

Appendix B

Methanol-From-Coal
Total Capital Requirement

| | <u>1975, M\$</u> |
|--|------------------|
| Total Direct & Indirect Cost of Plant (Incl. Contractor & Engr. Fees Tax & Licenses) | 472,000 |
| Contingency | <u>42,000</u> |
| Total Plant Investment | 514,000 |
| Interest During Construction Interest Rate (9.0%) x Total Plant Investment x 1.875 Average Year Period | 87,000 |
| Plant Start-Up Cost 40% of Operating Cost for 1/2 year | 11,000 |
| Working Capital | M\$ |
| Coal @ \$3.60/ton ** (64 days supply) | <u>7,320</u> |
| Catalyst & Chemical (60 days supply) | 800 |
| Receivables Less Payable (1/24 of annual Revenue from Methanol @\$1.80/MMBtu) | <u>5,460</u> |
| Total Working Capital | 14,000 |
| Total Capital Requirement | <u>626,000</u> |

** Mine-Mouth Coal Cost. This figure is taken from the average coal cost in New Mexico as reported by Steam-Electric Plant Factors, 1973 Edition, National Coal Association with escalation of 10% per year to 1975.

Appendix B (Cont'd.)

Methanol-From-Coal
Annual Operating Cost
 On Stream Factor = 0.9

| | <u>1975, M\$/Yr.</u> |
|--|----------------------|
| 1. <u>Raw Materials</u> | |
| Coal at \$3.60/ton | 37,600 |
| 2. <u>Purchased Utilities</u> | |
| Power | -- |
| Water | 400 |
| 3. <u>Labor</u> | |
| A. Operating Labor at \$8/hr | 10,800 |
| B. Maintenance Labor (15% of Total Plant Investment) | 7,700 |
| C. Supervision (0.15 of A+B) | 2,800 |
| 4. <u>Supplies</u> | |
| A. Operating Catalyst & Chemicals | 6,000 |
| B. Maintenance (1.5% of Total Plant Investment) | 7,700 |
| 5. <u>Administration & General Overheads</u> | |
| 60% of Labor Including Supervision | 12,800 |
| 6. Tax & Insurance at 2.7% of Total Plant Investment | 13,900 |
| 7. Total Operating Cost (Without By-Product Credits) | <u>99,700</u> |
| 8. <u>By-Product Credits</u> | <u>M\$/Yr.</u> |
| A. Tar Oil, Naphtha (\$8/barrel) | 32,500 |
| B. Phenols (\$70/ton) | 3,600 |
| C. Ammonia (\$50/ton) | 5,400 |
| D. Sulfur (\$10/LT) | 400 |
| E. Higher Alcohols (\$100/ton) | <u>1,900</u> |
| Total By-Product Credits | 43,800 |
| 9. Total Net Operating Cost | 55,900 |

Unit Costs

10. Methanol Cost (with By-product Credits)

| | | |
|----|-----------|------|
| A. | \$/MMBtu | 1.80 |
| B. | \$/Barrel | 4.90 |

11. Methanol Cost (without By-product Credits)

| | | |
|----|-----------|------|
| A. | \$/MMBtu | 2.42 |
| B. | \$/Barrel | 6.58 |

Appendix B (Cont'd.)

Methanol-From-Coal Cost

For 20 year average price without escalation
(Based on Shortcut Method on Panhandle
Eastern Accounting Procedure)

Cost of Methanol

$$\begin{aligned} & \text{(Net Operating Cost + 0.1198 x Total Capital} \\ & \text{Requirement + 0.0198 x Working Capital)} \\ = & \frac{\hspace{10em}}{\text{Methanol Production}} \end{aligned}$$

Methanol Production

$$= 72.75 \times 10^6 \text{ MMBtu/year (26.75 MMBarrels)}$$

Cost of Methanol

$$\begin{aligned} = & \frac{55.9 + 0.1198 \times 626 + 0.0198 \times 14}{72.75} \\ = & \$1.80/\text{MMBtu (With By-product Credits)} \\ = & \$4.90/\text{Barrel (With By-Product Credits)} \end{aligned}$$

