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COED CONCEPT DESIGN PROJECT
CAPITAL COST VALIDATION

U. S. ARMY ENGINEER DIVISION HUNTSVILLE
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ABSTRACT

The U. S. Army Engineer Division, Huntsville (USAEDH) has reviewed, validated and updated a capital cost estimate of the COED coal conversion process prepared by R.M. Parsons Co. in 1975.[1] This facility was designed to have a feed rate of 25000 TPD of clean coal and produce about 28000 bbl/day of synthetic crude oil and 830 mw of power. Results of the USAEDM estimate showed a fixed capital cost of $863.0 million which is 15.8% less than the Parsons estimate of $999.3 million (both estimates based on 1st quarter 1974 dollars). This difference is practically within the overall confidence limits of ± 15% estimated by USAEDH. Escalation of the USAEDH estimate to May 1976 resulted in a fixed capital cost of $1028.4 million for the facility.

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(1) "Commercial Complex Conceptual Design/Economic Analysis. Oil and Power by COED Based Coal Conversion". R&D Report No. 114 - Interim Report No. 1 by R.M. Parson Co., Pasadena, California September 1975.

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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/FE by its contractors. USAEDH is qualified for this type work by their extensive experience on major construction projects with which they have been associated. The study includes a review of an evaluation of the COED process prepared by the Ralph M. Parsons Co. in 1975.[1] The Parsons evaluation encompassed the conceptual design and economic evaluation of a COED facility having a capacity of 25000 TPD of clean coal and producing approximately 28000 bbl/day of synthetic crude oil and 830 mw of power. The COED facility also included a large captive coal mine. Parsons estimated the fixed capital investment to be about $999.3 million based upon first-quarter 1974 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 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

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(1) "Commercial Complex Conceptual Design/Economic Analysis, Oil and Power by COED based Coal Conversion" R&D Report No. 114- Prepared by R.M. Parsons Co. (FE-1775-1) September 1975.

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 1st quarter 1974 fixed capital cost estimate of $863.0 million compared to the $999.3 million Parsons estimate. This is a difference of 15.8% which is not appreciably different from the overall confidence factor estimated by USAEDH at $\pm$ 15%. Escalation of the USAEDH estimate to May 1976 resulted in a fixed capital cost of $1028.4 million.

2.0 Project Capital Cost Validation

This study is a review of the "Commercial Complex Conceptual Design/ Economic Analysis Oil and Power by COED-based Coal Conversion," R&D Report No. 114, prepared by the Ralph M. Parsons Company, dated September 1975. 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 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. Parsons' factors in some cases included the cost of civil items, miscellaneous pipings, and small equipment; and in other cases, these costs were included in the estimated equipment cost. Cost differences between USAEDH and Parsons are explained as follows:

Unit #10-1. No difference.

Unit #10-2. Parsons' historical total construction cost of $26,700,000 included $5,000,000 for a 30-day coal pile. The cost of the coal pile was considered to be an operational cost and was removed by USAEDH. The remaining $21,700,000 was factored by 3.62 to arrive at equipment cost of $6,000,000. USAEDH used the same equipment cost factored by 2.73 to arrive at a total construction cost of $16,380,000.

Unit #11-1. Parsons' estimated equipment cost of $53,738,000 was factored by 2.18 to arrive at a total construction cost of $117,200,000. USAEDH used the same equipment cost factored by 1.98 to arrive at a total construction cost of $106,401,000.

Unit #11-2. Parsons' estimated equipment cost of $10,087,000 was factored by 3.07 to arrive at a total construction cost of $31,000,000. USAEDH used the same equipment cost factored by 1.64 to arrive at a total construction cost of $16,543,000.

Unit #12-1. Parsons' estimated equipment cost of $7,480,000 was factored by 2.18 to arrive at a total construction cost of $16,300,000. USAEDH used the same equipment cost factored by 1.74 to arrive at a total construction cost of $13,015,000.

Unit #13-1. Parsons' estimated equipment cost of $2,150,000 was factored by 3.28 to arrive at a total construction cost of $7,100,000. USAEDH used the same equipment cost factored by 2.24 to arrive at a total construction cost of $4,816,000.

