Report No. 448-IN

Appraisal of Trombay IV Fertilizer Expansion and Plant Operations Improvement Project India

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Industrial Projects Department

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CURRENCY EQUIVALENTS

Rs	1.0	= $0.133
Rs	7.50	= $1.00
Rs	1,000,000	= $133,000

WEIGHTS AND MEASURES

All weights and measures are in metric units
1 Metric Ton (t) = 1,000 Kilograms (KG)
1 Metric Ton (t) = 2,204 Pounds
1 Kilometer (km) = 0.62 Miles
1 Hectare (ha) = 2.47 Acres

PRINCIPAL ABBREVIATIONS AND ACRONYMS USED

DAP	Diammonium Phosphate (18-46-0)
FACT	Fertilisers and Chemicals, Travancore Ltd.
FAI	Fertilizer Association of India
FCI, Corporation	Fertilizer Corporation India
GOI, Government, Borrower	Central Government of India
KWH	Kilowatt Hour
K_2O (Potash)	Potassium Oxide Content in Fertilizers
MMTC	Metals and Mining Trading Corporation
MW	Megawatts
MWH	Megawatt Hours
N	Nitrogen Content in Fertilizers
NP	Nitrophosphate (21-21-0)
NPK	Complex Fertilizer Containing N, P_2O_5 and K_2O
P_2O_5 (Phosphate)	Phosphorous Pentoxide Content in Fertilizers
PPM	Parts per Million
SSP	Single Superphosphate (0-18-0)
TPD	(Metric) Tons per Day
TPY	(Metric) Tons per Year
TSP	Triple Superphosphate (0-46-0)
Trombay IV	Trombay IV Nitrophosphate Project
Trombay V	Trombay Ammonia/Urea Project

FISCAL YEAR

April 1- March 31

All years in the Report refer to Indian Fiscal Years

INDIA

APPRAISAL OF TROMBAY IV FERTILIZER EXPANSION AND PLANT OPERATIONS IMPROVEMENT PROJECT

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APPRAISAL OF TROMBAY IV FERTILIZER EXPANSION AND PLANT OPERATIONS IMPROVEMENT PROJECT

SUMMARY AND CONCLUSIONS

i. This report appraises a proposed IDA Credit of US$50 million equivalent consisting of two parts: US$33 million to help expand capacity of the Trombay Unit, near Bombay, of the Fertilizer Corporation of India (FCI), a public sector company and the country's largest fertilizer producer; and US$17 million to provide urgently needed assistance, to improve operations in other Government-owned fertilizer plants. The expansion project would increase Trombay's complex fertilizer production capacity by 355,000 tons per year (TPY) in the form of nitrophosphate of 21:21:0 grade, i.e., 21% nitrogen and 21% phosphate content, equivalent to 75,000 TPY each of nitrogen and phosphate nutrients. The project is estimated to cost nearly US$64 million (including initial working capital and interest during construction), of which US$25 million would be in foreign exchange, and it is expected to be completed by May 1977.

ii. FCI has five operating fertilizer units which are all being expanded and another seven are under construction, or under planning, and this program is to be completed by 1979 when FCI's fertilizer capacity would increase by about eight times over the 1974 level. However, as pointed out in reports on the IDA Credits for the Gorakhpur and Nangal Expansion Projects, the Corporation's operations continue to be hampered by low capacity utilization in some of the existing plants and delay in commissioning new plants. The latter generally is due to procurement and start-up difficulties. As a result, FCI's recent earnings as a whole have been unsatisfactory -- less than 1% return on capital. Financial forecasts show a steady increase in earnings but the anticipated improvement is dependent upon successful operation of the plants to be commissioned in the next few years and better capacity utilization of existing plants.

iii. The US$17 million part of the proposed IDA Credit for plant operations improvement is to be used to assist FCI as well as the Fertilisers and Chemicals Travancore Ltd. (FACT) in overcoming some of their problems by making possible the import of critically needed equipment, spare parts, some consumable materials and technical assistance for the commissioning of new plants and improving the operations of existing units. It is the prime objective of this portion of the Credit to increase fertilizer supply in India within the next 2-3 years, thus making a significant and immediate impact on the country's agricultural production.

iv. The expansion project (Trombay IV) is part of a continuing investment program at Trombay, estimated to cost about US$225 million over the next five years, to increase capacity from about 81,000 to 304,000 TPY of N and 36,000 to 129,000 TPY of P_2O_5. The project is relatively independent of the rest of Trombay's operations with two exceptions: (1) part of the nitric acid to be produced by the project as an intermediate product will feed the existing nitrophosphate plant at Trombay, now being expanded; and (2) the project will obtain ammonia, one of its two major raw materials, from planned

surplus production of a new ammonia/urea plant (Trombay V) to be commissioned about one year after Trombay IV. Until the time Trombay V can provide ammonia, the project will have to rely on other domestic sources of ammonia and on imports. The other principal raw material input -- phosphate rock -- will be imported until local supplies become available within a few years after completion of the project. Considering the shortage of ammonia and urea in the world and sharp rises in fertilizer prices, India's decision to undertake Trombay V, rather than import ammonia and urea as an alternative, seems justifiable. This conclusion is supported by the satisfactory economic return envisaged, the availability of heavy fuel oil feedstock in adjacent refineries, the large nearby markets for fertilizer and India's acute foreign exchange problems. The Government has presented a firm plan for implementation of Trombay V on a schedule compatible with the needs of Trombay IV.

v. The project (Trombay IV) will utilize commercially proven processes, with FCI as the overall contractor. However, substantial responsibility for project implementation and start-up will rest with the foreign contractors of the two production units -- the nitric acid and the nitrophosphate plants. Thus, there is reasonable assurance that the project will be executed on schedule and without major difficulties. Furthermore, no significant commercial risk is foreseen because: (1) the fertilizer grade (21:21:0) to be produced by the project is very close to one of the popular grades (20:20:0) Trombay is already selling; (2) fertilizers in general will continue to be in short supply in India; and (3) Trombay's marketing system is well developed. The operating and financial performance of Trombay has improved significantly over the past few years with net income before taxes reaching 22% of capital employed in 1974, and this trend is projected to continue in the future. The single most important risk that this project faces lies in the present very tight fertilizer equipment supply conditions which -- although ample price contingencies have been provided for in the capital cost estimates -- could cause more than anticipated price increases and lengthen equipment delivery periods with a consequential rise in project costs.

vi. While the Trombay Unit could finance most of the local currency expenditures of its modernization and expansion programs out of internally-generated funds, its cash surplus, as is the case with the surpluses of all FCI constituent units, is transferred to FCI. Therefore, Trombay IV will be financed by an equity contribution of the Government equivalent to US$30.7 million and the proposed IDA Credit portion of US$33.0 million and Trombay V is expected to be financed by suppliers' credits from Italy and Austria and by an equity investment of the Government. The proposed IDA Credit portion for Trombay IV would be on-lent by the Government to FCI in rupees for 15 years, including 5 years of grace, at an annual interest rate of 9.5%; it would be used for equipment, supplies and spares (20% of which is expected to be manufactured in India) procured under Bank/IDA Guidelines, as well as to cover almost all expenditures of engineering, license fees, erection and commissioning. Upon project completion, the Trombay Unit is expected to have a sound financial structure with a debt/equity ratio of about 25/75 and a satisfactory debt service coverage and liquidity position.

vii. On the basis of international prices of inputs and fertilizer prices expected to prevail in the late 1970's, which are consistent with the assumptions made in other fertilizer projects presently being considered by the Bank Group, the project's economic rate of return is about 16% at 90% capacity utilization. A six-month delay in project implementation combined with a 10% capital cost overrun and 80% capacity utilization, would drop the return to about 13%, still a satisfactory figure. The net annual foreign exchange savings from the Trombay IV project are estimated at about US$18 million, once it is operating normally at 90% of capacity, and its output would help increase food production in India by about 700,000 tons per year. Trombay's employment will increase by about 20% and existing staff will be utilized more efficiently as a result of the project. Indirect employment benefits are limited primarily to construction and marketing activities.

viii. In addition to the fertilizer projects already financed in India by IDA (Cochin II, Gorakhpur and Nangal) and IFC (Indian Explosives and Zuari-Agro), the Bank was Executing Agency for a UNDP project for an evaluation of the phosphate rock deposits in Rajasthan. The Bank Group intends to continue being active in this priority sector in India and is presently appraising an expansion phase of FCI's Sindri Unit and a project sponsored by the Indian Farmers' Fertiliser Cooperative.

ix. Based on the agreements spelled out at the end of the report, a US$50 million IDA Credit to the Government of India is recommended.

I. INTRODUCTION

1.01 The Government of India (GOI) has requested an IDA Credit of US$50 million equivalent consisting of two parts--US$33 million to help expand capacity of the Trombay Unit of the Fertilizer Corporation of India (FCI) and US$17 million to provide urgently needed assistance- to FCI and FACT (The Fertilisers and Chemicals Travancore, Ltd.) fertilizer plants in general. The Trombay project, referred to as Trombay IV, will add 355,000 metric tons per year (TPY) of nitrophosphate fertilizer (21-21-0) capacity, equivalent to 75,000 TPY each of nitrogen (N) and phosphate (P_2O_5). 1/ The project will obtain ammonia, one of its two major raw materials, from a new ammonia/urea plant (Trombay V) to be constructed nearby and on essentially the same schedule as that for the project; the other principal input--phosphate rock--will be imported until local supplies become available within a few years after the completion of the project. The balance of the proposed Credit would help expedite completion and commissioning of FCI and FACT plants and eliminate actual and possible production constraints.

1.02 Trombay is located in the industrial zone of Bombay (Map IBRD 10453R). The original plant was commissioned in 1966 2/ and, in the beginning, experienced operating difficulties resulting in low capacity utilization. Trombay has a modernization program now underway to improve operations, the final phase of which will be carried out concurrently with the project. The proposed IDA Credit portion of US$33 million equivalent to for Trombay IV will cover about 95% of the project's foreign exchange costs (US$25 million) plus nearly 23% of its local costs; the remainder of the Credit (US$17 million) will be needed entirely for foreign exchange expenditures.

1.03 FCI's financial situation and prospects were analyzed in the Nangal appraisal report (Report No. 46-IN, dated January 2, 1973); they are summarized and updated in this report. FACT's operations were reviewed in the Cochin II appraisal report (Report No. PI-8, dated May 14, 1971). Its present situation is described in paras 3.04 and 3.05. This appraisal is based on missions to India in May/June 1973 and October 1973, consisting of Messrs. D.E. Brown and A.R. Perram and subsequent review in Washington with the addition of Y.T. Shetty, all of the Industrial Projects Department.

II. FERTILIZER CORPORATION OF INDIA (FCI)

A. Organization and Management

2.01 FCI was incorporated in 1961, merging two public sector companies--Sindri Fertilizers & Chemicals (Sindri) in Bihar and Hindustan Chemicals & Fertilizers Ltd. (Nangal) in the Punjab, which began production in 1951 and

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1/ A glossary of technical terms is given in Annex 1.

2/ All years refer to fiscal years ending March 31.

1961 respectively. FCI today has five operating units and is India's largest fertilizer producer, accounting for about 25% of nitrogen and 10% of phosphate capacity in the country. During 1974, FCI produced 279,000 tons of N and 32,000 tons of P_2O_5.

2.02 Major FCI projects under implemention (Map IBRD 10453R) are: (a) Durgapur, (b) Barauni, (c) Namrup Expansion, (d) Ramagundam, (e) Talcher, (f) Sindri Rationalization, (g) Gorakhpur Expansion, 1/ (h) Haldia, and (i) Nangal Expansion. 1/ Five other projects are being planned: (a) Trombay IV Expansion (the subject of this report), (b) the ammonia/urea plant at Trombay (Trombay V, which is closely tied to the project), (c) Sindri Modernization 2/, (d) Korba and (e) Paradeep. FCI is described in more detail in Annex 2-1. By 1979, when all these projects are to be completed, FCI is expected to have a capacity of about 2.5 million TPY of N and 0.65 million TPY of P_2O_5 compared to the present capacity of 376,000 TPY of N and 36,000 TPY of P_2O_5 in its five operating units.

2.03 Total existing FCI employment is approximately 19,000, which is high even though it includes staff for schools, hospitals, townships and training programs. FCI recognizes overstaffing to be a serious financial problem, particularly at Sindri, and although no politically and socially acceptable solution has as yet been found, the expansion projects should enable FCI to better utilize its staff.

2.04 FCI has a 13-member board: six senior officers of FCI, two from Government ministries, four from other public sector organizations, and one retired head of a research institute. The Board functions as a control body and as a coordinating group between FCI and the Government, whose influence on operations, finance and planning is strong.

2.05 There were changes in the top management of FCI last year (Annex 2-2); in particular, there is a new Managing Director, Mr. K.C. Sharma, who was formerly responsible for the Corporation's expansion program. He and five senior Directors (Production, Marketing, Projects, Finance and Personnel) are responsible for policy development and operations; they have accumulated substantial industrial experience within FCI and are considered capable. Each fertilizer plant operates as a separate profit center under its General Manager. The large expansion program now in progress has been straining available experienced staff in middle management for both project execution and operations, and the provision of adequate personnel and know-how is becoming an increasingly important consideration for each of FCI's projects and operating plants.

1/ IDA Credits of US$10 million and US$58 million equivalent, respectively, have been made for the Gorakhpur (279-IN of January 7, 1972) and Nangal (357-IN of February 9, 1973) expansion projects.

2/ GOI has requested IDA to assist in financing a new ammonia/urea plant at Sindri expected to be similar in size to the Nangal expansion project.

B. Profitability and Debt Service Coverage

2.06 Detailed income and cash flow statements--actual and projected--for the period 1970-1982 together with the major assumptions made are given in Annexes 2-3 and 2-4, and are summarized below:

FCI - Selected Income Statement Items

(In Rs Million unless otherwise noted)

	1970	1973	1974	1975	1976	1977	1978	1982
	--Actual---		(Est.)	---------Projections /1---------				
Net Sales	597	847	1,140	1,438	1,934	3,072	3,854	5,046
Operating Income	164	166	185	348	552	1,058	1,375	2,040
Net Income Before Taxes:	17	2	40	113	178	303	345	918
% of Net Sales	2.8	0.3	3.5	7.9	9.2	9.9	9.0	18.2
Cash Generation	134	112	159	374	556	555	1,198	989
Debt Service Coverage (times)	1.6	0.7	0.9	1.9	2.2	3.0	2.9	2.7

/1 Based on the revised fertilizer prices of October 1973.

2.07 FCI's net income and debt service coverage were unsatisfactory in 1973 and 1974 because of operational losses in Sindri and Namrup, and substantially higher raw material costs. However, these financial indicators are projected to reach satisfactory levels in 1975 and improve further during the Trombay IV implementation period and beyond. Agreements already included in the credit documents for the Gorakhpur and Nangal expansion projects have been reiterated, namely that the Government will provide adequate funds to FCI to complete its on-going and new projects on terms compatible with FCI's sound financial position.

2.08 The above income projections for FCI show increasingly large sales revenues and profits as new plants come on stream. However, particularly over the next few years, their achievement will depend on the performance of new plants such as Durgapur, Barauni, Namrup, Talcher and Ramagundam, and on increased capacity utilization in the existing plants. The plant operations improvement part of the proposed IDA Credit is designed to help achieve the necessary operational improvements and accelerate plant commissioning (paras 3.03 - 3.06).

C. Financial Position

2.09 Past balance sheet statements and projections for 1975-1982 are contained in Annex 2-5 and are summarized below:

FCI - Selected Balance Sheet Items

(In Rs Million)

	1970	1973	1974	1975	1976	1977	1978	1982
	--Actual--		Est.	----------Projections----------				
Long-term Debt	998	1,245	1,209	1,778	3,561	4,606	4,632	2,510
Equity	1,132	2,213	3,245	4,487	5,665	6,157	6,502	7,763
Current Ratio	1.5:1	0.7:1	1.2/1	1.4:1	2.7:1	1.4:1	1.4:1	1.4:1
Long-term Debt/Equity Ratio	47/53	36/64	27/73	28/72	39/61	43/57	42/58	24/76

/1 Funds available from the Government budget for FCI, excluding project funds, have been added to current assets in 1974 as they may be used to repay current maturities of long-term debt incurred for plants not yet commissioned.

2.10 The Corporation has a satisfactory debt/equity ratio of 27/73 (1974), indicating that its fixed assets have been financed on a sound basis. Also during project implementation, the debt/equity ratio is expected to remain satisfactory. In this context, the agreement already reached with GOI and FCI in connection with the Gorakhpur and Nangal projects was reiterated requiring the Government to provide adequate funds to FCI so that the Corporation can maintain a current ratio of at least 1.2:1 and that FCI will not at any time have a debt/equity ratio of more than 50/50. Further, FCI will not declare dividends or prepay any debt if, after the payment of such dividends or debt, FCI's current ratio shall be less than 1.5:1.

D. Trombay Unit

2.11 The existing Trombay plant has an annual design capacity of 240,000 tons of NPK fertilizer (15-15-15); 99,000 tons of urea; and 30,000 tons of methanol. Intermediate products include ammonia, nitric acid and sulfuric acid. In addition, some minor quantities of industrial chemicals such as argon, concentrated nitric acid, sodium nitrate and ammonium bicarbonate are produced. The Trombay complex includes necessary facilities such as maintenance shops, storage, utilities, offices and townships; it is near to the Bombay port and has good rail and road connections. Present plant facilities are described in detail in Annex 2-6. The General Manager of the Trombay Unit, Mr. R. S. Kachwaha, 52, and the Project Manager for Trombay IV, Mr. S. C. De Baksi, 45, are capable and are assisted by well-trained, experienced executive and technical personnel. FCI agreed that it will consult with IDA before making any change in the positions of the General Manager or the Project Manager in the Trombay Unit and will promptly staff any vacant position related to the project with experienced and competent personnel.

2.12 The original Trombay plant was financed by loans of US$37.8 million and Rs 134 million from the U.S. Agency for International Development and its total cost was about Rs 495 million (US$66 million). The plant was built during 1962-65 by two US firms--the Chemical Construction Corporation (Chemico) and the Chemical and Industrial Corporation (C&I), now C&I-Girdler which is owned by the Bechtel Corporation. FCI has withheld the last payment due to C&I-Girdler and has sued IDI Management Inc. (C&I-Girdler's holding company at that time) for alleged design deficiencies.

2.13 IDI Management Inc. has filed a counterclaim for non-fulfillment of the original contract, and arbitration is now proceeding through the International Chamber of Commerce. While a series of hearings has been held, as is usual in such cases, it is difficult to form an accurate opinion of where the major fault lies and how the arbitration will be settled. However, since the claims discussed are large, ranging from US$13-23 million with an interim award of US$250,000 agreed by a majority of the tribunal in February 1974, IDA has obtained agreement from GOI that payment, if any, resulting from the countersuit will be settled in a manner which would not impair FCI's and Trombay's financial position.

2.14 During the initial years of operation, the technical problems, including maintenance, at Trombay limited production in the ammonia, NPK and methanol plants which, in turn, adversely affected the output of urea. In 1968, Trombay embarked on a number of improvements to overcome the then existing limitations (Annex 2-7). Emphasis was placed on removing the bottlenecks in the ammonia and nitrophosphate plants which have now achieved about 90% utilization of attainable capacity. Production of several industrial chemicals has also been expanded. These operations are small but profitable and will continue to be enlarged in the future as markets develop. Finally, facilities have been erected to increase methanol output and to produce phosphoric acid. The cost of the above plant improvements and additions is estimated at about Rs 80 million, financed by the Government on a 50/50 loan-equity basis.

2.15 To conclude the streamlining of the existing plant facilities, Trombay has embarked (under the so-called modernization program) on four additional investments to (1) increase the 15-15-15 NPK production capacity from 240,000 to about 330,000 TPY; (2) improve NPK quality from about 35% to 60% phosphate water solubility; (3) increase urea capacity from 99,000 to about 129,000 TPY; and (4) improve pollution control--all described in more detail in Annex 2-7. FCI has prepared detailed engineering for these projects and Trombay has received approval from the Government for the modernization program as well as the necessary foreign exchange to begin procurement. This program is not part of the proposed IDA-assisted project, but will be implemented concurrently and is important to Trombay's expected operational and financial improvements. The only links between the project and the modernization program are a nitric acid plant and some common utilities, both included in Trombay IV. The modernization program is estimated to cost about Rs 45 million and, considering the preparatory work already undertaken, it should be completed by the end of 1976.

2.16 Historical income statements for Trombay are given in Annex 2-8 and selected items are summarized below:

Trombay Unit - Summary Historical Income Statements

(In Rs Million unless otherwise notes)

	1970	1971	1972	1973	1974 Est.
Capacity Utilization (% of Design Capacity)					
Nitrogen	59	71	84	86	80
Phosphate	47	67	75	85	90
Net Sales	194	294	379	353	366
Cost of Goods Sold	153	210	270	180	204
Gross Profit	41	84	109	173	162
Depreciation	34	34	35	54	46
Interest on Long-term Debt	19	16	13	13	6
Net Income (Before Taxes)	(27)	6	25	81	89
Net Income as % of:					
Sales	(14)	2	7	23	24
Capital Employed /1	(5)	1	6	23	22

/1 Current Assets + Net Fixed Assets (excluding construction in progress).

2.17 The large losses in 1970 were mainly due to an explosion in the ammonia plant that caused unusually low capacity utilization. Since then Trombay has improved capacity utilization and increased profitability, indicating that the investments to overcome the earlier operating problems are beginning to show results. In 1974, however, power shortage limited nitrogen production to about 80% of capacity. The increased earnings reflect lower fixed costs per unit of production; lower per unit raw material consumption; increased production and sales of urea, methanol and other products; and higher sales prices since October 1973. Total sales revenue in 1973 showed a drop over 1972 when a high volume of imported fertilizer for Trombay's seeding program (Rs 96 million in 1972 versus Rs 50 million in 1973) inflated the sales figures.

2.18 Trombay's historical balance sheets given in Annex 2-9 are summarized below:

Trombay Unit - Summary of Historical Balance Sheets

(In Rs Million)

	1970	1971	1972	1973	1974 (Est.)
Assets					
Current Assets	175	177	149	127	159
Net Fixed Assets	326	303	286	245	278
Construction in Progress	9	20	45	88	39
Total	510	500	480	460	476
Liabilities and Capital					
Current Liabilities	53	64	84	187	248
Long-term Debt	508	470	381	169	35
Equity	(51)	(34)	15	104	193
Total	510	500	480	460	476
Current Ratio	3.3:1	2.8:1	1.8:1	0.7:1	0.6:1
Long-term Debt/Equity Ratio	-	-	96/4	62/38	15/85

2.19 Trombay's current ratio in 1973 and 1974 was reduced, falling below 1:1, primarily because of large and accelerated debt repayments to GOI out of surplus cash, but it is projected to improve to 1.2:1 in 1975 (para 7.01). Through 1971, Trombay had a negative net worth, but thereafter capitalization quickly improved and the debt/equity ratio reached an estimated 15/85 at the end of 1974 due to debt repayments and increased earnings. Trombay's accounting and internal reporting systems are satisfactory; they are computerized and management has up-to-date daily and monthly operational and financial reports at its disposal for proper decision-making. Trombay's accounts are independently audited in addition to the Government audit. FCI has agreed to submit to IDA detailed annual and quarterly production, income and cash flow statements for the Trombay Unit. In addition, FCI will submit consolidated annual and quarterly financial statements including income, balance sheet and cash flow statements.

III. THE NEED FOR IMPROVEMENT OF PLANT OPERATIONS

A. Problems of FCI and FACT Units

3.01 FCI has five operating fertilizer units of which Nangal, Gorakhpur and Namrup are undergoing expansion, Trombay is being modernized and will be expanded on a large scale, and Sindri is being rationalized and its subsequent modernization is being planned. In addition, FCI is building six new fertilizer plants (Durgapur, Barauni, Talcher, Ramagundam, Haldia and Korba) and a seventh (Paradeep) is in the planning stage. FCI's operations are

affected by: (1) Low capacity utilization (less than 80%) in some existing units; and (2) delays in the commissioning of new projects, particularly because of procurement and "start-up" difficulties. The major causes for these problems are power shortages and variations in supply; inadequate availability of imported spare parts and consumable materials; lack of timely technical assistance; design deficiencies necessitating modifications and replacements; shortages of cement and steel; and delays in the supply of local equipment. The problems of FACT (Annex 3) are also similar to those of FCI. To help overcome these adverse factors, GOI is seeking US$17 million from IDA for the foreign exchange costs of critical equipment and spares, engineering and consulting services and some consumable materials.

3.02 For three of the existing FCI plants -- Gorakhpur, Namrup and Nangal -- the attainable capacity is the same as the installed capacity, whereas for Trombay the attainable capacity has been placed at 90% of the installed capacity primarily because of the shortfall in the capacity of the naphtha gasification unit. This will, however, be rectified as soon as the new naphtha gasification unit, presently under commissioning, comes on stream. As for Sindri, it has practically outlived its economic life but is being kept in operation in part for social considerations, especially because it employs a large labor force. An expert committee of FCI has estimated that Sindri's attainable capacity is only 75,000 TPY of N, i.e., 83% of the installed capacity of 90,000 TPY. The coke-oven batteries and gas plants in Sindri are fast deteriorating from age, and raw materials like gypsum and coal are not available in required quality. To overcome these problems, measures are being taken to repair and renovate the coke-oven batteries; to use by-product gypsum in the place of high-cost, poor-quality natural gypsum; and to rationalize and modernize the facilities by replacing the outmoded process of making ammonia, and to expand ammonia and fertilizer production. IDA is currently appraising the Sindri Modernization Project.

B. Capacity Utilization in Existing Units

3.03 The following table shows the capacity utilization in 1974 in FCI and FACT units:

Capacity Utilization in Existing Units of FCI and FACT

	Installed Capacity	Attainable Capacity	Production in 1974	Production as % of Installed Capacity	Production as % of Attainable Capacity
	'000 TPY of Nutrient Tons				
FCI					
Gorakhpur	80	80	64	80	80
Namrup	45	45	36	80	80
Nangal	80	80	62	77	77
Sindri	90	75	59	66	79
Trombay	117	105	97	82	92
	412	385	318		
FACT					
Udyogamandal	118	n.a.	40 /1	34	n.a.

/1 1973 figure.

3.04 The above table indicates that the attainable capacity utilization in FCI was the lowest in Nangal, which is experiencing drastic cuts in power supply from the Bhakra Dam. However, this unit had been operating at near-full production before 1971, when the power cuts were imposed. Since then, it has not been able to achieve more than 70% capacity utilization until recently. In 1973, the average power supplied to Nangal was only about 63% of the contracted quantity, i.e., 103 MW out of 164 MW. Although the power supply situation improved during 1974, the supply still fell short of requirements. FCI has asked the Government to ensure adequate power to this plant as well as to Namrup, Gorakhpur and Trombay, which are also affected by power interruptions, voltage dips and low power frequencies. Because of the power problems alone, FCI suffered a production loss of 48,000 tons of nutrients in 1974 valued at about Rs 40 million (US$5.3 million); at present import prices (May 1974), it is worth about US$15 million. Nangal alone is estimated to have experienced a production loss from power shortages of about Rs 23 million (US$3.1 million) in 1973. In spite of that, it showed a pre-tax profit of nearly Rs 35 million (US$4.7 million). In the case of the FACT unit at Udyogamandal, the capacity utilization is very low mainly because of obsolete equipment needing replacement, power shortage, and labor and management problems. It showed a net loss of Rs 23 million (US$3.0 million) in 1973.

C. Implementation of New Projects

3.05 Of the FCI projects under implementation, Durgapur, Barauni and Namrup (Expansion) are three years behind schedule, mainly because of design and engineering problems and delays in supplying equipment. The Durgapur plant went into trial production in October 1973 after considerable "start-up" difficulties and consequent modifications and replacements. However, it has

not yet been possible to achieve continuous stabilized production because of equipment failures, mainly in the ammonia section. As a result, the commissioning period has been lengthened and some of the imported equipment still needs replacement. Barauni and Namrup (Expansion) are also at an advanced stage of construction and are scheduled to be commissioned in calendar year 1974. However, they too are facing technical problems which could be overcome without additional adverse effect if corrective measures are taken promptly. Furthermore, additional improvements might be necessary to achieve high capacity utilization in all three plants, judging by the present situation. FACT's new projects -- Cochin I and Cochin II 1/ -- have experienced delays and cost overruns. Further, Cochin I has not yet fully overcome its technical deficiencies though the plant was mechanically complete in December 1971; it needs additional modifications and replacements to attain sustained production. Cochin II is expected to be completed by March 1975, about 1 year later than originally forecast due to procurement delays and strikes.