Cost of Methanol

$$\begin{aligned} = & \frac{99.7 + 0.1198 \times 635 + 0.0198 \times 14}{72.75} \\ = & \$2.42/\text{MMBtu (Without By-Product Credit)} \\ = & \$6.58/\text{Barrel (Without By-Product Credit)} \end{aligned}$$

Appendix C

Substitute Natural Gas Production
Total Capital Requirement

| | <u>1975, M\$</u> |
|---|------------------|
| Total Direct & Indirect Cost of Plant (Incl. Contractor & Engr. Fees, Tax & Licenses) | 365,000 |
| Contingency | 34,000 |
| Total Plant Investment | <u>399,000</u> |
| Interest During Construction (Interest Rate (9.0%) x Total Plant Investment x 1.875 years average period) | 67,000 |
| Plant Start-up Cost 40% of Operating Cost for 1/2 year | 7,000 |
| Working Capital ** | <u>M\$</u> |
| Coal @ 3.60/ton (64 day supply) | 6,150 |
| Catalyst & Chemicals (60 days supply) | 500 |
| Receivables Less Payables - 1/24 of annual revenue at \$1.13/MMBtu) | <u>3,900</u> |
| Total Working Capital | <u>11,500</u> |
| Total Capital Requirement | 484,000 |

** Mine-Mouth Coal Cost. This figure is taken from the average coal cost in New Mexico as reported by Steam-Electric Plant Factors, 1973 Edition, National Coal Association with escalation of 10% per year to 1975.

Appendix C (Cont'd.)

SNG Annual Operating Cost
Stream Factor = 0.9

| | <u>1975, M\$/year</u> |
|---|--------------------------|
| 1. <u>Raw Material</u> | |
| Coal at \$3.60/ton | 31,590 |
| 2. <u>Purchased Utilities</u> | |
| Power @ 0.8¢/KWH | --- |
| Raw Water | 300 |
| 3. <u>Labor</u> | |
| A. Operating Labor at \$8.00/hr | 5,980 |
| B. Maintenance Labor (1.5% of total plant investment) | 5,990 |
| C. Supervision (15% of A + B) | 1,780 |
| 4. <u>Supplies</u> | |
| A. Operating Catalyst & Chemicals | 3,000 |
| B. Maintenance @ 1.5% of Total Plant Investment | 5,990 |
| 5. <u>Administration & General Overhead</u> | |
| 60% of total labor including supervision | 8,250 |
| 6. Taxes & Insurance at 2.7% of total Plant Investment per Year | 10,773 |
| 7. Total Operating Cost (Without By-Product Credits) | 73,650 |
| 8. By-Product Credits | |
| A. Tar, Oil, Naphtha (\$8/Barrel) | <u>M\$/Yr.</u> 31,960 |
| B. Crude Phenols (\$70/ton) | 2,880 |
| C. Ammonia (\$50/ton) | 3,420 |
| D. Sulfur (\$10/LT) | <u>440</u> |
| Total By-Product Credit | 38,700 |
| 9. Net Annual Operating Cost | 35,000 |

Unit Costs

- 10. Substitute Natural Gas (with By-Product Credits)
 - A. \$/MMBtu 1.13
- 11. Substitute Natural Gas (without By-Product Credits)
 - A. \$/MMBtu 1.60

Appendix C (Cont'd.)

SNG Gas Cost

For 20-year Average Gas Price Without
Escalation (Based on Short-Cut
Method on Panhandle Eastern Accounting
Procedure)

Gas Price

$$= \frac{(\text{Net Operating Cost} + 0.1198 \times \text{Total Capital Requirement} + 0.0198 \times \text{Working Capital})}{\text{Gas Production}}$$

Gas Production

$$= 82.4 \times 10^6 \text{ MMBtu/year}$$

Gas Price

$$= \frac{35.0 + 0.1198 \times 484.0 + 0.0198 \times 11.0}{82.4}$$
$$= \$1.13/\text{MMBtu (With By-Product Credit)}$$