Unit #19-3. Parsons' estimated equipment cost of $9,984,000 was factored by 1.70 to arrive at a total construction cost of $17,000,000. USAEDH did not agree with some of the items included in the Parsons' equipment cost, and removed the cost of some civil items. The USAEDH estimated equipment cost of $3,524,000 was factored by 2.26 to arrive at a total construction cost of $7,964,000.

Unit #19-4. Parsons' estimated equipment cost of $65,000 was factored by 1.69 to arrive at a total construction cost of $110,000. USAEDH did not agree with some of the items included in Parsons' equipment cost and removed the cost of the wells and reduced the cost of the pumps. The USAEDH-estimated equipment cost of $43,000 was factored by 2.26 to obtain a total construction cost of $97,200.

Unit #19-5. Parsons' estimated equipment cost of $400,000 was factored by 1.75 to arrive at a total construction cost of $700,000. USAEDH did not agree with some of the items included in Parsons' equipment cost, and removed the cost of some civil items and associated piping. The USAEDH equipment cost of $77,000 was factored by 3.02 to arrive at a total construction cost of $232,500.

Unit #19-6. Parsons' estimated equipment cost of $182,000 was factored by 3.8 to arrive at a total construction cost of $700,000. USAEDH did not agree with some of the items included in Parsons' equipment cost, and removed the cost of some civil items and the contingency. The USAEDH-estimated equipment cost of $70,300 was factored by 4.21 to arrive at a total construction cost of $296,000.

Unit #19-7. Parsons' estimated equipment cost of $4,000,000 was factored by 1.25 to arrive at a total construction cost of $5,000,000. USAEDH used an estimated equipment cost of $2,690,000 factored by 1.45 to arrive at a total construction cost of $3,900,000.

Unit #19-8. No difference.

Unit #20. Parsons used a total construction cost of $29,390,000. USAEDH disagreed with Parsons' cost and reduced the cost of concrete, insulation, roads and paving, site preparation, and other civil items to arrive at a total construction cost of $24,567,600.

Unit #21 required the addition of a main substation with a 500 MVA generator synchronizing control house. Cost has been added to provide export power for sale at 138 KV. Export sales of 827 MW is an extremely large quantity of power and it is unlikely it would be sold at 13.8 KV. Providing a step-up transformer from 13.8 KV to 138 KV system will provide a marketable sale of export power to a utility company.

Unit #13-2. Parsons' historical total construction cost of $27,400,000 was factored by 3.91 to arrive at equipment cost of $7,000,000. USAEDH used the same equipment cost factored by 2.14 to arrive at a total construction cost of $14,980,000.

Unit #14-1. Parsons' estimate was made up of some historical data and some equipment item cost resulting in a composite total construction cost of $23,500,000. This was factored by 3.56 to arrive at an equipment cost of $6,600,000. USAEDH used the same equipment cost factored by 2.14 to arrive at a total construction cost of $14,124,000.

Unit #14-2. Parsons' historical total construction cost of $5,300,000 was factored by 3.79 to arrive at major equipment cost of $1,400,000. USAEDH used the same equipment cost factored by 1.99 to arrive at a total construction cost of $2,786,000.

Unit #15-1. Parsons' estimated equipment cost of $28,118,000 was factored by 2.20 to arrive at a total construction cost of $61,900,000. USAEDH used the same equipment cost factored by 1.91 to arrive at a total construction cost of $53,705,000.

Unit #16-1; 16-2. Parsons' historical total construction cost of $6,600,000 was factored by 3.88 to arrive at a major equipment cost of $1,700,000. USAEDH used the same equipment cost factored by 2.13 to arrive at a total construction cost of $3,621,000.

Unit #17. No difference.

Unit #18-1. Parsons' estimated equipment cost of $12,894,000 was factored by 1.90 to arrive at a total construction cost of $24,500,000. USAEDH used the same equipment cost factored by 1.64 to arrive at a total construction cost of $21,146,000.

Unit #18-2. Parsons' historical estimate of $321,400,000 was reduced to $240,557,000 equipment cost using a factor of 1.55. USAEDH used the same equipment cost with a factor of 1.15 resulting in a total construction cost of $276,640,000.

Unit #19-1. Parsons' estimated equipment cost of $620,000 was factored by 2.58 to arrive at a total construction cost of $1,600,000. USAEDH used the same equipment cost factored by 1.61 to arrive at a total construction cost of $998,200.

