FISCHER--TROPSCH DESIGN PROJECT CAPITAL COST VALIDATION

ARMY ENGINEER DIV., HUNTSVILLE, ALA

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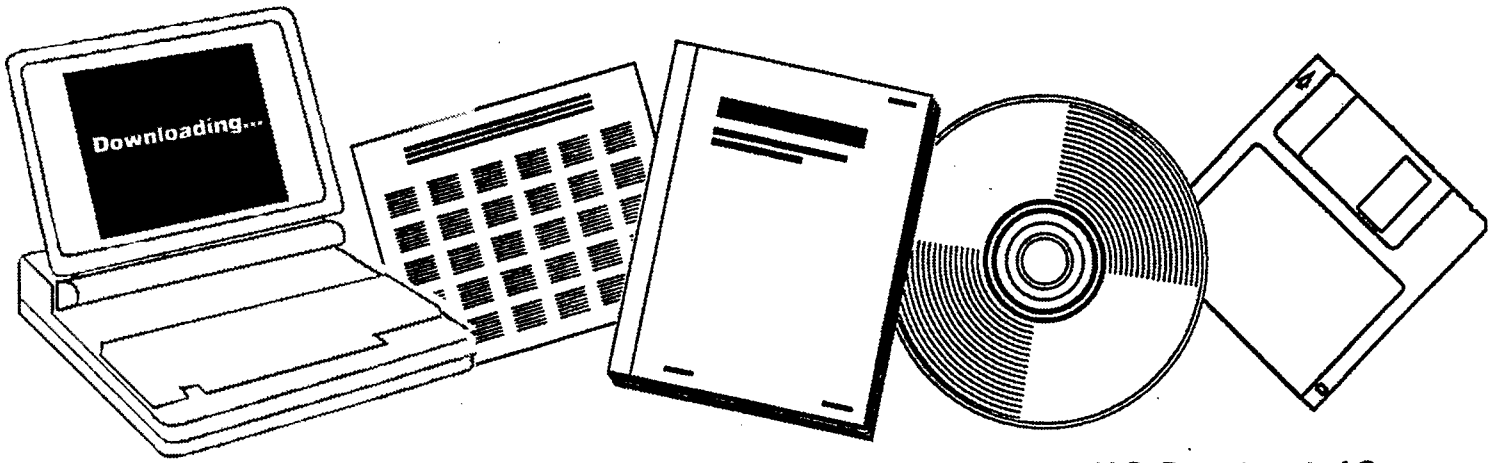

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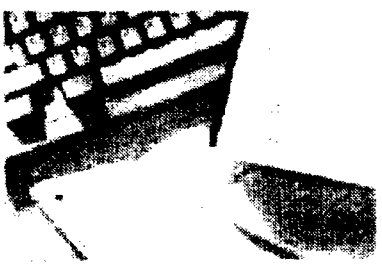

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FISCHER–TROPSCH DESIGN PROJECT CAPITAL COST VALIDATION

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ABSTRACT

The U. S. Army Engineer Division, Huntsville (USAEDH) has reviewed, validated, and updated a capital cost estimate of the "Commercial Complex Conceptual Design/Economic Analysis, Fischer-Tropsch Plant." R&D Report No. 114. This facility was designed to have a feed rate of 30,000 tons per day of clean coal and produce about 50,000 barrels per day of liquid products and 260 MMSCFD of synthetic natural gas. Results of the USAEDH estimate showed a fixed capital cost of $1,399 million which is greater than the Parsons estimate of $1,540 million (both estimates based on March 1976 dollars). The overall confidence factor was determined to be plus or minus 10%. Escalation of the USAEDH estimate to mid 1976 resulted in a fixed capital cost of $1,440 million for the facility.

Table of Contents

1.0 Introduction and Summary

Periodically the U.S. Army Engineer Division, Huntsville (USAEDH) reviews, validates, and updates capital cost estimates that have been prepared for ERDA/MFPM by its contractors. USAEDH is qualified for this type work by their extensive experience on major construction projects with which they have been associated. This study includes a review of an evaluation of the Fischer-Tropsch process prepared by the Ralph M. Parsons Co.[1] The Parsons evaluation encompassed the conceptual design and economic evaluation of a Fischer-Tropsch facility having a capacity of 30,000 ton per day of clean coal and producing approximately 50,000 barrel a day of liquid products and 260 million standard cubic feet a day of synthetic natural gas. Parsons estimated the fixed capital investment to be about $1,540 million based upon March 1976 dollars.

