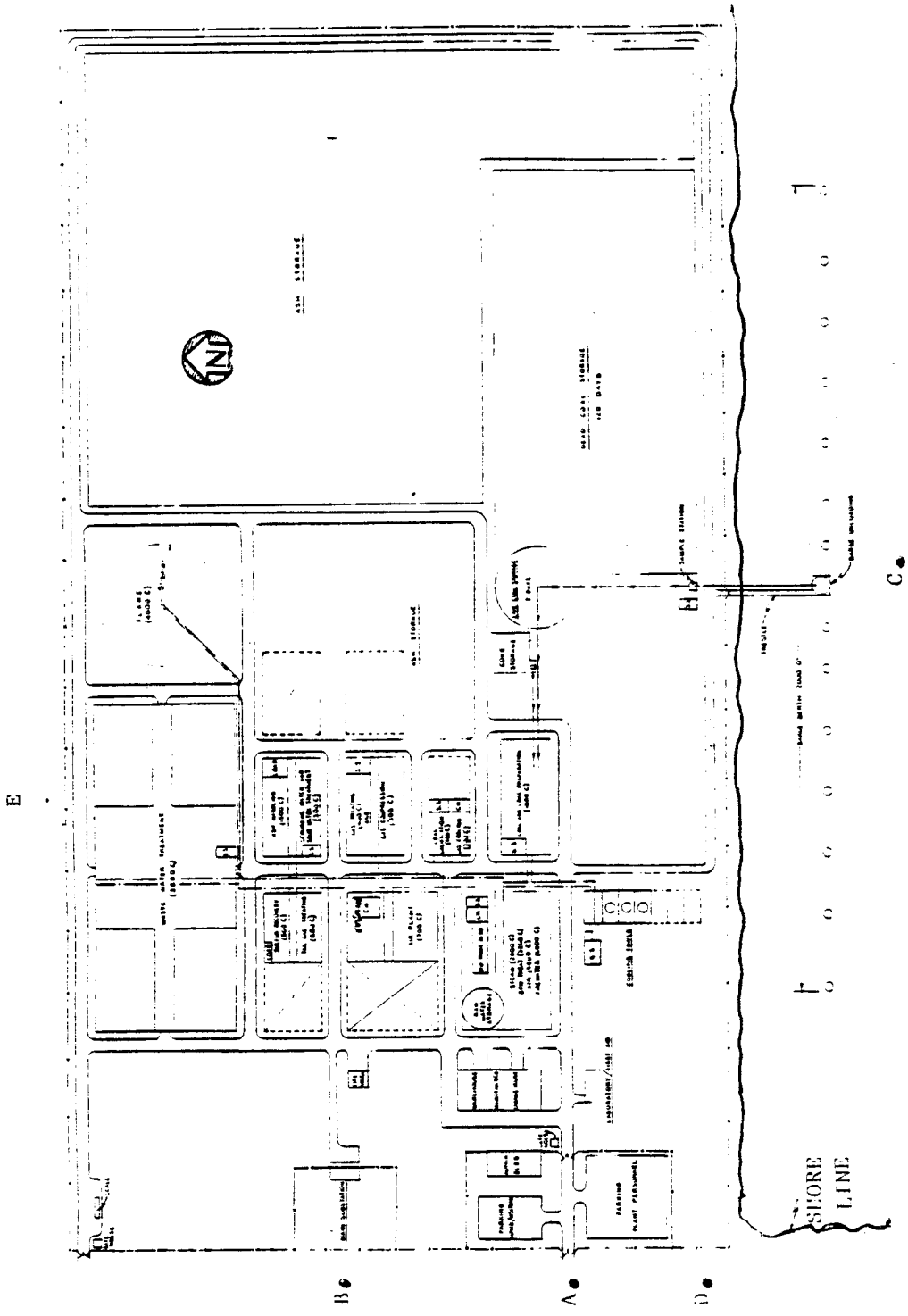
GASIFIER BALANCE

Stream No.	④ Recycle Dry Product Gas		⑤ Product Gas	
Temp., °F	80		1875	
	mols/hr	mol %	mols/hr	mol %
CO	1.63	32.59	30.85	21.50
CO_2	1.08	21.56	20.42	14.23
H_2	1.98	39.63	37.55	26.17
H_2O	-	-	47.58	33.16
CH_4	0.27	5.34	5.06	3.53
H_2S	-	-	1.13	0.79
COS	-	-	0.05	0.03
N_2	0.04	0.88	0.82	0.57
NH_3	-	-	0.03	0.02
Total	5.00	100.00	143.49	100.00

2.1.8 Utility tie-in Locations (See Figure 2-2)

In order to design the demonstration plant, certain tie-ins will have to be made to existing municipal services and/or commercial entities. These items are listed below:

Electrical:	Approximately 50 MVA at 161 KV will be required at the Battery Limit, and will enter the plant at point B as shown on the attached preliminary plot plan.
City Water:	Approximately three million gallons/day of city water will be required at the Battery Limit and will enter the plant at point D.
Roads:	A single access to the plant south of point A shall be provided. The road will run about ½ mile back to the Pidgeon levee.
Product Pipeline:	The new product IFG pipeline will terminate at the fence line at the approximate location of point E. It shall be extended to the IFG customers by MLGW.
Treated Waste Water:	Treated water effluent from the Waste Water Treatment Area will be piped approximately 1½ miles to the Mississippi River and exit the plant on the west.
Dock Facilities:	Bulk solids transport (coal) will be accomplished by barge, and will require the construction of docking facilities along the south B.L. of the plant. This might also require the upgrading of the waterway between the dock and the existing channel as indicated by point C.
Sanitary Sewers:	The sanitary sewer will be tied into the existing city waste treatment plant.
Natural Gas:	There is an existing pipeline supplying the TVA plant, and a branch will be run to the south-east corner of the plant B.L. as indicated by point D.



PRELIMINARY PLOT PLAN (BASIS - COMMERCIAL PLANT)
MLGW/DOE INDUSTRIAL FUEL GAS PLANT
TASK II DEMONSTRATION PLANT

Figure 2-2

2.2 AREA DESIGN BASES

2.2.1 Air Separation

The air separation system is a cryogenic unit to provide gaseous oxygen to the gasifiers and gaseous nitrogen to the instrument and plant nitrogen systems.

Area design rate - 105% of the Plant Material Balance.

There are 2 air compressors each sized for 50% of the area design basis to serve the IFG substitution part of the Credit Generation System as well as the Air Separation System.

The Air Separation System is capable of producing specification quality product streams with only one air compressor operating.

A liquid oxygen storage system is provided. Two nitrogen vaporizers are provided - one for instrument N_2, the other for all other N_2 users. N_2 storage capacity is provided for use during startup and for possible use as a natural gas diluent in the credit generation unit.

No additional oxygen production capacity is provided to refill the liquid oxygen storage, when full oxygen production is required by the gasifiers.

2.2.2 Coal/Coke Treating & Feed

This section takes coal delivered by the Coal/Coke Handling Area, crushes it (see Section 2.1.5.1) and dries it, then stores it and feeds it into the gasifier.

It also takes coke breeze delivered by the Coal/Coke Handling Area, dries and stores it, and feeds it to the gasifiers during startup.

Proportions of coke to coal are in increments of 0, 20, 40, 60, 80 and 100%.

Area design coal rate: 110% of the Plant Material Balance

Area design coke rate: 40 tons/hr.

2.2.2.1 Coal/Coke Treating Number of trains and capacities for the equipment up to the feed bins based on the area design coal rate are:

ITEM	NO. TRAINS	CAPACITY EACH
Coal Crusher	2	* 50 + %
Drying Furnace	1	2 x(50 + %)
Coal Transport to Silo	2	50 + %
Treated Coal Silo	1	12 hours
Coal Conveyor (Silo to Gasifier Feed)	2	100 %
Coke Conveyor	1	45 tons/hr.
Coke Drier	1	45 tons/hr.
Coke Silo	1	1500 tons
Coke Screen	1	45 tons/hr.

*Capacity of 50 + % set by next largest standard size coal crusher above 50% of Area design coal rate.

The two 100% conveyors from the silos are each capable of handling coal. In addition, one of the two conveyors are capable of providing the following mixtures of coke and coal to the feed bins.

% Coal	% Coke
100	0
80	20
60	40
40	60
20	80
0	100

The coal and coke silos are "in line" - material will be continuously fed to and from them during operation.

2.2.2.2 Gasifier Feeding There is a separate coal/coke feeding system for each gasifier. These systems will receive treated coal or coke from the conveyors, pressurize it to gasifier pressure, and inject it into the gasifiers.

Number of trains - Four (one for each gasifier).

Train design rate - 33-1/3% of the area design coal rate.

The capacities and number of equipment items for a single Gasifier Feed train are as follows (based on the Train design rate):

ITEM	NO. EQUIPMENT ITEMS/TRAIN	CAPACITY/ITEM
Feed Bin	1	30 tons
Lock Hopper	2	10 tons
Injection Hopper	2	15 tons
Coal Feeder	6	7 STPH
Feeding Lines	6	7 STPH

The lock hoppers are pressurized with nitrogen, the injection hoppers with product gas.