3.06 Durgapur, Barauni, Namrup and Cochin I are all of equal size with an aggregate capacity of some 600,000 TPY of N (in the form of urea) compared to the estimated 770,000 tons of nitrogen imported in 1973/1974 and the estimated shortfall in supply of 800,000 tons (paras 4.06 - 4.08). It is, therefore, urgent to complete these projects as well as other FCI and FACT units under construction as quickly as possible, particularly in view of the current worldwide shortage of fertilizers and their high prices. The following table shows the capacity and completion targets for these plants:

1/ Cochin II is being assisted by an IDA Credit (264-IN dated July 30, 1971) of US$20 million equivalent.

Incremental Capacity of FCI and FACT Units under Development

	Capacity N	Capacity P_2O_5	Expected Year of Commissioning
	('000 TPY)		
FCI			
Under Implementation			
Durgapur	152	-	1975
Barauni	152	-	1975
Namrup (Expansion)	152	-	1975
Gorakhpur (Expansion)	51	-	1975
Sindri (Rationalization)	-	156	1975
Trombay (Modernization)	18	18	1976
Nangal (Expansion)	152	-	1976
Talcher	228	-	1977
Ramagundam	228	-	1977
Haldia	152	75	1977
Sub-total	1,285	249	
Planned			
Trombay IV and V	205	75	1978/79
Sindri	129	-	1979
Korba	228	-	1979
Paradeep	311	300	1979
Sub-total	873	375	
Total - FCI	2,158	624	
FACT			
Under Implementation			
Cochin I	152	-	1975
Cochin II	-	115	1975
Total - FACT	152	115	
Grand Total	2,310	739	

3.07 It is out of an urgent need to utilize available or anticipated capacity as quickly and as effectively as possible that a portion of the IDA Credit is to be used for assistance as described in Chapter V.

IV. THE MARKET

A. Supply and Demand

4.01 A detailed analysis of the market for fertilizers in India is provided in Annex 4.1. This analysis is based on data collected during appraisal of the project and a more recent appraisal of another fertilizer plant in India and has been updated by information supplied by GOI/FCI officials during negotiations. 1/

4.02 In 1974, the total installed capacity in India was 1.95 million TPY of N (58% in the public sector and 42% in the private sector) and 571,400 TPY of P_2O_5 (one-third in the public sector and two-thirds in the private sector). The total production in 1974 was 1.06 million tons of N and 0.32 million tons of P_2O_5, representing a capacity utilization of about 54% for N and 56% for P_2O_5. Although some 517,000 TPY or 21% of the presently installed capacity became available only during 1974, and has, therefore, to be discounted, capacity utilization is nevertheless very low for the various reasons described earlier (paras 3.01 and 3.02).

4.03 Starting from a low base, fertilizer production increased more than fourfold during the last seven years (1966-1973) but it continues to fall short of requirements. As a result, India still relies on imports, putting a heavy burden on its scarce foreign exchange resources. Imports nearly trebled during 1966-1973, reaching about 691,400 tons of N, 211,400 tons of P_2O_5 and 316,300 tons of K_2O in 1973 with actual import cost in that year estimated at about US$158 million; it is worth about US$435.0 million at present (May 1974) prices.

4.04 During 1966-1973, the consumption of N expanded at an annual rate of 18.0%, while P_2O_5 and K_2O consumption increased at a higher annual rate of 24% and 23% respectively from a low base. During that period, the average annual rate of growth for all plant nutrients was 20%. In 1973, the total consumption of plant nutrients reached nearly 2.7 million tons, of which approximately 1.8 million tons (67%) was N, 0.6 million tons phosphate (22%) and 0.3 million tons potash (11%).

4.05. The proportion of N consumed is still far higher than that of P_2O_5 and K_2O because of the immediate effect that nitrogenous fertilizers have on the luxuriant growth of crops and their consequent popularity with farmers. However, it has to be noted that the ratio of $N:P_2O_5:K_2O$ consumption has improved from 16:2:1 in 1951 to about 6:2:1 in 1973, but it will take many years to bring the ratio to 4:2:1 which is considered desirable for Indian farm conditions. To achieve this balanced fertilization, complex (NPK) fertilizers are gaining in importance. Trombay is one of the pioneering fertilizer plants in India to produce complex fertilizers.

1/ Some figures thus differ slightly from those given in the Economic Report (Report No. 402-IN dated May 7, 1974) chapter on Fertilizers and Steel.

4.06 The following table shows the trend of fertilizer production, apparent imports and consumption in India during 1966-1974 and projections for 1979-1984:

India - Fertilizer Consumption /1 (1966-1984)
('000 tons)

	Nitrogen (N)			Phosphate (P_2O_5)			Potassium (K_2O)
	P	I	C	P	I	C	C
1966	230	315	545	117	13	130	78
1969	530	600	1,130	212	178	390	154
1970	705	655	1,360	225	195	420	210
1971	840	650	1,490	228	232	460	228
1972	950	810	1,760	291	269	560	304
1973	1,056	723	1,779	330	257	587	331
1974	1,065	770	1,835	320	315	635	314
1979 (Proj.)	3,870	730	4,600 (5,100)/2	1,090	440	1,520 (1,925)	1,000 (920)
1984 (Proj.)	6,500	500	7,000 (8,100)/3	2,600	200	2,800 (4,000)	1,400 (2,300)

/1 P = Production; I = Apparent Imports; C = Consumption.
/2 Figures in brackets give the latest revised Indian consumption forecasts.
/3 Interpolated from Indian consumption forecasts for 1986.

4.07 A joint Bank-GOI report 1/ forecast that the demand for N would range between 4.0 million tons and 5.2 million tons by the end of the Fifth Five-Year Plan in 1979. The level of 5.2 million tons now appears optimistic considering more recent data which show a slower growth rate in consumption in recent years because of delays in the build-up of domestic production capability, and scarce and high-cost imports. The figure of 4.6 million tons of N for 1979 given in the above table is the "median" of the "low" and the "high" forecasts made in the report, and it appears to be a realistic projection. However, the N consumption in 1979 could be as low as 4.0 million tons because of a probable continued shortfall in domestic production, continued scarcity of fertilizers in world markets, strained availability of foreign exchange and agricultural credit, lack of irrigation and rainfall, and related factors which are difficult to evaluate with a degree of certainty at this time. Further, even if domestic nitrogenous fertilizer production is pretty well on target, India's consumption needs beyond 4 million tons in 1979 will have to be met from imports.

1/ Joint IBRD-GOI Fertilizer Report by D.D. Brown and W.B. Donde, dated March 1972, based on 1959-1969 data.

4.08 There was only a marginal increase in fertilizer consumption during 1972-1974, primarily because of sharp increases in fertilizer prices and shortages in world supply. But for this abnormal situation, the 1974 consumption could have reached 2,660,000 tons of N as forecast in mid-1973 by GOI. From this level, according to the implicit assumption in the "median" of the Bank-GOI forecasts for 1979 as well as 1984, the N consumption would grow at an annual rate of 11.5% during the Fifth Plan and at a slower rate of 9% during the Sixth Plan (1979-1984). Phosphate and potash consumption forecasts are based on the continuation of the present nutrient balance of 6:2:1 until 1979 and the attainment of a better balance of 5:2:1 by 1984 compared to the generally recommended level of 4:2:1.

4.09 Indian planners forecast in mid-1973 that the N consumption would expand at an annual rate of 14% during the Fifth Plan, with the total consumption reaching somewhat more than five million tons in 1979. They also projected that the P_2O_5 and K_2O consumption would increase to nearly two million tons and one million tons respectively by that year. Further, they forecast that the N consumption would grow at the annual rate of 9.5% during 1979-1986, with the total consumption reaching 9.6 million tons in 1986. Their corresponding projections for P_2O_5 and K_2O consumption for that year were 6.2 million tons and 4.2 million tons, respectively. The Indian forecasts are based on what now seems to be a rather optimistic assumption namely that the projects under construction and planning would be completed and commissioned on schedule and these projects as well as the existing ones would operate at 90% capacity by the end of the Sixth Plan (1984). However, indications are that there will be delays in the commissioning of some of the projects and overall capacity utilization may not be realized as envisaged. Because of these and other reasons already cited (para. 4.07), the projections by the Indian planers for fertilizer consumption are most likely to be underfulfilled, particularly if at the same time the shortage of imported fertilizers and their high prices were to continue.

4.10 Although inter-country comparisons of fertilizer application rates have to be used with care because of differences in crops, soils, climate, extent of irrigation and agricultural practices, prospects for potential fertilizer consumption in India are good because the use of plant nutrients per hectare of arable land is still low at about 16 kg compared to 45 kg in the U.S.S.R., 60 kg in Romania, 81 kg in the U.S., 82 kg in Yugoslavia, 140 kg in Egypt, 259 kg in Korea, 390 kg in Japan and 709 kg in the Netherlands. 1/ Mainly because of the low fertilizer consumption rate, per hectare yields in India are low as shown in the following table:

1/ 1972 Figures. FAO Annual Fertilizer Review (1972).

Per Hectare Yields (1970-1971)
('000 kg)

	Paddy (Rice)	Wheat	Maize (Corn)	Sugarcane
India	17.1	13	12.0	485.0
Egypt	54.4	27.7	41.1	933.0
Taiwan	34.2	21.5	27.9	890.0
Japan	52.5	26.5	30.0	627.0
U.S.	52.0	22.8	54.5	921.0

Source: FAO Production Year Book, Vol. 25, 1971.

B. Market for Trombay Production

4.11 The principal marketing area for Trombay is Maharashtra but its products are also sold in a few nearby districts of Gujarat, Mysore, Andhra Pradesh and Madhya Pradesh States (Annex 4-2), where Trombay has a freight advantage over its nearest competitors in Gujarat and Goa. Trombay is the only producer of complex fertilizers in Maharashtra and its current production capacity for various fertilizers is shown below:

Trombay Production Capacity (1974)
('000 TPY)

	N	P_2O_5
Nitrophosphate /1	36	36
Urea	45	-
	81	36

/1 In 1973, Trombay produced about 70% of total complex fertilizer output in the form of 15-15-15 grade NPK.

4.12 The Trombay plant is currently operating at about 90% of attainable capacity, but its production is not adequate to meet the demand in Maharashtra, and this situation is likely to continue in the near future even with the Trombay IV and V projects. This is shown in the following table prepared on the basis of the "low" estimates in the joint Bank-GOI report cited earlier (para 4.07):

Comparison of Fertilizer Capacity
with Projected Demand in Maharashtra
(in '000 TPY)

	Nitrogen (N)			Phosphate (P_2O_5)		
	Demand	Capacity	Deficit	Demand	Capacity	Deficit
1974 (Est.)	251	81/1	170	142	71/2	71
1979	417	372	45	241	175	66

/1 Trombay
/2 Trombay 36,000 tons and superphosphate producers 35,000 tons.

4.13 Most of the fertilizers in India are manufactured in the form of straight N fertilizers (e.g. urea) and there is an obvious shortage of phosphate which is often produced as part of nitrophosphate fertilizers as is done in Trombay. The project will help increase Trombay's complex fertilizer capacity from about 330,000 to 685,000 TPY in terms of products. The grade proposedfor production by Trombay IV is 21-21-0 NPK which is agronomically very similar to the two grades, 20-20-0 and 28-28-0, already in use in India, but the new product will have a higher phosphate water solubility (60% as compared to 30-35% now produced at Trombay), helping farmers to obtain better results from its application. Considering these factors, the project is not expected to face any difficulties in marketing the new grade of NP fertilizer.

C. Fertilizer Marketing

4.14 FCI has three marketing zones -- eastern, northern and south-western -- with Trombay serving mainly the south-western zone. Each zonal division of FCI is responsible for sales, promotion, and market research in its area and all activities are coordinated by FCI's Director of Marketing. Each division also handles transportation and distribution, dealer contacts as well as farmer education services including soil analyses, introduction of new seeds and modern agronomic practices.

4.15 Fertilizer is generally sold through private dealers as well as cooperatives which provide many services including credit. Credit is also available from State and commercial banks for fertilizer. However, lack of adequate credit could become a constraint in the future as fertilizer consumption increases and this matter will have to be kept under review.

4.16 Fertilizer prices for straight N products are statutorily controlled in India. The last price revision took place in October 1973. For four years prior to that, the Government had allowed no increases in these prices. Since the last price revision, the prices of fuel oil and naphtha, the main raw materials for fertilizer in India, have risen sharply in the world. In the light of this, although the Government is trying to control as far as possible the prices of the major raw material inputs, another upward fertilizer price revision is most likely to occur in the near future.

4.17 In the case of complex fertilizers, prices are not directly controlled by GOI but it normally distributes sufficient quantities of imported complex fertilizers through the Government Fertilizer Pool to insure that the pool prices are in effect the listed sales prices throughout the country. As domestic production increases and imports decline, the Government may decide to establish more direct price controls for complex fertilizers as well. Assurances were received from the Government that future fertilizer prices will be allowed to reflect increases in production costs.

4.18 Typical sales prices for Trombay products after the 1973 revision are shown below:

Retail Sales Prices /1
(per ton)

	In Rs	In US$
Urea (46-0-0)	1,050	140
20-20-0 NPK	1,200	160
17-17-17 NPK	1,875	216
15-15-15 NPK	1,375	183

/1 Including excise duties, freight and dealers' margin.

4.19 The prices shown in the above table are low compared to the present abnormally high international fertilizer prices 1/ because of the worldwide fertilizer shortages, high fuel and phosphate rock prices and the sharply increased cost of fertilizer plants. However, the prices given in the table are in line with the long-term prices for fertilizers as projected by the Bank Group (Chapter VIII). It has to be noted that because of the present acute shortage of fertilizers, Indian farmers in some cases are paying two to three times the listed prices.

V. THE PROJECT

5.01 As noted previously, the proposed credit consists of two parts: (1) the Trombay Expansion Project; and (2) an operations improvement program for FCI and FACT fertilizer plants in general. The two credit components are described below.

1/ For example, the present (May 1974) import price for urea (c.i.f., Bombay Port) is about US$300 (Rs 2,250) per ton.

A. Trombay Expansion Project

1. Project Scope

5.02 The project will add 355,000 TPY of fertilizer capacity equivalent to 75,000 TPY of nitrogen and 75,000 TPY of P_2O_5 in the form of the 21-21-0 grade nitrophosphate production (Annex 5-1). Two large units are involved, each one being of single-train modern design: (1) a 250,000-TPY nitric acid plant, and (2) a 355,000-TPY nitrophosphate plant which would utilize nitric acid to solubilize phosphate rock. The process is referred to as "nitrophosphate technology" and is commonly used in Europe in producing phosphate fertilizers. Offsite facilities to be added consist mainly of storage, utilities and housing.

2. Raw Materials and Utilities

5.03 The principal raw materials to be used are ammonia, phosphate rock and diammonium phosphate (DAP) or triple superphosphate (TSP). The ammonia requirements (about 100,000 TPY) will be met from the new ammonia plant to be established at Trombay as part of the Trombay V project which is to be carried out concurrently with the expansion project (Trombay IV) but will go into operation about one year later than Trombay IV. The Government has stated that during the first year of operation in particular and in the subsequent years until Trombay V reaches full production, the ammonia needs of the project will be met from various local sources as well as imports, possibly from Kuwait, Iran and Qatar to the extent necessary.

5.04 The proposed Trombay V project will be similar in size and product mix to the Nangal (Expansion) project. Considering sharp increases in equipment costs since 1973, Trombay V is likely to cost at least 30% more than Nangal. It will have a 900 TPD (or 300,000 TPY) ammonia plant and a 860 TPD (or 280,000 TPY) urea plant. The ammonia plant will have surplus product available for sale, of which about one-third would be transferred to Trombay IV to meet its entire ammonia needs. The ammonia plant will utilize residual heavy fuel oil as a raw material to be received through the existing pipelines to Trombay from the two adjacent refineries. According to latest indications, preliminary engineering proposals for Trombay V are expected to be received by June 1974. The financing arrangements include suppliers' credits from Italy and Austria. Assurance on the availability of financing was given by the Government and FCI and arrangements for project implementation were agreed to, all stipulating that Trombay V will be completed by May 1, 1978.

5.05 India produces small quantities of phosphate rock in Rajasthan, but meets most of its requirements for fertilizer production from imports. As Rajasthan production increases, eventually all of Trombay's needs could be met locally. However, for the purpose of this report, it is assumed that all phosphate rock requirements (about 150,000 TPY) of Trombay's new nitrophosphate plant would be met from imports as supply from Rajasthan is not yet assured. Nevertheless, with high rock prices and freight rates which together have recently doubled the c.i.f. price of imported rock, the development

of the Rajasthan phosphate deposits has become even more urgent. Since Trombay will be a natural recipient of Rajasthan rock, and a recent UNDP-financed study, for which the Bank was Executing Agency, has demonstrated the feasibility of a mine and beneficiation plant, the Government has told IDA that it intends to proceed with execution of the Rajasthan project as rapidly as possible.

5.06 Trombay currently imports DAP for use in the production of the 15-15-15 grade NPK fertilizers. DAP as well as TSP are widely traded commodities in the world, and no serious problem is foreseen in meeting the project's relatively small requirements of about 44,000 TPY of DAP or TSP. According to present plans, Trombay IV will be using locally-produced TSP.

5.07 Tata Power Company (generating capacity: 615 MW) currently supplies 40 MW to Trombay through a sub-station--located adjacent to the factory--which has two 90 MVA transformers. Two additional transformers will be installed under the project whose power requirements are estimated at 9 MW; and a new sub-station is expected to be established by Tata's, which has informed FCI that it could meet fully the additional requirements of Trombay subject to the approval of the Maharashtra State Government. FCI, with the Government's full support, has agreed to take prompt steps to obtain necessary action by the State of Maharashtra in regard to electric power and water, and in regard to pollution controls with the municipal authorities of Bombay, to enable the full utilization of the facilities to be constructed at the Trombay Unit.

3. Project Execution

5.08 FCI's difficulties in executing projects on time and within the budget have been mentioned earlier (para. 3.01). IDA's approach in financing FCI projects has been concentrated on utilizing outside engineering companies to supplement FCI staff in project execution. In the Gorakhpur project, FCI used the services of Toyo (Japan); and Uhde (FRG) and Tecnimont (Italy) are assisting FCI in the execution of the Nangal project. In Trombay IV, the nitric acid plant contractor is Power-Gas (FRG) and the nitrophosphate plant contractor is Uhde, both selected after international competition. FCI will be the prime contractor and, through its Planning and Development (P&D) Division and Trombay staff and the two engineering contractors, will--on the basis of a detailed plan--share responsibility for engineering and procurement of the entire project. The timing of project implementation is given in Annex 5-1. The commissioning of the nitric acid and nitrophosphate plants is planned for October 1976 and April 1977, respectively.

5.09 Trombay staff and local contractors will assist the foreign engineering firms in erection. FCI is to arrange the necessary expansion of utilities and services, and has prepared a Critical Path Schedule and a project implementation plan, including staff assignments. These were reviewed during negotiations and FCI has agreed, appropriately supported by the Government, that it will use its best efforts to carry out the project in accordance with the implementation plan and the Critical Path Schedule.

5.10 Execution of the Trombay modernization program is the responsibility of the Trombay staff with assistance from FCI's Planning and Development (P&D) Division. For Trombay V as well, detailed technical work is to be carried out by the P&D Division. These arrangements, together with advanced training for selected managerial and technical Trombay personnel as envisaged under the project, should ensure the capable execution of the large-scale expansion of Trombay's capacity.

4. Employment and Training

5.11 Trombay has a present staff of about 1,900 in manufacturing and about 500 in marketing. This personnel strength is high by international standards but is reasonable in the context of employment practices in India. The project will directly create about 440 additional jobs, while enabling Trombay to better utilize the existing manpower. Indirect employment generation is primarily limited to increased marketing activities. During construction, some 2,000 workers will be needed for a period of about two years. Management/labor relations at Trombay are good and recent labor disputes have been settled. Workers with industrial experience are available in the Bombay area and FCI has a good training program to provide the specific skills needed in a modern chemical factory. Under the project, 60 personnel of Trombay will be provided advanced training abroad under a program to be drawn up with the assistance of Power Gas and Uhde.

5. Ecology

5.12 The factory is located in the Bombay industrial zone. The Trombay township proper, adjacent to the factory, contains a population of about 10,000 people. Several potentially harmful waste materials and gases will be produced by the project, including fluorides and nitrogen oxide. The project scope provides for adequate equipment to control pollution (Annex 5-2) and satisfactory arrangements regarding all aspects of environmental control for inclusion in the detailed engineering of the project have been agreed. It is difficult to separate the costs solely attributable to pollution control; they are estimated at approximately US$2 million, about 4% of total project cost. FCI has also assured IDA that it will comply with the environmental quality standards set by the Bombay Munnicipal Government and those specifically agreed to for the engineering of the project will be strictly followed.

B. Plant Operations Improvement Program

5.13 As noted above US$17 million of the proposed IDA credit will be used to assist FCI and FACT in completing and commissioning some of their projects presently under construction--with particular emphasis on those plants closest to commissioning--and achieve in the shortest possible time high capacity utilization in these plants as well as in units already operating. To this end, the credit portion will be used to meet the foreign exchange costs of critically-needed equipment, spare parts, consumable materials and technical assistance.

5.14 FCI and the Government has submitted an implementation plan which is described in more detail in Annex 5-3 and which has been approved by the Association. GOI will also obtain FACT's agreement to the plan and related undertakings consistent with those reached with FCI. In brief the implementation procedures will involve:

(a) the establishment of a Coordination Group by June 30, 1974 including representatives of the Ministry of Petroleum and Chemicals, FCI, FACT, and consultants as necessary, the latter appointed in consultation with IDA;

(b) a preliminary review by the Coordination Group of the six operating units of FCI and FACT (Gorakhpur, Namrup, Nangal, Sindri, Trombay and Udyogamandal) and the four plants about to be commissioned, (Barauni, Cochin, Durgapur and Namrup) with a view to establishing priorities and constituting small groups of specialists (including consultants as necessary) to study the operations of each plant;

(c) the development of a detailed optimization program, including estimated costs and benefits, for each plant for review by the Coordination Group and IDA; this program is expected to be developed by November 1974;

(d) a formal request to IDA for disbursements against a specific list of goods and services to meet the foreign exchange costs of the measures agreed upon. Disbursements are expected to be completed by June 1976.

5.15 A list of the plants to be assisted and the items expected to be financed under the plant operations improvement program is contained in Annex 5-3. These are subject to change on the basis of the detailed plant-by-plant optimization programs. This list indicates that the major part of the funds would be needed to overcome technical difficulties in the three FCI plants (Durgapur, Barauni and Namrup), and one FACT plant (Cochin I) which are now undergoing trial operations or are about to be commissioned. Their problems spring essentially from the facts that (i) their financing (bilateral suppliers' credits) permitted only very limited choice of equipment and (ii) the involvement of the process licensors was limited to specific process considerations. Unlike the more recent IDA-financed projects, no engineering firm had overall responsibility for the total project execution, including design, engineering, procurement, construction, and performance guarantees. The plants are based on similar designs and two of them (Durgapur and Cochin I) are identical. The Durgapur plant, which is the farthest along, has never been able to operate at more then 50-60% of capacity due to equipment limitations, most of which could be overcome with the investment of about US$3 million, as indicated in Annex 5-3, permitting attainment of at least 90% of capacity utilization. The 60,000 tons of additional nitrogen which could be produced each year from Durgapur alone would be worth US$15 million at projected 1978 prices or over US$30 million annually at current prices. Comparable costs and benefits would be obtained at Cochin, Namrup and Barauni.

5.16 Discounting production losses due to power shortages (primarily at Gorakhpur and Nangal; in the latter case this problem is being dealt with through the on-going IDA credit) existing FCI plants achieved about 80% capacity utilization in 1974 as a result of recent investments and other measures. Therefore, these existing plants will absorb the smaller part of the IDA funds available for the operations improvement program; most of the funds are intended to be used for a trubo-alternator to provide captive power to Gorakhpur (which lost 23,600 tons of nitrogen production over the last year due to power shortages) and some equipment for the FACT plant at Udyogamandal.

5.17 In view of the high priority being accorded to better utilization of FCI's and FACT's fertilizer plants, the Government will make available any additional funds that are needed to carry out the detailed optimization program (para 5.14, c) expeditiously.

VI. CAPITAL COSTS AND FINANCING PLAN

A. Project Costs

6.01 Estimated financing required for the Trombay Expansion Project (Annex 6-1) is Rs 479 million (US$63.7 million) as summarized below:

Summary of Capital Cost Estimates

(in Millions)

	Indian Rupees			US Dollars			
	Local	Foreign	Total	Local	Foreign	Total	%
Equipment, Supplies and Spare Parts	54	105	159	7.2	14.0	21.2	35.5
Freight and Handling	3	11	14	0.4	1.5	1.9	3.2
Duty and Taxes	49	-	49	6.5	-	6.5	10.9
License Fees and Engineering	4	23	27	0.6	3.0	3.6	6.0
Erection and Commissioning	33	5	38	4.4	0.6	5.0	8.4
Project Management and Training	10	4	14	1.3	0.5	1.8	3.0
Civil Works	54	-	54	7.2	-	7.2	12,0
Sub-total	207	148	355	27.6	19.6	47.2	79.0
Initial Working Capital	12	8	20	1.6	1.1	2.7	4.5
Contingencies: Physical	10	8	18	1.3	1.1	2.4	4.0
Price	31	22	53	4.1	2.9	7.0	11.7
Employees' Housing Colony	3	-	3	0.4	-	0.4	0.8
Total Project Cost	263	186	449	35.0	24.7	59.7	100.0
Interest During Construction	30	-	30	4.0	-	4.0	
Total Financing Required	293	186	479	39.0	24.7	63.7	

6.02 These estimates have been prepared on the basis of April 1974 costs after reviews with the engineering firms selected to assist FCI. Physical contingencies provided are 15% of local and foreign erected plant costs. Price escalations assume 15% annual increase in 1974 and 10% in 1975, for the foreign costs, and 15% annual increase in 1974 and 1975 for local costs. Virtually all supplies are expected to be ordered by the end of 1974. Price escalation was determined in consultation with several engineering contractors. With respect to procurement, 10% of the equipment in terms of cost is reserved for local suppliers and will not be financed under the IDA Credit. Indian suppliers are expected to win about 20% of the remaining equipment to be bid internationally. The initial working capital requirements at start-up is estimated to be Rs 20 million, including Rs 8 million for imported raw materials.

B. Financing Plan

6.03 Financing for the project would be provided as shown below:

Financing Plan

	Amount (US$ Million)	Percent
Long-term Debt (GOI on-Lending of IDA Credit Portion)	33.0	51.8
Equity (GOI Funds)	30.7	48.2
Total	63.7	100.0

6.04 The portion of the proposed IDA Credit for Trombay IV (US$33 million) will be onlent to FCI for 15 years, including 5 years' grace, at an annual interest rate of 9.5%. The foreign exchange risk will be borne by the Government. GOI's equity contribution of nearly US$31 million equivalent will be independent of the earnings capacity of the Trombay Unit or FCI as a whole. Any additional funds needed for the timely completion of the modernization program, the expansion projects (Trombay IV and V) and all other projects (para. 2.07) and the settlement of present litigation would be provided to FCI by GOI on terms and conditions normally applicable within FCI's obligation to IDA to maintain a debt/equity ratio of better than 50/50.

6.05 The portion of the proposed credit to be used BY fci and FACT for plant operations improvement will be made available to the companies by the Government against cash through the banking system (as is normal for the sale of foreign exchange) with payments to be made by FCI and FACT in rupees out of their own resources.

C. Allocation of IDA Credit

6.06 Proceeds of the IDA Credit would be used as follows:

Allocation of IDA Credit

(US$ million)

	Local	Foreign	Total
1. Trombay Expansion			
Equipment, Freight, Supplies and Spares	3.6	14.9/1	19.5
License Fees and Design Engineering	0.6	3.0	3.6
Erection and Commissioning	4.0	0.6	4.6
Project Management and Training	1.3	0.5	1.8
Unallocated	0.5	3.0	3.5
Sub-total	10.0	23.0	33.0
2. Plant Operations Improvement			
Equipment and Spares	-	12.0	12.0
Engineering and Consulting Services, and Training	-	3.0	3.0
Consumable Materials	-	2.0	2.0/2
Sub-total	-	17.0	17.0
Total	10.0	40.0	50.0

/1 Includes about US$116,000 of imported proprietary items.

