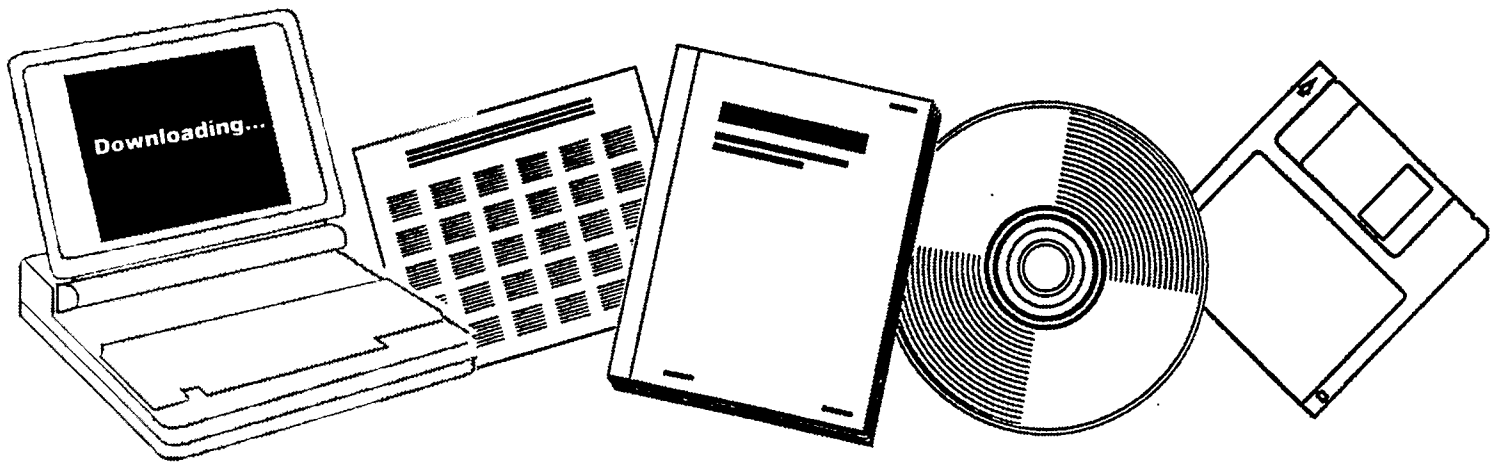
SCALE-UP REQUIREMENTS OF THE EXXON CATALYTIC COAL GASIFICATION PROCESS. MONTHLY REPORT, NOVEMBER 1--NOVEMBER 30, 1977

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

November 1 - November 30, 1977

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ABSTRACT

A study design and cost estimate have been completed for a major revamp of the Synthane Coal gasification pilot plant which would allow it to be operated as a catalytic coal gasification (CCG) large pilot plant. The study design was based upon modifying the Synthane Unit so that it would duplicate as closely as possible the size and capabilities of the grass roots large pilot plant (LPP) for CCG.

As in the grass roots case (described in previous monthly summaries) the revamped gasifier is 3.5' I.D. and can feed up to 92 T/D of Illinois No. 6 coal (as received). The size was set to permit scaleup to a pioneer commercial plant with acceptable risk (no demonstration plant). Also, as in the grass roots case, synthesis gas and catalyst are recycled to the gasifier to permit integrated operation of all key process steps.