Coal feed weighing is done in the lock hoppers.

2.2.3 Coal Gasification

This section will gasify coal with steam and oxygen in a fluidized-bed gasifier to produce hot medium-BTU gas.

Area design rate - 100% of the Plant Material Balance.
(2296 STPD - MAF coal)

Number of Trains - four

Train design rate - 33-1/3% of the Plant Material Balance.

The minimum operating rate of each gasifier is 65% of the train design rate.

The system for handling fines from the second stage cyclones is a dual system; which is capable of sending fines either to the gasifier or to storage for subsequent use within the plant.

Each gasifier has six equally spaced feed points. In addition, six equally spaced blanked-off feed nozzles are provided.

Sufficient flexibility is designed into the shell diameter and height to accomodate changes in the grid design.

Ash agglomerates from the gasifier venturi are quenched in water and sent as an ash/water slurry to the Ash Treatment Area. A hydraulic transport system using the gasifier pressure will be used to transport the slurry and reduce its pressure if a control device is available. Lock hoppers are used to reduce the ash slurry pressure.

A Bed Material Withdrawal system is provided, to allow removal of excess bed material from the gasifier bed during startup. The Bed Material withdrawal system in each gasifier train is sized to handle an ash flow equal to 15% by weight of the train design dry coal rate.

Withdrawn bed material is sent to the Ash Treatment Area.

2.2.4 Gas Cooling & Scrubbing

This section cools the hot raw gas from the Coal Gasification Area and recovers heat by generating steam. It then scrubs the gas with circulating water to remove dust before the gas is sent to the Gas Compression Area.

Area design rate - 100% of Plant Material Balance.

Number of trains - 4

Train design rate - 33-1/3% of Plant Material Balance.

Design dust content - 0.05 gr/ACF, max.
98% < 10 micron
90% < 5 micron
0% > 20 micron

The raw gas is cooled to approximately 450°F in two stages. In the first stage of cooling a minimum exchanger tube wall temperature of 550°F is maintained. In the second stage of raw gas cooling an exchange tube wall minimum temperature of 400°F is maintained. The plant facilities, such as scrubbers and steam boilers are designed to accommodate the operation when the second stage of cooling is bypassed.

The scrubber slurry blowdown and any other water condensed from the gas is sent to the Sour Water Stripping Area.

2.2.5 Gas Compression (Raw/Recycle Gas)

This section compresses the cooled scrubbed gas from the Gas Cooling and Scrubbing Area before it is treated in the Gas Treating Area.

Area Design rate - 105%* of the Plant Material Balance.

Number of trains - one. If necessary to meet driver limitations or for other similar reasons, it may be split into two or more parallel trains.

*Capacity factor compensates for minor variations in gas parameters (composition, amount, density, suction temperature or pressure). Major variations would modify compressor capacity or discharge pressure.

2.2.6 Gas Treating

This area shall use the SELEXOL process to remove sulfur compounds, some carbon dioxide and water from the product gas before the gas goes to the IFG distribution system. This process also provides the means to control product gas HHV.

Area Design rate - 110% of the Plant Material Balance.

Number of trains - one.

This unit is designed to produce a gas with a controlled gross heating value of 300 BTU/SCF.

Recommendations on solvent makeup rate and purification were obtained from the process licensor.

This section odorizes the IFG product to a level of one pound of tetrahydrothiophene per MMSCF before it enters the distribution pipeline. Gas Treating area is designed to remove H_2S and produce specification product fuel gas when the sulfur content of the coal drops to the minimum sulfur content shown in Section 2.1.5.1 and the plant capacity drops to 33-1/3% of the Plant Material Balance.

2.2.7 Sour Water Stripping

This area treats scrubber slurry and sour water from other areas in the IFG plant to remove H_2S, CO_2, and NH_3. Acid gases are sent to the Sulfur Recovery Area. The dust from the Scrubber slurry is settled and filtered.

Area design rate - 110% of the Plant Material Balance.

Number of trains - One.

Stripped water is returned to the Gas Scrubbing Area or sent to the Waste Water Treatment Area.

The dust slurry is stripped in a separate tower. The stripped slurry is settled, the sludge filtered and the filter cake burned, preferably in the plant boilers.

2.2.8 Sulfur Recovery

This unit converts the H_2S and COS from the Gas Treating and Sour Water Stripping Area acid gas streams to liquid elemental sulfur, which is sold.

Area design rate - 110% of the Plant Material Balance.

Number of trains - As required by turndown considerations.

Product sulfur quality 99.9% wt. dry basis (Bright Sulfur)

Sulfur Storage - liquid storage for 15 days production at the Plant design is provided.

Liquid sulfur tank truck loading facilities are included.

Area produces specification quality products for all ranges. of operation given in Paragraphs 2.1.4 and 2.1.5 above.

2.2.9 Tail Gas Treating

This unit uses a Beavon unit to remove residual sulfur compounds from the Sulfur Recovery Area tail gas.

Area design rate - 110% of the Plant Material Balance

Number of trains - One.

Tail Gas Quality:

H_2S - 10 ppmv maximum

Total Sulfur - 250 ppmv maximum

Sulfur produced in this section is melted and sent to liquid sulfur storage in the Sulfur Recovery Area.

Area produces tail gas of the same quality as specified for all ranges of operation given in Paragraphs 2.1.4 and 2.1.5 above.

2.2.10 Credit Generation

This area handles methanation of IFG and send-out to the MLGW natural gas system to build BTU credits; also letdown and dilution of natural gas with air to replace IFG when the IFG plant is shut down. This area is integrated with the IFG plant for all utility systems, but is not integrated in a process sense.

2.2.10.1 Methanation Methanation of the IFG is by the Conoco Methanation Process.

Design IFG feed rate to methanation:

Normal	5×10^9 BTU/day
Maximum	15×10^9 BTU/day
Diurnal Variation	$\pm 5 \times 10^9$ BTU/day

Number of trains - One.

Product Gas Battery Limit Conditions:

Pressure	300 psig
Temperature:	120°F
Minimum Gross Heating Value (Dry Basis):	950 BTU/scf
Maximum CO Content:	0.5% volume
Water Dew Point at 300 psig:	15°F

The product gas is also odorized to 1 lb odorant/MMSCF and metered before being delivered.

2.2.10.2 IFG Substitution The substitution system consists of a single train natural gas letdown and air mixing station. Gas delivery conditions are (at plant battery limit):

Substitute IFG flow:	45×10^9 BTU/day
Pressure:	150 psig
Temperature:	120°F
Heating Value (HHV):	300 ± 10% BTU/SCF
Water Dew Point at 150 psig:	15°F max.

The air compression for this use is a combination of one of the air compressors in the Air Separation Area and a booster compressor in the Credit Generation Area.

This section connects with the MLGW gas distribution system at its Weaver station through an existing 16" pipeline.

2.2.11 Coal/Coke Handling

This section receives coal delivered by barge, and unloads, stores, and transports it to the Coal/Coke Treating and Feed Area. It also handles unloading and transport of the coke required for startup of the gasifiers.

2.2.11.1 Coal Handling Number of trains and equipment capacity:

Item	No. Trains	Capacity Each
Barge Unloader	1	850 tons/hr
Coal Weigher	1	850 tons/hr
Coal Sampler	1	850 tons/hr
Conveyors (to live storage)	1	850 tons/hr
Live coal storage pile	1	14 days (*)
Conveyors (storage to Area 2322	1	100% (**)
Coal Sampler	1	

Notes:

(*) At 110% of the Plant Material Balance.

(**) Capacity is the same as that of the coal crushers in the Coal/Coke Treating and Feed Area.

2.2.11.2 Coke Handling

Design rate: 45 tons/hr dry coke (10% oversize)

Number of Trains - One.

2.2.12 Ash Treatment

This section takes the water quenched agglomerates from the Coal Gasification Area and the bottom ash from the coal fired steam boilers and produces a settled and drained ash which is delivered to the Long Term Ash and Solid Waste Storage Area.

Area design rate - 115% of the Plant Material Balance.

ITEM	NO.	CAPACITY
Slurry Transport from Gasifier to Dewatering Bin	2/Gasifier 8 Total	100%
Slurry Transport from Steam Boilers to Dewatering Bin	1	100% (Intermittent)
Dewatering Bins	2	36 hrs @ 100%
Clarifier	1	100%
Surge Tank	1	100%

2.2.13 Utility Area - Steam Generation

The boilers are conventional coal fired boilers with stack gas scrubbing. Scrubber sludge is sent to the Long Term Ash and Solid Waste Storage Area.

There are two boilers.

2.2.14 Waste Water Treatment

This area treats water condensed from the raw gas in the Gas Cooling and Scrubbing Area, as well as any other waste water generated in the plant after stripping in the Sour Water Stripping Area before it is discharged to the Mississippi River. The relevant water quality specifications will be met.