Gas Price

$$= \frac{73.650 + 0.1198 \times 494.0 + 0.0198 \times 11.0}{82.4}$$
$$= \$1.60/\text{MMBtu (Without By-Product Credit)}$$

Appendix D

Low Btu Gas Production
Total Capital Requirement

| | <u>1975, M\$</u> |
|--|------------------|
| Total Direct & Indirect Cost of Plant (Incl. Contractor & Engr. Fees Tax & Licenses) | 218,000 |
| Contingency | 20,000 |
| | <hr/> |
| Total Plant Investment | 238,000 |
| Interest During Construction (Interest Rate (9%) x Total Plant Investment x 1.875 Years Average Period) | 40,000 |
| Plant Start-Up Cost 40% of Operating Cost for 1/2 year | 5,400 |
| Working Capital ** | <u>M\$</u> |
| Coal at \$3.60/ton (64 day supply) | 4,900 |
| Catalyst and Chemicals (60 day supply) | 300 |
| Receivable Less Payable (1/24 of Annual Revenue at \$0.8/MMBtu) | <u>2,600</u> |
| Total Working Capital | 7,800 |
| | <hr/> |
| Total Capital Requirement | 291,000 |

** Mine-Mouth Coal Cost. This figure is taken from the average coal cost in New Mexico as reported by Steam-Electric Plant Factors, 1973 Edition, National Coal Association with escalation of 10% per year to 1975.

Appendix D (Cont'd.)

Low Btu Gas Production
Annual Operating Cost
On Stream Factor = 0.9

1975M\$/Year

| | | |
|----|--|----------------|
| 1. | <u>Raw Materials</u> | |
| | Coal at \$3.60/ton (Catalyst & Chemicals included with supplies) | 25,160 |
| 2. | <u>Purchased Utilities</u> | |
| | Power | -- |
| | Raw Water | 200 |
| 3. | <u>Labor</u> | |
| | A. Operating Labor at \$8/hr | 3,990 |
| | B. Maintenance Labor at 1.5% of Total Plant Investment | 3,570 |
| | C. Supervision @ 15% of A+B | 1,130 |
| 4. | <u>Supplies</u> | |
| | A. Operating Catalyst & Chemicals | 2,000 |
| | B. Maintenance @ 1.5% of total plant investment | 3,570 |
| 5. | <u>Administration & General Overhead</u> | |
| | (60% of total Labor Including Supervision) | 5,210 |
| 6. | Tax & Insurance at 2.7% of Total Plant Investment per year | 6,430 |
| 7. | Total Operating Cost (Without By-Product Credits) | 51,260 |
| 8. | By-Product Credits | <u>M\$/Yr.</u> |
| | A. Tar, Oil, Naphtha (\$8/barrel) | 18,880 |
| | B. Crude Phenols (\$70/ton) | 2,300 |
| | C. Ammonia (\$30/ton) | 2,710 |
| | D. Sulfur (\$10/LT) | 350 |
| | Total By-Product Credit | 24,240 |
| 9. | Net Annual Operating Cost | 27,000 |

Unit Cost

| | | |
|-----|--|------|
| 10. | Low Btu Gas (with By-Product Credits) | |
| | A. \$/MMBtu | 0.86 |
| 11. | Low Btu Gas (without By-Product Credits) | |
| | A. \$/MMBtu | 1.20 |

Low Btu Gas Production
Gas Cost

For 20-year Average Gas Price Without
Escalation (Based on Short-Cut
Method on Panhandle Eastern Accounting
Procedure)

$$\text{Gas Price} = \frac{(\text{Net Operating Cost} + 0.1198 \times \text{Total Capital Requirement} + 0.0198 \times \text{Working Capital})}{\text{Gas Production}}$$

$$\text{Gas Production} = 72.5 \times 10^6 \text{ MMBtu}$$

$$\text{Gas Price} = \frac{(27 + 0.1198 \times 291 + 0.0198 \times 7.8)}{72.5}$$

$$= \$0.86/\text{MMBtu (With By-Product Credits)}$$

$$\text{Gas Price} = \frac{(51.26 + 0.1198 \times 296 + 0.0198 \times 7.8)}{72.5}$$

$$= \$1.20/\text{MMBtu (Without By-Product Credit)}$$

Appendix D (Cont'd.)

