FE-2012-096
May 1980

PIPELINE GAS DEMONSTRATION PLANT

Phase I

ABBREVIATED VERSION OF

PROCESS EVALUATION REPORT

CONCEPTUAL COMMERCIAL PLANT

SECTION 6

BASELINE ECONOMIC EVALUATION

ROBERT J. EBY

ILLINOIS COAL GASIFICATION GROUP

122 S. MICHIGAN AVENUE
SUITE 2014
CHICAGO, ILLINOIS 60603
(312) 431-4925

Date Published - May 1980

PREPARED FOR THE
UNITED STATES DEPARTMENT OF ENERGY
(ENERGY TECHNOLOGY, FOSSIL ENERGY, COAL CONVERSION)

UNDER CONTRACT NO. EF-77-C-01-2012

PROCESS EVALUATION REPORT
CONCEPTUAL COMMERCIAL PLANT

This Process Evaluation Report (PER) contains the results and recommendations of comprehensive analyses and studies which were made to optimize the ICGG Commercial Plant Baseline Process Concept for producing synthetic pipeline gas (SPG) from coal. Design studies to optimize the thermal efficiency and economic attractiveness of the COGAS Process Areas of the plant were conducted along with design studies and trade-off studies of available process subsystems to complement the COGAS Process Areas. The results, recommendations and description of the work accomplished in developing the PER are contained in six separately bound sections of the PER which are summarized as follows:

Section 1 - Executive Summary

This section provides an overview of the total PER and presents results, recommendations and conclusions in a brief format.

Section 2 - Process Analysis - Commercial Plant Concept

This section gives a brief description of plant size, configuration, feedstocks, operating conditions, products and by-products for the Commercial Plant Concept.

Section 3 - Process Design Studies

This section describes various design studies which were conducted to optimize the COGAS Process Areas and other plant areas.

Section 4 - Trade-off Studies

This section describes those trade-off studies which were made to select processes which would best complement the COGAS Process Areas and provide the most efficient and economical Commercial Plant Concept.

Section 5 - Baseline Process Concept

This section describes the ICGG Commercial Plant Baseline Process Concept which was developed from the Tentative Baseline Design (TBD) and was used as a standard for measuring the results of the Process Design Studies and Trade-off Studies.

Section 6 - Baseline Economic Evaluation

This section describes an economic evaluation which has been performed for the Commercial Plant Baseline Process Concept, described in Section 5.

TABLE OF CONTENTS

Subsection	Title	Page
6.1	Economic Summary	6-1
6.2	Basis of Estimate	6-3
6.3	Capital Requirement	6-5
6.4	Operating Cost Estimate	6-14
6.5	Gas Cost Estimate	6-34
6.6	Unit Costs of Utilities	6-39
6.7	Sensitivity Analysis	6-46

6.1 Economic Summary

The Commercial Plant capital requirement is defined as the summation of the costs for the categories listed in Figure 6.1-1 and is estimated at $1,550,602,000. These costs are all expressed in year end-1977 dollars and are described in detail in Subsection 6.3. The total plant investment cost, which is the capital requirement less the sum of the working capital, interest during construction and the costs of land, start-up and administration, amounts to $1,450,486,000 or 93.6% of the capital requirement.

Capital Requirement Category	Category Costs	Percentage
Construction Plans and Drawings	$ 91,391	5.9%
Site Preparation	10,000	0.6
Plant Construction	1,263,959	81.6
Construction Engineering	85,136	5.5
Subtotal-Plant Investment Cost	$ 1,450,486	93.6%
Land	$ 1,438	0.1%
Start-up	34,704	2.2
Administration	3,500	0.2
Working Capital	60,474	3.9
Total Capital Requirement*	$ 1,550,602	100.0%

*Interest during construction ($207,238,000) is not included. See Subsection 6.3.8.

Figure 6.1-1 Commercial Plant Capital Requirement
(Thousands of Dollars)

The operating cost for the Commercial Plant is based on a 20 year plant design life, operating for 330 days per year (90.4% plant effectiveness) with an overall thermal efficiency of 62.4% (see Figure 6.4-1). The operating cost is defined by classifications as shown in Figure 6.1-2 for a total cost of $157,017,409 per year. These costs are expressed in year end 1977 dollars and are described in Subsection 6.4.

6.1 Economic Summary (Cont'd)

Cost Classification	Annual Cost (Dollars)
Coal	$213,342,525
Labor	20,854,796
Chemicals and Catalysts	18,204,602
Insurance and Taxes	9,173,160
Repairs and Replacements	35,882,000
Other Operating Supplies	1,964,000
Royalties	3,218,820
Gross Operating Cost	302,639,903
Less Utilities (Credit)	(3,739,400)
Less By-products (Credit)	(141,883,094)
Net Operating Cost	$157,017,409

Figure 6.1-2 Annual Operating Cost for Commercial Plant

The Commercial Plant gas cost is computed on the net present value analysis basis using the "revenue requirement" method. A discount rate of 9% is used in the calculation. The revenue requirement method determines the lowest gas selling price per MM Btu which will recover all costs incurred during the twenty-five year project life. The selling price in year end 1977 dollars is $4.597 per MM Btu, as shown in Figure 6.5-1 of Subsection 6.5.

6.2 Basis of Estimate

The following considerations were used throughout the total capital requirement development:

- End-1977 dollars.
- Solicited quotations on highly specialized equipment.
- In-house estimates on other equipment, materials and labor.
- Factored total constructed cost based on equipment cost by area. The factors vary depending on equipment make-up and the characteristics of the process.
- Preliminary Geo-Technical and Hydrological Survey observations.

The following categories were used to develop the total capital requirements as described in Subsection 6.3:

Subsections	Capital Requirement Category
6.3.1	Construction Plans and Drawings
6.3.2	Land
6.3.3	Site Acquisition and Preparation
6.3.4	Plant Construction
6.3.5	Engineering and Start-up
6.3.6	Administration up to Plant Commissioning
6.3.7	Working Capital
6.3.8	Interest During Construction

Within each capital requirement category, the individual cost elements are identified and the cost estimated.

The operating costs are based on the following considerations:

- End 1977 dollars.
- 20-year Commercial Plant design life.
- 62.4% overall thermal efficiency.
- 90.4% plant effectiveness.

The operating costs are defined as the day to day expenses for the following categories:

Subsection	Operating Cost Category
6.4.1	Coal
6.4.2	Labor
6.4.3	Chemicals and Catalysts
6.4.4	Insurance and Taxes
6.4.5	Repairs and Replacements
6.4.6	Utilities
6.4.7	Other Operating Supplies
6.4.8	By-products
6.4.9	Royalties

6.2 Basis of Estimate (Cont'd)

Within each operating cost category, the individual cost elements are identified and the cost estimated.

The gas cost for the Commercial Plant is calculated using a 9% discount rate, based on the revenue requirement method. The following assumptions were used to develop the gas cost:

- 25-year project life (design, construction and operation).
- Straight line depreciation over a 20-year period.
- The rate of return, interest rate, percent of debt, federal income tax rate, state income tax rate are reflected in the 9% overall discount rate.

The utility cost units were developed for use in the trade-off studies. The capital requirement and labor cost associated with each utility category were derived from a 1975 estimate and escalated to 1977 dollars. A 20-year straight line depreciation on capital investment and a modified utility financing method excluding the tax, insurance, interest and return were used to calculate the average utility cost.

6.3 Capital Requirement

6.3.1 Construction Plans and Drawings

The cost of construction plans and drawings is defined as the total engineering effort taking place prior to the beginning of plant construction. Elements of this cost include:

- Process and Engineering Flow Diagrams
- Energy and Material Balances
- Plant Layout
- Engineering for all "Bulk Items," i.e., painting, piping, instrumentation, structural, electrical, HVAC, and similar considerations
- Equipment Listing
- Development of Bid Packages

The cost of engineering services for the Commercial Plant was estimated based on experience with similar large engineering and construction projects. The cost of construction plans and drawings (preconstruction engineering) was developed based on the ratio of preconstruction engineering to total engineering developed for the 1975 estimate. This fraction (0.81) was applied to the total Commercial Plant engineering estimate of $107,456,000 to derive the preconstruction engineering estimate of $87,039,000, adding the G&A and fee of $4,352,000 gives a total of $91,391,000 for the estimated cost of construction plans and drawings. The remainder of the cost of engineering services of $20,417,000 is the estimated cost less G&A cost plus fee of engineering during construction. The G&A cost plus fee for this portion of the engineering is developed in Subsection 6.3.5.

6.3.2 Land

Land requirements for the Commercial Plant were defined as 1750 acres, which consist of process plant site, offsite, roadway, and buffer zone acreage. The 20 mile pipeline route from the plant site to the Mississippi River will be 25 feet wide. Acquisition cost estimates for land were made by utilizing a price per acre of $750 to $1000 verbally quoted by the present owners of the land. The $750 per acre price was assumed to apply to reclaimed strip-mined land, while the higher figure applied to virgin land. At the site being considered, 1250 acres of reclaimed strip-mined land are available for the Commercial Plant. The balance of the land required, 500 acres, will have to be virgin land. This yields a complete site cost for the Commercial Plant of $1,438,000.

6.3 Capital Requirement

6.3.3 Site Acquisition and Preparation

The cost of site acquisition and preparation is defined as all costs associated with the search for a suitable site (i.e., the fees, licenses, and other costs associated with acquiring the land), plus the preparation of the site for construction of the Commercial Plant. The cost of land is included under Subsection 6.3.2. Site selection costs are assumed to be minimal for the Commercial Plant since the original site selection for the Demonstration Plant considered both plants. Site acquisition costs have similarly been assumed to be minimal. Site preparation costs were estimated based on fragmentary information regarding site conditions to be $10,000,000.

6.3.4 Plant Construction

The investment cost for plant construction is defined as the sum of the following cost elements:

- Equipment Costs
- Construction Material Costs
- Field Labor for Installation and Erection

The following subsections will describe the cost details for the above elements and identify the source of each cost estimate.

6.3.4.1 Equipment Costs

The investment cost for the Commercial Plant equipment is defined as the cost of all equipment identified by the Equipment List in Subsection 5.8. Selected suppliers (i.e., both vendors and manufacturers) were contacted for quotations on certain equipment items. Replies were received for 75% of these inquired items which represent approximately 50% of the total equipment cost. The balance was estimated estimated based upon in-house experience in recently purchased identical or comparable items of equipment. Figure 6.3-1 summarizes the equipment cost by process area for the Commercial Plant.

The total delivered equipment cost (in Thousands of Year End 1977 Dollars) was determined as follows:

Equipment Listing Cost Breakdown	$589,088
Freight-In	9,300
Procurement	1,515
Total Delivered Equipment Cost	$599,903

6.3 Capital Requirement

Process Area Number and Description	Equipment Cost	Total Constructed Cost
101 Coal Unloading and Handling	$ 9,833	$ 13,133
102 Coal Preparation	22,367	54,586
103 Pyrolysis and Gasification	86,811	200,462
104 Oil Recovery and Treatment	97,717	197,846
105 Gas Purification	45,666	67,633
106 Hydrogen Generation	5,138	10,043
107 Shift and Methanation	20,994	40,460
108 Bulk CO_2 Removal	6,871	16,084
109 Gas Compression and Dehydration	7,909	11,424
110 Flue Gas Power Recovery	106,402	148,669
111 SO_2 Removal	26,204	76,172
112 Sulfur Recovery	15,271	21,223
113 Ammonia Recovery	1,122	3,772
114 Thermal Oxidizer & Flare	1,650	3,265
115 Utilities	75,520	117,658
116 Water Supplies	1,114	23,798
117 Water Treatment Systems	6,113	16,102
118 Waste Treatment and Disposal	13,070	30,798
119 Fire Protection System	695	5,597
120 Major Facilities	38,621	63,787
Miscellaneous Yard Facilities		135,566
Insurance & Procurement		5,881
Total	$589,088	$1,263,959

Figure 6.3-1 Summary of Commercial Plant Equipment Cost and Total Constructed Cost (Thousands of Year End 1977 Dollars).

6.3 Capital Requirement

6.3.4.2 Construction Materials Cost

Construction materials are defined as any purchased goods used in plant construction, in Subsection 5.8 but not included in the Equipment List. Typical examples of these items include instrumentation, piping, insulation, paint, buildings, foundations, concrete, structural steel, electrical installation, small tools, temporary construction, and unallocated construction supplies and equipment.

SUBCONTRACTED SERVICES

The estimated costs in year end 1977 dollars for the work in the following list to be performed or supplied by subcontractors are:

Function	Estimated Cost (Thousands of Dollars)
HVAC	$ 2,067
Insulation	63,112
Piling-Special Foundations	19,055
Site Work	4,929
Architectural	3,307
Fireproofing	3,998
Electrical	27,292
Temporary Construction Miscellaneous Field Expense	4,254
TOTAL	128,014

6.3 Capital Requirement

OTHER DELIVERED MATERIALS

The following list of additional construction materials, not included under the above Subcontracted Services, is needed to complete plant construction. The estimated cost in year end 1977 dollars is shown opposite each material listing.

