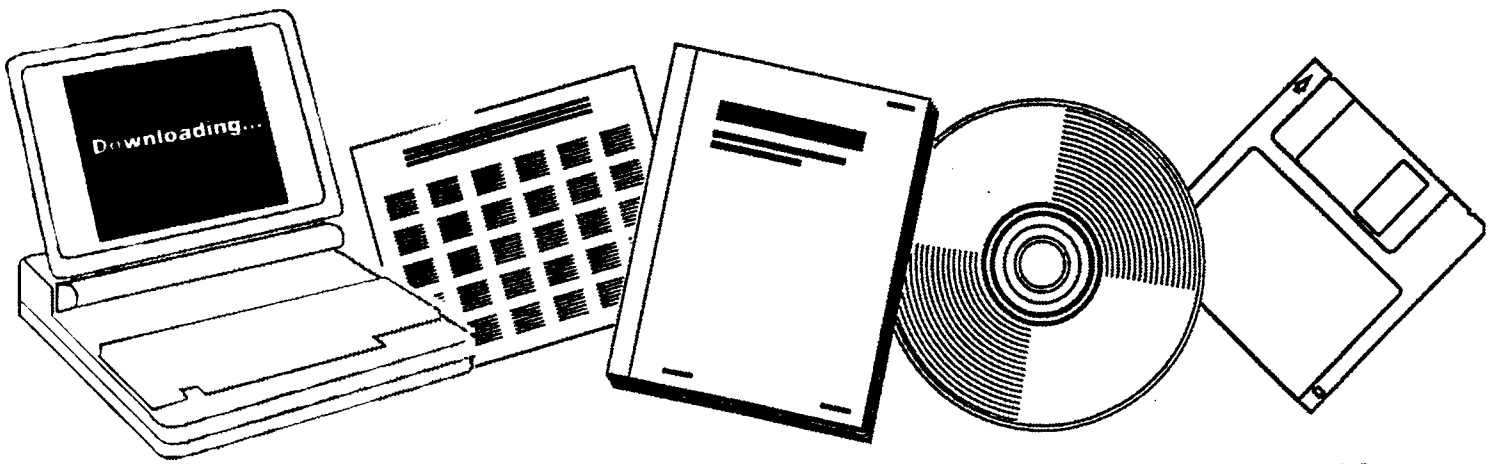
SCALE-UP REQUIREMENTS OF THE EXXON CATALYTIC COAL GASIFICATION PROCESS. MONTHLY REPORT, SEPTEMBER 1--SEPTEMBER 30, 1977

EXXON RESEARCH AND ENGINEERING CO.,
FLORHAM PARK, N.J

MAY 1978



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SCALE-UP REQUIREMENTS OF THE EXXON CATALYTIC COAL GASIFICATION PROCESS

Monthly Report for the Period

September 1 - September 30, 1977

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ABSTRACT

As reported in previous Monthly Summaries, the size of the grass-roots large pilot plant for the Catalytic Coal Gasification (CCG) Process was set to allow scaleup to a pioneer commercial plant with acceptable risk (no demonstration plant). It was determined that the gasifier diameter should be 3.5' I.D., and that the feed rate of Illinois Bituminous Coal would be 92 T/D (as received). Facilities were included for recycle to the gasifier of both synthesis gas and catalyst to simulate integrated commercial operation.

The total erected cost (TEC) for the grass roots Catalytic Coal Gasification Large Pilot Plant is estimated to be 130 M$. This cost is for a Gulf Coast location and assumes that there is an adjacent oil refinery to supply certain utilities and services. The investment includes the effect of cost escalation through the design and construction period. Operating costs are not included.

