BASE CASE II

4.5 OFFSITE UNITS

Majority of the offsite units in Base Case II are very similar to those in Base Case I. Consequently, descriptions are not repeated; differences, principally capacities, are discussed below.

Unless stated otherwise, units are shown on Block Flow Diagram ZO-GEM-6988 in Sub-Section 4.4. In addition, units such as boilers, generators and water treaters are also included in Steam/BFW Balance ZO-GEM-6986 located in Sub-Section 4.6.

4.5.1 Oxygen Production Unit 221

Identical to Unit 121.

4.5.2 Boiler Unit 222

Differences are as follows:

Main Fuel

Fine coal quantity (composition listed in Sub-Section 2.3)	406.90 Mlb/hr

Supplementary Fuels

- Oil quantity (from Gas Liquor Separation Unit 207)	46.49 Mlb/hr
- Vacuum tower residue (from Fractionation Unit 252)	
Quantity	2.0 Mlb/hr
Low heating value	17,750 Btu/lb

Incineration Fuel

Sour offgases (mainly from Sulfur Recovery Unit 206)	
Quantity	1,826.5 Mlb/hr
Low heating value	243 Btu/lb

NOTE: The heat content of these gases (30 Btu/SCF) has not been included in the boiler thermal balance.

Normal Capacity 3,111.3 Mlb/hr

4.5.3 Main Superheater Unit 223

Capacity is changed as follows:
Normal Capacity 3,111.3 Mlb/hr

4.5.4 Superheater Unit 224

Duties are as follows:

	200 psig Steam	100 psig Steam
Inlet pressure, psig	200	100
Outlet pressure, psig	185	85

	200 psig Steam	100 psig Steam
Inlet temperature, °F	387	338
Outlet temperature, °F	586	469

Fuel consists of a portion of the oil recovered from Gas Liquor Separator Unit 107:

Oil quantity 5.22 Mlb/hr

Normal Capacity

Coil 1: 200 psig steam superheating	78.7 Mlb/hr
Coil 2: 100 psig steam superheating	777.1 Mlb/hr

4.5.5 Electrostatic Stack Gas Precipitator Unit 225

Normal Capacity 216.5 Mlb-mol/hr

4.5.6 Stack Gas Clean-Up Unit 226

Normal Capacity 216.5 Mlb-mol/hr containing 48.1 lb-mol/hr SO_2

4.5.7 Instrument and Plant Air Unit 227 (not shown)

Identical to Unit 127 (Estimated instrument air requirement for the total complex is 750 lb-mol/hr; see Paragraph 3.5.7.)

4.5.8 Coal Handling Unit 228 (See SFD ZO-GEM-6909, Sub-Section 3.5.)

Gasifier well-sized coal production is identical to Base Case I. Because of the higher energy requirements in Base Case II, the quantity of boiler feed coal is increased to 406.9 Mlb/hr.

4.5.9 Ash Handling Unit 229 (See SFD ZO-GEM-6911, Sub-Section 3.5.)

Identical to Unit 129

4.5.10 BFW Preparation Unit 231

Deaerator (231/1)

Normal Capacity

	Temp., °F	Flow, Mlb/hr
MP condensate	479	346.6
LP condensate	297	1,628.5
Vacuum condensate	173*	2,190.7
Methanation Unit 212 process condensate	288	110.8
BFW make-up water	173*	2,090.4
Total	221	6,367.0

*After heating in 250-E-03.

Demineralizer (231/2)

Normal Capacity	2,090.4 Mlb/hr

1.5.11 Cooling Water Make-Up Preparation Unit 232

Normal Capacity

	Mlb/hr
Treated fresh water	2,284.5
Treated water from Unit 235 and humidity from Unit 221	1,961.9
Total	4,246.4

4.5.12 Cooling Water Tower Unit 233

Normal Capacity

	GPM
Steam turbine condenser duty	174,300
Trim cooler duty	109,590
Total	283,890

4.5.13 Electric Power Generation Unit 234

Description

Generator 234-M-01 uses 48 psig, 378°F steam with Condensing Turbine 234-T-01. Back Pressure Turbine 234-T-02 of Generator 234-M-02 is fed with two superheated streams:

185 psig steam:	78.7 Mlb/hr
85 psig steam:	777.1
Total	855.8

Normal Capacity

	MW	Steam Flow, Mlb/hr
234-M-01	46.9	955.4
234-M-02	8.9	855.8

4.5.14 Waste Water Treatment Unit 235

Normal Capacity

Composition	Flow, Mlb/hr
Organic acids and phenols	8.9
Ammonia	1.3
Water containing some H_2S	2,093.4
Total	2,103.6