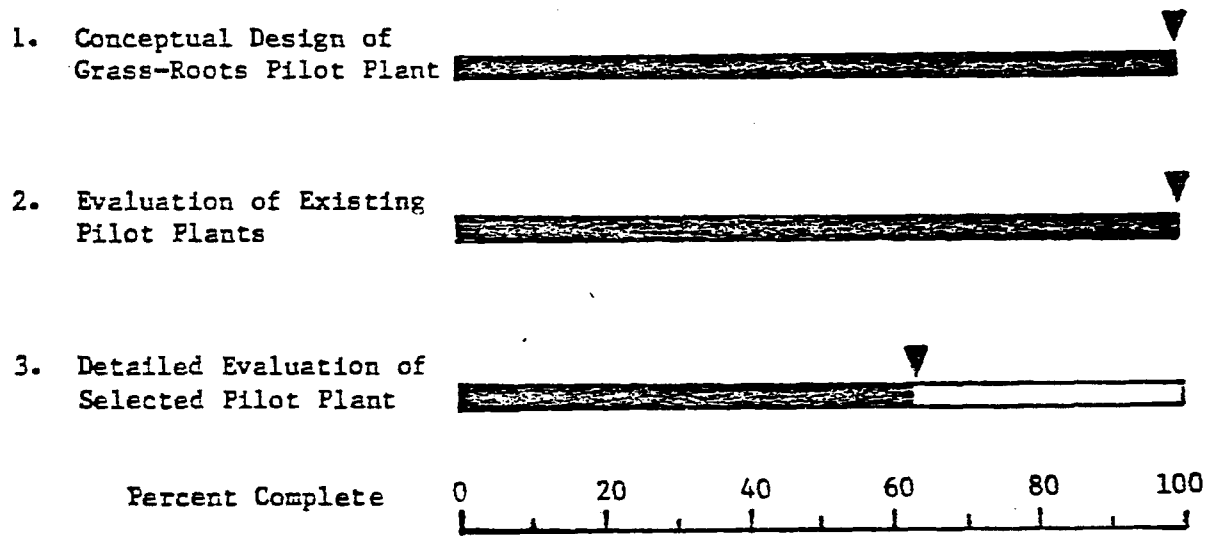
The investment required to modify the Synthane LPP for CCG operation is estimated to be 150 M$. As reported in the September monthly summary the cost for constructing a grass roots LPP at a Gulf Coast location is 130 M$. The higher cost to modify the Synthane Unit results primarily from the high labor costs for a revamp and the higher labor costs for the Pittsburgh area relative to the Gulf Coast. The cost of operating the revamped Synthane LPP is estimated to be 80 M$. This is about 10% higher than for the grass roots case.

SUMMARY OF PROGRESS THROUGH NOVEMBER, 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

DISCUSSION

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

No work scheduled in this category.

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)

A study design and cost estimate have been completed for a major revamp of the Synthane Coal gasification pilot plant which would allow it to be operated as a Catalytic Coal Gasification (CCG) large pilot plant. The study design was based upon modifying the Synthane unit so that it would duplicate as closely as possible the size and capabilities of the grass roots large pilot plant (LPP) for CCG.

As in the grass roots case (described in previous monthly summaries) the revamped gasifier is 3.5' I.D. and can feed up to 92 T/D of Illinois No. 6 coal (as received). The size was set to permit scaleup to a pioneer commercial plant with acceptable risk (no demonstration plant). Also as in the grass roots case synthesis gas and catalyst are recycled to the gasifier to permit integrated operation of all key process steps. However, due to site related limitations, certain features of the grass roots case could not be included in the Synthane revamp. These include a spare coal preparation train and the ability to feed coal at the design rate of 92 T/D when operating with once-through synthesis gas.

The investment required to modify the Synthane Unit for CCG operation is estimated to be 150 M$. An investment breakdown is presented in Table 1. The cost for constructing a grass roots LPP at a Gulf Coast location is 130 M$, as previously reported.

The investment for the Synthane revamp includes escalation to an April 1, 1983 startup. The escalation basis is presented in Table 2. The schedule for the revamp is presented in Figure 1. As in the grass roots case, this is based on obtaining LPP design data from a Process Development Unit (PDU) which begins operating in early 1979. The revamp schedule assumes prudent overlap with the PDU and any delay in PDU operations would delay the LPP schedule. The project execution time for the revamp is approximately four months longer than for a grass roots pilot plant. The incremental time reflects delays for removal and relocation of existing equipment. Construction time also has to be spread out because of the high manning levels and limitations on the number of field labor personnel that can be effectively utilized on the congested site.

The investment for the Synthane revamp is compared in Table 3 with the investment for the grass roots LPP on a Gulf Coast location. To further illustrate the difference between the two cases, the investment for the Gulf Coast grass roots facilities was adjusted to a Pittsburgh location basis. As shown in Table 3, on this basis the grass roots investment is 150 M$. It should be emphasized that this estimating approach reflects only the difference in labor conditions. It does not reflect other differences such as climate, terrain and specific site factors, and therefore, is not a true estimate of the cost of building a grass-roots LPP in the Pittsburgh area.