Category/Material	Estimated Cost (Thousands of Dollars)
Instrumentation	$ 16,639
Piping	108,950
Painting	1,006
Site Work Materials	1,733
Concrete	14,045
Structural Steel	49,528
Building Materials	4,964
Electrical	29,333
Construction Equipment Rental, Small Tools, Miscellaneous, and Overhead	33,774
Freight-In	4,495
Procurement	928
Insurance	3,438
Total	$268,833

6.3.4.3 Installation and Erection

The costs of installation and erection are defined as the cost of labor to transform the delivered construction material and the purchased equipment items into an operable coal gasification plant. This estimate is based upon actual productivity experience with field labor in southern Illinois, the magnitude of the job, and experience with installation and erection of similar equipment items. This category of cost can be broken down as follows:

6.3 Capital Requirement

6.3.4.3 Installation and Erection (Cont'd)

Field Labor to Install or Erect	Estimated Cost* (Thousands of Dollars)
Equipment	$ 13,567
Instrumentation	3,636
Piping	120,019
Painting	4,038
Site Work	3,122
Concrete	34,048
Structural Steel	11,308
Buildings	4,359
Craft showup, overtime pay, cleanup labor, temporary and unallocated	7,255
Field Payroll Burden	49,857
Construction Management & Supervision	16,000
Total Installation & Erection Labor	$267,209

*In Year End 1977 Dollars

6.3 - Capital Requirement

6.3.5 Engineering and Startup Costs

Engineering and Startup costs are composed of three elements: (1) all engineering costs occurring during construction, (2) the construction contractor's fee, and (3) the cost of startup. This cost category does not include the pre-construction engineering discussed in Subsection 6.3.1.

The Construction Engineering cost is defined as the cost of the engineering during construction, the associated G&A cost plus fee and the construction subcontractor's G&A cost plus fee on the total materials and labor for the Commercial Plant.

In Subsection 6.3.1 the cost of engineering during construction was determined to be $20,417,000. The G&A cost plus fee for this work at 5% is $1,021,000.

The construction subcontractor's G&A cost plus fee is based on the sum of the plant construction and site preparation cost, which is $1,273,959,000. At 5% this gives a G&A cost plus fee of $63,698,000.

The construction engineering cost of $85,136,000 is the summation of the costs for engineering during construction of $20,417,000, its associate G&A cost plus fee of $1,021,000 and the construction subcontractor's G&A cost plus fee of $63,698,000.

Start-up costs were estimated as detailed in Figure 6.3-2 to total $34,704,000. A total start-up period of six months was assumed to bring the plant up to a 90% level of effectiveness.

6.3 Capital Requirement

6.3.5 Engineering and Startup Costs (Cont'd)

Cost Category	Months of Costs Incurred	Estimated Cost (thousands of dollars)
Coal	3 months	$53,337
Chemicals and Catalysts	3 months	4,632
Labor	6 months	10,427
Insurance and Taxes	6 months	4,587
Utilities	6 months	385
Operating Supplies	6 months	982
Repairs and Replacements	6 months	17,941
Royalty	1 1/2 months	402
	Subtotal	92,693
By-Product Revenue Credit	1 1/2 months	(17,754)
Gas Revenue Credit	1 1/2 months	(40,235)
	Total Start-up	$ 34,704

Figure 6.3-2

*In Year End 1977 Dollars

6.3.6 Administration and Inspection Prior to Plant Commissioning

Administration and inspection prior to plant commissioning is assumed to be the owner surveillance of engineering and construction. This cost was assumed to occur from the beginning of design through the beginning of start-up i.e., a total of 4-1/2 years. Illinois Coal Gasification Group was assumed to have twenty people involved in this task for the first two years of design and construction. For the third and fourth years twenty-two and twenty-four people would be required respectively.

The last 6 months prior to start-up would have 28 professionals working on this task.

6.3 Capital Requirement

6.3.6 Administration Prior to Plant Commissioning (Cont'd)

The annual cost with loading for each professional was estimated to be $35,000. The following calculations develop the total cost for this category:

Year	Professionals	$ Total Cost at 35,000/employee
1	20	$700,000
2	20	700,000
3	22	770,000
4	24	840,000
5 (first 6 months)	28	490,000
	Total Administration Cost	$3,500,000

6.3.7 Working Capital

Working capital is defined as the investment in net current assets. This consists of the sum of inventories, accounts receivable cash equivalents and net of accounts payable. The working capital cost of $60,474,000, which was assumed to be 3.9 percent of the total ($1,550,602,000) sum of the capital requirement categories total detailed in Subsections 6.3.1 through 6.3.7 inclusive. The 3.9 percent was derived from the ICGG proposal to ERDA dated February 4, 1976, which evaluated the impact of inventories, accounts receivable, cash equivalents and net of accounts payable on the working capital requirements.

6.3.8 Interest During Construction

The interest during construction is defined as the product of the plant investment cost, the annual interest rate and the average spending period in years. Quantifying these terms for the Commercial Plant results in an interest cost of $207,238,000, where the plant investment cost is $1,450,486,000 (See Subsection 6.1), the interest rate of 9% per annum and the average spending period is slightly over 19 months. The interest during construction is included in the 9% discount rate indicated in the government guidelines and thus not included as a separate item in the revenue requirement analysis.

6.4 -Operating Cost Estimate

Operating costs for the Commercial Plant are defined as the summation of day-to-day expenses in the following cost categories:

Subsection	Operating Cost Category
6.4.1	Coal
6.4.2	Labor
6.4.3	Chemicals and Catalysts
6.4.4	Insurance and Taxes
6.4.5	Repairs and Replacements
6.4.6	Utilities
6.4.7	Other Operating Supplies
6.4.8	By-products
6.4.9	Royalties

Revenue from the sale of process by-products (See Subsection 6.4.8) is applied as a credit against the operating expenses on a yearly basis to derive a net annual operating cost for the Commercial Plant.

Within each of the aforementioned operating cost categories, the individual cost elements are identified and estimated, with the basis and source of estimation identified. All costs are developed based upon the following considerations:

- End 1977 dollars
- 20-year Commercial Plant design life
- 62.4% overall thermal efficiency (See Figure 6.4-1)
- 90.4% plant effectiveness (330 days per year operation)

The summation of all expenses and credits (See Figure 6.4-2) identifies an annual operating cost of $157,017,409 for the Commercial Plant.

Based on the plant output of 80,546,000 MM Btu per year in the synthetic pipeline gas, the operating cost component of the gas price is $1.949/MM Btu.

6.4.1 Coal

The operating cost for coal feedstock delivered to the Commercial Plant is defined as the combination of: (1) selling price of coal F.O.B. the mine sites and (2) transportation charges

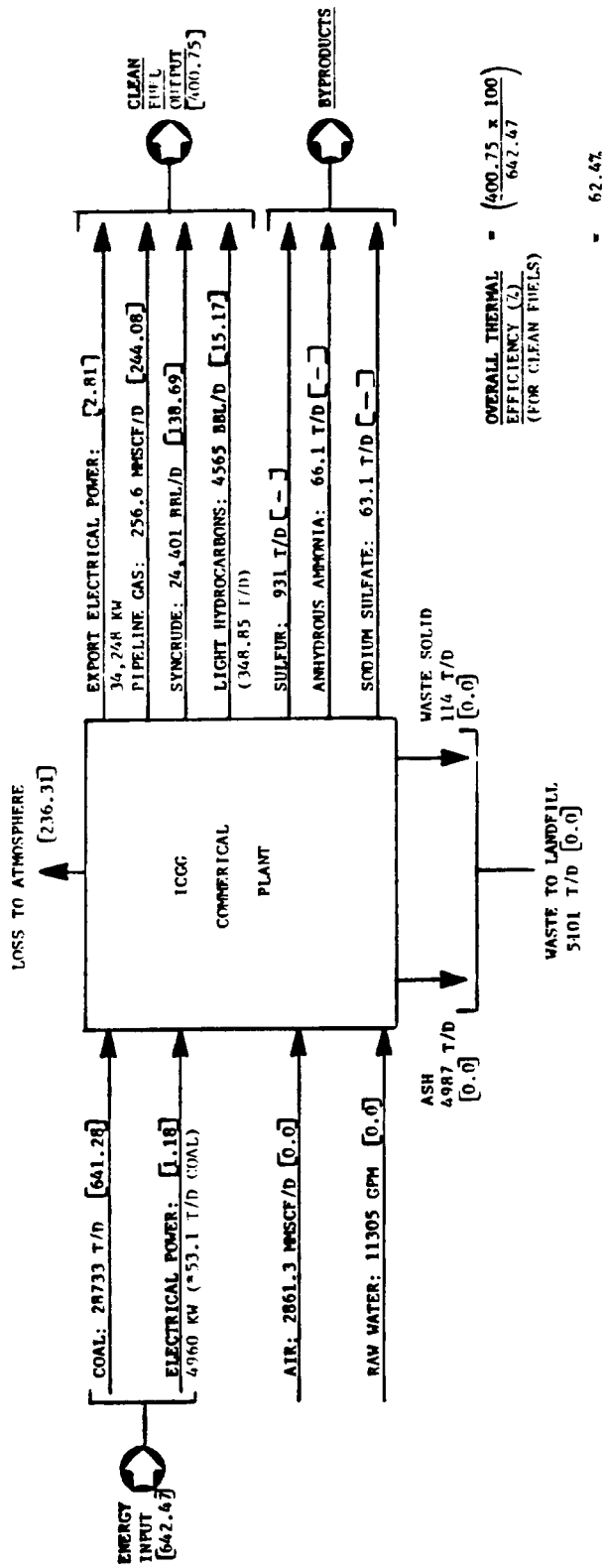


Figure 6.4-1

Overall Energy Balance for Commercial Plant

Cost Classification	Annual Cost* (Dollars)	Percent of Gross Operating Cost	$/MM Btu
Coal	$213,342,525	70.5%	2.649
Labor	20,854,796	6.8%	0.259
Chemicals and Catalysts	18,204,602	6.1	0.226
Insurance and Taxes	9,173,160	3.0	0.114
Repairs and Replacements	35,882,000	11.9	0.445
Other Operating Supplies	1,964,000	.6	0.024
Royalties	3,218,820	1.1	0.040
Gross Operating Cost	$302,639,903	100.0	3.757
Less Utilities (Credit)	($3,739,400)	(1.2)	(0.046)
Less Byproducts (Credit)	($141,883,094)	(46.9)	(1.762)
Net Operating Cost	$157,017,409	51.9%	1.949

Figure 6.4-2 Summary of Annual Operating Costs for Commercial Plant
*In Year End 1977 Dollars

6.4 Operating Cost Estimate

6.4.1 Coal (Cont'd)

for shipping coal from the mine sites to the Commercial Plant site.

Based on a coal feedstock requirement of 28,733 TPD (See Figure 6.4.-1), the annual coal consumption will be 9,481,890 tons. This large quantity can be purchased from five suppliers. The average delivered cost of coal feedstock is $22.50 per ton which results in a total annual operating coal cost for the Commercial Plant of $213,342,525. Dividing the annual coal cost by 80,546,000 MM/Btu output of the synthetic pipeline gas yields the operating cost component of the gas price from coal as $2.649/MM Btu.

6.4.2 Labor

The operating cost for labor for the Commercial Plant is defined as the combined total of: (1) direct wages with inside payroll fringe benefits (i.e., computed on an annual base of 2080 hours per employee which includes vacation, holidays, and sick-leave), and (2) outside-payroll fringe benefits (i.e., insurance, pensions, and all other employee benefits), for all personnel staffing of the plant.

The annual operating cost for labor is based on the average plant staffing for a typical year of Commercial Plant operation.

Labor rates are derived, primarily, from two sources: (1) The Peoples Gas Light and Coke Company (PGL) and (2) Illinois State Department of Energy (ISDE). Management and clerical labor rates are based on the mid-range of existing pay scales at PGL in Chicago, Illinois, for comparable level positions. Operating and maintenance labor rates were furnished by ISDE as appropriate skill classification averages for the plant location. Additional sources were Central Illinois Public Service Company and the Bureau of Labor Statistics, which were used to confirm the realism of the labor rates utilized for this report. Figure 6.4-3 shows the labor rate breakdown by classification, identifying the hourly and annual wages (based on 2080 hours per year) for all plant personnel.

The inside-payroll fringe benefits are detailed in the annual salary rates identified in Figure 6.4-3, whereas the outside-payroll fringe benefits are defined in Figure 6.4-4 and applied as a gross factor in Figure 6.4-3.