2.2.15 General Facilities

2.2.15.1 Long Term Coal Storage Long term (dead) storage is provided for a 90 day supply of coal at a rate of 110% of the Plant Material Balance.

Transport to and from Long Term Coal Storage is by mobile equipment.

Provision for dust control have been made.

2.2.15.2 Long Term Ash and Solid Waste Storage This area stores ash agglomerates from the Ash Treatment Area as well as other solid wastes produced in the plant.

Plot space is provided for storage of a total of 20 years ash production at the Plant Material Balance rate. Initial plant facilities are provided for 5 years storage.

Provision for dust control has been made.

2.2.16 Pressure-Temperature Design

The design pressure and temperature is based on the process requirements for each individual plant area (see 2.2 Area Design Basis). Vendor designed or package unit systems have design pressure/temperature normally associated with the system, as determined by the vendor and approved by FWEC, which is consistent with the process requirements.

Section 3.0

MAJOR ENGINEERING PARAMETERS

3.1 Basic Engineering Data

3.1.1 Location

The plant site is located on water front property along the river in Memphis, Tennessee.

3.1.2 Elevation

The overall site is taken as 233 ft. above MSL.

3.1.3 Seismic Zone

The site is located in Seismic Zone 3

3.1.4 Climatic Conditions

The design temperature used for this location was 17^{o}F. Prevailing winds are from the south in summer and north in winter. Wind speed used for design was a maximum of 75 mph for a 100 year occurence and a maximum design rainfall of 5 in. in 24 hrs. on a 5 year occurence. Flood design is not required since plant elevation will be above the Corps of Engineers recommended elevation.

3.1.5 Water Availability

Water is available from the City of Memphis System. Analyses from the Davis Pumping Station were used.

3.1.6 Power

Electrical power is available from the City of Memphis.

3.1.7 Transportation

All modes of transportation are available on site, including waterways.

3.1.8 Miscellaneous

See Appendix for further detailed data.

3.2 Materials of Construction

All materials selected for piping, vessels and equipment were chosen based on the pressure, temperature and fluid handled for each component.

Corrosion life was based on a 20 year life for vessels, pump casings, piping, exchanger shells, channels and tubesheets and air fan headers. The following items were based on a corrosion life of 10 years: exchanger tubing, pump internals, heater tubes and removable vessel internals.

In cases where a complete system or unit was purchased from a vendor, either proprietary units or general units, the material selection specified by the vendor, consistent with the above criteria, was utilized.

Material selection for the plant was generally based on the following:

- NACE corrosion data survey
- FWEC experience and corrosion rack data
- For H_2 resistance Nelson Curves API Report June 1977 with a $25^{\circ}F$ safety factor
- For H_2S resistance A.S. Cowper and J. W. Gorman, Jan. 1971 and J. D. McCoy Corrosion, 1974.
- For sulphur resistance, H.F. McConomy API Report, 1963 (50% of published data)
- Fully killed carbon steel was used for equipment and piping exposed to wet H_2S.
- Threaded connections were not permitted in H_2 service.
- Carbon steel piping and equipment containing wet CO_2 will be steam traced.

For detailed material selection review, the materials of construction flow sheets are included in each unit description in Volume II thru XII of the Task III Report.

3.3 Sizing and Spacing Philosophy

Sufficient spare equipment is provided to allow the plant to achieve a 50% service factor. Further specific information concerning spares is found on pages 17 and 40 of the Basic Engineering Data Sheets found in the Appendix.

Section 4.0

ENVIRONMENTAL PARAMETERS OF DESIGN

The Industrial Fuel Gas Demonstration Plant (IFGDP) must satisfy a number of environmental design contraints in order to receive the full range of environmental permits required for construction and operation. This section describes the requirements related to the various possible sources of pollutants - gaseous, aqueous, and solid -- that can be generated by the plant. The design requirements are specified, the emission sources are identified, and the control technologies used in the plant to reduce emissions to acceptable levels are described.

Permission is required to construct and operate all sources of gaseous, aqueous and solid pollutants. Permits for construction and operation of gaseous emission sources require a Prevention of Significant Deterioration Permit, a Permit to Construct, a Permit to Operate and a Compliance Inspection. Permitting aqueous discharges, dredge and fill for the site and construction of pipelines require a National Pollutant Discharge Elimination System permit, approval of an Engineering Report describing treatment facilities and a Department of the Army Permit (construction approvals under Section 10 of the Rivers and Harbor Act of 1899 and Section 404 of the Clean Water Act and Certification under Section 401 of the Clean Water Act). Disposal of solid waste requires approval of disposal facility construction and operation plans and registration of the disposal facility following a compliance inspection.

In addition to the permitting requirements, the plant must also satisfy the requirements of the National Environmental Policy Act (NEPA) because it will be the recipient of significant federal funding.

NEPA requires the preparation of an Environmental Impact Statement (EIS) on the project which includes a full evaluation of the projected effect on the environment from construction and operation of the plant. The EIS must demonstrate the full environmental acceptability of the plant and be approved by the cognizant regulatory and reviewing agencies before construction can commence.

The plant must also conform to federal environmental regulations and executive orders such as those dealing with floodplain management, wetlands, rare and endangered species, and preservation of historical objects.

Since environmental regulations have had a history of evolving with time, it is also possible that new regulations may come into effect in the near future that the design of the plant will have to satisfy.

4.1 Gaseous Emissions

4.1.1 Requirements

For gaseous emission stream, the IFGDP is required to:

- Apply Best-Available-Control-Technology (BACT) pollutant abatement.
- Meet New Source Performance Standards (NSPS)
- Maintain ambient air quality within the National Ambient Air Quality Standards (NAAQS) and limit the levels of particulate and sulfur dioxide concentrations to below the designated Prevention of Significant Deterioration (PSD) increments for Class II areas.

These requirements are established by Tennessee and federal regulations and have associated with them requirements for permits and an inspection before the IFGDP can legally operate.

While the IFGDP is located in an attainment area (NAAQS are not violated) for particulates, the area north of IFGDP on Presidents Island is presently designated as non-attainment for particulates. The IFGDP site and the immediately surrounding area is designated attainment for sulfur dioxide, nitrogen dioxide and carbon monoxide. Shelby County is designated as non-attainment for ozone. Therefore, the IFGDP will be required to undergo a non-attainment review for ozone and TSP and demonstrate that the plant will not be a major source of these pollutants. Otherwise, Lowest Achievable Emission Rates (LAER) must be employed or emission offsets obtained.

4.1.2 Sources of Pollutants

Major IFGDP gaseous emissions to the environment are listed below:

- Flue gas from Flue Gas Desulfurization Unit where the pollutants consist of sulfur dioxide, nitrogen oxides, carbon dioxide and particulates
- Vent gas from the Beavon Unit where the pollutants consist of carbon dioxide and nitrogen oxides.
- Coal pile fugitive particulates.

There are several other minor pollutant sources that pose no environmental problems.

4.1.3 Control Technology

Sulfur Removal

Sulfur dioxide is removed in a double alkali flue gas desulfurization process that represents best available control technology. Since high sulfur coal is used for fuel in steam generation, high levels of SO_2 are produced by combustion. In order to prevent pollution of the atmosphere and to meet environmental regulations, 90 percent of the SO_2 is removed in the Double Alkali Flue Gas Desulfurization Unit. The double alkali system consists of sodium sulfite scrubbing of SO_2 and regeneration of the scrubbed solution with hydrated lime.

Particulate Removal

Particulates are removed in separate bag houses that represent best available control technology. Particulate-containing streams include the boiler flue gas and the dryer mill vent gas from coal preparation and feeding. Bag houses remove 99.9 percent of stream particulates.

Organics Removal

Six process streams are incinerated to destroy organics prior to being discharged to the atmosphere. These streams are listed below:

- Tail Gas from Sulfur Recovery
- Acid Gas from Sulfur Recovery
- Fines silo vent gas from coal gasification
- Feed hopper vent gas from coal preparation and feeding
- CO_2 vent gas from gas treatment
- CO_2 off gas from credit generation

The first three streams listed are not normally sent to the incinerator, but are released to incineration in the case of emergency shutdown.

Sufficient IFG is burned in the incinerator to heat the gases to $1500^{\circ}F$ to ensure destruction of all organic compounds. The hot gases leaving the incinerator join the scrubbed flue gas leaving the boiler flue gas scrubber. This provides the reheat required to obtain a sufficient plume rise.

Nitrogen Oxides and Carbon Monoxide Control

Generation of nitrogen oxides and carbon monoxide are controlled to acceptable levels by the design and operation of combustion equipment.

4.2 Aqueous Effluents

4.2.1 Requirements

Approval of certain design features and obtaining of certain permits dealing with aqueous effluents are required for construction and operation of the IFGDP. These requirements include:

- Conformance with industrial effluent limitations plus additional limitations that may be imposed during agency review.
- Obtaining a National Pollution Discharge Elimination System Permit.
- Approval of the Engineering Report and Preliminary Plans for the treatment facilities
- Obtaining permits under Section 10 of the River and Harbor Act 1899 and Section 404 of the Clean Water Act.
- Obtaining certification under Section 401 of the Clean Water Act.