In this study, USAEDH reviewed the costs for each of the process units designed by Parsons. In many of these units, the basic equipment costs estimated by Parsons

(1) "Commercial Complex Conceptual Design/Economic Analysis, Fischer-Tropsch Complex." R&D Report No. 114 Interim Report #3, prepared by R. M. Parsons Co.

were substantiated but different mark-up factors (ratio of total construction cost to equipment cost) were used by USAEDH. These revised mark-up factors were based upon data for similar items in other projects with appreciably more design completion. In other units both the basic equipment costs and mark-up factors were changed. Results of the USAEDH cost analysis showed a March 1976 fixed capital cost estimate of $1,399 million compared to the $1,540 million Parsons estimate. The overall confidence factor in the estimate was determined to be ± 10 percent. Escalation of the USAEDH estimate to mid 1976 resulted in a fixed capital cost of $1,440 million.

?.0 Project Capital Cost Validation

This study is a review of the "Commercial Complex Conceptual Design/ Economic Analysis, Oil and SNG by Fischer-Tropsch Complex," R&D Report No. 14, prepared by the Ralph M. Parsons Company. The Parsons-prepared commercial plant capital cost estimate was validated, updated to mid-1976 dollars, and a level of confidence of the estimate was determined.

Table I depicts Parsons versus US Army Engineer Division, Huntsville (USAEDH) estimates. Table II depicts USAEDH mark-up factors for each unit. USAEDH factors were determined from the ratio of total construction cost to equipment cost for similar items in other projects with appreciably more design completion. Cost differences between USAEDH and Parsons are explained as follows:

Unit #9. The Parsons original total direct construction cost of $142,409,000 was revised by Parsons as follows:

a. Reduced by $15,058,000 to delete vendor field indirects.

b. Increased by $14,258,000 to add buildings and other support.

The revised Parsons total direct construction cost of $141,609,000 was increased by 16% to provide for field indirects for a total construction cost of $164,266,400.

Parsons-estimated equipment cost of $141,700,000 was reduced by $14,983,100 ($15,058,000 ÷ 1.005) by USAEDH to delete vendor field indirects arriving at an estimated equipment cost of $126,716,900.

USAEDH used the same equipment cost factored by 1.12 to arrive at a total direct construction cost of $141,669,000. The $141,669,000 was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $164,336,000. The USAEDH construction factor (1.12) included the cost of mobile flood lights not considered in Parsons' estimate.

Unit #10. The Parsons-estimated equipment cost of $9,812,400 was reduced by $660,800 since laboratory building and shop were covered in Unit #9. The revised equipment cost of $9,151,600 was factored by 1.94 to arrive at a total direct construction cost of $17,780,300. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $20,625,200.

USAEDH used the revised equipment cost of $9,151,600 factored by 1.33 to arrive at a total direct construction cost of $12,171,600. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $14,119,100.

Unit #11-1&2. The Parsons-estimated equipment cost of $12,667,900 was factored by 1.55 to arrive at a total direct construction cost of $19,598,500. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $22,734,300.

USAEDH used the equipment cost of $12,667,900 factored by 1.46 to arrive at a total direct construction cost of $18,482,900. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $21,440,200.

Unit #12. The Parsons-estimated equipment cost of $18,546,300 was factored by 2.04 to arrive at a total direct construction cost of $37,887,200. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $43,949,200.

USAEDH used the equipment cost of $18,546,300 factored by 1.30 to arrive at a total direct construction cost of $24,132,700. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $28,017,100.

Unit #13. The Parsons-estimated equipment cost of $55,118,200 was factored by 2.60 to arrive at a total direct construction cost of $143,313,300. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $166,243,400.

USAEDH used the equipment cost of $55,118,200 factored by 1.57 to arrive at a total direct construction cost of $86,772,700. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $100,656,300.

Unit #14. The Parsons-estimated cost of $77,000,000 for "Acid Gas Removal System - Proprietary System Installed." This number could not be validated since the system is proprietary and therefore, was accepted.

The $77,000,000 was factored by 1.05 to arrive at a total direct construction cost of $80,850,000. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $93,786,000.

USAEDH used the $77,000,000 factored by 1.10 to arrive at a total direct construction cost of $84,700,000. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $98,252,000.

Unit #15. The Parsons-estimated equipment cost of $7,270,300 was factored by 2.10 to arrive at a total direct construction cost of $15,268,900. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $17,711,900.

USAEDH used the equipment cost of $7,270,300 factored by 1.38 to arrive at a total direct construction cost of $9,997,700. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $11,597,300.

Unit #16. The Parsons-estimated equipment cost of $88,172,400 was factored by 1.87 to arrive at a total direct construction cost of $165,019,300. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $191,422,400.