6.0 Baseline Economic Evaluation

FE-2012-096
May 1980

6.4 Operating Cost Estimate

Title	Quantity Regular	Quantity Shift	Hourly (Shift Factor 1.2)	Source of Rate	Annual Salary
General Manager	1		31.06	PGL	$ 64,610
Secretary	1		7.76	PGL	16,143
Plant Manager	1		22.62	PGL	47,052
Manager - Engineering	1		14.95	PGL	31,102
Manager - Maintenance	1		14.95	PGL	31,102
Manager - Operations	1		14.95	PGL	31,102
Manager - Environmental Control	1		13.49	PGL	28,062
Manager - Accounting	1		13.49	PGL	28,062
Manager - Purchasing	1		13.49	PGL	28,062
Manager - Building & Grounds	1		13.49	PGL	28,062
Manager - Personnel	1		13.49	PGL	28,062
Manager - Public Relations	1		13.49	PGL	28,062
Clerical	32		6.02	PGL	400,719
Staff	26		8.93	PGL	483,044
Supervisor - Process Engineer	1		11.61	PGL	24,154
Supervisor - Mechanical Engineer	1		11.61	PGL	24,154
Supervisor - Drafting	1		11.61	PGL	24,154
Supervisor - Computer	1		11.61	PGL	24,154
Supervisor - Maintenance	3		11.61	PGL	72,458
Supervisor Instrument and Elect. (a)	1		11.61	PGL	24,154
(b)	5		10.86	PGL	112,921
Supervisor - Contract Maintenance Coordinator	1		11.61	PGL	24,154
Supervisor - Operating	3		11.61	PGL	72,458
Maintenance Engineer	3		10.86	PGL	67,753
Planners	6		10.86	PGL	135,505
Instrument Specialists	60		8.94	CIPS	1,116,163
Plant Engineer	3		11.61	PGL	72,458
Shift Foreman		12	10.86	PGL	271,007
Nurse		4	7.52	ILL	64,854
Safety		8	8.93	PGL	148,629
Storekeeper	1		8.93	PGL	18,580
Chief Chemist	1		11.61	PGL	24,153
Engineers - Process	9		9.65	ILL	180,671
Technician	3		7.23	ILL	45,096
Engineers - Mechanical	3		10.31	ILL	64,351
Technician	1		7.23	ILL	15,032
Drafting Staff	6		7.31	ILL	91,204
Consulting Specialists	2		10.86	PGL	45,169
Computer Staff	4		6.83	ILL	56,847
Chemist	2	4	8.93	PGL	111,472
Technician	4	24	7.86	PGL	457,977
Maintenance Foreman	30	4	10.13	PGL	716,169
Welding	78	8	8.89	CIPS	1,594,928
Mechanical Shop & Garage	24	4	8.76	ILL	512,763
Machinery	50	8	7.71	ILL	935,367
Pipefitters	75	12	7.99	ILL	1,453,686
General Labor	50	8	5.94	ILL	720,163
Refractory & Insulation	60	8	9.67	ILL	1,400,544
Operator	38	316	6.80	ILL	5,170,524
Chief Operator	2	36	10.41	ILL	851,257
Storekeeper Staff	12		6.97	ILL	174,013
Buildings & Grounds Staff	5		5.13	BLS	53,324
	619 + 456 = 1,075 Total Employees			Sub-Total	$18,245,666
				Overall Fringe at 14.3%	2,609,130
				Total	$20,854,796
			Labor Cost = $20,854,796/year / 80,546,000/MM Btu/year = $0.259/MM Btu		

Source: PGL The Peoples Gas Light and Coke Company
ILL State of Illinois, Department of Energy
CIPS Central Illinois Public Service Company
BLS Bureau of Labor Statistics

Figure 6.4-3 ICGG Commercial Plant Labor Costs

6.4 Operating Cost Estimate

6.4.2 Labor (Cont'd)

The fringe benefits are based on a level of benefits consistent with the industrial environment of the plant location area. Figure 6.4.5 summarizes the labor cost breakdown according to the four major plant functions - Administration, Engineering, Maintenance and Operations.

The total annual operating labor cost for the Commercial Plant is $20,854,796, yielding a gas cost component of $0.259/MM Btu based on the annual process yield of 80,546,000 MM Btu for synthetic pipeline gas.

Benefit Costs Outside-Payroll	% of Base Pay
Retirement Plan	5.0%
Group Medical Insurance	1.1%
Group Life Insurance	0.6%
Non-Occupational Disability	0.8%
Other Insurance	---
Other Miscellaneous	---
Federal and State Unemployment Tax	1.0%
Social Security Tax (1977)	5.8%
Total	14.3%

Figure 6.4-4 Commercial Plant Outside Payroll Fringe Benefits

Functional Area	Salary	Fringe	Total Annual	$MM/Btu
Administration	$1,206,080	$ 172,470	$ 1,378,550	$0.107
Engineering	1,282,356	183,376	1,465,732	0.018
Maintenance	9,210,579	1,317,113	10,527,692	0.131
Operations	6,546,651	936,171	7,482,822	0.093
Total	$18,245,666	$2,609,130	$20,854,796	$0.259

Figure 6.4-5 Commercial Plant Labor Costs by Plant Function

6.4 Operating Cost Estimate

6.4.3 Chemicals and Catalysts

The operating chemicals and catalysts cost for the Commercial Plant is defined as the product of their consumption rate and cost.

Figure 6.4-6 identifies all chemicals and catalsyts required for Commercial Plant process operation together with their annual consumption and replacement cost. The annual consumed volume or weight was determined by the daily estimated consumption rate for each chemical and catalyst throughout the entire process for 330 days per year of operation. Annual replacement costs, based on these determined consumption rates, were derived through: (1) price quotations from chemical manufacturers or suppliers, or (2) recent purchase orders placed by ICGG member companies and affiliates.

The total annual operating chemicals and catalysts cost for the Commercial Plant is $18,204,602 yielding a gas cost component of $0.226/MM Btu. This component is based on the data elements summarized by Figure 6.4-6 and the annual process yield of 80,546,000 MM Btu of pipeline synthetic gas.

6.4.4 Insurance and Taxes

The annual insurance cost is defined as the premiums for the purchased insurance coverage, carried for the Commercial Plant, and includes: (1) Workmen's Compensation, (2) Comprehensive General Liability, and (3) Property Damage.

Workmen's Compensation covers the facility for any on-the-job injury to employees. The amount of coverage is determined by Illinois Statute and is based on job classifications and payroll costs.

Comprehensive General Liability insurance covers injury or property damage to third parties (i.e., other than ICGG plant property or ICGG employees). The maximum coverage would be $50,000,000 for each occurrence. This level is considered to be reasonable based on the rural location of the plant and the correspondingly low potential for significant damage or injury should an incident occur.

Property Damage covers the physical plant with a maximum limit set between $250,000,000 and $300,000,000 and sublimits of $50,000,000 for flood, $50,000,000 for earthquake, and $25,000,000 for boilers and machinery, per occurrence, with any claims being settled on a replacement value basis. All property insurance is for direct damage and does not include business interruption coverage.

AREA OF USAGE	CHEMICAL OR CATALYST	UNIT	INITIAL CHARGE	ANNUAL USAGE	COST/UNIT $	INITIAL CHARGE COST $	ANNUAL COST $
AREA 4: Oil Recovery and Treatment	Filter Aid (Diatomaleous Earth)	Tons	C	7,187	100	-	718,700
	Hydrotreatment Catalyst	Tons	150	600	3800	570,000	2,280,000
AREA 5: Gas Purification	Selexol Solvent	Gallons	90,000	19,800	8.60	774,000	170,280
	N. Heptane	Gallons	19,500	136,800	0.48	9,360	65,660
AREA 6: Hydrogen Generation	ZnO Catalyst	Cu. Ft.	15,200	2,535	70	1,064,000	177,450
	Shift Catalyst	Cu. Ft.	7,700	1,540	52.50	404,250	80,850
	Methanation Catalyst	Cu. Ft.	970	970	115	111,550	111,550
	K_2CO_3 Solution (30 wt. %, plus Additives)	Gallons	78,282	26,094	0.97	75,930	25,310
AREA 7: Shift and Methanation	ZnO Catalyst	Cu. Ft.	18,420	7,000	70	1,289,400	490,000
	Ni-type Catalyst	Cu. Ft.	37,380	17,820	180	6,728,400	3,207,600
AREA 8: Bulk CO_2 Removal	Selexol Solvent	Gallons	173,000	7,370	8.60	1,487,800	63,380
AREA 9: Gas Compression and Dehydration	Triethylene Glycol	Pounds	20,800	324,720	0.36	7,490	116,900
AREA 11: SO_2 Removal	Soda Ash	Tons	C	13,266	55	-	729,630
	Antioxident	Tons	C	257	4000	-	1,028,000
	Ethylene Glycol	Gallons	6,000	1,635	2.80	16,800	4,580
	Lime	Tons	C	25	37	-	925
	Refrigerant (R-11)	Gallons	w/Ref. Unit Cost	1,635	7.74	-	12,650

C = Continuous

AREA OF USAGE	CHEMICAL OR CATALYST	UNIT	INITIAL CHARGE	ANNUAL USAGE	COST/UNIT $	INITIAL CHARGE COST $	ANNUAL COST $
AREA 12: Sulfur Recovery	Bauxite Catalyst	Cu. Ft.	5,642	1,880	11.72	63,200	21,000
AREA 13: Ammonia Recovery	45% H_3PO_4	Gallons	C	6,970	2.03	-	14,150
	50% NaOH	Barrels	C	204,030	37.47	-	7,645,000
AREA 15: Utilities	Betz 35	Tons	C	23	1,300	-	29,900
	Betz 65	Tons	C	23	960	-	22,080
	Betz C-30	Tons	C	3	7,060	-	21,180
	Chlorine	Tons	C	172	137.50	-	23,650
	Betz Corrogen	Tons	C	3	680	-	2,040
	Betz Poly-sperce	Tons	C	54	1,140	-	61,560
	Betz Hyzeen	Tons	C	1	4,000	-	4,000
	Betz WA3	Tons	C	21	2,180	-	45,780
	Disodium Phosphate	Tons	C	6	440	-	2,640
	H_2SO_4 (66° Baume)	Tons	C	2,004	39.54	-	79,240
	Betz 419	Tons	C	23	2,360	-	54,280
AREA 16: Water Supply	Chlorine	Tons	C	44	137.50	-	6,050
	Betz 2890	Tons	C	48	1,440	-	69,120

C = Continuous

Figure 6.4-6 Commercial Plant Estimate Chemical and Catalyst Cost

AREA OF USAGE	CHEMICAL OR CATALYST	UNIT	INITIAL CHARGE	ANNUAL USAGE	COST/UNIT $	INITIAL CHARGE	ANNUAL COST $
AREA 17: Water Treatment Systems	Lime	Tons	C	4,537	37	-	167,869
	Soda Ash	Tons	C	3,354	55	-	184,470
	H_2SO_4 (66° Baume)	Tons	C	705	39.54	-	27,880
	50% NaOH	Barrels	C	1,508	37.47	-	43,910
	Betz 2800	Pounds	C	15,840	2.70		42,770
	Chlorine	Pounds	C	395	137.50	-	54,310
AREA 18: Waste Treatment and and Disposal	100% NH_3	Tons	C	1,140	130	-	Plant Byproduct
	75% H_3PO_4	Gallons	C	118,295	2.03	-	240,140
	Lime	Tons	C	614	37	-	22,718
	Polymer	Tons	C	30	1,180	-	35,400
Total Annual Cost							18,204,602

C = Continuous

6.4 Operating Cost Estimate

6.4.4 Insurance and Taxes (Cont'd)

All costs are based on estimates made by Marsh & McLennan, Incorporated, insurance consultants, and are predicated on no changes in the insurance marketplace or risk factors during the life of the plant. Since there has been very little experience with coal gasification plants by the insurance industry, these estimates are based on other similar industries such as refineries and chemical plants.

Figure 6.4-7 identifies the total annual operating insurance cost (premium) for the Commercial Plant at $1,772,000 with the detailed breakdown for: (1) Workmen's Compensation and Comprehensive General Liability, (2) Property Damage (excluding boilers), (3) Boilers and Machinery, and (4) Deductible Limitation.

The total annual operating insurance cost for the Commercial Plant is $1,772,000 yielding a gas cost component of $0.022/MM Btu. This component is based on the cost elements summarized by Figure 6.4-7 and the annual process yield of 80,546,000 MM Btu of synthetic pipeline gas.

Type of Coverage	Annual Premium*
Workmen's Compensation and Comprehesive General Liability ($50,000,000 limit on liability)	$ 400,000
Property Damage (excluding boilers) ($250,000,000 to $300,000,000 overall limit)	1,272,000
Boiler and Machinery Damage ($25,000,000 limit)	101,000
Total	$ 1,772,000
*Premiums based on a $250,000 deductible for each occurrence	
Source: Marsh & McLennan, Incorporated	

Figure 6.4-7 Summary of Annual Commercial Plant Insurance Costs

6.4 Operating Cost Estimate

6.4.4 Insurance and Taxes (Cont'd)

The annual property tax for the Commercial Plant is defined as the product of the assessed value of the tangible property at the facility and the established tax rate for the area. Such items as buildings, equipment, machinery, site improvements, and similar depreciable assets are included.

The tax department of the Peoples Gas Light and Coke Company estimated the tax by (1) reducing the $1,451,924,000 total plant investment cost including land to an assessment base to eliminate nontaxable intangible items in that cost, (2) annualizing that assessment base since it decreases with depreciation of the plant, and (3) applying a tax rate based on plant location. The tax rate was estimated using the actual 1977 rate of $4.212 per $100 of assessed valuation at the plant location in Perry County, Illinois, adjusted for the economic impact of the plant and the resultant increase in the total assessed valuation for Perry County.

Based on these assumptions, the annual tax cost for the Commercial Plant was estimated at $7,401,160 yielding a gas average cost component of $0.092/MM Btu. This cost is based on the aforementioned method of tax estimation and the annual process yield of 80,546,000 MM Btu for synthetic pipeline gas.