4.5.15 Flare and Blowdown Facilities 236 (not shown)

Normal Capacity

Blowdown water to holding pond	526.6 Mlb/hr

4.5.16 Storage 237 (not shown)

The following is a summary of the product, intermediate and chemical storage tank capacities which are not located within the process offsite units:

Product Storage (15 days)

Anhydrous ammonia	1,700 ton (refrigerated)
Sulfur	1,000 ton (covered)
Gasoline	224,000 Bbl (floating roof)
Diesel fuel	38,000 Bbl (cone roof)
Heavy fuel oil	11,000 Bbl (cone roof)
Propane LPG	18,500 Bbl (pressure)
Butane LPG	2,400 Bbl (pressure)
Alcohols	34,000 Bbl (floating roof)

Intermediate Storage

Hydrotreater Unit 251 feed (15 days)	22,000 Bbl (floating roof)
Hydrotreater Unit 253 feed (15 days)	188,000 Bbl (floating roof)
Reformer Unit 255 feed (5 days)	24,000 Bbl (floating roof)
Polymerization Unit 257 feed (2 days)	14,000 Bbl (pressure)

Chemical Storage

Diisopropyl ether	1,500 Bbl
Methanol	1,000 Bbl

4.5.17 Interconnecting Pipeway 238 (not shown)

Requirements are somewhat larger than in Base Case I because of the greater number of onsite units needed for F-T product upgrading.

4.5.18 Refrigeration Unit 241

Normal Capacity

Temperature Level	Duty, MMBtu/hr + 32°F	- 45°F
Purification Unit 205 including ammonia storage	25.5	70.5
HC Recovery Unit 210	-	43.4
H_2 Purification Unit 261	2.1	-
	27.6	113.9

4.5.19 Gasoline Blending Unit 270

Except for additional blending steams, identical to Unit 154.

4.5.20 F-T Catalyst Preparation Unit 271

Purpose of the Unit is to prepare from magnetite iron ore (Fe_3O_4) a promoted, reduced iron catalyst for the fluid-bed Fischer-Tropsch reactors.

Technology Used

The catalyst plant design is based on literature articles describing: (a) the manufacture of iron ammonia catalysts, (16), and (b) the Sasol catalyst plant (13). An overall general design has only been developed. Promotors used and dosages, concentrate specifications, specific operating conditions, etc., are confidential and, thus, unavailable. This unit has been added to the offsites because of the quantity of fused catalyst required and the problems of shipping the sensitive catalyst under a H_2 or inert gas atmosphere.

Process Description

Catalyst preparation consists of 3 steps: iron ore purification, catalyst fusion and size reduction, and catalyst reduction. Equipment contained in the iron ore purification area includes:

- Ore unloading and storage
- Rotary drier for moisture removal before grinding
- Rod mill for size reduction required by air table
- Air separation table for tailings removal
- Concentrate storage

Concentrate yield has been assumed to be 50 percent.

Equipment in the catalyst fusion and size reduction step includes:

- Electric resistance furnace for melting/intimate mixing of concentrate and promotors
- Gyratory crusher and ball mill for size reduction required by the fluid-bed reactor
- Air separator for elimination of fines and oversize particles
- Catalyst storage

Equipment required in catalyst reduction includes:

- Fluidized-bed reactor for contact of hydrogen and unreduced F-T catalyst
- Hydrogen heater
- Heat exchangers for condensing water product
- Hydrogen recycle compressor
- Recycle gas drier for moisture control
- Reduced catalyst storage under H_2 or inert gas atmosphere

Reduction takes place under elevated temperature and pressure.