Unit #19-2. Parsons' estimated equipment cost was factored by 1.43 to arrive at a total construction cost of $12,600,000. USAEDH used the same equipment cost factored by 1.85 to arrive at a total construction cost of $16,336,000.

Unit #22 lacked start-up capability. No provision was made in the estimate to provide construction and start-up electricity. Temporary utilities were added to the process and coal mine areas. The construction contractor can install one gas turbine with fuel oil storage tanks which can be used for onsite electricity during construction and start-up of the process plant. Also, in this added cost are the fuel and temporary utility bills for both facilities.

Units #'s 13-2, 14-2, 16-1, 16-2, and 17. These are proprietary items, and as such, some back-up was withheld by Parsons.

A percentage difference range is shown for each unit with a total percent difference range of 16.99. Escalation from 1974 dollars to mid-1976 dollars was determined by using the May 1976 wholesale price index for the major items of equipment, and by using the 9 July 1976 AR 415-17 for the construction cost index. Weighted averages were then used to arrive at reasonable and comprehensive estimates. An overall confidence factor in the estimate of approximately plus or minus 15% can be expected.

TABLE I

PROJECT COED - 25,000 TPD COMMERCIAL PLANT COST COMPARISONS

UNIT NO.	UNIT NAME	PARSONS CO. CONST. COST 1974	USAEDH CONST. COST 1974	ESC. COST FROM 1974 TO 1976 - USED WHOLE-SALE PRICE INDEX AND AR 415-17 INDEX			USAEDH CONST. COST MID-1976 DOLLARS	DIFFERENCE RANGE AS OF 1974
				Equip.	AR415-17	AVG.		
10-1	COAL MINE	* 96,300,000	96,300,000	1.347	1.226	1.33	128,079,000	-0-
10-2	COAL PREPARATION	* 26,700,000	16,380,000	1.224	1.226	1.23	20,147,400	1.630
11-1	PYROLYSIS & GASIFICATION	117,200,000	106,401,000	1.218	1.226	1.22	129,809,220	1.101
11-2	OIL-VAPOR RECOVERY	31,000,000	16,543,000	1.229	1.226	1.23	20,347,890	1.874
12-1	OIL FILTRATION	16,300,000	13,015,000	1.226	1.226	1.23	16,008,450	1.253
13-1	PYROLYSIS GAS TREATING	7,100,000	4,816,000	1.218	1.226	1.22	5,875,520	1.474
13-2	LOW-BTU GAS TREATING	* 27,400,000	14,980,000	1.099	1.226	1.17	17,526,600	1.829
14-1	HYDROGEN PLANT	23,500,000	14,124,000	1.178	1.226	1.20	16,948,800	1.664
14-2	H_2 PLANT TAIL GAS DESULFURIZER	* 5,300,000	2,786,000	1.218	1.226	1.22	3,398,920	1.902
15-1	OIL HYDROTREATING	61,900,000	53,705,000	1.229	1.226	1.23	66,057,150	1.153
16-1	SULFUR RECOVERY UNIT, GAS H_2 PYROLYSIS UNIT	* 6,600,000	3,621,000	1.218	1.226	1.23	4,453,830	1.823
16-2	BEAVON TAIL GAS FROM UNIT 16-1	(INCL. IN UNIT 16-1)						
17	OXYGEN PLANT	* 86,400,000	86,400,000	1.086	1.226	1.18	101,952,000	-0-
18-1	FUEL GAS COMPRESSION	24,500,000	21,146,000	1.279	1.226	1.26	26,643,960	1.159

