LARGE PILOT PLANT ALTERNATIVES FOR SCALEUP OF THE CATALYTIC COAL GASIFICATION PROCESS

APPENDIX II

DETAILS OF STUDY DESIGN FOR MAJOR SYNTHANE REVAMP CASE

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APPENDIX II-A

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

ONSITE STUDY DESIGN

This specification covers the onsite facilities for a study design for converting the Synthane Pilot Plant located in Bruceton, Pennsylvania to a Catalytic Coal Gasification Process - Large Pilot Plant.

Major areas covered by the specification are as follows: coal feeding system, gasifier and cyclones, char withdrawal system, gasifier fines recovery system, high temperature heat recovery facilities, wet scrubbers, NH_3 scrubber, methane recovery facilities, preheat furnace, steam reformer, sour slurry stripper and catalyst recovery section.

Design Basis

The Major Synthane Revamp case of the Large Pilot Plant study is designed to gasify 92 ST/SD of raw bituminous coal and produce pipeline quality SNG.

Process Description

Illinois No. 6 feed coal is fed via a lock hopper system to a fluidized bed gasifier which operates at approximately 1300°F and 500 psia. Gasification of the coal occurs with a mixture of steam and recycled synthesis gas, producing CH_4, CO_2, CO, H_2 and unconverted steam as the gasifier effluent. The gasifier contains internal primary and secondary cyclones where unconverted coal fines and ash are separated from the effluent gas and returned to the fluid bed.

The effluent gas enters a gas-gas exchanger where it is cooled to approximately 1050°F. Further cooling of the gas is achieved in a high-pressure waste heat boiler where 600 psig steam is generated. The gas leaves the boiler at approximately 520°F. After leaving the waste heat boiler, the gas is sent to a tertiary cyclone to recover as many of the overhead fines as possible.

A fines scrubbing system is provided to remove particulate solids from the gas prior to further treating. The raw product gas from the tertiary cyclone is fed to a venturi scrubber where it is contacted and scrubbed with the NH_3 scrubber bottoms slurry. The water slurry leaving the scrubber surge drum, which contains NH_3, H_2S, CO_2 and dissolved catalyst in addition to the particulate solids and water, is fed to a sour slurry stripper for further treating. The gas from the scrubber surge drum is cooled to 110°F in a product gas cooler and fed to an NH_3 scrubber where final NH_3 cleanup is accomplished. The gas from the NH_3 scrubber is then fed to the acid gas removal facilities which is the existing Benfield unit. Removal of H_2S, CO_2, COS and other sulfur compounds takes place in this section.

Downstream of the Benfield unit, molecular sieve purifiers are provided to assure complete removal of the CO_2, H_2S and to absorb other impurities which could freeze in the downstream cryogenic facilities. Leaving the purifiers, the gas is fed to the cryogenic methane recovery facilities where synthesis gas (H_2 + CO) is separated from the product methane. The recycled synthesis gas plus makeup from the reformer is compressed, mixed with 600 psig steam and heated in the preheat furnace. This gas is fed to the gasifier and provides the heat input for the gasification reactor.

Ash and char residue from the gasification step and overhead fines from the fines slurry drum are sent to a catalyst recovery unit. Semi-rich catalyst solution from the recovery unit is used to slurry each of the feed solids streams. A large fraction of the catalyst is leached from the residue and fines using counter current water washing. The recovered catalyst solution is concentrated, mixed with fresh makeup catalyst and is used to impregnate the coal to complete the catalyst recovery loop.

TABLE II-A-1

ONSITES UTILITIES AND CHEMICALS

Cooling Water

Requirements, GPM		Normal	Maximum
E-103	Product Gas Cooler	52	274*
E-104	Slurry Stripper Ov'hd Cond.	251	291*
E-105	Slurry Stripper Btm's Cooler	520	520*
E-113	MRT R 12 Condenser	18	18*
E-114	MRT Methane Comp After Cooler	31	31*
E-118	Reformer Effluent Trim Cooler	23	81*
E-119	Cat Recovery Slurry Cooler	9	33*
E-120	Evaporator Ov'hd Condenser	123	123*
E-121	Reactivation Gas Cooler	68	68*
E-123	MRT Methane Comp. Int. Cooler	30	30*
C-102	MRT Methane Comp. Jacket Cooling	47	47*
EA-201 & 218	Scrubbing Water Cooler	429	1052*
EA-207	Catacarb Regen. Ov'hd cond.	177	177*
E-125 & EA-205	Lean Sol'n Cooler	102	102*
		1880	2847
	Simultaneous Maximum		2847

Boiler Feed Water

Requirements, GPM		Normal	Maximum
E-102	Gasifier Waste Heat Boiler	17	24*
E-116	Reformer Waste Heat Boiler	9	22*
		26	46
	Simultaneous Maximum		46

Industrial Water

Requirements, GPM		Normal	Maximum
D-113	Char Quench Drum	1	2*
D-121N	Hydroclone Mix Drum	6	17*
T-101	Ammonia Scrubber	50	50*
		57	69
	Simultaneous Maximum		69

TABLE II-A-1 (Cont'd)

Steam

Steam - 600

Requirements, #/hr		Normal	Maximum
E-111	Reactivation Gas Heater	5500	5500*
R-101	Gasifier	12430	12430*
F-102	Reformer	3046	9135*
DC-202	Char Quench Drum	7220	7220*
		28196	34,285
	Simultaneous Maximum		34,285

Steam - 125

Requirements, #/hr		Normal	Maximum
E-122	Slurry Stripper Reboiler	8694	8694*
J-101	Evaporator Ejector	2110	2110*
F-101	Preheat Furnace	300	3000*
F-102	Reformer	185	3000*
E-126	CO_2 Vaporizer	150	700*
EA-204	Benfield Reboiler	3300	3300*
DA-203	Benfield Regenerator	3570	3570*
FB-201	Benfield Sol'n Tank	200	200*
		18509	24574
	Simultaneous Maximum		24574

Steam - 600

Production, #/hr		Normal	Maximum
E-102	Gasifier Waste Heat Boiler	7870	11160*
E-116	Reformer Waste Heat Boiler	2345	5050*
E-102	Reformer Convection Section	1630	4585*
		11845	20795
	Simultaneous Maximum		20795

TABLE II-A-1 (Cont'd)

Electric Power

Requirements, kW		Service	Operating Load	Reacceleration
E-117	Ref. Effluent Cooler	N	6*	A
C-101A	Recycle Gas Compressor	N	250*	A
C-101B	Recycle Gas Compressor	S	250	A
C-102A	MRT Methane Compressor	N	370*	A
C-102B	MRT Methane Compressor	S	370	A
C-103A	MRT Ethylene Compressor	N	54*	A
C-103B	MRT Ethylene Compressor	S	54	A
C-104A	MRT R-12 Compressor	N	64*	A
C-104B	MRT R-12 Compressor	S	64	A
P-101A	Ref. WH Boiler Circul. Pump	N	6*	A
P-101B	Ref. WH Boiler Circul. Pump	S	6	A
P-104A	Slurry Stripper Reflux Pump	N	1*	A
P-104B	Slurry Stripper Reflux Pump	S	1	A
P-105	Sulfuric Acid Metering Pump	N	0.5*	B
P-106A	Neutralization Circul. Pump	N	2*	A
P-106B	Neutralization Circul. Pump	S	2	A
P-107A	MRT Reflux Pump	N	0.5*	A
P-107B	MRT Reflux Pump	S	0.5*	A
P-108A	MRT Bottoms Pump	N	0.5*	A
P-108B	MRT Bottoms Pump	S	0.5*	A
P-109A	Char Slurry Pump	N	22*	A
P-109B	Char Slurry Pump	S	22	A
P-110A	Cat Solution Surge Pump	N	7*	A
P-110B	Cat Solution Surge Pump	S	7	A
P-111A	Slurry Feed Pump	N	2.3*	A
P-111B	Slurry Feed Pump	S	2.3*	A
P-112A	Recycle Cat Solution Pump	N	1.5*	A
P-112B	Recycle Cat Solution Pump	S	1.5*	A
P-113A	Spent Char & Ash Pump	N	1.5*	A
P-113B	Spent Char & Ash Pump	S	1.5*	A
P-114A	Hydroclone Pump	N	2.3*	A
P-114B	Hydroclone Pump	N	2.3*	A
P-114C	Hydroclone Pump	N	2.3*	A
P-114D	Hydroclone Pump	N	2.3*	A
P-114E	Hydroclone Pump	N	2.3*	A
P-114F	Hydroclone Pump	N	2.3*	A
P-114G	Hydroclone Pump	N	2.3*	A
P-114H	Hydroclone Pump	N	2.3*	A
P-114I	Hydroclone Pump	N	2.3*	A
P-114J	Hydroclone Pump	N	2.3*	A
P-114K	Hydroclone Pump	N	2.3*	A
P-114L	Hydroclone Pump	N	2.3*	A
P-114M	Hydroclone Pump	N	2.3*	A
P-114N	Hydroclone Pump	N	2.3*	A
P-115A	Evaporator Circ. Pump	N	11*	A

TABLE II-A-1 (Cont'd)

Requirements, kW		Service	Operating Load	Reaccel-eration
P-115B	Evaporator Circ. Pump	S	11	A
P-116A	Concentrated Solution Pump	N	0.3*	A
P-116B	Concentrated Solution Pump	S	0.3	A
GA-208	Makeup Water Booster Pump	N	0.7*	A
GA-208S	Makeup Water Booster Pump	S	0.7	A
GA-201	Scrubbing Water Circulation Pump	N	33.5*	A
GA-207	" " " "	S	33.5	A
GA-207S	" " " "	S	33.5	A
P-118A	MRT HP Flash Btm's Pump	N	0.5*	A
P-118B	MRT HP Flash Btm's Pump	S	0.5	A
P-119A	Scrubbing Water Booster Pump	N	34.6*	A
GA-401	Scrubbing Water Booster Pump	S	34.6	A
P-120	Dimethyl Sulfide Metering Pump	N	0.1	C
M-101	Neutralization Mix Drum Mixer	N	1*	A
M-102	Char Slurry Drum Mixer	N	4*	A
M-103	Fines Slurry Drum Mixer	N	4*	A
M-104	Slurry Feed Drum Mixer	N	1*	A
M-105	Recycle Cat Solution Drum Mixer	N	1*	A
M-106A	Hydroclone Mix Drum Mixer	N	1*	A
M-106B	Hydroclone Mix Drum Mixer	N	1*	A
M-106C	Hydroclone Mix Drum Mixer	N	1*	A
M-106D	Hydroclone Mix Drum Mixer	N	1*	A
M-106E	Hydroclone Mix Drum Mixer	N	1*	A
M-106F	Hydroclone Mix Drum Mixer	N	1*	A
M-106G	Hydroclone Mix Drum Mixer	N	1*	A
M-106H	Hydroclone Mix Drum Mixer	N	1*	A
M-106I	Hydroclone Mix Drum Mixer	N	1*	A
M-106J	Hydroclone Mix Drum Mixer	N	1*	A
M-106K	Hydroclone Mix Drum Mixer	N	1*	A
M-106L	Hydroclone Mix Drum Mixer	N	1*	A
M-106M	Hydroclone Mix Drum Mixer	N	1*	A
M-106N	Hydroclone Mix Drum Mixer	N	1*	A
			926.6	

Fuel System

Fuel Gas

Requirement, MBtu/hr		Normal	Maximum
F-101	Preheat Furnace	11.0	15.0*
F-102	Reformer	6.8	24.6*
		17.8	39.6
	Simultaneous Maximum		39.6

TABLE II-A-1 (Cont'd)

Pilot Gas

Requirements, MBtu/hr		Normal	Maximum
F-101	Preheat Furnace	1.0	1.0*
F-102	Reformer	0.6	1.2*
		1.6	2.2
	Simultaneous Maximum		2.2

Fuel Oil

Requirements, MBtu/hr			
F-101	Preheat Furnace	11.0	15.0*
F-102	Reformer	6.8	24.6
		17.8	39.6
	Simultaneous Maximum		39.6

Air System

Instrument Air

Requirement, SCFM		
	Estimated	200

Utility Air

Requirement, SCFM		
	Estimated	100

Catalyst and Chemicals

Dimethyl Sulfide

Requirement, #/hr			
		0.5	1.6

Methane

Requirement, SCFM		Normal	Maximum
F-102	Reformer	215	645

Sulfuric Acid - 98% H_2SO_4

Requirement, #/hr			
D-107	Neutralization Mix Drum	950	950

Carbon Dioxide (Liquid)

Requirement, #/hr			
E-126	CO_2 Vaporizer	1000	5000

TABLE II-A-1 (Cont'd)

ZnO Adsorbent

3200 lbs of Adsorbent 1/8" - 3/16" spheres

Mol Sieve Adsorbent

30,000 lbs of 1/16" molecular sieve

Activated Carbon

3000 lbs of activated carbon

Reformer Catalyst

52 ft^3 of 5/8" x 5/8" x 1/4" nickel on alumina gas reforming rasching rings. 52-54 lbs/ft^3 bulk density

TABLE II-A-2

ONSITES EQUIPMENT LIST - HEAT EXCHANGERS

•Shell and Tube Exchangers

Equipment No.	Service	Duty, MBtu/hr	Total Surface, Ft^2	No. Shells	Comments
E-101	Gas-Gas Exchanger	3.5	326	1	
E-102	Gasifier W. H. Boiler	11.3	722	1	
E-103 A and B	Product Gas Cooler	4.8	660	2	
E-104	Slurry Stripper O'H Condenser	5.2	430	1	
E-105 A and B	Slurry Stripper Bottoms Cooler	8.6	1160	2	
E-111	Reactivation Gas Heater	1.22	200	1	
E-113	MRT Condenser R-12	0.32	130	1	
E-114 A and B	MRT Methane Comp. After Cooler	0.54	340	2	
E-115	ZnO Bed Preheated	0.69	90	1	
E-116	Reformer W. H. Boiler	4.7	190	1	
E-118	Ref. Effluent Trim Cooler	0.8	456	1	
E-119	Cat Recovery Slurry Cooler	0.7	40	1	
E-120	Evaporator O'H Condenser	2.1	110	1	
E-121	Reactivation Gas Cooler	1.2	300	1	
E-122	Slurry Stripper Reboiler	7.6	2660	1	
E-123	MRT Methane Comp. Inter Cooler	0.51	350	2	
E-124	Evaporator Heater	2.9	300	1	
E-125	Lean Sol'n Cooler	1.27	400	1	
EA-205	Lean Sol'n Cooler		400	1	Existing

TABLE II-A-2 (Cont'd)

- Shell and Tube Exchangers (Cont'd)

Equipment No.	Service	Duty, MBtu/hr	Total Surface, Ft^2	No. Shells	Comments
EA-204	Benfield Reboiler	3.2	500	2	Existing
EA-207	Benfield Regen. OV'HD Condenser	3.1	1000	1	Existing
EA-201	Scrubbing Water Cooler	18.5	1562	2	Existing
EA-218	Scrubbing Water Cooler		1560	2	Existing
E-126	CO_2 Vaporizer	0.65		1	

- Plate Fin Exchangers

E-106 A and B	MRT Feed Cooler	1.8	11,400	0	
E-107	MRT Feed Chiller	0.44	1100	0	
E-108	MRT Feed Condenser	0.11	240	0	
E-109	MRT Aux. Cooler	0.94	300	0	
E-110	MRT O'H Condenser	0.71	3000	0	
E-112	MRT Ethylene Condenser	0.09	450	0	

- Air Fin Exchangers

E-117	Ref. Effluent Cooler	10.0	718	0	

TABLE II-A-3

ONSITES EQUIPMENT LIST - PUMPS

Equipment No.	Service	Type	Capacity, GPM	ΔP, PSI	BHP	Comments
P-101 A and B	Ref. WH Boiler Circulating Pump	Centrifugal	322	25	7.0	
GA-201	Scrubbing Water Circulating Pump	Centrifugal	230	165	50.	Existing
GA-207 and S	Scrubbing Water Circulating Pump	Centrifugal	230	165	50.	Existing
P-104 A and B	Slurry Stripper Reflux Pump	Centrifugal	15	25	1.	
P-105	Sulfuric Acid Metering Pump	Metering	0.1	110	0.5	
P-106 A and B	Neutralization Circulating Pump	Centrifugal	90.	20	2	
P-107 A and B	MRT Reflux Pump	Centrifugal	16.	10	1	
P-108 A and B	MRT Bottoms Pump	Centrifugal	16.	10	0.5	
P-109 A and B	Char Slurry Pump	Centrifugal	350	40	30.	
P-110 A and B	Cat Solution Surge Pump	Reciprocal	18	480	7.5	
P-111 A and B	Slurry Feed Pump	Centrifugal	21	50	2.5	
P-112 A and B	Recycle Cat Solution Pump	Centrifugal	10	65	2.0	
P-113 A and B	Spent Char and Ash Pump	Centrifugal	10	70	2.0	
P-114 A-N	Hydroclone Pump	Centrifugal	30	45	2.5	
P-115 A and B	Evaporator Circulating Pump	Centrifugal	880	5	15.0	
P-116 A and B	Concentrated Solution Pump	Centrifugal	5	50	1	
GA-208 and S	Makeup Water Booster Pump	Centrifugal	11	50	2.0	Existing
P-118 A and B	MRT H.P. Flush BTM's Pump	Centrifugal	23	10	0.75	
P-119	Scrubbing Water Booster Pump	Centrifugal	60	570	50.	
GA-401	Scrubbing Water Booster Pump	Centrifugal	60	570	50.	Existing
P-120	Dimethyl Sulfide Metering Pump	Metering	0.004	625	0.1	
GA-202 and S	Semi-Lean Sol'n Pump	Centrifugal	285	500	200	Existing

TABLE II-A-3 (Cont'd)

Equipment No.	Service	Type	Capacity, GPM	ΔP, PSI	BHP	Comments
GA-203	Benfield Sol'n Sump Pump	Reciprocal	2	20	0.5	Existing
GA-204 and S	Benfield Reflux Pump	Centrifugal	10	75	3.0	Existing
GA-212 and S	Lean Sol'n Pump	Centrifugal	28	500	30.	Existing

TABLE II-A-4

ONSITES EQUIPMENT LIST - COMPRESSORS

Equipment No.	Service	Type	No. Stages	Suction Flow, ACFM	BHP
C-101 A and B	Recycle Gas Compressor	Reciprocal	1	240	330
C-102 A and B	MRT Methane Compressor	Reciprocal	2	1400	500
C-103 A and B	MRT Ethylene Compressor	Reciprocal	2	112	75
C-104 A and B	MRT R-12 Compressor	Reciprocal	2	227	100

TABLE II-A-5

ONSITES EQUIPMENT LIST - PRESSURE VESSELS

Equipment No.	Service	Dimensions Diameter, Ft	Length, Ft	Position	Comments
R-101	Gasifier	3'6"	154'0"	Vertical	
DA-201	Ammonia Scrubber	2'6"	39'0"	Vertical	
T-102	Slurry Stripper	2'6"	62'0"	Vertical	
T-103	Methane Recovery Tower	1'6"	36'0"	Vertical	
T-104	Benfield Absorber	2'10" (Btm) x 1'9" (Top)	95'0"	Vertical	
DA-203	Benfield Regenerator	4'0"	112'0"	Vertical	Existing
FE-106	Weigh Hopper	5'3"	4'2"	Vertical	Existing
FE-104 AX, BX	Storage Injectors	3'6"	6'6"	Vertical	Existing
FE-105X	Primary Injector	6'0"	11'0"	Vertical	Existing
D-101	Gasifier Steam Drum	3'0"	13'0"	Vertical	
D-102	Gasifier Steam Blowdown Drum	1'0"	5'0"	Vertical	
FA-204	Benfields Abs. OV'HD K.O. Drum	2'6"	6'0"	Vertical	Existing
FA-205	Acid Gas K.O. Drum	2'6"	6'0"	Vertical	Existing
FA-215	Scrubber Surge Drum	5'0"	14'0"	Horizontal	Existing
D-106	Stripper Distillate Drum	3'0"	9'0"	Horizontal	
D-107	Neutralization Mix Drum	3'0"	9'0"	Vertical	
D-108	MRT Distillate Drum	3'0"	9'0"	Vertical	
D-109	MRT Bottoms Flash Drum	3'0"	9'0"	Vertical	
D-110	Reformer Steam Drum	3'0"	12'0"	Vertical	
D-111	Reformer Steam Blowdown Drum	1'0"	5'0"	Vertical	
D-112	Reformer Effluent K.O. Drum	2'6"	10'0"	Vertical	
DC-202	Char Quench Drum	4'6";2'6"	34'0"	Vertical	

TABLE II-A-5 (Cont'd)

Equipment No.	Service	Dimensions		Position	Comments
		Diameter, Ft	Length, Ft		
D-114	Char Slurry Drum	4'0"	6'0"	Vertical	
D-115	Fines Hopper	2'6"	7'0"	Vertical	
D-116	Fines Slurry Drum	4'6"	7'6"	Vertical	
D-117	Slurry Feed Drum	3'0"	6'0"	Vertical	
D-118	Recycle Cat Solution Drum	2'0"	6'0"	Vertical	
D-119	Spent Char and Ash Drum	2'0"	4'0"	Vertical	
D-120	Cat Solution Surge Drum	2'6"	7'6"	Vertical	
D-121 A-N	Hydroclone Mix Drum	3'6"	6'0"	Vertical	
DC-204A	ZnO Bed	2'0"	20'0"	Vertical	Existing
D-123 A-C	Mol Sieve Absorber	4'6"	16'0"	Vertical	
D-124	MRT Ethylene Compressor K.O. Drum	1'6"	4'6"	Vertical	
D-125	MRT R-12 Compressor K.O. Drum	1'6"	5'0"	Vertical	
D-126	Product SNG K.O. Drum	1'6"	6'0"	Vertical	
D-127	MRT H. Pressure Flash Drum	3'0"	10'0"	Vertical	
D-128	Evaporator	4'6"	7'0"	Vertical	
D-129	Condensate Surge Drum	2'6"	8'0"	Horizontal	
FD-201	Semi-lean Sol'n Filter	1'0"	3'0"	Vertical	Existing
FB-201	Benfield Sol'n Tank	10'0"	8'0"	Vertical	Existing
CYC-101	Primary Gasifier Cyclone	1'2.5"	3'5"	Vertical	
CYC-102	Secondary Gasifier Cyclone	1'0.5"	3'	Vertical	
CYC-103	Tertiary Gasifier Cyclone	1'1"	4'1"	Vertical	
CYC-104	Quench Drum Cyclone	8"	2'	Vertical	

240

300

TABLE II-A-6

ONSITES EQUIPMENT LIST - FURNACES

Equipment No.	F-101	F-102
Service	Steam/Recycle Gas Preheat Furnace	Steam Reformer Furnace
Type	Vertical Tube Box Furnace with Horizontal Convection Section	Vertical Tube Box Furnace with Horizontal Convection Section
Duty, MBtu/hr	11.6	12.5 Radiant/6.9 Convection
Efficiency, %	75.3	76.7
Excess Air at Stock, %	20	15

TABLE II-A-7

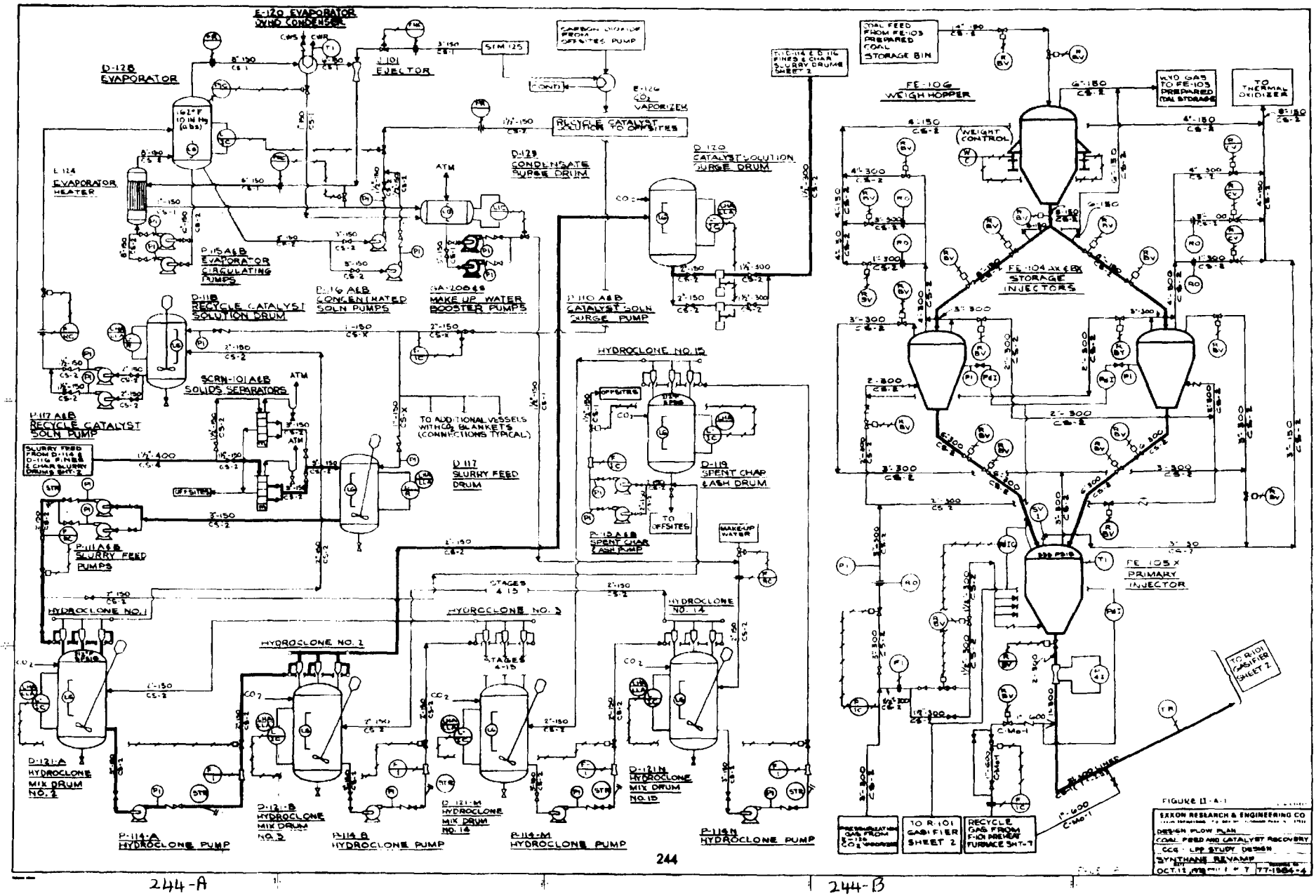
ONSITES EQUIPMENT LIST - SPECIAL EQUIPMENT

SCRN - 101 A and B	Screens to remove particles larger than 1000 microns from slurry feed to D-117 slurry feed tank. Sweco Vibro-Energy Separater Model LS485 818 10CD, 24" diameter or equivalent.
STR - 101 A and B	Char Slurry Strainers, screen type to remove particles larger than 3/16", screen area is 40 in?
J-101	Steam jet ejector. Suction pressure 10 in. Hg, back pressure 40 in. Hg., 886.6 lb/hr saturated steam.
J-102	Venturi Scrubber for product gas coal fines removal, gas rate is 15.5 ACFS, solid content (max.) is 10wt% (10 microns), scrubbing liquid rate is 460 gpm, design efficiency is 98%.