BASE CASE II

4.6 UTILITY REQUIREMENTS AND STEAM/BFW BALANCE

4.6.1 Utility Requirements

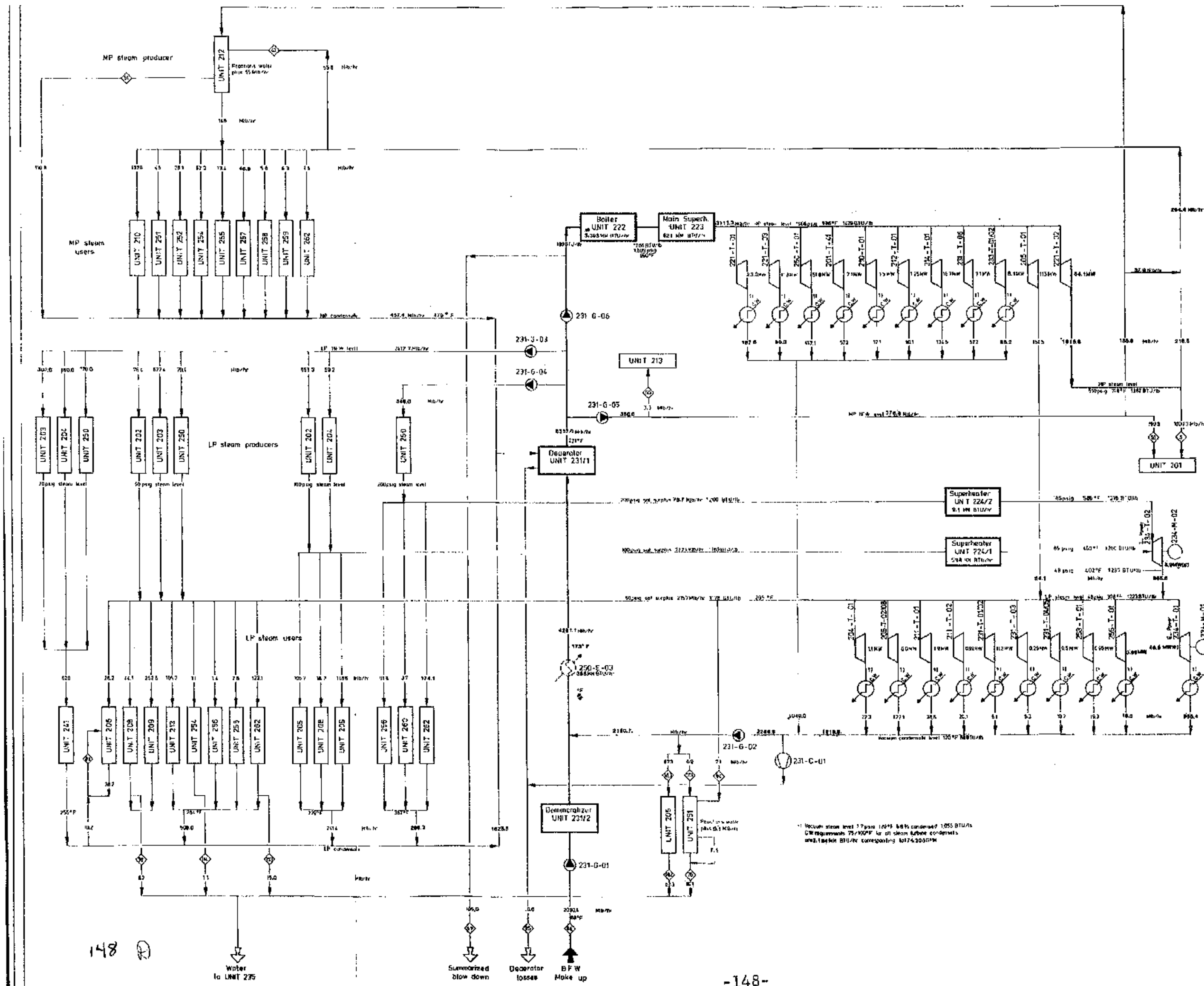
Utility requirements for the individual units can be found as follows:

Utility	Source
Fuel	Type and stream number: BFD ZO-GEM-6988 (Sub-Section 4.4) Quantity and composition: Material balance sheets (Appendix B)
Power	BFD ZO-GEM-6988
Cooling water	BFD ZO-GEM-6988
Boiler feed water	Steam/BFW Balance ZO-GEM-6986 (Sub-Section 4.6)
Steam	Steam/BFW Balance ZO-GEM-6986

In addition, offsite Sub-Section 4.5 contains utility information.

4.6.2 Steam/BFW Balance

The steam and boiler feed water flows are shown on Drawing ZO-GEM-6986. The steam/electric power balance is acceptable in accordance with the study bases. Only about 6 MW(e) is surplus in comparison with 257 MW of total electric and steam power required in the plant complex. In addition, all steam produced is utilized.



