SECTION 6

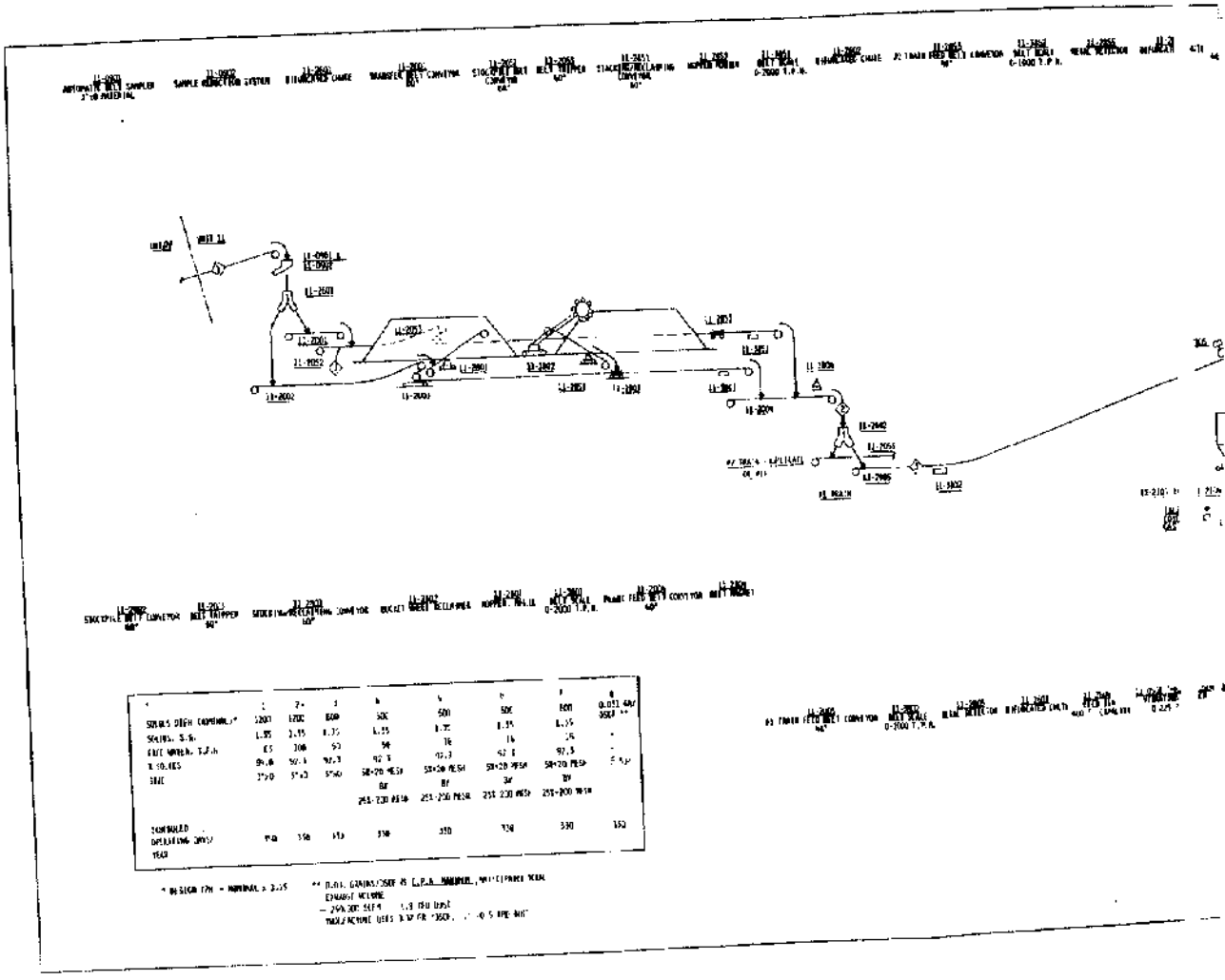
PROCESS FLOW DIAGRAMS

The flow diagrams for the units described in Section 5 are shown on the drawings contained in this section. A list of these drawings appears on page 5-1 in Section 5.

These drawings show the process flow, material balances, and characteristics of the major process equipment. Also shown are the control instruments critical for the process.

The flow diagrams for proprietary processes are shown in a simplified form and contain only the material balances in and out of the units.

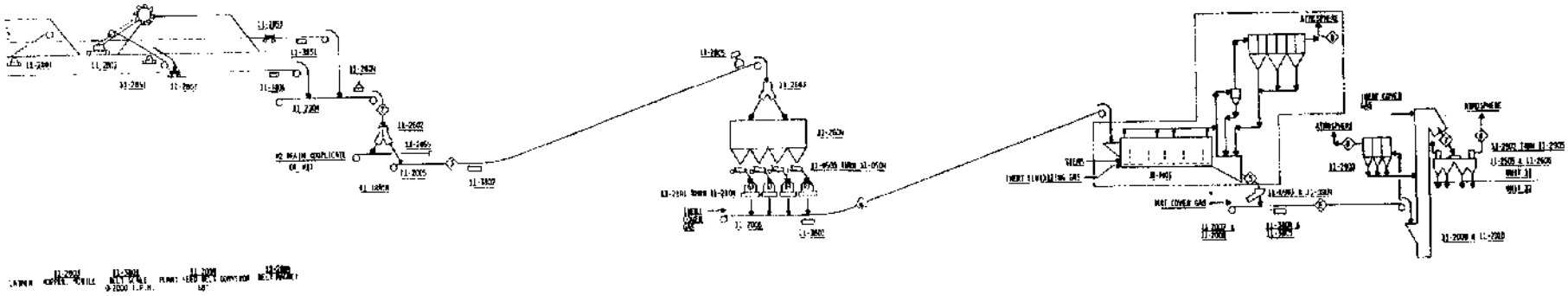
6-2 C



SOLIDS DISCH CAPACITY*	1200	1200	800	500	500	500	800	0.053 GAL/ 100F **
SOLIDS, S.G.	1.35	1.35	1.35	1.35	1.35	1.35	1.35	-
FEED WATER, T.P.H.	65	300	53	50	78	76	35	-
% SOLIDS	94.8	80.1	92.3	92.5	85.3	62.5	97.5	5 %V
SIZE	3"x0	5"x0	5"x0	50+20 MESH	50+20 MESH	50+20 MESH	50+20 MESH	
				0#	0#	3#	3#	
				25%-230 MESH	25%-230 MESH	25% 230 MESH	25%-200 MESH	
NOMINAL OPERATING CAPACITY TPH	950	350	150	350	350	350	350	350

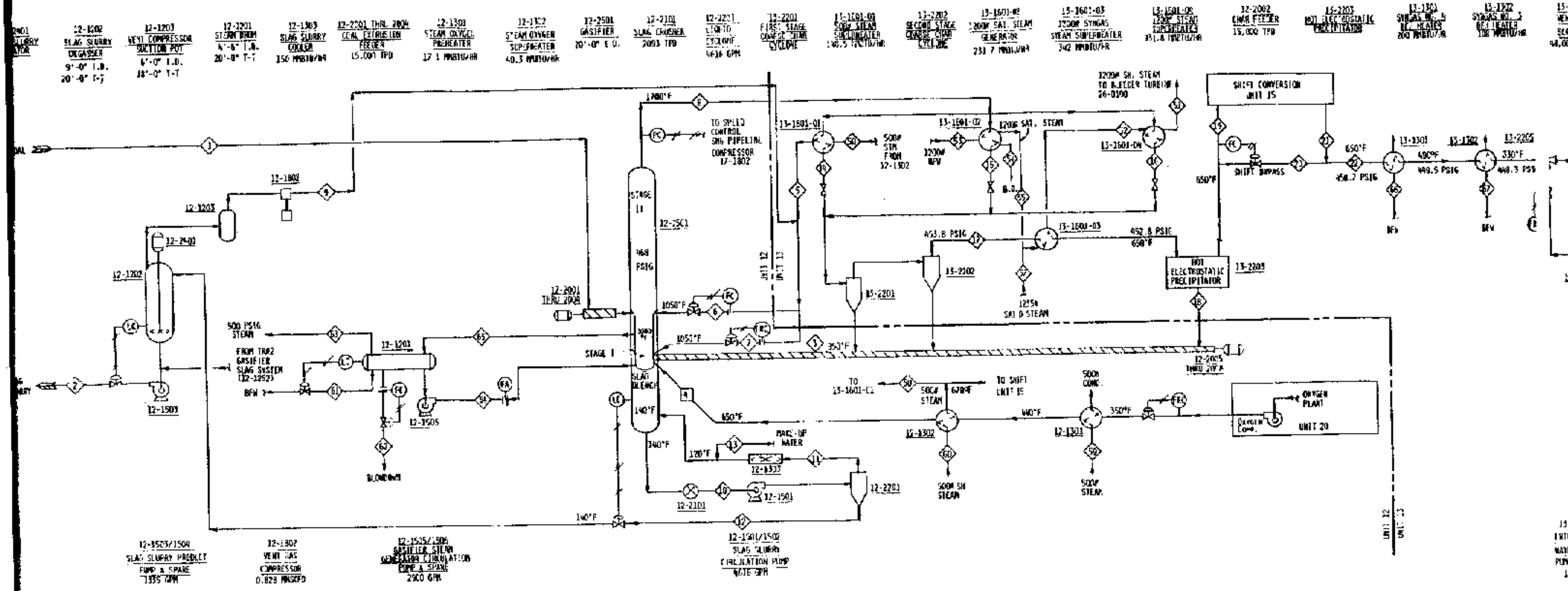
* DESIGN TPH = NOMINAL x 1.15

** 0.053 GAL/100F IS C.P.S. MAXIMUM, WITH REFERENCE TO EXHAUST MOISTURE
— 20% 30F SAT'N 1.0 LBS H2O
MOISTURE USES 1 MP FOR 350F, 10.5 PPE-MIT



	A	F	B
	409	420	0.931 GAV
	1.55	1.55	
	18	16	-
	97.3	97.3	-
MESH	54x20 MESH	59x20 MESH	≤ 5 P.
	BY	BY	
MESH	253-200 MESH	253-200 MESH	
	350	350	350

6-3 C



STREAM NO.	1	2	3	4	5	6	7	8	9	10	11	12	13
DESCRIPTION	COAL FEED	SLAG SLURRY	CHAR RECYCLE	OXYGEN	STEAM TO GASIFIER	STAGE II STEAM	STAGE I STEAM	SYN GAS AND CHAR	VENT GAS SEE NOTE 2	QUENCHED SLAG	SLAG WATER RECYCLE	SLAG SLURRY WITH VENT GAS	SLURRY MAKE-UP WATER
Flow, MPH													
H_2	-	-	-	-	-	-	-	48,642	1	8	7	1	-
CO	-	-	-	-	-	-	-	57,038	-	[illegible]	15	-	-
CO_2	-	-	-	-	-	-	-	13,352	30	233	237	30	-
CH_4	-	-	-	-	-	-	-	2,401	-	-	-	-	-
H_2S	-	-	-	-	-	-	-	1,206	-	-	-	-	-
N_2	-	-	-	105	-	-	-	578	-	-	-	-	-
O_2	-	-	-	24,482	-	-	-	-	-	-	-	-	-
H_2O	1,833	22,600	-	-	39,733	22,613	11,920	15,746	9	89,309	38,300	11,309	11,309
NH_3	-	-	-	-	-	-	-	33	-	-	-	-	-
COS	-	-	-	-	-	-	-	37	-	-	-	-	-
SO_2	-	-	-	-	-	-	-	1	-	-	-	-	-
Solids: Ash (TPD)	1,010	1,640	-	-	-	-	-	-	-	1,355	185	1,010	-
Char (TPD)	-	212	14,990	-	-	-	-	14,800	-	-	-	166	-
MAF Coal (TPD)	13,526	-	-	-	-	-	-	-	-	-	-	-	-
Flow Total, MPH	-	-	-	25,457	39,733	22,213	11,920	139,992	48	89,591	38,249	11,345	11,309
Flow Total, Lb/Hr	1,250,000	693,162	1,250,000	819,537	715,824	401,528	214,240	1,990,592	1,620	1,776,619	1,430,999	303,573	203,743
M.W.	-	-	-	32.19	18.0	18.0	18.0	19.2	36.0	18.1	18.1	[illegible]	18.0
MMSCFD	-	-	-	3.161	0.251	4.136	0.01	0.88	0.0001	-	-	-	-
Temperature, °F	200	140	950	653	1050	1250	1050	1,700	250	310	140	140	140
Pressure, PSIG	0	-	473	473	470	470	473	468	428	458	493	483	-