4.2.2 Sources of Pollutants

Aqueous effluents are generated in the IFGDP from several sources. Major wastewater sources are listed below:

- Process wastewater consisting of clarified blowdown from Gas Scrubbing, stripped condensate from sour water stripping and condensates from credit generation.
- Cooling tower blowdown
- Coal pile leachate
- Ash pile leachate
- Spent service water (flushings and deck washings)
- Storm water drainage from inside limits of processing units
- Neutralization water from boiler feed water preparation
- Sanitary wastewater generated by plant personnel

4.2.3 Control Technology

Except for sanitary wastewater, which is sent to the municipal treatment plant, and ash pile leachate (non-toxic), all plant wastewater is treated at the plant site prior to discharge into the Mississippi River. If testing during Phase III, noncommercial operation, shows that toxic concentrations result from the ashpile leachate, the leachate will be treated to acceptable levels prior to discharge.

Four aqueous effluent streams and their best available control technology treatment systems are:

(1) Storm water and spent service water treatment, which consists of dissolved air flotation and oil separation.

(2) Coal pile runoff water treatment, which consists of neutralization, aeration and clarification.

(3) Process wastewater treatment, which consists of stream stripping, flotation, clarification, recarbonization, filtration/ozonation/oxygenation, filtration and carbon absorption.

(4) Cooling tower blowdown treatment, which consists of electrolytic chromate destruction and clarification.

4.3 Solid Waste

4.3.1 Requirements

Construction and operation of a solid waste disposal facility requires approval of construction and operation plans prior to permission to begin construction, and registration following a compliance inspection. Approval of the compliance inspection constitutes permission to begin operation.

Upon finalization of regulations under the Resource Conservation and Recovery Act (RCRA), the IFGDP will be required to determine the hazardous or non-hazardous nature of all solid wastes. Pilot plant bottom ash has been determined to be non-hazardous under the current draft RCRA regulations.

4.3.2 Sources of Pollutants

Plant solid emissions are listed below:

- Gasifier ash
- Boiler bottom ash
- Flue gas desulfurization sludge
- Solids from sludgepits resulting from coal pile runoff and storm water treatment sludges
- Solids from dewatering of chromate destruct and process wastewater treatment sludges

4.3.3 Control Technology

Two on-site solid waste storage areas are to be used during the life of the IFGDP. The short-term storage area has sufficient area to store the equivalent of 4 years production of solid waste. A long-term storage area will store the equivalent of 16 years of solid waste. The short-term storage area will be lined with a commercially available plastic. If analyses of ash pile leachate over the first 4 years of operation indicate the lining is necessary, the long-term storage area will be similarly lined.

Current plans for the flue gas desulfurization sludge are that this stable sludge (after dewatering) will be mixed with flyash and trucked to an onsite storage area.

Dewatered sludges from process wastewater treatment and chromate destruct unit are sent to a solid waste storage area.

Section 5.0

DESIGN CODES AND STANDARDS

All applicable national, state and local design codes and standards are listed on page 2 and page 3 of the Basic Engineering Data, FWEC Specification 2200-01A1, which is shown in the Appendix, in its entirety, in this report.

Further interpretation of required codes or standards rests with the agency governing that area of design or construction requirements.

JOB SPECIFICATION NO. 2200-01A1

BASIC ENGINEERING DATA

The subject specification is issued herewith per index of pages noted below. If this is a later revision than now in your possession, please destroy superseded pages and insert the revised pages

Initial issue
Entire specification reissued
Revised pages only attached X

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* Pages revised for this issue are noted by asterisk

Issue No. 3 10/4/79 Basis: FWEC ENG STD 01A1

FWEC CONTRACT No. 15-2200

CLIENT MEMPHIS LIGHT, GAS AND WATER DIVISION

(MLGW)

PLANT LOCATION Memphis, Tennessee

INDEX

I. GENERAL

A. Project Description

FWEC Contract No. 15-2200

1. Client Memphis Light, Gas & Water Division
2. Plant Name Industrial Fuel Gas Demonstration Plant
3. Plant Location Memphis, Tennessee
4. This is a (grass roots, ~~expansion~~, ~~other~~) project.

   Specify: 50×10^9 BTU/day of 300 ± 30 BTU/Scf IFG
   Process
5. Units: Air Separation, Coal/Coke Treat & Feed,

   Coal Gasification, Gas Cooling & Scrubbing, Gas Compr., Gas Treating

   Sour Water Stripping, Sulfur Recovery, Tail Gas Treating
6. The System of measurements shall be (English, ~~Metric~~, ~~other~~).

   Specify:
7. Atmospheric contamination (for materials and protective covering selection)

   a) Extreme moisture (tropical climate) No

   b) Marine exposure (salt spray) No

   c) Sand storms No

   d) Copper-attacking fumes (ammonia, sulfur, etc.)

   Yes: SO_2 (875 t/yr); H_2S (1 t/yr)

   e) Exposure to conductive or corrosive dusts (carbon, iron oxide, ammonium nitrates or phosphates, etc.)

   No

   f) Exposure to corrosive agents (nitric or sulfuric acids, chlorine, caustic, etc.) Yes: SO_2, H_2S, CO_2

(1)

FORM NO. 135-37A

BASIC ENGINEERING DATA

FOSTER WHEELER
PROCESS PLANTS DIVISION

I. GENERAL

B. Applicable Codes and Standards

1. (FWEC, ~~others~~) Engineering Standards shall be applicable

Specify: _____

_____

_____

2. Design and construction shall conform to the latest edition of the following applicable codes and/or regulations:

	National	State, Local ~~or Foreign~~ (A)
Pressure Vessels	ASME VIII	
Boilers	ASME I	
(1) Buildings	ANSI	Standard Building Code - 1976
(1) Structural	AISC	Standard Building Code - 1976
Electrical	NEC, NEMA	
Sanitary	EPA , COE (B)	MSCHD (B)
Aircraft Warning	FAA	
Safety	COE, OSHA, NFPA	
Water Pollution	EPA , COE	MSCHD
Air Pollution	EPA	MSCHD
Noise	OSHA , EPA	MSCHD
Fire Protection	UL, NFPA	
Piping	API, ANSI , COE	MSCHD
Concrete	ACI	
Roads	TAI, COE	
Materials	ASTM, ASME	
Mechanical Equipment	NEMA, API	
Welding	ASME IX	

(A) This is a preliminary definition. Others will be identified later.
(B) COE = U.S. Army, Corps of Engineers
MSCHD = Memphis-Shelby County Health Dept.

FORM NO. 135-37A

I. GENERAL

B. Applicable Codes and Standards

2. Codes and Regulations (Contd):

	National	State, Local ~~or Foreign~~
Heat Exchangers	TEMA, ASME, API	
Tanks	API	
Burner Controls:		
Package Boilers	FM, FIA	
Process Heaters	API-RP	
Product Pipeline	COE	
Landfill	COE, EPA	MSCHD, MATCOG
Dock Facilities	COE	
Other		

BASIC ENGINEERING DATA

FOSTER WHEELER
PROCESS PLANTS DIVISION

II. ECONOMICS

(A) 1. Economic evaluations (shall, ~~shall not~~) be made.

(A) 2. The plant payout period shall be 20 years. (330 operating days/year)

(A) 3. Taxes (shall, ~~shall not~~) be included in the evaluation.

4. Utility cost are -

a. Steam -	H.P. psig	(C)	350 ¢/1000#
	M.P. psig	(C)	300 ¢/1000#
	L.P. psig	(C)	275 ¢/1000#
	psig		¢/1000#
b. Water -	City	(B)	25 ¢/1000 gals
(1) Cooling			4 ¢/1000 gals
			¢/1000 gals
c. Condensate -			¢/1000 gals
d. Fuel - Oil			$/Bbl
- Gas			140 ¢/1000 scf
- Coal	(Kentucky No. 9)		26 $/longton
- other. Specify			
e. Electrical power	(D)		2 ¢/KWH
f. Air			¢/1000 cf
g. Chemicals			$/XXX
Liq. Anhyd. Ammonia			120 $/Ton
NaOH Liq. (50%)			160 $/Ton
Sulfur By-Product			48 $/Long Ton
h. Operating Labor			11.00 $/m.h.

5. Remarks: (A) See Task I Report, Vol. III for additional details; (B) 60% of investment cost to bring city water to B.L. to be included in project cost; (C) for use in process alternative evaluations; (D) as delivered to B.L.