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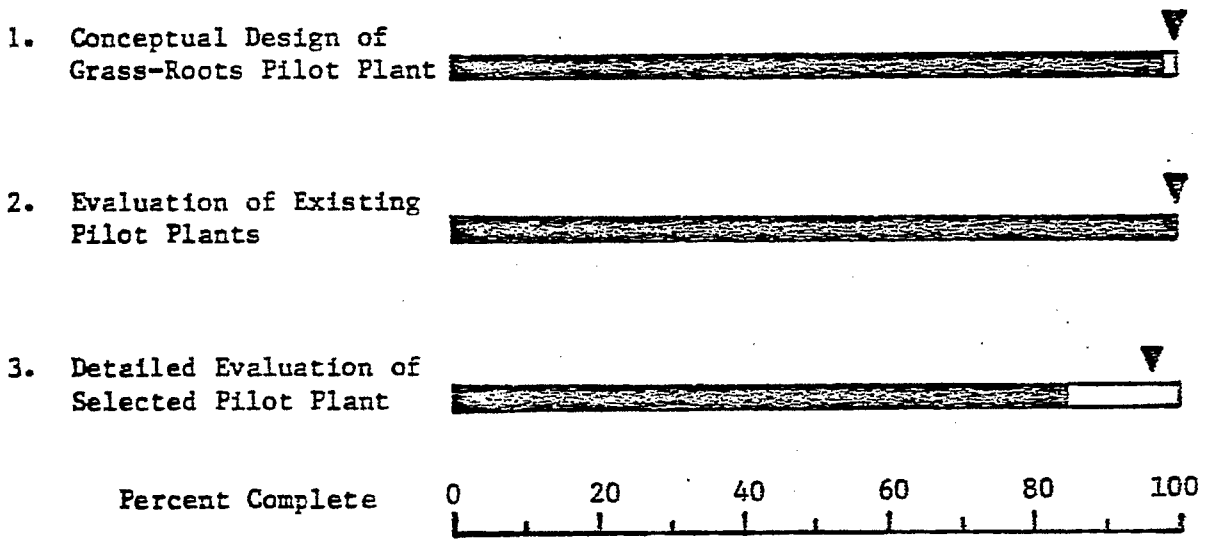
SUMMARY OF PROGRESS THROUGH SEPTEMBER, 1977

FOR THE STUDY OF SCALE-UP REQUIREMENTS

OF THE EXXON CATALYTIC COAL GASIFICATION PROCESS

Technical Reporting
Category



Legend

Shaded area = percentage of activity actually completed

▼ = percentage of activity scheduled for completion

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DISCUSSION

STUDY DESIGN FOR GRASS ROOTS LARGE PILOT PLANT - (Reporting Category 1)

As reported in previous Monthly Summaries, the size of the grass-roots large pilot plant for the Catalytic Coal Gasification (CCG) Process was set to allow scaleup to a pioneer commercial plant with acceptable risk (no demonstration plant). It was determined that the gasifier diameter should be 3.5' I.D., and that the feed rate of Illinois Bituminous Coal would be 92 T/D (as received). Facilities were included for recycle to the gasifier of both synthesis gas and catalyst to simulate integrated commercial operation.

The total erected cost (TEC) for the grass roots Catalytic Coal Gasification Large Pilot Plant is estimated to be 130 M$. This cost is for a Gulf Coast location and assumes that there is an adjacent oil refinery to supply certain utilities and services. The investment includes the effect of cost escalation through the design and construction period. Operating costs are not included.

A breakdown of the plant investment is given in Table 1. Direct material, labor and subcontract costs are 47 M$ (1Q77). Table 2 presents a section-by-section breakdown of the direct costs. Material costs were developed from equipment specifications and are based on cost levels for domestic purchase. Local sales tax and delivery charges to the site are included. Material charges also include the cost for shop fabrication of piping and structural steel. Labor rates are based on open shop hiring and reflect requirements of the Davis-Bacon Act. The actual job mix labor rate is $10.40/hr., which does not include payroll burdens (payroll taxes and benefits).

Total indirect project costs are 35.5 M$ (1Q77). This includes field labor overhead (17 M$) which covers temporary construction, consumables, field labor supervision and construction equipment. Also included are payroll burdens of 2.8 M$ which covers payroll taxes and benefits. Detailed engineering, which adds 11 M$, covers design, drafting, procurement, and vendor plant inspection work. Contractors' fees, which are based on published 1Q77 rates are 4 M$. Also included in this rate is a nominal royalty fee for the acid gas treating facilities.

The investment estimate includes 23 M$ to cover the escalation which is expected to occur between 1Q77 (the time basis used for estimating direct costs) and estimated project completion in 4Q82. Figure 1 presents the project schedule that was developed for estimating escalation. The June 1, 1980 starting date for detailed engineering is based on the assumption that a Process Development Unit (PDU) of approximately 1 T/D capacity begins operation in early 1979 to generate data for the LPP design. The LPP schedule is thus based on prudent overlap between the Process Development Program and the basic design phase for the large pilot plant project. Since the start of LPP design is keyed to PDU operation, any change to the PDU operating schedule would affect the LPP schedule. Engineering and construction

times are estimated from study design specifications and estimated field labor man-hours. Overall escalation rates are 23% for materials, 26% for labor and 36% for engineering. Details on how these rates were developed are given in Table 3.

Finally, the investment estimate includes a 20% project contingency to cover changes normally resulting from the firming of design and construction details. The project contingency excludes any scope or design basis changes or effects of extraordinary random events. No process development allowance for changes resulting from new laboratory data is included. However, costs for additional modifications during turnarounds will be included in the pilot plant operating cost estimate.