STREAM NO.	14	15	16	17	18	19	20	21	22	23	24	26
DESCRIPTION	RAW SYN GAS AND CHAR	RAW SYN GAS AND CHAR	RAW SYN GAS AND CHAR	RAW SYN GAS	CHAR FROM ELECTROSTATIC PRECIPITATOR	SYN GAS TO SHIFT UNIT	SHIFT BY-PASS	SHIFTED SYN GAS	SHIFTED & BY-PASS SYN GAS	SYN GAS HOT CONDENSATE	SYN GAS	SYN GAS COLD CONDENSATE
Flow, MPH												
H_2	5,866	8,618	34,536	48,247	-	18,933	13,209	26,933	62,542	-	62,542	-
CO	6,045	10,095	40,496	57,075	-	12,560	19,576	3,680	43,136	-	83,136	-
CO_2	1,569	2,163	9,481	13,151	-	4,130	9,255	17,064	27,214	-	22,252	-
CH_4	210	434	1,762	2,401	-	882	1,719	282	2,481	-	2,481	-
H_2S	116	226	914	1,288	-	305	493	395	1,288	19	1,288	19
N_2	11	123	694	579	-	300	478	300	378	-	378	-
O_2	-	-	-	-	-	-	-	-	-	-	-	-
H_2O	271	2,791	11,494	15,766	-	4,801	50,923	4,852	80,675	79,043	30,428	26,641
NH_3	1	5	33	15	-	-	15	4	19	19	19	19
COS	3	5	39	27	-	4	19	8	22	-	22	-
SO_2	-	-	1	1	-	-	-	-	5	-	3	-
Solids: Ash (TPD)	-	-	-	-	-	-	-	-	-	-	-	-
Char (TPD)	1,675	2,5[illegible]	10,850	351	49	0.6	1.4	0.8	2.0	2	-	2
MAF Coal (TPD)	-	-	-	-	-	-	-	-	-	-	-	-
Flow Total, MPH	15,724	24,708	98,111	139,553	-	42,859	96,725	61,565	158,681	29,128	156,314	26,681
Flow Total, Lb/Hr	440,153	615,215	2,340,720	2,304,847	34,444	833,049	1,867,786	1,165,888	3,027,286	534,221	2,944,959	480,925
M.W.	19.2	19.2	9.2	19.2	-	19.2	19.2	18.8	19.1	18.0	19.[illegible]	18.0
MMSCFD	0.9	0.355	0.677	0.88	-	0.513	3.881	0.398	0.971	-	9.986	-
Temperature, °F	850	953	953	950	450	653	650	650	650	280	384	136
Pressure, PSIG	467	467	467	454	452	452	452	451	451	445	445	430

6-4

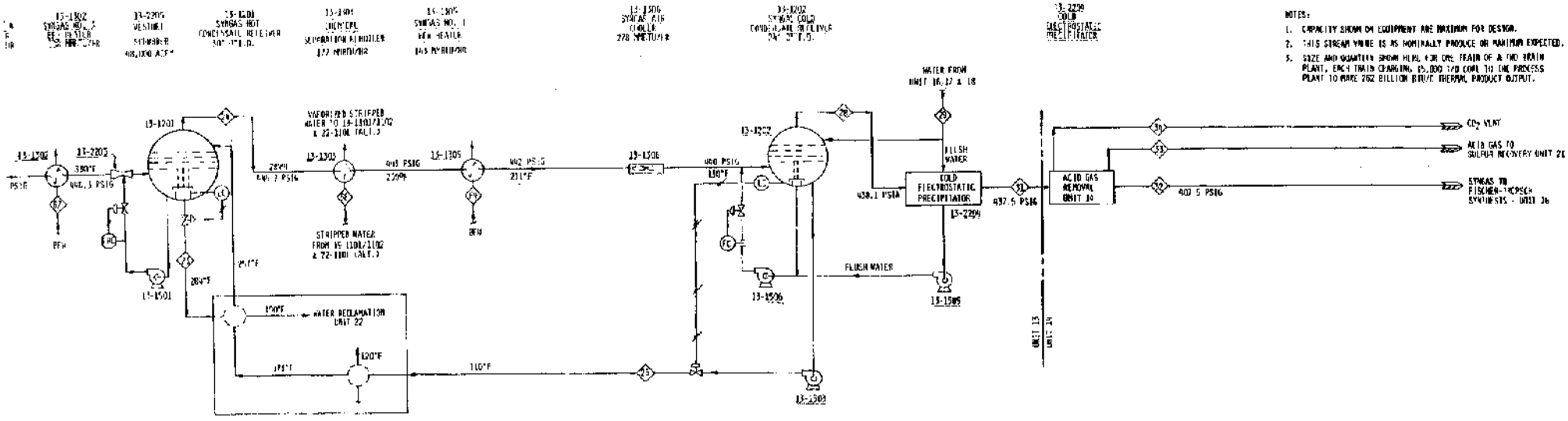
A

6-4

B

6-4

C



ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION (ERDA-FE) U.S.A. FISCHER-TROPSCH PLANT PROCESS FLOW DIAGRAM PROCESS GASIFICATION UNIT 12 HEAT RECOVERY AND GAS CLEANING UNIT 13 AND ACID GAS REMOVAL UNIT 14		
	5435-3	R-12-13-14-FS-1

13-1501/1502
VENTURI SCRUBBER WATER RETRIEVER PUMP & SPARE
1150 GPM

13-1506/1507
COLD WASH WATER RECIRCULATION PUMP & SPARE
1850 GPM

13-1503/1504
SYNGAS SEPARATOR RECYCLE PUMP & SPARE
1600 GPM

13-1505
COLD ELECTROSTATIC PRECIPITATOR FLUSHING PUMP
55 GPM

FOR EQUIPMENT DESIGN

STREAM NO. SEE NOTE 1	26	27	31	32	33	34	35
DESCRIPTION	SYN GAS TO ACID REMOVAL	WATER FROM 13-1202	DRY FEED SYN GAS (DRY, 100 = 500 mol)	SWEET SYN GAS	ACID GAS TO UNIT 21 SEE NOTE 2	CO_2 VENT SEE NOTE 2	
Flows (lb/hr)							
H_2O (liquid)			58,947	67,485	-	LO	
H_2O (vapor)			13,336	42,767	6,435	256 ppm	
Solids (lb/hr)			27,133	[illegible]		21,230	
Total (lb/hr)			2,481	2,306	-	35	
	19		1,219	[illegible]	1,258	5,999	
			916	955	33	-	
	16,681		500	188	127	185	
	59		-	-	-	-	
			77	-	77	-	
			3	-	3	-	
			-	-	-	-	
			-	-	-	-	
	24,400	138,188	338,188	189,731	8,866	21,863	
	466,971	2,615,994	P 655,008	1,438,369	201,186	960,583	
	-	-	19.3	13.5	43.3	83.7	
	-	-	0.871	0.411	0.069	0.339	
	819	15	438	404	90	90	
	418	64					

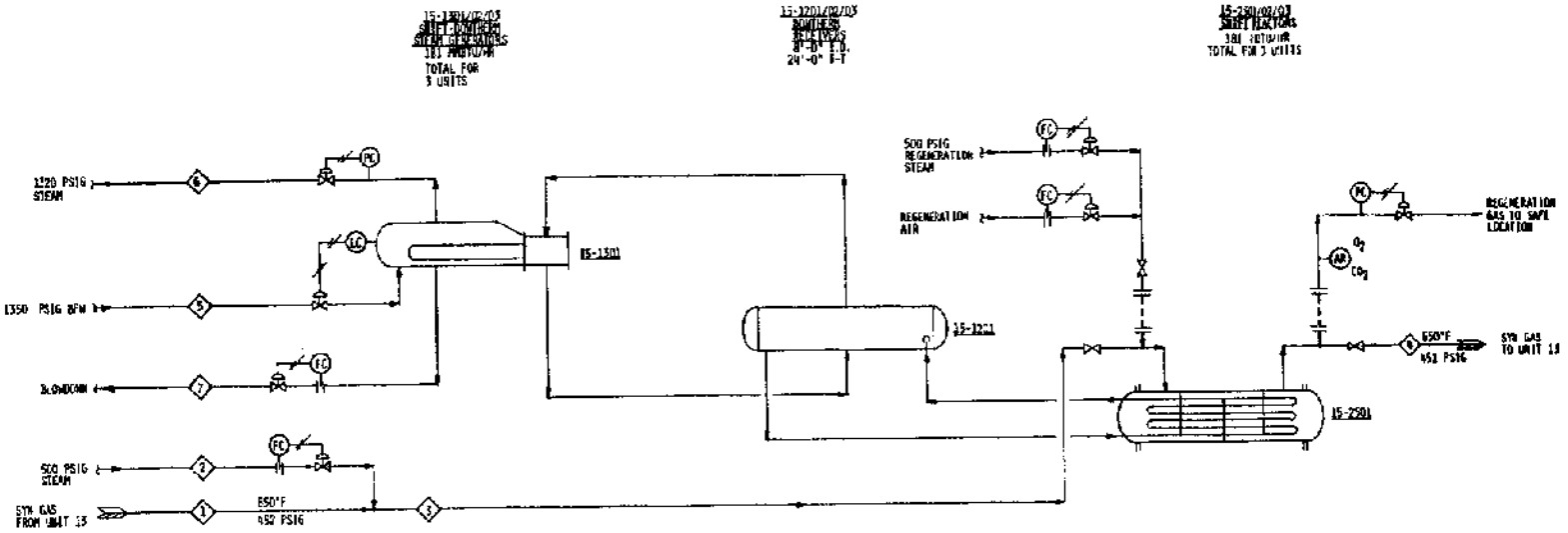
STREAM NO. SEE NOTE 1	40	41	42	43	44	45	47	48
DESCRIPTION	500# S.H. STEAM (TO 13-1401)	1200# S.H. STEAM	1200# S.H. STEAM (TO 33-1401-01)	1200# BFW (FR 13-1401-01)	1200# B.D. (FROM 13-1401-01)	1200# SAT. STEAM (FROM 13-1401-02)	1200# SAT. STEAM (FROM UNITS 15,16,17)	500# SAT. STEAM (TO 17-1301)
Flows (lb/hr)								
H_2O (liquid)	-	-	-	387,000	10,000	-	-	-
H_2O (vapor)	715,826	6,369,771	6,369,771	-	-	248,890	4,043,133	80,458
Solids (lb/hr)	-	-	-	-	-	-	-	-
Total (lb/hr)	715,826	6,369,723	6,369,723	387,000	10,000	236,850	4,043,133	80,458
Temperature (°F)	670	150	630	661	568	568	571	748
Pressure (PSIG)	495	1200	1195	1250	1200	1200	1235	500

STREAM NO.	50	51	52	53	54	55	56	57	58	59
DESCRIPTION	500# S.H. STEAM (TO 13-1202)	900# BFW (FR 13-1201)	500# B.D. (TO 13-1501)	GASIFIER 500# STEAM	GASIFIER HOT COOLING BFW	GASIFIER 900# STEAM & COND.	1200# BFW (TO 13-2201)	1200# BFW (TO 13-1502)	STRIPPED WATER FROM 13-1101/1102 & 22-1101 (ALT.)	1100# BFW (TO 13-1202)
Flows (lb/hr)										
H_2O (liquid)	-	138,950	3,450	-	3,315,600	1,315,600	4,515,378	4,293,023	860,000	3,000,000
H_2O (vapor)	873,248	-	-	135,000	-	-	-	-	-	-
Solids (lb/hr)	-	-	-	-	-	-	-	-	-	-
Total (lb/hr)	873,248	138,950	3,450	135,000	3,315,600	1,315,600	4,515,378	4,293,023	860,000	3,000,000
Temperature (°F)	740	-	420	420	169	-	469	498	540	184
Pressure (PSIG)	500	500	500	500	560	520	1250	1250	15	60