TABLE II-A-8

ONSITES EQUIPMENT LIST - ANALYSERS

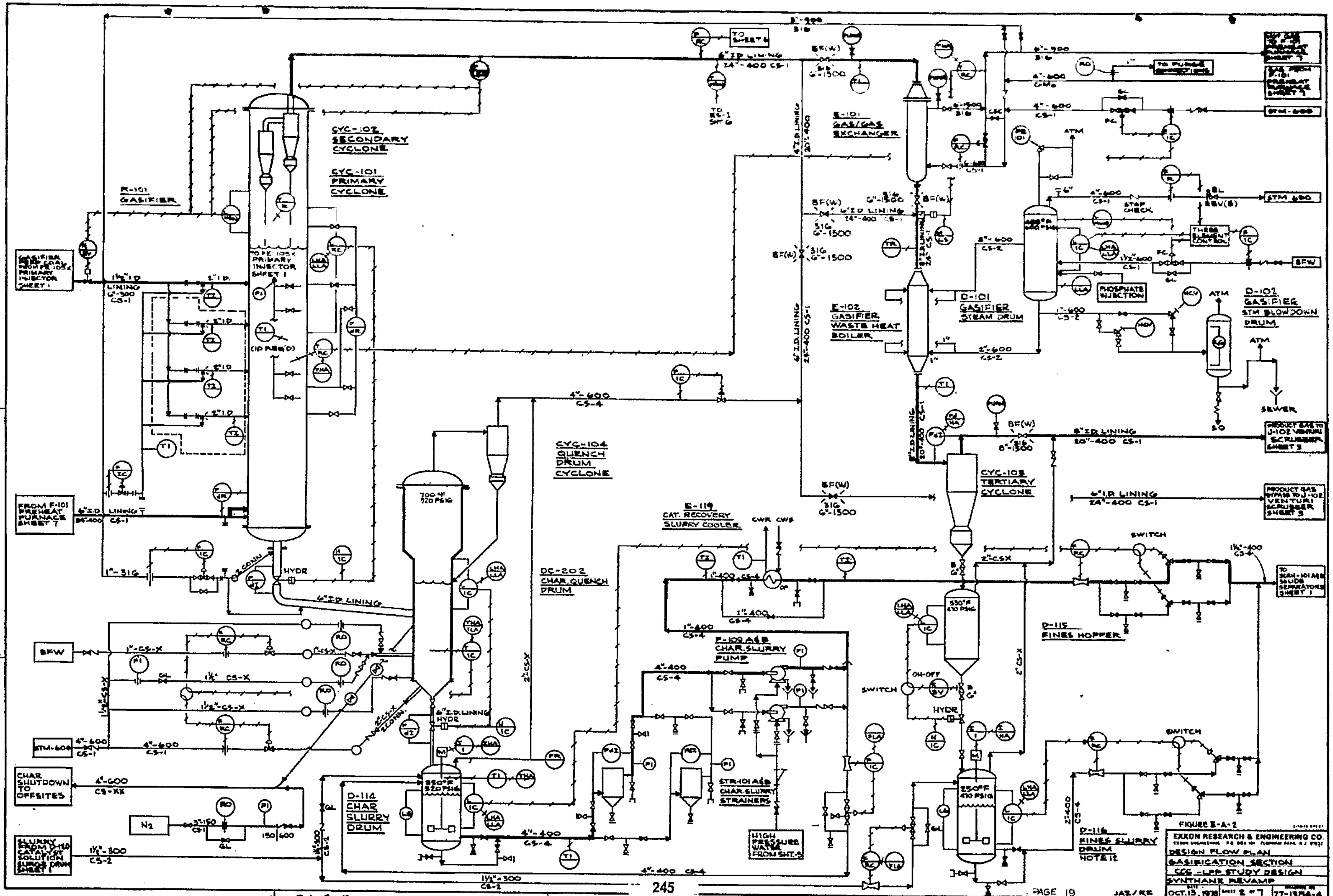
Item	Stream	Type	Components
A-101 R	Ammonia Scrubber Overhead	GC	H_2, CO, CO_2, CH_4 (Hewlett Packard)
A-102 R	Ammonia Scrubber Overhead	GC	H_2S, NH_3, C_2+ (Hewlett Packard)
A-103 R	Sour Slurry Stripper Bottoms	pH	
A-104 R	Feed to MRT Cooler	H_2O Dew Point	0 to -140 °F (duPont)
A-105 R	Feed to MRT Cooler	CO_2 (ppm)	
A-106 R	Synthetic Product Gas	GC	H_2, CO, CO_2, CH_4 (Hewlett Packard)
A-107 R	Steam Reformer Feed	H_2S	0-2 ppm
A-108 R	Preheat Furnace Feed	GC	H_2, CO, CO_2, CH_4 (Hewlett Packard)
A-109 R	Preheat Furnace Effluent	H_2S	0-2 ppm

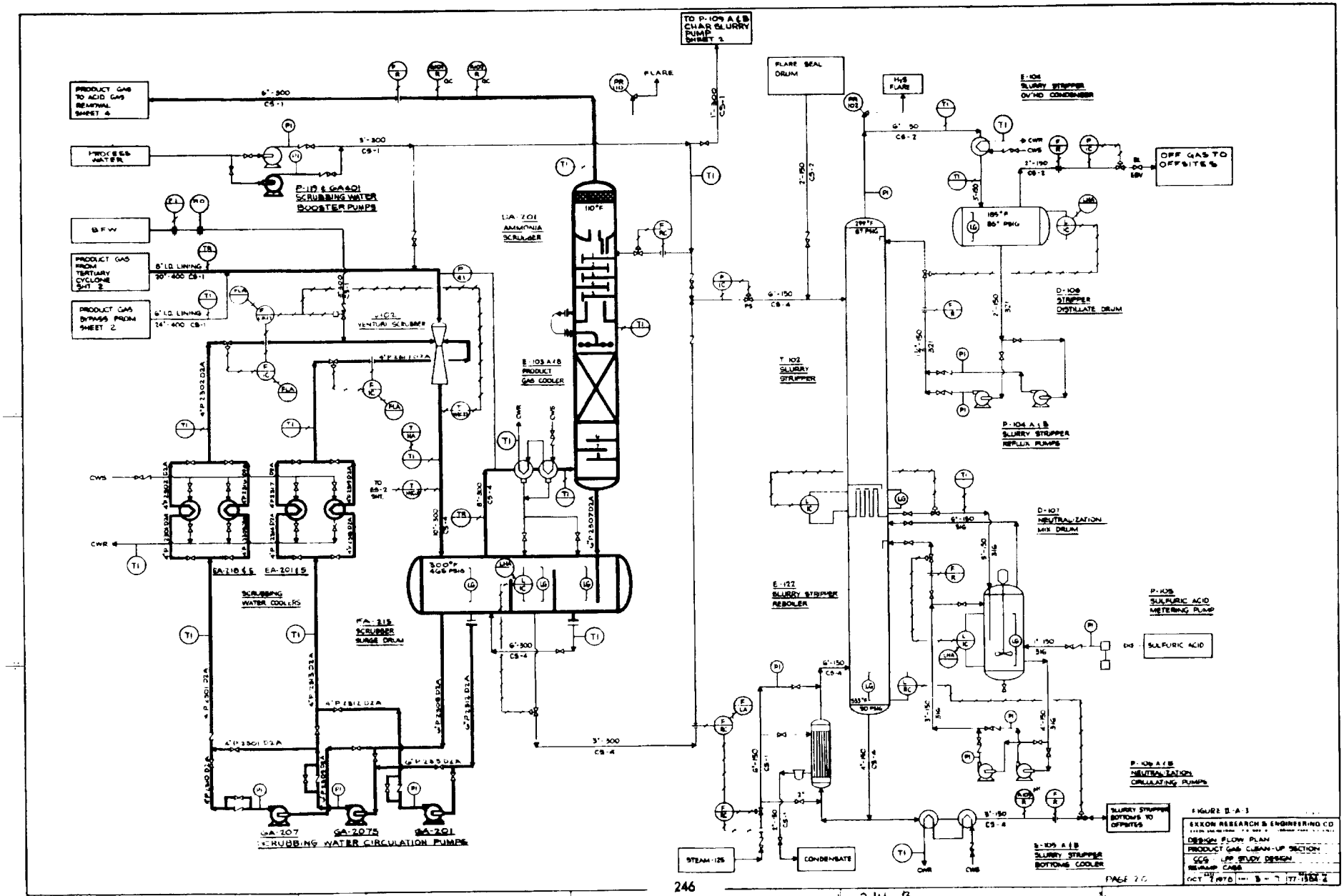


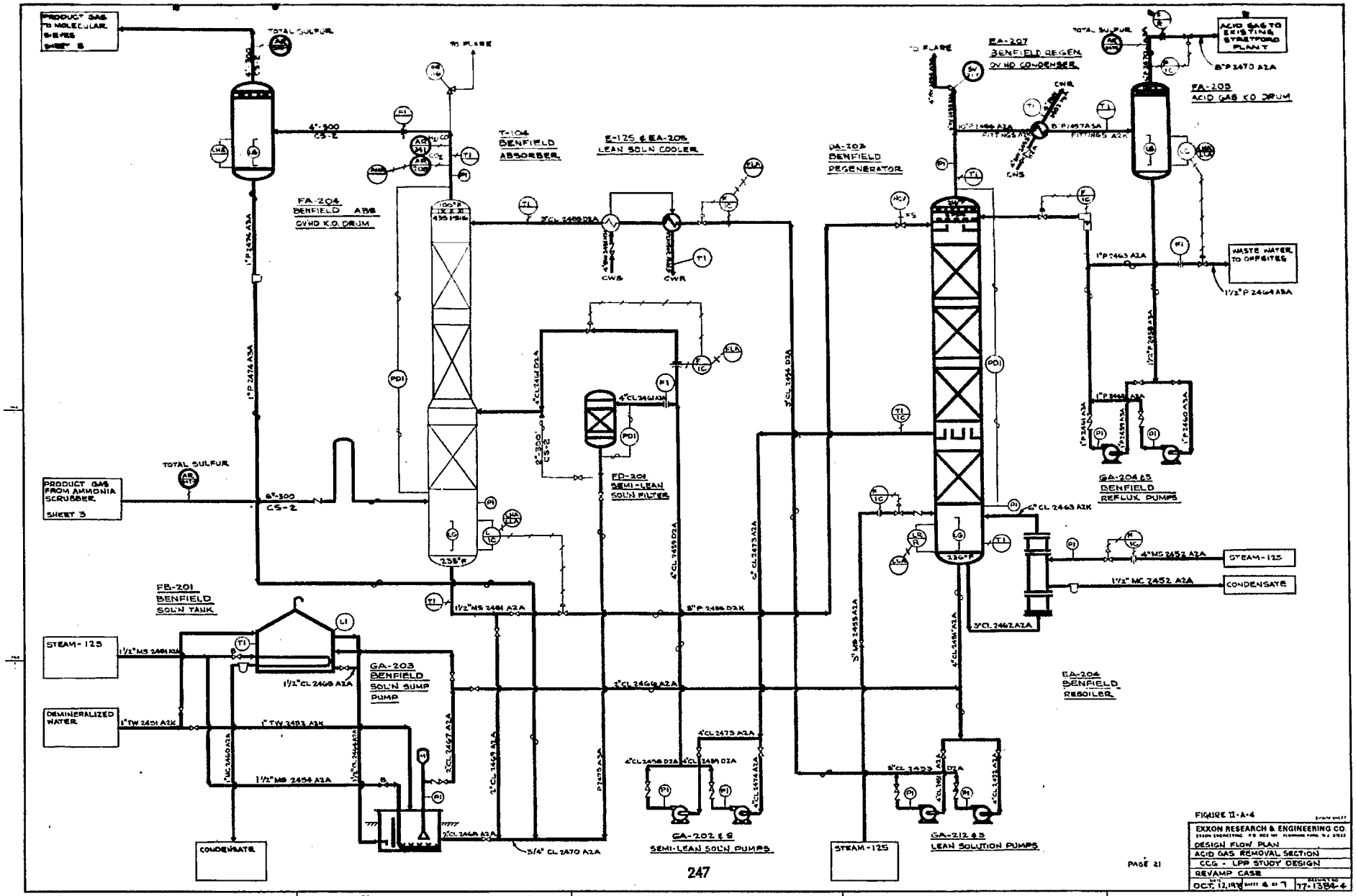
244

244-A

244-B


R-101 GASIFIER
CYC-102 SECONDARY CYCLONE
CYC-101 PRIMARY CYCLONE
CYC-104 QUENCH DRUM CYCLONE
DC-202 CHAR QUENCH DRUM
D-114 CHAR SLURRY DRUM
E-119 CAT. RECOVERY SLURRY COOLER
P-102 A&B CHAR SLURRY PUMP
STR-101 A&B CHAR SLURRY STRAINERS
E-101 GAS/GAS EXCHANGER
E-102 GASIFIER WASTE HEAT BOILER
D-101 GASIFIER STEAM DRUM
D-102 GASIFIER STM BLOWDOWN DRUM
CYC-103 TERTIARY CYCLONE
D-115 FINES HOPPER
D-116 FINES SLURRY DRUM NOTE 12
GASIFIER FEED COAL FROM FE-105X PRIMARY INJECTOR SHEET 1
FROM F-101 PREHEAT FURNACE SHEET 7
BFW
STM-600
CHAR SHUTDOWN TO OFFSITES
SLURRY FROM D-120 CATALYST SOLUTION SURGE DRUM SHEET 1
N2
HIGH PRESSURE WATER FROM SHT-5
PHOSPHATE INJECTION
THREE ELEMENT CONTROL
PRODUCT GAS TO J-102 VENTURI SCRUBBER SHEET 3
PRODUCT GAS BYPASS TO J-102 VENTURI SCRUBBER SHEET 3
TO SRH-101 A&B SOLIDS SEPARATORS SHEET 1
TO PURGE CONNECTIONS
STM 600
SEWER
ATM
SWITCH
700°F 720 PSIG
350°F 520 PSIG
530°F 410 PSIG
250°F 410 PSIG
FIGURE B-A-2
EXXON RESEARCH & ENGINEERING CO.
DESIGN FLOW PLAN
GASIFICATION SECTION
CCG - LPP STUDY DESIGN
SYNTHANE REVAMP
OCT. 13, 1978 SHEET 2 OF 7 77-1354-4
JAZ/RK
PAGE 19


TO P-109 A&B CHAR SLURRY PUMP SHEET 2
PRODUCT GAS TO ACID GAS REMOVAL SHEET 4
PROCESS WATER
BFW
PRODUCT GAS FROM TERTIARY CYCLONE SHT 2
PRODUCT GAS BYPASS FROM SHEET 2
P-119 & GA-201 SCRUBBING WATER BOOSTER PUMPS
FLARE
FLARE SEAL DRUM
H2S FLARE
E-104 SLURRY STRIPPER OVHD CONDENSER
OFF GAS TO OFFSITES
D-108 STRIPPER DISTILLATE DRUM
P-104 A&B SLURRY STRIPPER REFLUX PUMPS
T-102 SLURRY STRIPPER
D-101 NEUTRALIZATION MIX DRUM
P-105 SULFURIC ACID METERING PUMP
SULFURIC ACID
E-122 SLURRY STRIPPER REBOILER
E-103 A&B PRODUCT GAS COOLER
EA-201 AMMONIA SCRUBBER
V-102 VENTURI SCRUBBER
EA-218 & 5 EA-201 & 5
SCRUBBING WATER COOLERS
FA-215 SCRUBBER SURGE DRUM
GA-207 GA-207S GA-201
SCRUBBING WATER CIRCULATION PUMPS
P-106 A&B NEUTRALIZATION CIRCULATING PUMPS
SLURRY STRIPPER BOTTOMS TO OFFSITES
E-105 A&B SLURRY STRIPPER BOTTOMS COOLER
STEAM-125
CONDENSATE
CWS
CWR
FIGURE II-A-3
EXXON RESEARCH & ENGINEERING CO
DESIGN FLOW PLAN
PRODUCT GAS CLEAN-UP SECTION
CCG LPF STUDY DESIGN
REVAMP CASE
OCT 1978



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247-A

247-B

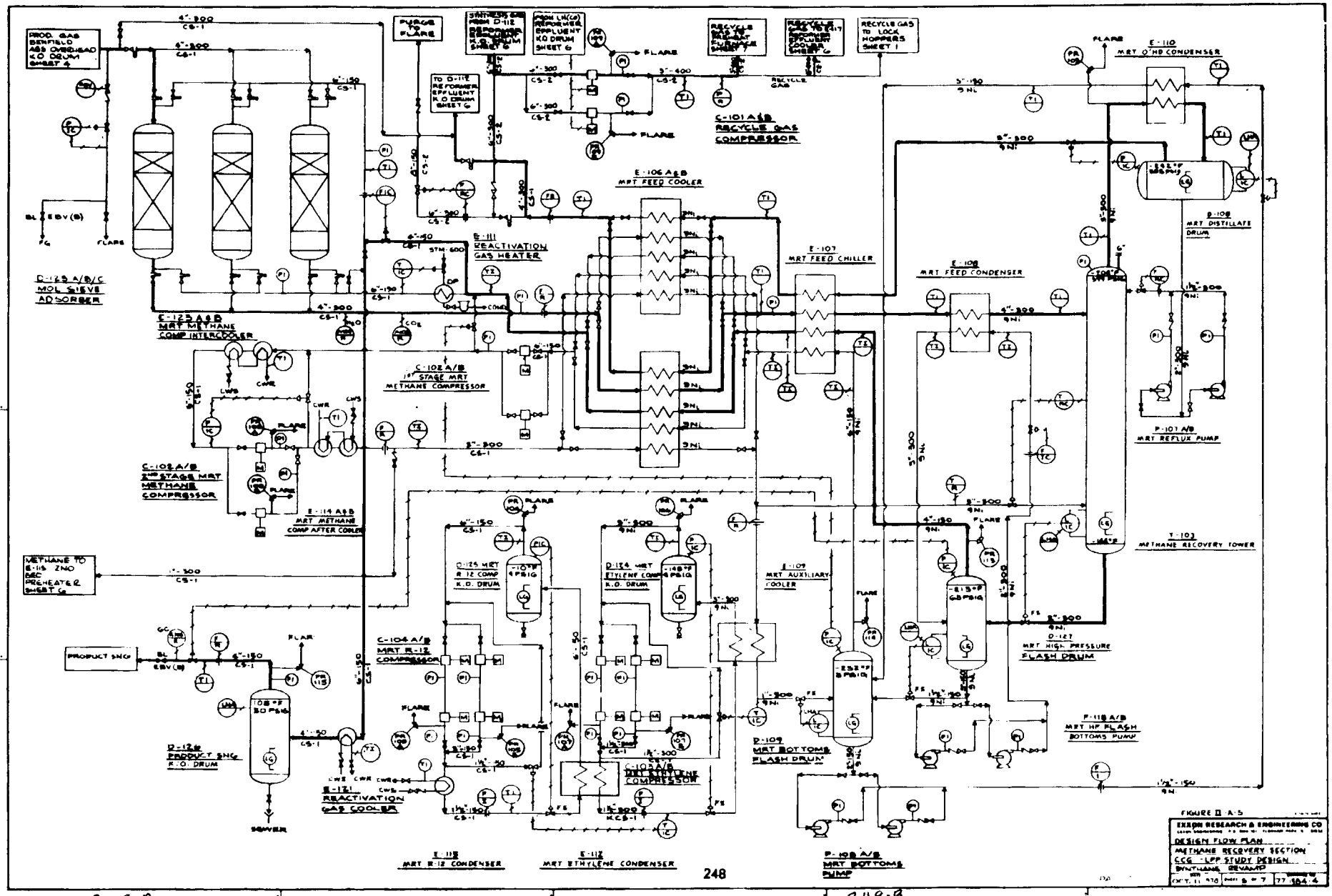

FIGURE II-A-5

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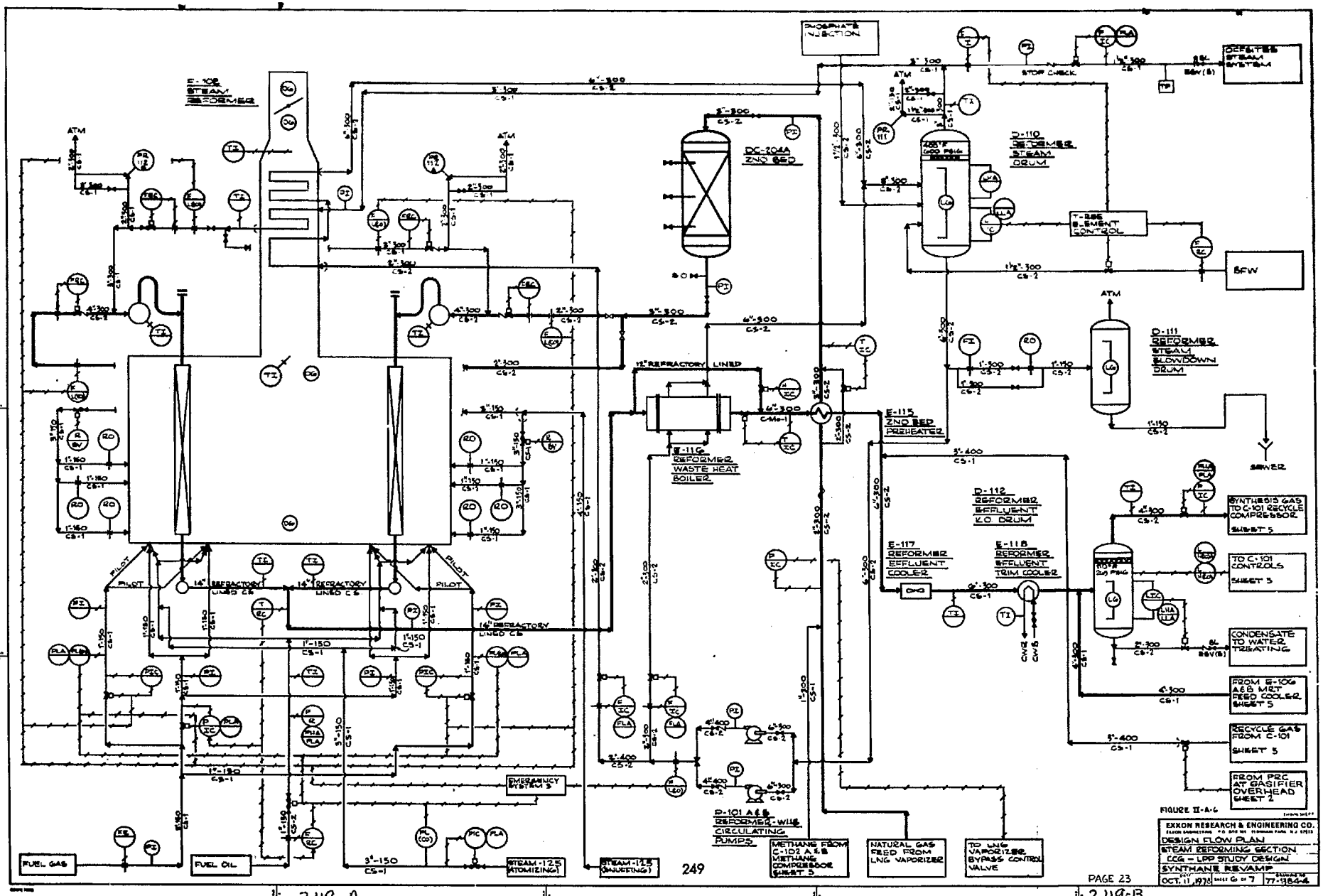
248-A

