CHAPTER VI

INVESTMENT ANALYSIS

After the preliminary design, an investment analysis is done in order to determine the feasibility of the project. The estimation of cost on each equipment is done, then, the approximate value of the fixed capital investment and total capital investment are calculated. After the determination of utilities and general expenses, total cost and net annual income is known. A profitability analysis utilizing the internal rate of return on the capital investment is done to determine the economic possibilities of the design. By varying natural gas price, the sensitivity of profitability on the above can be determined. Table VI-I shows the result of the calculation and Figure VI-I shows the present value and the rate of return at various natural gas price. At natural gas price of $4/1000 cu.ft. and ammonia price of $400/ton, the internal rate of return is 22.5%

The capital investment cost is estimated by following the estimation method given by Guthrie (1969) which is based on the module concept. The major cost elements of a process plant are grouped into six distinct modules, five direct and one indirect. An estimating module represents a group of cost elements having similar characteristics and relationships. From FOB equipment cost, which can be determined from the data given by Guthrie, the bare module cost of each item of each equipment is calculated by multiplying equipment cost by the bare module factor. The price escala-

Table VI-1

Present Value VS Internal Rate of Return

IRR	Present Value at Gas Price of		
	$4/1000 cu.ft.	$5/1000 cu.ft.	$6/1000 cu.ft.
25	-9002		
22	681		
20	7280	-9242	
17		853	
15	30153	9298	-11361
12			+ 113
11			+4866

tion is estimated roughly from the CE plant cost index in the Chemical Engineering from 1968-1979. The bare module factor includes all the direct and indirect cost elements in the process module, and is used as a multiplier on equipment cost. It is a measure of the capital required to integrate single or multiple pieces of equipment into a particular process circuit. The bare module cost does not include any adjustment for unlisted items or insufficient scope definition and contractors' fee. The freight and and insurance on the transportation of equipment is estimated at 10 per cent on fixed capital investment, land and buildings at 10 per cent. The total investment can then be calculated from the sum of the fixed investment cost and working capital, which is assumed to be 20 per cent of the total invest-