TABLE 1
INVESTMENT SUMMARY FOR
GRASS ROOTS LARGE PILOT PLANT

Cost Breakdown	k$, 1Q77	
Material	27,000	
Labor	12,300	
Subcontracts	7,700	
Total Direct Costs		47,000
Payroll Burdens	2,800	
Field Labor Overheads	17,300	
Vendor Representatives	300	
Loss on Surplus	300	
Insurance	200	
Enginering	10,600	
Fees: Engineering, Construction & Royalty	4,000	
Total Indirect Costs		35,500
Total Prime Contract		82,500
Project Management Services		3,800
Escalation		23,200
		109,500
Project Contingency (20%)		21,900
Total Erected Cost		131,400
CALL		130 M$

TABLE 2
DIRECT COST SUMMARY
GRASS ROOTS LARGE PILOT PLANT

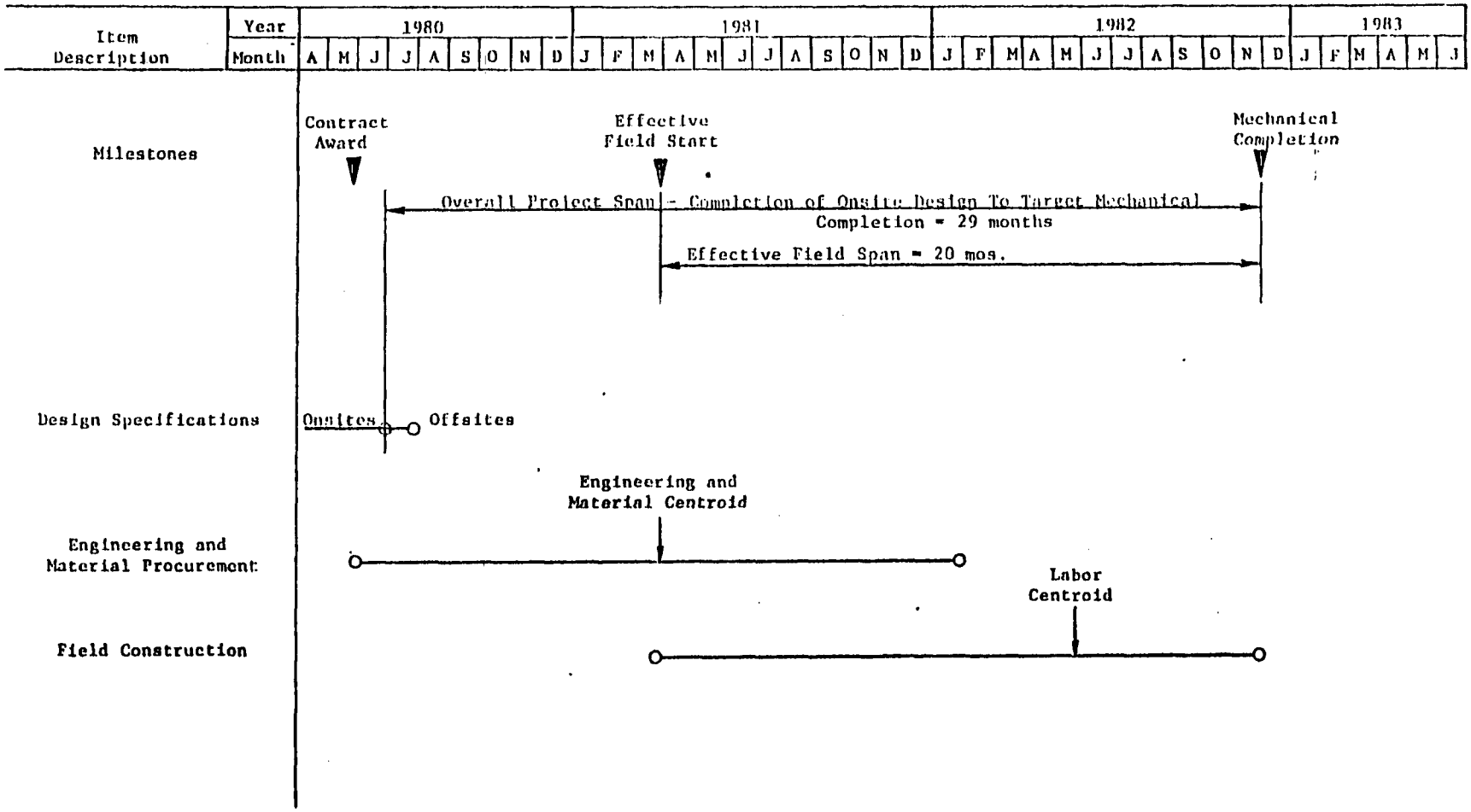
	1Q77-Gulf Coast		
	Material k$	Labor kMH	Subcontract k$
Onsites			
• Coal Feed & Catalyst Recovery	2,780	120	10
• Gasification	3,150	95	570
• Product Gas Cleanup	1,040	35	--
• Methane Recovery	3,170	70	--
• Steam Reforming	870	40	1,060
• Preheat Furnace	240	15	850
• Acid Gas Removal	1,930	60	--
• Common Facilities	1,190	55	360
Total Onsites	14,370	490	2,850
Offsites			
• Coal Preparation	3,250	120	150
• Coal Receipt & Storage	1,400	65	1,000
• Waste Treating	1,640	110	350
• Electrical	1,150	25	--
• Interconnecting Lines	1,620	160	10
• Fire Protection	240	10	10
• Safety	330	15	--
• Site Preparation	--	10	960
• Layout	600	65	700
• Buildings	150	--	1,460
• Utilities	1,830	85	90
• Chemical Handling	130	10	70
• Catalyst Handling	290	15	50
Total Offsites	12,630	690	4,850
Total Onsites & Offsites	27,000	1,180	7,700