248-B


E-102 STEAM REFORMER
DEAERATOR SECTION
DC-204A ZNO BED
D-110 REFORMER STEAM DRUM
T-886 ELEMENT CONTROL
BFW
D-111 REFORMER STEAM BLOWDOWN DRUM
SEWER
E-115 ZNO BED PREHEATER
E-116 REFORMER WASTE HEAT BOILER
D-112 REFORMER EFFLUENT K.O. DRUM
E-117 REFORMER EFFLUENT COOLER
E-118 REFORMER EFFLUENT TRIM COOLER
SYNTHESIS GAS TO C-101 RECYCLE COMPRESSOR SHEET 5
TO C-101 CONTROLS SHEET 5
CONDENSATE TO WATER TREATING
FROM E-106 A&B MeOH FEED COOLER SHEET 5
RECYCLE GAS FROM C-101 SHEET 5
FROM PRC AT GASIFIER OVERHEAD SHEET 2
OFFSITES STEAM SYSTEM
EMERGENCY SYSTEM 3
D-101 A&B REFORMER WATER CIRCULATING PUMPS
METHANE FROM C-102 A&B METHANE COMPRESSOR SHEET 5
NATURAL GAS FEED FROM LNG VAPORIZER
TO LNG VAPORIZER BYPASS CONTROL VALVE
FUEL GAS
FUEL OIL
STEAM-125 (ATOMIZING)
STEAM-125 (SNUFFING)
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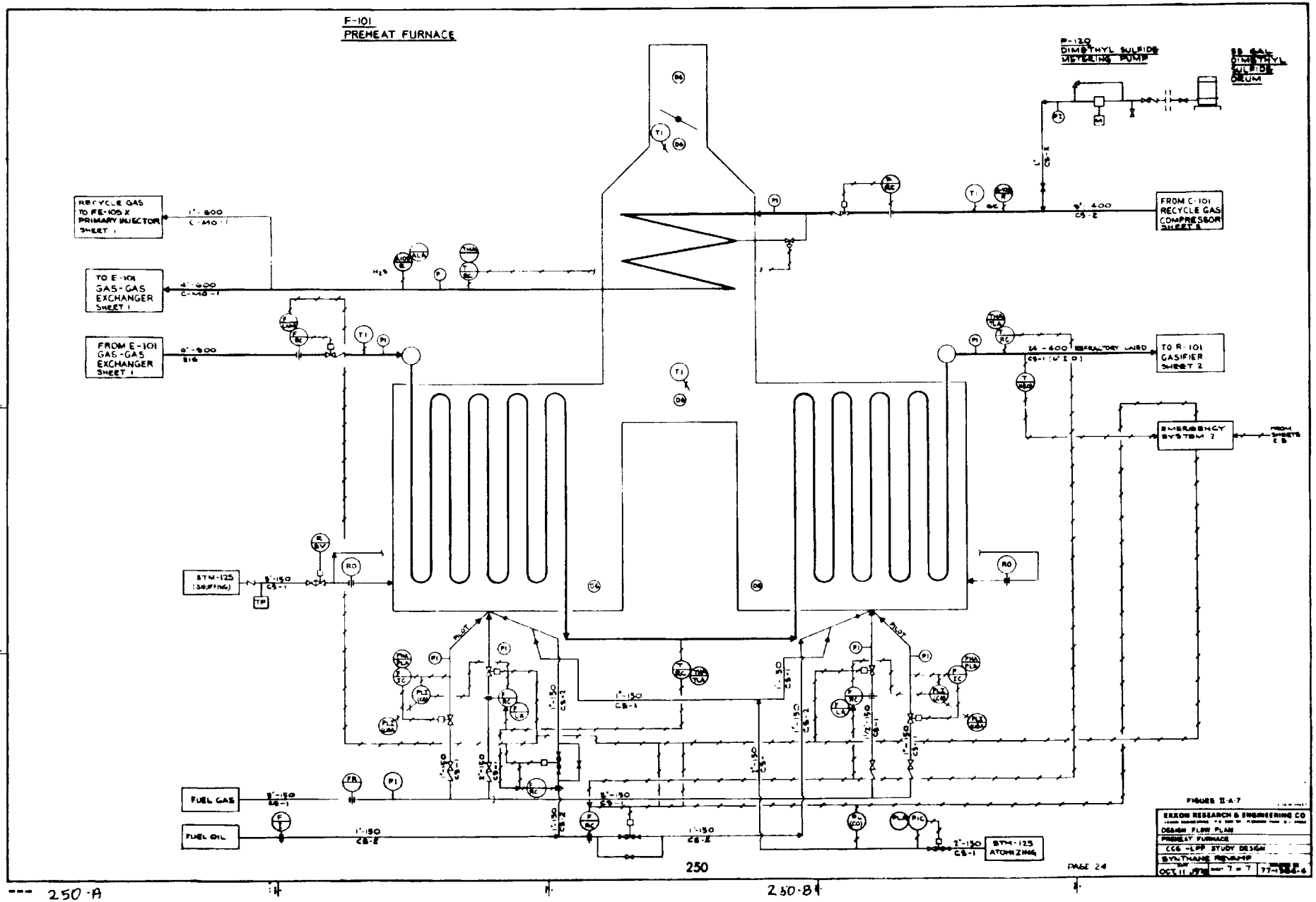
PAGE 23
FIGURE II-A-6
EXXON RESEARCH & ENGINEERING CO.
DESIGN FLOW PLAN
STEAM REFORMING SECTION
CCG - LPP STUDY DESIGN
SYNTHANE REVAMP
OCT. 11, 1978
77-1154-6

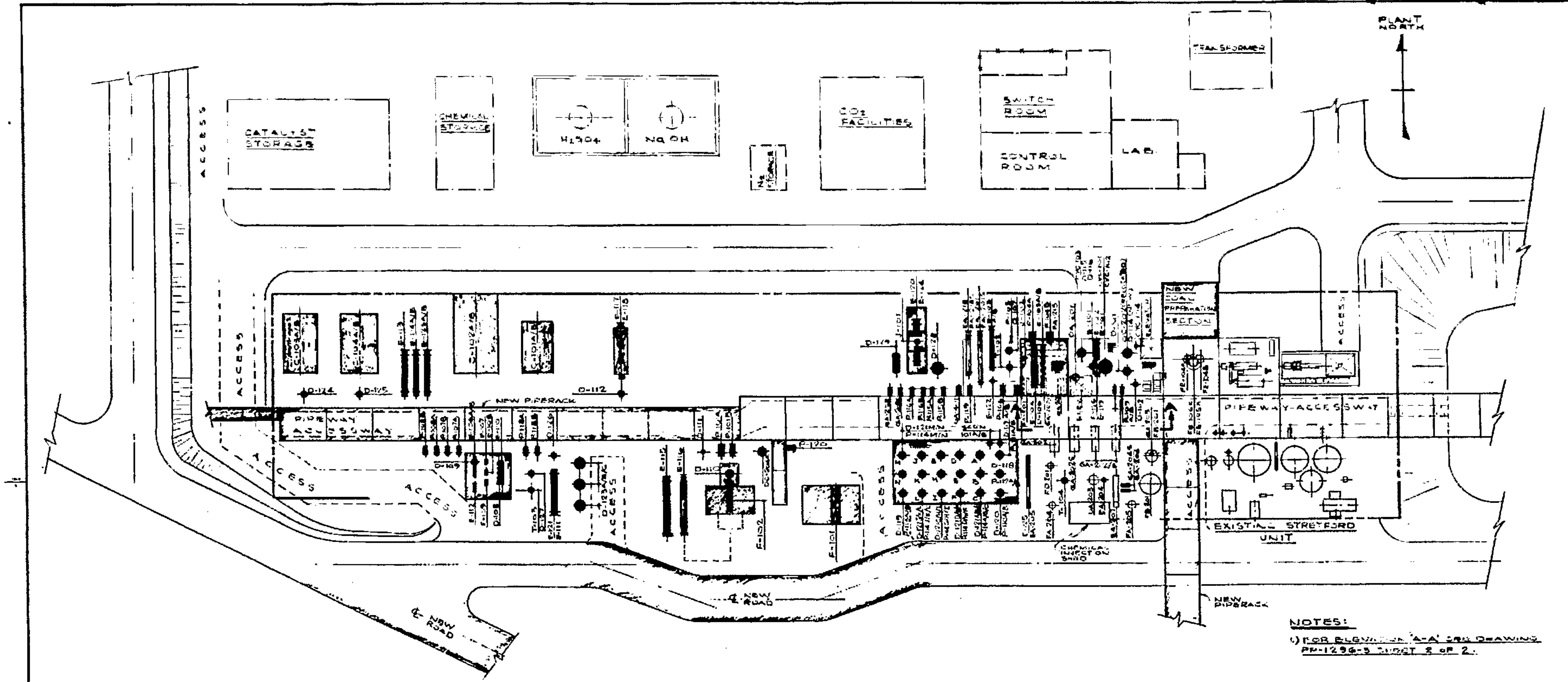
249-A

249-B


F-101
PREHEAT FURNACE
P-120
DIMETHYL SULFIDE
METERING PUMP
55 GAL
DIMETHYL
SULFIDE
DRUM
RECYCLE GAS
TO FE-105 X
PRIMARY INJECTOR
SHEET 1
1"-600
C-MO-1
TO E-101
GAS-GAS
EXCHANGER
SHEET 1
4"-600
C-MO-1
FROM E-101
GAS-GAS
EXCHANGER
SHEET 1
6"-900
B16
FROM C-101
RECYCLE GAS
COMPRESSOR
SHEET 3
6"-600
CS-2
TO R-101
GASIFIER
SHEET 2
24-600
REFRACTORY LINED
CS-1 (6" I.D.)
EMERGENCY
SYSTEM 2
STM-125
(SNUFFING)
1"-150
CS-1
TP
STM-125
ATOMIZING
FUEL GAS
FUEL OIL
1"-150
CS-2
PILOT
RO
FIGURE II-A-7
EXXON RESEARCH & ENGINEERING CO
DESIGN FLOW PLAN
PREHEAT FURNACE
CCG -LPP STUDY DESIGN
SYNTHANE PROJECT
OCT. 11, 1976
PAGE 24
250

--- 250-A

250-B



NOTES:
1) FOR ELEVATION 'A-A' SEE DRAWING PP-1296-3 SHEET 2 OF 2.

LEGEND:
EXISTING
RELOCATED
NEW

0 10 20 30 40 50 60 70 80 90 100
— SCALE IN FEET —

EQUIPMENT LISTING	
NO.	DESCRIPTION
	TOWERS
DA-201	AMMONIA SCRUBBER
DA-203	BENFIELD REGENERATOR
T-102	SLURRY STRIPPER
T-103	METHANE RECOVERY
T-104	BENFIELD ABSORBER
	DRUMS
FA-201	BENFIELD SOL'N MAKEUP SUMP
FA-204	BENFIELD OVH'D K.O.
FA-205	ACID GAS K.O.
FA-215	SCRUBBER SURGE
D-101	GASIFIER STEAM
D-102	GASIFIER STM. BLOWDOWN
D-106	STRIPPER DISTILLATE
D-107	NEUTRALIZATION
D-108	MRT DISTILLATE
D-109	MRT BOTTOMS FLASH
D-110	REFORMER STEAM
D-111	REFORMER STEAM BLOWDOWN
D-112	REFORMER EFFLUENT K.O.
DC-202	CHAR QUENCH
D-114	CHAR SLURRY
D-115	FINES HOPPER
D-116	FINES SLURRY
D-117	SLURRY FEED
D-118	RECYCLE CATALYST
D-119	SPENT CHAR AND ASH
D-120	CATALYST SOLUTION SURGE
D-121	HYDROCLONE MIX
DC-204A	ZNO BED
D-123	MOL SIEVE ADSORBER
D-124	MRT ETHYLENE COMPR. K.O.
D-125	MRT R-12 COMPR. K.O.
D-126	PRODUCT SNG K.O.
D-127	MRT HIGH PRESSURE FLASH
D-128	EVAPORATOR
D-129	CATALYST SOLUTION
	CYCLONES
CYC-101	PRIMARY } INTERNAL
CYC-102	SECONDARY } INTERNAL
CYC-103	TERTIARY
CYC-104	QUENCH DRUM

NO.	DESCRIPTION
	EXCHANGERS
E-101	GAS/GAS
E-102	GASIFIER WASTE HEAT BOILER
E-103A/B	PRODUCT GAS COOLER
E-104	SLURRY STRIPPER OVH'D COND.
E-105A/B	SLURRY STRIPPER BTMS COOLER
E-106A/B	MRT FEED COOLER
E-107	MRT FEED CHILLER
E-108	MRT FEED CONDENSER
E-109	MRT AUXILIARY COOLER
E-110	MRT OVH'D CONDENSER
E-111	REACTIVATION GAS HEATER
E-112	MRT ETHYLENE CONDENSER
E-113	MRT R-12 CONDENSER
E-114A/B	MRT METHANE COMPR AFTERCOOLER
E-115	2ND BED PREHEATER
E-116	REFORMER WASTE HEAT BOILER
E-117	REFORMER EFFLUENT COOLER
E-118	REFORMER EFFLUENT TRIM COOLER
E-119	CAT RECOVERY SLURRY COOLER
E-120	EVAPORATOR OVH'D CONDENSER
E-121	REACTIVATION GAS COOLER
E-122	SLURRY STRIPPER REBOILER
E-123A/B	MRT METHANE COMPR. INTERCOOLER
E-124	EVAPORATOR HEATER
E-125	LEAN SOL'N COOLER
E-126	CO_2 VAPORIZER
EA-201/5	SCRUBBING WATER COOLERS
EA-204	BENFIELD REBOILER
EA-205	LEAN SOL'N COOLER
EA-207	BENFIELD REGEN OVH'D COND
EA-216	SCRUBBING WATER COOLERS
	COMPRESSORS
C-101A/B	RECYCLE GAS
C-102A/B	1ST & 2ND STAGE MRT METHANE
C-103A/B	MRT ETHYLENE
C-104A/B	MRT, R-12
	HOPPERS
FE-104X/104B	STORAGE INJECTORS
FE-105X	PRIMARY INJECTOR
FE-106X	WEIGH HOPPER

NO.	DESCRIPTION
	PUMPS
GA-201	SCRUBBING WATER CIRCULATING
GA-202/3	SEMI-LEAN SOL'N.
GA-204/5	BENFIELD REFLUX
GA-207/8	SCRUBBING WATER CIRCULATING
GA-212/6	LEAN SOLUTION
GA-401	SCRUBBING WATER BOOSTER
GA-203	BENFIELD SOL'N SUMP
P-101A/B	REFORMER WHB CIRCULATING
P-104A/B	SLURRY STRIPPER REFLUX
P-105	SULFURIC ACID METERING
P-106A/B	NEUTRALIZATION CIRCULATING
P-107A/B	MRT REFLUX
P-108A/B	MRT BOTTOMS
P-109A/B	CHAR SLURRY
P-110A/B	CATALYST SOL'N SURGE
P-111A/B	SLURRY FEED
P-112A/B	RECYCLE CATALYST SOL'N.
P-113A/B	SPENT CHAR AND ASH
P-114A-N	HYDROCLONE
P-115A/B	EVAPORATOR CIRCULATING
P-116A/B	CONCENTRATED SOL'N.
GA-215/3	MAKEUP WATER BOOSTER
P-118A/B	MRT HP FLASH BOTTOMS
P-119	SCRUBBING WATER BOOSTER
P-120	DIMETHYL SULFIDE METERING
	FURNACES
F-101	PREHEAT
F-102	STEAM REFORMER
	REACTORS
R-101	GASIFIER
	MISCELLANEOUS
J-101	JET EJECTOR
J-102	VENTURI SCRUBBER
SCRN-101A/B	SOLIDS SEPARATORS
STR-101A/B	CHAR SLURRY STRAINERS (NOT SHOWN)
FD-201	SEMI-LEAN SOL'N. FILTER
FB-201	BENFIELD SOL'N. TANK

FIGURE II-A-8

EXXON RESEARCH & ENGINEERING CO.
ONSITE PLOT PLAN
CCG - LPP STUDY DESIGN CASE
SYTHANE PP REVAMP CASE
BRUCETON, PENNA.
OCT. 12, 1978 SHEET 1 OF 2 PP-1296-4

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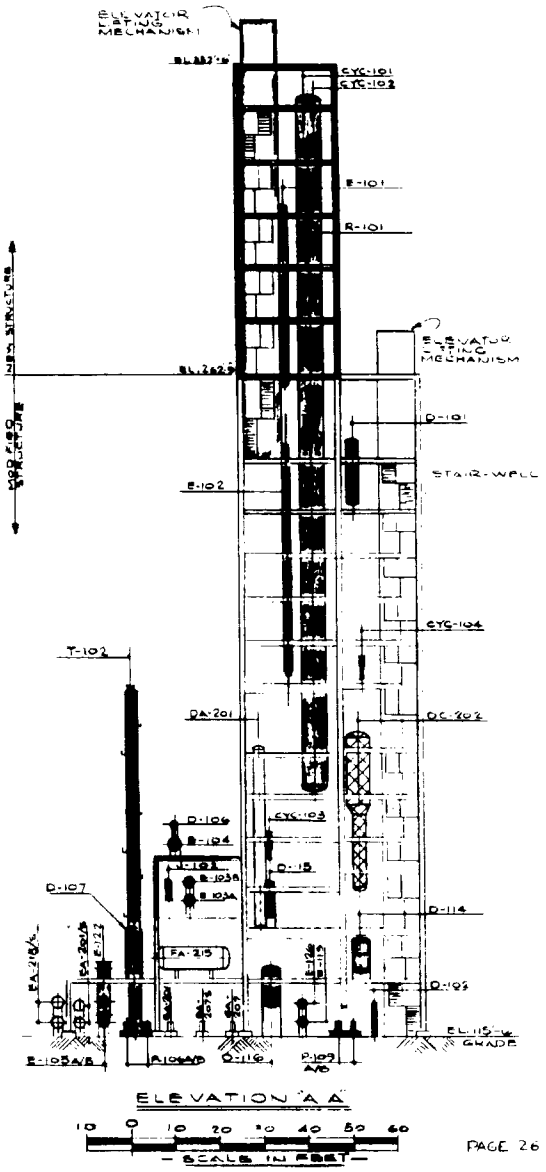
251-A

251-B



LEGEND:
- EXISTING
- NEW
- RELOCATED

FIGURE II-A-9

EXXON RESEARCH & ENGINEERING CO.
ELEVATION "A-A"
CCG -LPP STUDY DESIGN CASE
SYTHANE PP REVAMP CASE
BRUCETON, PENNA.
DATE OCT. 12, 1978 | SHEET 2 OF 2 | DRAWING NO. PR-1296-3

APPENDIX II-B

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

COAL RECEIPT AND COAL PREPARATION

This section of the Study Design covers the modifications and additions to the Synthane Pilot Plant coal receipt and coal preparation facilities required to convert the Synthane Pilot Plant to Catalytic Coal Gasification Process for the Major Synthane Revamp Case.

DESIGN BASIS

- General

The raw coal properties, the prepared coal properties, the gasification process flow rates, and the coal preparation system flow rates are summarized below.

+ Raw Coal Properties

The coal preparation equipment is designed to process Illinois No. 6 Bituminous coal.

	Illinois No. 6
- Moisture Content	
Total (wt%)	16.6
Surface (wt%)	3.6
- Bulk Density (lb/ft^3)	45-50
- Hardgrove Index	56
- Angle of Repose (Degrees)	40
- Particle Size Distribution	98% less than 3/4 inches

+ Prepared Coal Properties

- Moisture Content (total wt%)	less than 2
- Particle Size Distribution (98% less than)	8 mesh
- Catalyst	
Type	50/50 K_2CO_3/Na_2CO_3 or K_2CO_3
Loading (wt%)	up to 20

+ Gasification Process Flow Rates (Maximum)

	STPH
- Moisture Free Coal	3.21
- As-Received Coal (Illinois No. 6-16 wt% moisture)	3.85
- Catalyst (maximum loading)	0.64

+ Coal Preparation Plant Flow Rates

	STPH
- Moisture Free Coal	4.80
- As-Received Coal (Illinois No. 6-16 wt% moisture)	5.76
- Catalyst (maximum loading)	0.96

The coal preparation plant flow rates are based on the maximum throughput of the existing plant. All new equipment is designed to be compatible with the existing equipment design flow rates.

The coal preparation plant operating schedules are as follows:

+ 7 days/week, 16 hrs/day with the reactor at maximum rate.
+ 5 days/week, 12 hrs/day with the reactor at 50% maximum rate.

The coal preparation plant flow rates allow ample maintenance time (1 shift/day) and avoid operating the preparation plant on weekends as long as reactor is at or below 60% of its maximum rate.

The existing prepared coal storage bin has a capacity of 150 tons. 150 tons is 45 hours of storage with the reactor at full rate. This is sufficient storage to bridge a weekend when the reactor is at 60% of its maximum rate.

An inerted 40 ton capacity bin has been added to receive and store start-up coke or reactor char. The design temperature of the bin is 650°F. Hot char must be allowed to cool to a maximum of 300°F before it is fed to the coal pressurizing system.

- Coal Receipt

Synthane has a subcontractor, located 12 miles from the site, who receives coal by rail, stockpiles the coal and delivers it to Synthane in 20 ton trucks. These same facilities will be utilized without modification. However, arrangements will be required to change the present coal delivery schedule to account for an increase in raw coal feed rate from 85 to 92 tons per day. Synthane's raw coal handling facilities are sized for 119 ton/day.

This basis is a significant departure from the grass-roots design basis which calls for covered hopper rail cars, protected car unloading

facilities, and inert raw coal storage. However, provision of these facilities at Synthane would present exceptional project difficulties. The sizable land requirements for the rail spur and special raw coal handling facilities in the grass roots case cannot be readily accommodated on the limited land area of the Synthane site. As a result, there is potential risk that additional downtime or collection of non-representative data could result from coal degradation in storage. The risk is considered acceptable when weighed against the project debits.

- Coal Preparation

The existing coal preparation equipment will be modified and new equipment will be added to accomplish the following three processing steps: (1) crushing and drying the raw coal, (2) adding catalyst, and (3) final drying.

Data from Synthane indicate that the existing hot-gas swept mill is adequate for the first processing step of crushing and drying the raw coal. The only modification required is the replacement of the screen cloth to meet the 8 mesh top size.

New equipment has been specified for the catalyst addition and final drying steps. Catalyst addition is accomplished by spraying a 40 wt% solution of the catalyst on the coal and mixing the two streams in a ribbon blender. The coal is dried before catalyst addition, in order to eliminate the possibility of the catalyst solution "running off" (not coating) the coal.

An indirect heated steam dryer has been specified for the final drying step. A steam dryer was chosen because it is easy to operate and it does not require a large plot area.

TABLE II-B-1

UTILITIES AND CHEMICALS - COAL RECEIPT AND PREPARATION

ELECTRIC POWER

Requirements, KW

Symbol	Service	Duty	Load	
			Operating	Connected
• Existing Equipment				
JD-102	Raw Coal Conveyor	N	-	1.9
JD-103	Raw Coal Bucket Elevator	N	-	13.0
JD-105	Raw Coal Weigh Feeder	N	-	1.9
PA-102	Flash Drying Mill	N	-	62.1
GB-101X	Drying Air Heater	N	-	1.9
GB-102X	Drying System Fan	N	-	62.1
PA-104X	Drying System Bag Filter	N	-	1.9
FD-101X	Vibrating Screen	N	-	2.8
PA-114X	Vibrating Bin Discharge	N	-	1.9
• New Equipment				
B-1101	Inert Gas Bag Filter Fan	N	0.5	1.0
CO-1101	Screw Conveyor	N	0.5	1.0
CO-1102	Prepared Coal Bucket Elevator	N	1.9	1.9
CO-1103	Screw Conveyor	I	2.0	2.8
D-1101	Steam Dryer	N	41.7	41.7
DC-1101	Inert Gas Bag Filter	N	-	1.9
DC-1102	Steam Dryer Bag Filter	N	-	1.9
FE-1101	Rotating Vane Feeder	N	1.4	1.4
FE-1102	Rotating Vane Feeder	N	1.4	1.4
FE-1103	Rotating Vane Feeder	I	1.4	1.4
M-1101	Mixer	N	6.6	6.6
P-1101	Coal Receiving Pit Sump Pump	I	1.5	1.9
	Instruments		By Contractor	
	Lighting		By Contractor	

TABLE II-B-1 (Cont'd)

Steam - 125 psig (saturated)

Requirements, lb/hr

• D-1101	5700
• Steam Tracing of DC-1102 and Associated Ducts	100

LP CONDENSATE

Production, lb/hr

• D-1101	5700

COMPRESSED AIR

Requirements, SCFM

• Instrument	50
• Utility	50

INERT GAS - LOW PRESSURE

Requirements, SCFM

• Existing	40
• Additional	40

INERT GAS - HIGH PRESSURE

Requirements, SCFM

• Existing	30

FUEL - NO. 2 FUEL OIL

Requirements, 10^6 Btu/hr

• Existing Flash Dryer Mill	3.6

TABLE II-B-2

EQUIPMENT LIST - COAL RECEIPT AND COAL PREPARATION

D-1101 No. 2 Steam Dryer

Service	Reduce the total moisture in the coal/ catalyst mixture from 4 wt% moisture to 2 wt% moisture.
Type	Indirect Steam Dryer
Design Capacity	
• Coal (STPH)	5.0 (includes 4 wt% moisture)
• Catalyst (GPM)	6.4
Product Moisture Content (wt%)	4

Notes:

(1) Dryer shall be similar to Strong Scott Torus Disc Dryer Model TD60-20.

TABLE II-B-2 (Cont'd)

Pumps

Equipment No.	P-1101
Service	Coal Receiving Pit
Type	Vertical Sump
Capacity (GPM)	50
ΔP, psi	20

Compressors

Equipment No.	B-1101
Service	Inert Gas Bag Filter Fan
Flow Rate, SCFM	50
Gas Mol. Wt.	28
Fan ΔP, in H_2O	5
Inlet Temp., $^{2}°F$	300
Inlet Press., in H_2O	-5
Fan Type	Centrif.

TABLE II-B-2 (Cont'd)

Storage Bins

Equipment No.	BN-1101
Service	Coke and Char Storage Bin
Type	Circular, Conical Outlet
Diameter, ft.	10
Straight Side ht., ft.	24
Tape Height, ft.	16
Capacity, tons	40

Conveyors

Equipment No.	CO-1101	CO-1102	CO-1103
Service	Screw	Continuous Bucket Elevator	
Length, ft.	10	140 (c/c Pulleys)	21
Diameter	9.0	-	12
Design Capacity (STPH)	6.0	6.0	4.0

Bag Filters

Equipment No.	DC-1101
Service	Inert Gas Bag Filter
Type	Continuous, self-cleaning
Bag Area (ft^2)	25
Gas Rate (ACFM)	73

TABLE II-B-2 (Cont'd)

Equipment No.	DC-1102 Steam Dryer Bag Filter
Service	To remove the dust from the gas steam leaving dryer D-1101
Type	
Bag Area (ft^2)	650
Gas Rate (ACFM)	2000

Feeders

Equipment No.	FE-1101	FE-1102
Service	Dried Coal Feeder	Wet Catalyzed Coal Feeder
Type	Rotating Vane	Rotating Vane
Width, Ft.	By Contractor	By Contractor
Diam. (width), in.	By Contractor	By Contractor
Capacity, STPH	5.0	7.5

Equipment No.	FE-1103
Service	Startup Coke or Char Feeder
Type	Rotating Vane
Width, ft.	By Contractor
Diam. (width), in.	By Contractor
Capacity	By Contractor

TABLE II-B-2 (Cont'd)

M-1101 Catalyst Addition Mixer

Service	Mix coal and catalyst solution
Type	Ribbon Blender
Design Capacity	
Coal (STPH)	5.0
Catalyst Solution (GPM)	6.4
Material Being Handled	
• Coal	
• Catalyst Solution	40% aqueous solution of K_2CO_3
Operation	Continuous

Remarks:

(1) Mixer shall be fully enclosed and inerted.

(2) Mixer design shall be similar to Teledyne Readco 16" diameter by 15' long continuous blender.

Coal Preparation Equipment Shelter

• Service	Shelter new coal preparation equipment
• Approximate Size	625
• Maximum Height	30

Vibrating Screen

The existing vibrating screen appears to be adequate for the new system. However, new screen cloth is required to meet the 8 mesh top size. (Present system design is 20 mesh top size).

TABLE II-B-2 (Cont'd)

Gas-Swept Mill System

The gas-swept mill system will be used to crush, dry, and classify as-received coal and to convey it to the elevated screen. The system will consist of a closed gas circuit containing a gas-swept crusher, pneumatic classifier, cyclone separator, and ducts as shown on Drawing No. 77-1072-4. Also associated with the gas-swept mill system is a gas heater furnace, secondary gas cleaner (scrubber), and fans. The system will have the capability to crush the coal to 100% less than 8 or 16 mesh and dry it to 4-5% total moisture. This type of system is similar to those used in coal fired generating stations in that it uses a hot gas to classify, dry, and convey the coal. However, a controlled oxygen gas recycle system is necessary in order to operate the system safely (minimum risk of fires) at the temperatures required to reduce the coal moisture contents to the levels specified.