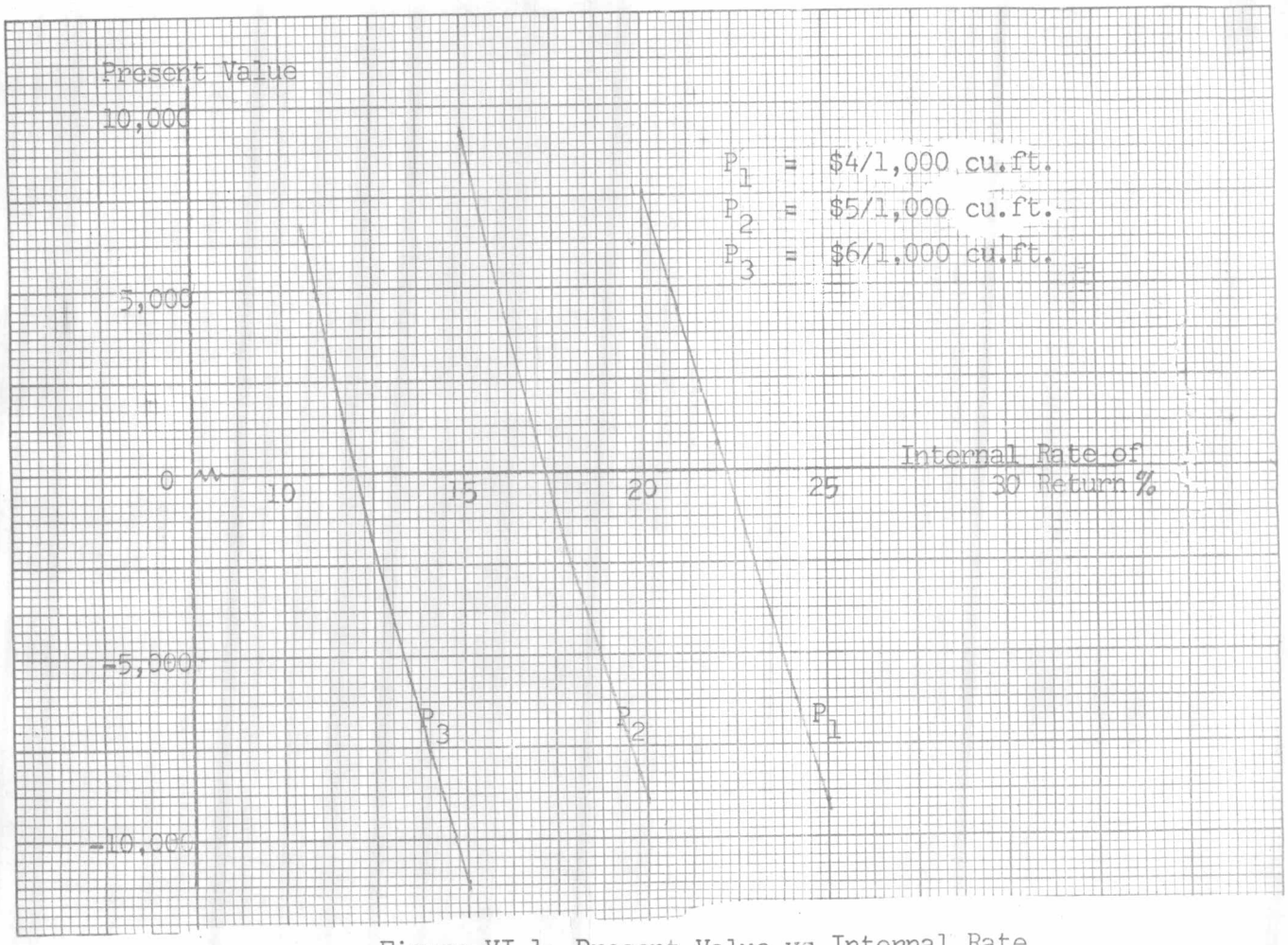

Figure VI-1 Present Value vs Internal Rate of Return

ment. Royalties at 20% of the revenue at full capacity for 1 year. The result of the capital cost estimation is shown in Table VI-2.

Total cost of products consists of manufacturing cost and general expenses. Manufacturing cost consists of natural gas cost, catalyst and chemical cost, cooling water cost, maintenance and labor cost, overhead cost, electrical power and steam cost, insurance and depreciation. The cost of natural gas raw material is estimated to be $4.0/1,000 cu.ft. The cost of raw material, utilities, catalyst and labour cost are listed in Table VI-3. Labour cost is calculated from 3 shifts 10 workers each.

Table VI-2

CAPITAL INVESTMENT ESTIMATION

			1979
Compressors	CP-1	US$	2,688,426
	CP-2		10,255,241
	CP-3		11,669,757
Pressure Vessels	DS-1		36,311
	DS-2		116,142
	SR		548,723
	HTS		991,211
	LTS		854,492
	ME		639,362
	FD-1		62,911
	FD-2		15,486
	FD-3		825,027
	CR		183,891
	RG		280,676
Heat Exchanger	HE-1		274,364
	HE-2		165,565
	HE-3		510,884
	HE-4		227,059
	HE-5		165,565
	HE-6		658,406
	HE-61		510,884
	HE-7		1,345,644
	HE-8		4,406,137
	HE-9		672,822
Refrigeration	RF		8,241,304
Furnace	PR		3,402,689
Converter	SC		2,693,101
Storage	ST		2,803,424
Land & Building (10% of Fixed Capital Investment)			6,905,688
Freight on Transportation of equipment (10% of Fixed Capital Investment)			6,905,688
FIXED CAPITAL INVESTMENT			69,056,880
Contingency & Contractor's fees (15% of Fixed Capital Investment)			10,358,532
Royalties & Patents			31,680,000
Working Capital			27,773,853
TOTAL CAPITAL INVESTMENT IN 1979		US$	138,869,265

Table VI-3

RAW MATERIAL, UTILITIES & LABOUR COST

Natural Gas	$4.0/1,000 cu.ft.
Cooling Water	$0.05/1 cu. m.
Catalyst	$1.7763/ton of product
Electricity	$0.05/kWh
Labour	$2.0/man-hour

The maintenance of the plant is estimated at 10 per cent on the fixed capital investment, insurance at 1 per cent. Overhead is valued at 100 per cent of labour cost. Depreciation is calculated by the straight line method at 10 per cent per annum as the life of the plant is assumed for 10 years.

General expenses consist of administration cost, distribution and marketing cost, and research and development cost. They are valued at 5 per cent, 10 per cent and 5 per cent on sales respectively (Timmerhaus, 1968).