The direct cost for the revamp is 41.5 M$ on a 1Q77 basis. A breakdown of the direct cost components for each section of the plant is presented in Table 4. This compares to a direct cost of 47.0 M$ for the grass roots LPP at a Gulf Coast location and to 48.5 M$ for the grass roots facilities on a Pittsburgh estimating basis. Most of the savings are for materials and result from reuse of the coal feed and acid gas removal facilities, pipeways, and the control room. Smaller material savings were made in the areas of coal receipt, storage and preparation. Subcontracts - which are principally for refactory lining of vessels and furnaces, installation of solids handling equipment, buildings, and site preparation - were 8 M$ in all three cases. Direct labor charges, on the other hand, were higher for the Synthane revamp: 15.3 M$, versus 12.3 - 14.7 M$ for the grass roots cases. This is due to increased labor manhours resulting from the need to relocate or remove equipment, and lower labor productivity at a revamp site. In addition both Pittsburgh location cases reflect a higher general labor cost than for the U.S. Gulf Coast. A section by section breakdown of the combined costs for direct material and labor and subcontracts is presented along with comparable information for the grass-roots case in Table 5.

The savings in direct cost for the revamp is offset by increased indirect costs relative to the grass roots case. For example, the indirect costs for the revamp are 44.6 M$ compared to 40.4 M$ for the grass roots facilities on a Pittsburgh estimating basis and 35.5 M$ for a Gulf Coast basis. The increased indirect costs for the revamp are a result of the inefficiencies associated with a revamp project and differences in the productivity and payroll burden between the Gulf Coast and the Pittsburgh area.

As shown in Table 3, the escalation for the revamp is 34.2 M$ versus 32.9 M$ for Pittsburgh grass roots estimate and 23.2 M$ for the Gulf Coast grass roots case. The reason for the large difference between the Gulf Coast and Pittsburgh locations is a difference in labor escalation. The Gulf Coast grass roots case is based on the use of open-shop hiring, and under the terms of Davis-Bacon Act, a higher initial wage rate which is not subject to escalation after contract award. The revamp is based on a union shop with wage rate escalation over the course of the contract.

Estimated costs for 2 1/2 years of operation of the revamped Synthane unit are 80 M$. A year-by-year breakdown of the operating cost components is presented in Table 6, and information on the estimating basis is presented in Table 7. Overall, the operating cost for the Synthane revamp is approximately 10% higher than for the Gulf Coast, grass-roots CCG pilot plant. Principle cost increases are for fuel (17.4 vs. 11.0 M$) and maintenance (31.7 vs. 25.4 M$). There is a saving of 5.6 M$ in property taxes and land leasing costs for using the existing DOE property at Synthane.

The high cost for fuel at Synthane is the result of choosing LNG for feed to the synthesis gas generator (steam reformer). This choice was

made because pipeline natural gas was not available and the pipeline quality propane that is available, is not suitable without considerable treatment. Adding reating facilities would have increased investment and utilities requirements, and created equipment layout problems. The increased maintenance cost is attributable to the higher construction craft labor cost in the Pittsburgh area.

TABLE 1

INVESTMENT SUMMARY FOR
SYNTHANE REVAMP

Cost Breakdown	k$	
Material	18,300	
Labor	15,200	
Subcontracts	8,000	
Total Direct Costs (1Q77)		41,500
Payroll Burdens	7,200	
Field Labor Overheads	20,600	
Vendor Representatives	300	
Loss on Surplus	200	
Insurance	200	
Engineering	11,700	
Fees: Engineering, Construction & Royalty	4,400	
Total Indirect Costs (1Q77)		44,600
Total Prime Contract (1Q77)		86,100
Project Management Services		4,000
Escalation		24,200
		124,300
Project Contingency (20%)		24,900
Revamp Contingency		2,700
Total Erected Cost		151,900
CALL		150 M$

k = Thousand
M = Million

TABLE 2

BASIS FOR COST ESCALATION ESTIMATE - SYNTHANE REVAMP

Escalation Rates	Annual 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
5th year	5	7	7
6th year	—	7	—
Centroid	July 1981	Aug. 1982	July 1981
Time from Base Point (yrs.)	4.25	5.33	4.25
Cumulative escalation effect, percent	25	47	39