/2 Purchases of consumable materials will be limited to US$2 million equivalent for items such as vanadium pentoxide and diethamolamine for the Benfield process, Comox catalysts, platinum rhodium gauze for nitric acid plants, liquid ammonia on spot purchases, carbon bricks and cement, and rubber lining materials of special quality.

D. Procurement and Disbursement

6.07 Equipment and materials to be financed by the IDA Credit for both parts of the project will be procured in accordance with IDA Guidelines from prequalified suppliers.

For Trombay IV

Equipment and materials will be procured by international competitive bidding except an estimated US$5 million for: process critical and proprietary equipment, items in short supply whose timely delivery is critical and packages under US$50,000 for which international shopping will be used whenever possible. Pre-qualified local suppliers will receive a preference of 15% or the amount of the customs duty whichever is lower, for purposes of bid evaluation.

For FCI and FACT Operations Improvement

Equipment and materials 1/ will be procured by international competitive bidding except (i) duplicate or replacement items, (ii) items whose delivery is critical for process or schedule purposes, and (iii) packages under US$50,000 equivalent. For the exceptions international shopping will be used whenever possible and the amount is not expected to total more than US$6 million. No local supplies are to be financed by this part of the credit.

6.08 The IDA Credit would be disbursed as follows:

For Trombay IV

(a) 100% of the total eligible expenditures (excluding taxes) for equipment, materials, foreign freight and spares.

(b) 100% of the total expenditures (excluding taxes) for license fees, design engineering, erection, commissioning, project management and training.

For FCI and FACT Plant Operations Improvement

(a) 100% of the CIF cost of equipment, spares and consumable materials. 1/

(b) 100% of the foreign exchange expenditures for technical services.

Disbursements would be made against appropriate documentation and are expected to extend over a period of three years (Annex 6-2). Any surplus funds remaining in the credit account after completion of the project will be cancelled.

VII. FINANCIAL ANALYSIS

A. Trombay Unit - Profitability and Financial Position

7.01 Detailed income, cash flow and balance sheet forecasts for Trombay through 1982 are given in Annexes 7-1, 7-2 and 7-3 respectively, and are summarized below:

1/ See footnote /2 on page 25.

Trombay Unit - Summary of Financial Projections /1

(In Rs Million unless otherwise noted)

	1974 Est.	1975	1976	1977	1978	1982
Income and Cash Flow						
Net Sales	366	472	504	573	802	938
Interest	6	11	-	-	24	13
Depreciation	46	53	53	65	90	51
Net Profit before Taxes	89	123	152	156	151	216
Net Profit /2	45	61	76	78	75	108
Cash Generation	91	114	129	143	165	159
Debt Service	125	145	11	21	27	38
Balance Sheet Items						
Current Assets	158	143	146	197	215	251
Current Liabilities	248	116	121	118	134	139
Net Fixed Assets	278	363	580	658	573	346
Long-term Debt	35	39	131	233	223	143
Equity	193	355	646	854	1005	1813
Ratios						
Current Ratio	0.6:1	1.2:1	1.2:1	1.7:1	1.6:1	1.8:1
Long-term Debt/Equity Ratio	15/85	10/90	17/83	21/79	18/82	7/93
Debt Service Coverage (times)	0.7	0.8	11.7	6.8	6.8	4.5

/1 Excluding Trombay V; refer para. 7.04 for impact of Trombay V.
/2 After notional taxes assumed to be 50% of net profit before taxes.

7.02 During 1974-1982, net sales are expected to increase by 156% to Rs 938 million (US$125 million) and pre-tax profit by 143% to Rs 216 million (US$28.8 million), reflecting the impact of the modernization and expansion of the Trombay Unit. Projected improvements in sales and pre-tax profits in 1975 are due to higher prices and the greater capacity utilization forecast. Income taxes for Trombay are difficult to predict since they are paid by FCI only at the corporate level. FCI has not so far paid any income taxes due to its overall low profits (Annex 2-7) as well as to tax holidays and exemptions related to new and expansion projects. The Corporation is expected to continue having substantial tax exemptions which are likely to exceed its tax liabilities until at least 1979. However, taxes for purposes of the above table have been assumed to be 50% of the pre-tax income of Trombay.

7.03 The Trombay modernization and expansion programs are being financed on a sound basis, with the Unit as a whole forecast to have a debt/equity ratio of 21/79 at the end of 1977 and a current ratio of at least 1.2:1 after 1974. The equity builds up significantly because of increased retained earnings. Agreement was reached that Trombay's debt/equity ratio will not exceed 50/50 and the current ratio will be at least 1.2:1 at all times. Debt service coverage would be more than satisfactory for the Trombay Unit after 1975. However, it would be low in 1975 as it was in 1974.

7.04 Trombay V's projected impact on the Trombay Unit's financial position and prospects is reflected in the table below. The financial covenants agreed with FCI are designed to assure that Trombay V as well as all other new FCI projects are carried out on a sound financial basis. Trombay V is estimated to cost about US$150 million (Rs 1,125 million) to be financed by GOI half in equity and half in loan with the equity to be invested first. The Trombay Unit's revenue and net profits before taxes would increase by about Rs 250 and Rs 120 million respectively on account of the 232,000 tons of urea and surplus ammonia forecast to be produced and sold from Trombay V at about 90% capacity from 1981 onward.

Trombay Unit With and Without Trombay V
(millions of Rupees)

A = With Trombay V
B = Without Trombay V

	1978		1979		1981	
	A	B	A	B	A	B
Sales	802	802	1,030	887	1,190	938
Net profit before taxes	151	151	200	165	335	216
Gross Fixed Assets	2,270	1,146	2,275	1,151	2,285	1,161
Net fixed assets	1,700	573	1,500	487	1,235	392
Long-term debt (LTD)	785	223	720	198	540	148
Share capital	900	346	900	346	900	346
Equity	1,570	1,005	1,720	1,170	2,220	1,597
LTD/Equity ratio	33/67	18/82	30/70	14/86	20/80	8/92
Trombay V Production (000 tons of urea)	-		129		232	

B. Project - Trombay IV

1. Production, Prices and Sales Revenue

7.05 The project is forecast to produce in 1980--the first year of full (90%) production --about 325,000 TPY of nitrophosphate (21-21-0 grade) and 179,000 TPY of nitric acid. Most of the nitric acid (141,700 TPY) will be used internally by the project, while 27,100 TPY will be transferred to the existing NPK plant of Trombay and another 10,000 TPY sold in the open market.

7.06 As mentioned current world market prices are abnormally high but are expected to decline, possibly as early as 1977. Therefore, prices as projected for 1978 have been used to value both fertilizer and its inputs. On this basis, the ex-plant price for the 21-21-0 grade NPK is assumed to be Rs 1,010/ton (US$135/ton). This is in line with the long-term fertilizer price forecasts of the Bank Group.

7.07 The production build-up and income projections for the project are shown below (Annexes 7-4 and 7-5):

Trombay IV - Projections of Production, Revenue and Income

(In Rs Million unless otherwise noted)

	1977	1978	1979	1980
Nitrophosphate Plant				
Capacity utilization (%)	-	50	75	90
Production (tons)	-	180,500	270,700	324,900
Revenue	-	183	274	329
Nitric Acid Plant				
Capacity utilization (%)	15	46	62	72
Production (tons)	18,550	115,850	155,225	178,800
(a) Sales to old Trombay Plant (tons)	13,550	27,100	27,100	27,100
Revenue	10	20	20	20
(b) Outside sales (tons)	5,000	10,000	10,000	10,000
Revenue	8	15	15	15
Total Revenue	18	218	309	364
Cost of Goods Sold	8	143	206	244
Other Expenses 1/	7	11	17	21
Interest	-	24	23	21
Depreciation	8	41	41	41
Net Profit (Loss) Before Taxes	(5)	(2)	22	37

1/ Maintenance, Selling and General Expenses.

7.08 Revenue forecasts are based on a build-up of production in the nitrophosphate plant from 50% of capacity in 1978, the first year of commercial operation, to 90% of capacity in 1980 and thereafter; and in the nitric acid plant, from 46% to 72% during the same period. Some reserve capacity will be available in the nitric acid plant for future use by Trombay and outside chemical plants as their requirements increase. With designs of commercially proven efficiency, the performance guarantees by the engineering contractors, assured supply of coal and power from nearby sources, and ammonia and phosphate rock from Trombay V and established sources respectively, the

assumed capacity utilization for the project appears reasonable. The sales revenue in 1980 from the project is forecast at about Rs 364 million (US$48.5 million), representing approximately 39% of the projected total revenue of Rs 938 million for the Trombay Unit in the same year. The project is expected to earn a profit before tax from the third year of operations, reaching a level of about 11% of net sales by 1980. Debt service coverage is expected to exceed 1.3 times throughout the project life.

2. Production Costs

7.09 Production costs are shown in more detail in Annex 7-6 and are summarized below:

Trombay IV - Direct Production Cost /1

(Rs/ton of NP)

	Production Cost	% of Total
Ammonia	283.5	39.1
Triple Superphosphate	141.0	19.4
Phosphate Rock	167.0	23.0
Fuel Oil and Coal	37.5	5.2
Other Raw Materials and Supplies	58.0	8.0
Utilities	27.5	3.8
Labor	11.0	1.5
Total	725.5	100.0

/1 At 90% capacity utilization and 1978 prices. Excluding general overhead expenses, depreciation, insurance and other operating expenses. Price assumptions for inputs are given in Annex 8-1.

7.10 Import prices have been calculated based on Bank Group estimates of 1978 prices for imported materials and US$140 for ammonia from Trombay V based on other Bank Group projects under study. Duties and taxes average about 20% of the delivered cost of materials. Including these taxes, the costs of raw materials, supplies and utilities constitute about 98.5% of the project's production costs, with labor accounting for about 1.5%. The (incremental) labor costs are low for the project, partly because of overstaffing in the existing Trombay plants, and partly because many labor-intensive activities (e.g., repair shops and township facilities) are adequate and need, therefore, not be expanded under the project. Assurances were provided that adequate quantities of all materials, including ammonia and phosphate rock, for the project would be ensured through timely imports to the extent that local supplies fall short.

3. Financial Rate of Return

7.11 The project provides a pre-tax incremental financial rate of return of 13.5%. Detailed assumptions are contained in Annex 8-1. Capital costs used for the rate of return calculations include Rs 6 million (US$0.8 million) for the construction of a housing colony for employees for the project.

7.12 Sensitivity tests have been conducted to determine the effects of various events on the financial rate of return; the results are shown in Annex 7-6 and are summarized below:

Trombay IV - Sensitivity Tests on Financial Rate of Return

Case		%
1.	Base case	13.5
2.	Sales revenue decrease by 10%	5.5
3.	Operating cost increase 10%	7.8
4.	6-month project delay and 10% capital cost overrun	11.4
5.	80% capacity utilization	11.3

7.13 The rate of return is more sensitive to changes in sales revenue than in operating and capital costs. It would drop to 5.5% if sales revenue were to fall by 10%; and decline to 7.8% if operating costs were to increase by 10%. Further, a six-month project delay, combined with a 10% capital cost overrun and the eventual attainment of only 80% capacity utilization, would reduce the financial rate of return to 9.2%. However, except for the overly tight equipment supply situation worldwide that is affecting all fertilizer plant construction proceeding at this time, the likelihood of this happening is low, particularly in view of the involvement of outside engineering firms.

4. Break-Even Point

7.14 The profit break-even point for the Trombay IV project in 1980 would be 68%, and the cash break-even would be 54%. A break-even chart is provided in Annex 7-7.

5. Major Risks

7.15 The project design is based on modern commercially proven technology for economically efficient large-scale production, thus minimizing technical and obsolescence risks in the project. Further, no commercial risk is foreseen because: (1) the fertilizer grade (21:21:0) to be produced by the project is very close to one of the popular grades (20:20:0) Trombay is already selling; (2) fertilizers in general will continue to be in short supply in India; and (3) Trombay's marketing system is well developed. The operating and financial performance of Trombay has improved significantly, especially since 1970, and this trend is projected to continue. Nevertheless, it is conceivable that the project could be affected by delays in implementation and temporary difficulties in getting imported materials in adequate

quantities. As noted, the risk of project delays is reduced because of the involvement of outside firms; however, it could increase significantly should the period of equipment deliveries lengthen further, with a consequential rise in project cost.

VIII. ECONOMIC ANALYSIS

A. World Fertilizer Prices

8.01 Future international fertilizer prices are difficult to determine as they fluctuate over relatively short periods of time. Freight charges, which constitute a major part of fertilizer costs, also vary widely. These fluctuations, combined with continuing foreign exchange shortages, have made it difficult for India to rely on imports to a major extent to meet the growing demand for fertilizers. During 1969-1971, world fertilizer prices were low due to over-supply. Beginning in 1972 and continuing to the present, there are worldwide fertilizer shortages, and prices have increased sharply, partly due to scarcity and partly due to price hikes of hydrocarbons and phosphate rock, the major raw materials for fertilizer production.

B. Economic Rate of Return

8.02 The economic rate of return for the project (Trombay IV) is 16.3% at 1978 constant prices (Annexes 8-1 and 8-2). The underlying price assumptions as given in those annexes are based on a Bank Group review, which included many outside discussions, of future fertilizer prices in general. The economic accounting price per ton (c.i.f., delivered Bombay Port and including costs of handling and transportation to warehouses) used for bagged 21-21-0 grade nitrophsphate is US$130; for bagged triple superphosphate, US$125; for ammonia, US$127; for phosphate rock, US$46; for fuel oil, US$54; and for nitric acid, US$100. Duties and taxes are excluded from capital and operating costs. No shadow wage rate has been used for labor because the total wage bill as a percentage of production costs is very small (para. 7.10).

8.03 Sensitivity tests performed on the economic rate of return (Annex 8-2) show that a 10% drop in the nitrophosphate price reduces the economic rate to 8.0%, while a 10% decrease in operating costs brings it to 21.4%. The return is also sensitive to delays in project implementation, cost overruns and underutilization of capacity--common problems experienced by many Indian fertilizer plants in the past. A six-month delay in project implementation combined with a 10% capital cost overrun and 80% capacity utilization (as against 90% assumed) would drop the economic rate of return to about 13.0%, still a satisfactory figure. Therefore, under moderately adverse conditions, the project yields an acceptable rate of return.

C. Supply of Fertilizer and Food

8.04 The project would augment the annual fertilizer supply capacity in India by 355,000 TPY of product or 150,000 TPY of plant nutrients. Assuming

90% capacity utilization, the increased actual supply of plant nutrients would be 135,000 TPY. Under present farm conditions, a ton of plant nutrient helps produce on average about 5 tons of foodgrains in India. 1/ Thus the annual supply of plant nutrients from the project would help increase food production in the country by about 700,000 TPY.

D. Direct Foreign Exchange Savings

8.05 One of the most important benefits from the project is the annual net direct foreign exchange saving to the economy after deducting the foreign exchange components of operating and capital costs. As shown in Annex 8-3, such net direct annual foreign exchange savings at the projected world prices of 1978 would be about US$18 million annually after the project achieves full production. Thus, the foreign exchange cost of the project--US$25 million--would be more than covered in less than two years of operation of the project at full production.

E. External Economies

8.06 The project will have a surplus of 37,000 TPY of nitric acid available for supply to other chemical plants. Of this, 27,000 TPY would go to the existing NPK plant at Trombay, helping to increase its production by 41,000 TPY of fertilizers. The remaining 10,000 TPY would be sold in the open market to meet part of the needs of the Indian chemical industry in general.

F. Use of Nitrophosphate Technology

8.07 The use of sulfur is common in the production of phosphate fertilizers, but India has hardly any indigenous source of sulfur. With the use of nitrophosphate technology based on nitric acid instead of sulfuric acid, Trombay IV would in effect overcome the need for about 54,000 TPY of imported sulfur which at 1978 projected international prices of US$60/ton (c.i.f., Bombay Port) would cost approximately US$3 million per year. However, it has to be noted in this context that generally a nitrophosphate plant based on nitric acid involves somewhat higher capital costs than one based on sulfuric acid.

G. Impact of Plant Operations Improvement Program

8.08 Delays in the construction and commissioning of new plants result in higher capital costs and outflow of foreign exchange on imports during the intervening period. The plant operations improvement program will help FCI and FACT in the earlier commissioning of their new fertilizer plants as well as in the achievement of greater production in their existing units. The economic impact of this on the economy is expected to be very significant--though difficult to quantify--because of increased supply of fertilizers

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1/ Under controlled conditions on the farmer's field, a ton of plant nutrient applied to wheat and rice helps to produce 10-12 tons of grains.

within a short period of time. It is conservatively estimated that the program would help increase FCI and FACT annual capacity utilization by at least 3-5% during 1975-80, thus resulting in an average incremental annual production of 60,000-90,000 tons of plant nutrients. Assuming that the international price and direct production cost per ton of fertilizer nutrients on an average are US$280 and US$120 respectively in 1978, the incremental production would account for a net annual benefit of US$10-15 million to the economy.

IX. AGREEMENTS

9.01 During negotiations, the implementation plan for the proposed ammonia/urea plant (Trombay V) was confirmed (para 5.04); and the following principal agreements were obtained:

A. From the Government that it will:

(i) provide adequate funds to FCI to complete all its on-going and new projects (para. 2.07 and 5.17);

(ii) allow FCI to observe certain financial covenants (para. 2.10);

(iii) not impair FCI's or Trombay's financial position while settling payments under litigation (paras. 2.13 and 6.04);

(iv) not take any action which would preclude efficient fertilizer manufactuers from meeting their expenses, servicing debt and earning a reasonable return on invested capital out of revenues (para. 4.17);

(v) assure adequate supplies of utilities and consumable materials for the Trombay Unit (para. 5.03, 5.07 and 7.10);

(vi) take or cause to be taken all steps necessary to implement the Plant Operations Improvement Program of FCI and FACT (para. 5.13);

(vii) obtain agreements satisfactory to IDA from FACT to permit FACT's inclusion in the Plant Operations Improvement Program and have it carried and according to the implementation Plan (para 5.14);

(viii) on-lend the Trombay IV portion of the Credit to FCI at 9.5% (para. 6.04).

B. From FCI that it will:

(i) consult with IDA in making changes in Trombay's top management (para. 2.11);

(ii) submit annual and quarterly reports (para. 2.19);

(iii) maintain a debt/equity ratio of not more than 50/50 and a current ratio of not less than 1.2:1 (para. 7.03);

(iv) carry out the project according to the Critical Path Schedule and the Implementation Plan (para. 5.09 and 5.14); and

(v) ensure satisfactory environmental protection (para. 5.07 and 5.12).

9.02 The foregoing agreements provide a sound basis for an IDA Credit to GOI equivalent to US$50 million for 50 years, including a 10-year grace period.

Industrial Projects Department
May 20, 1974

ANNEX 1

INDIA: TROMBAY EXPANSION PROJECT

GLOSSARY OF TECHNICAL TERMS

1. Following is a description of the technical terms used in this report:

2. Plant Nutrients: Essential to plant growth are some 16 elements, 6 in large and the remainder in small or micro quantities. Carbon, hydrogen, oxygen, nitrogen, phosphorus and potassium comprise the first six, and others of lesser significance include calcium, magnesium, sulfur, silicon, zinc, iron, aluminium, manganese, boron, sodium, and copper. Carbon, hydrogen and oxygen are readily available from the atmosphere and water. Nitrogen, phosphorus and potassium -- three main nutrients -- and the other elements are drawn from the soil. Unless supplemented by regular additions of materials containing the three main nutrients, soil is soon depleted of fertility by cropping. Use of organic materials such as animal and vegetable wastes can be utilized but the scale and intensity of modern agriculture have far exceeded the availability of natural "fertilizers." Consequently, the majority of the world's primary plant nutrient needs are now supplied in the form of manufactured or "chemical" fertilizers. To an increasing degree, secondary nutrients such as calcium, magnesium, sulfur, and micro nutrients such as boron, zinc, copper and manganese are also added to soils along with the primary nutrients in ratios prescribed by agronomists according to specific crop and soil needs.

3. Chemical Fertilizers: Chemical compounds suitable as fertilizers should be high enough in nutrient content; stable to avoid hazards and handling problems; and readily water soluble and available to plant root systems. Commercially available materials meeting these requirements to a large degree are:

Primary Fertilizer Materials

	% of N Nutrient		% of P_2O_5 Nutrient		% of K_2O Nutrient
Urea	46%	Triple Super-phosphate	46%	Potassium Chloride	61%
Ammonium Nitrate	34%	Single Super-phosphate	18%	Potassium Sulfate	54%
Amonium Sulfate	21%				
Diammonium Phosphate	18%	Diammonium Phosphate	46%		

Because of the high nutrient content of urea, diammonium phosphate and potassium chloride (KCL), they are some of the most popular fertilizer materials in the world today. It is the common practice to report the nutrient content of materials in terms of percentages of N and P_2O_5 (phosphorus pentoxide) and potassium K_2O (potassium oxide).

4. Complex or NPK Fertilizers: All three primary nutrients (N, P_2O_5, K_2O) are frequently applied to the soil at the same time in ratios varying with the nutrient requirements of different crops. To facilitate handling, the several required chemicals are usually agglomerated into uniform granules for distribution. The analysis of each nutrient is given as a ratio to describe the NPK product. Thus 15-15-15 complex fertilizer contains 15% each of N, P_2O_5, and K_2O; and 12-24-12 complex fertilizer contains 12% N, 24% P_2O_5 and 12% K_2O.

5. Phosphate Water Solubility: The agronomic availability (or efficiency) of phosphate materials vary substantially. A common practice is to use water solubility as a criterion although in acidic soils it is a less significant factor. Higher P_2O_5 water solubility permits the fertilizer to be absorbed more rapidly. The minimum recommended in most cases is about 60% solubility but in some cases up to 80-85% solubility is preferred.

6. Ammonium Nitrate (AN) is produced by reacting ammonia with nitric acid. Nitric acid (HNO_3), in turn, is made from ammonia (NH_3). AN contains 34.5% nitrogen, half in the ammonium form and half in the nitrate form, and is very hydroscopic. It also is a commercial explosive. In many countries, a diluent -- e.g. limestone -- is added to lower the analysis and negate the explosive properties as well as to minimize the hydroscopic properties.

7. Nitrophosphates are mixtures of ammonium phosphates, ammonium nitrate and a small amount of dicalcium phosphate. Thus, they are combinations of conventional fertilizer or salts and are not unique chemical compounds. They are made by dissolving phosphate rock in nitric acid instead of sulfuric acid and separating the undesired calcium as useful calcium nitrate crystals instead of waste calcium sulfate (gypsum) prior to ammoniation. A more appropriate name would be ammonium phosphate-nitrate instead of nitrophosphate which is misleading. Some earlier nitrophosphate (NP) processes made fertilizers with low phosphate water-solubility that gave slower responses under certain soil and crop conditions. Modern processess produce ammonium phosphate-nitrate mixtures with P_2O_5 water solubilities of at least 80%. These give crop yields at least as good as those obtained with other nitrogen and phosphate fertilizers and millions of tons annually are produced and used in Europe. By-product calcium nitrate from the NP plant can be converted to a solid prilled or granular product. Or, it can be reacted with ammonia and carbon dioxide to produce ammonium nitrate (AN) and by-product calcium carbonate. The AN is usually converted to solid granules or prills containing 35% N, or combined with some by-product calcium carbonate beforehand to produce fertilizers containing 26% to 33% N, as desired. The by-product calcium carbonate can be used as a soil dressing, or as a "chemical chalk" in chemical and cement production, or simply discarded. Throwing away unwanted calcium carbonate compared to discarding gypsum from phosphate plants using sulfuric acid, represents a much lower economic loss. The chalk represents merely unwanted calcium from the phosphate rock and by-product carbon dioxide from the ammonia plant.

8. Diammonium Phosphate (DAP) or chemically $(NH_4)_2HPO_4$, is produced by reacting NH_3 with phosphoric acid (H_3PO_4) followed by granulation and drying.

9. Partial Oxidation is a method of producing hydrogen from hydrocarbon fuels of almost any type by a non-catalytic reaction with oxygen followed by removal of the by-product, carbon monoxide.

10. Feedstocks are the hydrocarbons used to produce hydrogen for the ammonia synthesis. Natural gas is usually the most economical choice when available. Other potential feedstocks are naphtha, fuel oil, crude oil, coal or lignite.

11. Urea is known chemically as carbamide or NH_2CONH_2 - the normal amide of carbonic acid; this compound contains about 46% N, all in the ammonium form. It is considerably less hydroscopic than ammonium nitrate and it is the most widely used straight nitrogen fertilizer today.

12. Urea Synthesis: Urea is made by reacting ammonia with carbon dioxide. Since both of the materials are produced during the ammonia synthesis, urea production is usually undertaken alongside an ammonia plant. Unfortunately, the corresponding acid of carbon dioxide (carbonic acid) does not form stable ammonium salts as do nitric, sulfuric or phospheric acids. Therefore, simple neutralization as used in making ammonium nitrate and sulfate fertilizers is not possible. Instead, ammonia and carbon dioxide are combined under heat and pressure to make ammonium carbomate which, although unstable, can be dehydrated under pressure to form urea, a stable compound. Again, unfortunately, the overall reaction is completely reversible and even at 300 atmospheres pressure and 200°C, the conversion to urea in a single pass through the reactor is under 70%. This introduces several complications: high pressure must be used to maximize conversion; unconverted reactants must be separated and recycled; increased corrosion under the high temperatures and pressures used must be overcome, and urea decomposition into undesirable products must be minimized. In recent years, several engineering and producing companies have developed ways of surmounting these problems, and large plants capable of producing a thousand tons per day, or more, of urea to rigid chemical and physical specifications are now operating successfully for long periods throughout the world.

Petroleum Units and Measures

13. The petroleum industry historically has used units of measure based on the English measuring system. Conversion rates for some units are given below:

1 barrel	= 42 US gallons;
1 US gallon	= 0.95 liters = 0.00095 M^3;
1 ton crude oil	= 7.0 barrels (approximately, based on the crude oil specific gravity); and
1 ton oil	= 1.25 M^3 of natural gas (approximately, based on oil and gas compositions)

The conversion rates between volumetric units, such as gallons, and weights are approximate since the specific gravity of the oil varies slightly with its composition.

14. Materials that exist in the form of gases, such as methane (natural gas), are measured in volumetric units. Since gases are compressible, standard conditions of temperature and pressure (0° C and 1.0 atmosphere) are used to define the quantity (in volume) of gas, and designated as "normal cubic meters" or "normal cubic feet."

Industrial Projects Department
May 1974

INDIA: TROMBAY EXPANSION PROJECT

DESCRIPTION OF FERTILIZER CORPORATION OF INDIA (FCI)

A. Existing Operating Divisions of FCI

1. FCI is the largest fertilizer company in India with five operating units, plus the Planning and Development Division, which are described below. Production capacities in these operating units as well as FCI's new projects are summarized in Table 1. Historical performance of the operating divisions is given in Annex 2-3. Capacity utilization has averaged about 70% for nitrogen and about 55% for phosphate over the past three years (1970-1973). Gorakhpur and Nangal have had relatively little difficulty (except recent power shortages) and have consistently operated at high efficiency. Sindri and Namrup have continuing operating problems and operate considerably below desirable levels of capacity utilization. Trombay has showed good performance in recent years with the net profit reaching about Rs 81 million (nearly US$11 million) in 1973.

2. The overall performance of FCI has been relatively poor. As indicated above, the performance of its individual units vary widely for complex reasons and these are discussed below.

Trombay (Maharashtra State)

3. The existing Trombay plant has an annual design capacity of 240,000 tons of NPK fertilizer (15-15-15); 99,000 tons of urea; and 30,000 tons of methanol. Intermediate products include ammonia, nitric acid and sulfuric acid. In addition, some minor quantities of industrial chemicals such as argon, concentrated nitric acid, sodium nitrate and ammonium bicarbonate are produced. The Trombay complex includes necessary facilities such as maintenance shops, storage, utilities, offices and townships; it is near to the Bombay port and has good rail and road connections. Present plant facilities are described in detail in Annex 2-6.

Gorakhpur (Uttar Pradesh State)

4. This plant, which produces urea only, began production in early 1968. Gorakhpur was financed with a Japanese credit plus funds from GOI and was built by Toyo (Japan) at a total cost of about US$45 million. This cost is considered high due to imbalances and excessive spare capacity of some equipment. The plant units at Gorakhpur are ammonia and urea, with low-grade naphtha serving as the feedstock. The ammonia plant is designed to have two streams, each with a capacity of 175 TPD of ammonia. Partly because the plant uses electrically-driven reciprocating compressors, it has a relatively high operating cost and high dependence on outside power. The project operates well and can easily exceed 100% of design capacity on a daily basis. Output has been seriously impaired by power supply problems; were the reliability of power supply to improve in Uttar Pradesh, the performance of this plant should steadily increase.