FORM NO. 135-37A

III. UTILITIES

A. Steam

(LATER)

1. At Boiler Plant - Steam quality required: Superheated MP & LP at header. HP header @ 900 psig/840 °F.

SERVICE	PRESSURE, PSIG					AVAILABLE
	NORMAL	MAX	MIN	PSV * SETTING	°F	#/HR.
High Pressure	915	935	905	1035	865 (MAX.)	
Med. Pressure	125				490	
Low Pressure	85				420	
Sects. 380/390 to Utility Area	50				298	
Deaerator						

* at boiler or superheater outlet

2. In Process Area at equipment: (except steam turbines)

SERVICE	PRESSURE, PSIG				TEMPERATURE, °F				
	NORMAL	MAX	MIN	DESIGN	NORMAL	MAX	MIN	DESIGN	
High Pressure	890	905 900	890 870	1000	840	850	840 ($AT.) 840 ($AT.)	850	W/O C.V W/C.V.
(a) Med. Pressure	120	125	120	155	485	490	485	700	
Low Pressure	80	85	80 70	120	324	420	324 316	650	W/O C.V W/C.V.
(b) Clean Exhaust	45	60	45 40	75	293	307	293 287	700	W/O C.V W/C.V.
Oily Exhaust									
Deaerator									

(3)

FORM NO. 135-37A

(a) Dedicated header for gasifiers only.

(b) Dedicated header for deaerator only.

III. UTILITIES (contd)

3. Steam Turbines

(LATER)

THROTTLE STEAM CONDITIONS	NORMAL* PSIG	NORMAL* °F	MAXIMUM PSIG	MAXIMUM °F	HEADER PSV** SETTING PSIG
High Pressure	890	840	900	850	1000
Med. Pressure	--	--	--	--	---
Low Pressure	--	--	--	--	---
Exhaust 1.	130	490	155	700	155
(3) Exhaust 2.	95	445	120	650	120

* Equal to or less than turbine nameplate pressure rating.
** NEMA Std. SM-21 states that during abnormal conditions the steam pressure at the turbine inlet connection may exceed the rated nameplate pressure briefly by as much as 20 percent, but not exceeding a duration of 12 hours per 12 month operating period.

B. Condensate

1. Condensate (shall, ~~shall not~~) be recovered.

2. Condensate from ALL psig steam system shall discharge at 50 psig minimum to L.P. condensate system. (3) 7A

3. Condensate from _____ psig steam system shall discharge at _____ psig to _____

Remarks:

III. UTILITIES (contd)

C. Water

DESCRIPTION	SERVICE				
	CITY WATER	SERVICE WATER	COOLING WATER	FIRE WATER	OTHER
Source	City*		City	City	
Return					
Supply Press. at grade, psig	85/65 (3)		70	125	
Return Press. at grade, psig	--		40		
System Design pressure, psig	110		100		
Supply °F for Exchanger Des.	--		88		
Return °F Max. for Exchr. Des.	--		118		
Availability, GPM	No limit		2250		
Below grade header					
Treatment required	None		Yes	None	
Analysis: (ppm)			(Later)		
pH	7.5			7.5	
Total hardness as CaCO3	86.0			86.0	
3) Calcium as CaCO3	46.4			46.4	
Magnesium as CaCO3	39.6			39.6	
3) Bicarbonate as HCO3	98.0				
Sulfate as SO4	4.0			4.0	
Chloride as Cl	5.0			5.0	
Silica as SiO2	14.8			14.8	
Total dissolved solids	118.0			118.0	
3) Sodium & Potassium as Na	10.6				

SAME AS CITY WATER

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1. For cooling tower design use 78 °F wet bulb.
   a. Cooling Water Return Pressure 40 psig
2. Client water treatment consultant _____
3. When pumped by City Water Pump P-4301

* City water source - MLGW Davis Pumping Station

BASIC ENGINEERING DATA

FOSTER WHEELER
PROCESS PLANTS DIVISION

III. UTILITIES (contd)

C. Water (contd)

DESCRIPTION	SERVICE				
	TREATED WATER	BOILER FEED-WATER	DEMINERALIZED WATER	POTABLE WATER	OTHER
Source		Deaerated Water	City		
Return					
Supply Press. at grade, psig	SAME AS CITY WATER	(4) (5) 1200/465		SAME AS CITY WATER	
Return Press. at grade, psig					
System Design pressure, psig					
Supply °F		228	Amb.		
Return °F Max. for Exchr. Des.					
Availability, GPM					
Below grade header					
Treatment required		Amine Treatment for Corrosion & Deaeration			
Analysis: (ppm)					
pH					
Total hardness as CaCO3		< 0.05	< 0.05		
Calcium as CaCO3	SAME AS CITY WATER			SAME AS CITY WATER	
Magnesium as CaCO3					
Bicarbonate as HCO3					
Sulfate as SO4					
Chloride as Cl					
Silica as SiO2		< 0.05	< 0.05		
Total dissolved solids		< 0.1	< 0.1		
Oxygen as O_2		< 0.005			
(3) Sodium & Potassium as Na Carbon Dioxide (CO_2)		0			

(4) HP BFW Pump Discharge
(5) LP BFW Pump Discharge

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III. UTILITIES (contd)

(1) D. Nitrogen

	SERVICE		
	PLANT ~~AIR~~ N_2	INSTRUMENT ~~AIR~~ N_2	
(1) A new system (shall, ~~shall not~~) be provided.	Shall	Shall	
(1) Compressor driver	Motor	Motor	
Present system (does, does not) furnish dry air.	N/A	N/A	
(1) System pressure - psig	125	125	
(1) Capacity, SCFM -	4500	4500	
Dew Point Required - ^{o}F @ system pressure	-40	-40	
Present system (does, does not) furnish oil-free air.	N/A	N/A	

Remarks: _____

_____

E. Inert gas

1. An inert gas system (~~is~~, is not) existing.
2. An inert gas system (shall, ~~shall not~~) be provided.
3. (1) Type of system: Same as Plant N_2

_____

4. (1) Capacity of system: 4500 SCFM

BASIC ENGINEERING DATA

FOSTER WHEELER
PROCESS PLANTS DIVISION

III. UTILITIES (contd)

F. Fuel

1. The existing fuel system (~~has, has not~~) adequate capacity.

Refinery off-gas (shall, shall not) be used as a fuel on the following basis: N/A

A new fuel system or systems (shall, ~~shall not~~) be provided. The type shall be: (~~six, gas, coal, other~~) with a capacity of:

2. Oil and Gas Characteristics

		FO		FG		
(2)	Type of Fuel	N/A		Nat.	Gas	1FG
(2)	Heating Value: HHV-BTU/SCF			1031		
(2)	LHV-BTU/SCF			926		274
(2)	Molecular Weight			16.71		19.45
)	Specific Gravity			0.582		
	H/C Ratio (by Weight)					
(1)	Temperature at Burner, Deg F			Ambient		
(1)	Viscosity: At ____ F					
	At ____ F					
(2)	Fuel Pressure Available at Burner, psig				20	20
	Atomizing Steam Pressure, psig					
	Atomizing Air Pressure, psig					
	Vanadium Content, ppm (for Liquid Fuels)					
	Sodium Content, ppm " " "					
(1)	Sulfur Content, Percent by Weight (for oil)			0.22 as H_2S		
	grains/1000 C.F. (for gas)			1.72 Total Sulfide		
	Composition, Mole Percent			96.0	CH_4	
				2.3	C_2H_6	
				0.7	CO_2	
				0.4	C_3H_8	
				0.3	N_2	
				0.3	Others	

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III. UTILITIES (contd)

2. Oil and Gas Characteristics (contd)

	FO		FG	
Availability, gpm, scfh.				
Header Pressure psig			250	

3. Coal

Provide proximate and ultimate analysis, type coal, preparation, (grate, fluidized), heating value, ash content, disposal, storage, size, handling.

Remarks: Kentucky No. 9 - see Demonstration Plant Design Basis for specs.

4. Reject Fines

For use as boiler fuel - specs to be developed during Task II, Process Design.

5. Industrial Fuel Gas

IFG Product Gas (prior to blending and insertion into distribution main)

1)

a.	Quantity	50 X 10^9 Btu/day, gross
b.	Lower Heating Value	275 Btu/scf for composition in "f"
c.	Pressure	150 psig
d.	Density	0.601 lb/cu. ft. @100°F/180 psia
e.	Composition limits	H_2S 10 ppm vol. (max.) COS 80 ppm vol. (max.)

f. Nominal composition and component heating values

	Mole %	HHV, Btu/lb	HHV, Btu/Scf
H_2	41.8	60958	325.
CO	33.9	4344	321.4
CO_2	20.4	0	---
CH_4	3.0	23862	1009.7
N_2	0.9	0	---
H_2O	0.03	0	---
COS	0.005	3915	627.
H_2S	0.001	7100	637.

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IV. PRESSURE VESSELS

A. Welded Unfired Pressure Vessels

1. Job Spec. 2200-10A (shall, ~~shall not~~) apply.

2. The following Federal, State or local codes (shall, ~~shall not~~) apply:

   Per Section IB

3. There shall be no conflict in Codes and Standards. The most stringent requirements of all of the above shall apply.

V. HEAT EXCHANGERS

There shall be no conflict in the Codes and Standards. The most stringent requirements shall apply.