TABLE 3

TOTAL ERECTED COST COMPARISON
SYNTHANE REVAMP VERSUS GRASS ROOTS

Project Type	Revamp	Grass Roots	
Location	Bruceton, PA	Gulf Coast	Pittsburgh
Direct Costs, M$			
Material	18.3	27.0	26.0 (1)
Labor	15.2	12.3	14.7
Subcontracts	8.0	7.7	7.8
Direct Cost Total (1Q77)	41.5	47.0	48.5
Indirects	44.6	35.5	40.4
Project Management	4.0	3.8	4.1
Escalation	34.2	23.2	32.9
Total Cost Excluding Contingency	124.3	109.5	125.9
Project Contingency	24.9	21.9	25.2
Revamp Contingency	2.7	-	-
Total Erected Cost	151.9	131.4	151.1
CALL	150	130	150

Note:

(1) Lower material cost shown is to reflect sales tax differences between Pennsylvania and Texas.

TABLE 4

DIRECT COST SUMMARY - SYNTHANE REVAMP

	----- 1Q77 Bruceton, Pa. ----- Material kS	Labor kMH	Subcontract kS
Onsites			
• Catalyst Recovery	1,830	130	--
• Gasification	2,700	180	500
• Product Gas Cleanup	920	60	--
• Acid Gas Removal	270	20	--
• Methane Recovery	3,150	105	--
• Steam Reforming	690	50	940
• Preheat Furnace	250	20	890
• Common Facilities	430	60	390
• Onsite Dismantling	--	65	--
Total Onsites	10,240	690	2,720
Offsites			
• Coal Receipt & Preparation	770	60	50
• Waste Treating	1,260	140	110
• Electrical	340	20	190
• Safety	430	35	--
• Site Preparation	140	55	1,310
• Layout	180	40	50
• Buildings	10	5	1,410
• Potable, Industrial, & Firewater	280	30	160
• LNG, LPG, & Fuel Oil	510	40	20
• Cooling Water	360	35	80
• CO_2 & Inert Gas	370	65	--
• Boilers & Steam Distribution	2,420	170	1,790
• Compressed Air	520	50	--
• Chemical Handling	190	15	60
• Catalyst Handling	280	20	50
Total Offsites	8,060	780	5,280
Total Onsites & Offsites	18,300	1,470	8,000

TABLE 5

DIRECT COST BREAKDOWN
GRASS ROOTS VERSUS SYNTHANE REVAMP

Facilities	1Q77 Costs, k$[3] Grass-Roots (Gulf Coast)	Synthane Revamp	Comments on Revamp
Onsites			
Coal Feed	1,595	----	Existing can be used at Synthane
Gasification	4,870	5,690	2 times labor for major revamp
Steam Reformer	2,415	2,320	Synthane units must handle dual fuels
Preheat Furnace	1,270	1,415	Synthane units must handle dual fuels
Product Gas Cleanup	1,465	1,750	2 times labor for major revamp
Acid Gas Removal	2,655	545	New absorber
Methane Recovery	4,015	4,600	Duplicate of Grass Roots
Catalyst Recovery	2,650	3,625	Duplicate of Grass Roots
Common Facilities	2,215	1,650	Substantially less material
Unused Equipment Dismantling	--	900	Primarily methanation
Total Onsites	23,150	22,495	
Offsites			
Coal Receipt & Storage	3,185	--	Existing at Synthane
Coal Preparation	4,850	1,650	Only one train
Catalyst Handling	520	605	Duplicate of Grass Roots
Utilities			
Interconnecting Lines[1]	3,580	--	
Steam & BFW[2]	825	6,560	Relocation & major expansion
CO_2 and Inert Gas[2]	10	1,270	Relocation
Compressed Air	1,010	1,210	Relocation & expansion
Fuel Systems[2]	250	1,085	Pipeline NG not available
Cooling Water	735	925	Relocation & major expansion
Fire Protection	490	855	Includes all water systems
Chemicals Handling	320	455	Relocation & expansion
Electrical	1,450	805	Expansion & upgrading
Waste Water Treating	3,320	3,305	Smaller - some existing reused
Safety	510	915	Expansion
Buildings	1,610	1,490	Relocation
Layout	2,085	780	Expansion/compact
Site Preparation	1,080	2,210	Hilly terrain at Bruceton
Total Offsites	25,830	24,120	
Total Direct Costs	48,980	46,615	

Notes:

(1) Steam, nitrogen and fuel gas are supplied to the pilot plant and fuel gas product and acid gas streams are returned to the refinery.

(2) For the grass roots case, costs listed are for distribution lines within the pilot plant boundaries.