Low Btu Gas Production
Annual Operating Cost

Alternate Case with On Stream Factor = 0.7

| | <u>1975M\$/Year</u> |
|--|---------------------|
| 1. <u>Raw Materials</u> | |
| Coal at \$3.60/ton (Catalyst & Chemicals included with supplies) | 19,570 |
| 2. <u>Purchased Utilities</u> | |
| Power | -- |
| Raw Water | 200 |
| 3. <u>Labor</u> | |
| A. Operating Labor at \$8/hr | 3,990 |
| B. Maintenance Labor at 1.5% of Total Plant Investment | 3,570 |
| C. Supervision @ 15% of A+B | 1,130 |
| 4. <u>Supplies</u> | |
| A. Operating Catalyst & Chemicals | 2,000 |
| B. Maintenance @ 1.5% of total plant investment | 3,570 |
| 5. <u>Administration & General Overhead</u> (60% of total Labor Including Supervision) | 5,210 |
| 6. Tax & Insurance at 2.7% of Total Plant Investment per year | 6,430 |
| 7. Total Operating Cost (Without By-Product Credits) | 45,670 |
| 8. By-Product Credits | <u>M\$/Yr.</u> |
| A. Tar, Oil, Naphtha (\$8/barrel) | 14,700 |
| B. Crude Phenols (\$70/ton) | 1,800 |
| C. Ammonia (\$30/ton) | 2,100 |
| D. Sulfur (\$10/LT) | 300 |
| Total By-Product Credit | 18,900 |
| 9. Net Annual Operating Cost | 26,800 |

Unit Cost

| | |
|--|------|
| 10. Low Btu Gas (with By-Product Credits) | |
| A. \$/MMBtu | 1.10 |
| 11. Low Btu Gas (without By-Product Credits) | |
| A. \$/MMBtu | 1.44 |

Low Btu Gas Production
Gas Cost

Alternate Case with On Stream Factor = 0.70

For 20-year Average Gas Price Without
Escalation (Based on Short-Cut
Method on Panhandle Eastern Accounting
Procedure)

$$\text{Gas Price} = \frac{(\text{Net Operating Cost} + 0.1198 \times \text{Total Capital Requirement} + 0.0198 \times \text{Working Capital})}{\text{Gas Production}}$$

$$\text{Gas Production} = 56.4 \times 10^6 \text{ MMBtu}$$

$$\text{Gas Price} = \frac{(26.8 + 0.1198 \times 291 + 0.0198 \times 7.8)}{56.4}$$

$$= \$1.10/\text{MMBtu (with By-Product Credits)}$$

$$\text{Gas Price} = \frac{(45.67 + 0.1198 \times 296 + 0.0198 \times 7.8)}{56.4}$$

$$= \$1.44/\text{MMBtu (without By-Product Credit)}$$

Appendix E

Description of the Panhandle Eastern Accounting Procedures**

Basis:

- 20-year project life
- 5% straight line depreciation on Total Capital Requirement excluding Working Capital
- 48% federal income tax rate
- Debt/equity ratio of 75%/25%
- 9% percent interest on debt
- 15% percent return on equity

Derived Parameters:

- Rate Base = Total Capital Requirement less Accrued Depreciation (includes 1/2 depreciation for given year)
- Percent Return on Rate Base = Fraction Debt x Percent Interest + Fraction Equity x Percent Return on Equity

Calculated Cash Flows in Given Year:

- Return on Rate Base = Rate Base x (Percent Return on Rate Base ÷ 100)
- Return on Equity = (Fraction Equity x Rate Base) x (Percent Return on Equity ÷ 100)
- Federal Income Tax = Return on Equity x (Percent Tax Rate ÷ [100 - Percent Tax Rate])
- Depreciation = 0.05 x (Total Capital Requirement - Working Capital)
- Total Revenue Requirement in Given Year = Return on Rate Base + Federal Income Tax + Depreciation + Total Net Operating Cost

** Final Report of the Supply-Technical Advisory Force - Synthetic Gas From Coal, April, 1973

Appendix E. (Cont'd.)