The combined annual operating cost for insurance and taxes for the Commercial Plant is $9,173,160 yielding a gas average cost component of $0.114/MM Btu.

6.4.5 Repairs and Replacements

The operating repair and replacement cost for the Commercial Plant is defined as the combined cost of maintenance tools and the cost of maintenance supply items such as gaskets, packing, replaceable wear parts, and pipe fittings, but excluding any costs for lubricating materials or installed equipment spares.

The cost of lubricating materials is accounted for under the operating cost category of Other Operating Supplies (See Subsection 6.4.7). The cost of installed equipment spares is accounted for under Equipment Costs (See Subsection 6.3.4.1).

The operating repair and replacement cost is based on an experience developed ratio of 2:1 for the labor and material. Based on this ratio the estimated total maintenance cost (Figure 6.4-8) of $46,409,700 would result in a labor cost of $30,989,800 and a material cost of $15,469,900.

Process Area Number and Description	Total* Constructed Cost	% of T.C.C.	Maint. Cost Mat'l. & Labor
101 Coal Unloading and Handling	$ 13,133,000	6	$ 788,000
102 Coal Preparation	54,586,000	6	3,275,200
103 Pyrolysis and Gasification	200,462,000	6	12,027,700
104 Oil Recovery and Treatment	197,846,000	4	7,913,800
105 Gas Purification	67,633,000	3	2,029,000
106 Hydrogen Generation	10,043,000	3	301,300
107 Shift and Methanation	40,460,000	3	1,213,800
108 Bulk CO_2 Removal	16,084,000	3	482,500
109 Compression and Dehydration	11,424,000	3	342,700
110 Flue Gas Power Recovery	148,669,000	6	8,920,100
111 SO_2 Removal	76,172,000	3	2,285,200
112 Sulfur Recovery	21,223,000	3	636,700
113 Ammonia Recovery	3,772,000	3	113,200
114 Thermal Oxidizer & Flare	3,265,000	1	32,700
115 Utilities	117,658,000	2	2,353,200
116 Water Supplies	23,798,000	1	238,000
117 Water Treatment Systems	16,102,000	3	483,100
118 Waste Treatment and Disposal	30,798,000	3	923,700
119 Fire Protection System	5,597,000	1	56,000
120 Facilities	63,787,000	1	637,900
121 Yard Facilities	135,566,000	1	1,355,700
Total	$1,258,078,000	3.7 Avg.	$46,409,700

Figure 6.4-8 Estimated Total Maintenance Cost

*In Year End 1977 Dollars

6.4 Operating Cost Estimate

6.4.5 Repairs and Replacements (Cont'd)

The labor cost of $30,989,800 includes $10,527,000 of plant maintenance staff salaries which is included under labor in Subsection 6.4.2. The balance of $20,412,100 for Subcontract labor is included in this account. The total combined annual operating repair cost of $20,412,100 and replacement cost of $15,469,900 is $35,882,000 for the Commercial Plant yielding a gas cost component of $0.445/MM Btu based on an annual process yield of 80,546,000 MM Btu of synthetic pipeline gas.

6.4.6 Utilities

The operating utilities cost for the Commercial Plant is defined as the cost of purchased electrical power to: (1) pump water feedstock about 20 miles from the Mississippi River to the Commercial Plant site at Perry County, Illinois and (2) support such functional needs as plant and security lighting. The overall energy balance for the Commercial Plant, shown in Figure 6.4-1, identifies the electrical power consumption demand as 4960 kw. Based on 330 days per year of operation, the annual electrical power consumption will total 39,283,200 kwh. The cost for purchased electrical power is $0.27/kwh estimated by Illinois Power Company, yielding an annual operation cost of $1,060,600.

Credit for export electrical power of 34,248 kw per hour is set at $0.0177 per kwh estimated by two Illinois Utility Companies. Based on 330 days per year of operation and the annual export of electrical power at 271,244,160 kwh, the annual credit is $4,800,000.

The difference between the annual purchased electrical power cost of $1,060,600 and the credit of export power of $4,800,000 results in a net credit of $3,739,400, yielding a gas average credit component of $0.046/MM Btu based on an annual yield of 80,546,000 MM Btu of pipeline gas.

6.4.7 Other Operating Supplies

The costs for other operating supplies for the Commercial Plant are defined as all operating costs other than those which are specifically identified under Subsection 6.4.1 through 6.4.6 and Subsection 6.4.9. The following are specifically identified:

6.4 Operating Cost Estimate

6.4.7 Other Operating Supplies (Cont'd)

Operating Cost Category	Subsection
Coal	6.4.1
Labor	6.4.2
Chemicals and Catalysts	6.4.3
Insurance and Taxes	6.4.3
Repairs and Replacements	6.4.5
Utilities	6.4.6
Royalties	6.4.9

The cost of other operating supplies includes such day-to-day items associated with plant operations as special clothing, safety equipment, lubricating materials, office supplies, instrument charts and inks, janitorial and facility housekeeping supplies, non-maintenance tools, etc. Recognizing the annual consumption of these other operating supplies will vary somewhat from year to year, their cost has been estimated to average 30% of the operating labor for the typical operating year.

The total annual cost of other operating supplies for the Commercial Plant is $1,964,000 yielding a gas cost component of $0.024/MM Btu based on an annual process yield of 80,546,000 MM Btu of synthetic pipeline gas and an annual process operating labor cost of $6,546,651 (Subsection 6.4.2).

6.4.8 By-Products

In addition to the primary product of synthetic pipeline gas, shown in Figure 6.4-1, the ICGG Commercial plant will produce the following quantities of by-products each day of plant operation.

By-Product	Quantities
Syncrude	24,041 barrels
Ammonia	66.1 tons
Sulfur	931 short-tons
Light Hydrocarbons	4,565 barrels
Sodium Sulfate	63.1 tons

The total annual credit for by-product revenue against the annual operating cost for the Commercial Plant is $141,883,094, yielding a gas credit component of $1.762/MM Btu. This credit is based on the summarized detailed annual by-product yields shown in Figure 6.4-9

6.4 Operating Costs Estimate

6.4.8 By-Products (Cont'd)

with the annual process yield of 80,546,000 MM Btu of synthetic pipeline gas.

By-Product	Operating Cost Credit	
	Market Value	Value/MM Btu
Syncrude	$109,323,326	$1.357
Light Hydrocarbons	16,372,629	.204
Ammonia	2,835,690	.035
Sulfur	12,102,069	.150
Sodium Sulfate	1,249,380	.016
Total	$141,883,094	$1.762

Figure 6.4-9 Summary of Byproduct Annual Revenue and Credit Against Annual Operating Cost

6.4.8.1 Syncrude

The ICGG Commercial Plant will produce a significant quantity of syncrude, 24,041 barrels per stream day (See Figure 6.4-1). ICGG syncrude has characteristics similar to Oklahoma crudes, which were used as a bench-mark for establishing the syncrude market price. Phillips Petroleum Company Crude Oil Price Bulletin dated September 1, 1977 for new crude petroleum, released crude petroleum and stripped well crude petroleum establishes a price of $13.13 per barrel for Oklahoma crude oils with an average API gravity of at least 25°. ICGG syncrude has an API gravity equal to 31°.

Most domestic crudes have higher levels of sulfur, nitrogen, and oxygen than the syncrude, which supports a premium value for the sale of syncrude over that for natural crude. This premium was estimated at $0.65 per barrel based on information contained in a report for ERDA, "Economic Evaluation of Coal-Based Synthetic Crude,: by Bonner and Moore Associates, Incorporated, dated April, 1975.

6.4 Operating Cost Estimate

6.4.8.1 Syncrude (Cont'd)

The sum of the "base" value of $13.13 and the premium value of $0.65 gives a total estimated market value, F.O.B. the plant of $13.78 per barrel.

The total annual credit for syncrude by-product revenue against the annual operating cost for the Commercial Plant is $109,323,326 yielding a gas credit component of $1.357/MM Btu. This credit is based on a daily process production rate for syncrude of 24,041 barrels, 330 days per year of operating and an annual process yield of 80,546,000 MM Btu of synthetic pipeline gas.

6.4.8.2 Light Hydrocarbons

Figure 6.4-1 shows 4565 barrels of light hydrocarbons produced each day by the Commercial Plant, with the following composition and volume available for marketing:

Light Hydrocarbon By-Product Composition	Volume (Barrels/day)
Ethane (C_2H_6)	2102
Ethylene (C_2H_4)	499
Propane (C_3H_8)	707
Propylene (C_3H_6)	443
C_4's = (butane, et al.)	814
Total	4565

The market value of this by-product is estimated as the sum of the market values of the various constituents. Figure 6.4-10 summarizes the market value and the calculated annual operating credit for light hydrocarbon production.

6.4 Operating Cost Estimate

6.4.8.2 Light Hydrocarbons (Cont'd)

The total annual credit for light hydrocarbon by-product revenue against the annual operating cost for the Commercial Plant is $16,375,920 yielding a gas credit component of $0.204/MM Btu. This credit is based on a daily process production rate for hydrocarbons of 4565 barrels of the aforementioned composition distribution, 330 days per year of operation and an annual yield of 80,546,000 MM Btu of synthetic pipeline gas.

Light Hydrocarbon Composition	Daily Volume in Gallons*	Market Value ($/Gallon)	Daily Revenue
Ethane (C_2H_6)	88,326	0.25	$22,082
Ethylene (C_2H_4)	20,958	0.33	6,916
Propane (C_3H_8)	29,694	0.20	5,939
Propylene (C_3H_6)	18,606	0.33	6,140
C_4's (butane et al)	34,188	0.25	8,547
		Total	$49,624

* 42 gallons/barrel
** 330 days year operation

Annual Revenue** = ($49,624) x (330) ≅ $16,372,629

Figure 6.4-10 Summarized Annual Light Hydrocarbon Revenue

6.4.8.3 Ammonia

Figure 6.4-1 shows 69.6 tons of 99.99% pure anhydrous ammonia produced each stream day. The Waste Treatment and Disposal process step of the Commercial Plant will consume 3.5 tons, leaving 66.1 tons per day available for market. A market value estimate of $130 per ton has been verbally quoted by N-REN Corporation of Cincinnati, Ohio.

The total annual credit for ammonia by-product revenue against the annual operating cost for the Commercial Plant is $2,835,690 yielding a gas credit component of $0.035/MM Btu. This credit is based on a marketable daily process production rate of 66.1 tons, 330 days per year of operation and an annual process yield of 80,546,000 MM Btu of synthetic pipeline gas.

6.4 Operating Cost Estimate

6.4.8.4 Sulfur

Figure 6.4-1 shows 931 short tons of sulfur produced each stream day. A current market value of $43.33 per long ton has been quoted by Freeport Minerals Company of New York. Figure 6.4-11 summarizes the calculated annual production volume, revenue and credit for sulfur production.

The total annual credit for sulfur by-product revenue against the annual operating cost for the Commercial Plant is $12,102,069 yielding a gas credit component of $0.150/MM Btu. This credit is based on a daily process production rate of 931 short tons, 330 days per year of operation and an annual process yield of 80,546,000 MM Btu of synthetic pipeline gas.

Annual Sulfur Volume	
931	Short tons per stream day
0.91	Conversion factor for short to long tons
846	Long tons per stream day
x 330	Stream days per year
279,300	Annual long ton production

Annual Sulfur Revenue	
279,300	Annual Long Tons
x$43.33	Market value per long ton
$12,102,069	Total annual sulfur revenue

Figure 6.4-11 Summarized Annual Sulfur Production Volume and Revenue

6.4 Operating Cost Estimate

6.4.8.5 Sodium Sulfate

Figure 6.4-1 shows 63.1 tons of sodium sulfate produced each stream day. A current market value of $60 per ton has been established by the Chemical Marketing Reporter, dated October 31, 1977. The total annual credit for sodium sulfate revenue against the annual operating cost for the Commercial Plant is $1,249,380 yielding a gas credit component of $0.16/MM Btu.

This credit is based on a daily production rate of 63.1 tons, 330 days per year of operation and an annual process yield of 80,546,000 MM Btu of synthetic pipeline gas.

6.4.9 Royalties

The operating cost due to royalties for the Commercial Plant is defined as the amount of negotiated royalty fee, if any, payable to the principal licensor for the employed use of his process.

COGAS Development Company (CDC) is the Licensor for the COGAS process to be employed by the ICGG Commercial Plant. The amount of royalty fee, if any, will be negotiated between ICGG and CDC prior to commissioning of the ICGG Commercial Plant.

For the purposes of this evaluation a royalty fee will be estimated at 1% of the anticipated $321,882,000 gross annual revenue from the Commercial Plant.

The total annual operating cost of royalties for the Commercial Plant is $3,218,820 yielding an average cost of $0.040/MM Btu based on the actual annual process yield of 80,546,000 MM Btu of synthetic pipeline gas.

6.5 Gas Cost Estimate

The estimated cost or product gas from the Commercial Plant is computed on the net present value analysis basis using the "revenue requirements" method. As requested by DOE, a 9% discount rate is used in the calculation. The 9% discount rate is not to be confused with current market cost of money which reflects inflationary expectations. This discount rate was chosen to approximate the sum of three things: (1) the historical time value of money, (2) a return for risk, and (3) the requirement for income taxes. The revenue requirement method determines the lowest product gas selling price sufficient to recover all costs incurred during the twenty-five year project life. Such costs include engineering, recovery of capital, return on investment, start-up and operating expenses less by-product revenues. The estimated required selling price of product gas per MM Btu is that amount which is required to recover the time value of all costs incurred over the life of the project.