EQUIPMENT LIST

ITEM NO.	NAME	OPER. +SPARE
231-C-01	STEAM TURBINE CONDENSERS VACUUM BLOWER	1 + 1
231-G-01	BFW MAKE UP PUMP	1 + 1
231-G-02	VACUUM CONDENSATE PUMP	1 + 1
231-G-03	LP BFW PUMP	[illegible] + 1
231-G-04	200 PSIG BFW PUMP	1 + 1
231-G-05	MP BFW PUMP	1 + 1
231-G-06	HP BFW PUMP	[illegible] + 2
234-M-01	MAIN ELECTRIC POWER GENERATOR	[illegible] + 0
234-M-02	SECOND ELECTRIC POWER GENERATOR	1 + 0
201-T-41	LOCK GAS COMPRESSOR STEAM TURBINE	1 + 0
204-T-01	SHIFTED GAS BOOSTER COMPRESSOR STEAM TURBINE	1 + 0
205-T-01	RECTISOL VACUUM BLOWER HP STEAM TURBINE	[illegible] + 0
205-T-02	RECTISOL VACUUM BLOWER LP STEAM TURBINE	[illegible] + 0
205-T-08	RECTISOL ABSORBER MAIN FEED PUMP STEAM TURBINE	[illegible] + 0
210-T-01	HEPTANE WASH OFFGAS COMPRESSOR STEAM TURBINE	1 + 0
211-T-01	PRESSURE SWING OFFGAS RECOMPRESSOR STEAM TURBINE	1 + 0
211-T-02	UNIT 211 HYDROGEN COMPRESSOR STEAM TURBINE	1 + 0
212-T-01	METHANATION RECYCLE COMPRESSOR STEAM TURBINE	1 + 0
214-T-01	SNG COMPRESSOR STEAM TURBINE	1 + 0
221-T-01	OXYGEN COMPRESSOR STEAM TURBINE	1 + 0
221-T-02	AIR COMPRESSOR STEAM BACK PRESSURE TURBINE	1 + 0
221-T-03	AIR COMPRESSOR STEAM CONDENSING TURBINE	1 + 0
231-T-01	BFW MAKE UP PUMP STEAM TURBINE	1 + 0
231-T-02	VACUUM CONDENSATE PUMP STEAM TURBINE	1 + 0
231-T-03	LP BFW PUMP STEAM TURBINE	2 + 0
231-T-04	200 PSIG BFW PUMP STEAM TURBINE	1 + 0
231-T-05	MP BFW PUMP STEAM TURBINE	2 + 0
231-T-06	HP BFW PUMP STEAM TURBINE	3 + 0
233-T-01	VACUUM CONDENSATION C.W. PUMP STEAM TURBINE	3 + 0
233-T-02	PROCESS C.W. PUMP STEAM TURBINE	1 + 0
234-T-01	MAIN ELECTRIC POWER GENERATOR STEAM TURBINE	[illegible] + 0
234-T-02	SECOND ELECTRIC POWER GENERATOR STEAM TURBINE	1 + 0
250-T-01	SYNGAS & RECYCLE COMPRESSOR STEAM TURBINE	1 + 0
253-T-01	HYDROTREATER RECYCLE COMPRESSOR STEAM TURBINE	1 + 0
255-T-01	REFORMER RECYCLE COMPRESSOR STEAM TURBINE	1 + 0
222	BOILER	[illegible] + 0
223	MAIN SUPERHEATER	[illegible] + 0
224/2	200 PSIG STEAM SUPERHEATER	1 + 0
224/1	100 PSIG STEAM SUPERHEATER	1 + 0
231/1	DEAERATOR	1 + 0
231/2	DEMINERALIZER	1 + 0

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STEAM/BFW BALANCE
COAL TO GASOLINE CONV.
VIA F-T SYNTHESIS
BASE CASE II

ZO-GEM-6986
MRDC/ERDA STUDY EF-76-C-01-2447

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BASE CASE II
4.7 TRAIN PHILOSOPHY

The train philosophy for the various units was selected on the basis of providing a plant complex having an onstream factor of 92%. Consequently, parallel trains have been used for many units to give flexibility in both operation and maintenance. Also, because of the large size of the complex, some units must be divided into parallel trains. In the hydrocarbon processing area, however, intermediate storage is used to provide this flexibility.

In addition, all normally operating pumps, reciprocating compressors and conveyors are provided with an 100% spare.

Since the same train philosophy is used for Base Case II as is used in Base Case I, only the philosophy of the new units in Base Case II are discussed below.

Hydrocarbon Recovery Unit 210

Because of size limitation, two parallel trains are provided.

F-T Synthesis Unit 250

Using a conservative scale-up factor of 2 over current commercial fluid-bed reactors, four reactors are required. In addition, a spare reactor is provided for catalyst changing and maintenance. Size considerations also require multiple towers, compressors, and pumps; see equipment list on PFD ZO-GEM-6977 in Sub-Section 4.4.

F-T Product Upgrading Units 252 Through 262

These units are single trains as equipment sizes are small enough to be shop fabricated. The only exception is Catalyst Polymerization Unit 257 which is provided with two reactors for operating flexibility.

To achieve operating flexibility in the upgrading area, feedstock storage capacity has been provided for the following units:

Naphtha Hydrotreating Unit 251	-	15 days
F-T Product Hydrotreating Unit 253	-	15 days
Catalytic Reforming Unit 255	-	5 days
Catalytic Polymerization Unit 257	-	2 days

Offsite Units

The offsite units are designed for a minimum of two parallel trains. In cases where commercial-sized equipment is too large with two trains, the number of trains has been increased.

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