(3) Direct costs in this table include payroll burden on direct labor (2.0 M$ for grass-roots case and 5.1 M$ for Synthane case). Thus, the total direct cost for Synthane presented here is 5.1 M$ higher than the direct cost present in Table 1, where payroll burden for direct labor and field supervision is shown as a separate item.

TABLE 6

OPERATING COST SUMMARY - SYNTHANE REVAMP

	2nd Half 1980	1981	1982	1983	1984	1st Half 1985	Total
	k$						
• Raw Materials							
- Coal (Illinois)	-	-	-	168	441	419	
- Catalyst (K_2CO_3 Sol'n)	-	-	-	251	293	164	
Total Raw Materials	0	0	0	419	734	583	1736
• Transportation							
- Coal	-	-	-	296	775	736	
- Catalyst	-	-	-	22	26	15	
Total Transportation	0	0	0	318	801	751	1870
• Salaries, Wages, Benefits, and Support Services							
-	259	709	3500	7859	8219	4354	
Total S,W,B, and SS	259	709	3500	7859	8219	4354	24,900
• Administrative							
- Miscellaneous	10	80	155	185	195	98	
Total Administrative	10	80	155	185	195	98	723
• Technical							
- Miscellaneous	-	-	25	200	200	100	
Total Technical	0	0	25	200	200	100	525
• Process Operations							
- Catalyst & Chemicals	-	-	-	186	312	212	
- Utilities	-	-	-	5449	7441	4531	
- Process Services	-	-	10	34	35	35	
- Miscellaneous	-	-	20	20	20	20	
Total Process Operations	0	0	30	5689	7808	4798	18,325
• Mechanical							
- Labor	-	-	-	5639	5400	2374	
- Material	-	-	1000	6864	6572	2885	
- Miscellaneous	-	-	200	300	300	130	
Total Mechanical	0	0	1200	12803	12272	5389	31664
GRAND TOTAL	269	789	4910	27473	30229	16073	79743

TABLE 7

OPERATING COST ESTIMATING BASIS - SYNTHANE REVAMP

Raw Materials

- Coal
  - Illinois No. 6 Bituminous
  - 1980 price - $22.50/ST
  - 15% contingency on annual requirements
  - escalated at 6.6% per year
- Catalyst
  - 47 wt% K_2CO_3 solution
  - 1976 price - $152/ST
  - 15% contingency on annual requirements
  - escalated at 6.6% per year

Transportation

- Coal
  - spot-shipment by rail from St. Louis to local supplier in Pittsburgh area
  - truck shipment from local supplier to plant site
  - 1977 rail shipping cost of $22.40/ST
  - 1977 truck shipping cost of $10.25/ST
  - escalated at 6.6% per year
- Catalyst
  - truck shipment from Niagara Falls to Pittsburgh
  - 1976 truck shipping cost of $13.60/ST
  - escalated at 6.6% per year

Salaries, Wages, Benefits, and Support Services

- Salaries, Wages, and Benefits
  - staff composed of 29 professionals and 70 technicians/operators during the 2½-year operating period
  - increasing portion of staff deployed onsite during the 2½-year engineering and construction period
  - salaries, wages, and benefits based on projected rates through 1982 and escalated at 6.6% per year through 1985

- Process and Technical Consultation

  - staff composed of 6 professionals during the 2½-year operating period
  - costs based on projected engineering billing rates

- Relocation Costs

  - relocate 13 professionals to and from Pittsburgh

Administrative

- Miscellaneous

  - office supplies
  - telephone service
  - plant security
  - travel

Technical

- Miscellaneous

  - laboratory technician salaries
  - supplies and services

Process Operations

- Catalysts and Chemicals

  - current costs obtained from Chemical Marketing Reporter
  - 15% contingency on annual requirements
  - escalation at 6.6% per year