5. In January 1972, IDA approved a US$10 million credit to Gorakhpur to increase its capacity from 180,000 TPY to 314,000 TPY of urea by 1975.

Nangal (Punjab State)

6. The Nangal plant produces heavy water and calcium-ammonium nitrate (CAN) fertilizer containing 25% N, using a process involving intensive use of power. Initial production began in 1961 with a rated capacity of 80,000 TPY nitrogen. Power supply has been severely restricted, thus limiting production to 60-70% of capacity. Ammonia and urea capacity expansion is underway, utilizing an IDA credit of US$58 million. Included in the expansion program is a provision to reduce Nangal's heavy reliance on power by using a new process in the old plant.

Namrup (Assam State)

7. The Namrup factory produces urea and ammonium sulfate. The plant started commercial production in January 1969 but has not achieved full production so far. The factory has small process units for ammonia, urea and ammonium sulfate. A detailed evaluation of Namrup was not made but it is doubtful if the existing facilities can ever be profitable without major modifications. The plant is being expanded to produce 330,000 TPY of urea, with the new units expected to go on stream in 1975. As the total market for fertilizer in Assam is limited, most of the increased production must be shipped to the neighboring States of Bihar and Uttar Pradesh.

Sindri (Bihar State)

8. The Sindri plant produces ammonium sulfate, urea and industrial chemicals. Most of the existing production facilities are old and inefficient, involving high maintenance costs; and the plant has an excessively high employment of about 8,000 persons. It operates at about 70% capacity, with major causes for low capacity utilization being power and equipment failures; and the high cost of gypsum feedstock for ammonium sulfate is also responsible for the plant's operating losses. Sindri's financial performance has deteriorated sharply in recent years and it is a major reason for FCI's poor financial results. A rationalization program is underway for additional production facilities for phosphoric acid and triple superphosphate (TSP), and reduction in ammonium sulfate production costs. Possibly, some old facilities would be shut down after this program. Following this, modernization and expansion of Sindri is envisaged. IDA is currently evaluating this project.

Planning and Development (P&D) Division (Bihar State)

9. The P&D Division is the engineering and research and development arm of FCI. It is located adjacent to the Sindri plant in Bihar. It has a total staff of about 2,000 with about 700 engineers and designers working directly on engineering, planning and technical service functions for FCI units. In addition, the division develops and manufactures catalysts for use in ammonia plants and has extensive pilot plant and research development facilities. The catalyst manufacturing program is technically sound and some catalysts have

been sold for use in fertilizer plants in India. Over the next few years as the catalyst consumption grows in the country, FCI catalyst production should become profitable.

10. The P&D Division has several license agreements with international process engineering firms, the most notable being: Montecatini-Edison, Italy, for ammonia and urea; Lurgi, Germany, for rectisol CO_2 removal; Shell, the Netherlands, for fuel oil gasification; Koppers, Germany, for coal gasification; and Nissan, Japan, for phosphoric acid. Licensing arrangements for other process technology are obtained when needed for other projects. The Division has developed its own process know-how for ammonium sulfate, ammonia synthesis gas purification and some others. For all of the present ammonia-urea plants under implementation, the Division has been responsible for engineering, design and project schedule as well as procurement based on process design packages from various licensors. Where suppliers' credits are involved, the foreign process collaborator handles most procurement from outside India.

11. Project implementation responsibilities under FCI are not clearly defined and, as a result, the completion of a number of projects has been delayed as long as three years. Except for the Nangal Expansion Project, there is no one project manager with overall responsibility; instead, the functions are divided between the general manager of a particular unit and the P&D Division. Supervision of work at the site is the responsibility of the General Manager of the unit. Although the P&D Division is responsible for the project schedule, its completion time can be greatly affected by the General Manager's staff. Communications from the Division headquarters at Sindri are poor and procurement delays are inevitable. The Division could function considerably better if its engineering operations are moved to a major city like Bombay. Budget control is another critical area of split responsibility with the P&D Division being responsible for design and procurement and the management of the unit concerned being responsible for construction costs. The Division appoints a project coordinator to supervise project work and maintains liaison with project management. Major decisions on design and procurement are made by a committee consisting of the top management of the Division; as a result, the project coordinator does not have full responsibility for project management. The general engineering capabilities of the Division, however, are quite good. Typical design drawings and specifications were reviewed for the several projects now in the design stage and they appear to be satisfactory.

12. The overall responsibility of the Division in executing the several ammonia-urea projects is greater than heretofore generally recognized by the Bank. The responsibilities of the process licensors appear to include only the initial process package, a limited amount of checking, and supply of construction and commissioning advisors. The guarantees offered are process guarantees and are not likely to be enforceable to any significant degree. FCI as a whole has total responsibility for project management, project schedule and budget.

13. Project coordinators and newly-appointed General Managers are not always experienced in the complex task of procuring adequate equipment, materials and manpower required for the new projects involving heavy capital investments. Furthermore, the expansion program of FCI has taxed management

capabilities, especially of the middle management. Causes for many delays are outside the control of the P&D Division; they include license restrictions, suppliers' credit limitations and domestic difficulties with respect to communications, transport and fabrication. These probelms require more attention in project implementation and more advanced planning than at present.

B. FCI's Expansion Program

14. FCI will be one of the world's largest fertilizer producers after its expansion program is completed in 1979. It has nine major projects (including three expansions) under implementation at present. The capacities, costs and expected commissioning dates are given in Table 1. All these projects are being executed by the P&D Division of FCI with the assistance of various process and engineering firms.

15. Durgapur, Namrup (expansion) and Barauni are similar plants based on process designs obtained from Montecatini-Edison (Italy), and include process units for ammonia and urea. These projects are being financed with Italian credits and funds from GOI. Haldia (capacity: 152,000 TPY of N and 75,000 TPY of P_2O_5) will be producing both urea and nitrophosphates. The Sindri Rationalization Project includes a triple superphosphate (TSP) unit and facilities for sulfuric and phosphoric acid production. Haldia is the first of the fuel oil based ammonia plants under construction with an ammonia plant capacity of 600 TPD and facilities for the production of methanol. The ammonia is converted partly to urea and is utilized partly for the production of nitrophosphates. The facilities include a soda ash plant based on the use of by-product chalk. The knowhows used are from Shell, Lurgi, Tecnimont, Stamicarbon, Nissan and Polimex. The project is scheduled for completion by 1977. Much of the engineering for it is domestic, including a subcontract with FACT. GOI is providing all funds including foreign exchange from Belgian and Bulgarian suppliers' credits.

16. Talcher and Ramagundam as well as the Korba plant (under planning) are large ammonia-urea units with ammonia to be produced by coal gasification. Montecatini-Edison is the major engineering collaborator with additional assistance from Koppers (Germany), Lurgi (Germany), and Technoexport (Czechoslovakia). Coal gasification is a relatively unproven technology in large commercial plants and the projects are ambitious undertakings. They are in the early design stage and, because of anticipated design problems, are not expected to be completed before 1977.

17. All the new projects would be financed about half by equity and half debt. All expenses including interest during construction on new projects are being capitalized so that FCI's profit performance will not be affected by these projects until production starts. Three projects under construction - Durgapur, Namrup (expansion) and Barauni - have experienced about three-year delays in implementation, primarily because of desing, procurement, and project management problems. Work on the IDA-financed Gorakhpur and Nangal Expansion Projects started in 1972 and 1973 respectively. Agreements on procurement between GOI and IDA are designed to prevent delays on these projects.

C. FCI Board of Directors and Management

18. The FCI Board of Management is shown in Table 2. Of the total 13 members, six are from FCI, two from Government Ministries, four from other public sector enterprises and one retired head of a research institute. The influence of GOI, particularly the Ministries of Finance, and Petroleum and Chemicals is felt very strongly in the FCI's management and operations. The organization chart of FCI is given in ANNEX 2-2.

Table 1

INDIA: TROMBAY EXPANSION PROJECT

FCI EXISTING UNITS AND PLANNED EXPANSION PROGRAM

Name	Location	Products	Design Capacity '000 TPY N	Design Capacity '000 TPY P_2O_5	Year of Commissioning
Existing Units					
Trombay	Maharashtra	Urea, Nitrophosphate	81	36	1966
Gorakhpur	Uttar Pradesh	Urea	80		1968
Nangal	Punjab	Calcium Ammonium Nitrate	80		1961
Namrup	Assam	Urea, Ammonium Sulfate	45		1968
Sindri	Bihar	Urea, Ammonium Sulfate, Ammonium Sulphate Nitrate	90		1951
Total			376	36	
Projects Under Construction					
Durgapur	West Bengal	Urea	152		1975
Namrup(Expansion)	Assam	Urea	152		1975
Barauni	Bihar	Urea	152		1975
Gorakhpur (Expansion)	Uttar Pradesh	Urea	51		1975
Sindri (Rationalization)	Bihar	Triple Superphosphate		156	1975
Trombay (Modernization)	Maharashtra	Urea, Nitrophosphate	18	18	1976
Nangal(Expansion)	Punjab	Urea	152		1976
Ramagundam	Andhra Pradesh	Urea	228		1977
Talcher	Orissa	Urea	226		1977
Haldia	West Bengal	Urea, Nitrophosphate	152	75	1977
Total			1,285	249	
Projects in Planning Stage					
Korba	Madhya Pradesh	Urea	228		1979
Sindri (Modernization)	Bihar	Urea	129		1979
Trombay (IV & V)	Maharashtra	Nitrophosphate, Urea	205	75	1979/1979
Paradeep	Orissa	Urea, NPK Compounds	311	300	1979
Total			873	375	
GRAND TOTAL			2,534	660	

Table 2

INDIA: TROMBAY EXPANSION PROJECT

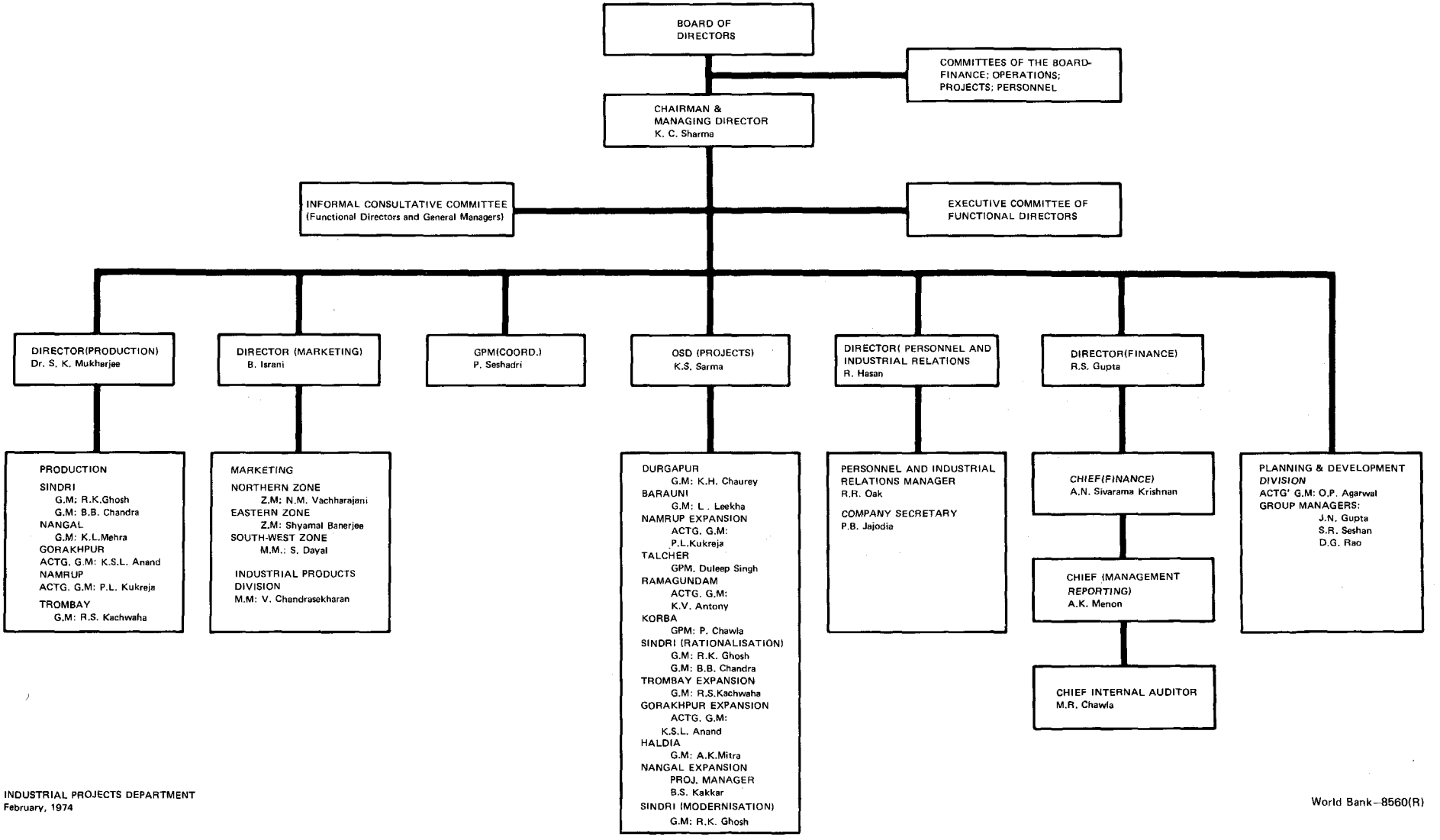
FCI MANAGEMENT - BOARD OF DIRECTORS

			Years of FCI Service	
			Board	Company
1.	Mr. K. C. Sharma	Chairman and Managing Director,* FCI, New Delhi	4	25
2.	Dr. S. K. Mukherjee	Director (Production), FCI, New Delhi	4	25
3.	Mr. R. Hassan	Director (Personnel & Industrial Relations), FCI, New Delhi	1	26
4.	Mr. R. S. Gupta	Director (Finance), FCI, New Delhi	From December 1973	
5.	Mr. Bhag Israni	Director (Marketing), FCI, New Delhi	From September 1973	
6.	(To be appointed)**	Director (Projects), FCI		
7.	Mr. N. K. Sreenivasan	Joint Secretary, Union Ministry of Petroleum and Chemicals, New Delhi	1	-
8.	Mr. S. Krishnaswami	Chairman and Managing Director, Hindustan Petroleum Corporation, Bombay	From December 1973	-
9.	Miss Anna R. George	Joint Secretary, Union Ministry of Petroleum and Chemicals, New Delhi	From December 1973	-
10.	Mr. S. Fareeduddin	Officer on Special Duty and Project Director, Bhabha Atomic Research Center, Bombay	From April 1974	-
11.	Mr. B. K. Khanna	Chairman and Managing Director, Fertilisers and Chemicals (Travancore) Ltd. (FACT), Cochin	1	-
12.	Mr. Kamaljit Singh	Managing Director, Marketing Division Indian Oil Corporation, Bombay	3	-
13.	Dr. Atmaram	Former Director - General, Council of Scientific and Industrial Research, New Delhi	From April 1974	-

* Since August 22, 1973.
** At present, Mr. K. S. Sarma, Officer on Special Duty, FCI, is performing the function of Director (Projects).

Industrial Projects Department
May, 1974

INDIA: TROMBAY EXPANSION PROJECT
ORGANIZATION CHART OF FERTILIZER CORPORATION OF INDIA (FCI)



INDUSTRIAL PROJECTS DEPARTMENT
February, 1974

World Bank–8560(R)

ANNEX 2-2

INDIA: TROMBAY EXPANSION PROJECT

FCI CONSOLIDATED INCOME STATEMENTS - HISTORICAL[1/2/]

(In Rs Millions)

	Fiscal Year Ended March 31					
	1969	1970	1971	1972	1973	1974 Est.
Net Sales[3/]	483	597	730	897	847	1,140
Costs of Goods Sold						
Raw Materials	127	156	173	195	210	252
Consumable Stores	21	25	30	32	35	29
Bags	27	37	44	51	51	52
Others	23	3	46	102	42	274
	198	221	293	380	338	607
Increase (Decrease) in Inventories[4/]	32	48	(15)	(62)	(12)	12
Gross Profit	317	424	422	455	497	545
Operating Expenses						
Salaries, Wages and Benefits	66	86	104	114	126	135
Power and Fuel[5/]	71	97	98	113	118	134
Freight and Handling	11	25	32	40	27	19
Taxes, Insurance and Royalties	4	6	9	10	6	6
Repairs and Maintenance	43	54	52	60	73	85
Interest on Short-Term Borrowings	4	5	7	8	9	7
Depreciation	85	117	119	113	110	119
Administrative Overheads[6/]	15	25	29	45	57	66
Consolidation Adjustment[7/]	(12)	(16)	(24)	(59)	(43)	(42)
Expenses Allocated to Projects under Construction	(20)	(22)	(30)	(11)	(42)	(50)
	267	377	396	433	441	479
Operating Profit	50	47	26	22	56	66
Other Income[8/]	11	12	20	19	22	23
Other Expenses						
Interest on Long-Term Debt	52	67	67	68	68	n.a.
Interest Capitalized for Projects under Construction	(27)	(29)	(38)	(46)	(44)	n.a.
Net Interest Charges	25	38	29	22	24	20
Miscellaneous[9/]	10	4	3	7[10/]	52	29
Sub-Total	35	42	32	29	76	49
Net Profit	26	17	14	12[11/]	2	40

1/ These statements have been adjusted. A breakdown of the adjustments to the published profit figures is presented in Annex 2-5, Page 2 of the Nangal Report (46-IN dated January 2, 1973)

2/ The comparative net profits of the individual units and consolidated income expenditure breakdown are presented in Annex 2-5, Page 3 of the Nangal Report.

3/ Net of excise duty imposed from April 17, 1969.

4/ Finished Product Inventories.

5/ Retroactive adjustments for increased power rates for the Nangal unit have been allocated to the respective years.

6/ The increases from 1967 onwards are due to the gradual shift from distribution through the Government Fertilizer Pool to direct marketing by FCI.

7/ Indirect expenses on repairs, power and fuel, etc., not charged under other heads of expenditure.

8/ Includes interest from Rourkela contract, and also compensation of Rs 7 million in FY1971 and Rs 5 million in FY1972 from the Bhakra Management Board to FCI for losses due to power cuts at Nangal.

9/ Includes retroactive adjustments for different heads of expenses and write-off for the Korba Project. For FY1973, this also includes adjustments for the previous year amounting to Rs 44 million to cover arrears of depreciation on plant and machinery since inception of the existing operational units, as a result of the change in the rate of depreciation from 8-1/3% per year to 10% per annum for nine years and 5% in the tenth year. For FY1974, this includes adjustments for the previous year amounting to Rs 29 million to cover such arrears of depreciation on plant and machinery.

10/ Includes a retroactive adjustment for operating loss from October 1, 1971 to March 31, 1972, of the sulphuric plant at Sindri.

11/ In FY1972, Rs 11.5 million selling and distribution expenses of existing units were capitalized by FCI for new projects; FCI may also be liable for additional excise duty on "Suphala" fertilizer (Trombay) up to Rs 17 million and on naphtha up to Rs 8 million, both related to FY1972.

INDIA: TROMBAY EXPANSION PROJECT

COMPARATIVE NET PROFIT OF FCI UNITS[1/]
(In Rs Millions)

	Fiscal Year Ended March 31					
	1969	1970	1971	1972	1973	1974 Est.
Central Office	-	-	-	(2)	(3)	(6)
Sindri	(4)	(2)	(16)	(39)	(58)	(60)
Nangal	34	50	27	21	35	47
Trombay	(3)	(27)	6	25	81	89
Gorakhpur	1	20	12	13	2	(1)
Namrup	(3)	(21)	(14)	(5)	(5)	(1)
P & D	3	(1)	1	1	2	1
	28	19	16	14	54	69
Write-off of Korba Development Expenditures	(2)	(2)	(2)	(2)	(52)	(29)
Total FCI Net Profit (Adjusted)	26	17	14	12	2	40

FCI CONSOLIDATED INCOME AND EXPENDITURE BREAKDOWN[2/]
(In Percentage)

Net Sales	100	100	100	100	100	100
Cost of Goods Sold & Inventory Changes	34	29	42[3/]	49[3/]	41	52
Gross Profits	66	71	58	51	59	48
Operating Expenses	55	63	54	48	52	42
Operating Profit	10	8	4	3	7	6
Other Income	2	2	3	2	2	2
Other Expenses	(5)	(7)	(5)	(3)	(9)	(4)
Net Income	7	3	2	2	-	4
Debt Service Coverage (Times)	1.5	1.6	1.2	0.9	0.7	0.9

1/ These net profits are based upon published profit statements, corrected by redistributing expenses relating to past periods.

2/ The adjustments discussed above have been incorporated in this breakdown.

3/ The large increase in this figure over past years represents the purchase of finished products for resale.

INDIA: TROMBAY EXPANSION PROJECT

PROJECTED FCI CONSOLIDATED INCOME STATEMENT
(Rs Million)

Year Ending March 31	1975	1976	1977	1978	1979	1980	1981	1982
Income								
Net Sales Revenue	1,438	1,934	3,072	3,854	4,683	4,970	5,046	5,046
Miscellaneous Receipts	99	99	99	99	101	102	102	102
Total	1,537	2,033	3,171	3,953	4,784	5,072	5,148	5,148
Operating Expenses								
Raw Materials	381	513	767	986	1,200	1,193	1,177	1,177
Utilities	186	233	333	389	495	531	535	535
Consumable Stores	53	68	95	95	108	112	112	112
Salaries & Wages	178	186	210	220	233	233	233	233
Maintenance Materials	97	122	210	249	295	295	295	295
Bags	82	119	170	218	251	267	273	273
Miscellaneous Expenses	51	65	97	138	154	162	166	166
Selling & Administrative Expenses	24	35	55	83	94	101	104	104
Central Office & Training Expenses	19	19	20	26	30	32	32	32
Deferred Revenue & Development Expenditures	17	10	12	16	12	20	21	-
Interest on short-term borrowing	2	12	45	59	70	76	79	79
Sub-total	1,090	1,382	2,014	2,479	2,942	3,022	3,027	3,006
Depreciation	261	378	652	853	1,014	956	958	967
Total Operating Expenses	1,351	1,760	2,666	3,332	3,956	3,978	3,985	3,973
Net Profit Before Interest & Taxes	186	273	505	621	828	1,094	1,163	1,175
Interest and Other Charges on Debt								
GOI Borrowings	53	62	153	209	308	287	256	222
US-AID	3	2	1	-	-	-	-	-
Others	19	40	67	43	36	31	25	22
Proposed IDA Credit	-	-	-	24	23	21	17	13
Total Interest and Other Charges on Debt	75	104	221	276	367	339	298	257
Less: Interest charged to construction	2	9	19	-	-	-	-	-
Interest charged to operations	73	95	202	276	367	339	298	257
Net Income After Interest but Before Taxes	113	178	303	345	461	755	865	918
Less: Income Taxes	-	-	-	-	-	234	608	896
Net Profit	113	178	303	345	461	521	257	22

Industrial Projects Department
May 1974

INDIA: TROMBAY EXPANSION PROJECT

FCI CONSOLIDATED SOURCES AND APPLICATION OF FUNDS - HISTORICAL
(In Rs. Millions)

	Year Ended March 31					
	1969	1970	1971	1972	1973	1974 Est.
Sources of Funds						
Net Income Before Interest	51	55	43	34	26	60
Depreciation	85	117	119	113	110	119
	136	172	162	147	136	179
Increase in Equity	52	238	190	219	655	963
Increase in Long-Term Debt:						
GOI	192	10	78	143	201	37
US-AID 1/	-	-	-	(2)	(15)	-
Suppliers' Credits	115	201	82	16	216	114
	307	211	160	157	402	151
Increase in Short-Term Bank Borrowings	9	9	13	58	(10)	(126)
Increase in Other Current Liabilities	34	(25)	38	43	75	6
Total Sources of Funds	538	605	563	624	1,258	1,173
Application of Funds						
Increase in Fixed Assets - Plants Under Construction	(197)	378	280	304	1,074	969
Increase in Fixed Assets - Plants in Commercial Operation	501	80	70	86	31	48
Increase in Inventories	58	39	(2)	(41)	21	(6)
Increase in Receivables and Loans	63	(43)	28	(4)	(29)	(8)
Increase in Other Assets (Net)	-	4	(3)	39	(12)	-
Interest Charged to Profit & Loss Account:						
GOI	16	30	22	16	19)	20
US-AID	9	8	7	6	5)	
Interest: Capitalized for Plants Under Construction						
GOI	22	13	18	27)	44	-
Suppliers' Credits	5	16	20	19)		
	52	67	67	68	68	20
Loan Repayments:						
GOI	45	55	64	82	74	92
US-AID	18	16	17	19	-	22
Suppliers' Credits (for Projects Under Construction)	-	-	24	60	65	69
	63	71	105	161	139	183
Total Application of Funds	540	592	545	613	1,292	1,206
Annual Cash Surpluses	(2)	13	16	11	(34)	(33)
Accumulated Cash 2/	(15)	(2)	14	25	(9)	(42)

1/ Adjustment of outstanding loan amount due to rupee devaluation.
2/ Cash position differs from amounts shown in the balance sheets since adjustments for prior years have been made in the income statements. Cash balances are low since surpluses are transferred to GOI.

INDIA: TROMBAY EXPANSION PROJECT

PROJECTED FCI CONSOLIDATED SOURCES AND APPLICATION OF FUNDS
(Rs Million)

Year Ending March 31	1975	1976	1977	1978	1979	1980	1981	1982	---- Summary------ 1975-77	1975-82
SOURCES OF FUNDS										
Internal Source of Funds										
Net Profit before interest and taxes	186	273	505	621	828	1,094	1,163	1,175	964	5,845
Deferred revenue & development expenditures	17	10	12	16	12	20	21	-	39	108
Depreciation	261	378	652	853	1,014	956	958	967	1,291	6,039
Total Internal Source of Funds	464	661	1,169	1,490	1,854	2,070	2,142	2,142	2,294	11,992
Increase in Equity	1,129	1,000	189	-	-	-	-	-	2,318	2,318
Long-term Borrowing										
Government of India loans	545	1,750	1,192	449	-	-	-	-	3,487	3,936
Proposed IDA Credit	15	113	105	15	-	-	-	-	233	248
Other loans	211	114	-	-	-	-	-	-	325	325
Total Long-Term Borrowing	771	1,977	1,297	464	-	-	-	-	4,045	4,509
Increase in Current Liabilities										
Increase in short-term borrowings	17	87	308	121	105	55	20	-	412	713
Increase in sundry creditors	7	9	(15)	5	12	2	-	-	1	20
Total Increase in Current Liabilities	24	96	293	126	117	57	20	-	413	733
Total Sources of Funds	2,388	3,734	2,948	2,080	1,971	2,127	2,162	2,142	9,070	19,552
APPLICATION OF FUNDS										
Construction Expenditures										
Trombay Project - Construction	52	243	153	-	-	-	-	-	448	448
- Interest	2	9	19	-	-	-	-	-	30	30
Total	54	252	172	-	-	-	-	-	478	478
Other plants under construction	1,581	2,460	2,264	382	-	-	-	-	6,305	6,687
Total	1,635	2,712	2,436	382	-	-	-	-	6,783	7,165
Plant Operations Improvement Program	37	68	-	-	-	-	-	-	105	105
Other investments in existing plants	137	26	85	90	70	70	70	70	248	618
Total	174	94	85	90	70	70	70	70	353	723
Total Construction Expenditures	1,809	2,806	2,521	472	70	70	70	70	7,136	7,888
Increase in Current Assets										
Increase in inventories	161	262	127	136	30	17	3	-	550	736
Increase in receivables & loans	25	31	166	46	87	40	17	-	222	412
Increase in other assets	13	21	22	5	-	-	-	-	56	61
Total Increase in Current Assets	199	314	315	187	117	57	20	-	828	1,209
Income Taxes	-	-	-	-	-	234	608	896	-	1,738
Debt Service										
Interest & Other Charges on Debt										
GOI	53	62	153	209	308	287	256	222	268	1,550
US-AID	3	2	1	-	-	-	-	-	6	6
Others	17	31	48	43	36	31	25	22	96	253
Proposed IDA Credit	-	-	-	24	23	21	17	13	-	98
Total Interest and Other Charges on Debt	73	95	202	276	367	339	298	257	370	1,907
Loan Repayment										
GOI	106	120	106	159	310	395	454	437	332	2,087
US-AID	21	21	13	-	-	-	-	-	55	55
Others	50	61	75	93	103	103	63	65	186	613
Proposed IDA Credit	-	-	-	-	25	25	25	25	-	100
Total Repayments	177	202	194	252	438	523	542	527	573	2,855
Total Debt Service	250	297	396	528	805	862	840	784	943	4,762
Total Application of Funds	2,258	3,417	3,232	1,187	992	1,223	1,538	1,750	8,907	15,597
Annual Cash Surplus 1/	130	317	(284)	893	979	904	624	392	163	3,955
Cash Balance Beginning of Year	23	153	470	186	1,079	2,058	2,962	3,586		
Accumulated Cash	153	470	186	1,079	2,058	2,962	3,586	3,978		

1/ Commencing in 1977/78 the annual cash surplus has been allocated on the balance sheet between cash required for working capital purposes and surplus cash.