Costs of Production:

- In given year: Total Revenue Requirement \div Annual Production
- 20-year average: Total Revenue Requirement Over Project Life \div (20 x Annual Production)

Derivation of General Cost Equation

Definition of Terms:

- C = Total Capital Requirement, Million \$
W = Working Capital, Million \$
N = Total Net Operating Cost, Million \$
G = Annual Production, 10^{12} Btu/year
d = Fraction Debt
i = Percent Interest on Debt
r = Percent Return on Equity
p = Percent Return on Rate Base
n = Year, 1 to 20
 RR_n = Total Revenue Requirement in n^{th} Year

Calculate Rate Base in n^{th} Year:

$$\begin{aligned}\text{Depreciable Investment} &= C - W \\ \text{Accrued Depreciation @ Mid-Point of Year} &= 0.05(n-0.5)(C-W) \\ \text{Rate Base} &= C - 0.05(n-0.5)(C-W)\end{aligned}$$

Calculate Percent Return on Rate Base:

$$\begin{aligned}p &= (d)i + (1-d)r \\ &= 0.75 \times 9 + 0.25 \times 15 \\ &= 10.5\end{aligned}$$

Appendix E (Cont'd.)

Calculate Cash Flows in n^{th} Year:

$$\text{Return on Rate Base} = 0.01 p [C - 0.05(n-0.5)(C-W)]$$

$$\text{Return on Equity} = 0.01 r (1-d) [C - 0.05(n-0.5)(C-W)]$$

$$\text{Federal Income Tax} = \frac{48}{52} 0.01 r (1-d) [C - 0.05(n-0.5)(C-W)]$$

$$\text{Depreciation} = 0.05(C-W)$$

$$\text{Total Net Operation Cost} = N \text{ (excluding escalation)}$$

$$\text{Total Revenue Requirement (RR}_n\text{)} =$$

$$0.01 p [C - 0.05(n-0.5)(C-W)]$$

$$+ \frac{48}{52} 0.01 r (1-d) [C - 0.05(n-0.5)(C-W)]$$

$$+ 0.05 (C-W) + N$$

$$\text{RR}_n = N + 0.05 (C-W)$$

$$+ 0.01 \left[p + \frac{48}{52} (1-d) r \right] [C - 0.05(n-0.5)(C-W)]$$

Calculate Production Cost in n^{th} Year:

$$\text{Gas Cost in } n^{\text{th}} \text{ Year} = \text{RR}_n / G \quad (\$/\text{MMBtu})$$

Calculate 20-Year Total Revenue Requirement (excluding escalation):

$$\sum_{n=1}^{20} \text{RR}_n = 20N + (C-W)$$

$$+ 0.01 \left[p + \frac{48}{52} (1-d) r \right] [20C - 0.05(200)(C-W)]$$

$$\text{Total RR} = 20N + (C-W)$$

$$+ 0.1 \left[p + \frac{48}{52} (1-d) r \right] (C+W)$$

Appendix E (Cont'd.)

Calculate 20-Year Average Production Cost Without Escalation:

Average Production Cost

$$= \text{Total RR} / (20 \times G)$$

$$= \frac{N + 0.05 (C-W) + 0.005 \left[P + \frac{48}{52} (1-d)r \right] (C+W)}{G}$$

$$= \frac{N + 0.05 (C-W) + 0.005 \left[10.5 + \frac{48}{52} (0.25) (15) \right] (C+W)}{G}$$

$$= \frac{N + 0.05 (C-W) + 0.0698 (C+W)}{G}$$

or

$$\text{Average Production Cost (\$/MMBtu)} = \frac{N + 0.1198 C + 0.0198 W}{G}$$