A. Shell & Tube Exchangers -

1. Shell and Tube exchangers (shall, ~~shall not~~) be designed in accordance with Job Spec. 2200-21A1

   Remarks: Per Section IB

2. The following Federal, State, or Local Codes shall apply:

   Per Section IB

3. The maximum preferred tube lengths shall be for tubulars 30 ft.

(1) 4. The limitation on bundle diameter shall be: 60 in. (removable bundles)

5. The limitation on bundle weight shall be: 20 tons. (removable bundles)

6. The fouling factors shall be Water side .001 ~~Other~~ xxxxxxxxxx

7. The preferred tube pitch for tubulars shall be:
   Shell side - Clean service (fouling $<$ .002) Triangular

   Dirty service (fouling $\geq$ .002) Square

Preferred tube size for tubulars:	Clean Service (fouling $<$ .005)	Dirty Service (fouling $\geq$ .005)
a) Steel - O.D.	3/4"	1"
- BWG (min) ~~avg~~	14	12
b) Alloy - O.D.	3/4"	1"
- BWG (min) (~~avg~~)	16	14

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B. Double Pipe Exchangers

1. Double Pipe exchangers (shall, ~~shall not~~) be designed in accordance with Job Spec. 2200-22A2

   Remarks:

2. The following Federal, State, or Local codes shall apply:

   Per Section IB

3. The maximum tube length shall be 25 ft.

V. HEAT EXCHANGERS (Contd)

C. Air Coolers

1. Air coolers shall be used to the following extent:

According to Economics (See Section II)

2. Air cooled exchangers shall be in accordance with Job Spec. 2200-23A1.

Remarks: _____

3. The following Federal, State, and Local Codes shall apply:

Per Section IB

4. The design air inlet temperature shall be 94 °F - 98 °F - Condensers °F dry bulb. - other

5. The minimum ambient temperature shall be 17 °F dry bulb.

6. Fans shall be (~~induced~~, forced) draft type.

7. The preferred tube lengths for Air Coolers shall be 32 ft.

8. The preferred tube sizes for air coolers shall be:

a) Steel - O.D. 1"
- BWG (min) (avg) 12

b) Alloy - O.D. 1"
BWG (min) (avg) 14

D. Waste Heat Boilers

1. The following process heat exchangers shall generate steam: Later

2. These exchangers shall be designed to ASME Pressure Vessel Code (Section I for Power Boilers, ~~Section VIII for unfired pressure vessels~~)

Remarks: _____

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V. HEAT EXCHANGERS (contd)

E. Fired Heaters

1. Fired Heaters (shall, ~~shall not~~) be designed in accordance with Job Spec. 2200-24A1

Remarks: _____

2. The following Federal, State or Local codes shall apply: _____

Per Section IB

3. Heaters shall be equipped with (~~oil, gas, combination~~ later) burners.

4. Pilot burners (~~shall~~, shall not) be provided for each burner.

5. The minimum efficiency to be considered is Maximum %.

6. The minimum stack height required above grade line is as req'd ft.

7. The stack type shall be (later)

8. Air heaters (shall, ~~shall not~~) be provided.

Remarks: If Economical

9. (Soot blowers, provision for future soot blowers) (shall, ~~shall not~~) be provided, depending on fuel used.

VI. MECHANICAL EQUIPMENT

A. Pumps, Compressors and Turbines

1. Pumps, compressors and turbines (shall, ~~shall not~~) be specified in accordance with Job Specs 2200-Series 30.

   Remarks: _____

2. The following Federal, State, and Local Codes shall apply: _____

   Per Section IB, as applicable

3. Noncondensing Direct acting steam reciprocating pumps (shall, ~~shall not~~) be acceptable for limited use.

4. Steam reciprocating pumps shall exhaust to (as determined by plant steam balancing requirements)

5. Steam turbines shall exhaust to _____

6. Air blower design shall use 50 % relative humidity

   95 and 20 °F dry bulb temperature. (Summer and Winter)

B. Policy for drivers and spares

1. The primary driver shall be:

   a)

Equipment	Electric motor	Turbine	Other
Pumps Compressors Blowers Later Generally	Per Task II Process Design onsite steam preferred.		

   b) Exceptions shall be _____

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VI. MECHANICAL EQUIPMENT

B. Policy for drivers and spares (contd)

2. Installed spares for equipment shall be provided as follows:

a)

Equipment	All	Vital services only	Shared Allowed	3@50% Allowed	Other
Pumps	No	Yes	Yes	Yes	
Compressors	No	Yes	No	No	
Blowers	No	Yes	No	No	
(See Section XIV-B)					

b) Exceptions shall be _____

3. Drivers for spares shall be:

a)

Equipment	Electric motor	Turbine	Other
Pumps			
Compressors			
Blowers			
Later - Per Task II Process Design Generally electric preferred for spares			

b) Exceptions shall be _____

_____

VII. CIVIL ENGINEERING

A. Site Preparation

Site Preparation (shall, ~~shall not~~) be in accordance with FWEC Job Spec. 2200-41A3.

(2) Remarks: Grade elev. 233 ft. MSL shall be established for: The entire site. For details refer to Job Spec. 2200-41A3, and 2200-41A5.

B. Soil Conditions

1. A soil report (has, ~~has not~~) been made in the area.

   The report (is, ~~is not~~) available.

   The client consultant is Law Engineering & Testing (Nashville, Tenn.)

2. There (~~are~~, are not) existing foundations or underground obstructions including rock formations in the area.

   The obstructions are None

   A profile (is, ~~is not~~) available.

3. Foundation design:

   Foundations (shall, ~~shall not~~) be in accordance with Job Spec. 2200-43A1.

   Other standards which apply are See 2200-43A1

   a. Ground water level is not to be considered in foundation design.

   b. Allowable net bearing value 3000 PSF at 3 ft. below finished grade.

   c. Design Frost line depth is 2'6" below finished grade.

   d. Piling (~~is~~, is not) required.

4. For piles - Type & size - N.A.
   Capacity - "
   Maximum uplift - "
   Lateral resistance - "

VII. CIVIL ENGINEERING

B. Soil Conditions (contd)

5. Type of foundations:

1) a) Major equipment, buildings and structures - spread footings, slabs

b) Minor equipment, pipe supports spread footings

c) Other per Job Spec. 2200-43A1

C. Water Run-Off/Sewers

1. a) Paving (shall, ~~shall not~~) be provided in process area.

The requirement is _____

b) Accessways (shall, ~~shall not~~) be paved.

(1) c) Run-off design factors - Paved areas (FW=1.0) 1.0

(1) Unpaved areas 0.5

d) Roadways shall be paved to the following standards: _____

(1) FW Job Spec. 2200-43A5

2. Surface drainage systems (shall, ~~shall not~~) be designed in accordance with Job Spec. 2200-58A1. (1)

Remarks: _____

3. The following drainage systems shall be provided:

Clean Water Sewer _____

Oily Water Sewer Yes

Sanitary Sewer Yes

Chemical Sewer Yes

Other _____

Remarks: _____

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VII. CIVIL ENGINEERING

C. Water Run-Off/Sewers (contd)

4. Sewer pipe (shall, ~~shall not~~) be according to FWEC piping standards.

Remarks: _____

_____

VII. CIVIL ENGINEERING

C. Waste Treatment Facilities

1. Waste treatment facilities are ~~completely existing~~, partially existing, or are to be provided as follows:

Type Waste	Existing	Partially existing	To be provided by Client	To be provided by FWEC
Oily				XX
Sanitary	XX			
Chemical				XX
Other				XX

2. The following Federal, State, Local, or Foreign Codes are applicable:

EPA, MSCHD

3. Permit application for waste disposal (shall, ~~shall not~~) be prepared by FWEC.

Remarks: with EIA assistance as required.

4. Permits (shall, ~~shall not~~) be obtained by the Client.

Remarks: _____

E. Climatic Data

(1) 1. The design temperature for winterizing shall be 17 °F.

2. The direction of prevailing wind is from the South (Summer)
North (Winter)

(1) 3. For locations within USA, wind pressure for various height zones (shall, ~~shall not~~) be as specified in The Southern Building Code - 1976.

4. a. If ANSI A58.1 is not used, structural design wind pressure for various height zones shall be as follows:

(1) 11.5 (psf) below 30 (ft)

(1) 16 (psf) from 31 (ft) to 50 (ft)

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VII. CIVIL ENGINEERING

E. Climatic Data (contd)

(1) 18.5 (psf) from 51 (ft) to 100 ft.

(1) 23 (psf) above 100 (ft) less than 200 ft.

(1) 5. The basic wind speed to be used for structural design shall be 75 mph for 100 year recurrence.

(1) 6. The maximum recorded rainfall in 1 hour is 3.25 in.

(1) The maximum recorded rainfall in 12 hours is 9.67 in.

(1) The Design 12 hour rainfall for 10 year recurrence shall be 4.8 in.

(1) The Design 5 year 24 hour rainfall is 5.0 in.

7. The design snow loading shall be - psf.

(1) 8. Seismic zone (shall, ~~shall not~~) be per ANSI A58.1.

Remarks: Zone 3 to be used as risk zone.

(1) 9. The site (is, ~~is not~~) subject to possible flood condition.

The maximum 100 year flood level is elevation 224.9 ft.

(1) Remarks: Flood design is not required.