Industrial Projects Department
May 1974

INDIA: TROMBAY EXPANSION PROJECT

FCI CONSOLIDATED BALANCE SHEETS - HISTORICAL
(In Rs Million)

	Fiscal Year Ended March 31					
	1969	1970	1971	1972	1973	1974 (Est.)
ASSETS						
Current Assets						
Cash	17	14	14	35	34	23
Trade Receivables	112	87	105	108	70	65
Loans	64	46	56	49	58	55
Total Inventories	264	303	301	260	281	275
Total Current Assets	457	450	476	452	443	418
Fixed Assets						
a) Operating Units						
Gross Value	1,865	1,941	2,018	2,104	2,195	2,243
Less: Depreciation	673	790	913	1,030	1,190	1,309
Net Fixed Assets[2]	1,192	1,151	1,105	1,074	1,005	934
b) Expansion Projects						
Capital Work in Progress	384	756	1,043	1,375	2,240	3,209
Advances to Contractors	32	67	99	117	326	326
Other Assets[1]	19	23	20	59	47	47
Investments	1	1	1	1	1	1
Total Assets	2,085	2,448	2,744	3,077	4,062	4,935
LIABILITIES AND CAPITAL						
Current Liabilities						
Accounts Payable and Accrued Expenses	124	103	136	169	181	181
Short-Term Debt	58	67	80	138	128[3]	2
Accrued Interest	26	19	17	17	20	20
Other Current Liabilities	21	24	31	41	101	101
Current Portion of Long-Term Debt	71	105	149	142	174	183
Total Current Liabilities	300	318	413	507	604	487
Long-Term Debt						
G.O.I.	681	636	651	712	839	784
U.S.A.I.D.	147	130	113	92	77	55
Others	135	337	395	351	502	547
Total	963	1,103	1,159	1,155	1,418	1,386
Less Current Portion of Long-Term Debt						
G.O.I.	55	64	82	74	92	92
U.S.A.I.D.	16	17	21	18	21	22
Others	-	24	46	50	61	69
Total	71	105	149	142	174	183
Net Long-Term Debt	892	998	1,010	1,013	1,245	1,203
Equity						
Share Capital	728	966	1,156	1,375	2,030	2,993
Reserves and Surpluses	165	166	165	182	183	252
Total	893	1,132	1,321	1,557	2,213	3,245
Total Liabilities and Capital	2,085	2,448	2,744	3,077	4,062	4,935
Current Ratio	1.5:1	1.4:1	1.2:1	0.9:1	0.7:1	0.86:1
Net Long-Term Debt/Equity Ratio	50:50	47:53	43:57	39:61	36:64	27:73

1/ Mainly deferred revenue expenditures such as sales promotion costs for new projects.

2/ Includes capital expenditures on township and other assets for providing Amenities to staff.

3/ Includes Rs 101 million utilized for project financing which has since been reimbursed to the Corporation. Taking this into account, the current ratio comes to 0.9:1.

INDIA: TROMBAY EXPANSION PROJECT

PROJECTED FCI CONSOLIDATED BALANCE SHEETS
(Rs Million)

Year Ending March 31	1974	1975	1976	1977	1978	1979	1980	1981	1982
ASSETS									
Current Assets									
Cash	23	153	470	186	454	550	587	596	596
Trade Receivables	65	90	121	287	333	420	460	477	477
Loans	55	55	55	55	55	55	55	55	55
Inventories	275	436	698	825	961	991	1,008	1,011	1,011
Total Current Assets	418	734	1,344	1,353	1,803	2,016	2,110	2,139	2,139
Surplus Cash 1/	-	-	-	-	625	1,508	2,375	2,990	3,382
Fixed Assets									
Gross Fixed Assets in Operation	2,243	4,526	7,048	9,120	11,326	12,386	12,456	12,526	12,596
Less: Accumulated depreciation	1,309	1,570	1,948	2,600	3,453	4,467	5,423	6,381	7,348
Net Fixed Assets in Operation	934	2,956	5,100	6,520	7,873	7,919	7,033	6,145	5,248
Work in Progress	3,535	3,061	3,345	3,794	2,060	1,070	1,070	1,070	1,070
Total Fixed Assets	4,469	6,017	8,445	10,314	9,933	8,989	8,103	7,215	6,318
Other Assets									
Investment	1	1	1	1	1	1	1	1	1
Deferred revenue and Development Expense	47	43	54	64	53	41	21	-	-
Total Other Assets	48	44	55	65	54	42	22	1	1
TOTAL ASSETS	4,935	6,795	9,844	11,732	12,415	12,555	12,610	12,345	11,840
LIABILITIES AND EQUITY									
Current Liabilities									
Sundry Creditors	183	190	199	184	189	201	203	203	203
Short-term debt	20	37	124	432	553	658	713	733	733
Other current liabilities	101	101	101	101	101	101	101	101	101
Long-term debt due within 1 yr.	177	202	194	252	438	523	542	527	530
Total Current Liabilities	481	530	618	969	1,281	1,483	1,559	1,564	1,567
Long-Term Debt									
GOI loans	784	1,223	2,853	3,947	4,252	3,942	3,547	3,093	2,656
US-AID loans	55	34	13	-	-	-	-	-	-
Proposed IDA Credit	-	15	128	233	248	223	198	173	148
Other loans	547	708	761	678	570	467	364	301	236
Total	1,386	1,980	3,755	4,858	5,070	4,632	4,109	3,567	3,040
Less: Long-term debt due within one year	177	202	194	252	438	523	542	527	530
Net Long-Term Debt	1,209	1,778	3,561	4,606	4,632	4,109	3,567	3,040	2,510
Equity									
Share Capital	2,993	4,122	5,122	5,311	5,311	5,311	5,311	5,311	5,311
Reserves and Surplus	252	365	543	846	1,191	1,652	2,173	2,430	2,452
Total Equity	3,245	4,487	5,665	6,157	6,502	6,963	7,484	7,741	7,763
TOTAL LIABILITIES AND EQUITY	4,935	6,795	9,844	11,732	12,415	12,555	12,610	12,345	11,840

1/ These funds will be available for prepayment of debt, future construction expenditures or payment of dividends on share capital; therefore, no interest earned has been shown accruing on such funds.

Industrial Projects Department
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INDIA: TROMBAY EXPANSION PROJECT

EXISTING FACILITIES AT TROMBAY

1. The Trombay factory is located in the industrial zone of Bombay. Production facilities include plants for NPK fertilizer, urea, methanol as well as for intermediate products such as ammonia, nitric acid, and sulfuric acid. In addition, there are small-scale operations for producing industrial chemicals. All necessary ancillary facilities, such as maintenance shops, storage, utilities, offices, and townships are provided. The plant has the following main production units with capacities as indicated:

		Capacity	
		Designed	Attainable
Unit	TPD	(TPY)	(TPY)
Ammonia	350	105,000	96,000
Urea	300	99,000	96,000
Methanol	100	33,000	18,000
Nitric Acid	320	96,000	96,000
Sulfuric Acid	200	66,000	66,000
Nitrophosphate		240,000 (15-15-15)	210,000 (15-15-15)

Note: Attainable capacity is defined by Trombay management as the capacity that can reasonably be expected after allowances are made for design deficiencies. Capacity for the NPK plant depends on which product is being manufactured. For the 15-15-15 product, the design capacity is 240,000 TPY and attainable is 210,000 TPY. Or, for the 20-20-20 product, the attainable capacity is about 180,000 TPY.

2. A general flow sheet of the complex is given in Figure 1.

3. Raw materials and intermediates used are naphtha (for ammonia), phosphate rock, diammonium phosphate, potash, and sulfur.

4. Production plants use commercially acceptable technology although they are small by present standards. They have a staff of about 2,400; their employment level is rather high. No significant labor problems have been experienced at Trombay. Management is experienced and appears capable of implementing the various projects and maintaining reasonable performance. Trombay was financed by the United States (US AID funds) and built by two US firms: the Chemical Construction Co. with responsibilities for the ammonia, urea, nitric acid and sulfuric acid plants; and the C & I Girdler Corporation with responsibilities for the methanol and nitrophosphate plants. Construction began in 1962 and the units were commissioned in 1966. Because of the alleged design deficiencies, FCI is sueing C & I Girdler's former parent organization, IDI Management Inc., and arbitration is now proceeding through the International Chamber of Commerce.

5. Arbitration involves both the methanol and nitrophosphate plants supplied by C & I Girdler. Performance guarantees were allegedly not fulfilled for either plant; in particular, the nitro-phosphate plant failed to produce even at half of its rated capacity. FCI withheld the last payments due to C & I Girdler, and initiated a claim for about US$21.8 million to fulfill the original contract. (At that time, C & I Girdler consisted of two companies -- the Chemical and Industrial Corporation, Cincinnati, Ohio, and the Girdler Corporation, Louisville, Kentucky. These companies were merged in 1969, and then the new company was purchased by the Bechtel Corporation, San Francisco, California, in 1972). FCI is also suing the Chemical Construction Co. for tax liabilities amounting to US$ 1.1 million equivalent.

6. A series of hearings by the International Chamber of Commerce have been held in New Delhi and Geneva. As usual for a case such as this, it is difficult to form an accurate opinion of where the fault lies in the malperformance of the plants or even to predict when or how the arbitration will be settled. Since the sums of money being discussed are large, GOI should assure that any adverse ruling against FCI would not adversely affect the financial viability of the Company.

7. As stated previously, the Trombay plant has experienced problems. However, many of them have already been corrected and several modifications are in progress or planned which should considerably improve the Trombay operation.

8. Generally, the production efficiency has improved considerably from the very low levels in the early years of operation. Current operational levels in the urea and NPK units depend on management decisions since insufficient ammonia is available to run both units at maximum levels.

9. The most significant factor for increased future production of ammonia, urea, and methanol is the addition of a new reformer furnace for the methanol plant and the addition of an ammonia storage tank (see Trombay Modernization Program, Annex 2-6). The furnace and storage tank are under construction. After their installation, the present reforming capacity from the methanol unit will be diverted to the ammonia unit to produce additional ammonia (and CO_2) for the urea and NPK plants.

Ammonia Unit

9. The ammonia unit was designed and built by Chemical Construction Company (the U.S.). The designed capacity is 350 TPD utilizing two streams of 175 TPD each. Naphtha and refinery gas were to be used in the partial oxidation process. Naphtha is now used exclusively since the refinery gas could not be used successfully due to its varying composition and supply. The naptha pumps were not designed to supply the entire load.

10. The operation based on refinery gas requires less oxygen than that based on naphtha. The air separation plant also has problems, (para. 13) and the diversion of refinery gas to the methanol unit has further limited the attainable ammonia capacity. The maximum attainable capacity under present conditions is considered to be 320 TPD for 300 days. Discounting any unforeseen difficulties,

the staff at Trombay feel that the equivalent ammonia production can be maintained at 96,000 TPY. Equivalent ammonia production is defined as the actual production plus the production that could have been achieved from gas diverted to the methanol unit.

11. Once the new methanol reformer is operative, the attainable ammonia production should increase by approximately 20,000 TPY. Therefore, by the latter part of 1974, the ammonia unit should be producing at a rate of approximately 116,000 TPY.

12. In addition to design deficiencies, many minor recurring problems have limited the production rate in the past. Many of these have been solved and others have been identified and corrective action begun. Individual parts of the ammonia plant are discussed briefly below.

13. Air Separation Unit: Since more oxygen is required for naphtha than refinery gas, the capacity is not enough for the naphtha-based operation. Therefore, the air separation unit even at capacity operation is a limiting factor on ammonia production.

14. Gas Generation Section: There are four Shell reactors with integral waste heat boilers and a common steam drum for all the four. There is no standby reactor. Under boiler inspection regulations, the four waste heat boilers and one steam drum are treated as a single unit. Therefore, if one fails, all four must be shut down and inspected. Naphtha pumps were not designed to supply the full feedstock requirement since the specific gravity of the naphtha as received is less than the designed: 0.70 vs 0.76. As a result, the pumps are required to run at excessive speeds, lowering their life and causing pressure fluctuations.

15. The new reformer furnace being constructed for the methanol plant will allow the present reforming capacity of the methanol plant to be used to generate gas for increased ammonia production. Operation and maintenance of the naphtha pumps will also be improved by the installation of larger motors.

16. Carbon Monoxide Conversion Section: The design of this section is generally good. There have been problems with the desuperheaters of the carbon monoxide (CO) converters. The original design used a complicated concentric flow arrangement. There were a number of problems such as extensive cracking on the CO converter desuperheaters, and leaking tubes on the CO feed preheater.

17. Purification (CO and CO_2 Removal) Section: This section generally meets the design conditions. There were several problems which have been or are being solved. The monoethanolamine (MEA), caustic wash, and liquid nitrogen wash systems in this section are free from problems.

18. Ammonia Synthesis Section: The operation of this section is satisfactory. The design operating pressure in the synthesis loop is 365 kg/cm^2. The actual operating pressure is less than 300 kg/cm^2.

Urea Unit

19. The urea unit was designed and built by the Chemical Construction Corporation. It has three streams of 100 TPD capacity each with a total annual rated capacity of 99,000 tons. The unit has never operated at a consistently high level due to lack of ammonia and carbon dioxide. During the past three years,

the unit has been operating on average at about 60% of the rated capacity, (see Table 1).

20. In general, the synthesis section gives good performance. However, its primary problems have been with the ammonia charge pumps (total of six). The ammonia and carbamate pumps are vertical, piston-type pumps. The shaft speeds of both, especially the ammonia pumps, are excessive when compared to the more modern horizontal pumps.

21. There are problems even at the current rates (55,000 to 60,000 TPY) of operation in the evaporation section. The second-stage evaporators are rotary film evaporators operating under vacuum. The close clearances necessary for them cannot be maintained. Also, because of steam pressure fluctuations, the proper vacuum cannot be maintained. Therefore, the solution concentration cannot be kept as high as is necessary for good quality; as a result, excessive amounts of fines are generated.

22. Major causes for production losses have been: (1) Deficiencies in ammonia charge pumps, carbamate recycle pumps, and the evaporator rotating system; (2) ammonia and/or CO_2 limitation; and (3) lack of steam for the evaporator system. Production losses because of the high pressure ammonia and carbamate pumps are higher particularly, since all the pumps are fully spared. Production leakages from the ammonia pumps have decreased markedly during recent years. However, physical loss of ammonia through the pumps continues to be a problem. Consequently, the ammonia consumption per ton of urea is excessive: 0.661 ton in 1971 vs. the designed level of 0.580 ton.

23. If the urea unit is to operate at higher levels of production, replacement of one carbamate pump for each line with a new horizontal pump is essential. One of the existing pumps could be removed to be used for spare parts. One new ammonia pump should be installed on each line. The synthesis section should produce from 100,000 to 105,000 TPY, with new pumps and no limitation on ammonia supply. As production rates are further increased, the evaporation capacity will become a limiting factor. Therefore, replacement of the rotary evaporators with one large falling film evaporator is recommended.

Complex Fertilizer (NPK Unit)

24. The NPK fertilizer plant was originally designed by Chemical and Industrial Corporation (C & I) to produce 900 TPD of the 16-13-0 grade fertilizer utilizing the carbo-nitric process and 1,100 TPD of the 13-13-0 grade fertilizer utilizing the sulfo-nitric process. There are two reaction trains for acidulation and ammoniation, four spherodizers for granulation, and four trains of screening and recycle equipment.

25. The original design was based on an assumption of 20% water in the slurry fed to the spherodizers. Experience proved that a 20% water slurry was too viscous to pump. Additional water was required which seriously affected the overall heat balance. In addition, the design slurry temperature was 100°C. This temperature limitation further adversely affected the process heat balance. The temparature and which had to be increased to compensate for the lower temperature and higher water content of the slurry. This higher temperature caused heavy scaling in the spherodizers. For these and other reasons, the original processes have never operated successfully. The water solubility of such products also was lower than desired.

26. In 1967, FCI modified the processes successfully with the use of purchased diammonium phosphate (DAP). In this process, phosphate rock is acidulated with nitric acid and DAP is added to the acidulate. The slurry is then carefully ammoniated in a series of reactors so that P_2O_5 from DAP reacts with the free calcium nitrate to convert it into calcium phosphate. The excess phosphoric acid, on ammoniation, forms water-soluble ammonium phosphate.

27. The process, which has been patented, has the following advantages: (1) It is possible to produce a slurry containing less than 20% water; (2) scale formation in the spherodizers is much less because of lowered operating temperatures; (3) raw material efficiencies are improved; and (4) the water-soluble P_2O_5 content is 30% vs 1% for the original product.

28. In addition to deficiencies in the original processes, there were also problems with mechanical equipment which are too numerous to list here. However, most of these have either been solved or would be solved under the Modernization Program (Annex 2-7).

29. The Modernization Program would give particular attention to three major problems:

(1) Inadequate screens: The original screens were of the oscillating type and were too small. New screens with adequate capacity have been imported for installation;

(2) Inadequate fume scrubbing: As mentioned previously, there are two reaction trains and four granulation trains is necessary for producing 180,000 to 190,000 TPY of the 20-20-0 grade fertilizer using four spherodizers. The fume scrubber system for one reaction train operating at high rate is not adequate; and

(3) Inadequate dust removal: The original dust removal system consisted of bag filters. Due to the hydroscopicity of the dust, the filters have never worked properly.

Methanol, Nitric Acid, and Sulfuric Acid Units

30. The methanol unit was designed to produce 100 TPD or 30,000 TPY of methanol. Attainable capacity is only 18,000 TPY at present because of inadequate reformer capacity. Construction of a new reformer is in progress. When completed, the methanol unit should be able to produce 35,000 to 37,000 TPY.

31. FCI reports that both the sulfuric and nitric acid units operate well and produce at designed capacity rates. Therefore, these units are not included in the detailed analysis of Trombay facilities.

Table 1

INDIA: TROMBAY EXPANSION PROJECT

TREND OF TROMBAY PRODUCTION (1966 - 1972)
(Tons Per Year)

Unit	1966 (5 months)	1967	1968	1969	1970	1971	1972	1974 (Est)
AMMONIA								
Actual production 1/	Not	58,000	67,000	78,000	73,000	83,000	88,000	89,133
Nitrogen production	available	47,700	55,100	64,200	60,000	68,300	72,400	72,920
% rated capacity		54.9	63.5	73.8	69.2	78.7	83.3	84.0
% attainable capacity		60.4	69.8	81.3	76.1	86.5	91.7	92.4
UREA								
Actual production	8,000	53,200	57,400	68,500	57,700	63,900	55,100	64,360
Nitrogen production	3,680	24,500	26,400	31,500	26,500	29,400	25,300	29,700
% rated capcity	20	53.7	58.0	69.2	58.2	64.6	55.7	65.0
% attainable capacity	19.4	55.4	59.8	71.3	60.1	66.6	57.3	67.0
NPK								
Nitrophosphate (16-13-0)								
Actual production	16,400	71,600	22,400	-	-	-	-	
Nitrogen production	2,620	11,500	3,600					
P_2O_5 production	2,130	9,300	2,900					
SUPHALA 2/								
20-20-0			70,700	94,100	22,200	3,900		
18-18-9				7,700	11,500	20,000	24,600	-
15-15-15				6,600	59,000	56,600	135,200	219,652
14-10.5-14 & misc.					16,400	-		
20-20-2						53,300	33,700	-
Total NPK	16,400	71,600	93,100	108,400	109,100	135,800	193,500	219,652
Nitrogen production	2,620	11,500	17,700	22,000	17,700	23,900	31,940	32,950
P_2O_5 production	2,130	9,300	17,700	22,000	17,700	23,900	31,940	32,950
Total NP production	4,750	20,800	34,700	44,000	34,700	47,800	63,880	65,900
% NP capacity	14.6	26.6	44.3	56.2	44.3	61.1	81.6	92.0
METHANOL								
Actual production 1/		2,600	9,600	15,100	9,200	14,100	15,400	24,600
% rated capcity		7.9	29.1	45.8	27.9	42.7	46.7	74.6
% attainable capacity		14.5	53.3	83.8	51.1	78.3	85.6	N.A.

1/ Ammonia and methanol productions are both limited because of design deficiencies in the gas producing section. Therefore, when the synthesis section of either unit is down, gas is diverted to the other unit. Transfer of gas from either unit is reflected in this table as equivalent ammonia production.

2/ Suphala is FCI's trade name for NPK products produced by their new process which was introduced in late 1967.

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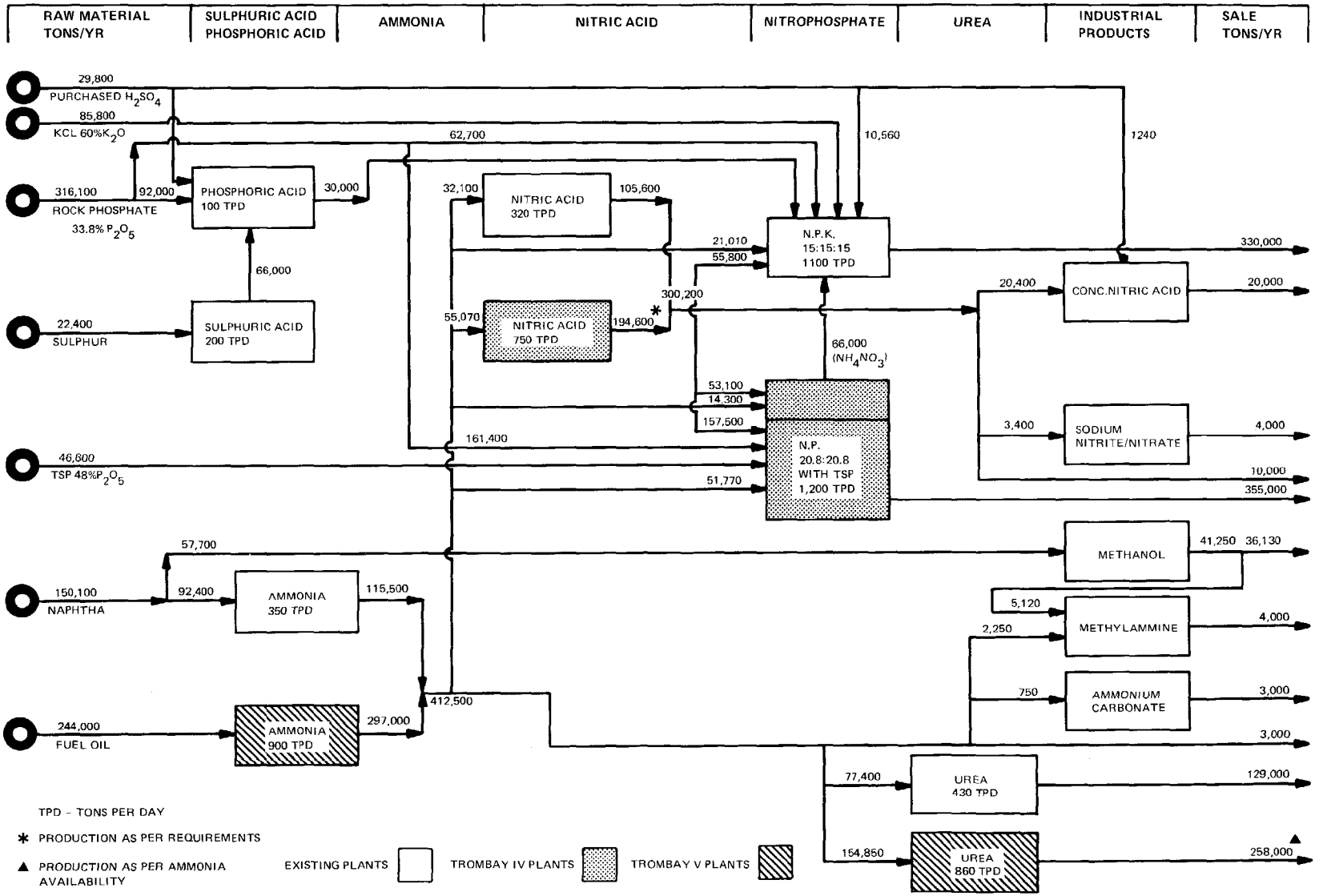
INDIA
TROMBAY EXPANSION PROJECT
TROMBAY PLANT FLOW SHEET



TOTAL ANNUAL PRODUCTION – TONS					
	PHOSPHORIC ACID 30,000			N.P.K. (15:15:15) 330,000	
	SULPHURIC ACID 66,000	AMMONIA 412,500	NITRIC ACID 300,200	N.P. (20.8:20.8) 355,000	UREA 387,000

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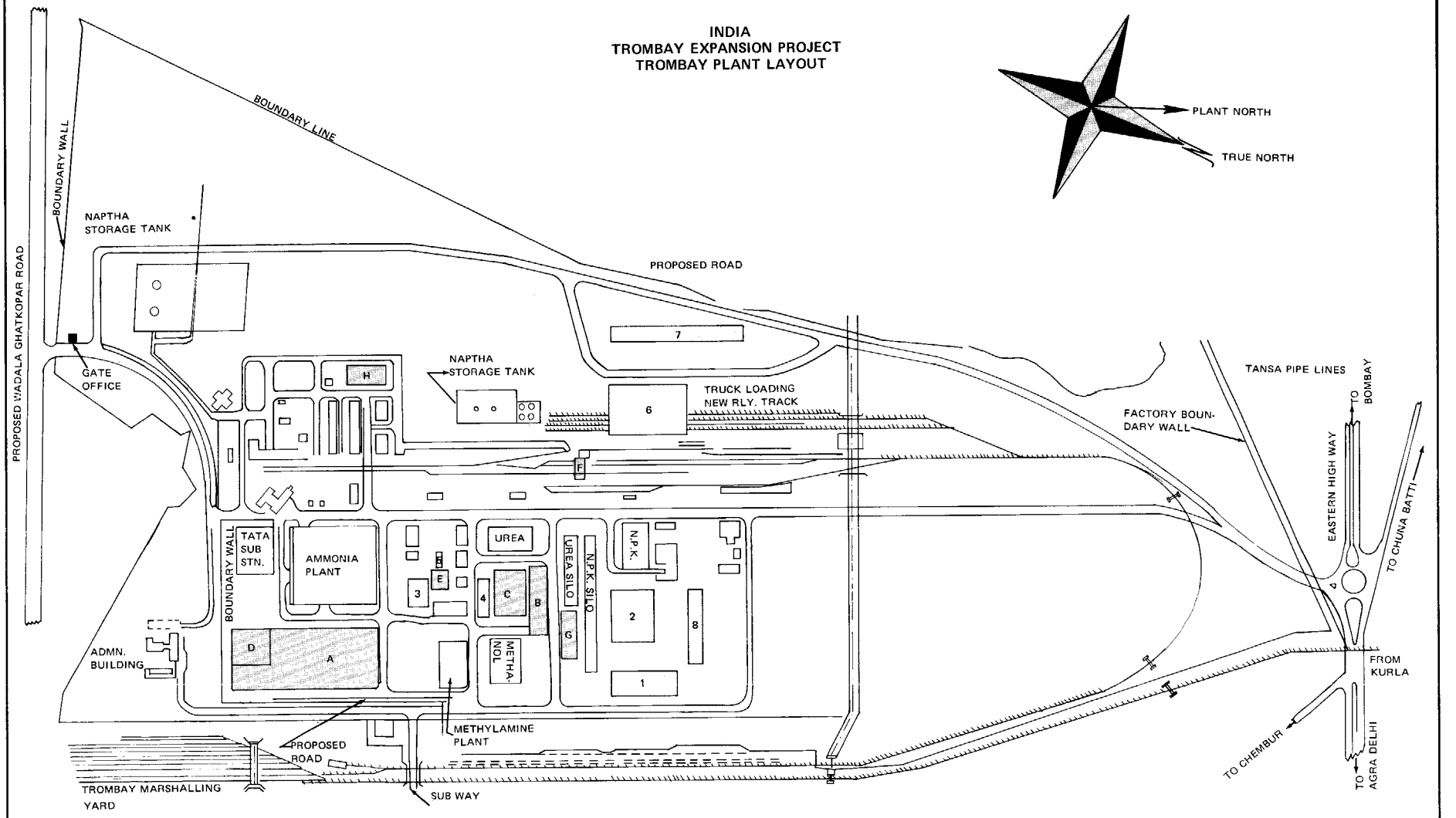
INDIA
TROMBAY EXPANSION PROJECT
TROMBAY PLANT LAYOUT



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INDIA: TROMBAY EXPANSION PROJECT

TROMBAY MODERNIZATION PROGRAM 1/

1. The large number of problems at Trombay in the early operating years limited production capability and the subsequent process improvements in the NPK plant caused a significant imbalance in ammonia supply and the operating levels of several other plants. In 1968, Trombay began a program to improve operations and supplement production by the addition of several units. Major emphasis was placed on improving the NPK and ammonia plants, and the overall maintenance.