TABLE II-B-2 (Cont'd)

CR-1101 Impact Venturi Mill

- Type — Gas-Swept Mill
- Solids Flow Rate (STPH) — 6.5
- Gas Flow Rate (SCFM) — 7000
- Gas Temperature (Normal Operating)
  - + Inlet (°F) — 800-1000
  - + Outlet (°F) — 225
- Mill shall be designed to operate under a positive internal pressure of 42 IWG.
- Mill shall be equipped with the following:
  - + Circulating oil system for main bearings
  - + V-Belt drive with changeable sheaves
  - + Venturi separator
  - + Motor base
  - + Feed control panel
  - + Bottom reject clean out spout with valve
  - + Velocity separator
- Remarks:
  - + The gas swept mill system equipment shall be designed to minimize gas leaks out of system

TABLE II-B-2 (Cont'd)

CY-1101 Mill Cyclone

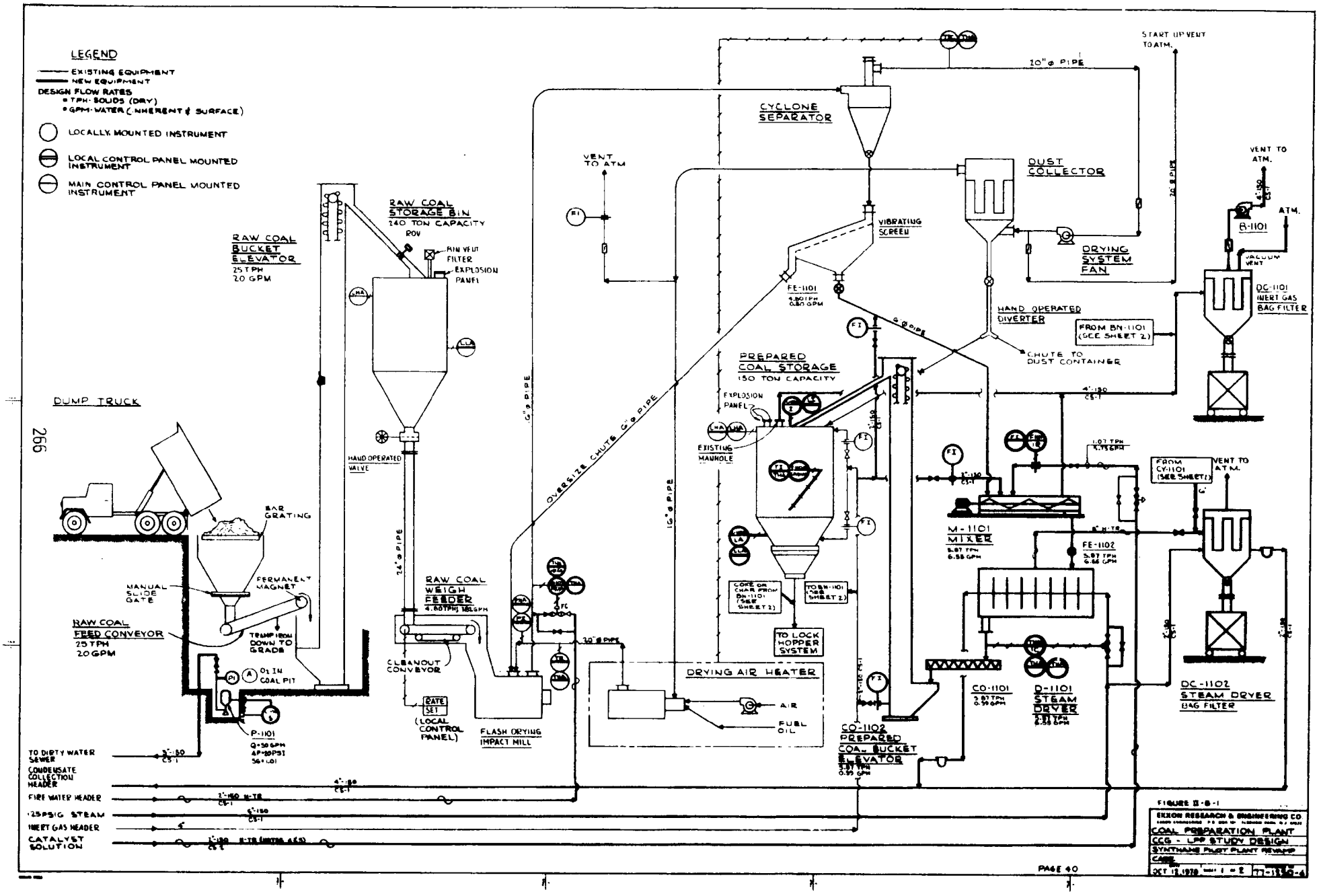
• Gas Flow (SCFM)	7000
• Design Solids Flow Rate (STPH)	5.0
• Operating Temperature (°F)	225
• Design Temperature (°F)	375
• Design Pressure (psig)	B-1101/B-1104 discharge pressure
• Maximum Diameter (ft) approx.	2.5

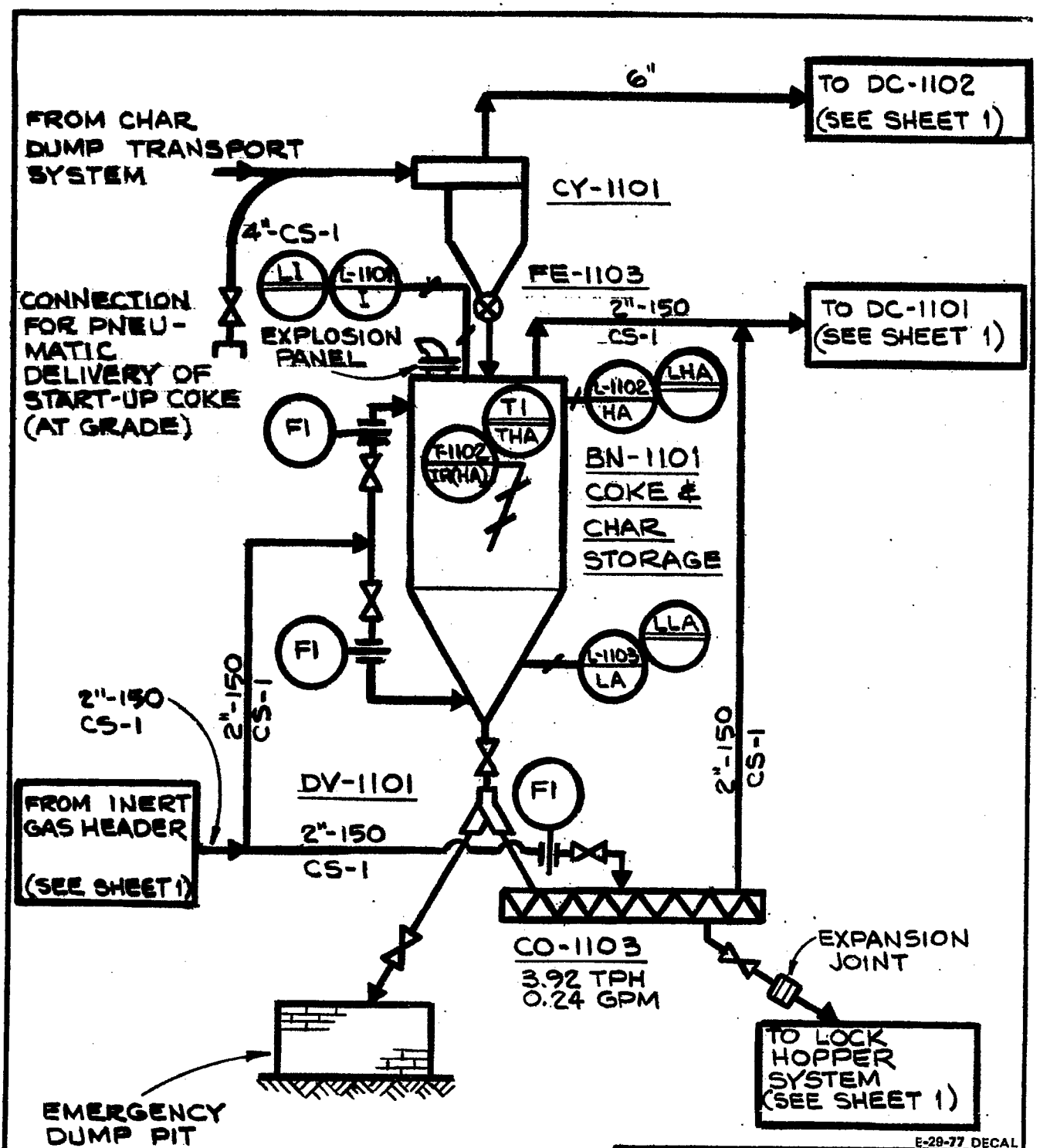
Remarks:

- Include 1" external insulation
- Cyclone shall be designed to maximize solids recovery

Ducts

- Total length (ft estimated): 350
- Provide 1" of external insulation on all ductwork in the coal preparation plant with the exception of the furnace discharge duct which is covered in Section 7.
- Include explosion hatch protection.
- Design Pressure: Discharge pressure from B-1101/B-1104.
- Condensate drains shall be provided at low points in the ductwork.


LEGEND
EXISTING EQUIPMENT
NEW EQUIPMENT
DESIGN FLOW RATES
• TPH: SOLIDS (DRY)
• GPM: WATER (INHERENT & SURFACE)
LOCALLY MOUNTED INSTRUMENT
LOCAL CONTROL PANEL MOUNTED INSTRUMENT
MAIN CONTROL PANEL MOUNTED INSTRUMENT
START UP VENT TO ATM.
10"ø PIPE
CYCLONE SEPARATOR
VENT TO ATM
DUST COLLECTOR
VIBRATING SCREEN
DRYING SYSTEM FAN
VENT TO ATM.
ATM.
B-1101
VACUUM VENT
DC-1101 INERT GAS BAG FILTER
RAW COAL STORAGE BIN
240 TON CAPACITY
RAW COAL BUCKET ELEVATOR
25 TPH
20 GPM
BIN VENT FILTER
EXPLOSION PANEL
FE-1101
HAND OPERATED DIVERTER
FROM BN-1101 (SEE SHEET 2)
CHUTE TO DUST CONTAINER
PREPARED COAL STORAGE
150 TON CAPACITY
EXPLOSION PANEL
EXISTING MANHOLE
OVERSIZE CHUTE 6"ø PIPE
DUMP TRUCK
BAR GRATING
MANUAL SLIDE GATE
PERMANENT MAGNET
RAW COAL FEED CONVEYOR
25 TPH
20 GPM
TRAMP IRON DOWN TO GRADE
HAND OPERATED VALVE
RAW COAL WEIGH FEEDER
CLEANOUT CONVEYOR
RATE SET
(LOCAL CONTROL PANEL)
FLASH DRYING IMPACT MILL
CORE OR CHAR FROM BN-1101 (SEE SHEET 2)
TO BN-1101 (SEE SHEET 2)
TO LOCK HOPPER SYSTEM
DRYING AIR HEATER
AIR
FUEL OIL
M-1101 MIXER
FE-1102
FROM CY-1101 (SEE SHEET 1)
VENT TO ATM.
CO-1101
D-1101 STEAM DRYER
DC-1102 STEAM DRYER BAG FILTER
CO-1102 PREPARED COAL BUCKET ELEVATOR
P-1101
TO DIRTY WATER SEWER
CONDENSATE COLLECTION HEADER
FIRE WATER HEADER
125PSIG STEAM
INERT GAS HEADER
CATALYST SOLUTION
FIGURE II-B-1
EXXON RESEARCH & ENGINEERING CO
COAL PREPARATION PLANT
CCG - LPG STUDY DESIGN
SYNTHANE PILOT PLANT REVAMP
OCT 15, 1978



E-28-77 DECAL

EXXON RESEARCH & ENGINEERING CO.
SYNTHETIC FUELS ENGINEERING
P.O. BOX 101 — FLORHAM PARK, N.J. 07932

FIGURE II-B-2 FEB. 28, 1979
COAL PREPARATION PLANT
CCG-LPP-STUDY DESIGN
SYNTHANE PILOT PLANT
MAJOR REVAMP CASE
SHEET 2 OF 2 NO. 77-1250-1

-41- JMH/FI

TEM 2297

APPENDIX II-C

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

CATALYST HANDLING FACILITIES

The catalyst handling facilities for the Major Synthane Revamp Case shall duplicate the facilities specified in the Grass Roots Case (Appendix I-F). The following modifications are required for the Major Synthane Revamp Case:

(1) In general, industrial water lines shall be buried. Portions located aboveground shall be steam-traced and insulated to protect the lines from freezing in the winter months.

(2) The rated capacity of P-1302 A & B (catalyst feed pumps) shall be increased to 6.4 gpm.

APPENDIX II-D

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

CO_2 AND INERT GAS FACILITIES

Scope

This section covers the process study design for the CO_2 and inert gas facilities serving the onsite and offsite systems of the Major Synthane Revamp case.

Design Basis

Liquid CO_2 will be provided to the process unit where it will be vaporized for onsite use. Inert gas will normally be provided to the offsite users. In the event of the inert gas generators breaking down, gaseous CO_2 will be provided to the offsite users.

Reuse of existing CO_2 and inert gas facilities has been emphasized in this study design. Synthane CO_2 and inert gas facilities will be relocated and modified to meet the revamp system demands. The CO_2 and inert gas facilities design flow plan is shown in Figure II-D-1.

CO_2 Facilities

The existing Synthane CO_2 storage tanks, CO_2 vaporizers, and CO_2 gas superheater shall be relocated and reused. Two new pumps shall be provided to pump liquid CO_2 to the process unit. One pump shall be a spare.

Inert Gas Facilities

The existing Synthane inert gas generators with their air blowers, the inert gas knockout drums, and the inert gas blowers shall be relocated and reused.

TABLE II-D-1

DESIGN FLOW PLAN DETAILS

- Existing relocated equipment

Details of existing equipment which has to be relocated and integrated with the new facilities is shown on CE Lummus Drawings.

Equipment	Lummus Drwg. No.
CO_2 Storage and Refrigeration system	E-7426-04005-J-3
CO_2 Vaporizers	
Inert Gas Generators	E-6656-03027-10
Inert Gas Blowers	

- Utilities tie-ins

Utility tie-in requirements for relocated equipment are as follows:

Equipment	Utilities tie-ins
CO_2 Storage and Refrigeration System	Electric Power
CO_2 Vaporizers	2 1/2" Steam Line (55 Psig)
Inert Gas Generators	Electric Power 1 1/2" LPG Line (stm traced and insulated) 4" Cooling Water Lines (supply and return)
Inert Gas Blowers	Electric Power

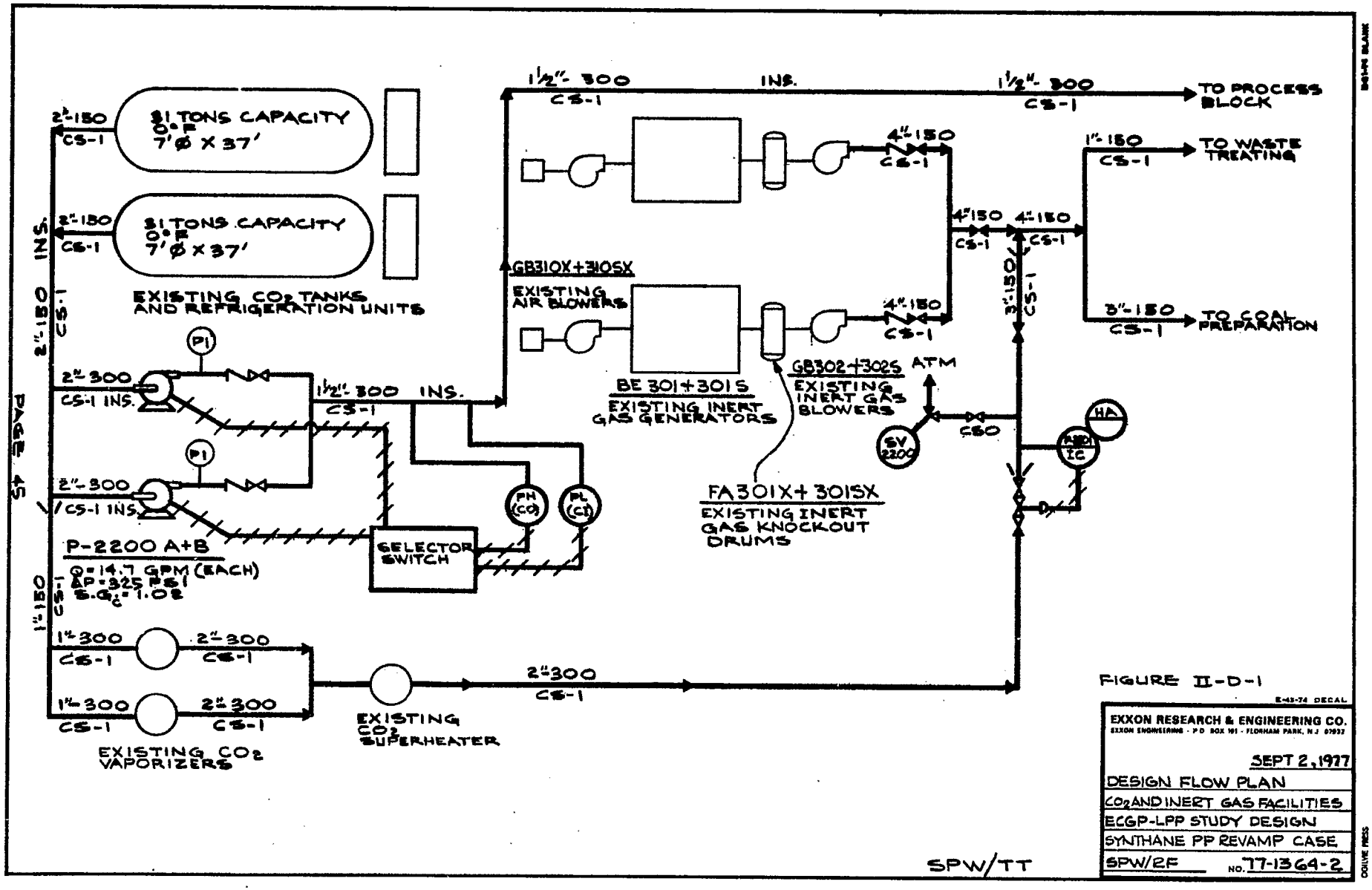


FIGURE II-D-1

E-43-74 DECAL

EXXON RESEARCH & ENGINEERING CO.
EXXON ENGINEERING · P O BOX 101 · FLORHAM PARK, N J 07932

SEPT 2, 1977

DESIGN FLOW PLAN
CO_2 AND INERT GAS FACILITIES
ECGP-LPP STUDY DESIGN
SYNTHANE PP REVAMP CASE
SPW/2F NO. 77-1364-2

BOWN BLANK

DOLLVE PRESS

APPENDIX II-E

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

PLANT FUEL SYSTEMS

This section covers offsite Plant Fuel System facilities for the Major Synthane Revamp Case. It includes:

- LNG - Storage, vaporization, and distribution facilities to onsites and offsites consumers.
- LPG-C_3 - Storage, vaporization, and distribution facilities to onsites and offsites consumers.
- Fuel Oil #2 - Storage and distribution facilities to onsites and offsites consumers.

Maximum use of existing facilities has been considered in this study design.

Design Basis

LNG Facilities

LNG will be delivered to the plant site by trailer truck in about 10,000 to 11,000 USG parcels. A new 55,000 USG atmospheric storage facility is required which is about equivalent to the feed required for 5 to 6 days normal operation of the onsite reformer.

Vaporized LNG will be used primarily as onsites reformer and pilot gas feed.

Excess product gas as available from process will be utilized as offsites boiler fuel, supplementing F.O. #2.

The design flow plans for the natural gas and product gas systems are covered in Figure II-E-1.

LPG-C_3 Facilities

LPG-C_3 will be delivered to the plant site by trailer truck. The existing 30,000 USG storage drum will be utilized after relocation to a new plant area. The capacity is equivalent to a 5-day supply for LPG-C_3 maximum requirements.

LPG-C_3 will be used primarily as pilot gas for the offsites boilers and the flare, and the offsites inert gas generators. Facilities are provided for use as backup for onsites pilot gas. The distribution system is interconnected with the natural gas system to permit use of natural gas as a backup pilot gas.

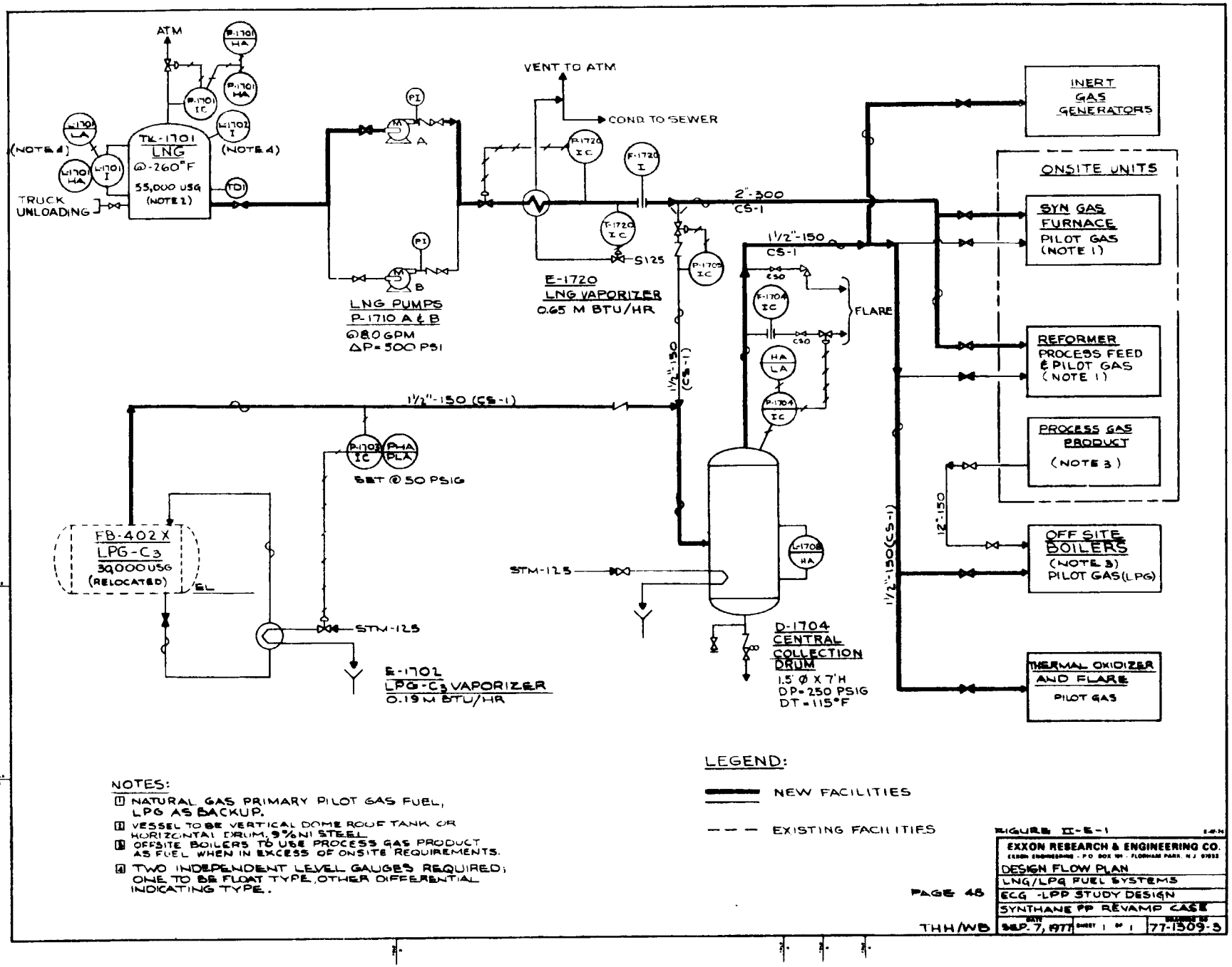
The design flow plan for the LPG-C_3 facilities is presented in Figure II-E-1.

Fuel Oil Facilities

The existing 100,000 USG tank will be used and the existing underground tank at the utility plant will be abandoned. A new 20,000 USG tank will be located adjacent to the proposed new boiler plant site. The combined capacity of about 120,000 USG is equivalent to about an 8-day supply for normal operations.

F.O. #2 will be used as primary fuel for the onsites boilers, offsites boilers, offsites oxidizer, and offsites coal preparation. No backup fuel will be provided.

The design flow plan for the F.O. #2 facilities is presented in Figure II-E-2.



NOTES:

1. NATURAL GAS PRIMARY PILOT GAS FUEL, LPG AS BACKUP.
2. VESSEL TO BE VERTICAL DOME ROOF TANK OR HORIZONTAL DRUM, 9%NI STEEL.
3. OFFSITE BOILERS TO USE PROCESS GAS PRODUCT AS FUEL WHEN IN EXCESS OF ONSITE REQUIREMENTS.
4. TWO INDEPENDENT LEVEL GAUGES REQUIRED; ONE TO BE FLOAT TYPE, OTHER DIFFERENTIAL INDICATING TYPE.