- Utilities

  - electric power
  - potable water
  - industrial water

  } purchased from West Penn at prevailing rates

  - LNG
  - LPG
  - No. 2 fuel oil
  - liquid CO_2

  } purchased from local supplier at prevailing rates

  - 15% contingency on annual requirements
  - escalation at 6.6% per year

- Process Services

  - char disposal
  - fire fighting service

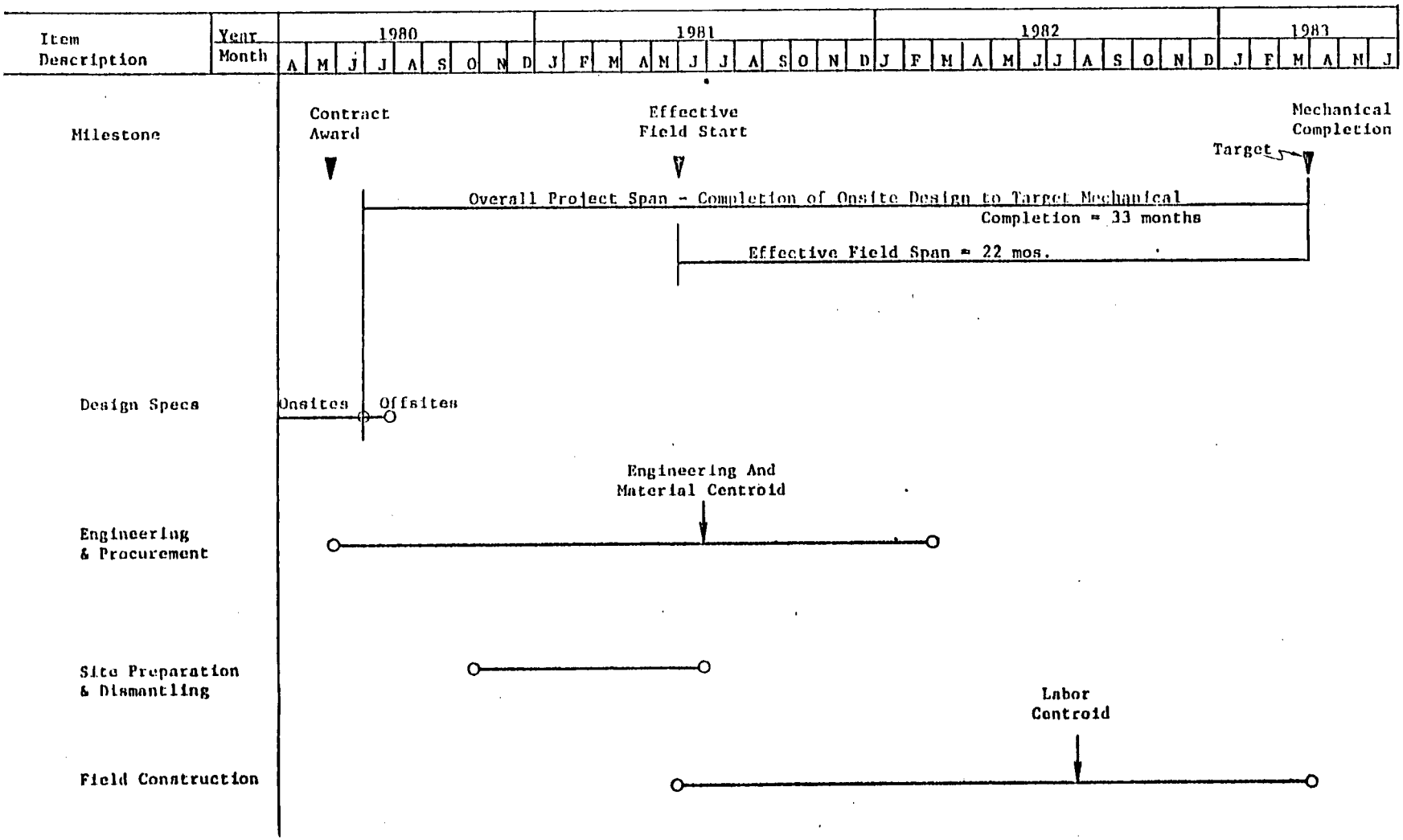
- Miscellaneous
  - radio system maintenance
  - safety equipment
  - tools
  - supplies

Mechanical

- Contract Labor and Supervision
  - direct mechanical labor based on an average of 175 men during plant operating period
  - one supervisor required for every ten direct labor men
  - wage rates based on current data from Synthane
  - escalation at 6.6% per year
- Maintenance Material
  - based on 150% of direct labor costs
- Miscellaneous
  - equipment rentals
  - supplies

FIGURE 1

ENGINEERING AND CONSTRUCTION SCHEDULE - SYNTHANE REVAMP



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