2. The NPK plant was adapted to a process developed by FCI to achieve the present design capability of 240,000 TPY of 15-15-15 NPK with 30-35% phosphate water solubility. This production level is a substantial improvement on the original production. To achieve this production, Trombay makes use of only half of the original reaction system; it also uses purchased diammonium phosphate to blend in the process. These modifications have created surplus capacity that will be utilized in the next phase of modernization as described below.

3. Trombay is now expanding the methanol plant to increase production of methanol and indirectly ammonia. Even with this, there will be insufficient ammonia available and, therefore, Trombay is installing a 15,000 TPY ammonia storage tank to utilize purchased ammonia. The ammonia storage tank should be completed soon. After that, there would be sufficient ammonia capacity to permit all plants to operate at full capacity.

4. Trombay is also building a 100-TPD phosphoric acid plant which is expected to be commissioned in 1975. The existing sulfuric acid plant is no longer needed for NPK production due to the process changes made by Trombay. However, by utilizing this plant along with the new phosphoric acid plant, Trombay can produce phosphoric acid to replace the use of DAP in the NPK plant, leading to improved operations and reduced costs.

5. Trombay has also expanded operations to include the production of several industrial chemicals, such as argon, concentrated nitric acid, sodium nitrite, ammonium bicarbonate, and anhydrous ammonia and sulfuric acid for industrial sales. These operations are small but profitable and will continue to be expanded in the future as the market develops.

6. There are some major phases of modernization that remain to be implemented including:

(1) further NPK plant modernization and expansion to 330,000 TPY and improvement of NPK quality to 60% phosphate water solubility;

(2) urea plant modernization and expansion to 129,000 TPY; and

(3) improvement in pollution control.

1/ Excluding Trombay IV and V.

These measures were identified as of major importance during an IDA mission in 1972, and the IDA consideration of the proposed expansion project was made contingent on satisfactory progress in modernization as well as improved overall profitability.

7. Trombay has prepared project implementation plans including detailed engineering for the modernization of above mentioned facilities and has received GOI financing to begin procurement. With this advance work by Trombay, the program should be completed in 24 months. Each part of the modernization program is discussed below.

8. NPK Plant Modernization and Expansion (to be completed by January 1975): The existing NPK plant has a spare reaction train. The modernization and capacity expansion to 330,000 TPY of product will help utilize this train and will also add two granulation lines similar to the four existing lines. Trombay, using its own know-how plus consulting services of Uhde (who operates similar plants in the Federal Republic of Germany) will incorporate substantially larger and better equipment in the new facilities compared to the existing plant. The proposed scheme will utilize the existing storage, bagging and shipping facilities without expanding them. The additional nitric acid required would be provided by the excess capacity envisaged in the proposed IDA-assisted expansion project.

9. The present plant produces 15-15-15 NPK with a P_2O_5 water solubility of 30-35%. While Trombay is able to sell this grade, the Ministry of Agriculture has generally recommended a minimum of 60% P_2O_5 water solubility. Trombay has initiated a series of in-plant tests to evaluate increased addition of DAP (or MAP or phosphoric acid) to either the reaction system or the granulation system to increase water solubility.

10. Urea Plant Modernization and Expansion (to be completed by February 1976): The existing urea plant can operate close to the design capacity of 99,000 TPY capacity when additional ammonia raw material is available. Further, Trombay, in consultation with Technip, a French firm, has determined that the urea capacity can be expanded to 129,000 TPY and the efficiency of the use of raw materials and utilities can be improved with only a few equipment modifications. Technip has submitted a preliminary proposal on this matter and Trombay is now completing the design and cost estimates.

11. Pollution Control: Emission levels of SO_2, NO_2 and dust are relatively high in the existing plants at Trombay and a small amount of flouride gas is exhausted. Water effluent containing a minor amount of impurities is discharged into a nearby stream and then into the bay.

12. The NPK plant modernization and expansion will include better designs for the scrubbing equipment to lower fluoride emissions and improve dust recovery as product and thereby improve plant efficiencies as well as the surrounding environment. The water effluent then would normally contain no harmful impurities.

13. Trombay is investigating methods to lower SO_2 emission levels in the existing sulfuric acid plant. There are two choices: (a) ammonia scrubbing to recover ammonium sulfate; and (b) double absorption to recover more sulfuric acid. Both methods are technically feasible but have to be evaluated for the least cost method. GOI has approved the necessary capital expenditures for this project.

14. The existing nitric acid plant was designed with high emission levels of nitrogen oxide of about 2,200 ppm. The plant has a combustion unit to lower NO_2 levels but it is inefficient. Trombay will evaluate the possibilities of replacing the combustion or scrubbing with the use of caustic soda to produce sodium nitrite. This evaluation will not start until after the other modernization works are underway.

15. The emission levels of Trombay before and after the Modernization Program will be:

Emission Levels
(Kg/day)

	Before Modernization	After Modernization
SO_2	2,600	30
NO_2	1,000	450
Fluorides	30	12

The Bombay Municipal Corporation, in general, has not set emission standards that can be used by Trombay in planning its environmental studies. However, it has banned SO_2 emissions from new plants which was instrumental particularly for the cancellation of a major fertilizer project (Dharamsi Morarji).

Industrial Projects Department
March 1974

INDIA: TROMBAY FERTILIZER PROJECT

HISTORICAL INCOME STATEMENTS FOR TROMBAY
(In Rs. Million)

	Years Ending March 31						
	1967	1968	1969	1970	1971	1972	1973
Sales Revenue[1/]	68	119	200	208	308	406	369
Less Excise Duty	-	-	2	9	6	6	8
Freight	-	1	2	5	8	21	8[2/]
	68	118	196	194	294	379	353
COST OF PRODUCTION							
Raw Material and Utilities	34	56	115	145	193	234	156
Operating Expenses							
a) Salaries and Wages	8	11	11	11	12	12	16
b) Maintenance Material	10	10	11	15	11	17	16
c) General Expense	3	14	8	13	11	9	8
Sub Total	21	35	30	39	34	38	40
Factory Cost of Production[1/]	55	91	145	184	227	272	196
Inventory Changes	(1)	(12)	(3)	(19)	5	24	8
Factory Cost of Goods Sold	54	79	142	165	232	296	204
Selling Expenses	1	1	3	5	7	12	5
Depreciation	31	34	34	34	34	35	54
Interest on Short-Term Loans	15	1	1	1	1	1	1
Interest on Long-Term Loans	10	23	19	19	16	13	13
Miscellaneous Income	(2)	(2)	(1)	(3)	(2)	(3)	(5)
Sub Total	55	57	56	56	56	58	81
Cost of Sales	109	136	198	221	288	354	282
Net Profit before Taxes	(41)	(18)	(2)	(27)	6	25	81
Less Tax	-	-	-	-	-	-	-
Net Profit (Loss)	(41)	(18)	(2)	(27)	6	25	81

1/ Including Purchased Fertilizers.
2/ Sales sold ex-freight beginning October 1, 1972.

Industrial Projects Department
March 1974

INDIA: TROMBAY FERTILIZER PROJECT

HISTORICAL BALANCE SHEETS FOR TROMBAY
(In Rs. Million)

	Years Ending March 31							
	1966	1967	1968	1969	1970	1971	1972	1973
ASSETS								
Current Assets								
Cash	-	-	1	1	1	10	14	4
Receivables & Advances (including Deferred Revenue)	9	36	54	95	82	80	64	44
Inventories	35	38	73	74	92	87	71	79
	44	74	128	170	175	177	149	127
Fixed Assets								
Gross Fixed Assets	336	456	460	467	470	480	497	511
Less: Accumulated Depreciation	14	44	77	111	144	177	212	266
Net Fixed Assets	322	412	383	356	326	303	286	245
Construction in Progress	56	4	3	3	9	20	45	88
Total Fixed Assets	378	416	386	359	335	323	331	333
Total Assets	422	490	514	529	510	500	480	460
LIABILITIES								
Current Liabilities								
State Bank of India	7	5	5	8	10	9	10	-
Sundry Creditors	30	35	40	50	26	38	54	68
Current Portion of Long Term Debt	12	16	17	17	17	17	20	119
	49	56	62	75	53	64	84	187
Long-Term Funds								
GOI 8½% Loans - Trombay Portion	278	302	327	345	395	374	306	113
Long-Term Debt - AID	105	163	147	130	113	96	75	56
FCI Paid-in Equity - Trombay Portion	9	9	56	56	56	70	95	116
Accumulated Deficit (Reserves & Surplus)	(19)	(40)	(78)	(77)	(107)	(104)	(80)	(12)
Total Liabilities	422	490	514	529	510	500	480	460

Industrial Projects Department
February 1974

ANNEX 2-2

ANNEX 3

INDIA: TROMBAY EXPANSION PROJECT

PRESENT SITUATION OF FACT

1. The Fertilisers and Chemicals Travancore Ltd. (FACT), a public sector organization like FCI, has its original plant located at Udyogamandal near Cochin Port in Kerala State. The Udyogamandal plant has been in operation for 26 years. Most of the equipment is worn out and obsolete, needing replacement. To keep the plant in operating condition and safeguard the jobs of its 3,500 employees, FACT has undertaken a rationalization program. The plant has an installed capacity of 82,000 TPY of N and 36,000 TPY of P_2O_5 and produces fertilizers in the form of ammonium sulfate, ammonium phosphate, ammonium chloride and single superphosphate. In addition, it produces other products such as sulfur dioxide, oleum, hydrated calcium silicate, dry ice and synthetic cryolite. The capacity utilization in the plant is low, e.g., 30% for N and 30% for P_2O_5 in 1973 when the plant showed a net loss of Rs 23 million (US$3.0 million) on sales of Rs 232 million (US$31 million). Apart from obsolete equipment, the main reasons for the poor performance of the plant are: unreliable power supply, voltage drops and power interruptions; low quality of phosphate rock used as a raw material; neglect of plant maintenance; overstaffing; labor unrest; and delayed management response to solve problems because of internal dissension.

2. FACT's problems at Udyogamandal have been compounded by difficulties in commissioning its new ammonia-urea plant (Cochin I) which has been built 20 km from Udyogamandal with an installed capacity of 152,000 TPY of N in the form of 330,000 TPY of urea. Work on Cochin I began in 1967 and the plant was to be commissioned in mid-1971. Though the plant was mechanically complete in December 1971, it could not go into commercial production because of design and technical deficiencies and equipment failures. Defective equipment includes particularly reformed gas boiler and waste heat recovery system, high-pressure boiler feed water and circulation pumps, boiler feed water heat exchangers, and the ammonia synthesis unit. As a result, the plant has not yet been able to achieve uninterrupted production.

3. On July 30, 1971, IDA provided US$20 million (Credit No. 264-IN) to FACT for its Cochin II project which is being built adjacent to Cochin I with an installed capacity of 485,000 of granulated NPK (using 47,000 TPY of N, 115,000 TPY of P_2O_5 and 54,000 TPY of K_2O), and 7,500 TPY of cryolite (which is used in the manufacture of aluminum). This project is based on imported sulfur, ammonia, rock phosphate and potash, and is planned to use about one-third of the urea from Cochin I. Cochin II was originally scheduled to be completed by March 31, 1974 but has experienced delays of about one year mainly because of labor strikes, which caused slippage in the civil works schedule, and management problems. As a result, there has been a cost overrun of about US$9 million equivalent from the original estimate of US$50.7 million.

Industrial Projects Department
April 1974

INDIA: TROMBAY EXPANSION PROJECT

FERTILIZER SECTOR IN INDIA

A. Present Situation in India

1. Consumption of fertilizers has been growing at a high rate and reached about 2.7 million nutrient tons in 1973. The supply of fertilizer materials is a major part of the agricultural program in India. Currently, about half of the required nitrogen fertilizer is imported but steps have been taken by GOI to increase domestic production. Nitrogen is now produced in India primarily as ammonia and urea based on naphtha from imported petroleum feedstocks. India has plans for increased reliance on fuel oil and indigenous coal as raw materials for ammonia feedstocks. Several plants have been sanctioned based on imported ammonia but few such additional projects are expected.

Consumption of Primary Nutrients

2. The following table shows consumption of the three primary plant nutrients from 1955-1973:

Consumption of Primary Nutrients
('000 tons)

Fiscal Year	Nitrogen	P_2O_5	K_2O	Approximate NPK Ratios $N:P_2O_5:K_2O$
1955	95	15	11	4.3:0.7:0.5
1960	229	54	21	4.4:1.0:0.4
1961	212	53	29	4.0:1.0:0.5
1962	292	64	28	4.2:1.0:0.4
1963	360	81	37	4.5:1.0:0.5
1964	407	117	52	3.2:1.0:0.4
1965	434	148	70	2.9:1.0:0.5
1966	547	132	78	4.1:1.0:0.6
1967	839	249	116	3.0:1.0:0.4
1968	800	236	130	2.5:1.0:0.4
1969	1,131	389	154	2.9:1.0:0.4
1970	1,360	420	209	3.2:1.0:0.5
1971	1,487	462	228	3.2:1.0:0.5
1972	1,760	564	304	3.0:1.0:0.5
1973	1,779	587	331	3.2:1.0:0.6

1/ Source: Fertilizer Association of India

3. Consumption of nitrogen fertilizer increased fivefold, phosphate fertilizer sevenfold, and potassium fertilizer ninefold during the last 10 years. While consumption of fertilizers grew substantially starting from a low base, in recent years the growth rate has decreased. Optimum nutrient ratios are functions of specific soils, crops and other conditions. For India, advisable minimum nitrogen, phosphate and potash ratio is 4:2:1. On this basis, the above table shows a need for higher rates of growth of P_2O_5 and K_2O consumption.

Production of Fertilizer

4. Details of domestic production of nitrogen and phosphate nutrients are shown below:

Historical Production of Fertilizers[1/]
('000 nutrient tons)

Fiscal Year	Nitrogen (N)			Phosphate (P_2O_5)		
	Straight Nitrogen	DAP and NPK	Total	SSP/TSP	DAP/NPK	Total
1960	84	-	84	51	-	51
1961	111	1	112	52	1	53
1962	152	2	154	63	3	66
1963	181	1	181	78	2	80
1964	127	5	132	99	6	105
1965	227	8	235	118	10	128
1966	221	11	232	104	13	117
1967	287	24	311	113	25	138
1968	319	29	348	146	49	195
1969	448	83	531	110	102	212
1970	600	105	705	104	121	225
1971	731	107	838	102	126	228
1972	807	142	949	128	163	291
1973	888	168	1,056	127	203	330

1/ Fertilizer Statistics, 1972-73, Fertilizer Association of India

5. Nitrogen production and consumption for recent years are shown below based on data from the Fertiliser Association of India:

Historical Production and Consumption of Fertilizer Nitrogen in India
(1,000 tons N)

Indian Five-Year Plan	Fiscal Year	Production	Consumption	Deficit
First	1955	68	95	27
	1956	77	107	30
	1957	79	123	44
	1958	81	149	68
	1959	81	172	91
Second	1960	84	229	145
	1961	112	212	100
	1962	154	292	138
	1963	181	360	179
	1964	132	407	275
Third	1965	235	434	199
	1966	232	547	315
	1967	311	839	528
	1968	348	800	452
	1969	531	1,131	600
Fourth	1970	705	1,360	655
	1971	838	1,487	649
	1972	949	1,760	811
	1973	1,056	1,779	723
	1974	1,065	1,835	770

6. The historical data show a considerable shortfall in production of fertilizers necessitating large imports. Production improved somewhat in the latter half of the 1960's when some fertilizer units, namely GSFC, Coromandel, IEL, Delhi Cloth Mills Ltd., Trombay, Gorakhpur and Namrup were commissioned. But despite these projects, the gap between production and consumption has been steadily increasing.

7. The product pattern of fertilizers in India has undergone a significant change over the years. Initially, a substantial part of production was low-analysis fertilizers containing only a single nutrient. The following table shows end-product capacity of nitrogen fertilizers:

Capacity for Different End-Products

As Percentage of N[1/]

Fiscal Year	Ammonium Sulfate	Urea	CAN	Others	Complex Fertilizers
1956	95.2	-	-	4.8	-
1961	51.0	4.1	24.8	18.1	2.0
1966	27.5	25.9	23.4	9.8	13.4
1970	15.0	54.5	15.0	3.6	11.9
1972	11.4	59.0	14.0	2.6	13.0
1973	9.9	64.2	10.2	1.4	14.3

1/ Fertiliser Statistics 1972/73, FAI.

8. Ammonium sulphate was formerly a substantial part of N production and reached 95% in 1956. However, its use is declining and this can be expected to continue. Urea (which is now the most popular nitrogen fertilizer) accounted for only 4% of total nitrogen capacity in 1961 but grew to 64% of the total in 1973, and its use may increase further in the future.

9. There has also been an appreciable expansion of phosphate and complex (multi-nutrient) fertilizer capacity in recent years. Until 1961, only about 2% of total nitrogen capacity was in the form of complex fertilizers. This rose to about 13% in 1966 and 14% in 1973, rising from 66,000 tons of N in 1966 to 282,540 tons of N in 1973. With the increasing production of DAP and NPK fertilizers, there is relatively less production of superphosphates. The trend for high-analysis fertilizers such as urea and DAP should continue during the next several years.

Fertilizer Imports

10. Summarized data for imports in terms of primary nutrients are given below:

Imports of Fertilizers by India
('000 Tons)

Fiscal Year	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
1953	44	-	3
1958	110	-	13
1962	143	1	30
1963	230	8	44
1964	198	12	64
1965	257	12	57
1966	376	22	94
1967	575	129	143
1968	976	371	276
1969	780	91	165
1970	574	88	100
1971	482	33	119
1972	463	241	267
1973	691	211	316

Source: Fertiliser Association of India

11. There were appreciable increases in imports of all three nutrients from 1966. Maximum imports occurred in 1968 when about a million tons of nitrogen fertilizers, 370,000 tons of P_2O_5 and 280,000 tons of K_2O were imported. Although imports of nitrogen fertilizers started declining from 1969, import levels during 1973 were still fairly high, when 691,000 tons of N were imported. Regarding phosphatic fertilizers, imports have been somewhat erratic over the years. There was a considerable increase in 1968 and 1972 when substantial quantities of DAP/complex fertilizers were imported.

World Comparison of Fertilizer Consumption

12. Nitrogen consumption varies widely throughout the world depending on availability of land resources and the intensity of cropping, as shown by the following data from the FAO Annual Fertilizer Review 1972:

Nitrogen Consumption
(kg/hectare of arable land)

Country	Rate
Netherlands	441
Belgium	198
Japan	161
Germany	140
Egypt	123
U.K.	129
U.S.	38
Pakistan	12
India	11
Australia	3

13. Foodgrain production, particularly of high-yielding varieties of rice and wheat, is a function of the fertilizer application rate. In India, this is low and the above table indicates the scope for growth in Indian fertilizer consumption.

B. Review of Market Forecasts for India

14. Consumption of fertilizers in India, as previously stated, has shown a rising trend over the years. Several attempts have been made by various agencies to estimate future fertilizer needs in India. Some of these estimates are given below:

Estimates of Fertilizer Consumption for 1974
(1,000 tons)

	Nitrogen	Phosphates
Planning Commission, 1971 Est.	3,200	1,400
Ministry of Agriculture (GOI), 1971 Est.	2,809	1,287
IBRD, 1972 Est. (Donde-Brown)	2,650	1,509
Fertilizer Association of India, 1971 Est. (FAI)	2,100	650
1974 (Actual)	1,835	635

15. In general, the forecasts represent demand targets rather than consumption forecasts. Apparently no consideration was given to the effects of constraints such as supply, seeds, farmer education, water, credit and prices. Actual consumption, especially of N, has proved to be well below the forecasts.

16. The projection considered to be the most reliable is the Donde-Brown joint IBRD/GOI study published in 1972.1/ This study was based on detailed analysis of data, on a district-by-district basis, for the period 1959-1969. The forecast technique involved primarily a trend projection based on a five-year sliding average and quoting from that report:

> "Projections were based on a close examination of the factors that influenced changes in sales during the ten years up to 1968/69. During this period, demand was influenced most by the cultivator's previous experience from the use of fertilizers (the learning process) and the area irrigated and planted to selected crops known to have consumed most of this material. These factors explained 70 to 90 percent of the changes in demand. Other factors, not measurable with the available data and assumed to be important, included the availability and use of agricultural credit, market and transport facilities and promotional efforts.
>
> "The above factors were used to project demand for N plus P_2O_5 for each district after making appropriate assumptions regarding changes in their growth rates. Inherent in these assumptions were the investments needed and time required to expand irrigation resources, develop and adopt new technologies, increase the availability of agricultural power and expand the agricultural input and commodity marketing systems. It was assumed that cost/benefit

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1/ Effective Demand for Fertilizers in India -- a Joint Study with the Government of India, March 27, 1972, Report No. SA-31 W. B. Donde (GOI and Dorris D. Brown, IBRD).

relationships would be about the same as observed during 1967 to 1969. In some districts assumptions included improvements in agricultural credit and transportation resources."1/

17. The summary projection from the Donde-Brown study is shown below and compared with actual results over 1970-1973:

Demand Forecast
(million tons of nutrients)

	Nitrogen			Phosphate		
	Demand		Actual	Demand		Actual
Fiscal Year	Low	High	Consumption	Low	High	Consumption
1970	1.20	1.46	1.36	0.50	0.56	0.42
1971	1.50	1.76	1.50	0.60	0.75	0.46
1972	1.70	2.11	1.76	0.70	0.97	0.56
1973	2.10	2.50	1.78	0.90	1.22	0.59
1974	2.40	2.91	-	1.10	1.51	-
1979	4.00	5.16	-	2.00	2.62	-

18. Consumption of nitrogen during 1970-1973 is generally within the forecast range, but on the low side. The very low 1973 figure can be attributed mainly to a short-term lack of supplies since production fell far short of targets and imports could not be made in time. The Nangal appraisal report (IDA-46-IN) based the nitrogen consumption forecast on the arithmetic average of the low and high forecast of Donde-Brown, or 4.6 million tons N in 1979. In view of recent consumption data, 4.6 million ton of N should be considered only as a target for 1979 but actual consumption is not likely to exceed the low forecast figure of 4.0 million.

19. One of the major dangers in using the Donde-Brown forecast is that one of its most important recommendations has not been followed, i.e.,

> "It is suggested that these data be updated each year and supplemented by additional information as needed to continue the study of demand for fertilizers. Factors such as multiple cropping and application of fertilizers to crops not usually fertilized would change the values of independent variables in the future. Particularly, a technological break-

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1/ Donde-Brown Study.

through in respect to paddy, pulses, oilseeds and cotton among the specified crops would change the projections, as the past influence for some of these crops on fertilizer demand had been low or insignificant. The dry farming program is yet another area which would make a difference in future demand. Further studies should concentrate on the farm business unit to determine the factors influencing the cultivator's expenditures for fertilizers. Also the role of agricultural credit, market facilities, promotion activities, and transportation resources may be delineated. Assembling and analyzing the data each year would provide guidance in achieving fertilizer targets and plan objectives and would be most rewarding for the future of Indian agriculture."1/

20. GOI has now formulated its Fifth Plan (1975-1979) goals on the basis of about 5 million ton N consumption. It should be apparent that the target of 5 million is not going to be reached unless the recent trend is quickly reversed. GOI should commission a continuing study of the demand forecast including improving the Donde-Brown model to include other variables. With a more realistic demand forecast, the planning for additional fertilizer capacity during the Fifth Plan could proceed on a more orderly basis. The production capacity now being discussed is 6.5-7.0 million tons N by 1979, but this level is also unlikely to be achieved.

C. Revised Market Forecast

21. Considering all of the above factors, a revised forecast for nitrogen and phosphate demand in India has been made. The nitrogen demand projection up to 1979 is based on the median Donde-Brown estimate as given in the Nangal report. Beyond 1979 no projections are available but it is assumed that the growth rate would decrease to an average of 9-10% per year compounded for nitrogen, reaching 6.4-7.0 million tons of N in 1984.

22. The phosphate forecast fell far short of the projection and substantially no progress was made toward achieving a 2:1 nutrient balance for N and P_2O_5. The forecast in para 23 assumes a 3:1 balance as the probable consumption ratio for 1974-1979 and a 2.5:1 target for 1984. This assumption fits the actual data for 1970-1973 reasonably well.

23. With these assumptions, the revised forecasts of probable consumption and targets for planning purposes are given below:

1/ Donde-Brown Study.

Revised Projected Fertilizer Demand in India
(million tons of nutrients)

Year	Nitrogen		Phosphate	
	Low (Probable Consumption)	Median (Target)	Low (Probable Consumption)	Median (Target)
1974	2.40	2.66	0.80	0.90
1975	2.66	2.96	0.89	0.99
1976	2.96	3.32	0.99	1.11
1977	3.28	3.72	1.09	1.24
1978	3.64	4.16	1.21	1.39
1979	4.00	4.57	1.33	1.52
1984	6.40	7.00	2.56	2.80

24. The somewhat arbitrary nature of the assumptions leading to these forecasts is recognized but in the absence of any study to update the Donde-Brown study, they are considered more realistic than the forecasts being used by GOI. The demand target for 1974 and 1975 is unrealistically high in view of lagging domestic production in 1973, 1974 and 1975, unless India can import large quantities of fertilizer.

25. The following tables give the median and low demand forecasts on a regional basis for India. Figures for individual States are prorated from the Donde-Brown report. The median forecast as shown in Tables 1 and 2 is then used in the subsequent tables to evaluate potential new projects on a regional basis.

26. The market forecasts given above are considered as realistically attainable. They are, however, apparently far from the optimum demand to produce total projected foodgrains requirements and to maximize farmers' revenue. The demand should be higher if population, nutrition and optimum use of area cropped are considered. The following indicative forecasts were made in 1969 by the Fertilizer Association of India:

Demand in 1974
(million tons of nutrient)

	N	P_2O_5	K_2O
Population, Nutrition Basis	3.07	1.53	0.77
Crop Area, Recommended Rates	3.68	2.20	1.67
Agricultural Growth Rate (5% annually)	3.54	1.77	0.88

27. The optimum nutrient application rates are given in the table below which is taken from the Donde-Brown study:

Optimum and Recommended Rates, Cost-Price Ratios and Price Elasticity of Demand for N

Crop	Optimum Rates[1]			Recommended Rate[2]			½ Recommended Rate		
	Kgs N per ha	Cost-Price Ratio Kg	Elasticity	Kgs N per ha	Cost-Price Ratio Kg[3]	Elasticity	Kgs N per ha	Cost-Price Ratio Kg[3]	Elasticity
Paddy (Rice), HYV	142	3.17	0.28	100	6.51	0.81	50	10.55	2.62
Paddy, Local	42	3.17	0.25	40	3.83	0.32	20	9.92	1.63
Wheat, HYV Irrigated	164	2.52	0.22	100	7.02	1.01	50	10.50	3.02
Wheat, Local Irrigated	52	2.52	0.14	48	4.16	0.25	24	12.57	1.49
Wheat Local, Not Irrigated	40	2.52	0.30	25	5.62	1.06	12	8.28	3.12
Maize, HYV	256	3.50	0.54	100	7.42	2.97	50	8.67	6.93
Maize, Local	50	3.50	0.20	42	6.27	0.43	21	13.62	1.85
Bajra, HYV	152	2.78	0.82	60	4.83	3.63	30	5.50	8.26
Bajra, Local	45	2.78	0.29	30	5.99	0.96	15	9.11	2.92
Jowar, Local	48	3.24	0.37	36	5.35	0.81	18	8.67	2.61

1/ Optimum rates of application were calculated from the fertilizer production function given the market price of N (1969-70) and of the produce price (1968-69).

2/ As recommended by the Department of Agriculture.