TABLE 3
BASIS FOR COST ESCALATION ESTIMATE
GRASS ROOTS LARGE PILOT PLANT

Escalation Rates	Yearly Percentage		
Base Point--1Q77	Material	Labor	Engineering
1st Year	1	8	9
2nd Year	8	8	9
3rd Year	8	7	7
4th Year	5	7	7
Centroid	April 1981	*	April 1981
Time From Base Point (yrs.)	4	3	4
Escalation Effect	23	26	36

* Note: Davis-Bacon minimum wage rate to be set at contract award 2Q80.

FIGURE I
ENGINEERING AND CONSTRUCTION SCHEDULE FOR
GRASS ROOTS LARGE PILOT PLANT



SELECTION OF PREFERRED EXISTING LARGE PILOT PLANT (Reporting Category 2)

No work scheduled in this category.

MODIFICATION OF THE SYNTHANE PILOT PLANT - (Reporting Category 3)

As reported in previous monthly summaries, the study design for the Synthane modification will be patterned after the grass roots case. The modification is based on a coal feed rate of 92 T/D with facilities for recycle of both synthesis gas and catalyst to the gasifier. This will permit scaleup to a pioneer commercial plant with acceptable risk (no demonstration plant).

Onsite Study Design

During September the onsite equipment layout drawing was completed. Major changes to the existing process block are required:

- The existing CO_2 compressor building is removed to make room for the cryogenic synthesis gas recovery equipment. (This eliminates the capability of using by-product CO_2 for the coal feed system. Purchased CO_2 will be used for this purpose for CCG operations.)
- The O_2 and methanation facilities, which are not required for CCG operations, are eliminated.
- The cooling tower is relocated away from the process block.
- Realignment of the road that runs along the south side of the process block is necessary to meet minimum safe spacing requirements for the process furnaces.

Gasifier structure calculations showed that the six-story addition to the existing structure can be supported by adding K bracing and increasing the size of the foundation.

No further onsite study design work is required.

Offsite Study Design

Specifications were completed for all remaining supporting facilities. These included:

- Catalyst addition - A ribbon blender is used to mix the coal with catalyst solution and a torus disk, steam heated drier is used to remove the water that enters with the catalyst solution.
- Fuel systems - New LNG storage and handling facilities are provided. A new 20,000 gal fuel oil storage tank is added along with a new distribution system to provide fuel to new furnaces and boilers as well as the relocated boiler.
- Steam - Two new high pressure steam boilers are added to provide for increased process steam loads and steam turbine spare drivers. The latter were added to critical service equipment to provide improved pilot plant operating reliability. Expansion of the demineralization plant is required to meet the new steam raising capacity of the plant.

- Power - Substation and switch gear changes and additions were defined. Because of the major plot plan changes and equipment relocations, it was decided to replace existing electrical conduit, that is exposed in the piperacks, with underground wiring. The latter is considered safer and more reliable, and the expected incremental cost is small.

- Compressed air - A new air compressor, having the same capacity of each of the existing ones, is added. It has a steam turbine drive to ensure a supply of instrument air during a power failure.

- CO_2 and inert gas - Cryogenic pumps are provided for supplying 600 psi liquid CO_2 to the coal feed system. A vaporizer is provided onsite to supply the high pressure CO_2 that is required for the coal feed lock hoppers. The inert gas generation equipment and low pressure blowers are relocated.

- Waste Water Treating - A secondary treatment plant similar to the one provided in the grass roots pilot plant study design is provided. Most of the equipment is smaller, primarily because there is less rainwater run-off to process.

- Layout, Buildings and Site Preparation - In order to accomodate new facilities and comply with minimum required safety standards, it is necessary to relocate some existing equipment and buildings and use land that is outside the present fence line.

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