Annual taxable income is derived from the sales of liquid ammonia at $400/ton less the total cost production. Net annual income is calculated by the reduction of 45 per cent income tax. Tables VI-4 to VI-6 show the result of the procedure.

The internal rate of return which is the discount rate at which the present value of cash inflows is equal to the cash outflows is made. The plant is assumed to be constructed for 2 years. The start-up period last for 4 years during which the capacity is run at 55%, 65%, 75%, 85% respectively. After the start-up period, full capacity period is followed for 6 years. During these two periods, the prices of ammonia and natural gas are assumed to be fixed as price increases of both are difficult to be determined. Salvage value of land and buildings is assumed to be 25% of the value purchased.

The calculation procedure begins with the preparation of cash-flow table. An estimated discount rate is then used to discount the net cash flow to the present value. If the NPV is positive, a higher discount rate is applied. If the NPV is negative at this higher rate, the internal rate of return is between the two rates. If the positive and negative NPV's are close to zero, linear interpolation to find the internal rate of return is made. At natural gas price of $4/1000 cu.ft. and ammonia price of $400/ton, the internal rate of return is 22.5%.

The sensitivity analysis of the project profitability is done in order to find the effect of changes in cost estimation. The price of natural gas is changed from $4/1000 cu.ft. to $5 and $6/1,000 cu. ft. The internal rate of return varies from 22.5%, 17.2% and 12.0% As 12% is the interest rate from the bank which is an alternative, a natural gas price higher than $6/1000 cu.ft. is not done as the calculated internal rate of return is unprofitable. Tables VI-7 to VI-9 shows the details of the calculation.

Table VI-4

ANNUAL INCOME ESTIMATION

Natural Gas Price at $ 4/1000 cu.ft.
Ammonia Price at $400/ton

Capacity	55%		65%		75%		85%		100%	
Total Sales US$1,000		87,120		102,960		118,800		134,640		158,400
Less: Manufacturing Cost										
Natural Gas	26,808		31,682		36,557		41,431		48,742	
Catalyst & Chemicals	387		466		527		598		703	
Cooling Water	122		144		166		188		221	
Electricity	212		251		290		328		386	
Labour	175		175		175		175		175	
Overhead	175		175		175		175		175	
Maintenance	6,906		6,906		6,906		6,906		6,906	
Insurance	691		691		691		691		691	
Depreciation	11,110		11,110		11,110		11,110		11,110	
Sub - Total	46,586	46,586	51,600	51,600	56,597	56,597	61,602	61,602	69,119	69,119
Gross Profit		40,534		51,360		62,203		73,038		89,281
Less: General Expenses										
Sales Tax	6,708		7,928		9,148		10,367		12,197	
Administration	4,356		5,148		5,940		6,732		7,920	
Distribution & Marketing	8,712		10,296		11,880		13,464		15,840	
Research & Development	4,356		5,148		5,940		6,732		7,920	
Interest on Working Capital (12% p.a.)	3,333		3,333		3,333		3,333		3,333	
Sub - Total	27,465	27,465	31,853	31,853	36,241	36,241	40,628	40,628	47,210	47,210
Net Income Taxable		13,069		19,507		25,962		32,410		42,071
Less: 45% Income Tax		5,881		8,778		11,683		14,585		18,932
ANNUAL NET INCOME		7,188		10,729		14,279		17,825		23,139

Table VI-5
ANNUAL INCOME ESTIMATION

Natural Gas Price at $ 5/1000 cu.ft.
Ammonia Price at $400/ton

Capacity	55%		65%		75%		85%		100%	
Total Sales US$1,000		87,120		102,960		118,800		134,640		158,400
Less: Manufacturing Cost										
Natural Gas	33,535		39,603		45,696		51,789		60,928	
Catalyst & Chemicals	387		466		527		598		703	
Cooling Water	122		144		166		188		221	
Electricity	212		251		290		328		386	
Labour	175		175		175		175		175	
Overhead	175		175		175		175		175	
Maintenance	6,906		6,906		6,906		6,906		6,906	
Insurance	691		691		691		691		691	
Depreciation	11,110		11,110		11,110		11,110		11,110	
Sub - Total	53,313	53,313	59,521	59,521	65,736	65,736	71,960	71,960	81,305	81,305
Gross Profit		33,807		43,439		53,064		62,680		77,095
Less: General Expenses										
Sales Tax	6,707		7,928		9,148		10,367		12,197	
Administration	4,356		5,148		5,940		6,732		7,920	
Distribution & Marketing	8,712		10,296		11,880		13,464		15,840	
Research & Development	4,356		5,148		5,940		6,732		7,920	
Interest on Working Capital	3,333		3,333		3,333		3,333		3,333	
Sub - Total	27,465	27,465	31,853	31,853	36,241	36,241	40,628	40,628	47,210	47,210
Net Income Taxable		6,342		11,586		16,823		22,052		29,885
Less: 45% Income Tax		2,854		5,214		7,570		9,923		13,448
ANNUAL NET INCOME		3,488		6,372		9,253		12,129		16,437