3/ Kilograms of added crop output required to equate the cost of one Kg of N.

D. Nitrogen and Phosphate Production Forecasts

28. The regional production forecasts for nitrogen and phosphate are shown in Tables 3 and 4. The assumptions used in preparing the forecasts are discussed below. Production figures for 1960-1973 are actual data from Fertilizer Statistics of FAI and 1974 data are provisional estimates. Production from existing plants after 1973 has been estimated at 70-95% of design capacity depending on type and condition of the individual plants. In recent years, production in public sector plants has averaged 60-70% of capacity but for several units, modernization programs are being implemented so that a higher utilization factor is optimistic but achievable. A 90% production estimate for the private sector is considered achievable based on its operating performance.

29. For most projects under construction, production has been assumed at 50% of design capacity in the first operating year, 75% in the second year, and 90% thereafter. The three coal-based plants (Talcher, Ramagundam and Korba) are assumed to achieve only 75% utilization in the second and subsequent years. Assumed new projects and commissioning dates are Bank staff estimates, and do not necessarily agree with GOI estimates.

30. The projects designated as probable for the near future are in various stages of planning. In most cases, project identity is not known, and all assume 230,000 or 320,000 TPY of N capacity. It is assumed implementation and operation will improve and in each case a three-year implementation period will be followed by production at 75% capacity the first year and 90% the second year and thereafter. The average capacity utilization assumed for 1974-1984 ranges from 70-87% largely depending on the number of plants being commissioned in any one year.

31. Although capacity utilization has been low over the past few years, experience varies widely and generally units operate well when timely supplied with the necessary inputs such as raw materials and power. With an expanding industry, limitations in infrastructure, however, are becoming increasingly more common. Power is particularly critical. Nangal, which uses a power-intensive process, is an unusual case in that its power supply has been limited to about 60% of normal need. Power rationing has been threatened in several other states but has not so far been imposed. Power interruptions are a major problem throughout the fertilizer industry since even a brief low voltage supply can cause lengthy production losses. Unless power supply and reliability is improved capacity utilization will continue to be low.

32. Labor unrest has been increasing in a number of plants and this factor has lowered overall utilization by several percent although accurate data are not available. This problem is compounded by overstaffing in most plants and so far there is little indication that major corrective steps will be taken.

33. Feedstock supply has been a constraint in some cases and problems are likely to increase in the future unless the refining capacity expansion program achieves its Fifth Plan goals or large imports of naptha and crude oil are permitted.

34. The Fifth Plan should include an assessment of capacity utilization and a development program to eliminate problems and improve operations. Failing this, the assumptions of capacity attainment made in this forecast will prove to be high and forecast production goals would not be met.

Table 1

INDIA: TROMBAY EXPANSION PROJECT

REGIONAL FORECAST OF NITROGEN DEMAND IN INDIA

('000 tons of N)

Fiscal Year (Ending March 31)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1984 9/	Average compound Growth rate, % 1974/79	1979/84
Median Forecast 7/													
North 1/	250	290	360	450	540	590	650	710	780	850	1300	9.5	
North Central 2/	280	350	410	500	580	650	730	820	920	1040	1600	12.3	
East 3/	120	150	170	210	240	270	310	360	410	460	700	14.0	
South 4/	180	210	240	270	300	340	380	430	480	550	840	12.8	
South Central 5/	310	380	440	530	600	660	730	800	890	980	1500	10.3	
West 6/	200	240	280	340	400	450	500	560	620	690	1060	11.5	
All India	1340	1620	1900	2300	2660	2960	3320	3720	4160	4570	7000	11.5	9.0 9/
Low Forecast 8/													
North	220	280	330	410	490	-	-	-	-	740	1180		
North Central	250	320	360	460	520	-	-	-	-	910	1460		
East	110	140	160	190	220	-	-	-	-	400	640		
South	160	190	210	250	270	-	-	-	-	440	700		
South Central	280	350	390	480	540	-	-	-	-	900	1440		
West	180	220	250	310	360	-	-	-	-	610	980		
All India	1200	1500	1700	2100	2400	2660	2960	3280	3640	4000	6400	10.7	10.0 9/

1/ Includes Punjab, Haryana, Rajasthan, Himachal Pradesh, Jammu and Kashmir.
2/ Includes Uttar Pradesh, Madhya Pradesh
3/ Includes Bihar, Assam, West Bengal, Orissa
4/ Includes Kerala, Tamil Nadu
5/ Includes Andra Pradesh, Mysore, Goa
6/ Includes Gujarat, Maharashtra
7/ 1970-1979 data based on arithmetic average of nitrogen projections of Donde-Brown with P at 1/3 N levels.
8/ 1970-1979 data based on low projections of Donde-Brown with P at 1/3 N levels.
9/ 1984 data based on P at 2.5:1 N:P_2O_5 ratio and assumes N growth rate of 9% for median and 10% for low forecast.

NOTE: All numbers have been rounded to nearest 10,000.

Table 2

INDIA: TROMBAY EXPANSION PROJECT ia

REGIONAL FORECAST OF PHOSPHATE DEMAND IN INDIA

('000 tons of P_2O_5)

Median Forecast 7/

Fiscal Year (Ending March 31)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1984 9/	Average compound Growth rate 1974/79	1979/84
North 1/	80	100	120	150	180	200	220	240	260	280	520	9.1	
North Central 2/	90	120	140	170	190	220	240	270	310	350	640	11.5	
East 3/	40	50	60	70	80	90	100	120	140	150	280	13.0	
South 4/	60	70	80	90	100	110	130	140	160	180	340	12.5	
South Central 5/	100	130	150	180	200	220	240	270	300	330	600	11.0	
West 6/	70	80	90	110	140	150	170	190	210	230	420	11.5	
All India	450	540	640	770	890	990	1110	1240	1380	1520	2800	11.0	13.0
					Low Forecast 8/								
North	70	90	110	150	160	-	-	-	-	250	470		
North Central	80	110	120	160	170	-	-	-	-	300	580		
East	40	40	50	70	80	-	-	-	-	130	260		
South	50	60	70	80	90	-	-	-	-	150	280		
South Central	90	120	130	150	180	-	-	-	-	300	580		
West	60	70	80	90	120	-	-	-	-	200	390		
All India	400	500	600	700	800	890	990	1090	1210	1330	2560	10.6	14.0

1/ Includes Punjab, Haryana, Rajasthan, Himachal Pradesh, Jammu and Kashmir.
2/ Includes Uttar Pradesh, Madhya Pradesh, Orissa.
3/ Includes Bihar, Assam, West Bengal,
4/ Includes Kerala, Tamil Nadu
5/ Includes Andra Pradesh, Mysore, Goa
6/ Includes Gujarat, Maharashtra
7/ 1970-1979 data based on arithmetic average of nitrogen projections of Donde-Brown with P at ⅓ N levels.
8/ 1970-1979 data based on low projections of Donde-Brown with P at ⅓ N levels.
9/ 1984 data based on P at 2.5:1 N:P_2O_5 ratio and assumes N growth rate of 9% for median and 10% for low forecast.

NOTE: All numbers have been rounded to nearest 10,000.

Table 3

INDIA: TROMBAY EXPANSION PROJECT

REGIONAL FORECAST OF DOMESTIC NITROGEN PRODUCTION
('000 tons of N)

Fiscal Year (ending March 31)	Capacity	Fifth Plan 1975	1976	1977	1978	1979	Sixth Plan 1980	1981	1982	1983	1984
North India											
FCI - Nangal	230										
DCM	150										
Planned	230										
Planned	320										
Planned	320										
Total	1,250	180	250	320	520	800	850	850	850	1,090	1,140
North Central											
IEL	200										
FCI - Gorakhpur	140										
FCI - Korba (Planned)	230										
IFFCO (Planned)	230										
Planned	230										
Total	1,030	250	280	305	475	630	845	885	885	885	885
East India											
FCI - Namrup	200										
FCI - Talcher	230										
FCI - Haldia	150										
FCI - Barauni	150										
FCI - Sindri	220										
FCI - Durgapur	150										
FCI - Paradeep	120										
(Planned)	300										
Total	1,400	415	520	645	795	980	1,010	1,010	1,010	1,010	1,010
South India											
Fact	290										
Neyveli	70										
Madras	190										
SPIC	250										
Planned	230										
Total	1,030	420	570	640	675	675	675	675	675	845	885
South Central											
Mangalore	160										
Coromandal	80										
Zuari Agro	180										
FCI - Ramagundam	230										
Planned	320										
Planned	230										
Planned	320										
Total	1,520	230	230	350	490	775	995	1,275	1,325	1,325	1,325
West											
FCI - Trombay	305										
GSFC	220										
IFFCO	220										
Planned	230										
Planned	230										
Planned	190										
Total	1,395	380	520	550	720	760	930	1,210	1,260	1,260	1,260
All India Production	-	1,880	2,370	2,810	3,680	4,620	5,300	5,900	6,000	6,400	6,500
All India Capacity	7,620	2,560	2,910	3,440	4,570	5,590	6,300	6,950	6,950	7,710	7,710
% Utilization		73	81	82	81	81	84	85	86	83	84

NOTE: Some existing capacity would be phased out of production by 1979-1984 and this has been omitted from forecast.

Table 4

INDIA: TROMBAY EXPANSION PROJECT

REGIONAL FORECAST OF DOMESTIC PHOSPHATE PRODUCTION

('000 tons of P_2O_5)

Fiscal Year (ending March 31)	Capacity	Fifth Plan 1975	1976	1977	1978	1979	Sixth Plan 1980	1981	1982	1983	1984
North India											
DCM	20										
Khetri	90										
SSP/TSP	-										
Planned	150										
Planned	100										
Total	360	15	60	75	170	170	205	320	320	320	320
North Central											
SSP/TSP	20										
Planned	150										
Planned	150										
Total	320	20	20	20	20	130	155	265	290	290	290
East India											
FCI - Sindri	160										
FCI-- Haldia	75										
SSP/TSP	20										
FCI - Paradeep (Planned)	300										
Total	555	15	95	175	210	210	210	210	320	345	455
South India											
Fact	155										
Madras	85										
SPIC	55										
SSP/TSP	35										
Planned	150										
Total	480	145	220	290	290	290	290	400	425	425	425
South Central											
Coromandal	75										
Zuari Agro	45										
SSP/TSP	25										
Planned	100										
Planned	150										
Planned	150										
Total	545	125	125	125	125	125	235	260	335	460	485
West India											
FCI -Trombay	120										
GSFC	55										
DMCC	25										
IFFCO	130										
SSP/TSP	25										
Planned	150										
Planned	150										
Total	655	190	275	325	325	435	460	460	570	595	595
All India Production	-	510	800	1,010	1,140	1,360	1,560	1,920	2,260	2,440	2,600
All India Capacity	2,915	-	-	-	-	1,630	-	-	-	-	3,070
% Utilization	-	-	-	-	-	83	-	-	-	-	85

NOTE: **Dashed lines for three years** indicate project implementation period. Some existing capacity would likely be phased out of production by 1979-1984 and this has been omitted from forecast.

Industrial Projects Department
May 1974

INDIA: TROMBAY EXPANSION PROJECT

TROMBAY MARKET AND MARKETING SYSTEM

A. Status of Agriculture in Maharashtra

1. The marketing area of Trombay is concentrated in the State of Maharashtra. Principal crops grown are coarse foodgrains (jowar and bajra) which form the staple food of the economically weaker section of the country's population, and commercial crops such as cotton, groundnut and sugarcane.

2. Maharashtra has a total area of 30.8 million hectares, about 9.4% of India's total geographic area. Land utilization is about 60% compared to about 40% for all India. The crop area represents 12 percent of India's total cropped area. However, intensity of cropping is lower, with only 4% of the total area sown more than once. The following table gives details of land utilization in Maharashtra:

Land Utilization in Maharashtra - 1970

Particulars	(Million Hectares) Maharashtra	All India	Percentage of all India
Geographic Area	30.8	328.0	9.4
Reporting area for land utilization	30.8	305.8	10.1
Forest	5.4	64.7	8.3
Land not available for cultivation	2.5	47.3	5.3
Other uncultivated land excluding fallow land	1.5	17.1	8.8
Cultivable waste	0.7	15.8	4.4
Fallow land	2.2	21.8	10.1
Net sown area	18.5	139.1	13.3
Area sown more than once	0.9	24.4	3.7
Total cropped area	19.4	163.5	11.9

SOURCE: Fertilizer Statistics, 1971-72, FAI

3. Maharashtra has a semi-tropical climate with three distinct seasons:

Rainy season - (June to September)
Winter season - (October to February)
Summer season - (March to May)

4. Average rainfall is around 1,000 mm varying from about 800 mm in Central Maharashtra to 2900 mm on the Konkan coast. In 17 out of 26 districts, rainfall is more than 750 mm which is normally adequate to grow

most crops. Over 85% of the rainfall in most of the area occurs between June and September and October to December. The distribution of rainfall is given in the following table:

Distribution of Normal Rainfall in Maharashtra

Areas in Maharashtra	Annual Normal Rainfall(mm)	Rainfall as Percentage of Annual			
		January to February	March to May	June to September	October to December
Konkan	2,872	0.1	1.2	93.9	4.8
Central Maharashtra	921	0.8	4.1	83.6	11.5
Marathawada	774	1.5	4.0	83.6	11.0
Vidarbha	1,100	2.9	3.1	87.0	7.0

SOURCE: Fertilizer Statistics, 1971-72, Fertilizer Association of India

5. However, several districts in Maharashtra experienced severe droughts for the third straight year in 1972. The immediate effect has been to disrupt the agricultural community, but the long-range effect with regard to fertilizer consumption is difficult to predict.

6. The predominant soil type is black cotton soil which is well suited for various crops like cotton, jowar and groundnut. On the western coast and in the central plains, the soils are mildly acidic. In the rest of the State, the soils are very mildly alkaline. In most parts of the State, the soil is poor in phosphate and potash. The low acidity indicates phosphate should be highly water soluble.

7. Agriculture is based on rainfall and limited irrigation facilities. With 22% of the net sown area irrigated in India the corresponding proportion in Maharashtra is only 8% or about 1.4 million hectares. The potential for creating irrigation facilities is for another 2.1 million hectares. A part of this, nearly one million hectares, could be exploited by 1974 and the remaining by about 1981. The table below gives details of irrigated areas and comparative figures for other States:

Area under Irrigation in Trombay's Marketing Area - 1970
(Area in '000 Hectares)

States	Net Irrigated Area	Net Cultivated Area	Proportion %
Maharashtra	1,431	18,367	8
Tamil Nadu	2,507	60,691	41
Andra Pradesh	3,189	11,510	28
Uttar Pradesh	6,818	17,438	39
West Bengal	1,478	5,569	27
Punjab	2,838	5,027	56
Haryana	1,403	3,548	40
Rajasthan	2,059	13,095	16
All India	30,369	139,066	22

SOURCE: Fertilizer Statistics, 1971-72. FAI

B. Principal Crops

8. The production of principal crops in Maharashtra is shown below:

Cropping Pattern in Maharashtra - 1972
(Area in '000 Hectares)

	Maharashtra		All India	
Foodgrains	Area cropped	%	Area cropped	%
Rice	1,332	6.9	37,334	22.8
Wheat	1,009	5.2	19,163	11.7
Jowar	6,169	31.7	16,802	10.3
Bajra	1,135	5.8	11,769	7.2
Maize	26	0.1	5,637	3.4
Other millets	425	2.2	9,345	5.7
Gram	433	2.2	8,027	4.9
Other pulses	1,646	8.5	14,147	8.8
Sub-total	12,175	62.6	122,224	74.8
Commercial Crops				
Sugarcane	182	0.9	2,418	1.5
Groundnut	751	3.9	7,250	4.4
Cotton	2,378	12.2	7,784	4.7
Other commercial crops	3,349	20.4	23,807	14.6
Sub-total	7,260	37.4	41,249	25.2
Total	19,435	100.0	163,473	100.0

SOURCE: Ministry of Food and Agriculture, GOI

9. Jowar is by far the most important crop in Maharashtra. It accounts for nearly 32% of the total cropped area. Important commercial crops are cotton, groundnut, oilseeds and sugarcane. Nearly 37% of the total cropped area is under commercial crops compared to 25% for all India.

10. The production trends for important crops in Maharashtra were as follows:

Production Trends
(000 tons)

Crop	Maharashtra			All India		
	1962	1967	1972	1962	1967	1972
Rice	1,401	1,119	1,369	34,805	30,440	42,737
Wheat	396	376	503	12,040	11,526	26,477
Maize	14	66	18	4,267	4,991	5,026
Bajra	439	431	239	3,553	4,511	5,357
Jowar	2,725	3,209	1,932	7,741	7,527	7,753
Gram	142	107	133	5,826	3,612	5,106
Groundnut	734	475	468	4,685	4,485	5,712
Sugarcane	8,210	10,680	11,495	99,870	94,940	115,378
Cotton 1/	902	1,070	917	4,456	4,931	6,526
Tobacco	15	8	7	345	350	409

1/ Production in thousand bales, each of 180 kg.

11. For Maharashtra there has been only a marginal increase in yield rates as shown below. The all-India data show a much higher yield rate.

Yield Trends
(Kg/Hectare)

Crop	Maharashtra			All India		
	1962	1967	1972	1962	1967	1972
Rice	1,112	814	1,027	1,060	855	1,145
Wheat	455	410	499	890	878	1,382
Maize	519	1,107	692	949	986	892
Bajra	192	234	210	330	361	455
Jowar	474	520	313	345	497	461
Gram	366	309	307	610	451	636
Groundnut	690	452	623	730	619	789
Sugarcane	58,130	69,160	63,159	40,800	40,770	47,716
Cotton	64	74	69	104	113	151
Tobacco	600	536	538	819	879	919

12. The following table gives a comparison of yield rates of principal crops in Maharashtra and other States in the country:

Comparative Yields of Principal Crops - 1972
(Kg/Hectare)

Crop	India	Maha-rashtra	Punjab	U.P.	A.P.	Gujrat
Rice	1,145	1,027	2,042	819	1,579	1,093
Wheat	1,382	499	2,413	1,249	200	1,560
Bajra	455	210	1,180	556	454	870
Jowar	461	313	667	384	447	404
Maize	892	692	1,560	571	1,057	1,606
Sugarcane	47,716	63,159	39,135	38,982	88,936	51,361
Cotton	151	69	368	84	88	222
Groundnut	789	623	925	573	764	867
Gram	636	307	838	782	260	702

SOURCE: Fertilizer Statistics, 1971-72, FAI

13. Yield rates in Maharashtra are comparatively low for almost all crops. There is considerable scope for improving agriculture through larger use of fertilizers and other agricultural inputs. Efforts in this direction are being made in two ways: (1) Bringing more area under high-yielding variety programs; and (2) introducing dry farming practices on an extensive scale through use of better inputs like fertilizers and improved seeds even under dry conditions of cultivation.

14. The following table gives the area under the high-yielding variety program (H.Y.V.P.):

Coverage under H.Y.V.P.-1972
(000 hectares)

	Maharashtra		All India	
Crop	Area under H.Y.V.P.	Total Area under Irrigation	Area under H.Y.V.P.	Total Area under Irrigation
Rice	216	308	5,588	13,577
Wheat	211	235	6,480	7,758
Jowar	501	301	802	774
Bajra	481	49	2,051	504
Maize	6	19	462	1,906
Total	1,415	912	15,383	24,519

SOURCE: Fertilizer Statistics, 1971-72, FAI

14. Most irrigated area under rice and wheat is already under the high-yielding variety. High-yielding variety practices have also been extended to crops like jowar, bajra and maize. The Government is introducing improved practices in dry farming areas and for this purpose two districts have been selected in Maharashtra.

15. Yield rates for several major crops in India are compared below with several other countries. In most cases, India is well below the highest producer but this usually can be attributed to especially intensified cropping techniques in other countries for specific crops. The data, in general, though, show that substantially better yields can be achieved in India.

Average Yield per Hectare in India Vs. Other Countries during 1970
(Kg)

	Rice	Wheat	Jowar	Sugar-cane	Ground-nut	Cotton
India	1,710	1,382	461	47,716	789	150
Japan	5,250					
Ceylon	2,640					
Philippines	1,720					
U.S.		2,280	3,180	92,100	2,300	490
Mexico		2,680				
Germany		4,620				
Cuba				42,200		
Egypt						780

SOURCE: FAO Production Year Book, 1970

C. Nutrient Consumption

16. Within India there are wide variations in fertilizer consumption as shown below:

Fertilizer Nutrient Consumption per Unit of Cropped Area - 1971
(Kg/Hectare)

	N	P_2O_5	K_2O	Total
Andhra Pradesh	14.88	5.64	2.07	22.59
Tamil Nadu	29.88	9.91	8.52	48.31
Mysore	9.08	3.84	2.53	15.45
Kerala	10.73	5.38	6.17	22.28
Gujarat	11.21	6.00	0.69	17.90
Maharashtra	6.70	3.47	2.25	12.42
Madhya Pradesh	3.86	1.64	0.29	5.79
Rajasthan	3.50	1.12	0.35	4.97
Uttar Pradesh	15.13	3.32	2.54	20.90
Haryana	14.77	1.35	0.50	16.62
Punjab	40.92	9.57	2.20	52.69
Bihar	7.92	1.28	0.59	9.79
Orissa	4.46	1.00	0.48	5.94
W. Bengal	8.39	2.63	3.30	14.32
India	10.74	3.44	1.85	16.03

SOURCE: Fertilizer Statistics, 1971-72, FAI

17. The consumption per hectare of N is as high as 41 kg in Punjab followed by 30 kg in Tamil Nadu while it is as low as 3.86 kg in Madhya Pradesh and 3.50 kg in Rajasthan. The consumption of fertilizers is quite high in some of the more agriculturally advanced districts in India as shown below:

Districts with High Fertilizer Consumption
(Kg/Hectare)

State	District	Consumption Per Hectare			
		N	P	K	Total
Andhra Pradesh	West Godavari	48.9	13.7	4.9	67.5
	Nizamabad	56.4	11.0	1.2	68.6
Tamil Nadu	Coimbatore	40.1	15.3	13.5	68.9
	Kanya Kumari	55.4	22.9	12.5	90.8
	Chingalpet	61.6	26.8	16.7	105.1
Haryana	Karnal	44.1	5.1	1.6	50.8
Punjab	Amritsar	64.5	8.0	2.2	74.7
	Ludhiana	71.1	29.2	3.0	103.3
Maharashtra	Ahmednagar	5.6	1.8	1.3	8.7
	Poona	9.8	2.3	1.8	13.9
	Kolhapur	17.7	7.1	4.0	28.8
	Thana	10.8	4.3	3.9	19.0
	Kolaba	13.2	10.8	5.6	29.6

SOURCE: Fertilizer Statistics, 1971-72, FAI

D. Supply and Demand in Trombay Marketing Area

18. As mentioned earlier, the marketing operation of the existing plants of Trombay is largely confined to Maharashtra. The quantities that are supplied to other States like Andhra Pradesh and Mysore are partly to meet the existing obligations of the marketing units functioning there or for meeting the seeding requirements of the Haldia Fertilizer Project (West Bengal) which will be producing similar products.

19. The trend of consumption of nitrogenous and complex fertilizers in the State of Maharashtra is given in the following table:

Consumption of Fertilizers in the Form of N and P_2O_5 in Maharashtra
(000 Tons)

Year	Maharashtra N	Maharashtra P_2O_5	India N	India P_2O_5
1962	17	6	292	64
1963	19	8	360	81
1964	29	9	407	117
1965	52	14	434	148
1966	34	18	547	132
1967	72	18	839	249
1968	96	56	800	236
1969	85	36	1,131	389
1970	92	30	1,360	420
1971	111	52	1,487	462
1972	130	67	1,755	563

NOTE: All India figures taken from Fertilizer Statistics, 1971-72. Figures up to 1967 refer to distribution and from 1968 to 1972, to consumption.

For Maharashtra, all figures referred above are consumption figures.
Figures up to 1967 are taken from Donde/Brown report and thereafter from Fertilizer Statistics, 1971-72.

12. Various consumption estimates are available for future years with regard to nitrogen and phosphate fertilizers. Of these, the most thorough one is that prepared by Donde and Brown, as a joint World Bank-GOI study. Donde and Brown made projections Statewise for future years up to 1979, based on historical data through 1969 and giving a high forecast and a low forecast. Both the high and low levels of demand have been considered in this analysis. The estimated consumption of N and P_2O_5 fertilizers in Maharashtra for the years 1974 and 1979 according to Donde and Brown and the pro-rata estimates for 1977 are given below:

Estimated Consumption in Maharashtra
(000 Tons)

			1972	1974	1977	1979
1. Actual Consumption:		N	130	-	-	-
		P_2O_5	67	-	-	-
2. Estimated by Donde-Brown:	High	N	-	305	429	538
		P_2O_5	-	196	262	316
	Low	N	-	251	356	417
		P_2O_5	-	142	203	241

21. The demand estimates for all States in the Trombay marketing zone are given below:

Comparison of Demand Forecasts
(000 Tons)

State	Year	Actual		Forecast			
				High		Low	
		N	P_2O_5	N	P_2O_5	N	P_2O_5
Maharashtra	1972	130	67	-	-	-	-
	1973	168	85	-	-	-	-
	1977	-	-	429	262	356	203
	1979	-	-	538	316	417	241
Gujarat	1972	114	61	-	-	-	-
	1973	132	70	-	-	-	-
	1977	-	-	191	129	153	96
	1979	-	-	241	160	187	122
Mysore	1972	98	42	-	-	-	-
	1973	115	55	-	-	-	-
	1977	-	-	200	108	161	80
	1979	-	-	252	134	196	102
Madhya Pradesh	1972	79	34	-	-	-	-
	1973	108	50	-	-	-	-
	1977	-	-	140	65	112	48
	1979	-	-	177	80	137	61
Andhra Pradesh	1972	196	74	-	-	-	-
	1973	250	90	-	-	-	-
	1977	-	-	720	350	578	258
	1979	-	-	908	433	705	330
All India	1972	1,755	563	-	-	-	-
	1973	1,990	735	-	-	-	-
	1977	-	-	4,090	2,120	3,282	1,566
	1979	-	-	5,155	2,622	4,000	2,000

NOTE:: 1972 figures represent actual consumption.
1973 figures are based on preliminary data.

22. Excluding Trombay, there are five other fertilizer plants in Maharashtra which produce only phosphate fertilizers. Two more fertilizer plants are expected to be established by 1979 when the total fertilizer capacity in the State would be:

Capacity in Maharashtra
('000 Tons)

Unit		1972 Material	1972 N	1972 P_2O_5	1979 Material	1979 N	1979 P_2O_5
FCI	Urea (old plant)	99	45	-	129	59	-
	NPK (15-15-15)	240	36	36	330	48	48
	NPK (21-21-0)	-	-	-	355	75	75
	Urea(Trombay V)				280	130	-
	Total	-	81	36		312	123
Others	SSP/TSP	-	-	35		60	52
TOTAL			81	71		372	175

23. Against an estimated "low" consumption of 417,000 tons of N and 241,000 tons of P_2O_5 in Maharashtra in 1979, the total capacity for production in the State will only be about 372,000 tons of N and 175,000 tons of P_2O_5. As normally these units on an average could be expected to produce at about 90 percent of rated capacity, the likely production in 1979 is about 335,000 tons of N and 158,000 tons of P_2O_5. Thus if only the realizable capacity of Maharashtra units is accounted, the production would be substantially less than demand, whereby despatches from units situated outside the State or from imports would be necessary. The net balance position would be:

Net Position of Demand and Supply (1979)
(000 Tons)

		N	P_2O_5
1.	Likely production at 90% of capacity	335	158
2.	Likely demand on the basis of Donde-Brown:		
	i) High estimate	538	316
	ii) Low	417	241
3.	Net deficit in the State on the basis of demand:		
	i) High	203	158
	ii) Low	82	83

E. Competitors Outside Maharashtra

24. The main competing units operating in Trombay's marketing area are GSFC and Zuari Agro. GSFC, 400 km from Bombay, has been in production since 1967. Zuari Agro, 750 km from Bombay, was commissioned in 1973. The estimated sales of various companies in Maharashtra in 1974 are:

Estimated Sales of Trombay and Competitors in Maharashtra in 1974
(000 Tons)

Company	Location	N	P_2O_5
FCI Trombay	Maharashtra	53.0	28.0
GSFC	Gujarat	10.0	-
Zuari Agro	Goa	4.8	-
DCM	Rajasthan	1.9	-
Coromandel	Andhra Pradesh	1.7	1.4
SSP/TSP Producers	Maharashtra	-	19.6
		71.4	49.0

25. Other units outside Maharashtra are selling relatively small quantities in Maharashtra since their principal marketing areas are their respective States. The only expansion of any consequence that is expected in these units by 1979 is that of Zuari Agro. The rated capacity for the two main competitors by 1979 will be:

Rated Capacity of Competitors
(000 Tons)

Unit/Product	1972 N	1972 P_2O_5	1979 N	1979 P_2O_5
GSFC				
Ammonium Sulphate	30.5	-	47.8	-
Urea	166.2	-	166.2	-
DAP	21.6	51.8	21.6	51.8
	218.3	51.8	235.6	51.8
Zuari Agro				
Urea	-	-	156.4	-
NPK	-	-	42.0	42.0
			198.4	42.0
Total	218.3	51.8	434.0	93.8

26. GSFC in 1974 marketed in Maharashtra only 5 percent of its N production and no P_2O_5. It could be expected by 1979 to stop completely its marketing in Maharashtra as the market in Gujarat increases. Similarly, for Zuari Agro the economic marketing area is in Goa, Mysore and some southern districts of Maharashtra. Only relatively small quantities of fertilizers could be expected to be sold by this unit in Maharashtra in 1979.