6-4 C

6-4 D

6-4 E



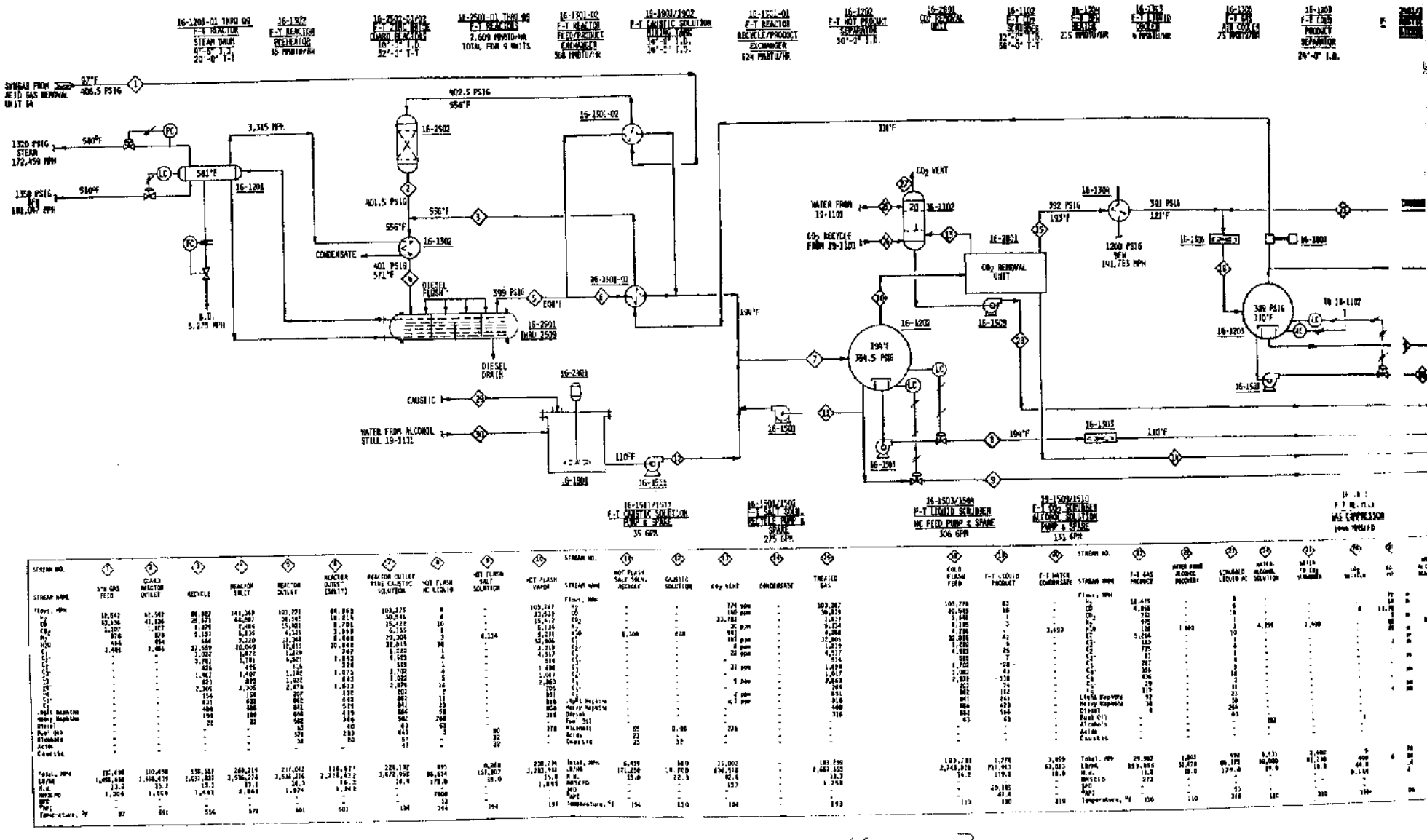
NOTES:

1. CAPACITIES SHOWN OR EQUIPMENT ARE MAXIMUM FOR DESIGN.
2. SIZE AND QUANTITY SHOWN HERE FOR ONE TRAIN OF A TWO TRAIN PLANT, EACH TRAIN CHARGING 35,000 T/D COAL TO THE PROCESS PLANT TO MAKE 262 MILLION BTU/D THERMAL PRODUCT OUTPUT.

STREAM NO.	1	2	3	4	5	6	7
STREAM NAME	SYN GAS	STEAM	SHIFT REACTOR FEED	SHIFTED SYN GAS	BFW	STEAM	BLOWDOWN
Flows, MPH							
H_2	14,933	-	14,933	28,433	-	-	-
CO	17,510	-	17,510	3,610	-	-	-
CO_2	4,100	-	4,100	17,989	-	-	-
CH_4	762	-	762	762	-	-	-
H_2S	395	-	395	395	-	-	-
N_2	800	-	800	800	-	-	-
O_2	-	-	-	-	-	-	-
H_2O	4,843	19,038	23,881	9,952	14,981	14,545	436
COS	6		6	6	-	-	-
NH_3	6		6	6	-	-	-
Cyd	0		0	0	-	-	-
SO_2	1		1	1	-	-	-
Char (TPH)	0.6		0.6	0.6	-	-	-
Total MPH	43,858	19,038	61,896	61,896	14,981	14,545	436
Total LB/HR	821,048	349,640	1,164,488	1,164,488	269,850	262,030	7,850
P.S.I.	18.2	18.0	18.6	18.0	18.0	18.0	18.0
MOLE%	0.270	0.350	0.238	0.321	-	0.027	-
Temperature, °F	650	80F	650	650	540	596	590

ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION (ERDA-FE)
U.S.A., FISCHER-TROPSCH PLANT
PROCESS FLOW DIAGRAM
SHIFT CONVERSION UNIT 15

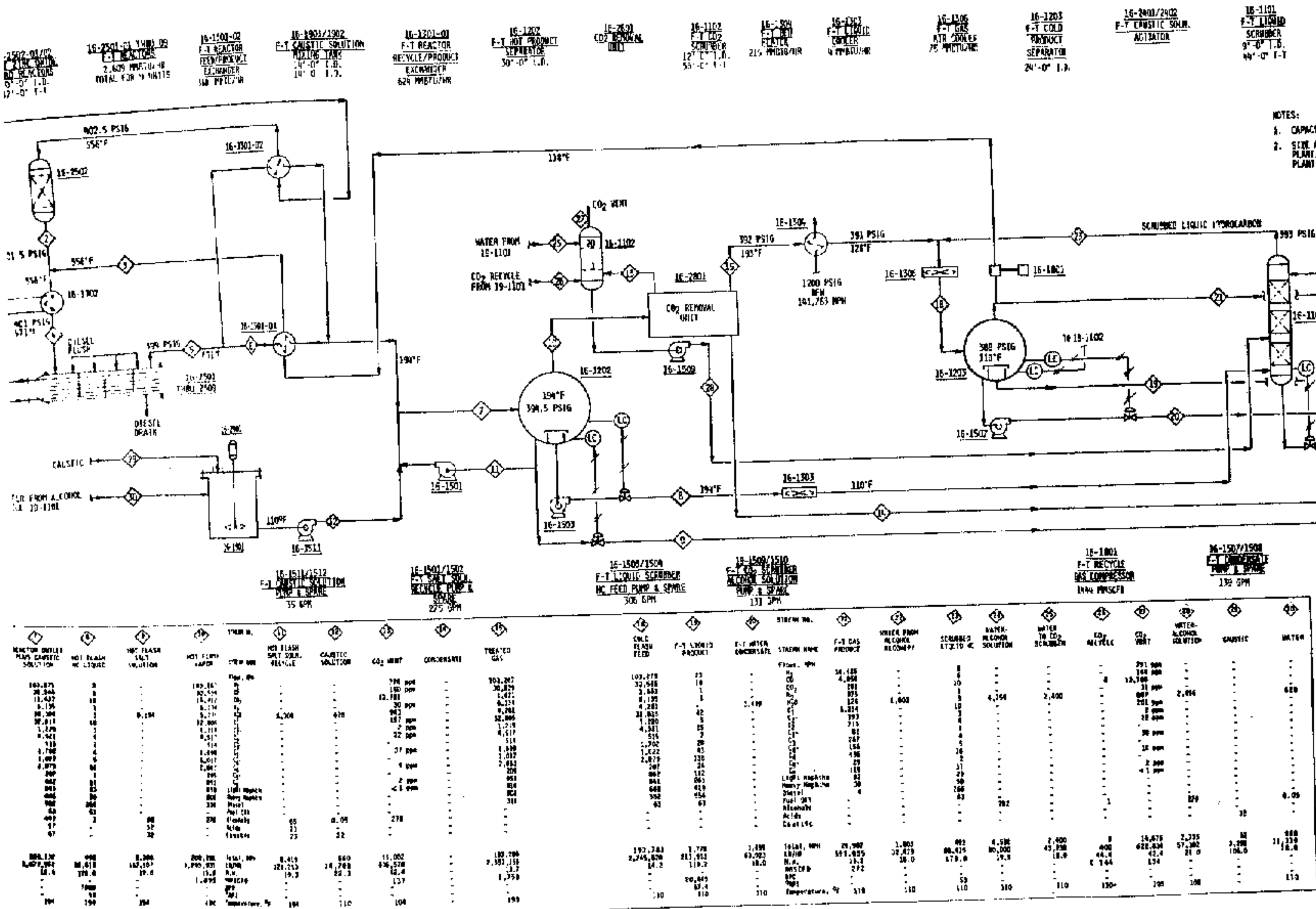
	JOB NO.	DWG NO.	REV.
	5435-3	A-15-FS-1	D



STREAM NO.	1	2	3	4	5	6	7	8	9
STREAM NAME	SYN GAS FEED	GAS/L REACTOR OUTLET	RECYCLE	REACTOR INLET	REACTOR OUTLET	REACTOR OUTLET (SPLIT)	REACTOR OUTLET SYNS CAUSTIC SOLUTION	HOT FLASH HC LIQUID	HOT FLASH SALT SOLUTION
Flow, MPH									
H2	18,642	61,542	86,882	141,369	103,291	68,861	103,375	0	-
CO	63,136	41,136	44,007	36,191	18,218	18,218	30,845	4	-
CO2	1,107	1,107	1,479	5,484	8,791	5,861	15,422	16	-
N2	876	876	2,153	3,129	4,335	3,059	6,135	1	-
H2O	464	464	3,220	3,220	18,268	8,698	29,304	3	6,134
HC	2,486	2,486	82,569	82,569	82,815	39,868	38,015	98	-
C1			1,002	1,002	6,822		1,525	1	-
C2			5,782	5,781	6,621		1,852	4	-
C3			836	836	836		588	1	-
C4			1,967	1,967	1,168		1,035	4	-
C5			893	893	1,022		1,022	5	-
C6			2,305	2,305	2,479		1,613	16	-
C7			154	154	207		430	7	-
C8			831	831	888		548	11	-
C9			684	684	841		841	33	-
Light Naphtha			684	684	684		436	58	-
Heavy Naphtha			1,098	1,098	1,098		886	208	-
Diesel			32	32	968		346	208	-
Fuel Oil					63		40	63	-
Alcohols					571		283	445	3
Acids					30		57	5	32
Caustic								32	32
Total, MPH	86,698	110,458	138,587	288,215	237,062	126,527	208,132	895	6,268
LB/HR	1,488,698	1,488,698	1,639,887	3,596,376	3,596,376	2,338,492	3,672,958	86,614	157,807
M.W.	17.2	13.5	11.8	12.5	15.2	18.5	17.6	97.0	25.2
MMSCFD	1,209	1,209	1,441	3,048	1,974	1,048	-	778.0	-
BPD	-	-	-	-	-	-	-	-	7908
API	-	-	-	-	-	-	-	-	32
Temperature, °F	97	551	554	578	601	601	194	194	194

STREAM NO.	10	11	12	13	14	15
STREAM NAME	HOT FLASH SALT SOLN. RECYCLE	CAUSTIC SOLUTION	CO_2 VENT	CONDENSATE	TREATED GAS
Flow, MPH					
H2	-	-	774 MPH	-	103,267
CO	-	-	102 MPH	-	30,839
CO2	-	-	33,782	-	1,653
N2	-	-	30 MPH	-	1,824
H2O	6,100	828	981	-	4,264
HC	-	-	183 MPH	-	15,905
C1	-	-	4 MPH	-	1,219
C2	-	-	25 MPH	-	4,517
C3	-	-	-	-	514
C4	-	-	32 MPH	-	1,498
C5	-	-	-	-	1,017
C6	-	-	4 MPH	-	2,863
C7	-	-	-	-	965
C8	-	-	4 MPH	-	851
C9	-	-	4.3 MPH	-	816
Light Naphtha	-	-	-	-	648
Heavy Naphtha	-	-	-	-	316
Diesel	-	-	-	-	-
Fuel Oil	-	-	-	-	-
Alcohols	88	0.05	778	-	-
Acids	33	-	-	-	-
Caustic	33	32	-	-	-
Total, MPH	6,419	940	35,002	-	183,298
LB/HR	171,256	18,800	836,578	-	2,681,153
M.W.	26.9	20.5	42.4	-	14.3
MMSCFD	-	-	157	-	1,358
BPD	-	-	-	-	-
API	-	-	-	-	-
Temperature, °F	194	110	104	-	193