Table VI-6
ANNUAL INCOME ESTIMATION

Natural Gas Price at $ 6/1000 CU.FT.
Ammonia Price at $400/ton

Capacity	55%		65%		75%		85%		100%	
Total Sales US$		87,120		102,960		118,800		134,640		158,400
Less: Manufacturing Cost										
Natural Gas	40,212		47,523		54,836		62,147		73,113	
Catalyst & Chemicals	387		466		527		598		703	
Cooling Water	122		144		166		188		221	
Electricity	212		251		290		328		386	
Labour	175		175		175		175		175	
Overhead	175		175		175		175		175	
Maintenance	6,906		6,906		6,906		6,906		6,906	
Insurance	691		691		691		691		691	
Depreciation	11,110		11,110		11,110		11,110		11,110	
Sub - Total	59,990	59,990	67,441	67,441	74,876	74,876	82,318	82,318	93,490	93,490
Gross Profit		27,130		35,519		43,924		52,322		64,910
Less: General Expenses										
Sales Tax	6,708		7,928		9,148		10,367		12,197	
Administration	4,356		5,148		5,940		6,732		7,920	
Distribution & Marketing	8,712		10,296		11,880		13,464		15,840	
Research & Development	4,356		5.148		5,940		6,732		7,920	
Interest on Working Capital	3,333		3,333		3,333		3,333		3,333	
Sub - Total	27,465	27,465	31,853	31,853	36,241	36,241	40,628	40,628	47,210	47,210
Net Income Taxable		(335)		3,666		7,683		11,694		17,700
Less: 45% Income Tax				1,650		3,457		5,262		7,965
ANNUAL NET INCOME		(335)		2,016		4,226		6,432		9,735

Table VI-7

Cash flow table and calculation of present value without outside financing

Natural Gas Price $ 4/1000 cu.ft.
Ammonia Selling Price $400/ton

Period	Construction		START - UP				FULL CAPACITY						Salvage Value	TOTAL
Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	in last year	
Production Programme	-	-	55%	65%	75%	85%	100%	100%	100%	100%	100%	100%		
Values US$ (Thousand)														
A. Cash Inflow														
1. Sales Revenue	-	-	87,120	102,960	118,800	134,640	158,400	158,400	158,400	158,400	158,400	158,400	-	1,393,920
B. Cash Outflow	-39,708	-71,387	-65,489	-77,778	-90,078	-102,372	-120,818	-120,818	-120,818	-120,818	-120,818	-120,818	1,726	-1,170,004
1. Total Investment	-39,708	-71,387											1,726	-109,369
2. Operating Cost	-	-	-59,608	-69,010	-78,395	-87,787	-101,886	-101,886	-101,886	-101,886	-101,886	-101,886	-	-906,116
3. Corporate Tax	-	-	-5,881	-8,778	-11,683	-14,585	-18,932	-18,932	-18,932	-18,932	-18,932	-18,932	-	-154,519
C. Net Cash Flow														
A - B	-39,708	-71,387	21,631	25,172	28,722	32,268	37,582	37,582	37,582	37,582	37,582	37,582	1,726	223,916
D. Present Value														
at 20%	-33,090	-48,880	12,518	12,139	11,543	10,807	10,488	8,740	7,284	6,070	5,058	4,215	194	7,286
at 22%	-32,548	-47,962	11,912	11,363	10,627	11,134	9,342	7,658	6,277	5,145	4,217	3,457	159	1,681
at 25%	-31,766	-45,688	11,075	10,310	9,412	8,459	7,882	6,305	5,044	4,035	3,228	2,583	119	-9,002
E. Cumulative Net Cash flow	-39,708	-111,095	-89,464	-64,292	-35,570	-3,302	34,280	71,862	109,444	147,026	184,608	222,190	-	223,916