LEGEND:

NEW FACILITIES

EXISTING FACILITIES

FIGURE II-E-1

EXXON RESEARCH & ENGINEERING CO.		
DESIGN FLOW PLAN		
LNG/LPG FUEL SYSTEMS		
ECG -LPP STUDY DESIGN		
SYNTHANE PP REVAMP CASE		
DATE SEP. 7, 1977	SHEET 1 OF 1	DRAWING NO. 77-1509-3

PAGE 48

THH/WB

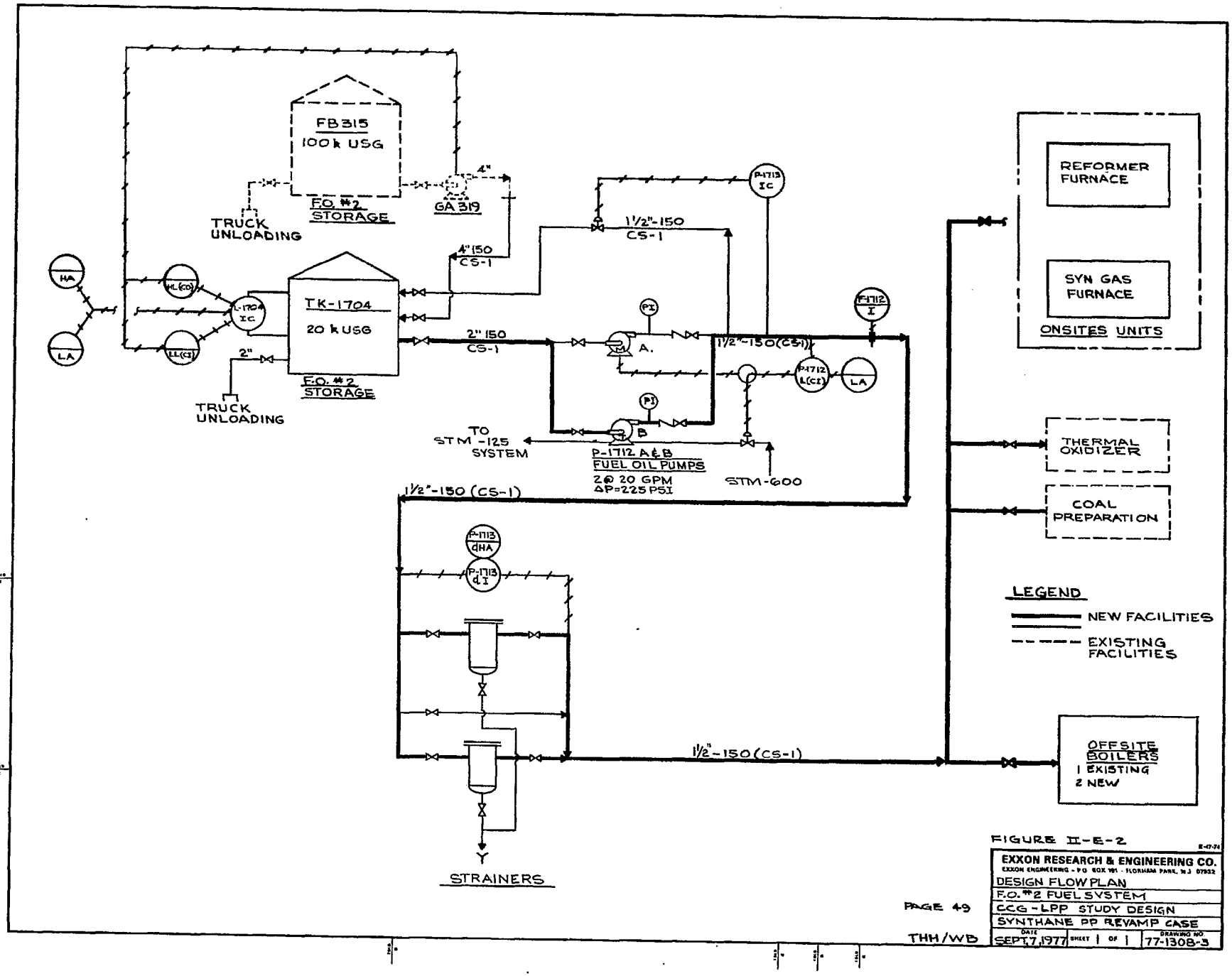


FIGURE II-E-2

EXXON RESEARCH & ENGINEERING CO.	
DESIGN FLOW PLAN	
F.O. #2 FUEL SYSTEM	
CCG-LPP STUDY DESIGN	
SYNTHANE PP REVAMP CASE	
DATE SEPT. 7, 1977	SHEET 1 OF 1
DRAWING NO 77-1308-3	

THH/WD

APPENDIX II-F

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

BOILER FEEDWATER AND STEAM FACILITIES

This section covers offsite Boiler Feedwater and Steam Facilities for the Major Synthane Revamp Case. It includes:

- BFW treating and distribution.
- Steam generation and distribution, condensate collection.

Maximum use of existing facilities has been considered in this study.

Design Basis

BFW Treating and Distribution

The existing 3 bed city water demineralization facilities with a production capacity of 50 GPM (net) will be relocated to the new utility plant site. Additional capacity of 150 GPM (net) will be provided by two new 3 bed trains. The existing H_2SO_4 and NaOH storage is considered adequate for the total facility. The city water feed supply will be obtained from a new raw water storage tank and pumping facility.

The design flow plan for the demineralization system is shown in Figure II-F-1.

The existing treated water storage tank FB-301 will be relocated to the new utility plant site for the same service. The 35k USG tank capacity is about a 3 to 4 hours supply for normal operations. New transfer pumps for treated water are required for deaerator feed and demineralization plant regeneration requirements. The existing deaerator will be abandoned and replaced by a new 140,000 lbs/hr. capacity deaerator. The existing hydrazine addition facilities will be relocated to the new utility plant site. New morpholine addition facilities will be provided. The existing phosphate injection and BFW pumps associated with the existing 1150 psig boiler will be relocated to the new utility plant along with the boiler. New phosphate injection facilities and BFW pumps will be provided for the new 600 psig boilers.

The deaerator, BFW treating and treated BFW distribution facilities are shown in Figures II-F-2 and II-F-3.

Steam Generation and Distribution
Condensate Collection

The steam facilities will be based primarily on 600 psig and 125 psig systems. The existing high pressure boiler (1150 psig) will be relocated to the new utility plant area. The 1150 psig steam produced will be let down to the 600 psig level. In addition, two new 600 psig boilers with individual capacities of 90k lbs/hr will comprise the offsite steam generation facilities. Additional 600 psig steam will be generated by two onsites waste heat boilers. Onsites consumers require 600, 125, and 55 psig steam services. These will be supplied by 600 and 125 psig headers with letdown stations for 55 psig requirements. The 55 psig services are required for the Benfield and Stretford units in addition to the heating services for the administration building. The 125 psig services are also required for the offsite coal preparation, flare, maintenance shops, LNG and LPG-C_3 vaporizers, and wastewater treating facilities.

Condensate will be recovered from the 125 psig systems in the onsite and coal preparation facilities.

The design flow plan for the steam generation and distribution system is presented in Figure II-F-3.

Existing Facilities

Existing facilities specified for reuse in this design study are covered in The Lummus Company piping and instrumentation drawings:

E-6656-03012A
E-6656-03012C
E-6656-03013
E-6656-03026

TABLE II-F-1

EQUIPMENT LIST

- DEMINERALIZATION PLANT

New Facilities

- 2 trains; 3 beds/train;cation, anion, mixed bed
- Production capacity - 150 GPM (net) for both trains.
- Feed quality - 400 ppm max. TDS
- Acid regeneration system
- Caustic regeneration system
- Neutralization pit

Existing Facilities (relocated to new utility plant site)

- 3 bed train with regeneration facilities.
- H_2SO_4 and NaOH storage tanks for existing and new facilities.

- DEAERATOR

• Flow Plan Symbol	D-1804
• Output capacity (lbs/hr)	140,000
• Operating Pressure (Psig)	20
• Materials	Stainless steel vertical deaeration section and carbon steel horizonal storage section

Notes:

(1) Storage section of deaerator shall be sized for 20 minutes holdup.

TABLE II-F-1 (Cont'd)

- BOILERS

• Number of Boilers	2
• Flow Plan Symbols	SG - 1809, 1810
• Capacity Per Unit	90,000 lbs./hr.
• Steam Outlet Conditions	
- Pressure	600 psig
- Temperature	750 °F
• Feed water temperature	250 °F
• Fuel (Dual fired)	No. 2 Fuel Oil (19,200 BTU/LB.) or Product Gas (23,100 BTU/LB.)
• Blowdown Rate	5%

Notes:

(1) Boilers shall be equipped with steam turbine driven force draft fans.

(2) Boilers shall be equipped with a 100 foot common self-supporting unlined steel stack.

- LET DOWN STATIONS

Service	Capacity, lbs/hr
1150# - 600#	25,000
600# - 125#	10,000
600# - 125#	40,000
125# - 55#	10,500
125# - 20#	20,000

- DESUPERHEATER STATIONS

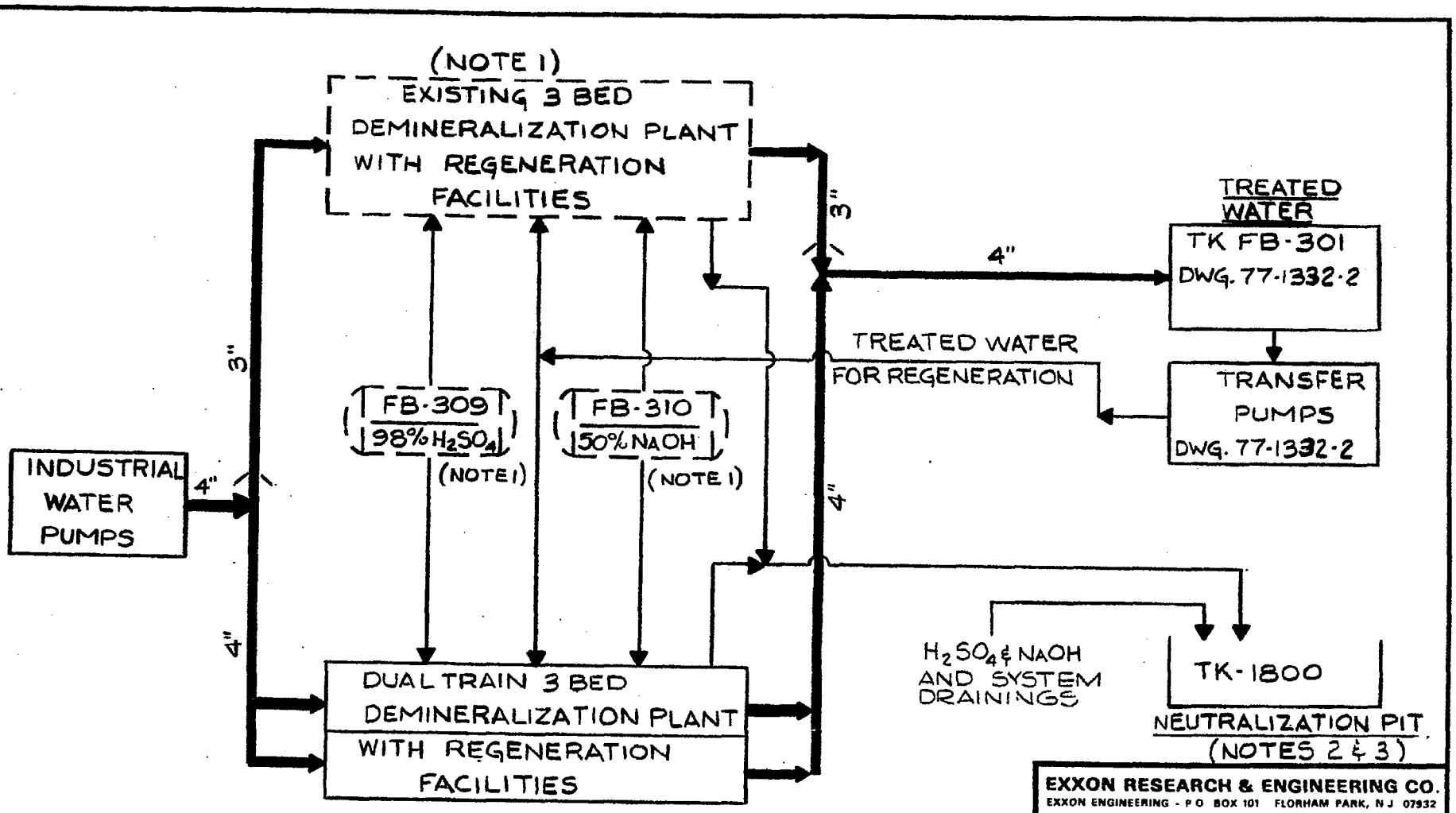
Location - Service	Steam Rate, lbs/hr Inlet/Outlet (a)	Operating Pressure, psig	Temp., °F Inlet/Outlet
• Utility Plant			
- Air compressor turbine	6800/8100	20	530/300
- Other turbines (b)	18200/21100	125	540/400
- Let down stations			
600 - 125 psig	10000/11600	125	693/400
600 - 125 psig	40000/46200	125	693/400
• Other Offsite Areas			
- Cooling water pump turbines (b)	7100/8200	125	540/400

(a) BFW rate (@ 250°F) to desuperheater is difference between inlet and outlet steam rates.

(b) Two stations required, each with indicated capacity.

- BOILER CONTROLS

The controls for the BFW and steam systems will be located in a new local control house. The controls for the relocated existing boiler (BF-301) will be integrated with the controls for the new boilers, SG-1809, 1810. Critical alarms will also be located in the main control house.



NOTES:

1. EXISTING FACILITIES TO BE RELOCATED TO NEW UTILITY PLANT SITE.
2. PIT TO BE SIZED FOR TOTAL CAPACITY OF EXISTING & NEW TRAINS.
3. FOR DISPOSITION OF NEUTRALIZED WASTE WATER, SEE WASTE TREATING STUDY DESIGN.

LEGEND

NEW FACILITIES

EXISTING FACILITIES

EXXON RESEARCH & ENGINEERING CO.
EXXON ENGINEERING - P O BOX 101 FLORHAM PARK, N J 07932

FIGURE II-F-1 SEPT 13, 1977

DESIGN FLOW PLAN - BFW

DEMINERALIZATION PLANT

ECGP-LPP STUDY DESIGN

SYNTHANE PP REVAMP CASE

THH/DPO NO. 77-1348-1

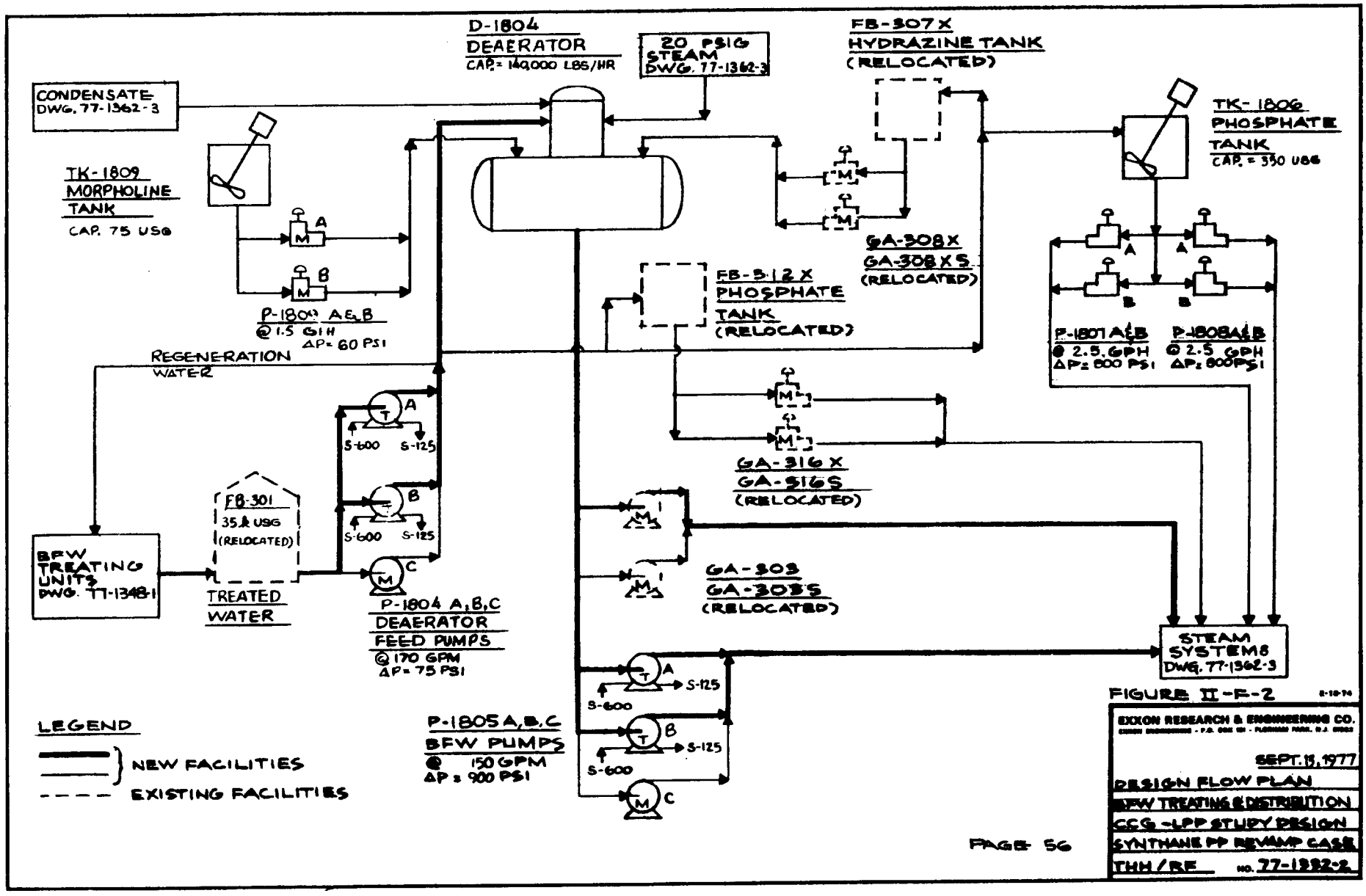
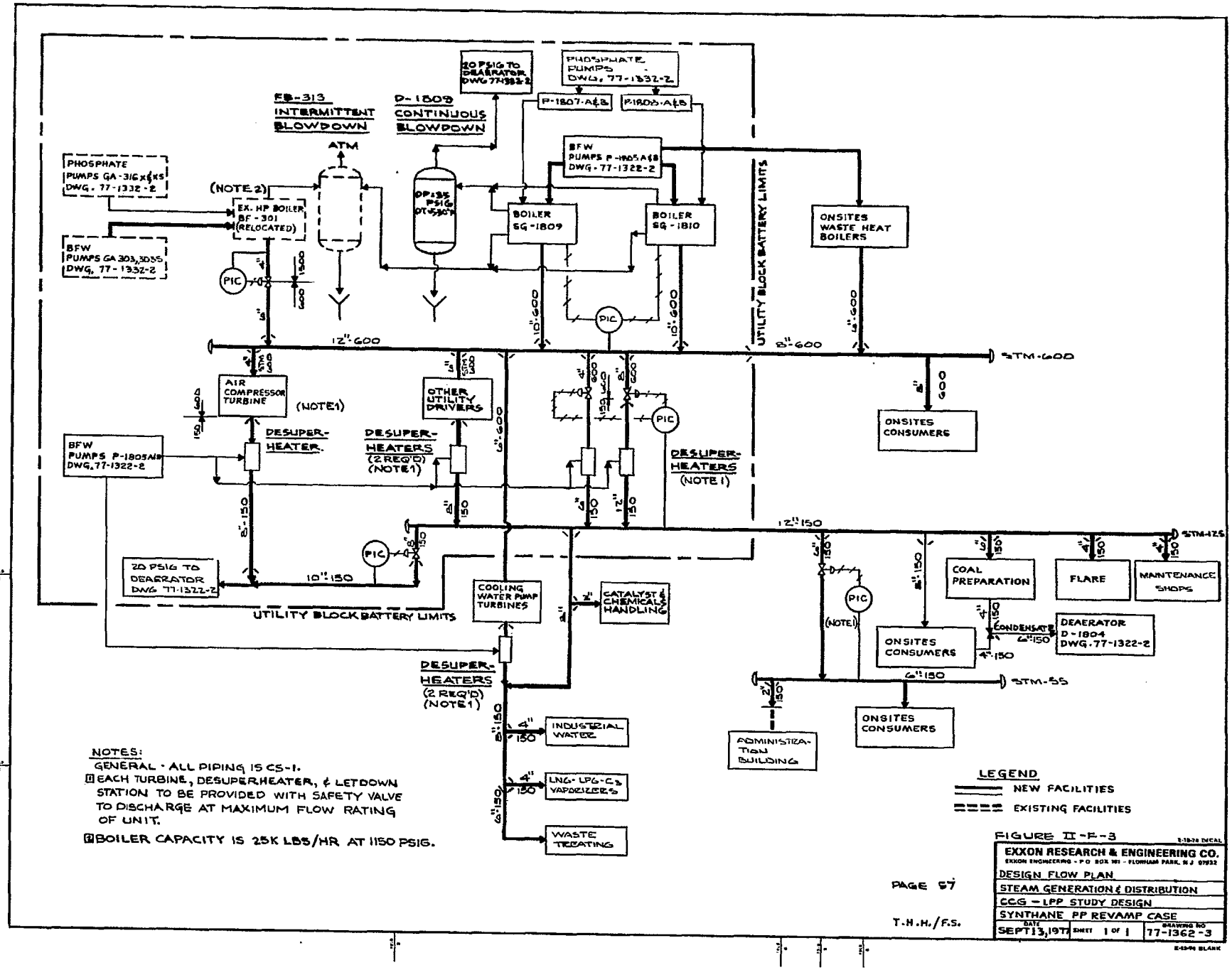


FIGURE II-F-2

EXXON RESEARCH & ENGINEERING CO.

SEPT. 15, 1977

DESIGN FLOW PLAN
BFW TREATING & DISTRIBUTION
CCG - LPP STUDY DESIGN
SYNTHANE PP REVAMP CASE
THH / RE NO. 77-1382-2


20 PSIG TO DEAERATOR DWG 77-1322-2
PHOSPHATE PUMPS DWG. 77-1332-2
P-1807-A&B
P-1805-A&B
FB-313 INTERMITTENT BLOWDOWN
D-1809 CONTINUOUS BLOWDOWN
ATM
PHOSPHATE PUMPS GA-316 X&XS DWG. 77-1332-2
BFW PUMPS GA 303,305S DWG. 77-1332-2
(NOTE 2)
EX. HP BOILER BF-301 (RELOCATED)
BFW PUMPS P-1805A&B DWG. 77-1322-2
BOILER SG-1809
BOILER SG-1810
ONSITES WASTE HEAT BOILERS
UTILITY BLOCK BATTERY LIMITS
PIC
12"-600
10"-600
8"-600
STM-600
AIR COMPRESSOR TURBINE
(NOTE1)
OTHER UTILITY DRIVERS
DESUPER-HEATER
DESUPER-HEATERS (2 REQ'D) (NOTE1)
DESUPER-HEATERS (NOTE 1)
ONSITES CONSUMERS
BFW PUMPS P-1805A&B DWG. 77-1322-2
12"-150
STM-125
20 PSIG TO DEAERATOR DWG 77-1322-2
10"-150
COOLING WATER PUMP TURBINES
CATALYST & CHEMICALS HANDLING
UTILITY BLOCK BATTERY LIMITS
COAL PREPARATION
FLARE
MAINTENANCE SHOPS
DEAERATOR D-1804 DWG. 77-1322-2
CONDENSATE
ONSITES CONSUMERS
STM-55
ADMINISTRATION BUILDING
DESUPER-HEATERS (2 REQ'D) (NOTE1)
INDUSTRIAL WATER
LNG-LPG-C3 VAPORIZERS
WASTE TREATING
NOTES:
GENERAL - ALL PIPING IS CS-1.
1 EACH TURBINE, DESUPERHEATER, & LETDOWN STATION TO BE PROVIDED WITH SAFETY VALVE TO DISCHARGE AT MAXIMUM FLOW RATING OF UNIT.
2 BOILER CAPACITY IS 25K LBS/HR AT 1150 PSIG.
LEGEND
NEW FACILITIES
EXISTING FACILITIES
FIGURE II-F-3
EXXON RESEARCH & ENGINEERING CO.
EXXON ENGINEERING - P.O. BOX 101 - FLORHAM PARK, N.J. 07932
DESIGN FLOW PLAN
STEAM GENERATION & DISTRIBUTION
CCG - LPP STUDY DESIGN
SYNTHANE PP REVAMP CASE
DATE SEPT 13, 1977
SHEET 1 OF 1
DRAWING NO 77-1362-3
PAGE 57
T.H.H./F.S.

APPENDIX II-G

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

COOLING WATER FACILITIES

This section covers the process study design for the cooling water facilities serving the onsite and offsite systems of the Major Synthane Revamp Case.

DESIGN BASIS

Cooling water for process and offsite consumers shall be provided via a recirculating water system with an induced draft multicell cooling tower.

The cooling water pumping, recirculation, and chemical systems will be new facilities similar to the Grass Roots CCG-LPP Study Design (Appendix I-D). The cooling tower will consist of a new basin with four tower cells and fans. The existing Synthane tower and fans will be relocated on the new basin (see plot plan in layout study design) and supplemented with two additional cells and fans to provide the total required capacity.

The Cooling Water Distribution Plan for the Revamp site is shown in Figure II-G-1, and the Cooling Water Flow Plan requirements (based on Grass Roots Study Design) are specified in Table II-G-2.

TABLE II-G-1

EQUIPMENT LIST

COOLING TOWER

The cooling tower design is based on the following conditions:

Total Circulating Water Rate	4150 GPM
Design Wet Bulb Temperature	76°F
Approach	11°F
On Tower Temperature	122°F
Off Tower Temperature	87°F
Range	35°F

The cooling tower capacity shall be met in the following manner:

- A new basin and pump suction bay shall be provided to handle the total flow of 4150 GPM. The basin shall be divided into four sections serving individual cells, and shall have the capability of shutting down one cell and draining its basin while the remaining cells are in operation. Dual trash screens shall be provided on the pump suction bay to provide continuous trash screening while one screen is taken out of service.

- The two existing tower cells and fans shall be relocated to the new basin. The capacity of these existing cells based on the new design conditions will be 1800 GPM.

- Two new tower cells and fans shall be required to handle a total flow of 2350 GPM. Each cell and fan shall be sized to handle 50% of the 2350 GPM GPM cooling water load. Non-reversing type fans shall be provided.

TABLE II-G-2

DESIGN FLOW PLAN CHANGES
COOLING WATER SYSTEM

(See Figure I-D-9 for Grass-Roots Case)

	Major Synthane Revamp	Grass Roots
Design Flowrate	4150 GPM	4325 GPM
Basin	4 cells (2 Existing)	2 cells
Recirculation Pumps	3 @ 2075 GPM Each	3 @ 2170 GPM Each
	2 Steam Turbine Driven	1 Steam Turbine Driven
	600 psig inlet steam	125 psig inlet steam
	125 psig outlet steam	0 psig outlet steam
	1 Electric Motor Driven	2 Electric Motor Driven
Sulfuric Acid Injection Pumps	2 @ 0.44 GPH Each	2 @ 0.7 GPH Each
Inhibitor Injection Pumps	2 @ 0.55 GPH Each	2 @ 0.6 GPH Each
Makeup Pipe Diameter	4"	6"
Chlorine Facilities	None	Chlorinator with Storage Facilities.