STREAM NO.	16	17	18	19	20	21	22	23	24	25	26	27
STREAM NAME	COLD FLASH FEED	F-T LIQUID PRODUCT	F-T WATER CONDENSATE	STEAM MPH	F-T GAS PRODUCT	WATER WASH ALCOHOL RECOVERY	SCRUBBED LIQUID HC	WATER-ALCOHOL SOLUTION	WATER TO CO_2 SCRUBBER	LOW WATER	LOW
Flow, MPH												
H2	103,778	83	-		16,415	-	0	-	-	-	-	77
CO	30,845	16	-		4,958	-	16	-	-	-	0	11.96
CO2	1,646	1	-		761	-	-	-	-	-	-	-
N2	1,824	1	-		975	-	1	-	-	-	-	1
H2O	4,264	3	3,693		1,236	1,000	1	4,264	3,500	-	-	36
HC	4,264	-	-		1,236	-	19	-	-	-	-	-
C1	15,905	41	-		5,264	-	-	-	-	-	-	-
C2	1,219	6	-		183	-	1	-	-	-	-	-
C3	4,517	25	-		729	-	4	-	-	-	-	-
C4	514	7	-		81	-	1	-	-	-	-	-
C5	1,498	28	-		287	-	4	-	-	-	-	-
C6	1,017	43	-		356	-	10	-	-	-	-	-
C7	2,863	138	-		436	-	8	-	-	-	-	-
C8	965	74	-		29	-	3	-	-	-	-	-
C9	851	122	-		119	-	23	-	-	-	-	-
Light Naphtha	816	228	-		92	-	58	-	-	-	-	-
Heavy Naphtha	648	428	-		38	-	208	-	-	-	-	-
Diesel	316	566	-		8	-	63	-	-	-	-	-
Fuel Oil	-	63	-		-	-	-	252	-	-	-	-
Alcohols	-	-	-		-	-	-	-	-	-	-	-
Acids	-	-	-		-	-	-	-	-	-	-	-
Caustic	-	-	-		-	-	-	-	-	-	-	-
Total, MPH	183,298	1,778	3,959		29,967	1,001	422	4,433	3,500	6	0	126
LB/HR	2,549,878	231,963	63,883		389,855	32,470	49,195	90,000	63,000	108	0	4,536
M.W.	14.3	119.9	18.8		13.8	18.0	129.0	19.9	18.0	18.0	44.0	36.0
MMSCFD	-	-	-		272	-	-	-	-	-	-	-
BPD	-	40,185	-		-	-	93	-	-	-	-	-
API	-	47.4	-		-	-	318	-	-	-	-	-
Temperature, °F	110	130	310		110	110	318	110	310	110+	110	96



NOTES:

1. CAPACITIES SHOWN ON EQUIPMENT ARE MAXIMUM FOR DESIGN.
2. SIZE AND QUANTITY SHOWN HERE FOR ONE TRAIN OF A TWO TRAIN PLANT. EACH TRAIN CHARGING 15,000 T/D COAL TO THE PROCESS PLANT TO MAKE 262 BILLION BTU/D THERMAL PRODUCT OUTPUT.

ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION (ERDA-FE)
U.S.A. FISCHER-TROPSCH PLANT
PROCESS FLOW DIAGRAM
FISCHER-TROPSCH SYNTHESIS UNIT 16

JOB NO.	DWG NO.	REV
5435-3	4-16-FS-1	0

6-6

17-1310
CO/CO_2
EVAPORATOR
8 MMBTU/HR

17-2502
FINAL
METHANATION
REACTOR
10'-0" I.D.
32'-0" T-T

17-1306
FINAL METHANATION
REACTOR FEED/SNG
EXCHANGER
60 MMBTU/HR

17-1307
FINAL METHANATION
START-UP HEATER
DESIGN 14 MMBTU/HR

17-1303
SNG PIPELINE
COMPRESSOR
SUCTION COOLER
14 MMBTU/HR

17-1205
SNG PIPELINE
COMPRESSOR SUCTION
RECEIVER
6'-0" I.D.
18'-0" T-T

17-2503
HYDROMETHANATION
REACTOR
12'-0" I.D.
35'-6" T-T

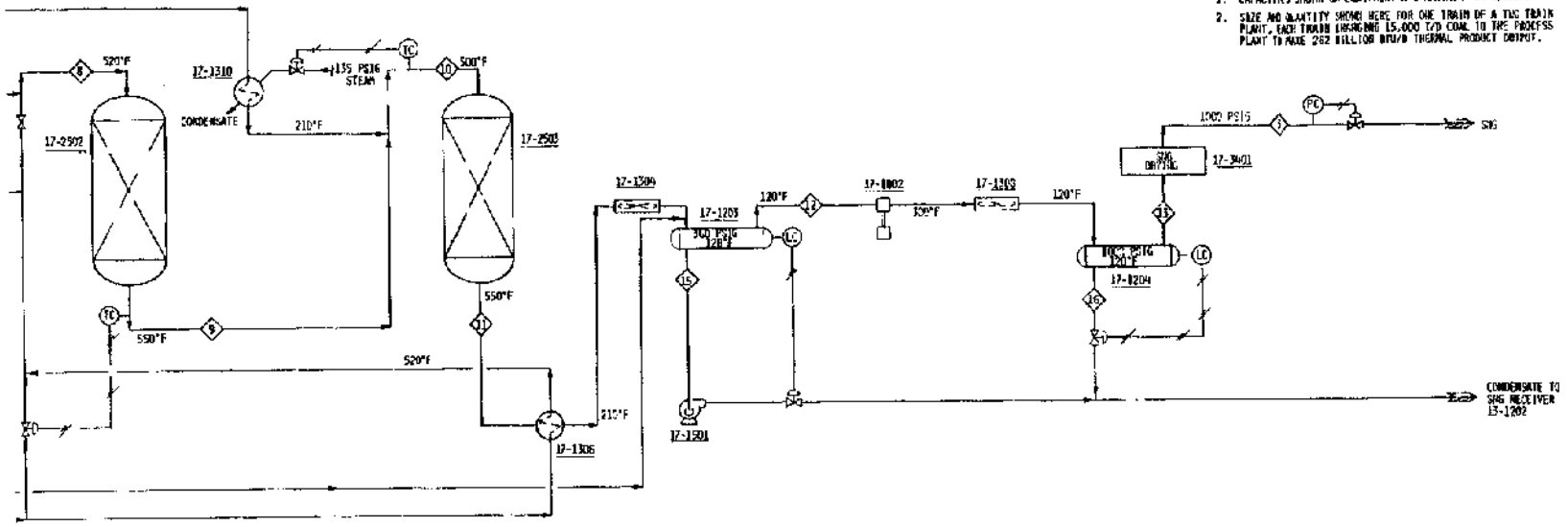
17-1302
SNG COOLER
30 MMBTU/HR

17-1224
FINAL METHANATION
RECEIVER
5'-0" I.D.
15'-0" T-T

17-3400
SNG DRYER

NOTES:

1. CAPACITIES SHOWN OR EQUIPMENT ARE MAXIMUM FOR DESIGN.
2. SIZE AND QUANTITY SHOWN HERE FOR ONE TRAIN OF A TWO TRAIN PLANT, EACH TRAIN GASIFYING 15,000 T/D COAL TO TWO PROCESS PLANT TO MAKE 282 BILLION BTU/D THERMAL PRODUCT OUTPUT.



17-1501/1502
CONDENSATE
PUMP & SPARE
225 GPM

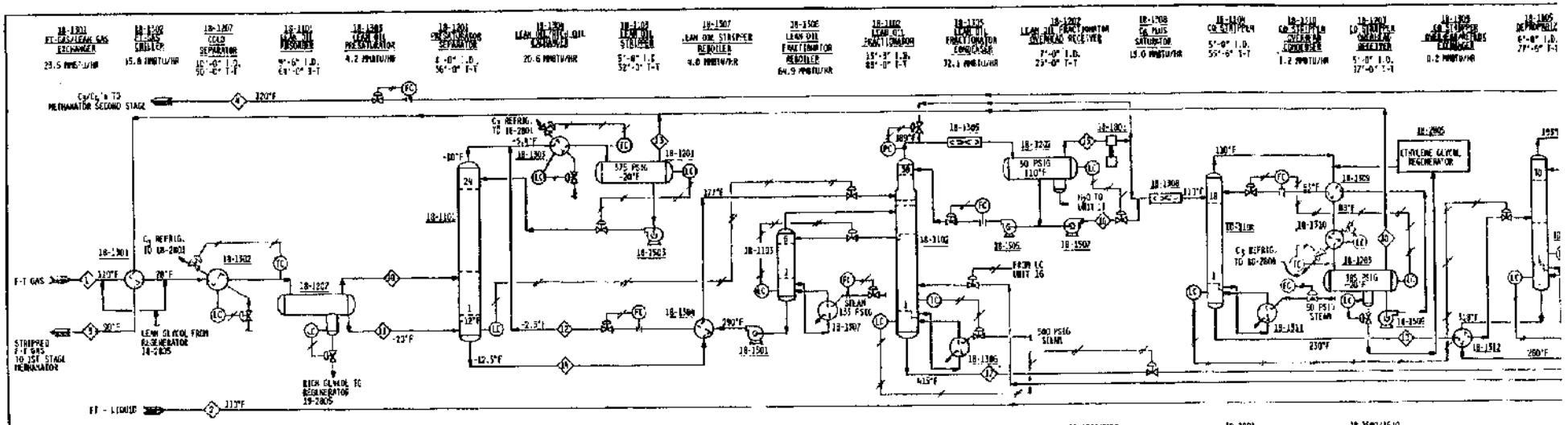
17-1802
SNG PIPELINE
COMPRESSOR
360 PSIG-1010 PSIG
132 MMSCFD

IND.	17	18	19	20
TRAM	MPS	L.O.	STEAM GENERATION	STEAM EXPORT
MPH	-	-	-	-
	-	-	-	-
	-	-	-	-
	36,188	1,052	35,854	33,633
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	-	-	-
Aqueous Naphtha	-	-	-	-
MPH	36,188	1,052	35,854	33,633
LB/HR	650,470	18,945	631,525	605,928
D	18,016	18,016	18,016	18,016
	-	-	319,272	306,349
	84,482	1,229	-	-
	10.	83.	-	-
PRESSURE PSI	510	580	500	480

ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION (ERDA-FE)
U.S.A. RUSCHER-FRIPSCH PLANT
PROCESS FLOW DIAGRAM
METHANATION UNIT 17

	JOB NO	DWG NO	REV
	5935-3	A-17-FS-1	0

69 C



STREAM NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	STREAM NO.	16	17	18	19	20
STREAM NAME	F-T GAS	F-T LIQUID	STRIPPED F-T GAS	C2/C3's TO METH 2ND ST	LEAN GLYCOL FROM REGEN	LEAN BUTANE PRODUCT	LEAN GASOLINE PRODUCT	BUTANE PRODUCT	GASOLINE PRODUCT	C2/C3 FLASH VAPOR	C2/C3 FLASH LIQUID	LEAN OIL	LEAN GAS	RICH OIL	LO TEMPT. RECYCLE VAPOR	STREAM NAME	LO TEMPT. OVERHEAD RECYCLE	LO TEMPT. BOTTOMS	STRIPPER OVERHEAD	STRIPPER BOTTOMS	STABILIZER FEED
Flow, MMSCFD																Flow, MMSCFD					
H_2																H_2					
CO_2																CO_2					
N_2																N_2					
C_1																C_1					
C_2																C_2					
C_3																C_3					
iC_4																iC_4					
nC_4																nC_4					
iC_5																iC_5					
nC_5																nC_5					
C_6																C_6					
C_7																C_7					
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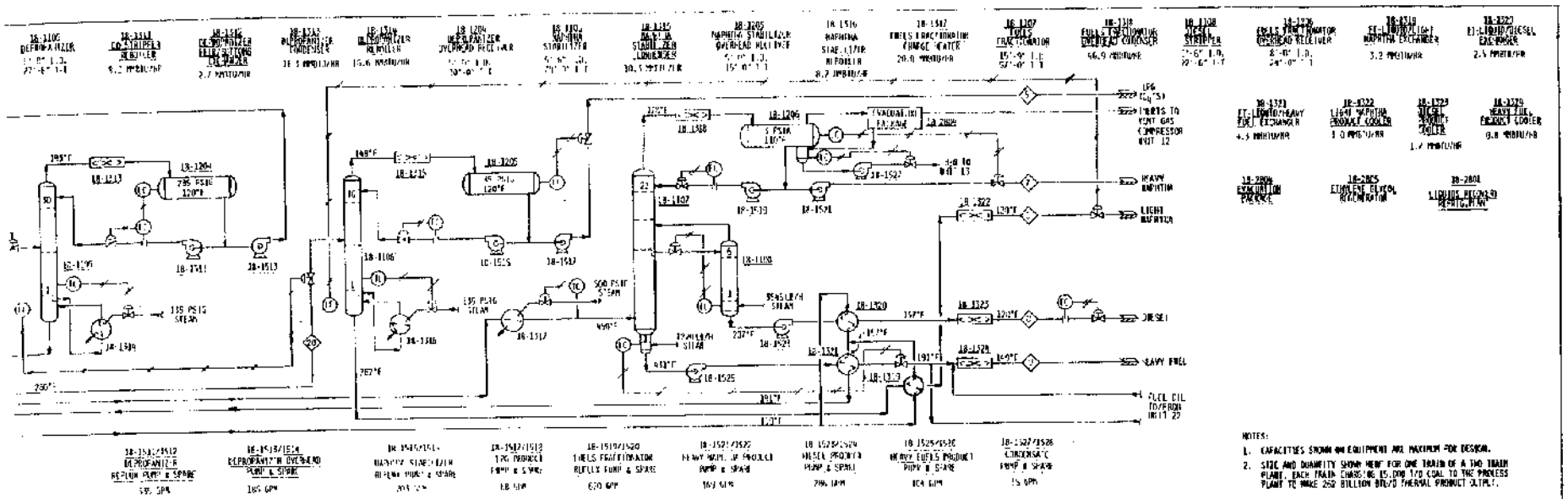
Total Mol	29,863	1,179	28,721	143	251	188	458	587	26,179	26,034	145	3,135	28,898	2,228	1,385	Total Mol	565	1,077	134	1,414	599
Total Lb/Hr	393,086	231,913	387,461	43,452	18,503	51,187	88,268	43,056	450,78	440,354	5,424	121,166	117,256	113,577	47,888	Total Lb/Hr	48,040	168,965	5,186	182,985	91,193
MW	13.16	196.68	13.49	86.61	94.99	204.26	192.64	73.38	17.24	16.93	37.19	38.68	4.06	51.18	34.58	MW	85.0	156.94	38.36	80.44	151.84
MMSCFD	293,159		288,673						258,119				268,853		13,538	MMSCFD			1,403		
API		46.6														API	71.3	35.5		82.6	7.4
Sp.Gr.		0.796		0.832	1.254	1.299	1.013	0.566	0.537		0.749	0.828		0.775		Sp.Gr.	0.83	0.847		0.868	1.014
Visc.		0.9		0.251	106.2	10.8	0.3	0.2	0.2		0.4	0.4		0.4		Visc.	0.3	1.5		0.4	10.1
Temperature °F	320	110	90	120	120	105	110	100	100	-24	-21	-23	-20	-12.5	100	Temperature °F	110	415	-20	414	260