F. Unit Elevation

(1) 1. Final plant elevation has been established as described in paragraph VII-A.

2. Plant design elevation (shall, ~~shall not~~) be considered, basis of the above, as low point of paving is 100'-0".

(1) Remarks: FWEC Elev. 100' 00" = Actual Elev. 233.0 ft.

(1) 3. Minimum height for top of foundations above low point of paving (shall, ~~shall not~~) be per Job Spec 2200-43A1.

Remarks:

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VII. CIVIL ENGINEERING

G. Structural Materials

1. a) Structural materials (shall, ~~shall not~~) be in accordance with Job Spec 220043A1, concrete foundations, and Job Spec 2200-46A1, structural steel.

   b) Additional special structural materials and locations where required are as follows: _____

   _____

2. Elevated walkways and platforms shall be (subway grating, ~~checkered plate~~).

   Remarks: _____

3. Pipe supports (shall, ~~shall not~~) be in accordance with Job Spec. 2200 48A1.

   Remarks: _____

H. Buildings

1. Buildings shall, ~~shall not~~) be in accordance with FWEC ENG STDS which apply to the type of construction specified below:

   Remarks: as modified by client

Required	Type of Construction
Administration	Concrete block/brick facade
Control houses	Masonry (blast resistant where necessary)
(1) Cafeteria	None. Lunch and coffee break rest areas will be provided.
Locker Room	/Gate House Concrete block/brick facade
Compressor shelter	Prefab metal/asbestos facing for noise reduction
Shop	)
Warehouse	) Prefab metal
Laboratory	Concrete block/brick facade
(1) Substation	(H-V) concrete block
(1) Switchgear shelter	(L.V.) Prefab metal

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BASIC ENGINEERING DATA

FOSTER WHEELER
PROCESS PLANTS DIVISION

VII. CIVIL ENGINEERING

H. Buildings (contd)

Required	Type of Construction
Water Treatment	Prefab metal
Waste Water Treatment	Prefab metal
Powerhouse	-
Firehouse	Prefab metal
Gatehouses	Concrete block
Process	-

Special equipment shelters shall be as follows: -

(1) 2. The following (State, Local) building codes shall apply:

Tennessee, Memphis ; Southern Building Code - 1976

3. a) Air conditioning (shall, ~~shall not~~) be provided for the control houses.

b) Other buildings where air conditioning is required are: All masonry buildings, maintenance bldg. (for offices and inst. rm.), and substation buildings

(1) 4. a) Pressurizing (is, ~~is not~~) required for the substation.

b) Other buildings where pressurizing is required are: by client.

5. Winter design ambient for heating is 17 °F dry bulb.

6. Summer design ambient for air conditioning is 98 °F dry bulb.
80 °F wet bulb.

7. Inside building design temperature is 72 °F. Summer
68 °F Winter

Remarks:

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I. Security

1. Perimeter fencing (shall, ~~shall not~~) be provided.

Type: Chain link or equal type of cyclone fencing

2. Area fencing (shall, ~~shall not~~) be provided.

Type: Chain link or equal type of cyclone fencing

Areas where fencing is required:

(1) Electrical substation transformer yards

(2) Open storage yards associated with warehouse facilities.

VIII. PIPING

A. Piping shall be designed in accordance with the ANSI Code for pressure piping: Chemical Plant and Petroleum Refinery Piping, ANSI B31.3; Power Piping, ANSI B31.1; and other sections which apply.

1. Piping (shall, ~~shall not~~) be designed in accordance with Job Spec. 2200 50A1.

Remarks: _____

_____

_____

2. Category D and Category M fluid Services

ANSI B31.3 requires the Owner (Client) to identify the Category D and Category M fluids.

a) Category D - A fluid service where the fluid is nonflammable and nontoxic, the design pressure does not exceed 150 psig, and the design temperature is between -20°F and 360°F.

These fluids are as follows: _____

_____

_____

Later

_____

_____

_____

_____

_____

_____

_____

VIII. PIPING (contd)

(1) b) Category M - A toxic fluid service in which exposure to very small quantities of the fluid in the environment can produce serious irreversible harm to persons on breathing or bodily contact, even when prompt restorative measures are taken.

These fluids are as follows:

(1) Raw gas from gasification through cooling, scrubbing, compression and treating to battery limits.

(2) Acid gas from gas treating to sulfur recovery.

(3) Tail gas from sulfur recovery to tail gas treating

3. Severe Cyclical Service Lines

ANSI B31.3 requires the designer to identify those lines subject to severe cyclic conditions. These conditions are those in which S_E exceeds 0.8 S_A, and the eqivalent number of cycles exceeds 7000; or other conditions which will produce an equivalent effect.

These lines are as follows:

LATER

BASIC ENGINEERING DATA

FOSTER WHEELER
PROCESS PLANTS DIVISION

IX. INSTRUMENTATION

A. Instrumentation and controls shall be furnished in accordance with the Engineering Flow Diagrams. JobSpec.2200- 60A1 (shall, ~~shall not~~) apply.

Remarks _____

_____

B. Type of Instrumentation

1. Instrumentation shall, ~~shall not~~) be for distributed control (~~with~~ without) analog backup.

2. Instrumentation (~~shall~~, shall not) be of conventional electronic type.

3. Instrumentation (~~shall~~ shall not) include a computer.

(1) 4. Data acquisition capability shall be installed.

5. The instrumentation shall ~~shall not~~) be an intrinsic safety installation.

6. Instrumentation shall ~~shall not~~) be of pneumatic type
(1) for local control only.

7. Thermocouple installation shall be (multiplexed, ~~conventional~~).

C. Control Room

The control room shall be a central multiple unit. ~~multiple unit~~

D. Control Panel

1. The control panel shall be distributed control console,

Remarks Trend recorders, etc. are also console mounted.

_____

2. Alarms shall be (conventional annunciator, ~~other~~).

Remarks For critical services.

Others will be CRT based.

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IX. INSTRUMENTATION

D. Control Panel (continued)

3. ~~The panel configuration shall be (conventional, xxxxxx style walk-in).~~

Remarks _____

E. Recorders

1. The following recorders shall be provided:

Only where shown on EFD

2. Recorders shall be (local, panel mounted, with integrators)

Remarks: Only as shown on EFD.

F. Analyzers

1. The following analyzers shall be provided:

~~As shown on EFD~~

2. A central analyzer house shall ~~xxxxxxxx~~ be provided, if sample lead time permits and economical justification grants it.

IX. INSTRUMENTATION (continued)

G. Systems Instrumentation

1. Shut down systems shall ~~shall not~~ be provided. They shall be of the ~~(hard-wired, relay~~, programmable controller) type.

2. Sequence control systems shall ~~shall not~~ be provided. They shall be of the (~~hard-wired, relay~~, programmable controller) type.

3. Blending systems shall ~~shall not~~ be provided. They shall be of the (~~hard-wired, relay~~, programmable controller) type.

4. Systems shall be provided for (tank gaging, water treatment, other).

Remarks As shown on EFD

H. Package Equipment Instrumentation

Instrumentation for package equipment shall be by FWEC ~~manufacturers, other~~ standards.

(1) Remarks All controls and valves within the package item are to be supplied by the vendor.

J. Special Approval Agency Requirements

Approval by (FM, CSA, other) agencies is required.

Remarks To be agreed with client.

K. General Remarks

X. ELECTRICAL

A. General requirements for electrical equipment, materials and design shall ~~shall not~~) be in accordance with FWEC ENG STD 70A1.

Remarks: _____

B. Power Supply

The current characteristics shall be as follows:

(1) 1. From the Utility Co: 161K Volts 3 Ph. 60 Hz 100,000 KVA.

2. At the Plant Generator: None Volts _____ Ph. _____ Hz. _____ KVA.

3. The power source location at the battery limit shall be: West Boundary

The type termination of the utility supply and the plant tie-in connection shall be: Overhead 161 Kv line tapped at poles at two locations

4. The max. short circuit is 6329 MVA at 161 K V.

5. The max. allowable motor start in-rush is 63 MVA.

6. The min. acceptable power factor shall be 0.90 .

7. An emergency power supply (shall, ~~shall not~~) be provided by FWEC.

Remarks: For emergency lighting

8. An uninterruptable power supply (shall, ~~shall not~~) be provided by FWEC.

Remarks: For emergency shutdown

C. Utilization Voltages

SERVICE	HORSEPOWER RANGE From	HORSEPOWER RANGE To	VOLTAGE	PHASE	Hz
Motors	200	6000	** 4000	3	60
(1) Motors	3/4	150	460	3	60
(1) Motors	0	½	* 110	1	60
Instruments			110	1	60
Lighting Distribution			120/208	3Ø 4W	60

* Process motors to be 460V - 3Ø-60 Hz

(1) **Motors larger than 6000 HP shall be fed from 34.5KV switchgear with captive transformers

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X. ELECTRICAL (contd)

D. Distribution and Lighting

1.