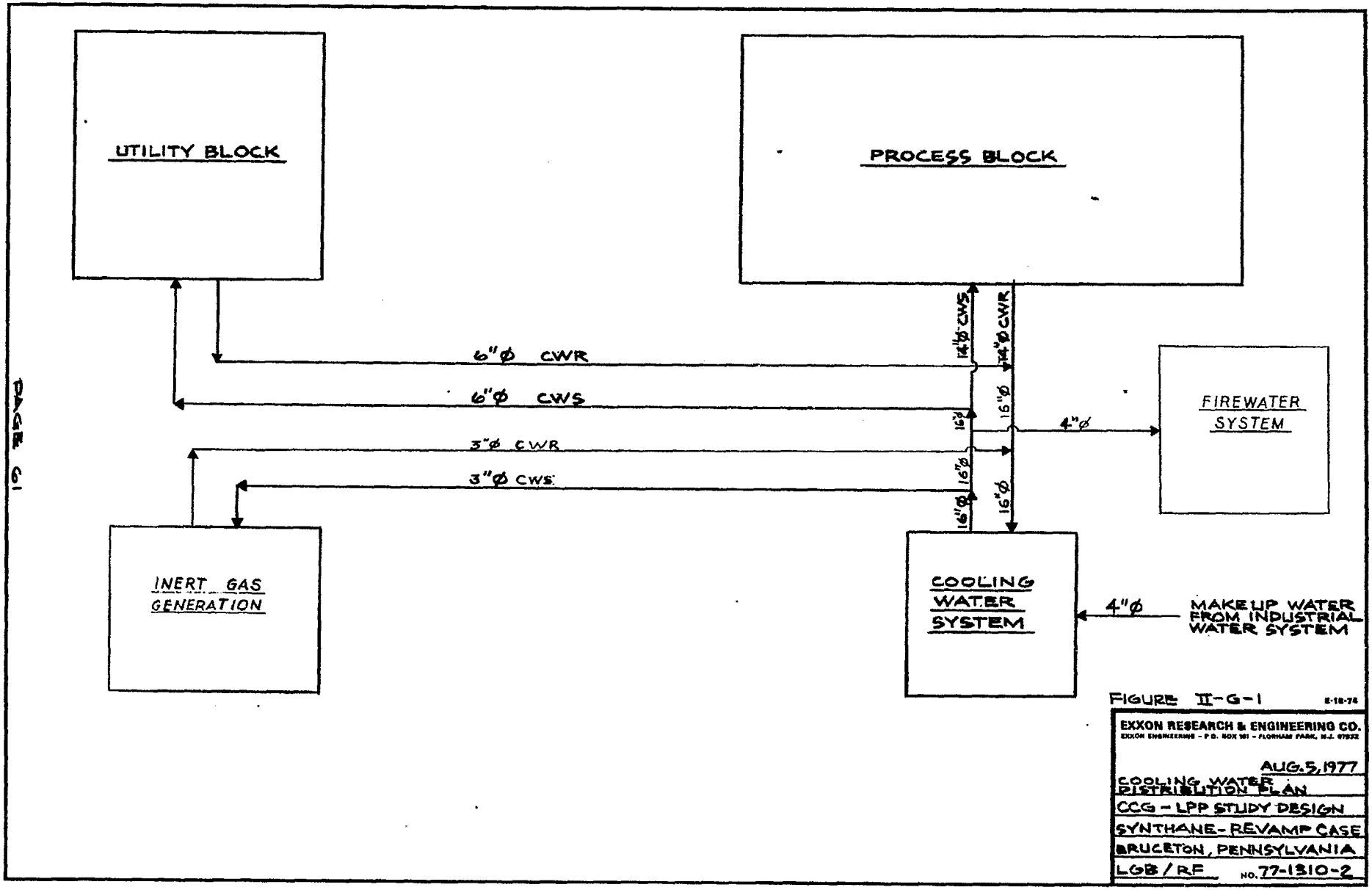


FIGURE II-G-1 8-18-76

EXXON RESEARCH & ENGINEERING CO.
EXXON ENGINEERING - P.O. BOX 101 - FLORHAM PARK, N.J. 07932

AUG. 5, 1977

COOLING WATER DISTRIBUTION PLAN
CCG - LPP STUDY DESIGN
SYNTHANE - REVAMP CASE
BRUCETON, PENNSYLVANIA
LGB / RF NO. 77-1310-2

APPENDIX II-H

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

COMPRESSED AIR FACILITIES FLOW PLAN

This section covers the process study design for the compressed air facilities serving the onsite and offsite systems of the Major Synthane Revamp Case.

DESIGN BASIS

Compressed air for process and offsite consumers shall be provided by three air compressors, two motor driven and one steam turbine driven.

Reuse of existing compressed air facilities at the Synthane Plant has been emphasized in this study design. Synthane compressed air facilities will be relocated and expanded to meet the needs of the revamped facility. The compressed air facilities design flow plan is shown in Figure II-H-1.

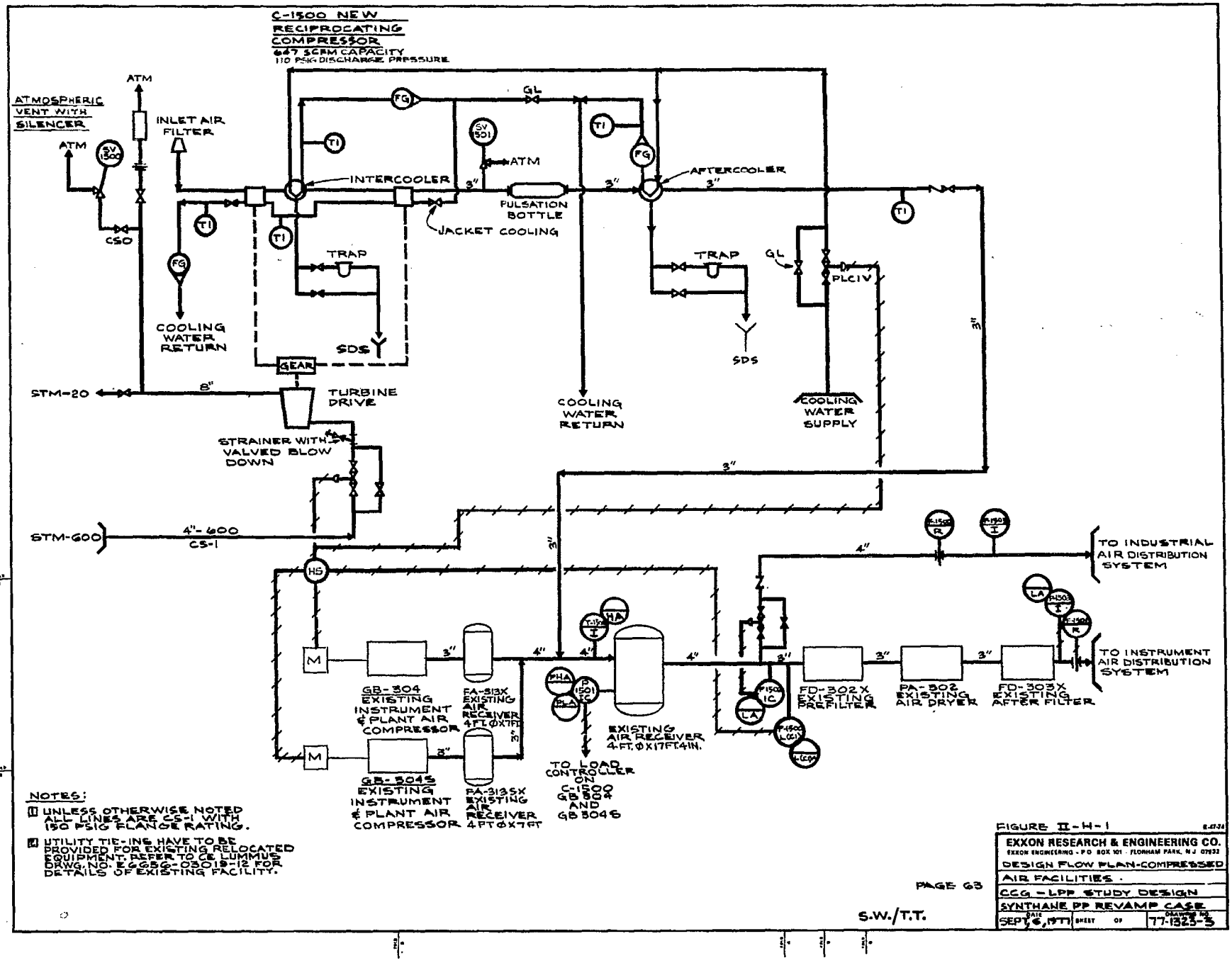
COMPRESSORS AND DRIVERS

The existing reciprocating compressors GB-304 and GB-304S with their motor drivers shall be relocated and reused. An additional air compressor C-1500 with the same rating as the existing units shall be provided (Joy Mfg. Co. Model WN 112 EHDL, Size 13-8 x 7). The new unit shall be steam turbine driven. An appropriate intercooler, after cooler, pulsation bottle, and related equipment shall be provided with the new compressor. The three compressors shall be placed in parallel. The new header pressure control scheme shown on the flow plan shall be integrated with the control packages of the three compressors.

The steam turbine driver for C-1500 shall be single stage. Inlet steam will be 600 psig, 750°F steam (STM-600) and outlet steam shall be 20 psig steam (STM-20).

ADDITIONAL EQUIPMENT

The existing air receivers, Prefilter FP-302X, Air Dryer PA-302, and After Filter FD-303X with bypass piping arrangements shall be relocated and reused.



NOTES:

1. UNLESS OTHERWISE NOTED ALL LINES ARE CS-1 WITH 150 PSIG FLANGE RATING.
2. UTILITY TIE-INS HAVE TO BE PROVIDED FOR EXISTING RELOCATED EQUIPMENT. REFER TO CE LUMMUS DRWG. NO. E-6656-03019-12 FOR DETAILS OF EXISTING FACILITY.

FIGURE II-H-1

EXXON RESEARCH & ENGINEERING CO.	
EXXON ENGINEERING - P.O. BOX 101 - FLORHAM PARK, N.J. 07932	
DESIGN FLOW PLAN-COMPRESSED AIR FACILITIES.	
CCG - LPP STUDY DESIGN	
SYNTHANE PP REVAMP CASE	
DATE SEPT 6, 1977	DRAWING NO. 77-1323-5

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S.W./T.T.

APPENDIX II-I

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

ELECTRICAL POWER SYSTEM

This section of the study design covers the electrical power supply and distribution system for the Coal Gasification Large Pilot Plant (CCG-LPP) Major Synthane Revamp Case.

DESIGN BASIS

Power for the CCG-LPP shall be obtained at 2400V from the West Penn Power Company substation within the plant battery limits.

Power shall be distributed radially from one existing 2400V substation and two existing 480V substations.

The estimated maximum simultaneous demand for the CCG-LPP is approximately 3.8 MVA, including contingencies. The loads are summarized by distribution center in Table

No planned pre-investment for future expansion shall be included in the electrical distribution system.

POWER SOURCE

Power for the CCG-LPP shall be supplied at 2400V, 60Hz, 3 phase from the West Penn Power Company substation existing at the Synthane Plant. A zig-zag grounding transformer and neutral resistor shall be added to the existing 2400V system. This system, according to West Penn Power, is capable of supplying the CCG-LPP estimated load of 3800 kVA.

The interrupting capability of equipment at the 2400V level shall be 36 kA symmetrical at 2400V, which is equivalent to 250 MVA interrupting duty at 4160V.

The contractor's responsibilities shall include, but are not limited to:

- Removal of existing SUB 1-A switchgear and replacement with new switchgear as indicated on one-line drawing, Figure II-I-1.
- Expansion of main electrical room to allow for addition of new MCC's and instrument power supplies.
- Installation of the new zig-zag grounding transformer and neutral resistor.

- Disconnection and reconnection of power cables, control wires, meters and relays at the SUB 1-A switchgear.

DISTRIBUTION SYSTEM

Figure II-I-1 is the simplified one-line diagram of the electrical power distribution system.

The location of the existing substations and new MCC's are indicated on plant layout Figure II-N-2 included in the Layout and Building Study Design.

System Voltage Levels

The distribution voltage level is 2400V. The medium voltage loads will be supplied at 2400V and the low voltage loads will be supplied at 480V.

Distribution System Description

Switchgear units are numbered the same as for the existing Synthane Plant and are located in the main electrical room.

The new SUB 1-A, 2400V switchgear is supplied radially from the West Penn Power Co.'s main transformer and the existing main 2400V circuit breaker located in the yard.

The two existing 480V Substations 1-B and 1-C, and the existing 2400V motor control center MCC 1-E are served radially from SUB 1-A.

SUB 1-B serves three existing MCC's and two existing power panels.

SUB 1-C serves four existing MCC's and shall serve two new MCC's. The two new 480V MCC's shown in Figure II-I-1 shall be designated as Utilities MCC and Waste Water MCC.

The main electrical room shall be air conditioned and pressurized as described in the Layout and Building Study Design.

System Grounding

The new zig-zag grounding transformer shall be connected to the load side terminals of the main 240V circuit breaker. The transformer and neutral resistor package shall be capable of supplying approximately 1200 amps of ground fault current for 10 seconds.

The two 2400-480V transformers have delta connected primary windings, and wye connected secondary windings with a solidly grounded neutral.

LOAD DESCRIPTION

The estimated maximum simultaneous demand for the CCG-LPP, including contingencies, is approximately 3800 kVA. The loads are summarized by distribution center in Table II-I-1. The contractor is responsible for finalizing all loads and for assuring compatibility of all equipment, both new and existing, throughout the system.

The contractor shall utilize existing motor starters wherever possible. Where new starters are required, they shall be added to the existing MCC's in the main electrical equipment room.

METERING

West Penn Power Company has their own revenue metering at their incoming transformer.

The transformer secondary is presently equipped with:

- An indicating watthour meter with a demand register.
- One single phase indicating ammeter with selector switch for three phases.
- Voltmeter with selector switch for three phases.

PROTECTION

The West Penn Power Co.'s main transformer has secondary phase overcurrent protection, undervoltage protection, and anti-single phasing protection, as shown in Figure II-I-1. A new backup ground overcurrent relay shall be added to the new zig-zag grounding transformer neutral circuit and shall be wired to trip the main 2400V breaker.

The outgoing SUB 1-A feeders have phase instantaneous and time overcurrent protection, and instantaneous ground fault protection.

The existing medium voltage motor starters have fuses and thermal overload relays. Locked rotor and instantaneous ground fault protection shall be added. New motor starters shall be supplied with the same protection.

Protection for SUB 1-B and SUB 1-C consists of existing breakers with direct acting trip devices, and with ground sensing relays which shall be rewired to trip the source breaker at SUB 1-A.

INSTRUMENT POWER SUPPLY

The contractor shall provide an IPS (instrument power supply) in the main electrical room for supplying power to instruments and other

essential services during power outages. Figure II-I-2 shows the IPS one line diagram. A new IPS shall also be provided in the new boiler room.

The existing computer IPS shall be moved from the existing boiler room to the main electrical room.

The two emergency generators shown in Figure II-I-2 are existing, but shall be reconnected as shown.

Transfer switches for a-c loads shall operate immediately upon drop of voltage below lower tolerable limit of loads served. A solid state transfer switch shall be provided.

The instrument power distribution panels shall be standardized metal enclosures with grouped fused disconnect switches.

The contractor's responsibilities shall include, but are not limited to:

- Selection and sizing of equipment for the IPS system based on the latest instrument.
- Complete coordination of switching and tripping elements.

COMMUNICATIONS

The communication system for this project is not the responsibility of the contractor; however, the contractor shall supply conduits, raceways, etc., as required for the installation of the new equipment which will include dial telephones and a two-way radio system.

TABLE II-I-1

DISTRIBUTION CENTER LOAD SUMMARY

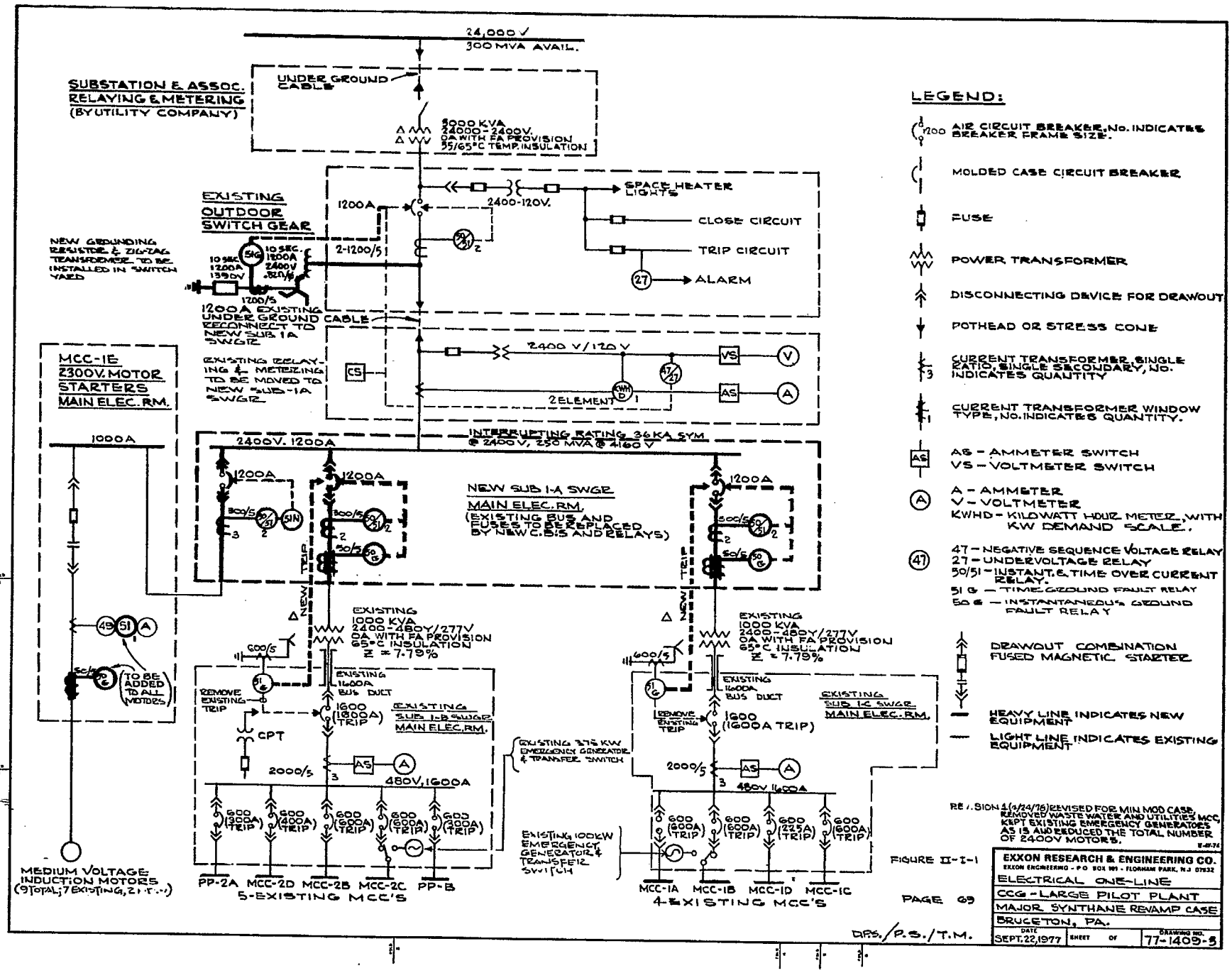
Distrib. Center	Loading Area	Existing Oper. kW	Existing Equiv. kVA(2)	New Oper. kW(1)	New Equiv. kVA(2)
SUB 1-A (2400V)	MCC 1-E	411	462	1191	1338
	SUB 1-B	428	504	395	465
	SUB 1-C	145	171	787	926
	Totals	984	1137(4)	2373	2729(4)
SUB 1-B (480V)	Onsite Coal Receipt & Storage	203	240	99	117
	Safety Syst	150	176	81	95
	I. P. S.	75	88	17	20
	Boiler Rm (3) & Lighting	-	-	8	10
	Totals	-	-	190	223
		428	504	395	465
SUB 1-C (480V)	Onsite Chemical Handling & Misc.	-	-	303	356
	CO_2	-	-	31	36
	Admin. Building (3) & Lighting	30	35	12	14
	Computer IPS	-	-	151	178
	Utilities MCC	17	20	-	-
	Waste H_2O MCC	31	37	11	13
	Totals	67	79	279	329
		145	171	787	926

Notes: (1) Additional allowance has been included.

(2) Assumed power factors are 0.89 for medium voltage loads, 0.85 for low voltage loads.

(3) These are estimated loads some of which will be existing.

(4) Total Sub 1-A kVA is approximated by arithmetic rather than vector summation.



LEGEND:

- 1200 — AIR CIRCUIT BREAKER, No. INDICATES BREAKER FRAME SIZE.
- MOLDED CASE CIRCUIT BREAKER
- FUSE
- POWER TRANSFORMER
- DISCONNECTING DEVICE FOR DRAWOUT
- POTHEAD OR STRESS CONE
- 3 — CURRENT TRANSFORMER, SINGLE RATIO, SINGLE SECONDARY, No. INDICATES QUANTITY
- 1 — CURRENT TRANSFORMER WINDOW TYPE, No. INDICATES QUANTITY.
- AS — AMMETER SWITCH
- VS — VOLTMETER SWITCH
- A — AMMETER
- V — VOLTMETER
- KWHD — KILOWATT HOUR METER, WITH KW DEMAND SCALE.
- 47 — NEGATIVE SEQUENCE VOLTAGE RELAY
- 27 — UNDERVOLTAGE RELAY
- 50/51 — INSTANT. & TIME OVER CURRENT RELAY.
- 51 G — TIME GROUND FAULT RELAY
- 50 G — INSTANTANEOUS GROUND FAULT RELAY
- DRAWOUT COMBINATION FUSED MAGNETIC STARTER
- HEAVY LINE INDICATES NEW EQUIPMENT
- LIGHT LINE INDICATES EXISTING EQUIPMENT

REVISION 1 (1/24/76) REVISED FOR MIN MOD CASE. REMOVED WASTE WATER AND UTILITIES MCC. KEPT EXISTING EMERGENCY GENERATORS AS IS AND REDUCED THE TOTAL NUMBER OF 2400V MOTORS.

FIGURE II-1-1

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DRS./P.S./T.M.

EXXON RESEARCH & ENGINEERING CO.		
EXXON ENGINEERING - P.O. BOX 101 - FLORHAM PARK, N.J. 07932		
ELECTRICAL ONE-LINE		
CCG - LARGE PILOT PLANT		
MAJOR SYNTHANE REVAMP CASE		
BRUCETON, PA.		
DATE SEPT. 22, 1977	SHEET OF	DRAWING NO. 77-1409-5

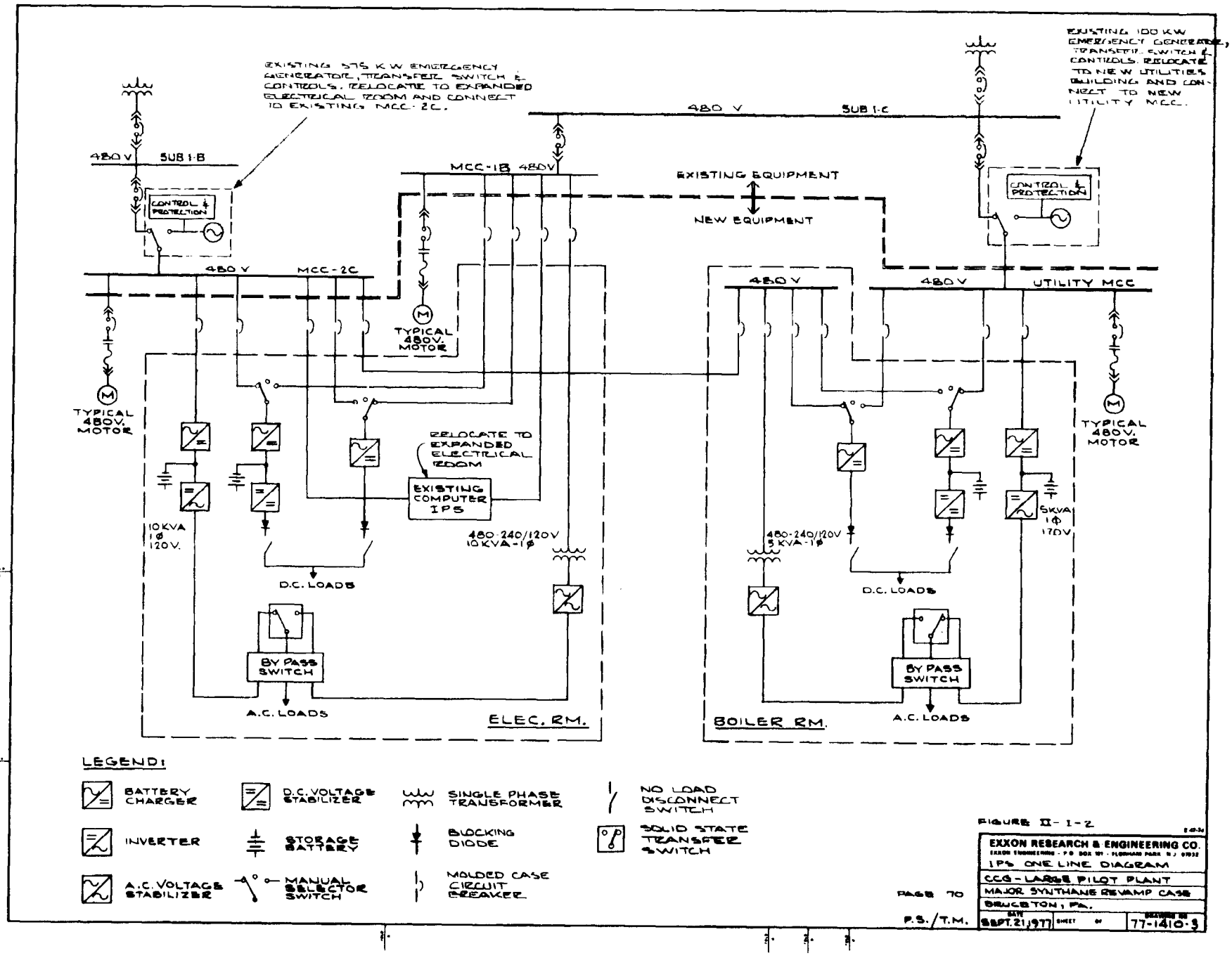

FIGURE II-1-2

EXXON RESEARCH & ENGINEERING CO.	
IPS ONE LINE DIAGRAM	
CCG-LARGE PILOT PLANT	
MAJOR SYNTHANE REVAMP CASE	
BRUCETON, PA.	
DATE SEPT. 21, 1977	DRAWING NO. 77-1410-3

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P.S./T.M.

APPENDIX II-J

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

POTABLE, INDUSTRIAL, AND FIREWATER SYSTEMS

This section covers the process study design for the potable water, industrial water, and firewater facilities serving onsite and offsite facilities of the Major Synthane Revamp Case.