NOTES:

1. CAPACITIES SHOWN ON EQUIPMENT ARE MAXIMUM FOR DESIGN.
2. SIZE AND QUANTITY SHOWN HERE FOR ONE TRAIN OF A TWO TRAIN PLANT. EACH TRAIN CHARGED 15,000 T/D COAL TO THE PROCESS PLANT TO MAKE 250 BILLION BTU/D THERMAL PRODUCT OUTPUT.

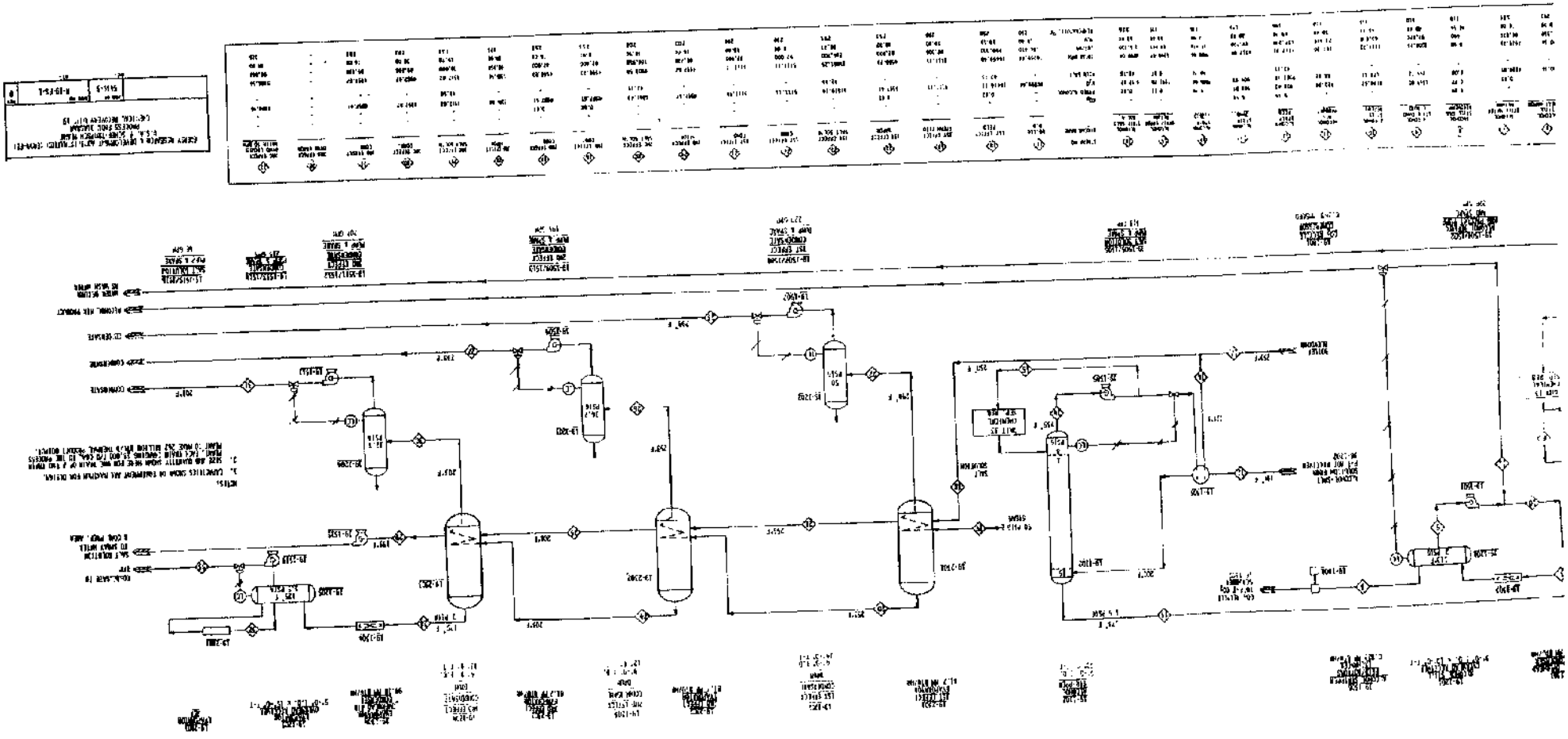
0	ISSUED FOR REPORT			

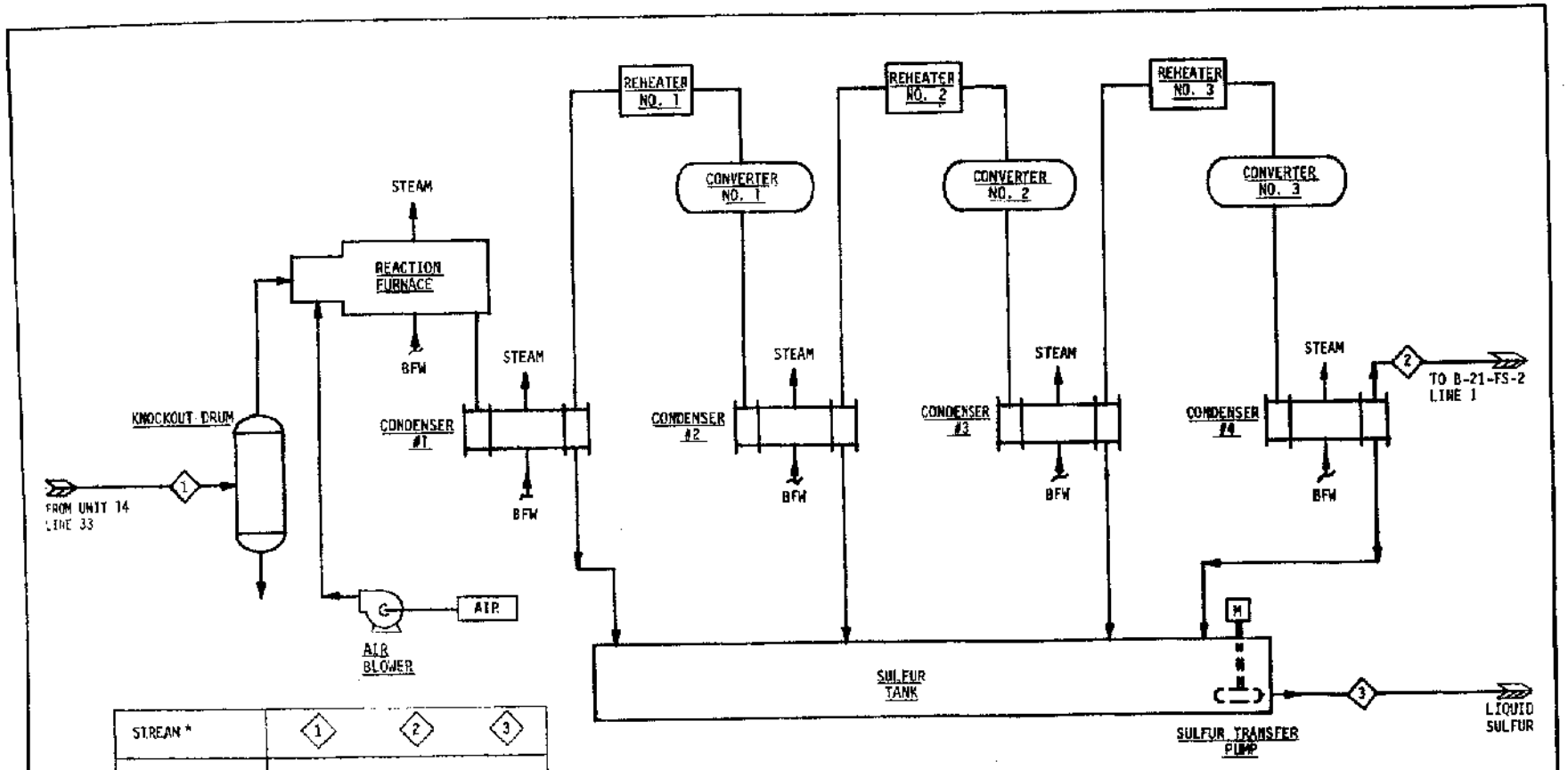
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION (ERDA-FE)
U.S.A. FISCHER-TROPSCH PLANT
PROCESS FLOW DIAGRAM
LIQUID PRODUCT RECOVERY UNIT 18

9435-3 | D-18-FS-8 | 0

6-8 D

6-8 E





STREAM *	1	2	3
FLUIDS, MOLS/HR.			
H_2S	2,005	71	
SO_2	---	35	
COS	27	--	
N_2	1	4,236	
H_2	10	--	
CO	68	--	
CO_2	4,941	5,173	
CH_4	34	--	
H_2O	249	2,557	
TOTAL LBS/HR	7,335	12,072	
	294,411	396,900	
SOLIDS, LBS/HR SULFUR			61,759

*FLOWS REPRESENT MAXIMUM FOR DESIGN PURPOSES AND DO NOT RELATE TO MATERIAL BALANCES ON OTHER FLOW DIAGRAMS

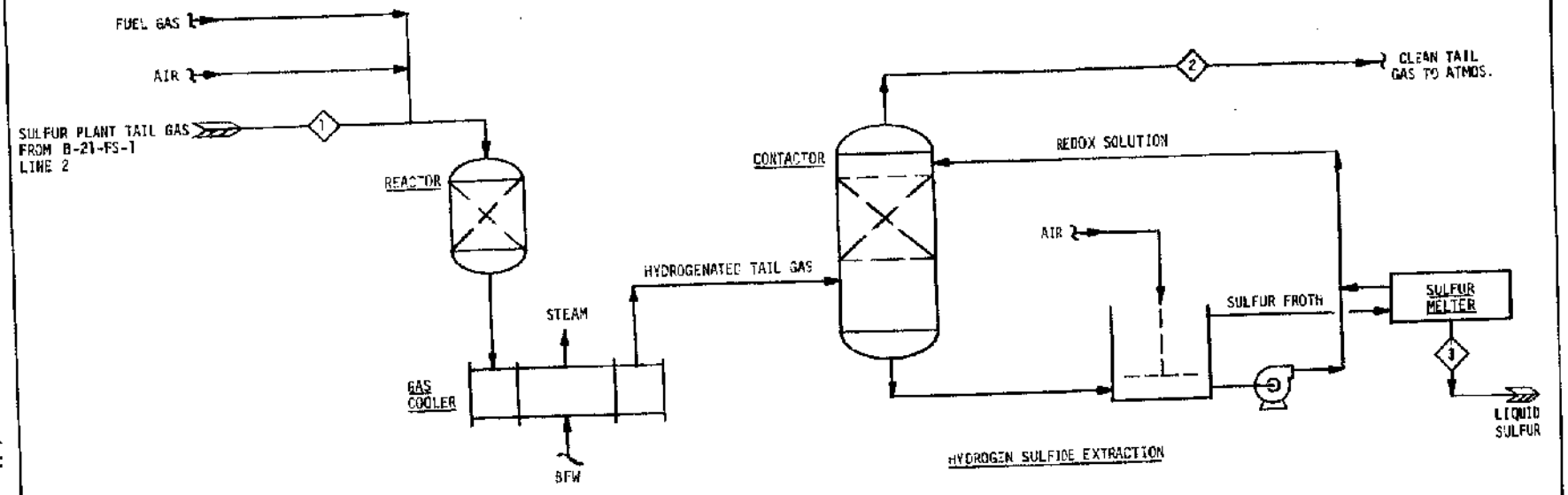
NO.	BY	DATE	REVISION
1			ISSUED FOR REPORT
0			PRELIMINARY ISSUE

ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION (ERDA-FE)
U.S.A. FISCHER-TROPSCH PLANT
PROCESS FLOW DIAGRAM
SULFUR RECOVERY (CLAUS UNIT) - UNIT 21

JOB NO. 5435-3 | DWG NO. B-21-FS-1 | REV 1

6-10 A

6-10 B



STREAM *	1	2	3
FLUIDS, MOLS/HR			
H_2S	71	(1 PPM)	
SO_2	35	-	
N_2	4236	5519	
CO_2	6173	5416	
H_2O	2557	765	
Total	12072	11690	
LBS/HR	396900	406550	
SOLIDS, LBS/HR			
SULFUR			3,398

*FLOWS REPRESENT MAXIMUM FOR DESIGN PURPOSES AND DO NOT RELATE TO MATERIAL BALANCES ON OTHER FLOW DIAGRAMS

NOTE: THIS PROCESS ILLUSTRATED IS ONE OF SEVERAL PROPRIETARY PROCESSES AVAILABLE FOR THE PURPOSE INTENDED.