It is important to note that the product selling price using the DOE guidelines is somewhat lower than what would be expected using utility financial requirements. Using the same revenue requirement program, with utility inputs, yields a product selling price of 20% to 30% higher than the base case. Key areas of difference in the DOE and utility guidelines include: debt/equity ratio, investment tax credit, Federal and State taxes and return on invested capital.

The estimated cost of product gas from the Commercial Plant, based upon the revenue requirements method of cash flow analysis using a 9% discount rate, would be $4.597/MMBtu. This selling price is based on costs estimated at end-1977 dollars.

A copy of the computer print-out showing computation of the $4.597 per MMBtu "base case" selling price estimate is shown in Figures 6.5-1, 6.5-2 and 6.5-3.

The project financing assumptions indicated in Figures 6.5-1, 6.5-2 and 6.5-3 consistent with assumption requested by DOE.

Assumptions used in this analysis include:

- Depreciation: straight line over a 20 year period for revenue requirements calculations and for tax purposes.
- Discount Rate: 9% in accordance with DOE's guidelines.
- Rate or return: Reflected in the 9% discount rate.
- Interest Rate: Reflected in the 9% discount rate.
- Percent of debt: Reflected in the 9% discount rate.

6.5 Gas Cost Estimate

- Federal income tax rate: Reflected in the 9% discount rate.
- State income tax rate: Reflected in the 9% discount rate.
- Property tax rate: Property taxes are estimated separately as a plant operating expense.
- Life of project in years: 25. This 25-year period is comprised of 20 months of engineering, 34 months of construction, 6 months of plant startup and 20 years of operation.
- State utility tax rate: Assumed to be zero.
- Discount rate: 9% in accordance with DOE's guidelines.
- Computation option: Option "0" selected in order to arrive at present value equivalent selling price reflecting an 9% discount rate and a 9% rate of return.
- Depreciation option: Option "1" selected to assure that all depreciable assets are written off by end of the project's 25 year life.
- Accelerated depreciation option: Option "0" selected in order to write depreciable assets off on a straight line basis.
- Operating costs as developed in Subsection 6.4 of this report.
- Investment costs as developed in Subsection 6.3 of this report.

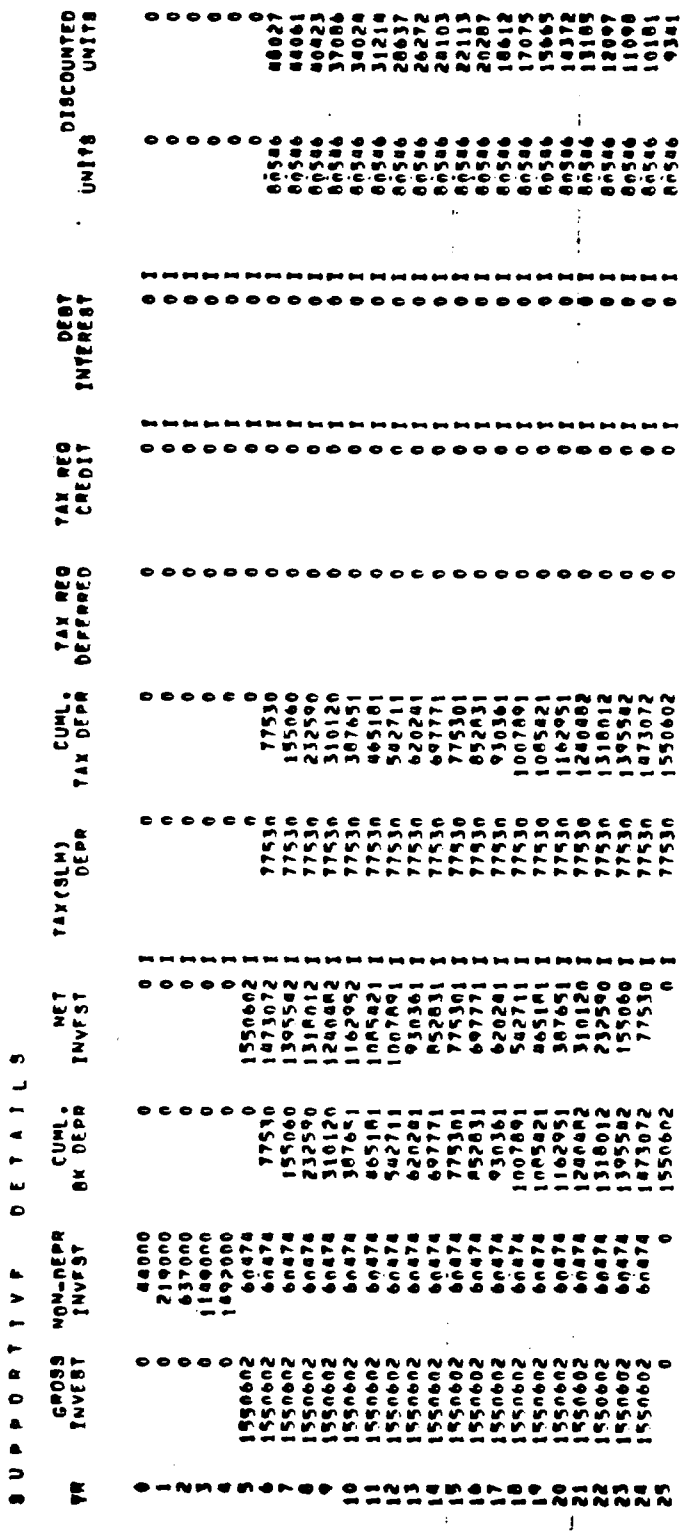
(UTILITY)-FEBRUARY 80 PACK VERSION: 2.09.035
STUDY: <GRAHAM>GRAHAM
PARAMETER LIST:

BOOK DEPRECIATION RATE (PCT)	5.00	TAX DEPRECIATION (YEARS)	20
RETURN ON INVESTED CAPITAL	9.00	BOND INTEREST RATE	0.00
PERCENTAGE OF DEBT	0.00	FEDERAL INCOME TAX RATE	0.00
STATE INCOME TAX RATE	0.00	PROPERTY TAX RATE	0.00
LIFE OF THE PROJECT (YEARS)	25	STATE UTILITY TAX RATE	0.00
INVESTMENT TAX CREDIT RATE	0.00	COMPUTATION OPTION: 0	= N. P. V.
ASSETS WRITTEN OFF AT END	YES	MODEL TYPE: UNIT PRICE	

DEPRECIATION METHOD: 0 (STRAIGHT LINE METHOD)
VARIABLE LIST:

YEAR	NONDEP INV	GROSS INV	OPER EXP	REVENUE	UNITS
0	440000	0	0	0	0
1	219000	0	0	0	0
2	637000	0	0	0	0
3	1149000	0	0	0	0
4	1492000	0	0	0	0
5	60474	1550602	0	0	0
6	60474	0	157017	370250	80546
7	60474	0	157017	370250	80546
8	60474	0	157017	370250	80546
9	60474	0	157017	370250	80546
10	60474	0	157017	370250	80546
11	60474	0	157017	370250	80546
12	60474	0	157017	370250	80546
13	60474	0	157017	370250	80546
14	60474	0	157017	370250	80546
15	60474	0	157017	370250	80546
16	60474	0	157017	370250	80546
17	60474	0	157017	370250	80546
18	60474	0	157017	370250	80546
19	60474	0	157017	370250	80546
20	60474	0	157017	370250	80546
21	60474	0	157017	370250	80546
22	60474	0	157017	370250	80546
23	60474	0	157017	370250	80546
24	60474	0	157017	370250	80546
25	0	0	157017	370250	80546

Figure 6.5-1 Gas Cost Calculation Revenue Requirement Method Based on Estimates in Year End 1977 Dollars



SUPPORTIVE DETAILS

YR	GROSS INVEST	NON-DEPR INVEST	BK DEPR	CUML. BK DEPR	NET INVEST	TAX(SLM) DEPR	TAX DEPR	CUML. TAX DEPR	TAX REQ DEFERRED	TAX REQ CREDIT	DEBT INTEREST	UNITS	DISCOUNTED UNITS
0	0	44000	0	0	0	0	0	0	0	0	0	0	0
1	0	219000	0	0	0	0	0	0	0	0	0	0	0
2	0	637000	0	0	0	0	0	0	0	0	0	0	0
3	0	1140000	0	0	0	0	0	0	0	0	0	0	0
4	0	1892000	0	0	0	0	0	0	0	0	0	0	0
5	1550602	66474	0	0	1550602	77530	77530	77530	0	0	0	86546	40827
6	1550602	66474	77530	77530	1473072	77530	77530	155060	0	0	0	86546	40061
7	1550602	66474	155060	155060	1395542	77530	77530	232590	0	0	0	86546	40423
8	1550602	66474	232590	232590	1318012	77530	77530	310120	0	0	0	86546	37086
9	1550602	66474	310120	310120	1240482	77530	77530	387651	0	0	0	86546	34024
10	1550602	66474	387651	387651	1162952	77530	77530	465181	0	0	0	86546	31214
11	1550602	66474	465181	465181	1085421	77530	77530	542711	0	0	0	86546	28637
12	1550602	66474	542711	542711	1007891	77530	77530	620241	0	0	0	86546	26272
13	1550602	66474	620241	620241	930361	77530	77530	697771	0	0	0	86546	24103
14	1550602	66474	697771	697771	852831	77530	77530	775301	0	0	0	86546	22113
15	1550602	66474	775301	775301	775301	77530	77530	852831	0	0	0	86546	20287
16	1550602	66474	852831	852831	697771	77530	77530	930361	0	0	0	86546	18612
17	1550602	66474	930361	930361	620241	77530	77530	1007891	0	0	0	86546	17075
18	1550602	66474	1007891	1007891	542711	77530	77530	1085421	0	0	0	86546	15665
19	1550602	66474	1085421	1085421	465181	77530	77530	1162951	0	0	0	86546	14372
20	1550602	66474	1162951	1162951	387651	77530	77530	1240482	0	0	0	86546	13185
21	1550602	66474	1240482	1240482	310120	77530	77530	1318012	0	0	0	86546	12097
22	1550602	66474	1318012	1318012	232590	77530	77530	1395542	0	0	0	86546	11098
23	1550602	66474	1395542	1395542	155060	77530	77530	1473072	0	0	0	86546	10181
24	1550602	66474	1473072	1473072	77530	77530	77530	1550602	0	0	0	86546	9341
25	0	0	1550602	1550602	0	0	77530	1550602	0	0	0	86546	

Figure 6.5-2 Gas Cost Calculation Revenue Requirement Method Based on Estimates in Year End 1977 Dollars

6.0 BASELINE ECONOMIC EVALUATION

FE-2012-096
May 1980

6.5 GAS COST ESTIMATE

REVENUE REQUIREMENTS

YR	BK DEPN 5.00	RETURN 9.00	INC TAX BEF ADJ	INC TAX ADJUST	PROP TAX	STATE UTIL TAX	OPER EXPENSE	TOT. REV. REQ.	P.V. REV. REQ.	CUML. P.V. REQ.	TOT. REVENUES	TOT. P.V. REVENUES	CUML. P.V. REVENUES
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	3960	0	0	0	0	0	3960	3633	3633	0	0	0
2	0	19710	0	0	0	0	0	19710	16590	20223	0	0	0
3	0	57330	0	0	0	0	0	57330	44269	64492	0	0	0
4	0	103410	0	0	0	0	0	103410	73258	137750	0	0	0
5	0	138280	0	0	0	0	0	138280	87273	225023	0	0	0
6	77530	140997	0	0	0	0	157017	375544	220310	451333	370250	220768	220768
7	77530	138019	0	0	0	0	157017	372566	203806	655139	370250	202540	423308
8	77530	131041	0	0	0	0	157017	365588	183477	838616	370250	185816	609124
9	77530	128064	0	0	0	0	157017	362611	165114	1003730	370250	170474	779598
10	77530	117086	0	0	0	0	157017	351633	148534	1152264	370250	156398	935995
11	77530	116108	0	0	0	0	157017	350655	133565	1285829	370250	143484	1079480
12	77530	103131	0	0	0	0	157017	337678	120056	1405885	370250	131637	1211117
13	77530	96153	0	0	0	0	157017	330700	107867	1513752	370250	120768	1331884
14	77530	89175	0	0	0	0	157017	323722	96873	1610625	370250	110796	1442680
15	77530	82197	0	0	0	0	157017	316745	86958	1697583	370250	101648	1544328
16	77530	75220	0	0	0	0	157017	309767	78021	1775604	370250	93255	1637583
17	77530	68242	0	0	0	0	157017	302789	69966	1845571	370250	85555	1723138
18	77530	61264	0	0	0	0	157017	295811	62710	1908281	370250	78491	1801629
19	77530	54287	0	0	0	0	157017	288834	56175	1964456	370250	72010	1873639
20	77530	47309	0	0	0	0	157017	281856	50292	2014748	370250	66064	1939703
21	77530	40331	0	0	0	0	157017	274878	44997	2059745	370250	60609	2000312
22	77530	33353	0	0	0	0	157017	267901	40234	2099979	370250	55605	2055917
23	77530	26376	0	0	0	0	157017	260923	35950	2135929	370250	51014	2106931
24	77530	19398	0	0	0	0	157017	253945	32100	2168029	370250	46801	2153732
25	77530	12420	0	0	0	0	157017	246967	28640	2196669	370250	42937	2196669

SUMMARY: DETERMINE REQUIREMENTS FROM RETURN ON INVESTED CAPITAL
CUML. P.V. REVENUES: $2,196,669 CUML. P.V. REQUIREMENTS: $2,196,669
COMPUTED DISCOUNT RATE: 9.00% NET PRESENT VALUE: $0
WEIGHTED DEBT INTEREST RATE: 9.00% ADJUSTED FOR % OF DEBT 9.00%
RET. ON INV. CAPITAL: 9.00% RETURN ON TOTAL EQUITY:
COMBINED INCOME TAX: 0.00% SELLING PRICE PER UNIT: $4.5967
ITERATIONS: 1
ELAPSED TIME(MM:SS.SSS): 0: 2.823 PROCESSOR TIME(MM:SS.SSS) 0: 0.051

Figure 6.5-3 Gas Cost Calculation Revenue Requirement Method
Based on Estimates in Year End 1977 Dollars

6.6 Unit Costs of Utilities

6.6.1 Introduction

Unit costs for the various utilities produced or generated in the Commercial Plant were needed for the economic evaluation phase of the Commercial Plant tradeoff studies. To satisfy this requirement, utility unit costs were developed utilizing a capital requirement estimate, feedstock prices and other cost information from The ICGG Proposal to ERDA dated February 4, 1975, all costs appropriately escalated.