USAEDH used the equipment cost of $88,172,400 factored by 1.54 to arrive at a total direct construction cost of $135,482,900. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $157,160,200.

Unit #17. The Parsons-estimated equipment cost of $20,979,600 was factored by 2.33 to arrive at a total direct construction cost of $48,892,800. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $56,715,700.

USAEDH used the equipment cost of $20,979,600 factored by 1.76 to arrive at a total direct construction cost of $36,948,800. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $42,860,600.

Unit #18. The Parsons-estimated equipment cost of $10,398,900 was factored by 2.37 to arrive at a total direct construction cost of $24,594,000. This number was increased by 16% to provide for field indirects resulting in total Parsons construction cost of $28,529,000.

USAEDH used the equipment cost of $10,398,900 factored by 2.83 to arrive at a total direct construction cost of $29,422,800. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $34,130,500.

Unit #19. The Parsons-estimated equipment cost of $4,954,400 was factored by 2.58 to arrive at a total direct construction cost of $12,802,700. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $14,851,100.

USAEDH used the equipment cost of $4,954,400 factored by 1.81 to arrive at a total direct construction cost of $8,984,200. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $10,421,700.

Unit #20. The Parsons-estimated cost of $245,000,000 for "Oxygen Plant Complete" was factored by 1.005 to arrive at a total direct construction cost of $246,225,000. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $285,621,000.

USAEDH used the $245,000,000 for "Oxygen Plant Complete" factored by 1.10 to arrive at a total direct construction cost of $269,500,000. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $312,620,000.

Unit #21. The Parsons-estimated total direct construction cost of $37,940,000 was composed of some factored equipment cost and some system complete cost. The $37,940,000 was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $44,010,400.

USAEDH used assumed factors to determine the equipment cost to be $13,660,000. This equipment cost was factored by 1.98 to arrive at a total direct construction cost of $27,035,200. This number was increased by 16% to provide for field indirects resulting in a total USAEDH cost of $31,360,800.

Unit #22. The Parsons-estimated equipment cost of $14,061,200 was factored by 2.32 to arrive at a total direct construction cost of $32,589,200. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $37,803,500.

USAEDH used the equipment cost of $14,061,200 factored by 2.91 to arrive at a total direct construction cost of $40,920,600. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $47,467,900.

Unit #23. No difference.

Unit #24. Parsons-estimated total direct construction cost of $5,948,500 was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $6,900,300.

USAEDH modified the unit costs of various buildings arriving at a total direct construction cost of $6,819,500. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $7,910,600.

Unit #25. No difference.

Unit #26-1&2. The Parsons-estimated equipment cost of $56,479,600 was factored by 1.90 to arrive at a total direct construction cost of $107,311,200. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $124,481,000.

USAEDH deleted two of the four stand-by turbine-generators to arrive at an equipment cost of $51,329,600. This equipment cost was factored by 1.80 to arrive at a total direct construction cost of $92,615,700. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $107,434,200.

Unit #27. The Parsons-estimated equipment cost of $36,000 was factored by 9.00 to arrive at a total direct construction cost of $324,000. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $375,800.

USAEDH used the equipment cost of $36,000 factored by 2.39 to arrive at a total direct construction cost of $86,200. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $100,000.

Unit #28. The Parsons-estimated equipment cost of $20,258,300 was factored by 1.33 to arrive at a total direct construction cost of $19,248,700. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $22,328,500.

USAEDH used the equipment cost of $20,258,300 factored by 1.57 to arrive at a total direct construction cost of $22,333,400. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $25,906,700.

Unit #29. The Parsons-estimated equipment cost of $290,500 was factored by 4.15 to arrive at a total direct construction cost of $1,205,600. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $1,398,500.

USAEDH used the equipment cost of $290,500 factored by 2.58 to arrive at a total direct construction cost of $749,500. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $869,400.

Unit #30. The Parsons-estimated equipment cost of $8,117,600 was factored by 2.10 to arrive at a total direct construction cost of $17,065,000. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $19,795,400.

USAEDH used the equipment cost of $8,117,600 factored by 2.12 to arrive at a total direct construction cost of $17,198,800. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $19,950,600.

Unit #31. The Parsons-estimated equipment cost of $942,900 was factored by 2.22 and then added to $341,900 for civil work to arrive at a total direct construction cost of $2,435,500. This number was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $2,825,200.

USAEDH deleted the storm water roll skimmer from the equipment cost reducing it to $927,400. This cost was factored by 3.01 (factor includes all civil work) to arrive at a total direct construction cost of $2,794,100. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $3,241,200.