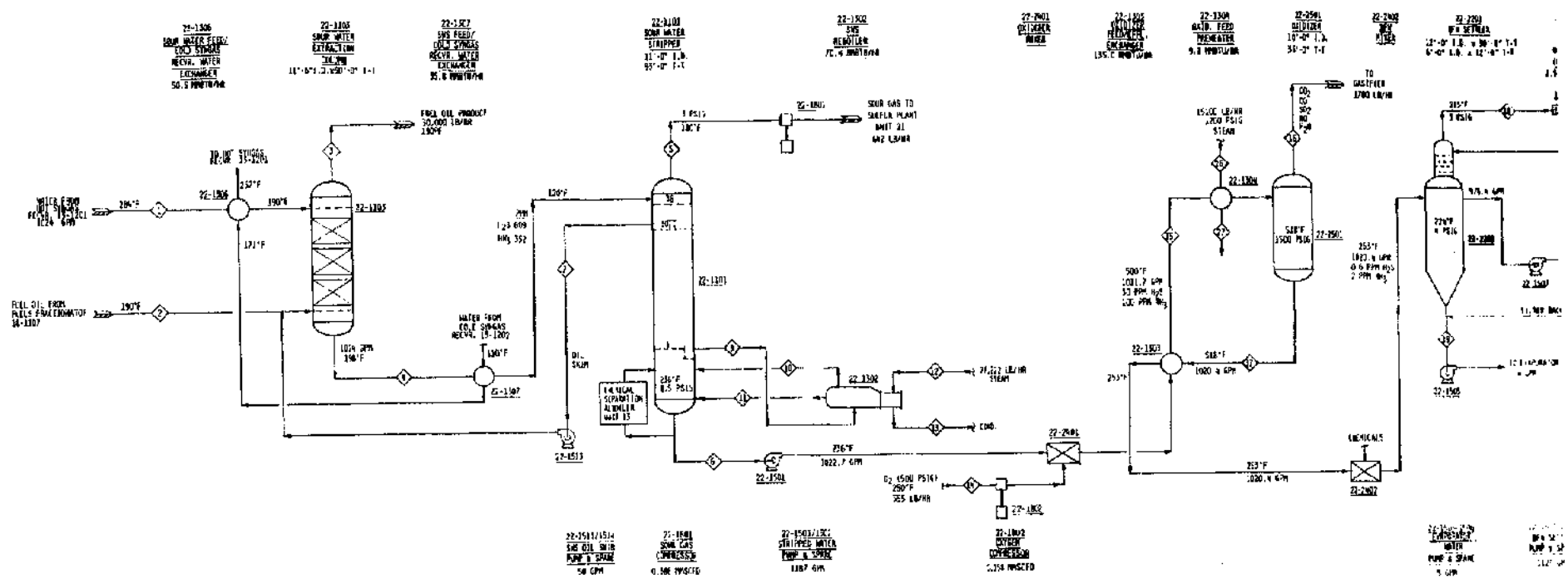
1	3/24/76	ISSUED FOR REPORT	RR	
0	3/29/76	PRELIMINARY ISSUE	RR	

ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION (ERDA-FE)
U.S.A. FISCHER-TROPSCH PLANT
PROCESS FLOW DIAGRAM
SULFUR RECOVERY (TAIL GAS UNIT)- UNIT 21

JOB NO. 5435-3 | DWG. NO. B-21-FS-2 | REV. 1

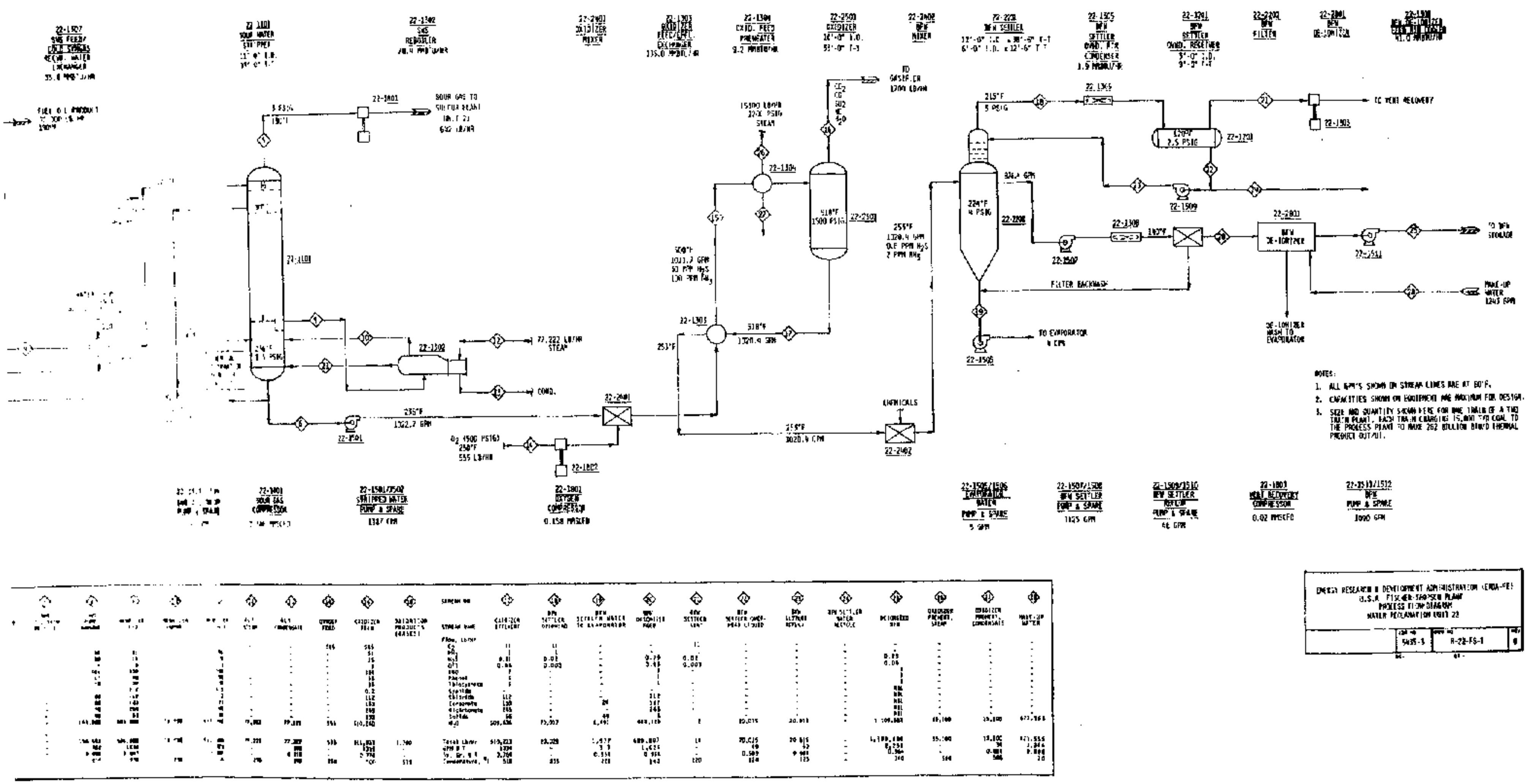
6-11

6-11 B



STREAM NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
STREAM NAME	SOUR WATER REACTOR WATER MIX	SOUR WATER TREATMENT OIL FEED	SOUR WATER REACTOR OIL PRODUCT	24" FEED	24" SOUR WATER	SOUR WATER STRIPPED WATER	24" OIL SEAL RECYCLE	24" SOUR AMMONIA	REBOILER FEED	REBOILER VAPOR	REBOILER CONDENSATE	24" STEAM	24" CONDENSATE	SOUR WATER FEED	OXIDIZER FEED
FLOW, LB/HR															
H2O	190	-	-	190	139	51	-	51	51	-	-	-	-	555	555
NH3	332	-	-	332	197	135	-	135	135	-	-	-	-	-	135
H2S	3	-	-	3	-	3	-	3	3	-	-	-	-	-	3
OIL	226	30,000	30,000	226	-	226	-	226	226	-	-	-	-	-	226
CO2	58	-	-	58	-	58	-	58	58	-	-	-	-	-	58
Phenol	36	-	-	36	-	36	-	36	36	-	-	-	-	-	36
Thiocyanate	0.3	-	-	0.3	-	0.3	-	0.3	0.3	-	-	-	-	-	0.3
Cyanide	0.3	-	-	0.3	-	0.3	-	0.3	0.3	-	-	-	-	-	0.3
Chloride	112	-	-	112	-	112	-	112	112	-	-	-	-	-	112
Carbonate	183	-	-	183	-	183	-	183	183	-	-	-	-	-	183
Bicarbonate	288	-	-	288	-	288	-	288	288	-	-	-	-	-	288
Sulfite	135	-	-	135	-	135	-	135	135	-	-	-	-	-	135
H2O	510,656	-	-	510,656	816	510,096	-	153,666	460,800	73,920	519,696	17,203	17,203	555	519,696
TOTAL LB/HR	512,050	30,000	30,000	512,050	952	511,256	-	154,153	509,684	73,920	519,696	17,203	17,203	555	511,815
GPM @ T	1024	73	-	1028	-	1029	-	309	1024	-	1044	-	35	-	1029
Sp. Gr. @ T	@ 60°F	0.5022	0.5022	@ 60°F	-	@ 60°F	-	@ 60°F	@ 60°F	-	@ 60°F	-	@ 60°F	-	@ 60°F
Temperature °F	284	190	190	284	386	284	-	284	284	250	250	750	250	250	250

STREAM NO.	16	17	18	19	20	21	22	23	24	25	26	27	28	29
STREAM NAME	OXIDIZER EFFLUENT	24" SETTLER OVERHEAD	24" SETTLER WATER TO EVAPORATOR	24" OIL/WATER FEED	24" SETTLER VENT	24" SETTLER OVERHEAD/H2S/NH3	24" SETTLER BOTTOMS	24" SETTLER OVER-HEAD TO RECYCLE	24" SETTLER BOTTOMS TO RECYCLE	RECYCLE GAS	SATURATED STEAM	CONDENSATE CONDENSATE	MAKE-UP WATER	
FLOW, LB/HR														
H2	51	51	-	-	51	-	-	-	-	-	-	-	-	
N2	4	4	-	-	4	-	-	-	-	-	-	-	-	
NH3	3,231	3,227	-	4.04	0.01	-	-	-	-	4.04	-	-	-	
CO2	9,866	9,860	-	6.06	0.01A	-	-	-	-	6.06	-	-	-	
CO	7	-	-	7	-	-	-	-	-	-	-	-	-	
Phenol	1	-	-	1	-	-	-	-	-	-	-	-	-	
Thiocyanate	1	-	-	-	-	-	-	-	-	-	-	-	-	
Cyanide	-	-	-	-	-	-	-	-	-	-	-	-	-	
Chloride	112	-	-	112	-	-	-	-	-	-	-	-	-	
Carbonate	183	-	25	157	-	-	-	-	-	-	-	-	-	
Bicarbonate	288	-	-	288	-	-	-	-	-	-	-	-	-	
S-Trace	135	-	-	135	-	-	-	-	-	-	-	-	-	
H2O	544,436	13,013	3,001	488,359	2	29,015	29,065	-	6,139,583	15,000	65,000	693,583		
TOTAL LB/HR	560,888	29,029	3,027	488,823	14	29,015	29,065	-	1,139,583	15,000	58,000	693,583		
GPM @ T	1,354	-	5.3	1,054	-	53	60	-	2,113	-	6,863	1,390		
Sp. Gr. @ T	@ Tank	-	@ 60°F	@ 60°F	-	@ 60°F	@ 60°F	-	@ 60°F	-	@ 60°F	@ 60°F		
Temperature, °F	588	115	120	140	170	120	120	-	140	140	566	90		