Accordingly, the derivation of the unit costs for the utilities presented herein are based on the adjusted 1975 cost information and the considerations described herein.

6.6.2 Basic Considerations

The basic considerations used in developing the investment and operating costs for calculating the utility unit costs are briefly described in the following paragraphs:

Annual Capital Requirement

The cost of the equipment associated with each specific utility was extracted from the 1975 Commercial Plant estimate. Escalation factors obtained from applicable indices were applied to obtain 1977 dollars. Installation factors were then used to convert the equipment costs into capital requirements for the utility production facility. A 20 year plant design life and straight line depreciation were used to compute the annual depreciation on the capital requirements.

Chemicals and Catalysts

The annual operating cost for chemicals and catalysts is the product of the daily consumption rate, the unit cost and 330 days per year of operation. The costs for each chemical and catalyst were updated to 1977 dollars from the 1975 estimate based on identical usage.

6.6 UNIT COSTS OF UTILITIES

6.6.2 Basic Considerations - continued

Utilities

Electricity

The electrical power requirements for each specific utility production area were obtained from the equipment motor lists. The cost of on-site generated electricity to power these motors was arbitrarily selected to be 1.5¢/KWhr, based on this value, the rest of the utility unit costs were calculated. Knowing the cost of the high pressure steam generated from coal permitted the cost of the generated power to be calculated and compared with the arbitrarily selected value. When there was too large a disparity, the iterative procedure was continued using the previously calculated value in the subsequent calculation. When the selected value agreed reasonably well with the calculated value, the procedure was discontinued. The results of this procedure are summarized in Figure 6.6-1 and show the unit cost for on-site generated power to be 2.3¢/KWhr.

Fuel Oil

On site produced Syncrude of API gravity 31°, which has a heating value of 19,000 BTU/lb HHV, was used as one of the heat sources in the utility cost calculations. The cost of this syncrude is set at $13.80/barrel.

Coal

For the purpose of this study, the cost of steam generated in coal fired boilers was based on coal with a heating value of 11,133 Btu/lb on an as received basis. In addition, a significant percentage of the steam is generated in the flue gas oxidizer and the waste heat boilers. The cost of this steam was determined by converting the sensible heat recovered from the flue gas and other gas streams to an equivalent number of pounds of coal.

Make Up Water

Fresh water is obtained from the Mississippi River at no cost. The cost of raw water was derived from the capital requirement for the water pumping station and transport piping and the associated operating costs. This raw water cost constitutes the principal utility cost for calculating the cost of soft water.

6.6 - UNIT COSTS OF UTILITIES

6.6.2 Basic Considerations (Cont'd)

Category	Unit	Electricity	
		1.5¢/ KWhr.	2.3¢/ KWhr.
Raw Water	$/M gal.	0.40	0.43
Soft Water	$/M gal.	0.66	0.69
Demin. Water	$/M gal.	2.05	2.10
Cooling Tower Circulation & Chemicals	$/M gal.	0.06	0.07
Biotreatment	$/M gal.	2.77	3.15
Evaporation	$/M gal.	2.57	2.57
1500# Steam	$/M lb.	2.11	2.14
600# Steam	$/M lb.	1.55	1.56
150# Steam	$/M lb.	1.54	1.23
50# Steam	$/M lb.	1.34	1.12
Plant Air	$/MSCF	0.03	0.04
Instrument Air	$/MSCF	0.03	0.04
Electricity (assumed)	¢/KWhr	1.5	2.3
(calculated)	¢/KWhr	2.3	2.1

Figure 6.6-1 Electric Power Unit Cost Determination

6.6 UNIT COSTS OF UTILITIES

6.6.2 Basic Considerations - continued

Labor

The annual cost for both the direct operating labor and the maintenance labor was obtained from the Commercial Plant Organization Chart. The labor cost for each specific utility area was distributed according to its percentage of the total capital requirement.

6.6.3 Procedure For Calculating Utility Costs

A modified utility financing method was used to calculate the average utility cost. Figure 6.6-2 shows the items that make up the average unit utility cost.

The results of each utility unit cost calculation are presented in the Figure 6.6-3 and Figure 6.6-4.

6.6 UNIT COSTS OF UTILITIES

6.6.3 Procedure For Calculating Utility Costs (Cont'd)

Catalyst & Chemicals

Utilities

a. Electricity _____
b. Fuel Oil _____
c. Coal _____
d. Make-up Water _____
e. Others _____

Labor

a. Operating Labor _____
b. Maintenance Labor _____
c. Supervision (20% of labor) _____
d. Administration & General Overhead (60% of a,b&c) _____

Supplies

a. Operating (30% of Operating Labor) _____
b. Maintenance (2/3 of Maintenance Labor) _____

Annual Capital Requirement

(20 year S/L Depreciation)

TOTAL _____

Product Production Rate _____

Average Cost: $\left(\frac{\text{Total Annual Cost}}{\text{Annual Production}}\right)$ ---- _____

Figure 6.6-2 Method for Calculating Utility Costs

Annual Costs	1500 PSIG Steam	600 PSIG Steam	150 PSIG Steam	50 PSIG Steam
Catalysts & Chemicals	$ 7,032	$ 3,428	$ 0	$ 1,749
Utilities				
Electricity	1,842,002	14,937	(1,929,074)(4)	(9,761,001)(4)
Fuel Oil	31,658,001	0	0	0
Coal	10,914,631	6,295,022	0	0
Make-up Water	2,924,904(1)	457,404(3)	0	1,855,338(3)
Others	1,583,979(2)	0	4,220,251(5)	20,844,990(5)
Labor				
Operating	137,558	31,418	6,793	46,702
Maintenance	160,310	36,614	7,917	54,426
Supervision	59,574	13,606	2,942	20,226
Administration & General Overhead	214,465	48,983	10,591	72,812
Supplies				
Operating	41,267	9,425	2,038	14,011
Maintenance	106,873	24,409	5,278	36,284
Annual Capital Requirement	4,367,597	1,666,275	104,178	674,151
Total	$ 54,018,193	$ 8,601,521	$ 2,430,914	$ 13,859,688
Production Rate (Pounds/Hour)	3,192,006	697,236	249,000	1,558,956
Average Unit Cost ($/1000 Pounds)	2.14	1.56	1.23	1.12

(1) Demineralized Water
(2) Make-up from evaporator
(3) Soft Water
(4) Credit for production
(5) 1500 psig steam

Figure 6.6-3 Utility Unit Cost Calculation Summary
Based on Estimates in Year End 1977 Dollars

Annual Costs	Raw Water Transport	Soft Water	Demineralized Water	Cooling Tower Circulation	Biotreatment	Evaporation	Plant Air	Instrument Air	Electricity
Catalysts & Chemicals	$ 0	$ 2,137,440	$ 1,244,867	$ 158,108	$ 46,075	$ 0	$ 0	$ 0	$ 0
Utilities									
Electricity	812,980	101,846	37,707	3,231,518	1,485,770	100,771	139,352	139,352	0
Fuel Oil	0	0	0	0	0	0	0	0	0
Coal	0	0	0	0	0	0	0	0	0
Make-up Water	0	3,900,442	1,208,595	3,347,753 (1)	0	0	0	0	0
Others	0	0	0	4,221,202 (2)	0	121,293 (3)	0	0	19,642,266(4)
Labor									
Operating	186,807	18,681	25,474	79,818	163,032	116,330	5,095	7,642	23,775
Maintenance	217,705	21,770	29,687	93,019	189,997	135,571	5,937	8,906	27,708
Supervision	80,902	8,090	11,032	34,567	70,606	50,380	2,206	3,310	10,297
Administration & General Overhead	291,249	29,125	39,716	124,443	254,181	181,369	7,943	11,915	37,068
Supplies									
Operating	56,042	5,604	7,642	23,965	48,910	34,899	1,529	2,293	7,133
Maintenance	145,137	14,513	19,791	62,013	126,665	90,381	3,958	5,937	18,472
Annual Capital Requirement	2,109,515	210,809	284,644	1,667,802	1,838,323	1,317,813	61,151	109,316	946,087
Total	$ 3,900,337	$ 6,448,320	$ 2,909,155	$ 13,044,188	$ 4,223,559	$ 2,148,811	$ 227,171	$ 288,671	$ 20,712,806
Production Rate	19,000 GPM	19,614 GPM	2,922 GPM	416,210 GPM	2,820 GPM	1,760 GPM	12,000 SCFM	16,000 SCFM	124,590 KW
Average Unit Cost	43.2¢/M Gal.	69.2¢/M Gal.	$2.10/M Gal.	7¢/M Gal.	$3.15/M Gal.	$2.57/M Gal.	$.04/MSCF	$.04/MSCF	2.1¢/KWH

(1) Soft Water
(2) Biotreatment
(3) 150 PSIG Steam
(4) Includes $33,620,707 for high pressure steam, $1,105,196 for cooling water & credits of $2,350,024 for 150 PSIG steam, $12,733,613 for 50 PSIG steam.

Figure 6.6-4 Utility Unit Cost Calculation Summary
Based on Estimates in Year End 1977 Dollars

6.7 Sensitivity Analysis

The cost of the synthetic pipeline gas (SPG) for the baseline design has been calculated to be $4.59/MM Btu. (See Subsection 6.5) The cost of the SPG can be affected by many different variables. The variables with the greatest influence are examined in this subsection and are as follows:

- Coal Cost
- Overall Thermal Efficiency
- Plant Stream-Time Efficiency
- Discount Rate
- Total Gross Investment
- Syncrude Price

Tables 6.7-1 and 6.7-2 summarize the results of this sensitivity analysis.