Unit #32. Parsons-estimated total direct construction cost of $4,944,000 was increased by 16% to provide for field indirects resulting in a total Parsons construction cost of $5,735,000. There is no factor since all work in this unit is civil work.

USAEDH reduced the total direct construction cost to $4,299,000. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $4,986,800.

Unit #33. This unit was added by USAEDH and consists of a commercial power substation not included in Parsons' estimate. The June 1976 estimated cost is $2,710,000. This number was increased by 16% to provide for field indirects resulting in a total USAEDH construction cost of $3,143,600.

A percent difference ratio is shown for each unit indicating an overall confidence factor of $\pm$ 10%. Escalation from March 1976 dollars to mid-1976 dollars was determined by using the June 1976 wholesale price index for the major equipment items and by using the March to June weighted average by using the construction cost factor for each unit.

TABLE I

UNIT NO.	UNIT NAME	PARSONS CO. CONSTR. COST MARCH 1976	USAEDH CONSTR. COST MARCH 1976	ESC. COST FROM MARCH 1976 TO MIDYEAR 1976-WHOLESALE PRICE INDEX & AR 415-17 INDEX			USAEDH CONSTR. COST MID-1976 DOLLARS	DIFFERENCE RATIO PARSONS CO./USAEDH MARCH 1976
				EQUIP.	CONSTR.	AVG.		
9	MINE EQUIP	$164,266,400	$164,336,000	1.03	1.03	1.03	$169,266,100	1.00
10	COAL PREPARATION	20,625,200	14,119,100	1.03	1.03	1.03	14,542,700	1.46
11-1&2	COAL STORAGE GRIND & DRY	22,734,300	21,440,200	1.03	1.03	1.03	22,083,400	1.06
12	GASIFICATION	43,949,200	28,017,100	1.01	1.03	1.01	28,297,300	1.57
13	GAS CLEAN-UP	166,243,400	100,656,300	1.05	1.03	1.04	104,682,600	1.65
14	ACID GAS REMOVAL	93,786,000	98,252,000	1.05	1.03	1.03	101,199,600	0.95
15	SHIFT CONVERSION	17,711,900	11,597,300	1.05	1.03	1.04	12,061,200	1.53
16	F. T. SYNTHESIS	191,422,400	157,160,200	1.05	1.03	1.04	163,446,600	1.22
17	METHANATION	56,715,700	42,860,600	1.05	1.03	1.04	44,575,000	1.32
18	LIQUID PRODUCTS	28,529,000	34,130,500	1.02	1.03	1.03	35,154,400	0.84
19	CHEMICAL RECOVERY	14,851,100	10,421,700	1.02	1.03	1.02	10,630,100	1.43
20	OXYGEN PLANT	285,621,000	312,620,000	1.03	1.03	1.03	321,998,600	1.09
21	SULFUR PLANT	44,010,400	31,360,800	1.02	1.03	1.02	31,988,000	1.40
22	WATER RECLAIMING	37,803,500	47,467,900	1.01	1.03	1.02	48,417,300	0.80
23	STEAM DISTRIBUTION	2,086,800	2,086,800	-	1.03	1.03	2,149,400	1.00

TABLE I (Cont'd)

UNIT NO.	UNIT NAME	PARSONS CO. CONSTR. COST MARCH 1976	USAEDH CONSTR. COST MARCH 1976	ESC. COST FROM MARCH 1976 TO MIDYEAR 1976-WHOLESALE PRICE INDEX & AR 415-17 INDEX			USAEDH CONSTR. COST MID-1976 DOLLARS	DIFFERENCE RATIO PARSONS CO./USAEDH MARCH 1976
				EQUIP.	CONSTR.	AVG.		
24	SHOPS & BUILDINGS	$ 6,900,300	$ 7,910,600	-	1.03	1.03	$ 8,147,900	0.87
25	FIRE WATER	2,088,000	2,088,000	-	1.03	1.03	2,150,600	1.00
26-1&2	PWR, GEN & UTIL.	124,481,000	107,434,200	1.01	1.03	1.02	109,582,900	1.16
27	POTABLE & SANITARY WATER	375,800	100,000	1.01	1.03	1.02	102,000	3.76
28	RAW WATER SYSTEM	22,328,500	25,906,700	1.01	1.03	1.02	26,424,800	0.86
29	FLARE SYSTEM	1,398,500	869,400	1.01	1.03	1.02	886,800	1.61
30	STORAGE TANK FARM	19,795,400	19,950,600	0.99	1.03	1.01	20,349,600	0.99
31	EFFLUENT WATER	2,825,200	3,241,200	1.01	1.03	1.02	3,306,000	0.87
32	SITE PURCH & PREP.	5,735,000	4,986,800	-	1.03	1.03	5,136,400	1.15
33	COMMERCIAL PWR. S. S.	-	3,143,600	-	-	-	3,143,600	-
	TOTAL CONSTR. COST	$1,176,284,000	$1,252,157,600			1.03	$1,289,722,900	1.10
	H.O. OV HD & FEE @ 10%	137,628,400	125,215,800				128,972,300	
	SUBTOTAL	$1,513,912,400	$1,377,373,400				$1,418,695,200	
	SALES TAX	27,000,000	22,000,000				22,200,000	
	TOTAL	$1,540,912,400	$1,399,373,400				$1,440,895,200	