DESIGN BASIS

In general, the basis of this study design is to utilize the existing pilot plant facilities where possible and expand them as required to meet the process and safety requirements of a Catalytic Coal Gasification Pilot Plant.

- Potable Water

The existing potable water distribution system can be used to meet the new pilot plant requirements by simply separating it from the existing industrial water system and adding new distribution lines.

- Industrial Water

Industrial water for process and offsite consumers shall be provided via a new industrial water system consisting of storage, pumping, and distribution facilities.

- Firewater

Firewater shall be provided to the pilot plant facilities by adding a new pumping system which takes suction from the industrial water tank. Additional distribution loops shall be added to the existing firewater network to serve the new areas of the plant.

POTABLE WATER DISTRIBUTION

Potable water is presently taken from the city water main at 160 psig and metered into the Synthane site at 30 psig. This pressure reducing system plus the existing distribution network shall be retained and expanded as shown in Figure II-J-1. New lines are required as follows:

- One 2" pipe line to the new utility block containing boilers and air compressors.
- One 1-1/2" pipe line to the relocated maintenance building.

INDUSTRIAL WATER DISTRIBUTION

The industrial water distribution system shall be an entirely new facility consisting of storage tank, pumps, and distribution lines. The storage tank shall also provide the necessary firewater inventory as required to meet safety standards.

Water shall be supplied to the tank via a new 8" Ø line which shall be tied into the existing city water main. For reliability and flexibility, the pumping facilities shall consist of three 50% pumps, 2 electric motor driven and one steam turbine driven.

The industrial water distribution network is shown in Figure II-J-2, and storage and pumping facilities are illustrated in Figure II-J-3.

FIREWATER SYSTEM

Firewater shall be distributed throughout the plant via the existing piping system plus additional loops required for new/relocated facilities as shown in Figure II-J-4.

A 6-hour firewater supply shall be provided in the industrial water tank.

New pumping facilities shall be provided and tied in to the firewater distribution network, as shown in Figure II-J-3.

FIREFIGHTING EQUIPMENT

For the purposes of this study design, it is assumed that the municipal mobile firefighting equipment is adequate to cover the needs of the revamped facility.

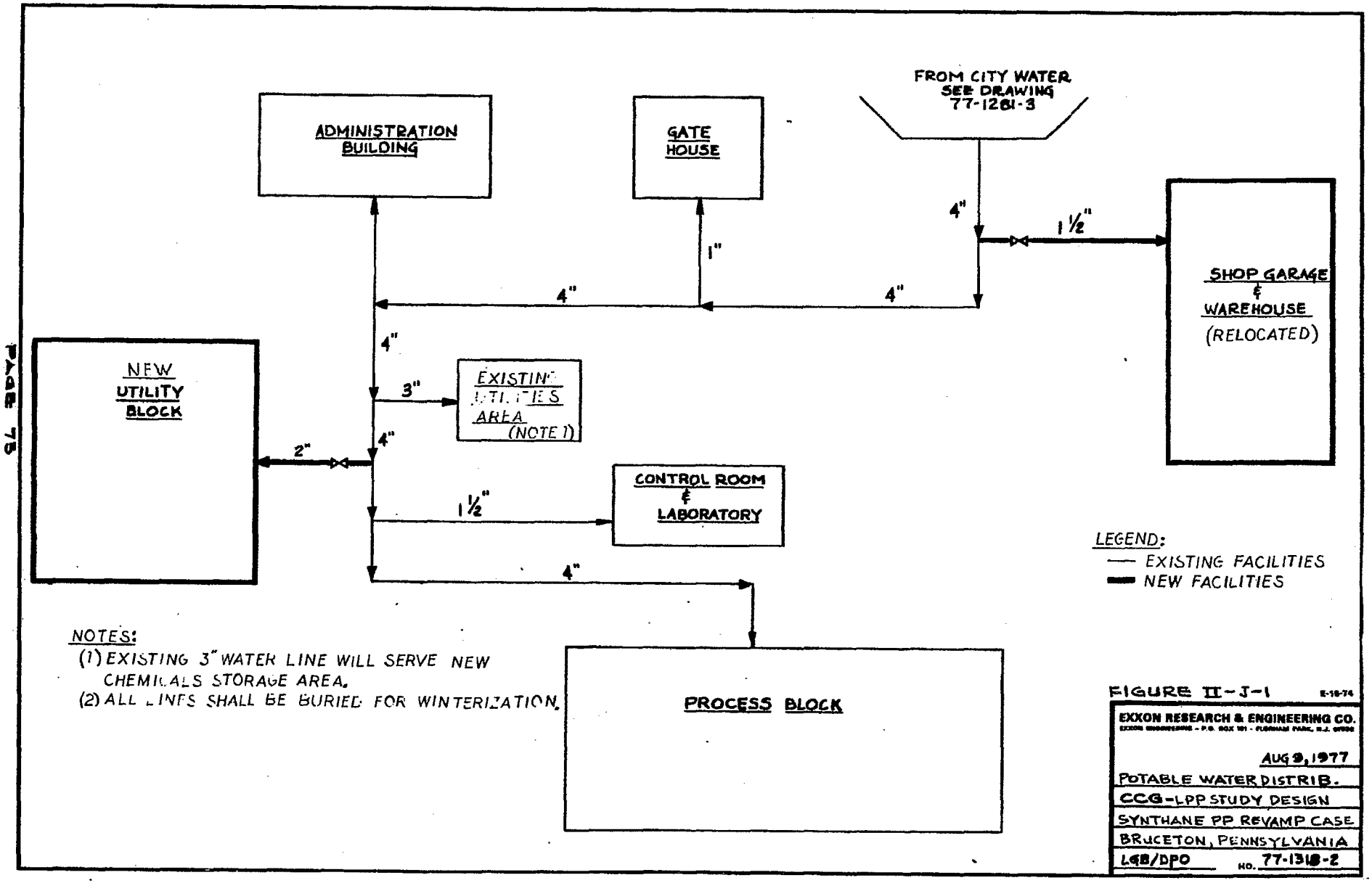


FIGURE II-J-1

EXXON RESEARCH & ENGINEERING CO.

AUG 9, 1977

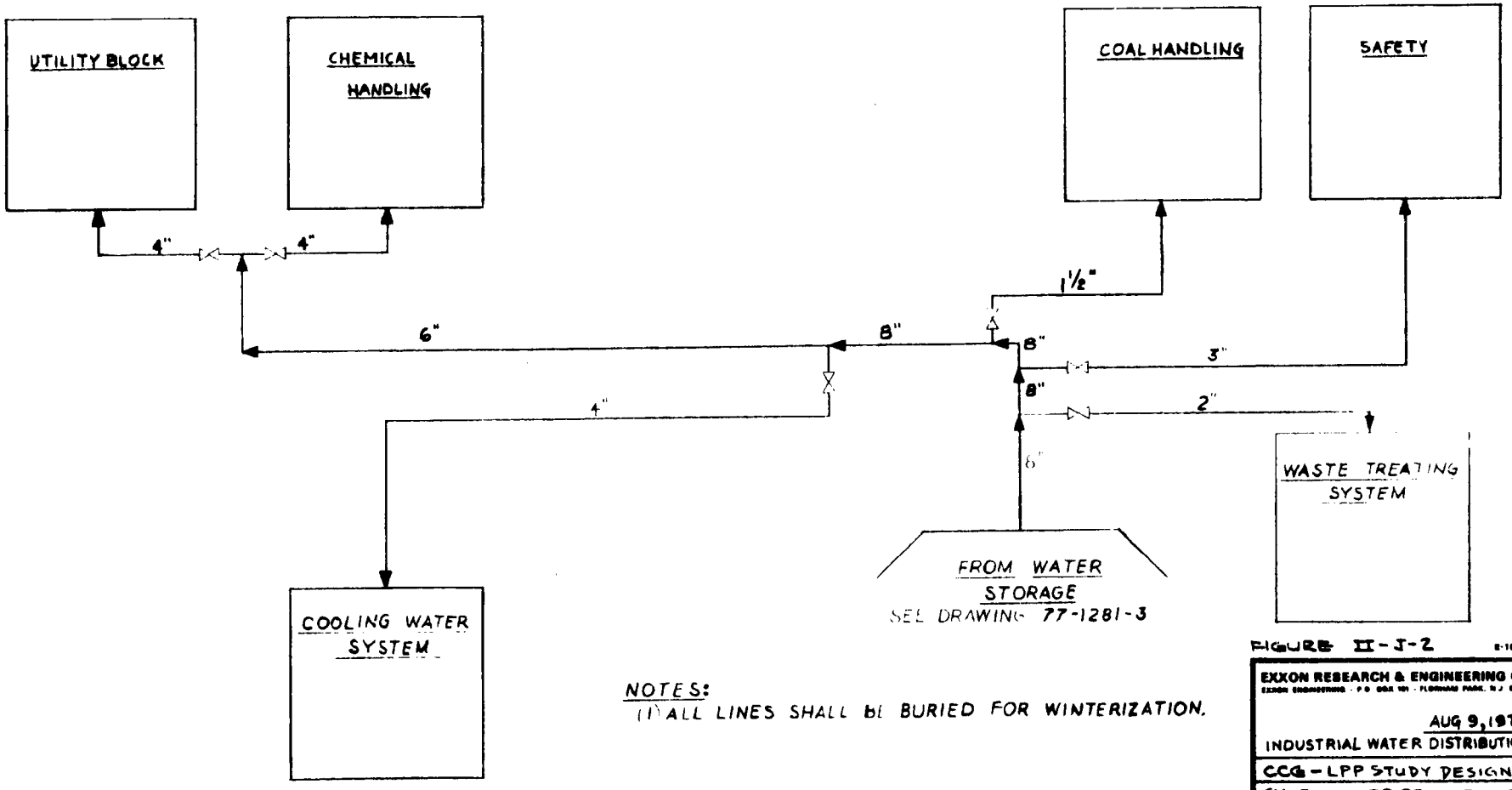
POTABLE WATER DISTRIB.

CCG-LPP STUDY DESIGN

SYNTHANE PP REVAMP CASE

BRUCETON, PENNSYLVANIA

LGB/DPO NO. 77-1318-2

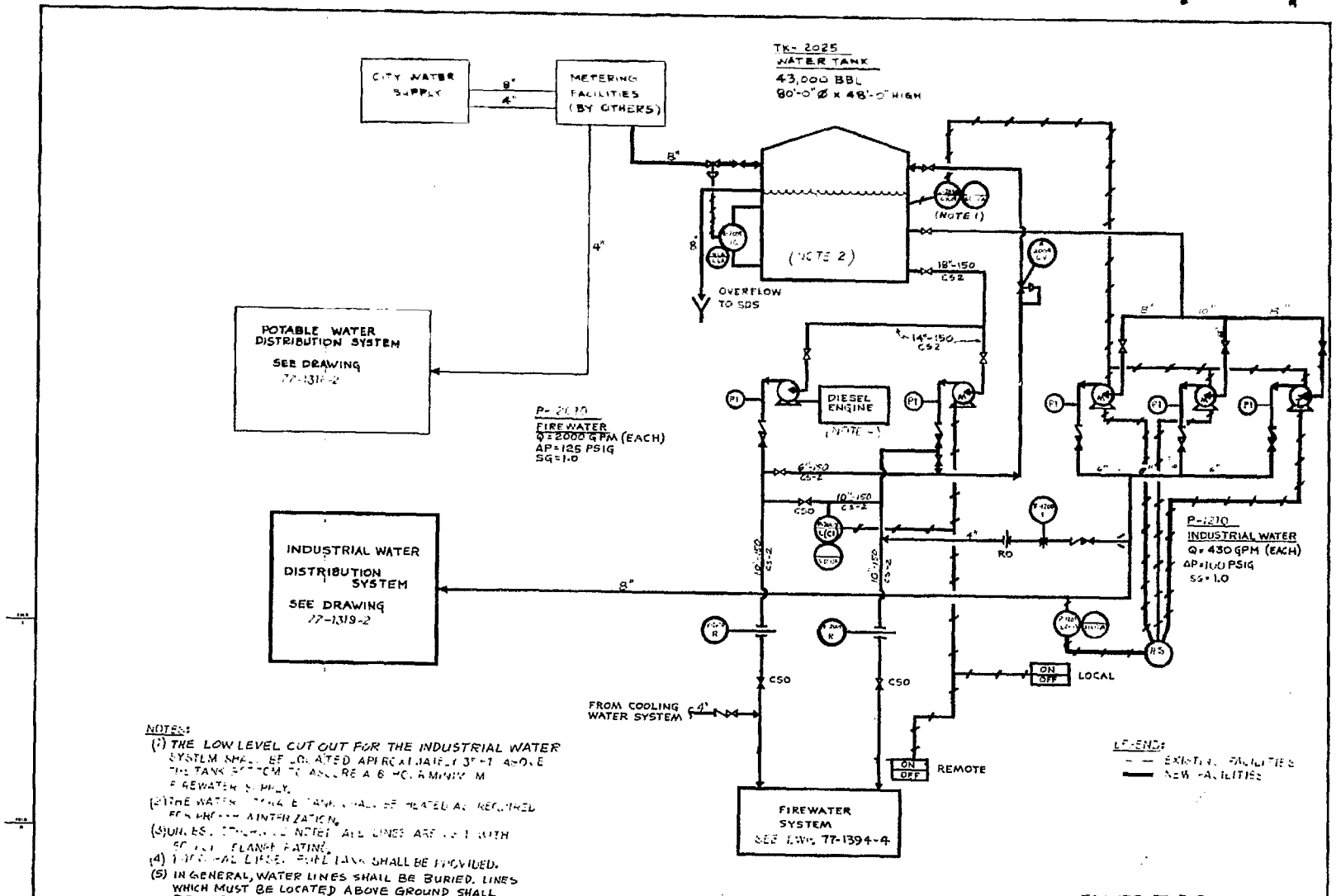


NOTES:
(1) ALL LINES SHALL BE BURIED FOR WINTERIZATION.

FIGURE II-J-2 8-10-74

EXXON RESEARCH & ENGINEERING CO.
EXXON ENGINEERING - P.O. BOX 101 - FLORHAM PARK, N.J. 07932

AUG 9, 1977
INDUSTRIAL WATER DISTRIBUTION
CCG - LPP STUDY DESIGN
SYNTHANE PP REVAMP CASE
BRUCETON, PENNSYLVANIA.
L98/DPO NO. 77-1319-2



NOTES:

(1) THE LOW LEVEL CUT OUT FOR THE INDUSTRIAL WATER SYSTEM SHALL BE LOCATED APPROXIMATELY 3'-1" ABOVE THE TANK BOTTOM TO ASSURE A 6 HOUR MINIMUM FIREWATER SUPPLY.

(2) THE WATER STORAGE TANK SHALL BE HEATED AS REQUIRED FOR FREEZE PROTECTION.

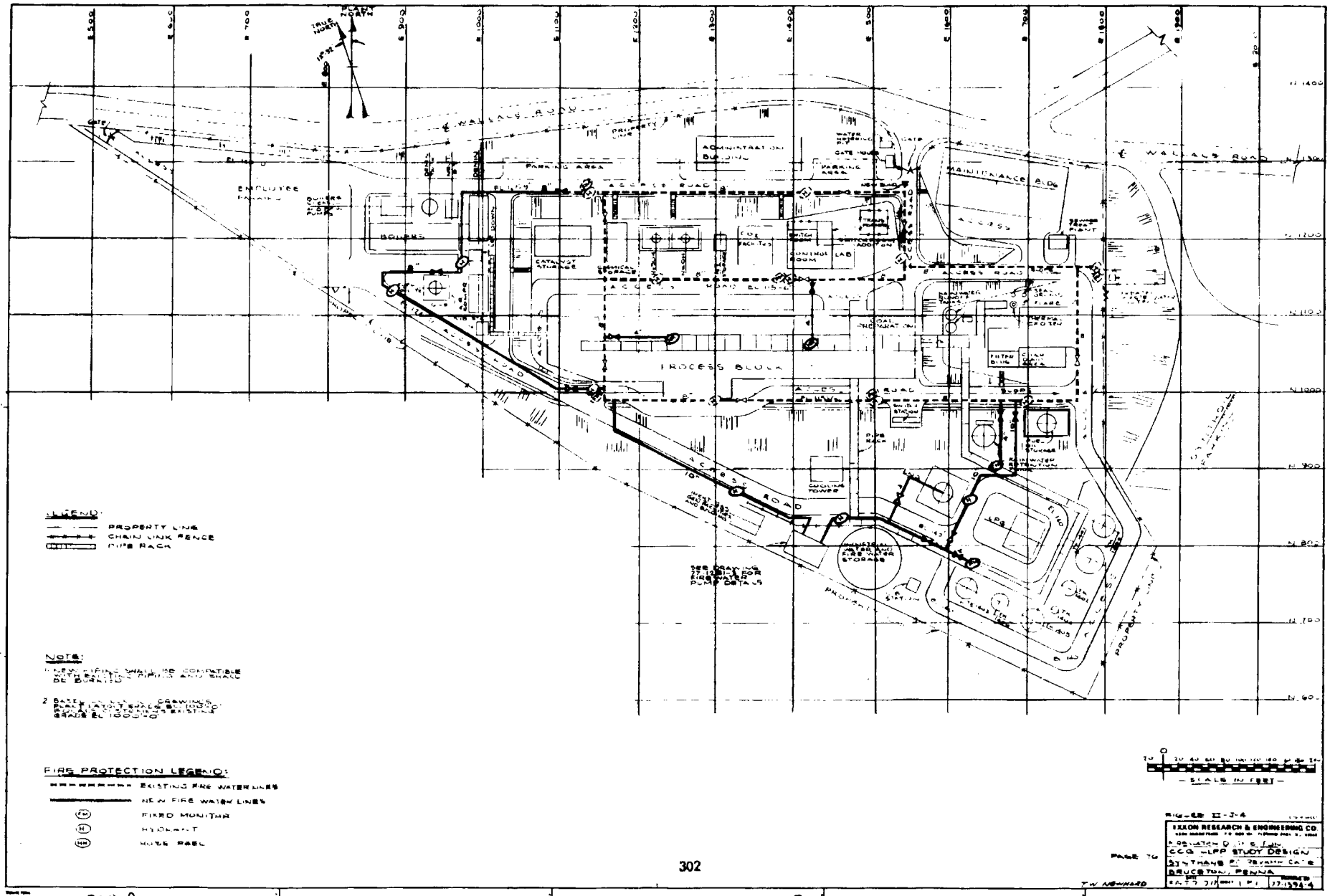
(3) UNLESS OTHERWISE NOTED ALL LINES ARE 150 LB WITH SOCKET WELD FLANGE RATING.

(4) TYPICAL LIQUID FUEL TANK SHALL BE PROVIDED.

(5) IN GENERAL, WATER LINES SHALL BE BURIED. LINES WHICH MUST BE LOCATED ABOVE GROUND SHALL BE STEAM TRACED AND INSULATED.

FIGURE II-3-3

EXXON RESEARCH & ENGINEERING CO.	
WATER STORAGE AND PUMPING	
CCG-LPP STUDY DESIGN	
SYNTHANE PP REVAMP CASE	
BRUCETON, PENNSYLVANIA	
DATE: AUG 3, 1977	DRAWING NO. 77-1281-3
SHEET 1 OF 1	


PLANT NORTH
TRUE NORTH
E. WALLACE ROAD
ADMINISTRATION BUILDING
PARKING AREA
ACCESS ROAD
MAINTENANCE BLDG.
EMPLOYEE PARKING
BOILERS
CONTROL HOUSE
CATALYST STORAGE
SHUTDOWN LAB
PROCESS BLDG.
FILTER BLDG.
COOLING TOWER
SEE DRAWING FOR FIRE WATER PIPING DETAILS
PROPERTY LINE
LEGEND:
PROPERTY LINE
CHAIN LINK FENCE
PIPE RACK
NOTES:
1. NEW PIPING SHALL BE COMPATIBLE WITH EXISTING PIPING AND SHALL BE BURIED.
FIRE PROTECTION LEGEND:
EXISTING FIRE WATER LINES
NEW FIRE WATER LINES
FIXED MONITOR
HYDRANT
HOSE REEL
SCALE IN FEET
EXXON RESEARCH & ENGINEERING CO.
CCA - LPP STUDY DESIGN
BRUCETON, PENNA.

APPENDIX II-K

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

WASTE TREATING FACILITIES

This section covers the handling, treating, and disposition of waste streams from the onsite and offsite facilities of the Major Synthane Revamp Case.

DESIGN BASIS

Onsite waste streams for the Major Synthane Revamp Case will be the same as the grass-roots case onsite waste streams except for the following:

- There will be a 0.4 gpm waste stream from the Stretford Plant, a unit not specified in the Grass-Roots LPP. Because of the toxicity of this waste stream, it shall be stored in a 5000 gal. drum at the Stretford Plant site for periodic removal by an outside contractor.
- The waste stream from the sour slurry stripper will be increased by 6-7 gpm. This is caused by the addition of a waste stream from the acid gas removal section to the sour slurry stripper.

Offsite Major Synthane Revamp Case waste streams will differ from offsite grass-roots case waste streams as follows:

- The design contaminated rainwater flowrate will be significantly less than the grass-roots case contaminated rainwater flowrate. This is caused by a smaller design rainfall and a smaller contaminated rainwater runoff collection area.
- There will be no waste stream from coal preparation.
- Sanitary waste will be treated by a separate existing facility.

Cooling tower blowdown, boiler blowdown, and the neutralized regeneration water from the demineralization plant will be purged from the LPP without treatment. These streams are presently purged from the Synthane Plant without treatment, so it has been assumed this practice is acceptable from an environmental standpoint.

Wherever possible, existing Synthane Plant waste treating facilities have been incorporated into the Synthane Revamp Case waste treating facilities. Following are existing facilities which shall be reused.

- The solids/liquid separation vacuum filter facilities.
- One of the 15,000 gal. rainwater runoff tanks.

- The 160,000 gal. waste water holdup tank.

To the extent possible, treated waste water will be reused in the Synthane Revamp LPP. Excess treated waste water shall be purged to an adjacent stream.

The design flow plans for the Major Synthane Revamp Case waste treating facilities are the same as the design flow plans for the Grass-Roots Case waste treating facilities (Appendix I-G), except as noted on the following tables.

TABLE II-K-1

DESIGN FLOW PLAN CHANGES
WASTE TREATING FACILITIES

- Changes to grass-roots case Figure I-G-3).

Item	Major Synthane Revamp	Grass Roots
Tank and Drum Volumes		
- TK-1400	3509 bbl.	3071 bbl.
- TK-1404	1469 gal.	5880 gal.
- D-1403	2000 gal.	4500 gal.
Thickener Diameter		
- TH-1401	36 ft.	50 ft.
Pump Flowrates (1)		
- P-1400	50 gpm	45 gpm
- P-1401 A&B	34 gpm (each)	40 gpm (each)
- P-1402 A&B	120 gpm (each)	355 gpm (each)

A new pump P-1415 is added to the vacuum filter overflow water line. Its characteristics follow.

Flowrate	21 gpm
Differential Pressure	25 psi

Inert gas or CO_2 shall be used to blanket TK-1400 instead of N_2.

There is no waste stream from coal preparation.

The two contaminated rainwater runoff lines from the coal receipt area and char fines storage area (separate from the main contaminated rainwater runoff line) are not required.

The existing Synthane Plant vacuum filtration pumps shall be modified to the following specifications and used in place of P-1405 A&B.

Flowrate	29 gpm
Differential Pressure	43 psi

Existing equipment at Synthane shall be reused and tied into the new facilities in place of the following grass roots equipment.

C-1400 A&B
D-1400
VF-1400 A&B
CO-1400 A&B
CO-1401 A&B

(1) Capacity proration factors also to apply to associated piping systems.

TABLE II-K-1 (Cont'd.)

Characteristics of mixers MA-1400 A&B and MA-1404 shall be prorated on the volumes of the tanks in which they are set.

For winterization, all piping shall be insulated and heat traced, all drums shall have heaters, and all tanks shall have steam spargers.

- Changes to grass-roots case Figure I-G-4)

Item	Major Synthane Revamp	Grass Roots
Tank and Aeration Basin Volumes		
- TK-1402	2,098 bbl.	6,526 bbl.
- TK-1403	4,798 bbl.	12,978 bbl.
- AB-1405	1,617 bbl.	4,292 bbl.
Diameter of Clarifier		
- CL-1406	27 ft.	44 ft.
Pump Flowrates(1)		
- P-1403 A&B	138 gpm (each)	380 gpm (each)
- P-1404 A&B	138 gpm (each)	380 gpm (each)
- P-1407 A&B	0.5 gph (each)	1.1 gph (each)
- P-1409 A&B	7 gph (each)	20 gph (each)
- P-1414 A&B	43 gpm (each)	190 gpm (each)
Purge of treated waste water.	**To outfall at east end of plant.**	**To refinery**

Sanitary waste shall be handled by a separate existing facility.

All piping shall be insulated and heat traced for winterization. All tanks shall have steam spargers for heating during winter.

(1) Capacity proration factors also to apply to associated piping systems.

TABLE II-K-1 (Cont'd.)

- Figure II-K-1 replaces grass-roots case Figure I-G-5. Stream designations for Figure II-K-1 are below.

Number	Stream
1.	Catalyst Recovery waste water.
2.	Catalyst Recovery and Product Gas Treating supply water.
3.	Product Gas Treating waste water.
4.	Steam reformer effluent condensate.
5.	Catalyst evaporator condensate.
6.	Sanitary waste.
7.	Site drainage contaminated runoff.
8.	To waste treating.
9.	Purge from activated sludge unit.

- Figure II-K-2 replaces grass-roots case Figure I-G-6. Following are notes pertaining to Figure II-K-2.

1. This flow is from the Segregated Sewer System in the process unit and other areas producing contaminated rainwater runoff. The Segregated Sewer System shall be sealed and have vents.

2. Level switches shall have level high cut in and level low cut out. Set points shall be determined by contractor to provide sequential startup and shutdown of Pumps P-1411A, P-1411B, and P-1412 with increasing/decreasing rainwater flow.

3. A trash rack consisting of 1" Ø bars on 2" centers shall be provided at the rainwater collection sump entrance.

4. All piping shall be insulated and heat traced for winterization. All tanks shall have steam spargers for heating during winter.