NOTES:

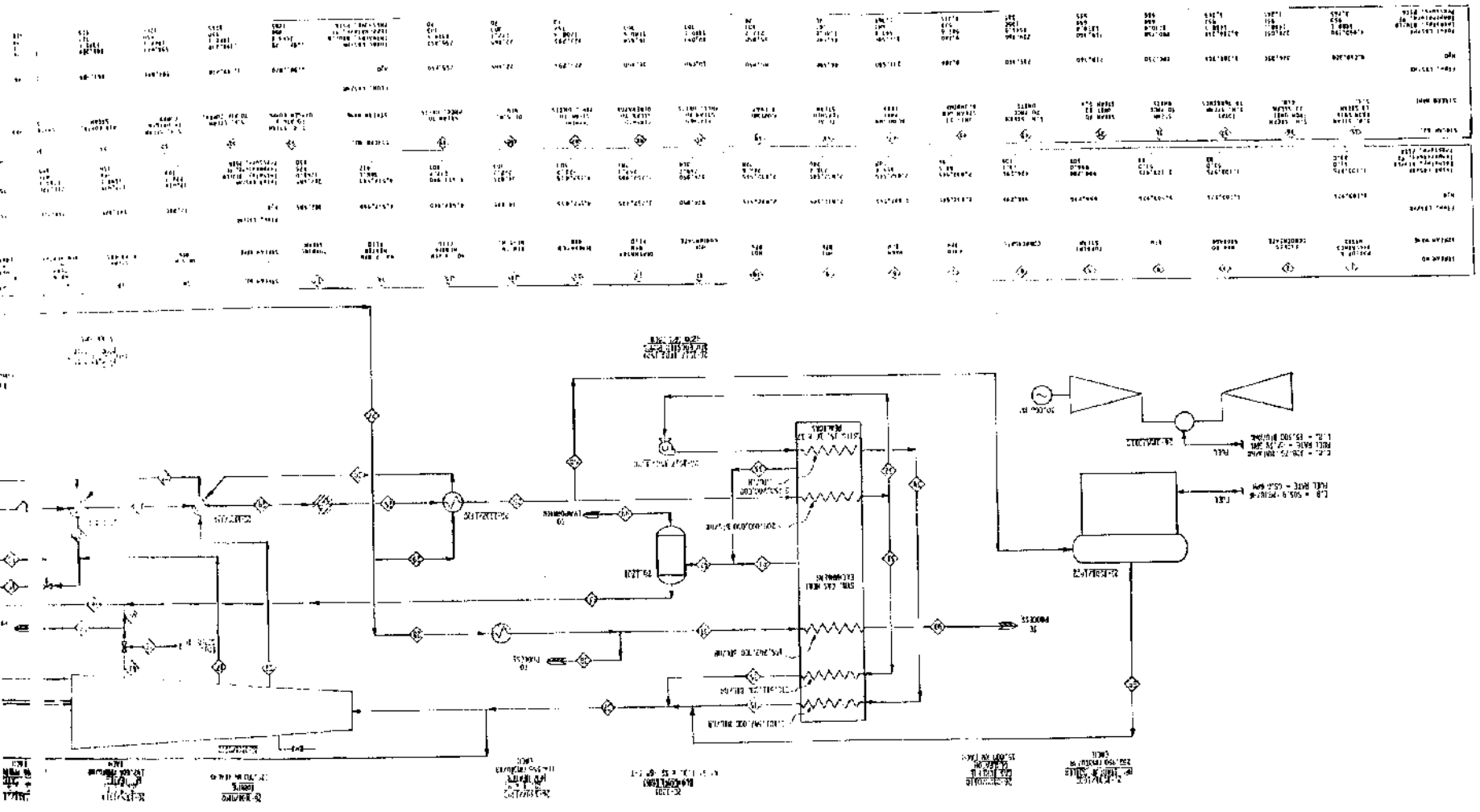
1. ALL GPM'S SHOWN ON STREAM LINES ARE AT 60°F.
2. CAPACITIES SHOWN ON EQUIPMENT ARE MAXIMUM FOR DESIGN.
3. SIZE AND QUANTITY SHOWN HERE FOR ONE TRAIN OF A TWO TRAIN PLANT. EACH TRAIN CHARGING 15,000 TPD COAL TO THE PROCESS PLANT TO MAKE 262 BILLION BTU/D THERMAL PRODUCT OUTPUT.

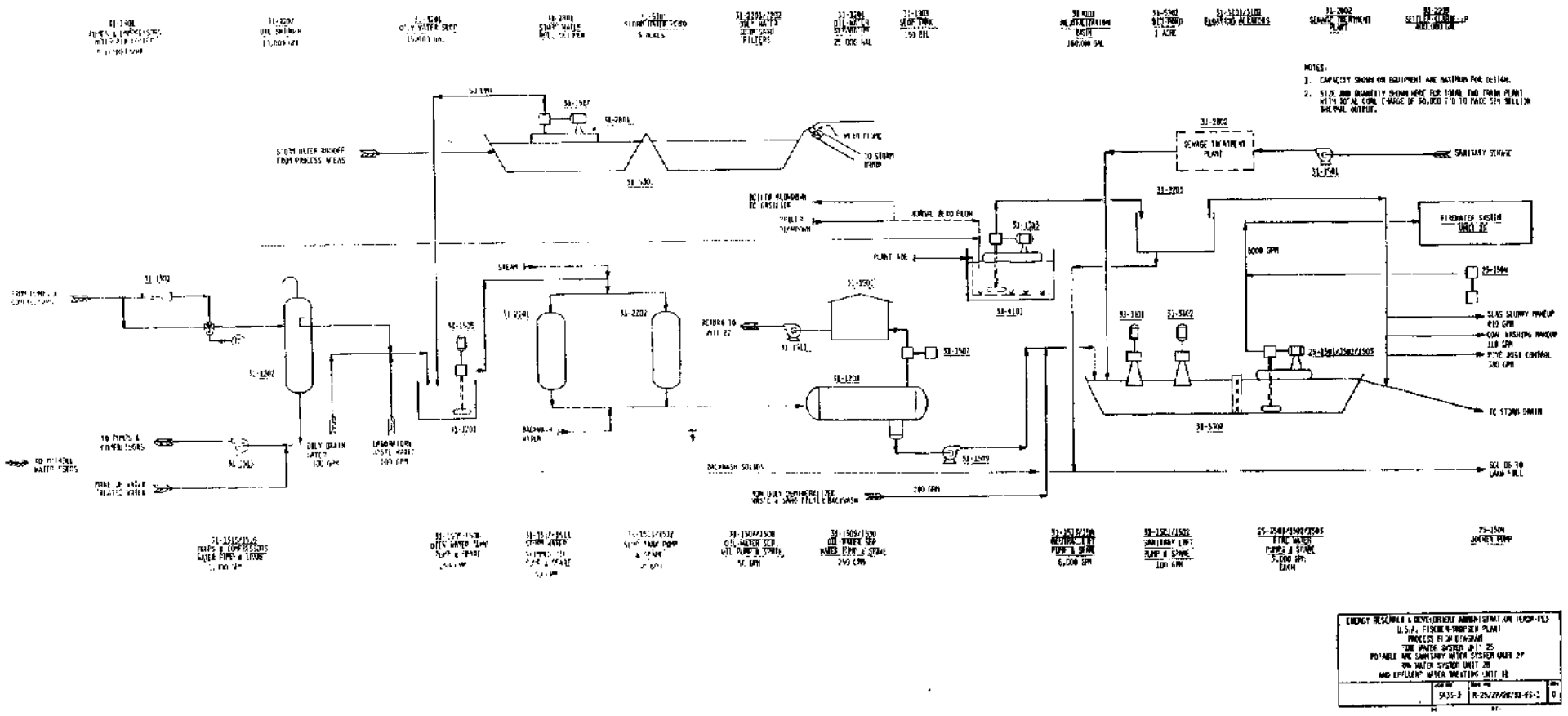
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION (ERDA-FE)
U.S.A. FISCHER-TROPSCH PLANT
PROCESS FLOW DIAGRAM
WATER RECLAMATION UNIT 22

JOB NO.	DWG NO.	REV
5435-3	R-22-FS-1	0

B

6-12 C





ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION (ERDA-FE) U.S.A. FISCHER-TROPSCH PLANT PROCESS FLOW DIAGRAM 25K WATER SYSTEM UNIT 25 POTABLE AND SANITARY WATER SYSTEM UNIT 27 RAW WATER SYSTEM UNIT 28 AND EFFLUENT WATER TREATING UNIT 88		
	5435-3	R-25/27/28/88-85-1

SECTION 7

PRODUCTS: MARKETABILITY AND PROJECTED CHARACTERISTICS

The need exists to demonstrate the abil[illegible] to produce liquids from coal, by any process, with characteristics which permit their direct sale to U.S. users. This includes liquids produced by the Fischer-Tropsch process. The fuel-to-user match may be accomplished by defining processing techniques which will produce fuels that exactly duplicate their counterparts produced from crude oil sources. However, a more likely long-term event is some mutual adjustment of fuel characteristics and design/operation of the fuel consuming equipment. This adjustment will provide the flexibility to use the more economical coal conversion process configurations.

Another likely approach will be the interaction of the coal conversion industry with the petroleum refining and petrochemical industries. Some coal-derived liquids have characteristics which can be used directly and effectively by the petrochemical industry; supplying a portion of this market will release crude oil sourced products for other uses, such as the gasoline pool. Also, some coal-derived liquids may best be used, from a national standpoint, as feedstocks to large scale refinery operations. There are other possibilities to consider before finalizing plans to maximize the contribution of coal liquefaction products to the U.S. energy supply program.

Preferred procedures have been considered for marketing and use of the products from this Fischer-Tropsch conceptual design. To do this, a detailed analysis of the projected characteristics of the products from the complex has been made, and probable marketing outlets defined. Current judgments regarding product marketability are presented in subsection 7.1, and detailed projections of the product characteristics to support the marketability judgments are given in subsection 7.2.

7.1 PRODUCT MARKETABILITY

The products, individually described in this section, are generally similar to petroleum products presently marketed in the U.S. There are, however, property differences when compared with their petroleum-based counterparts. A key difference is the nil sulfur, ash, and nitrogen content of the Fischer-Tropsch products, which is expected to enhance the potential value of the liquid products as blending stock.

Comments regarding marketability are presented for the following products:

- SNG
- Butane

- Naphthas
  - light naphtha
  - heavy naphtha
- Diesel fuel oil
- Fuel oil
- Oxygenates

7.1.1 SNG (SUBSTITUTE NATURAL GAS)

This product would be sold as pipeline gas for either industrial or residential use. A comparison of the projected SNG product characteristics with AGA Interchangeability Indexes for high methane content natural gas is shown in Table 7-1.

7.1.2 BUTANES

This product would be marketed in the LPG field. Other alternatives include marketing as an ethylene feedstock or separation of the butane content and using it as a blend stock for gasoline for vapor pressure control supplying the northern winter markets.

A comparison of the butane product with commercial butane specification is shown in Table 7-2.

7.1.3 NAPHTHAS, LIGHT AND HEAVY

The primary value of these products as produced in the Fischer-Tropsch complex would be as ethylene feedstocks. Their composition, consisting primarily of straight-chain saturated and monounsaturated hydrocarbons with nil sulfur and near nil aromatics content provides economic advantages for these purposes.

These products differ from normal petroleum naphthas in that they have nil aromatic content and low octane numbers. Therefore their use in the gasoline pool would require further processing. Representative processing procedures to produce higher octane gasoline from F-T liquids have been described.[1] Using a processing procedure consisting of catalytic polymerization of propylene and butylenes plus catalytic reforming of the naphtha, alcohol, and 3 cc tetraethyl lead addition, resulted in research octane numbers of the order of 92[1]. When alkylation of contained butane is included in the processing sequence, the resulting leaded research octane of the product gasoline pool was on the order of 96[1]. The proposed alternate of marketing them as chemical feedstocks would release petroleum-based naphthas for conventional processing to gasoline and other products.

7.1.4 DIESEL FUEL

With nil sulfur, high cetane number, and high HHV, this product is considered a marketable diesel engine fuel. This product could also be marketed as a low sulfur boiler fuel oil or as a home heating oil.