TABLE II

USAEDH MARK-UP FACTORS

UNIT NO.	UNIT NAME	MAJOR EQUIP COST IN DOLLARS	LABOR, CONSTR. FACTOR	TOTAL DIRECT CONSTR. COST IN DOLLARS	TOTAL USAEDH CONSTR. COST MARCH 1976 IN DOLLARS
9	MINE EQUIPMENT	$126,716,900	1.12	$141,669,000	$164,336,000
10	COAL PREPARATION	9,151,600	1.33	12,171,600	14,119,100
11-1&2	COAL STORAGE GRIND & DRY	12,667,900	1.46	18,482,900	21,440,200
12	GASIFICATION	18,546,300	1.30	24,152,700	28,017,100
13	GAS CLEAN-UP	55,118,200	1.57	86,772,700	100,656,300
14	ACID GAS REMOVAL	77,000,000	1.10	84,700,000	98,252,000
15	SHIFT CONVERSION	7,270,300	1.38	9,997,700	11,579,300
16	F.T. SYNTHESIS	88,172,400	1.54	135,482,900	157,160,200
17	METHANATION	20,979,600	1.76	36,948,800	42,860,600
18	LIQUID PRODUCTS	10,398,900	2.83	29,422,800	34,130,500
19	CHEMICAL RECOVERY	4,954,400	1.81	8,984,200	10,421,700
20	OXYGEN PLANT	245,000,000	1.10	269,500,000	312,620,000
21	SULFUR PLANT	13,660,000	1.98	27,035,200	31,360,800
22	WATER RECLAIMING	14,061,200	2.91	40,920,600	47,467,900
23	STEAM DISTR.	-	-	1,799,000	2,086,800

TABLE II (Cont'd)

USAEDH MARK-UP FACTORS

UNIT NO.	UNIT NAME	MAJOR EQUIP COST IN DOLLARS	LABOR, CONSTR. FACTOR	TOTAL DIRECT CONSTR COST IN DOLLARS	TOTAL USAEDH CONSTR. COST MARCH 1976 IN DOLLARS
24	SHOPS & BUILDINGS	-	-	$ 6,819,500	$ 7,910,600
25	FIRE WATER SYSTEM	-	-	1,800,000	2,088,000
26-1&2	POWER GEN. & UTIL.	$ 51,329,600	1.80	92,615,700	107,434,200
27	POTABLE & SANITARY H^2O	36,000	2.39	86,200	100,000
28	RAW WATER SYSTEM	14,258,300	1.57	22,333,400	25,906,700
29	FLARE SYSTEM	290,500	2.58	749,500	869,400
30	STORAGE TANK FARM	8,117,600	2.12	17,198,800	19,950,600
31	EFFLUENT WATER	927,400	3.01	2,794,100	3,241,200
32	SITE PUR. & PREP	-	-	4,299,000	4,986,800
33	COM. PWR. S.S.	-	-	2,710,000	3,143,600
	TOTAL	$778,657,100	1.39	$1,079,446,300	$1,252,157,600

3.0 Identification of Commercial Fischer-Tropsch Program Facility Process Units

Unit No.	Description
9	Mine Equipment
10	Coal Preparation
11-1&2	Coal Storage Grind & Dry
12	Gasification
13	Gas Clean Up
14	Acid Gas Removal
15	Shift Conversion
16	F.T. Synthesis
17	Methanation
18	Liquid Products
19	Chemical Products
20	Oxygen Plant
21	Sulfur Plant
22	Water Reclaiming
23	Steam Distribution
24	Shops and Buildings
25	Fire Water
26-1&2	Power Generation & Utilities
27	Potable & Sanitary Water
28	Raw Water System
29	Flare System
30	Storage Tank Farm
31	Effluent Water
32	Site Purchase & Preparation
33	Commercial Power Sub Station

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