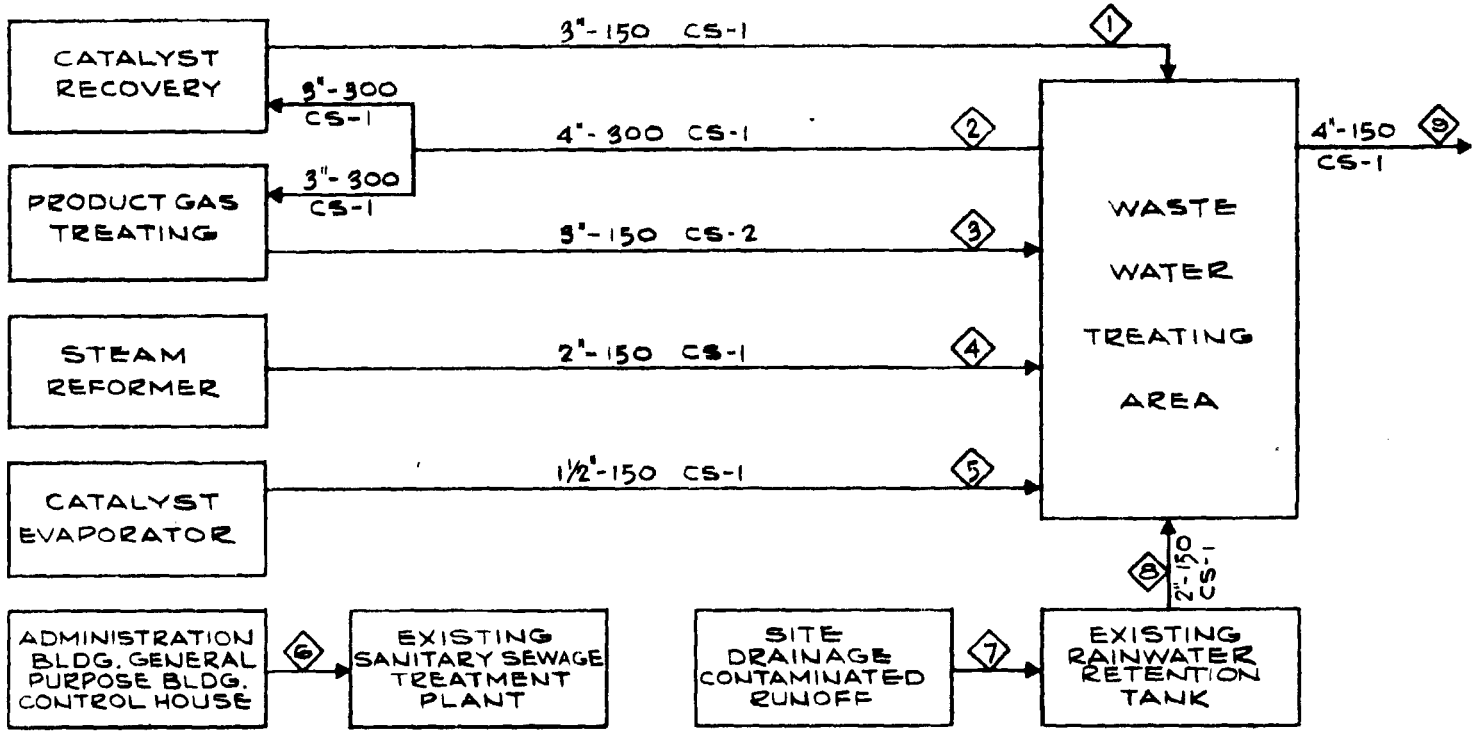


FIGURE II-K-1

EXXON RESEARCH & ENGINEERING CO.

SEPT. 2, 1977

WASTE TREATING FACILITIES

INTERCONNECTING LINES

CCG-LPP STUDY DESIGN

SYNTHANE REVAMP CASE

S.W./T.M. NO. 77-1413-2

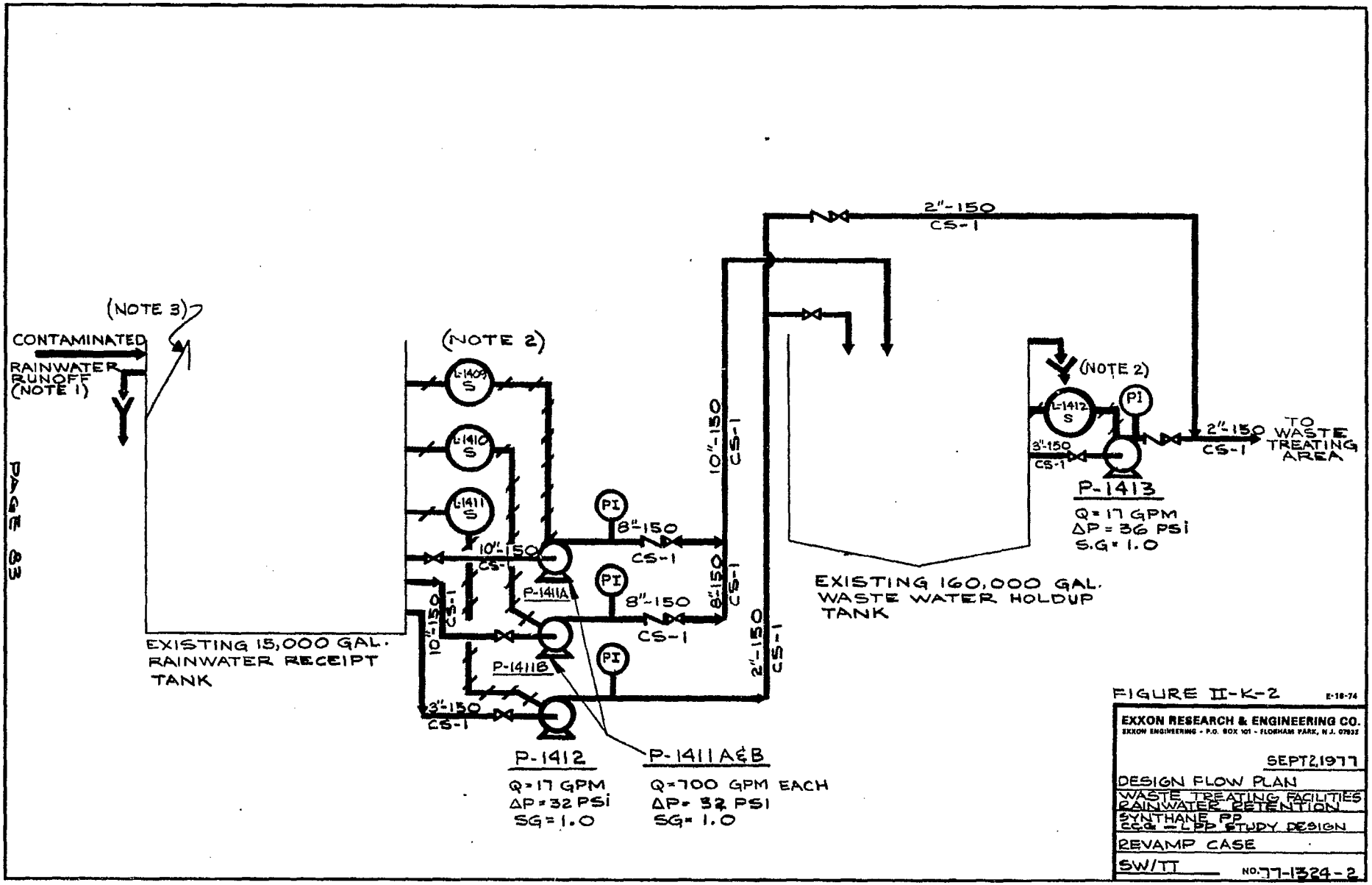


FIGURE II-K-2 E-16-74

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EXXON ENGINEERING - P.O. BOX 101 - FLORHAM PARK, N.J. 07932

SEPT 2, 1977

DESIGN FLOW PLAN
WASTE TREATING FACILITIES
RAINWATER RETENTION
SYNTHANE PP
CCG - LPP STUDY DESIGN
REVAMP CASE
SW/TT NO. 77-1324-2

APPENDIX II-L

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

SAFETY FACILITIES

This section covers the safety system required for the onsite and offsite facilities of the Major Synthane Revamp Case.

Equipment is provided to safely dispose of the continuous H_2S stream from the overhead of the slurry stripper and to flare the gaseous safety valve releases from the plant.

DESIGN BASIS

The existing thermal oxidizer is used to burn the continuous H_2S purge stream from the process area. Based on existing Synthane practices, it has been assumed that this is acceptable from an environmental standpoint. New equipment required to make the thermal oxidizer suitable for continuous H_2S burning is listed in Table II-L-1.

The flare gas facilities for safety valve releases will be similar to the grass-roots case flare system (Appendix I-K). Specific changes for the Major Synthane Revamp Case are listed.

The Coordination Flow Plan - Flare System shown in Figure II-L-1 gives a simplified overview of the Major Synthane Revamp Case Safety Facilities.

TABLE II-L-1

EQUIPMENT LIST

THERMAL OXIDIZER SYSTEM

The existing thermal oxidizer will be used to incinerate the continuous H_2S steam from the process area. Existing burners, controls and local piping at the thermal oxidizer will be reused. Only changes to the system are tie-ins from revamped offsite utilities systems (fuel oil, steam, compressed air) and the addition of an H_2S flare gas line with seal drum and associated facilities.

Details of new facilities are:

Item	Equipment
H_2S flare gas line from process to seal drum	4"Ø steam traced and insulated
Flare seal drum with water supply and sealing water disposal pumping system.	Duplicate of seal system for elevated flare (see grass roots case Figure I-K-1. All water and condensate lines to be heat traced and insulated.
H_2S flare gas line from seal drum to thermal oxidizer	4"Ø steam traced and insulated.

TABLE II-L-2

DESIGN FLOW PLAN CHANGES
FLARE SYSTEM

- Changes to grass-roots case Figure I-K-1.

	Major Synthane Revamp	Grass Roots
Flare Gas Lines		
- From Process	10"Ø	12"Ø
- From Utility Block	2"Ø	8"Ø
- From LPG/LNG Facilities	2"Ø	None
Flare Stack Diameter	10"Ø	12"Ø
Pilot Gas/Fuel Gas System	1-1/2"Ø LPG Line to Pilot Gas Systems	3" Natural Gas Line to Flare Stack and Pilot Gas System
Heat Tracing Required		
- Water Lines	Yes	No
- Condensate Lines	Yes	No

- Changes to grass-roots case Figure I-K-2.

	Major Synthane Revamp	Grass Roots
Heat Tracing of:		
- Condensate Drum Bottom	Yes	No
- Condensate Lines	Yes	No
Flare Gas Heater (1)		

Note:

(1) This information is common to both the Grass-Roots and Major Synthane Revamp Cases.

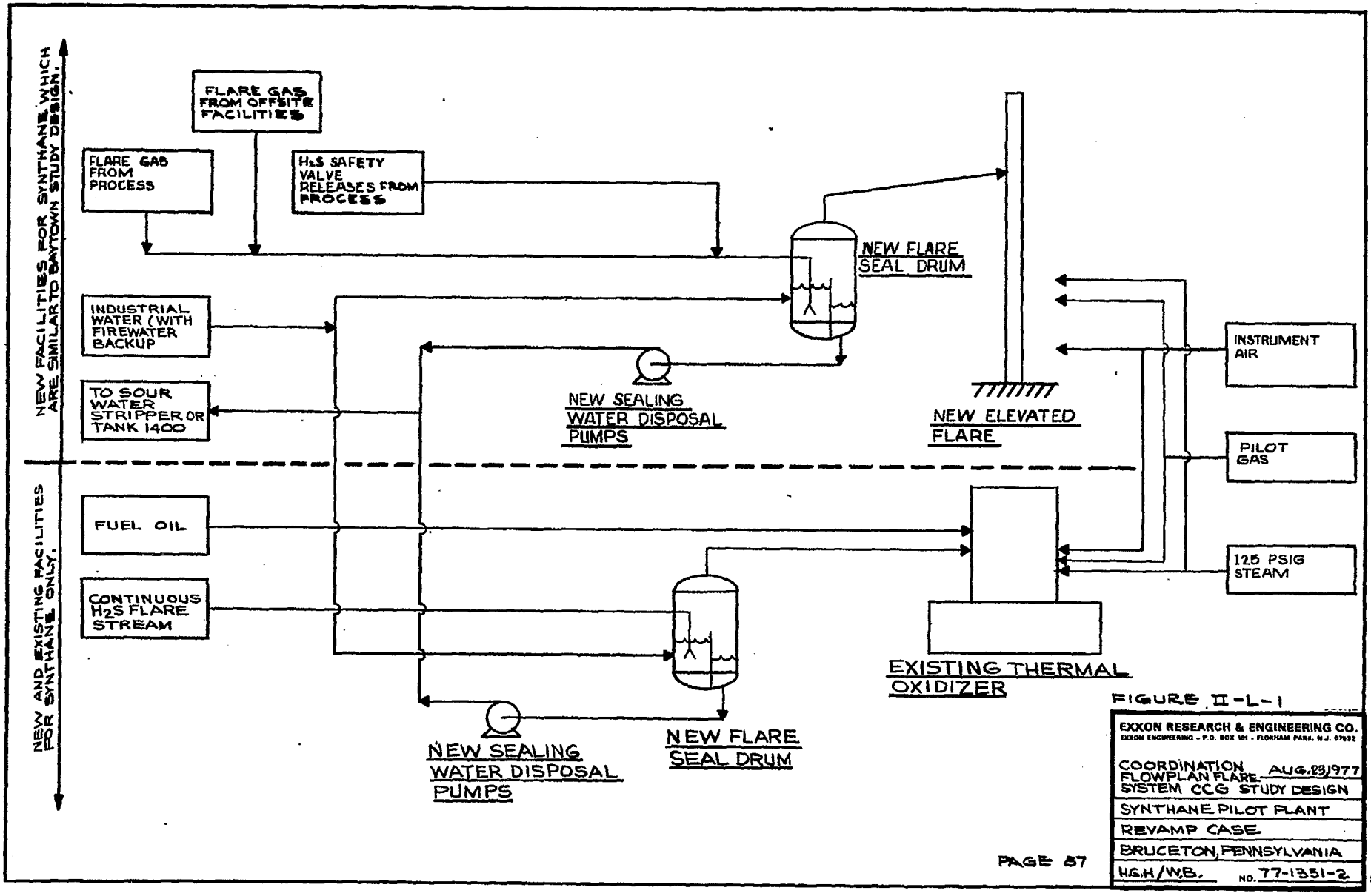

FIGURE II-L-1

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COORDINATION FLOWPLAN FLARE SYSTEM CCG STUDY DESIGN — AUG. 23/1977
SYNTHANE PILOT PLANT
REVAMP CASE
BRUCETON, PENNSYLVANIA
H.G.H./W.B. NO. 77-1351-2

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APPENDIX II-M

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

CHEMICAL HANDLING FACILITIES

The chemical handling facilities for the Major Synthane Revamp Case will be nearly a duplicate of the chemical handling facilities for the grass-roots case (Appendix I-H). Following are changes to the grass-roots chemical handling facilities for the revamp chemical handling facilities.

1. Chlorine and its related facilities have been deleted.

2. All caustic and sulfuric acid pumps and lines shall be heat traced. All caustic pumps and lines shall be stress relieved.

3. The sulfuric acid Tank TK-1601 shall be externally heated (steam or electric tracing).

4. Differential Pressures of the following pumps have been changed.

	Major Synthane Revamp	Grass-Roots
P-1601	44 psi	25 psi
P-1603	29 psi	14 psi

APPENDIX II-N

CATALYTIC COAL GASIFICATION
LARGE PILOT PLANT STUDY - MAJOR SYNTHANE REVAMP CASE

LAYOUT AND SITE PREPARATION

This section covers overall layout and site preparation for the Major Synthane Revamp Case.

DESIGN BASIS

The "Major Synthane Revamp Case" has been developed to provide a basis for comparison with the conceptual "Grass-Roots Case". The "Major Synthane Revamp Case" would be constructed on the existing DOE Coal Gasification Plant site at Bruceton, Pennsylvania in an attempt to utilize the existing facilities where possible.

In order to comply with minimum required safety standards, it is necessary to relocate some existing equipment and use additional land outside the present fence line for new offsite facilities.

The extent of the modifications of the existing DOE Plant may be visualized by comparing the Present Plant Layout in Figure II-N-1 with the Major Synthane Revamp Plant Layout in Figure II-N-2.

SITE DESCRIPTION

The proposed pilot plant site is the existing Synthane Coal Gasification Plant which is located in Bruceton, Pennsylvania. The plant is situated on a hilly, 15-acre tract and is graded on several different levels. The site is bounded by a public road (Wallace Road) on the north, by residential property on the west, by farmland on the south, and by Synthoil, another DOE Plant, on the east.

CONTRACTOR STAGING AREA

At present, the Synthane site is not large enough to include a contractor staging area and a contractor parking area. For the purpose of the study design only, it is assumed that an adjacent DOE site could be used for staging and parking.

EMPLOYEE PARKING

The parking area, as shown on the New Plant Layout, is not large enough to accommodate parking for the present Synthane staff. As with the Contractor Staging Area, it is assumed that adequate land can be made available to satisfy all future parking needs.

EQUIPMENT SPACING

The spacing of equipment follows ER&E's recommended spacing requirements as much as possible. However, because the Synthane site has limited available land for new facilities, some spacing requirements could not be met. All of these areas have been carefully assessed and judged acceptable.

Since the new LNG storage tank is located on a terraced portion of land above the process area, it is necessary to provide a reinforced concrete dike capable of retaining the entire tank volume.

PIPEWAYS

The layout illustrates only major pipebands. Pipeways within the process block and at road crossings shall be elevated.

ROADS

Roads and accessways are shown in Figure II-N-2. Accessways within the process block are covered in the onsite study design layout.

All site access roads shall be 20 feet wide. Onsite access roads, and off-road loading and unloading areas shall be asphalt paved.

Accessways shall be 12 feet wide and shall be of crushed stone construction.

PAVING AND SURFACING

Paving and surfacing for existing, reused Synthane facilities will not be changed. For land areas requiring new development, the following standards should be followed:

1. 4 inches of crushed stone or gravel (1-1/2" maximum size) for:

    - Utility Block
    - Waste treatment area
    - Substations areas
    - Under pipeways
    - Cooling tower area
    - Catalyst storage area

2. Concrete for:

    - Chemical storage area
    - Process block
    - Coal preparation area

SECURITY FENCING AND LIGHTING

The Synthane plant is presently fenced in, as shown in Figure II-N-1. Additional fencing and gates shall be provided as required to enclose the entire Revamp site, as shown in Figure II-N-2.

Security lighting shall be provided in the expansion areas.

BUILDINGS

The following existing Synthane buildings will be reused without modification:

- Gatehouse
- Administration Building
- Filter Building

The following existing Synthane buildings shall be relocated as shown on the layout drawings:

- Shop
- Garage
- Warehouse

The following new buildings are required:

- Utilities Building - To house boilers, boiler feed water treating and air compression facilities. Reuse of the existing utilities building or portion thereof shall be considered if practical. A new utilities control room shall be provided.

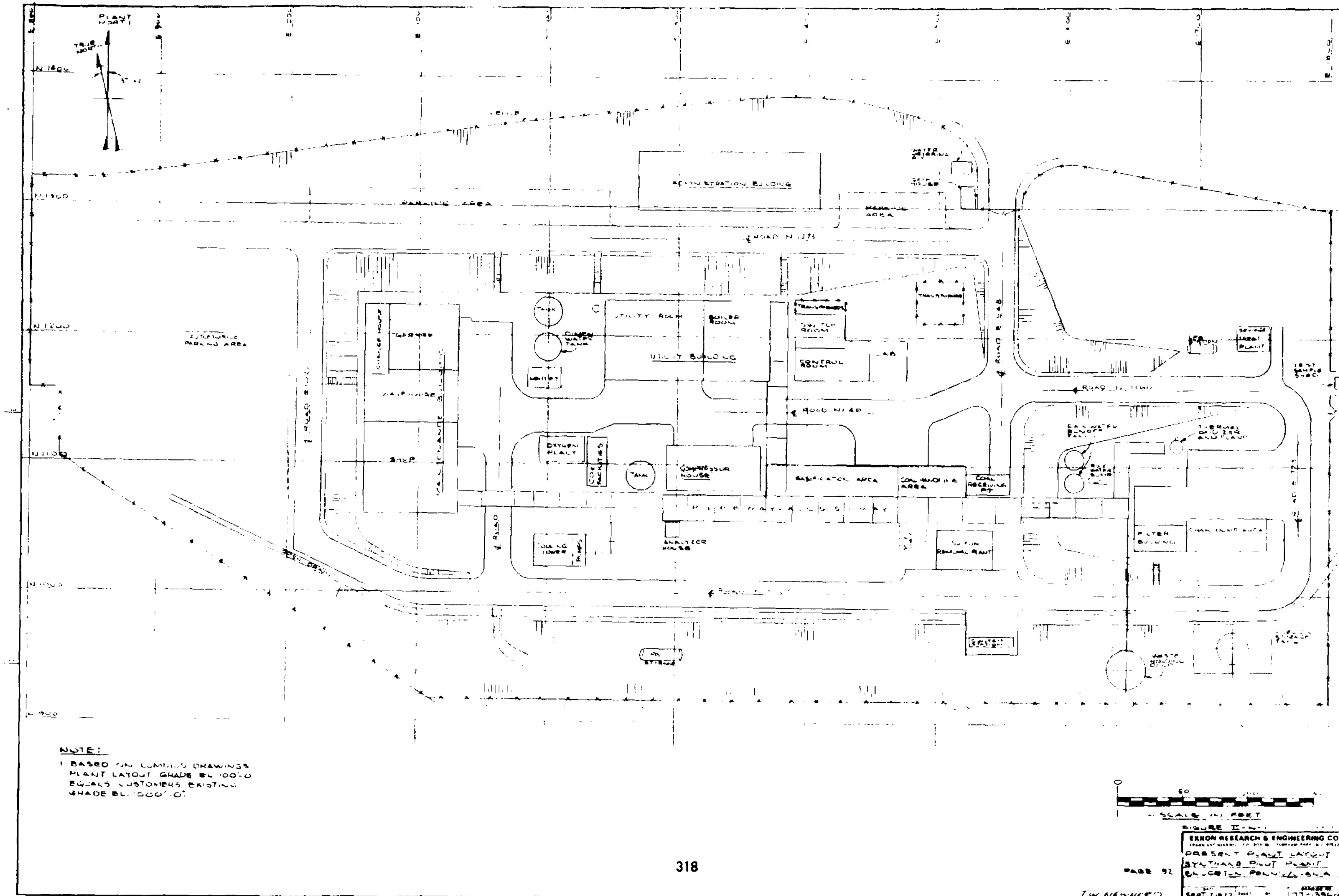
- Inert Gas Generation Building

The existing building housing the main control room, laboratory and electrical switch room shall be modified as follows:

- Provide air conditioning.
- Provide pressurization with air intake 40 ft. above roof.
- Replace existing glass partitions and windows with safety glass.
- Block off doorway between laboratory and control room and provide separate outside entrance to laboratory.

MOBILE EQUIPMENT

For the purposes of this study design, it is assumed that existing Synthane mobile equipment is adequate to cover the needs of the revamped facility.



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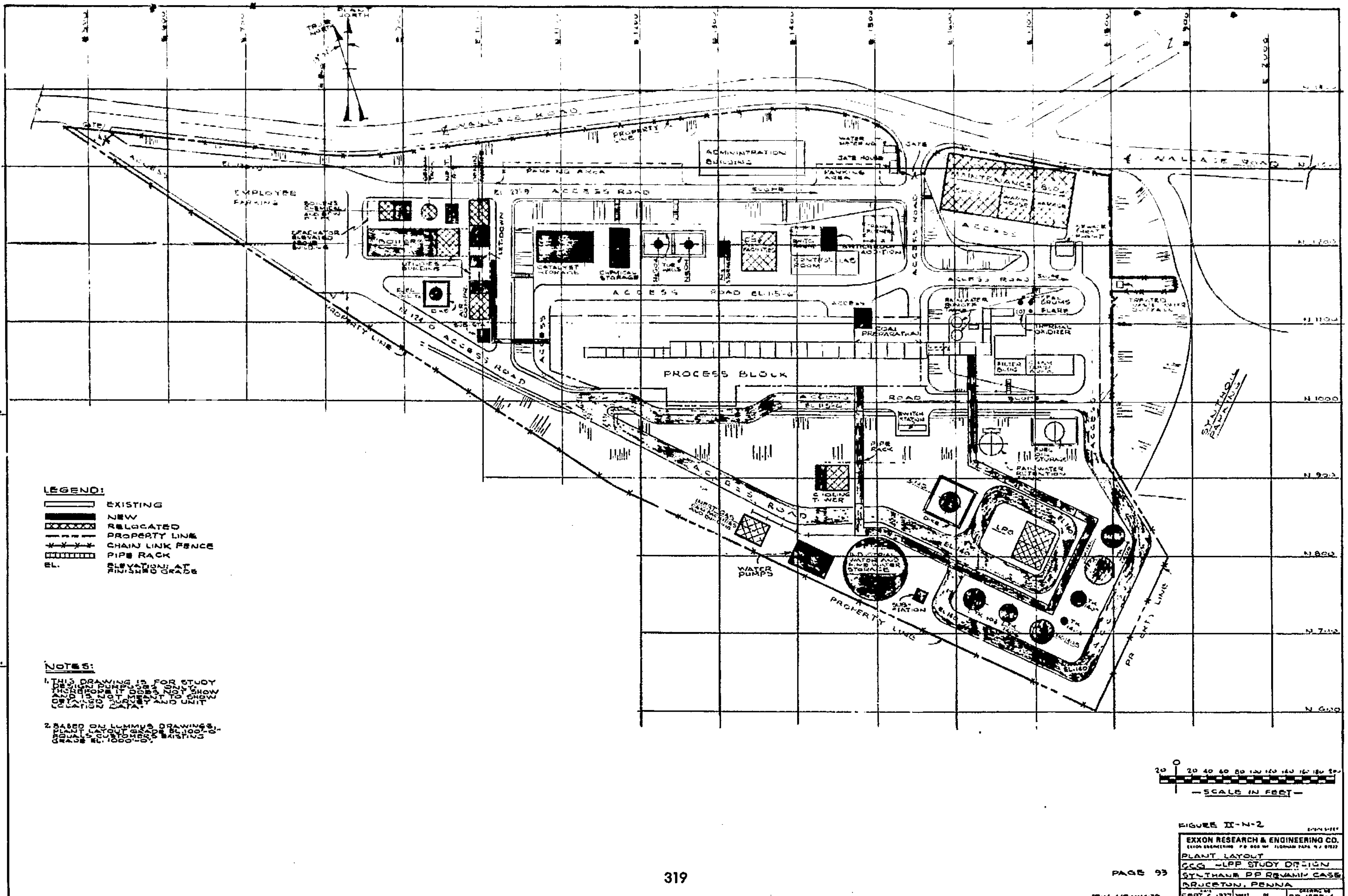

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