Service	Underground	Above ground	Direct burial	Conduit	Tray
Power - ISBL	XX			XX	
- OSBL		XX		XX	
Lighting - ISBL		XX		XX	
- OSBL		XX		XX	
Communications - ISBL		XX		XX	
- OSBL		--		--	
Instrument - ISBL		XX		XX	
- OSBL	-------To be defined later ----------				
Other					

2. Area Classification shall ~~shall not~~ be designated by FWEC. (API RP 500A)

3. One-Line Diagrams shall ~~shall not~~ be provided by FWEC.

(1) Remarks: 34.5 KV main substation to be located near switchyard (on-site)

4. The location of substations and motor control stations shall ~~shall not~~ be selected by FWEC.

Remarks: Unit substations shall be located centrally to concentration of loads as required

5. Lighting fixtures shall be:

Type	Areas or Locations
Incandescent	Emergency Ltg. in control room & outdoors
Fluorescent	Control room and offices
Mecury Vapor	All outdoor areas
Hi Pressure Sodium	Street Lighting
Other	

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X. ELECTRICAL (contd)

D. Distribution and Lighting (contd)

6. Supplementary Lighting (shall, ~~shall not~~) be provided.

Type	Location
Emergency Generator only for lighting	
Aviation obstruction Beacons	
Other	

7. Offsite lighting ~~shall~~, shall not be provided except for access road to Pidgeon levee.

E. Climatic Design Conditions

1. The general conditions listed in Section I shall apply.

2. The maximum ambient temperatures are:

Motors and MCC's (normal 40°C) 40°C
Transformers (8 hours) (normal 30°C) _____
Outdoor Wiring (normal 30°C) _____
Underground Wiring (normal 20°C) _____

F. Miscellaneous Requirements

1. A fire alarm system shall, ~~shall not~~ be provided & connected to outside fire station.

2. A telephone system shall, ~~shall not~~ be provided.

3. A radio communications system shall, ~~shall not~~ be provided.

Remarks: a) Walkie Talkie - Motorola or equal.

b) Sound powered phone system, with audible paging, for communication to high structures (1)

4. Intercom system for all process areas shall be provided. (1)

(1)

(1)

FORM NO. 135-37A

BASIC ENGINEERING DATA

FOSTER WHEELER
PROCESS PLANTS DIVISION

XI. PROTECTIVE COVER

A. Insulation for hot piping and equipment

1. Insulation for hot piping and equipment (shall, ~~shall not~~) be in accordance with Job Spec 2200 82A1.

   Remarks: _____

2. The design ambient temperature for hot service shall be 17 °F.

3. The design wind velocity for hot service shall be 10 mph.

B. Insulation for cold piping and equipment.

1. Insulation for cold piping and equipment (shall,) be in accordance with FWEC Job Spec. 2200-82A2. (1)

   Remarks: This will depend on whether piping is in hazardous or non-hazardous area. To be determined later.

2. The design ambient temperature for cold service shall be 100 °F.

3. The design relative humidity for cold service shall be 50 % at 100 °F.

4. The design wind velocity for cold service shall be 10 mph.

C. Winterizing

1. Winterizing (shall, ~~shall not~~) be in accordance with Job Spec. 2200-85A2).

   Remarks: _____

2. The design ambient temperature for winterizing shall be 17 °F.

D. External heating

1. External heating for piping and equipment shall be by (steam tracing, or ~~steam tracing with Thermon steam jacketing~~, electric tracing, ~~other~~).

   Remarks: _____

   High heat duty, continuous service
   Steam Tracing - per Job Spec. 2200-56A1 -

   Low heat duties;
   Electric Tracing - per Job Spec. 2200-78A3 - ~~non-continuous service~~.

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XI. PROTECTIVE COVER (contd)

E. Personnel protection

1. Piping and equipment operating at or above 150 °F shall be provided with insulation for personnel protection.

Remarks: _____

F. Fireproofing

1. Fireproofing of equipment and supports (shall, ~~shall not~~) be provided in accordance with JobSpec 2200 84A1.

Remarks: _____

_____

_____

G. Painting

1. Painting for all piping, equipment and structure (shall, ~~shall not~~) be in accordance with JobSpec 2200 83A1.

Remarks: _____

_____

_____

_____

H. Wrapping underground pipe

1. Coating and wrapping underground steel pipe shall, ~~shall not~~ be in accordance with Job Spec 220083A4.

Remarks: _____

_____

XII. SAFETY FACILITIES

A. Fire Fighting

Fire Fighting facilities (shall, ~~shall not~~) be provided in accordance with Job Spec. 2200-95A1

Remarks: _____

_____

1. New fire pumps (per NFPA) (shall, ~~shall not~~) be provided.

   Remarks: _____

2. Fire trucks (shall, ~~shall not~~) be provided.

   Remarks: _____

3. A foam system (~~shall~~, shall not) be provided.

   Remarks: _____

4. Sprinkler Systems shall be provided as follows:

Locations	Type	Extent
Buildings	Wet Type	
Equipment	Dry Type	Cooling Tower
LPG Vessels	-	-
Pipe Racks	-	-
Loading Racks	-	-
Other		

Remarks: _____

5. Safety showers and eye wash stations (shall, ~~shall not~~) be provided.

   Remarks: At hazardous chemical handling locations, and in the laboratory building

_____

XII. SAFETY FACILITIES (contd)

B. Blowdown and Flare System

1. Blowdown and flare facilities shall, ~~shall not~~) be provided.

   Remarks: _____

2. Flares shall be (elevated, ~~ground~~, smokeless).

   Remarks: 90% smokeless

3. Relief valves handling hydrocarbon vapor below 18 molecular weight shall be vented directly to the atmosphere.

4. Relief valves handling hydrocarbon vapor above 18 molecular weight shall be vented to a closed relief system discharging to flare.

   Industrial fuel gas shall be vented to flare in event of emergency or if specified.

5. The liquid relief system (shall, shall not) be combined with the vapor relief system.

   Remarks: Not applicable

6. The allowable ground level radiation shall be 1500 Btu/HR/sq. ft. (solar included, ~~solar not~~ included).

   Remarks: _____

7. The air pollution control requirements are as follows: _____

   Per Section IB

XII. SAFETY FACILITIES (contd)

C. Aircraft Warning Lights

1. Warning lights for aircraft shall be provided on the following tall structures:

_____

_____

Note: see also ELECTRICAL section.

a) Gasification complex
b) Coal and coke silos
c) Air plant cold box
d) Flare shall have continuous pilot flame serving as a warning light.

At time of detail design, FAA requirements relative to Memphis International Airport will be adhered to.

XIII. SHIPPING FACILITIES

A. 1. Marine facilities (shall, ~~shall not~~) be provided.

2. The facilities required are (~~pier, loading arms,~~ ~~other~~).

Remarks: Coal barge unloading facilities (mooring cell docking facilities)

B. 1. Rail facilities (~~shall~~, shall not) be provided.

2. The facilities required are (spur, loading rack, weigh scale, other).

Remarks: N/A

3. The railroads servicing the plant are: N/A

C. 1. Truck facilities (shall, ~~shall not~~) be provided.

2. The facilities required are (loading rack, weigh scale, scale house, other).

Remarks:

D. 1. Shipping Security facilities (shall, ~~shall not~~) be provided.

2. The facilities required are (Guard House, gates, other).

Remarks: - Later -

E. 1. Pipelines (shall, ~~shall not~~) be provided.

2. The facilities required are (~~marine lines, land lines, pump station, other~~).

~~Remarks:~~ per "Demonstration Plant Design Basis" for utility lines tie-in point to plot plan.

a) IFG product gas pipeline
b) Methanation product gas pipeline
c) Natural gas pipeline
d) City water pipeline
e) Treated wastewater effluent pipeline
f) Sanitary waste sewer line

XIV. SPECIAL PROJECT REQUIREMENTS

(To be listed below with details as required)

A. GENERAL COMMENTS: In order to achieve dependable construction and 20-year minimum design life, construction codes, equipment selection, and materials of construction as practiced in the petrochemical and gas industry will be generally adhered to.

o Mechanical Equipment: The need for reliability, safety, and long life justifies the selection of rotating equipment in accordance with API Specifications for critical fluid handling services. Some non-critical services could be specified to less stringent requirements.

o Heat Transfer Equipment: Similarly, the design life objective justifies the selection of TEMA, Class R shell and tube exchangers. Some non-critical services could be specified to less stringent requirements such as TEMA, Class B.

o Piping: The ANSI B31.3 Petroleum Refining Code is recommended to be adhered to. Piping items will be generally selected according to standards shown in Appendix E of this code.

B. SELECTION CRITERIA AND SPARING PHILOSOPHY

(1) Equipment selection shall be dictated by specification, criticality of service, steam balancing and economics.
(2) Equipment shall be compatible with "achieve continuous operation 330 days a year" design basis.
(3) Sparing philosophy is:

Class of Use	Sparing
(a) Intermittent use	No spares
(b) General process use	Spared in common
(c) Process-critical use	Dedicated spared
(d) High cost and/or process critical or special order	Not spared. High intensity preventive maintenance, program, incl. stocking critical parts.