Table VI-8

Cash flow table and calculation of present value without outside financing

Natural Gas Price $ 5/1000 cu.ft.
Ammonia Selling Price $400/ton

Period	Construction		START - UP				FULL CAPACITY						Salvage Value in last year	TOTAL
Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992		
Production Programme	-	-	55%	65%	75%	85%	100%	100%	100%	100%	100%	100%		
Values US$ (Thousand)														
A. Cash Inflow														
1. Sales Revenue	-	-	87,120	102,960	118,800	134,640	158,400	158,400	158,400	158,400	158,400	158,400	-	1,393,920
B. Cash Outflow	-39,708	-71,387	-69,189	-82,145	-95,104	-108,068	-127,520	-127,520	-127,520	-127,520	-127,520	-127,520	1,726	-1,228,995
1. Total Investment	-39,708	-71,387											1,726	-109,369
2. Operating Cost	-	-	-66,335	-76,931	-87,534	-98,145	-114,072	-114,072	-114,072	-114,072	-114,072	-114,072	-	-1,013,377
3. Corporate Tax	-	-	-2,854	-5,214	-7,570	-9,923	-13,448	-13,448	-13,448	-13,448	-13,448	-13,448	-	-106,249
C. Net Cash Flow														
A - B	-39,708	-71,387	17,931	20,815	23,696	26,572	30,880	30,880	30,880	30,880	30,880	30,880	1,726	164,925
D. Present Value														
at 20%	-33,090	-49,574	10,377	10,038	9,523	8,899	8,618	7,182	5,985	4,987	4,156	3,463	194	-9,242
at 15%	-34,529	-53,979	11,790	11,901	11,781	11,488	11,609	10,095	8,778	7,633	6,637	5,772	322	9,298
at 17%	-33,938	-52,149	11,196	11,108	10,808	10,359	10,289	8,794	7,516	6,424	5,491	4,693	262	853
E. Cumulative Net Cash flow	-39,708	-111,095	-93,164	-72,349	-48,653	-22,081	8,799	39,679	70,559	101,439	132,319	163,199	-	164,925

Table VI-9

Cash flow table and calculation of present value without outside financing

Natural Gas Price $ 6/1000 cu.ft.
Ammonia Selling Price $400/ton

Period	Construction		START - UP				FULL CAPACITY						Salvage Value in last year	TOTAL
Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992		
Production Programme	-	-	55%	65%	75%	85%	100%	100%	100%	100%	100%	100%		
Values US$ (Thousand)														
A. Cash Inflow														
1. Sales Revenue	-	-	87,120	102,960	118,800	134,640	158,400	158,400	158,400	158,400	158,400	158,400	-	1,393,920
B. Cash Outflow	-39,708	-71,387	-73,012	-86,501	-100,131	-113,765	-134,222	-134,222	-134,222	-134,222	-134,222	-134,222	1,726	1,288,110
1. Total Investment	-39,708	-71,387											1,726	-109,369
2. Operating Cost	-	-	-73,012	-84,851	96,674	-108,503	-126,257	-126,257	-126,257	-126,257	-126,257	-126,257	-	-1,120,582
3. Corporate Tax	-	-	-	-1,650	-3,457	-5,262	-7,965	-7,965	-7,965	-7,965	-7,965	-7,965	-	-58,519
C. Net Cash Flow														
A - B	-39,708	-71,387	14,108	16,459	18,669	20,875	24,178	24,178	24,178	24,178	24,178	24,178	1,726	105,810
D. Present Value														
at 15%	-34,529	-53,979	9,276	9,410	9,281	9,025	9,089	7,904	6,873	5,976	5,197	4,519	327	-11,631
at 12%	-35,454	-56,909	10,042	10,460	10,593	10,576	10,937	9,765	8,718	7,785	6,951	6,206	443	113
at 11%	-35,772	-57,939	10,316	10,842	11,079	11,161	11,646	10,491	9,452	8,515	7,671	6,911	493	4,866
E. Cumulative Net Cash flow	-39,708	-111,095	-96,987	-80,528	-61,859	-40,984	-16,806	7,372	31,550	55,728	79,906	104,084	-	105,810

From the above calculation, the internal rate of return of this project is 22.5% The reliability of this study falls in the range of ± 20%. From the rate of return view point, 22.5% is acceptable to make a further study into the details of the project. However, other factors should also be under consideration, for example, risk factor, government policy in agriculture. As ammonia is an intermediate in manufacturing nitrogen fertilizer a study into a fertilizer-complex project should be made.