TABLE II

USAEDH MARK-UP FACTORS

PROJECT COED 25,000 TPD COMMERCIAL PLANT

UNIT	DESCRIPTION	MAJOR EQUIPMENT IN DOLLARS	LABOR, CONSTRUCTION FACTOR	TOTAL CONSTRUCTION IN DOLLARS
10-1	COAL MINE	80,000,000	1.20	96,300,000
10-2	COAL PREPARATION	6,000,000	2.73	16,380,000
11-1	PYROLYSIS & GASIFICATION	53,738,000	1.98	106,401,000
11-2	OIL-VAPOR RECOVERY	10,087,000	1.64	16,543,000
12-1	OIL INFILTRATION	7,480,000	1.74	13,015,000
13-1	PYROLYSIS GAS TREATING	2,150,000	2.24	4,816,000
13-2	LOW-BTU GAS TREATING	7,000,000	2.14	14,980,000
14-1	HYDROGEN PLANT	6,600,000	2.14	14,124,000
14-2	H_2 PLANT TAIL GAS DESULFURIZER	1,400,000	1.99	2,786,000
15-1	OIL HYDROTREATING	28,118,000	1.91	53,705,000
16-1	SULFUR RECOVERY UNIT - PYROL GAS H_2S	1,700,000	2.13	3,621,000
16-2	BEAVON TAIL GAS TREATING			(INCL. ABOVE IN 16-1)
17	OXYGEN PLANT	27,000,000	3.20	86,400,000
18-1	FUEL GAS COMPRESSION	12,894,000	1.64	21,146,000

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PROJECT COED - 25,000 TPD COMMERCIAL PLANT COST COMPARISONS

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11-1	PYROLYSIS & GASIFICATION	117,200,000	106,401,000	1.218	1.226	1.22	129,809,220	1.101
11-2	OIL-VAPOR RECOVERY	31,000,000	16,543,000	1.229	1.226	1.23	20,347,890	1.874
12-1	OIL FILTRATION	16,300,000	13,015,000	1.226	1.226	1.23	16,008,450	1.253
13-1	PYROLYSIS GAS TREATING	7,100,000	4,816,000	1.218	1.226	1.22	5,875,520	1.474
13-2	LOW-BTU GAS TREATING	* 27,400,000	14,980,000	1.099	1.226	1.17	17,526,600	1.829
14-1	HYDROGEN PLANT	23,500,000	14,124,000	1.178	1.226	1.20	16,948,800	1.664
14-2	H_2 PLANT TAIL GAS DESULFURIZER	* 5,300,000	2,786,000	1.218	1.226	1.22	3,398,920	1.902
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TABLE II (CONT'D)

USAEDH MARK-UP FACTORS

PROJECT COED 25,000 TPD COMMERCIAL PLANT

UNIT NO.	DESCRIPTION	MAJOR EQUIPMENT IN DOLLARS	LABOR, CONSTRUCTION FACTOR	TOTAL CONSTRUCTION IN DOLLARS
18-2	POWER PLANT	240,557,000	1.15	276,640,000
19-1	PLANT AIR & INSTRUMENT NIT.	620,000	1.61	998,200
19-2	COOLING WATER	8,830,000	1.85	16,336,000
19-3	INDUSTRIAL WATER SYSTEM	3,524,000	2.26	7,964,000
19-4	POTABLE & SANITARY WATER SYSTEM	43,000	2.26	97,200
19-5	FIRE WATER	77,000	3.02	232,500
19-6	WASTE WATER TREATING	70,300	4.21	296,000
19-7	PRODUCT STORAGE	2,690,000	1.45	3,900,000
19-8	FLARE SYSTEM			3,800,000

3.0 Identification of COED Facility Process Units

Unit No.	Description
10 - 1	Coal Mine
10 - 2	Coal Preparation
11 - 1	Pyrolysis and Gasification
11 - 2	Oil - Vapor Recovery
12 - 1	Oil Filtration
13 - 1	Pyrolysis Gas Treating
13 - 2	Low Btu Gas Treating
14 - 1	Hydrogen Plant
14 - 2	H_2 Plant Tail Gas Desulfurizer
15 - 1	Oil Hydrotreating
16 - 1	Sulfur Recovery Unit, Pyrolysis Gas H_2S
16 - 2	Beavon Tail Gas Treating from Unit 16-1
17	Oxygen Plant
18 - 1	Fuel Gas Compression
18 - 2	Power Plant
19 - 1	Plant Air and Instrument Nitrogen
19 - 2	Cooling Water System
19 - 3	Industrial Water System
19 - 4	Potable and Sanitary Water System
19 - 5	Firewater System
19 - 6	Waste Water - Treatment and Dispostion
19 - 7	Product Storage

3.0 Identification of COED Facility Process Units (Con't)

19 - 8	Flare System
20	Buildings and General Facilities
21*	Unit Substation (For Export Power)
22*	Temporary Power, Fuel Tank

*These units added to Facility by USAEDH