Table 6.7-1

Effect on SPG Price due to Change in Variable
Based on Estimates in Year End 1977 Dollars

Variable	Change in Variable	Effect on SPG Price	
	%	¢/MMBtu	%
Coal Cost	+11 (+$2.50/ton)	+30	+6.5
	-11 (-$2.50/ton)	-29	-6.3
Overall Thermal Efficiency	+2.6	-24	-5.2
	-2.4	+25	+5.5
Plant Stream-Time Efficiency	+4.6 (+17 days)	-16	-3.5
	-5.4 (-20 days)	+23	+5.0
Discount Rate	+1%	+26	+5.7
	-1%	-23	-5.0
Change in Total Gross Investment	+15.0	+40	+8.7
	-15.0	-39	-8.5
Syncrude Price	+7.3 (+$1.00/bbl)	-9	-2.0
	-7.3 (-$1.00/bbl)	+11	+2.4

SENSITIVITY VARIABLE	TOTAL GROSS INVESTMENT ($000)	OPERATING COST ($000)	DISCOUNT RATE	ANNUAL PIPELINE GAS OUTPUT MMBTU'S	OPERATING DAYS	THERMAL EFFICIENCY	SPG COST PER MMBTU
Base Case	$1,550,602	$157,017	9%	80,546	330	62.4%	$4.59
COAL COST: BASE CASE - $22.50/ton							
$15/ton	1,500,602	85,903	9%	80,546	330	62.4%	3.71
$20/ton	1,550,602	133,313	9%	80,546	330	62.4%	4.30
$25/ton	1,500,602	180,722	9%	80,546	330	62.4%	4.89
$30/ton	1,500,602	228,132	9%	80,546	330	62.4%	5.48
$35/ton	1,500,602	275,541	9%	80,546	330	62.4%	6.07
OVERALL THERMAL EFFICIENCY; BASE CASE - 62.4%							
50%	1,550,602	182,907	9%	64,566	330	50%	6.14
55%	1,550,602	172,455	9%	71,017	330	55%	5.43
60%	1,550,602	161,989	9%	77,477	330	60%	4.84
65%	1,550,602	151,523	9%	83,937	330	65%	4.35
70%	1,550,602	141,070	9%	90,389	330	70%	3.92
75%	1,550,602	130,605	9%	96,849	330	75%	3.55
PLANT STREAM-TIME EFFICIENCY BASE CASE - 330 DAY/YR or 90.4%							
70%	1,550,602	136,446	9%	62,484	256	62.4%	5.60
75%	1,550,602	141,484	9%	66,878	274	62.4%	5.30
80%	1,550,602	146,522	9%	71,271	292	62.4%	5.05
85%	1,550,602	151,569	9%	75,665	310	62.4%	4.82
95%	1,550,602	161,645	9%	84,696	347	62.4%	4.43
99%	1,550,602	165,672	9%	88,113	361	62.4%	4.30
DISCOUNT RATE BASE CASE - 9%							
6%	1,550,602	157,017	6%	80,546	330	62.4%	3.92
8%	1,550,602	157,017	8%	80,546	330	62.4%	4.36
10%	1,550,602	157,017	10%	80,546	330	62.4%	4.85
12%	1,550,602	157,017	12%	80,546	330	62.4%	5.41
TOTAL GROSS INVESTMENT BASE CASE - $1,550,602,000							
+30%	2,015,783	157,017	9%	80,546	330	62.4%	5.39
+15%	1,783,190	157,017	9%	80,546	330	62.4%	4.99
-15%	1,318,012	157,017	9%	80,546	330	62.4%	4.20
-30%	1,085,421	157,017	9%	80,546	330	62.4%	3.80
SYNCRUDE PRICE BASE CASE - $13.78/bbl.							
-$3	1,550,602	180,817	9%	80,546	330	62.4%	4.90
-$1	1,550,602	164,950	9%	80,546	330	62.4%	4.70
+$1	1,550,602	149,083	9%	80,546	330	62.4%	4.50
+$3	1,550,602	133,216	9%	80,546	330	62.4%	4.30

Table 6.7-2

Summary of Sensitivity Analysis Results
Based on Estimates in Year End 1977 Dollars

6.7 Sensitivity Analysis

6.7.1 Coal Cost

The coal for the baseline case is priced at $22.50/ton, as received. If the price is varied from $15 to $35/ton, the gas cost varies from $3.71 to $6.07/MM Btu, as depicted in Figure 6.7-1.

Changes in coal cost do not affect the material or energy balance, the total gross investment, the rate of SPG production or the thermal efficiency. Only the coal component of the operating cost is changed.

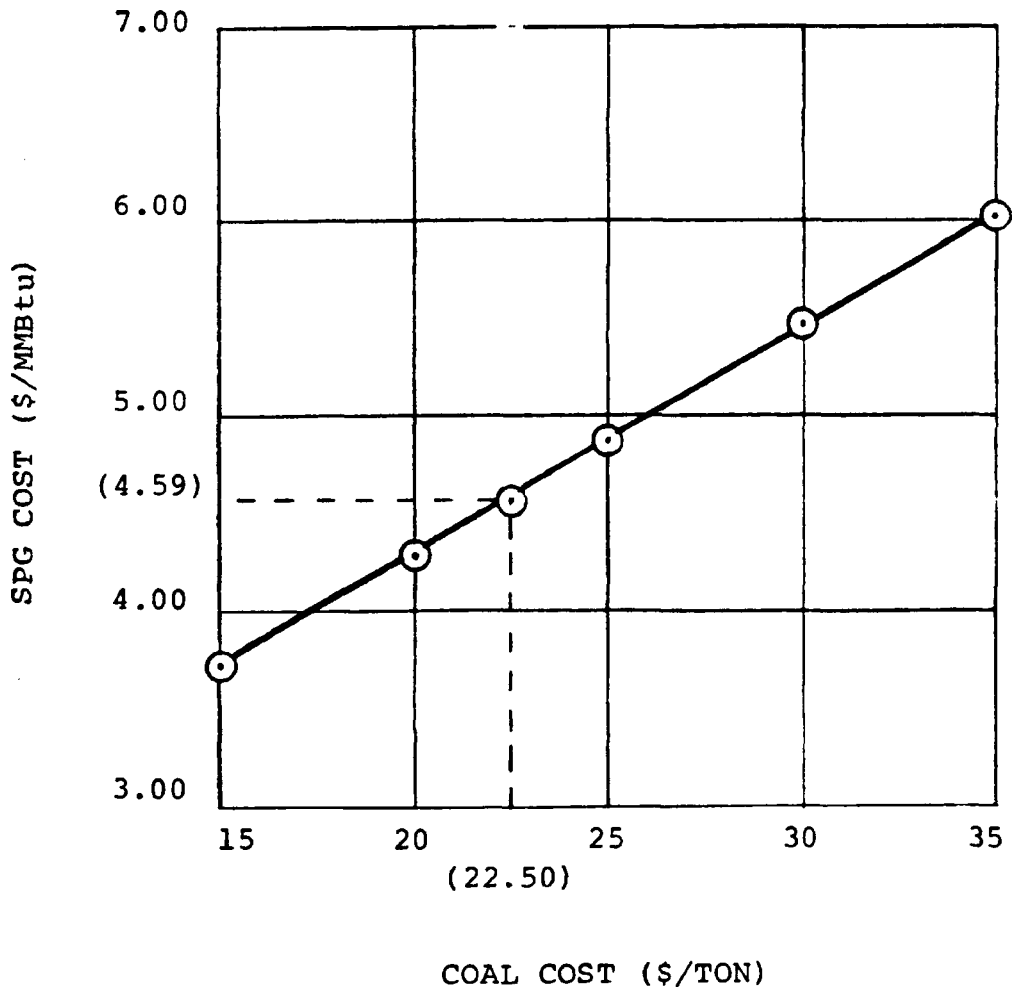


Figure 6.7-1 Sensitivity to Coal Cost
Based on Estimates in Year End 1977 Dollars

6.7 Sensitivity Analysis

6.7.2 Overal Thermal Efficiency

The overall thermal efficiency for the baseline case is 62.4%. For this analysis, it was varied between 50% and 75%, and the resulting gas cost varied between $6.14 and $3.55/MM Btu, as shown in Figure 6.7-2.

It is assumed that when the thermal efficiency changes, the yield of the SPG and the major by-products (electric power, syncrude, and light hydrocarbons) change proportionally, and the coal and other inputs to the plant do not change. This affects the rate of SPG production and the by-product credit component of the operating cost. Higher efficiency leads to higher SPG production, higher by-product credit, and lower net operating cost.

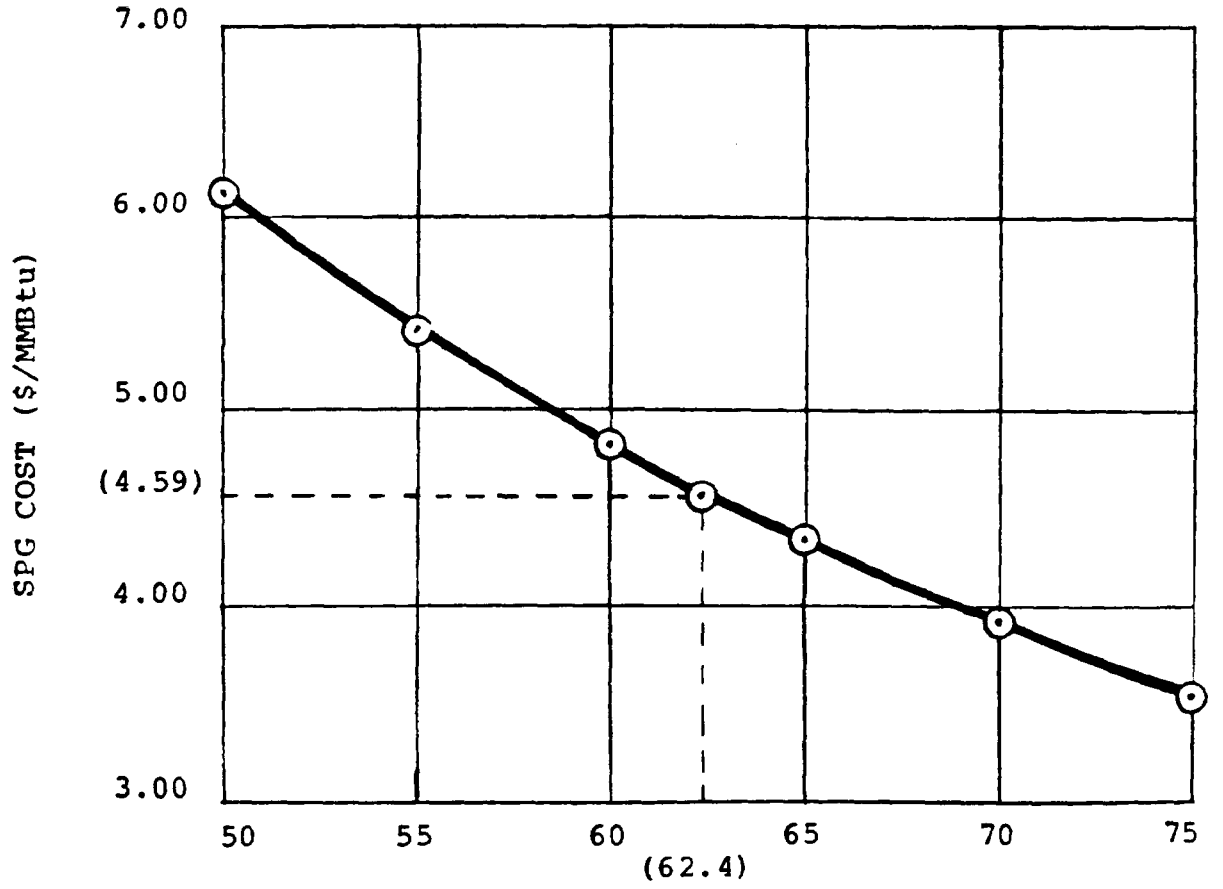


Figure 6.7-2 Sensitivity to Overall Thermal Efficiency Based on Estimates in Year End 1977 Dollars

6.7 - Sensitivity Analysis

6.7.3 Plant Stream-Time Efficiency

A plant stream-time efficiency of 90.4% is assumed for the baseline design, which corresponds to the plant operating at 100% of design 330 operating days per year. The remaining 35 days are for scheduled and unscheduled maintenance.

Figure 6.7-3 depicts the effect of changing the efficiency (or the number of days for maintenance) between 70% (256 operating days) and 99% (361 operating days). Changing the number of operating days changes the annual operating cost and SPG production and causes the SPG cost to vary from $5.60 to $4.30/MM Btu.

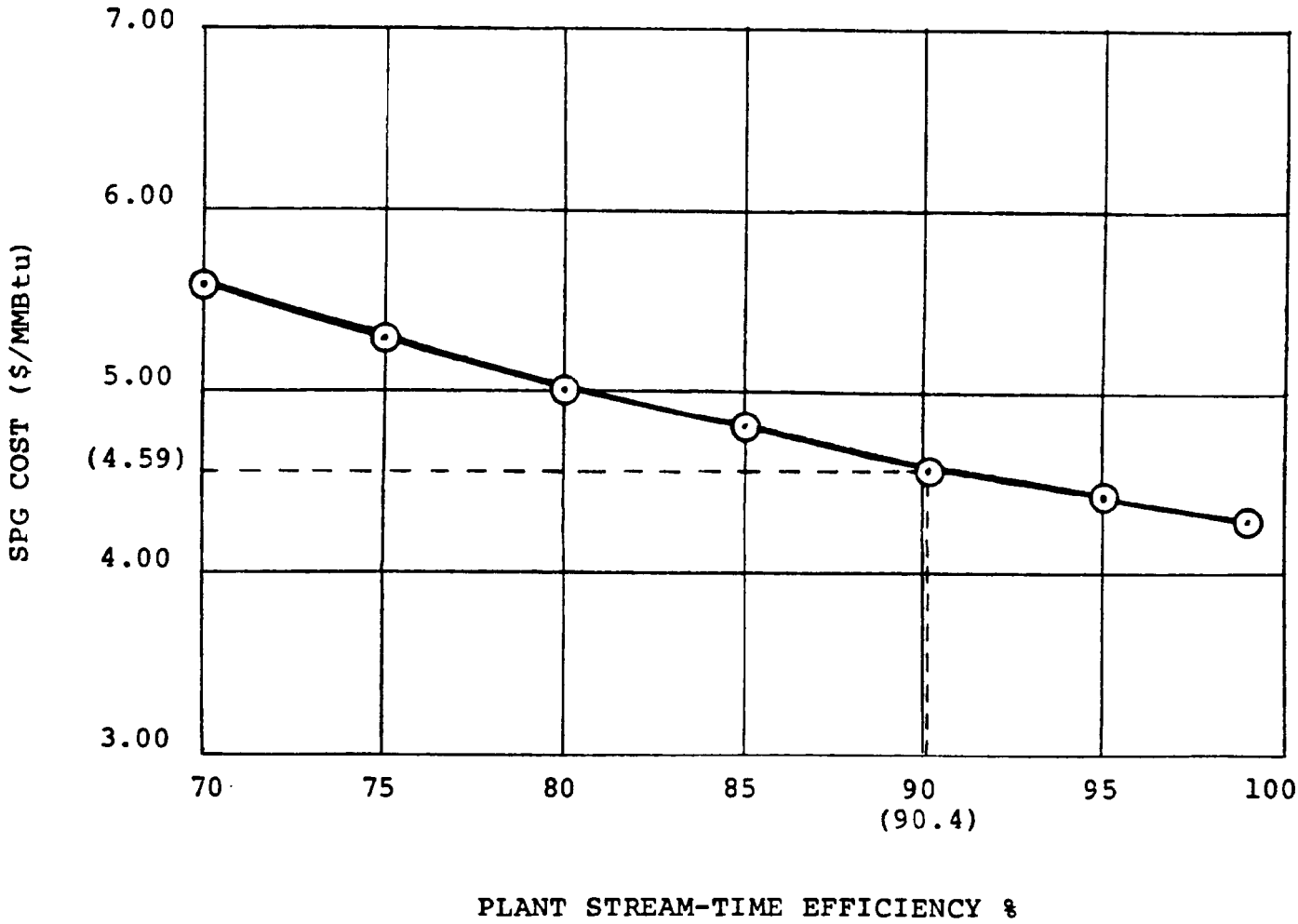


Figure 6.7-3 Sensitivity to Plant Stream-Time Efficiency Based on Estimated in Year Enf 1977 Dollars

6.7 Sensitivity Analysis

6.7.4 Discount Rate

For the Baseline Economic Evaluation case, the discount rate was assumed to be 9% in accordance with the DOE guidelines.