The comparisons of ASTM diesel fuel and fuel oil specifications with projected characteristics of this product are listed in Table 7-3.

7.1.5 FUEL OIL

Fischer-Tropsch-produced oils can be marketed either as turbine fuel or as utility/industrial fuel oil. The nil sulfur, metals, and nitrogen content will be a major advantage. Since only trace quantities of aromatics are projected, the luminosity associated with coal-derived fuels would not exist; this would be an asset for turbine use.

A comparison of ASTM gas turbine and fuel oil specifications and the projected properties of the Fischer-Tropsch fuel oil is shown in Table 7-4.

7.1.6 OXYGENATES

This is a mixture that represents about 3% by weight of the liquid products. It contains primarily alcohols and ketones; details are shown in subsection 7.2.6. The marketing concept is to sell the mixture to a chemical processor for separation and refining to end-product purity.

7.1.7 SUMMARY

An extensive assessment of the adaptability of all coal-derived liquids to current U.S. fuel markets is required. This requirement holds true for liquids produced by Fischer-Tropsch technology as well as hydroliquefaction, donor solvent, and pyrolysis processes.

The results of our current analysis indicate that the Fischer-Tropsch products can be marketed, but in some cases they may have to be modified to match the characteristics of currently marketed fuel products. The modifications in either product, end-use procedures, or product logistics are not insurmountable.

A key step in commercialization of this technology will be a functional product testing program using liquids produced in experimental facilities.

Table 7-1 - Comparison of Commercial SNG and Projected Fischer-Tropsch SNG Characteristics

	SNG Limits of Interchangeability for Various Base-Load Natural Gases (a)						Fischer-Tropsch SNG
AGA Indexes (a)	High Heating Value Natural Gas		High Methane Natural Gas		High Inert Natural Gas		
	Preferable	Objectionable	Preferable	Objectionable	Preferable	Objectionable	
Lifting Index	Under 1.0	Above 1.12	Under 1.0	Above 1.06	Under 1.0	Above 1.03	1.091 (b)
Flash-Back Index	Under 1.18	Above 1.2	Under 1.18	Above 1.2	Under 1.18	Above 1.2	1.048
Yellow Tip Index	Above 1.0	Under 0.7	Above 1.0	Under 0.8	Above 1.0	Under 0.9	0.942

(a) "Interchangeability of Other Fuel Gases with Natural Gas," AGA Research Bulletin No. 36.

(b) The Lifting Index can be lowered by increasing the SNG hydrogen content.

Table 7-2 - Comparison of Commercial Butane Specifications with Projected Fischer-Tropsch Butane Characteristics

Characteristic	Commercial Butane Specification ASTM D1835	Projected F-T Butane Characteristics
Vapor pressure at 100°F, psig max.	70	37
Volatile residue:		
evaporated temperature, 95%, max. °F	36	31
pentane and heavier, % max.	2.0	1.6
Residual matter:		
residue on evaporation, 100 ml, max.	0.05	0.05
oil stain observation	pass[a]	pass
Specific gravity at 60/60 F	[b]	
Corrosion, copper strip, max.	No. 1	No. 1
Sulfur, grains/100 ft^3 max.	15	None
Free water content	None	None

[a] An acceptable product shall not yield a persistent oil ring when 0.3 ml of solvent residue mixture is added to a filter paper in 0.1 ml increments and examined in daylight after 2 min. as described in Method D2158.

[b] Although not a specification requirement, the specific gravity must be determined for other purposes and should be reported.

Table 7-3 - Comparison of Diesel Fuel and Fuel Oil Specifications with Projected Fischer-Tropsch Diesel Fuel Oil Characteristics

Item	Diesel Fuel Specification	Fuel Oil Specification	Projected F-T Diesel Fuel Characteristics
Grade	No. 1-D ASTM D975	No. 1 ASTM D396	
Flash Point, °F PMCC ASTM D93	100 min. or legal	100 min. or legal	100
Pour Point, °F	(a)	(b)	plus 10°F
Water and Sediment Volume, % Max.	Trace	Trace	Trace
Carbon Residue on 10% Residuum, % Max.	0.15	0.15	Trace
Ash, Wt. % Max.	0.01	None Stated	0.01
Distillation Temp. °F			
10% Point, Max.	None Stated	420	327
90% Point, Max.	550	550	539
Viscosity at 100°F CS			1.4
Min.	1.4	1.4	
Max.	2.5	2.2	
Sulfur, Wt. % Max.	0.50 or legal	0.5 or legal	nil
Copper Strip Corrosion, Max.	No. 3	No. 3	No. 1
Cetane Number, Min	40	None Stated	60+
Gravity, API Min.	None Stated	35	57.4

(a) For cold weather operation, the pour point should be specified 10°F (5.6°C) below the ambient temperature at which the engine is to be operated except where fuel oil heating facilities are provided.

(b) Lower or higher pour points may be specified whenever required by conditions of storage or use. When pour point less than 0°F is specified, the minimum viscosity shall be 1.8 centistokes (32.0 seconds Saybolt Universal) and the minimum 90% point shall be waived.

Table 7-4 - Comparison of Fuel Oil and Gas Turbine Fuel Oil Specifications with Projected Fischer-Tropsch Fuel Oil Characteristics

Item	Fuel Oil Specifications	Gas Turbine Fuel Oil Specifications	Projected F-T Fuel Oil Characteristics
Grade	No. 5 (Light) ASTM D396	No. 3-GT ASTM D2880	
Flash Point °F, Min. PMCC ASTM D93	130 or legal	130 or legal	200
Pour Point °F, Max.	--	None Stated	150
Water and Sediment, Vol. % Max.	1.0	1.0	1.0
Ash, Wt.% Max.	0.10	0.03	Trace
Distillation, 90%			875
Temp. °F			
Min.	--	None Stated	
Max.	--	None Stated	
Saybolt Viscosity, SSU at 100°F			155
Min.	150	45	
Max.	300	None Stated	
Gravity °API, Min.	--	None Stated	41
Vanadium, ppm (wt) Max.	--	2	0
Na + K, ppm (wt), Max.	--	5	0.01
Calcium, ppm (wt), Max.	--	10	0
Lead, ppm (wt), Max.	--	5	0
Mg/V wt ratio	--	None Stated	--
Sulfur, wt %	Legal	None Stated	0

7.2 PROJECTED PRODUCT CHARACTERISTICS

The projected characteristics for each product follow.

7.2.1 SNG (SUBSTITUTE NATURAL GAS)

This is a gaseous mixture of methane, hydrogen, carbon monoxide, and carbon dioxide, together with sufficient quantity of light hydrocarbons to produce a nominal 1,035 Btu/CF gas.

Composition Volume Percent, dry basis

Methane	83.8
Ethane, propane, butane	6.9
Carbon monoxide	0.1
Hydrogen	1.0
Carbon dioxide	1.4
Nitrogen	6.8
	100.0

Product Characteristics

Higher Heating Value (dry)	1,035 Btu/scf	ASTM D900-55
Specific Gravity, air = 1, at 60°F	0.67	
Delivered Pressure to Pipe Line	1,000 psig	
Dew point (hydrocarbon)	32°F at 800 psia	ASTM D1142-56
Dew point (water)	32°F at 1,000 psia	ASTM D1142-58
AGA Interchangeability Indexes:		Preferable Value
Lifting Index	1.091	1.06
Flash-Back Index	1.048	1.2
Yellow-Tip Index	0.942	0.8

Note: The Lifting Index can be adjusted to the preferred range by increasing the SNG hydrogen content.

7.2.2 BUTANES

This is a mixed liquid product containing butane and butylene with some associated lighter and heavier saturated and monounsaturated hydrocarbons.

Composition	Weight %	Mol %	Liquid, Volume %
Butylene	16.2	16.7	15.8
Butane	82.1	81.8	82.6
Propane-propylene	0.1	0.1	0.1
Pentanes	1.7	1.4	1.6
Sulfur	nil		
Nitrogen	nil		

Product Characteristics		Tests
Nominal specific gravity at 60°F, liquid	0.59	ASTM D1657 or D2598
Vapor pressure, psig at 100°F	37	ASTM D1267
Temperature, 95% evaporation point, °F	31	ASTM D1837
Sulfur content (grains/100 ft^3)	nil	ASTM D2784
Corrosion, copper strip	1	ASTM D1838
Nominal dryness, weight % water	0.001	NGPA

7.2.3 NAPHTHAS, LIGHT AND HEAVY

These products are in the automotive gasoline distillation range and consist primarily of straight-chain monounsaturated and straight-chain saturated hydrocarbons boiling to 300°F ASTM end point range. These naphthas are free of sulfur and nitrogen and may be hydrogenated to produce turbine fuel or used as chemical feedstock.

Product Characteristics	Light Naphtha	Heavy Naphtha	Tests
Higher Heating Value, Btu/lb	20,815	20,430	ASTM D2383
Gravity, °API	85.5	71.3	ASTM D287
ASTM Distillation			ASTM D86
IBP	96°F	186°F	
10%	115°F	208°F	
30%	128°F	226°F	
50%	137°F	236°F	
70%	146°F	253°F	
90%	159°F	266°F	
EP	185°F	300°F	
Color, Saybolt	Plus 30	Plus 30	ASTM D156
Viscosity at -30°F, CS	0.8	1.7	ASTM D445
Freezing point, °F	-136	-67	ASTM D97
Aniline point, °F	140	160	ASTM D1012
Oxygen content, wt%, max	0.2	0.5	
Sulfur, wt %	nil	nil	ASTM D1323 or D1219
Hydrogen sulfide, wt%	nil	nil	
Doctor test	neg	neg	
Corrosion, copper strip			
at 150°F	1	1	
at 210°F	1	1	

Product Characteristics	Light[1] Naphtha	Heavy[1] Naphtha	Tests
Reid vapor pressure, psia	10		ASTM D323
IP smoke point, mm	Over 30	Over 30	(IP designation 57)
Yield nitrogen	nil	nil	
UOP "K"	12.3	12.3	

[1] Octane numbers of combined naphthas after bauxite treating to dehydrogenate oxygenates and shifting the double bond in the terminal olefins to an internal position are:

F-1	Clear	75.0	ASTM D2699
F-1	Clear	65.0	ASTM D2700

7.2.4 DIESEL FUEL

This product consists primarily of straight-chain hydrocarbons, free of sulfur and nitrogen; it meets specifications for commercial diesel fuel markets.

Product Characteristics		Tests
Grade	ASTM D975 No. 1-D	
Gravity, °API	57	ASTM D287
ASTM Distillation		ASTM D86
IPB	301°F	
10%	327°F	
30%	351°F	
50%	372°F	
70%	421°F	
90%	539°F	
EP	637°F	
Percent recovered	98%	
Viscosity at 100°F, CS	1.4	ASTM D445
Flash point, °F, Pensky-Marten	100	ASTM D93
Pour point	Plus 10°F	ASTM D97
Aniline point, °F	175	ASTM D611
Oxygen content, wt%	0.5 max.	
Sulfur, wt%	nil	ASTM D129
Mercaptan sulfur	nil	ASTM D1323 or D1219
Neutralization number, mg KOH/g	0.1	ASTM D611
Corrosion, copper strip		
at 150°F	1	ASTM D130
at 210°F	1	
Ash, wt%	less than 0.01	ASTM D482
IP smoke point, mm	25	(IP designation 57)
Engine cetane number	60 plus	ASTM D613
Kieldahl nitrogen, ppm	nil	ASTM D322

7.2.5 FUEL OIL

The fuel oil is a waxy, high pour point, sulfur-free product.

Product Characteristics		
Higher Heating Value, Btu/lb	19,855	ASTM D2382
Gravity, °API	41	ASTM D287
ASTM Distillation		ASTM D86
IBP	572°F	
5%	642°F	
10%	665°F	
30%	715°F	
50%	759°F	
70%	811°F	
90%	873°F	
95%	886°F	
EP	885°F	
Viscosity at 100°F, SSU	155	ASTM D88
Flash point, °F, Pensky-Marten	200	ASTM D93
Pour point, °F	150	ASTM D97
Color, Saybolt	dark	ASTM D1500
Oxygen, wt% max	0.5	
Sulfur	nil	ASTM D129

7.2.6 OXYGENATES

Oxygenates are a mixture of alcohols with a small amount of ketones.

Composition	Vol%, dry basis
Acetone	3.2
Methyl ethyl ketone	0.7
Methanol	6.0
Ethanol	67.6
Propanol	18.0
Butanol	2.4
Amyl alcohol	1.1
Higher alcohols and other oxygenates	1.0
	100.0

Product Characteristics

Higher Heating Value	
dry	13,160 Btu/lb average
as produced	12,505 Btu/lb average
Specific gravity	0.79
Water content	5.0 Wt% max.