Figure 6.7-4 shows the effect of changing the discount rate bewteen 6% and 12%. The cost of the SPG varies from $3.92 to $5.41/MM Btu.

Changing the discount rate +3% or 33 1/3% from the base case increase the gas cost by 17.9%. A 3% change from the base case reduces the gas cost by 14.6%.

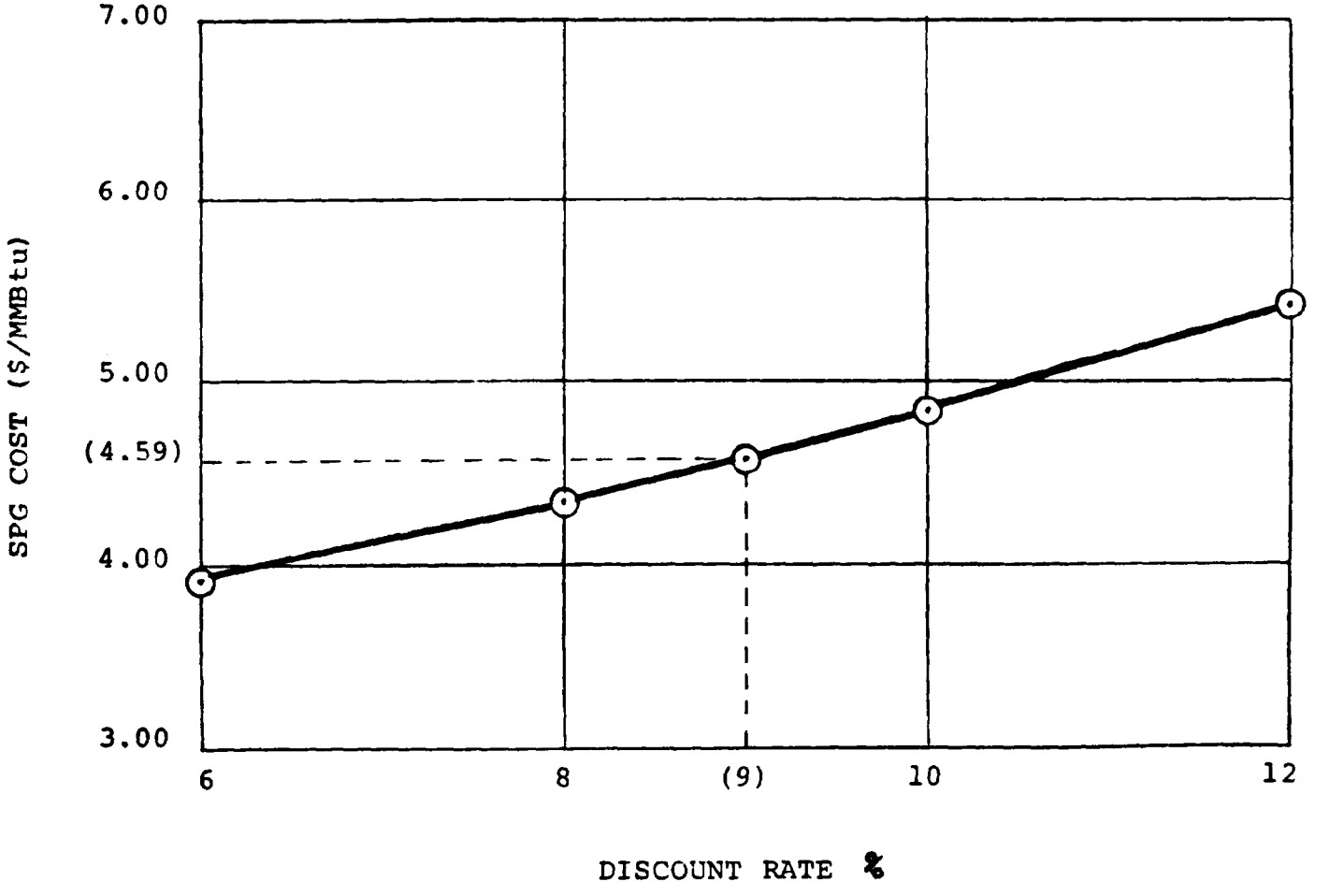


Figure 6.7-4 Sensitivity to Discount Rate
Based on Estimated in Year End 1977 Dollars

6.7 Sensitivity Analysis

6.7.5 Total Gross Investment

The total gross investment is $1,550,602,000 for the baseline case. Changing total gross investment by 30% (+30% = $2,015,783,000; -30% = $1,085,421,000), varies the cost of SPG from $5.39 to $3.80/MM Btu. Figure 6.7-5 illustrates this effect.

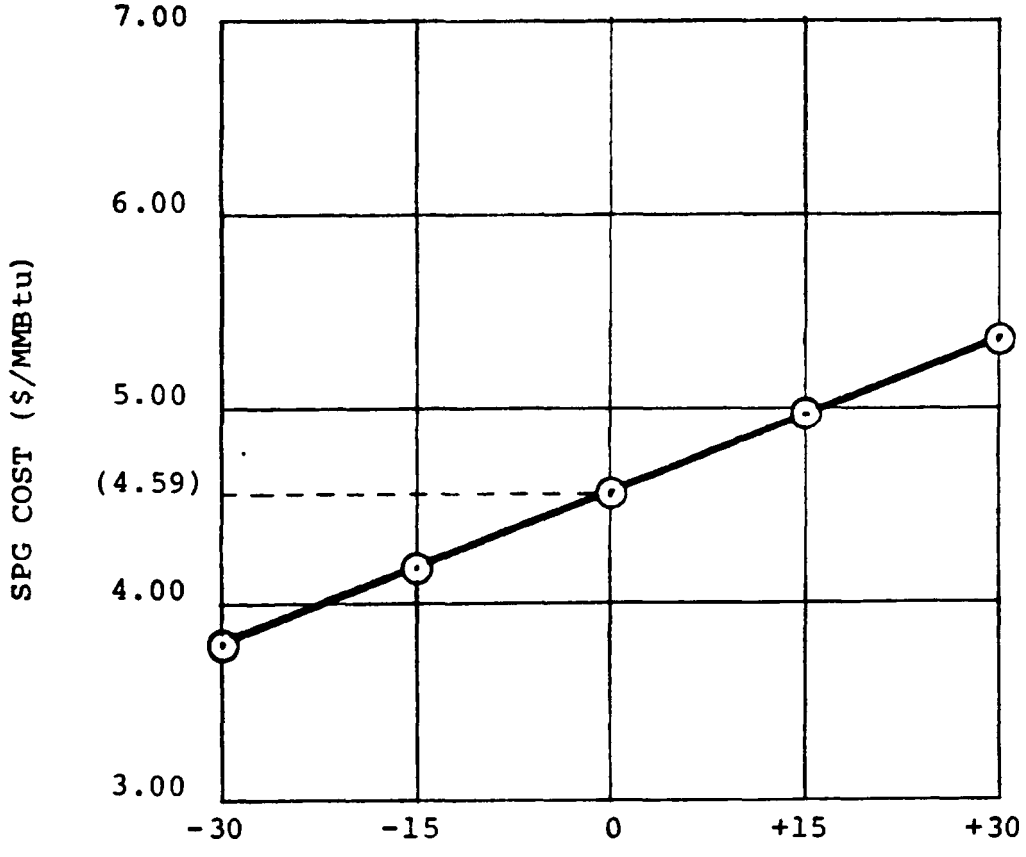


Figure 6.7-5 Sensitivity to Change in Total Gross Investment Based on Estimates in Year Enf 1977 Dollars

6.7 - Sensitivity Analysis

6.7.6 Syncrude Price

The market value of syncrude used in the baseline is $13.78/bbl. For each ± $1 change in the market price, the SPG price changes by ± $0.10/MM Btu's as shown in Figure 6.7-6.

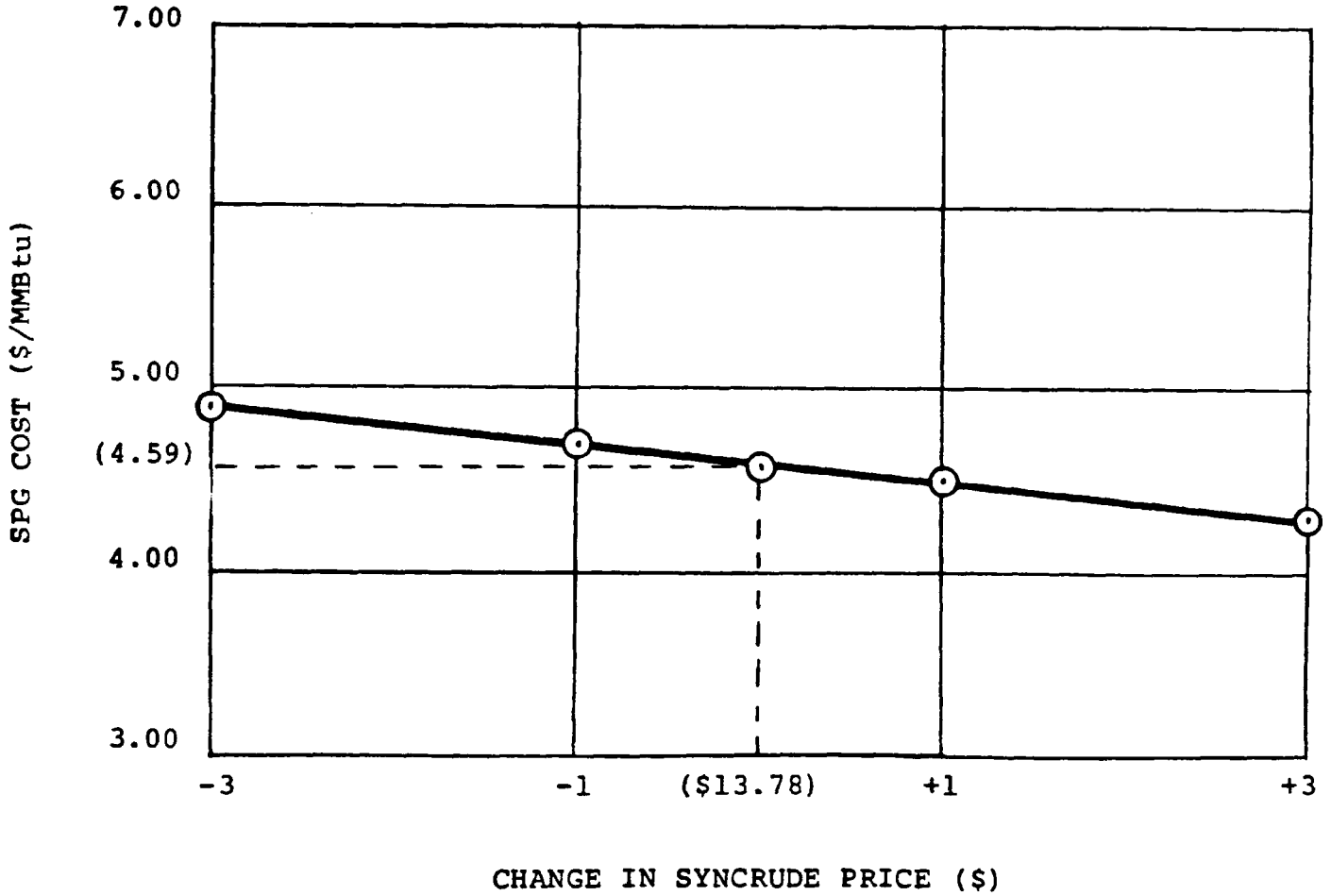


Figure 6.7-6 Sensitivity to Syncrude Price Based on Estimated in Year End 1977 Dollars