27. However, to take into account the most adverse situation, it is assumed that the demand for P_2O_5 in the State will first be met by the straight P_2O_5 producers within the State and, in the case of the remaining nutrients, both GSFC and Zuari Agro will also be marketing in Maharashtra together with FCI Trombay on the basis of relative freight advantages. The following are the assumptions with regard to share of each of these major producers with regard to their N and P_2O_5 production:

a) FCI's share of market will be 80% in the districts where it has a freight advantage of Rs 10/ton or more over the closest competitors;

b) Where the freight advantage is more than Rs 5/ton but less than Rs 10/ton, FCI's share will be 75%;

c) Wherever freight advantage or disadvantage to FCI is less than Rs 5/ton, 80% of the total market will be shared by the competitors in proportion to their capacity of production;

d) Where FCI's freight disadvantage exceeds Rs 5/ton but less than Rs 10/ton, 75% of the market will be shared by the competitor having most favorable location and the remaining 25% will be shared by others along with FCI in proportion to their capacity; and

e) Where the freight disadvantage exceeds Rs 10/ton, 80% of the market will be shared by the manufacturers located most favorably and the remaining 20% by FCI and other competitors in proportion to their capacity.

28. The following table gives the historical distribution of Trombay's production in different States during the years 1971 and 1973, and projections for 1979 based on the above analysis of freight cost advantages:

Distribution of FCI Trombay's Production

Quantity Marketed
('000 Tons of Product)

State	1971 Urea	1971 NPK	1973 Urea	1973 NPK	1979 Urea	1979 NPK
Maharashtra	34	65	49	116	227	432
Gujarat	4	20	1	3	18	28
Andhra Pradesh	10	23	2	30	-	7
Mysore	5	20	2	46	-	53
Tamil Nadu	3	4	-	-	-	-
Madhya Pradesh	-	-	-	-	-	25
Other States	-	20	-	50	-	-
Total	56	152	54	245	245	545

28. There are a few districts in Gujarat, Madhya Pradesh, Andhra Pradesh and Mysore with favorable freight rates compared to some districts of Maharashtra, and FCI will maintain marketing organizations in these districts to assure maximum flexibility and minimum freight costs in marketing.

F. Credit

29. Most farmers in India continue to be marginal or sub-marginal and depend to a large extent on credit for purchase of fertilizers. It is estimated that the credit requirement of farmers for purchase of fertilizers would be about 70% of the total sale value of fertilizers in any particular year. The credit to farmers in Maharashtra is usually advanced by Primary Agricultural Cooperative Credit Societies. About 25% of the credit advanced by Cooperatives is normally for fertilizers. The following table gives the value of fertilizers sold in Maharashtra for the years 1968 to 1971, the estimated requirement of credit of farmers for purchase of fertilizers for those years, and the estimated credit distributed by Primary Agricultural Societies for this purpose.

Credit Requirement and Actual Credit Distributed in Maharashtra during 1968-1971
(Rs Million)

Year	Value of Fertilizer Purchased by Farmers	Estimated Credit Requirements	Total Credit Advanced by Cooperatives	Estimated Credit Given for Fertilizers
1968	364	255	796	199
1969	268	188	874	219
1970	304	213	968	242
1971	408	286	940	235

30. Future requirements of credit in Maharashtra have been based on the projections of fertilizer consumption given by Donde and Brown. The likely requirements of fertilizer credit for 1977 under the two sets of projected consumption for N and P fertilizers are:

Farmers' Requirements of Credit, 1977

	Nutrient	Estimated Demand for Fertilizer ('000 Tons)	Value (Rs Million)	Likely Requirement of Credit (Rs Million)
High Estimate	N	429	894	626
	P	262	585	409
Total		691	1,479	1,035
Low Estimate	N	356	742	519
	P	203	453	317
Total		559	1,195	836

31. The total estimated credit of farmers would be of the order of Rs 1,035 million at the higher estimate and Rs 836 million at the lower estimate of consumption of N and P_2O_5 fertilizers by 1977.

32. The entire farm credit is expected to be channelled through cooperatives or through nationalized commercial banks. The nationalized commercial banks have large expansion schemes for meeting rural credit including that for fertilizers. Distribution credit would be met by the Reserve Bank and apex cooperative institutions as far as the distribution through cooperative channel is concerned. As cooperatives account for 50% of the distribution, their requirement of credit for N and P_2O_5 fertilizers is of the order of about Rs 300 million to 400 million in Maharashtra in 1977 which will be met from these sources. The private dealers will have to depend on nationalized banks. The credit to dealers for fertilizers is guaranteed by the Agricultural Credit Guarantee Corporation if the sale of the dealer is within Rs 500,000. This would cover about 80% of the fertilizer dealers in the country. On the whole, there should be little difficulty with regard to farmers' credit as far as Trombay's marketing area is concerned.

G. Transportation

33. The entire production of Trombay will be marketed within a freight zone of Rs 32 per ton under the "high" projected demand by Donde and Brown. In this case, urea would be marketed within a freight of Rs 23/ton and NPK would be marketed within a freight of Rs 32/ton. For both urea and NPK the average freight under the high demand forecast would be Rs 22/ton.

34. If the low forecast is used as a basis, urea will be marketed within a freight of Rs 24/ton and NPK within a freight of Rs 45/ton. The average freight in this case would be Rs 24/ton.

Average Freight
(Rs/ton)

Demand Alternatives (Donde-Brown)	Maximum Freight Within Which Entire Production Will be Marketed		Average Freight For All Products	Actual Freight 1973	
	Urea	NPK		Urea	NPK
High	22.8	32.2	21.6	38	58
Low	23.6	44.6	24.0		

35. The bulk of despatches from Trombay is by rail. During 1972 only 24 % of the urea and 3% of the NPK were despatched by road as shown below:

Quantities Despatched by Rail/Road - 1972
('000 tons)

Despatches by:		Urea	NPK	Total
Rail	Quantity	50	212	262
	%	76	97	96
Road	Quantity	16	8	24
	%	24	3	4
TOTAL	Quantity	66	220	286
	%	100	100	100

36. There has been no difficulty in obtaining railway wagons for despatches from Trombay. The number of wagons loaded from Trombay in different months for the period January to December 1972 was:

Number of Wagons Loaded in Trombay - 1972

Year	Month	No. of Wagons Loaded
1972	January	1,485
	February	1,287
	March	1,217
	April	917
	May	884
	June	1,008
	July	1,105
	August	1,163
	September	1,131
	October	946
	November	1,106
	December	1,066
	Total	13,315

37. The frequency distribution with regard to wagons loaded per day during 1972 was:

Frequency Distribution of Wagons Loaded per Day

No. of Wagons Loaded per Day	No. of Days	No. of Wagons Loaded per Day	No. of Days
Nil	14	51-55	25
1-5	8	56-60	19
6-10	18	61-65	13
11-15	27	66-70	10
16-20	25	71-75	4
21-25	36	76-80	2
26-30	42	81-85	2
31-35	36	86-90	2
36-40	34	91-95	-
41-45	34	96-100	1
46-50	13	101-105	1

The days on which no loading took place refer to those on which there was no production and it was not due to non-availability of wagons.

38. In 1978, when the Trombay Expansion Project (Trombay IV) goes into production, the total requirement of wagons per month will be as given below, if the entire production is to be moved by rail.

Monthly Requirements of Railway Wagons

Month	NPK		Urea		Total	
	Qty (000) Tons	No. of Wagons	Qty (000) Tons	No. of Wagons	Qty (000) Tons	No. of Wagons
January	44	1,833	7	299	51	2,125
February	19	792	3	125	22	917
March	18	750	3	125	21	875
April	41	1,708	6	250	47	1,958
May	86	3,583	13	541	99	4,124
June	106	4,417	16	667	122	5,084
July	74	3,083	12	500	86	3,583
August	42	1,750	6	250	48	2,000
September	43	1,792	7	292	50	2,084
October	78	3,250	12	500	90	3,750
November	82	3,418	13	541	95	3,959
December	65	2,708	10	417	75	3,125
Total	698	29,084	108	4,500	806	33,584

39. During the peak period, i.e., in June, Trombay would need about 170 wagons per day for loading both urea and NPK. Trombay has already been handling over 100 wagons on some days even at the present level of capacity and production.

40. With the Trombay Expansion Project (Trombay IV) going into production, the proportion of quantity despatched by road is likely to increase. It is estimated that despatches up to 200 km radius is cheaper by road than rail. There are four districts in Maharashtra within this distance from the Trombay factory and estimated sale in these districts is given below:

Estimated Sales in Districts Within 200 km
(000 Tons Per Year)

Districts Within 200 km	Estimated Sales					
	High Forecast			Low Forecast		
	Urea	NPK	Total	Urea	NPK	Total
Thana	12	26	38	10	20	30
Kolaba	2	48	50	9	37	46
Nasik	22	37	59	19	29	48
Poona	48	47	95	41	37	78
Total Sales	84	158	242	79	123	202

41. The total likely sales in these districts, it may be seen, amount to 242,000 tons accounting for about 30% of total sales, if we take the higher projected demand and 202,000 tons, accounting for 25%, if we take the lower projection of demand. To this extent, the requirement of railway wagons is likely to be reduced. If the likely despatches by road are also taken into account, the peak period requirement is likely to be reduced from 170 per day mentioned to 120 or 130 per day.

42. The expansion of existing railway facilities inside the unit has been planned for in the project with additional tracks of about 4 km covering the new bagging plant and other areas. The interchange yard with railways ensuring direct reception and despatch of trains to and from FCI's siding is also provided for in the project.

43. The outward despatches by rail have to traverse through three lines originating from Bombay, two of which are of the Central Railway and the third of the Western Railway. The bulk of the despatches would be made via two Central Railway routes, viz. Bombay-Manmad in the north-western region and Bombay-Poona in the south-eastern region. About 88% of the despatches would be made via the Central Railway route.

44. The probable future distribution by road and rail is summarized below:

Likely Distribution of Fertilizers by Road and Rail in 1973 and 1979
('000 Tons)

		Rail	Road	Total
1973	(Actual)			
	Urea	51	3	54
	NPK	233	12	245
	Total	284	15	299
1979	Urea	102	143	245
	NPK	468	77	545
	Total	570	220	790

H. Distribution System

45. Trombay has a strong dealer network in Maharashtra consisting of both cooperatives and private traders. The number of dealers under each of these categories at the end of December 1972 was:

Number of Dealers - Cooperative and Private
December 1972

Distribution	Number
Cooperatives	88
Private	91

46. Each of these dealers have 5-10 retailers under them. About 60% of production is projected as sales through cooperatives as shown below:

Quantity of Fertilizers Distributed Through Private/Coop. Dealers
('000 Tons)

	Private			Coop.			Percentages Distributed Through:	
Year	Urea	NPK	Total	Urea	NPK	Total	Coop.	Private
1970	18.8	27.7	46.5	22.8	6.7	29.5	39	61
1971	28.0	59.9	87.9	15.7	26.7	42.4	33	61
1972	15.2	37.7	52.9	46.2	53.2	99.4	65	35
1973	-	-	-	-	-	-	65	35
1977	-	-	-	-	-	-	60	40
1979	-	-	-	-	-	-	60	40

I. Prices

47. The prices of various grades of NPK produced by Trombay during the years 1971 and 1973 are:

Price of Main NPK Products Manufactured by Trombay (Rs/Ton)

Grade	Date	Ex-Works[1/]	Freight	F.O.R. Destination	Dealer Margin	Consumer Price
20:20:0	7. 5.71	800[1/]	40	840	60	900
	31.10.73	992	50	1,042	80	1,122
15:15:15	7. 5.71	770	40	810	60	870
	31.10.73	1,080	50	1,130	80	1,210

1/ Including 15% excise duty.

48. The prices of some of the competitors during 1972 were:

Price of Competitors' Products

Producer/Grade		Ex-Works Incl.15% Excise Duty	Freight	F.O.R. Destination	Dealer Margin	Consumer Price
Coromandel	28:28:0	1,231	65	1,296	64	1,360
	20:20:0	882	45	927	60	987
Zuari Agro	28:28:0	1,273	65	1,338	64	1,402
Madras Fertilizer						
	17:17:17	941	50	991	114	1,105
	14:28:14	1,042	50	1,092	114	1,216

49. The price of imported NPK 20:20:0 for 1969-73 is given below:

Average Price of Imported NPK
(Rs/Ton)

Country	Year	Bulk Bagged	F.O.B. Price	Estimated Freight	C & F Price
1. Germany	1969	Bagged	435	124	559
2. France	1971	Bagged	435	124	559
3. Germany	1971	Bagged	482	124	606
4. Fermany/France	1972	Bagged	495	124	619
5. Germany	1973	Jute Bag	577	150	727
		P.P. Bag	550	150	700
6. Germany	1973	Bulk	485	150	635

Industrial Projects Department
March 1974

INDIA: TROMBAY EXPANSION PROJECT

DESCRIPTION OF THE PROJECT

The Project is an expansion of the FCI's production facilities in the Trombay Unit designed to increase the production capacity of nitric acid by 250,000 tons per year and nitrophosphate fertilizers by 355,000 tons per year, including:

(i) Construction and commissioning of a single-train nitrophosphate production plant with a capacity of 355,000 tons per year (1,200 TPD);

(ii) Construction and commissioning of a single-train nitric acid plant with a capacity of 250,000 tons per year (750 TPD);

(iii) A steam generation unit, cooling towers, bagging machine and storage equipment, water treatment plant and miscellaneous equipment for Trombay IV; and

(iv) Utilization of engineering services for procurement and erection of equipment, materials and facilities for Trombay IV.

Nitric Acid Manufacture from Ammonia

Nitric acid production from ammonia takes place in two main stages - conversion and oxidation-absorption. In the first stage, liquefied ammonia is vaporized, mixed with the correct proportion of cleaned air and converted to nitrous oxides by burning over an assembly of platinumrhodium alloy screens. The nitrous oxides are converted to nitric oxides by the appropriate admission of air or oxygen and these gases absorbed by water in a tall column to produce a nitric acid solution containing 57 to 60% HNO_3. The conversion reaction produces much heat, which is used to raise steam for driving a turbine which powers several gas compressors used in the process. After absorption of most of the nitrogen oxides, process gas leaving the column is heated by transferring heat, via a suitable exchanger, from other in-process gas and expanded in a gas turbine to produce additional compressor power.

Nitrophosphate Manufacture

The nitrophosphate plant will produce 355,000 TPY of 21-21-0 grade nitrophosphate from phosphate rock and nitirc acid. The product will contain 75,000 TPY N and 75,000 TPY P_2O_5 (with at least 60% of the P_2O_5 in a water soluble form). Phosphate rock containing about 35% P_2O_5 is digested with nitric acid and ammoniated. Reaction products include phosphoric acid, ammonium phosphate, ammonium nitrate and calcium nitrate. The reaction liquor is centrifuged or filtered to remove insolubles and then chilled with brine to crystallize the calcium nitrate (CN), which is separated by centrifuging or filteration. The CN crystals are washed, melted and converted by reacting with ammonia and carbon dioxide to ammonium nitrate plus precipitated chalk, which is filtered off and can be used as outlined above.

The ammonium nitrate liquor is utilized in existing Trombay facilities. The highly concentrated solution is prilled by spraying from the top of a large cylindrical tower and the solid spheres or prills cooled, coated with a moisture resistant agent and bagged. The NP liquor, after removal of CN, is also evaporated, prilled, cooled, treated and bagged. The NP product will contain about 21% N and 21% P_2O_5 but provision will be made to add a potassium salt at a future time to make N-P-K grades. If desired, AN and NP liquors can be combined before prilling to give different ratios of N and P_2O_5 in the NP product.

Raw Materials and Utilities

The principal raw materials to be used are ammonia, phosphate rock and diammonium phosphate (DAP) or triple superphosphate (TSP). The ammonia requirements (about 97,000 TPY) of the project will be met from the new ammonia plant to be established at Trombay as part of the Trombay V development program which is to be carried out simultaneously with the expansion project (Trombay IV) but will go into operation about one year later (in 1979) than Trombay IV. The Government has stated that during the first year of operation in particular and in the subsequent years until Trombay V reaches full production, the ammonia needs of the project will be met from various local sources as well as imports possibly from Kuwait, Iran and Qatar to the extent necessary.

The proposed Trombay V project will have a 900 TPD (or 300,000 TPY) ammonia plant with surplus product available of which about 97,000 TPY to be transferred to Trombay IV to meet its entire ammonia needs. The ammonia plant will utilize heavy fuel oil as a raw material to be received through the existing pipelines to Trombay from the two nearby refineries--Burmah Shell and Esso.

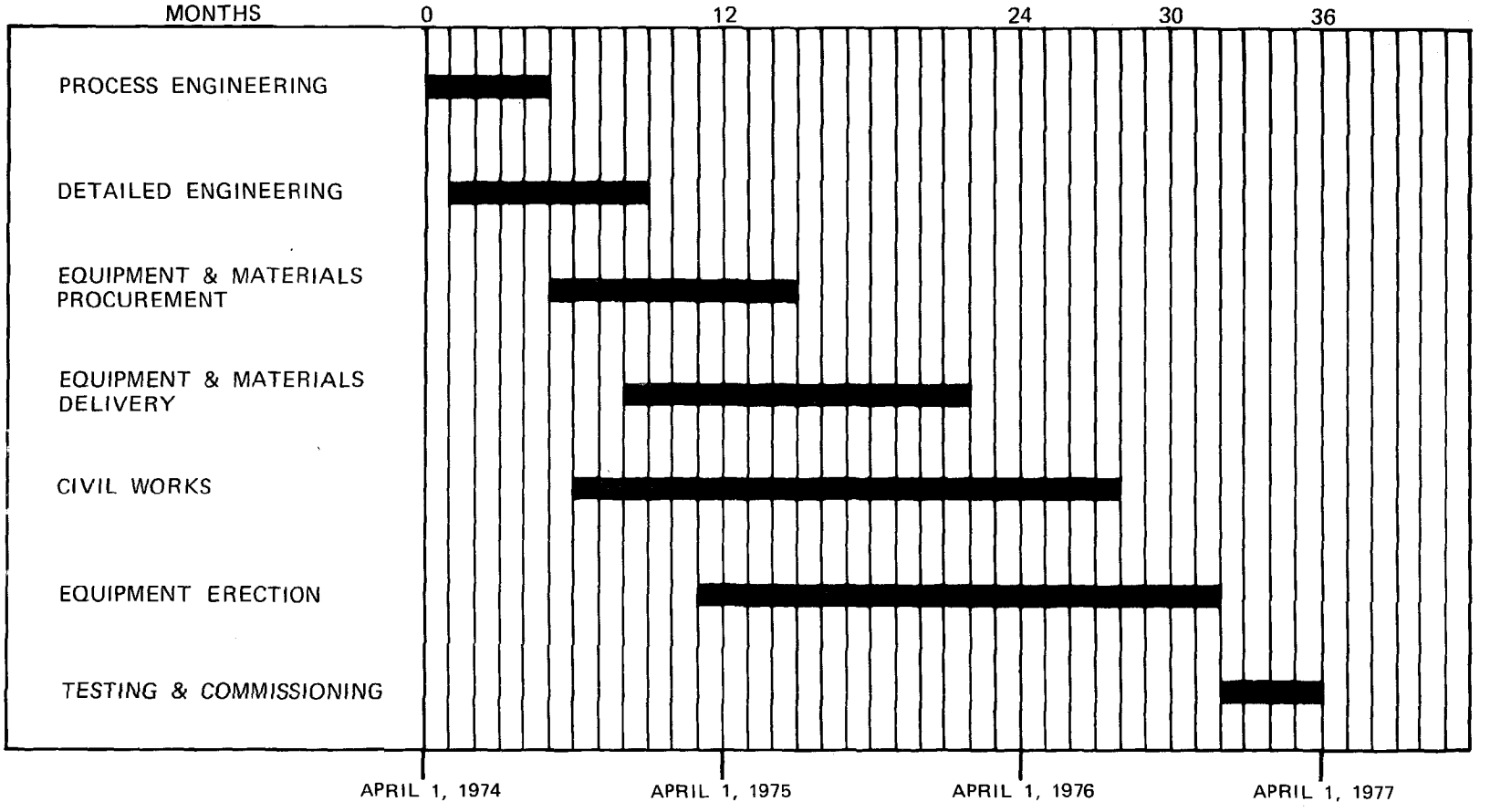
India produces small quantities of phosphate rock in Rajasthan, but meets most of its requirements for fertilizer production from imports. As Rajasthan production increases, eventually all of Trombay's needs could be met locally. However, for the purpose of this report, it is assumed that all phosphate rock requirements (about 151,000 TPY) of Trombay's new nitrophosphate plant would be met from imports as supply from Rajasthan is not assured. Nevertheless, with high rock prices and freight rates which together have recently more than doubled the c.i.f. prices of imported rock, the development of the Rajasthan phosphate deposits has become even more urgent.

Trombay current imports DAP for use in the production of the 15-15-15 grade NPK fertilizers. DAP as well as TSP are widely traded commodities in the world and no serious problem is foreseen in meeting the project's relatively small requirements of about 44,000 TPY of DAP or TSP. According to present plans, Trombay IV will be using locally-produced TSP.

Tata Power Company (generating capacity: 615 MW) currently supplies 40 MW to Trombay through a sub-station--located adjacent to the factory-- which has two 90 MVA transformers. Two additional transformers will be installed under the project whose power requirements are estimated at 9 MW; and a new sub-station is expected to be established by Tata which has informed FCI that it could meet fully the additional requirements of Trombay subject to the approval of the Maharashtra State Government. The provision of other services such as water is not expected to pose any problems.

INDIA: TROMBAY EXPANSION PROJECT

IMPLEMENTATION SCHEDULE – TROMBAY IV



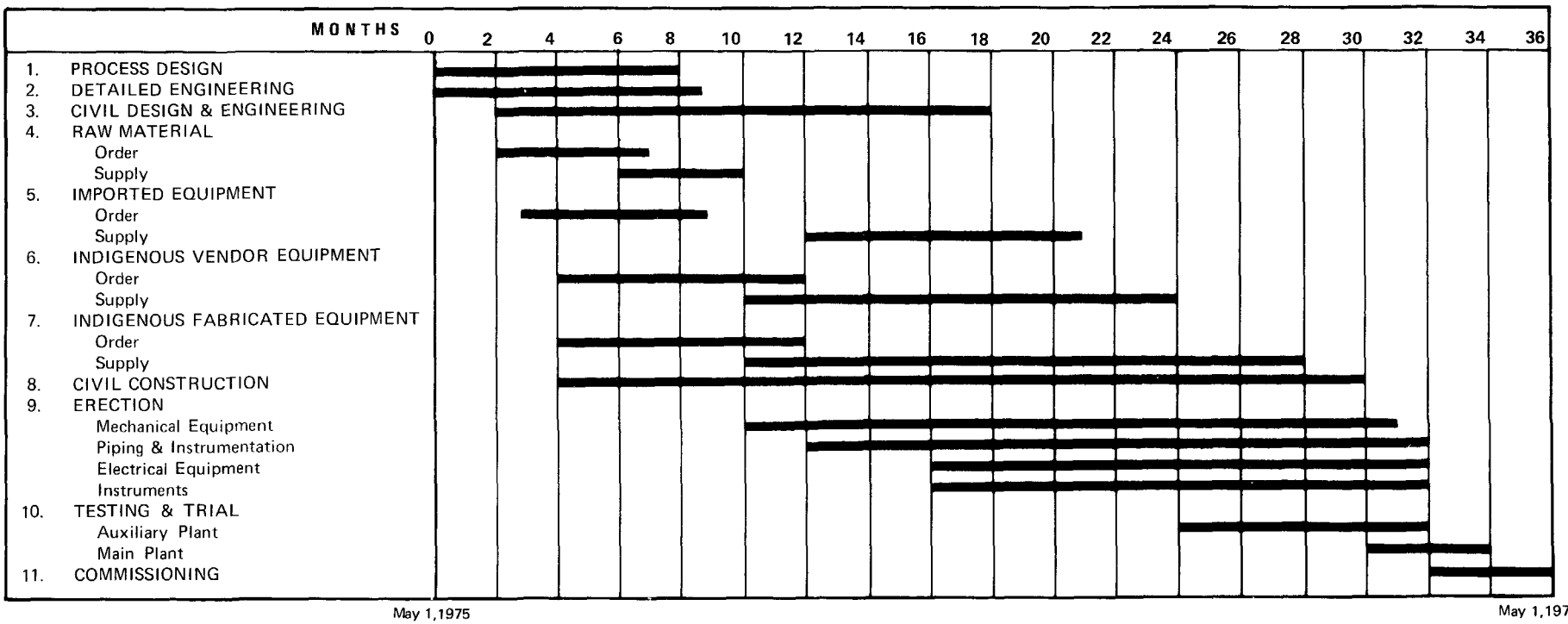
Industrial Projects Department
March, 1974

Note: The nitric acid plant is scheduled for commissioning six months earlier than the NPK plant.

World Bank–8635(R)

INDIA-TROMBAY EXPANSION PROJECT. IMPLEMENTATION SCHEDULE.

TROMBAY V



World Bank–8808

ANNEX 5-2

INDIA: TROMBAY EXPANSION PROJECT

ECOLOGY

1. There are several potentially harmful waste streams from the Trombay expansion project inherent in the raw materials and technology to be used. Phosphate rock contains about 3% fluorine, about 10% of which is emitted as gaseous compounds during processing. This gas would be processed and fluorine emission to the air would be limited to an acceptable level of about 10 kg/day, comparable to standards in the U.S. Further, there is a solid waste stream from limestone produced as a by-product of phosphate rock processing. This material can be used in the cement industry and sufficient market could be developed in the Bombay area to minimize disposal problems.

2. The nitric acid plant discharges nitrogen oxide gas as an effluent and the emission level has been set at 200 ppm maximum, which is comparable to the regulation now in force in the U.S. The Bombay City Corporation has not officially set a limit on emissions but legislation is expected. The project includes modern, efficiently-designed plants with modern pollution control equipment, thus minimizing the dangers from harmful emissions.

3. The total emissions at Trombay[1/] even after expansion would be at an internationally acceptable level as shown below:

Emissions at Trombay
(Kg/day)

	Expansion Project Proper (Trombay IV)	Total After Trombay IV
SO_2	0	30
NO_2	1,000	1,450
Fluorine	10	22

1/ Refer to Annex 2-7 for existing emission levels.

Industrial Project Department
May 1974

INDIA: TROMBAY EXPANSION PROJECT

IMPLEMENTATION PLAN FOR

PLANT OPERATIONS IMPROVEMENT

FCI

1. The Fertilizer Corporation of India has at present in operation five manufacturing units with a total installed capacity of 376 thousand tons of nitrogen and 36 thousand tons of P_2O_5. These include the plants at Sindri, Nangal, Trombay, Gorakhpur and Namrup with the installed capacities summarized below:

	(in '000 tons of nutrients)	
Unit	Nitrogen	P_2O_5
Sindri	90	-
Nangal	80	-
Trombay	81	36
Gorakhpur	80	-
Namrup	45	-
Total	376	36

2. The Company has also under construction a large number of projects, as summarized below, with a total installed capacity of 1,285 thousand tons of nitrogen and 251 thousand tons of P_2O_5.

	(in '000 tons of nutrients)	
Unit	Nitrogen	P_2O_5
Durgapur	152	-
Barauni	152	-
Namrup Expansion	152	-
Talcher	228	-
Ramagundam	228	-
Haldia	152	75
Gorakhpur Expansion	51	-
Nangal Expansion	152	-
Sindri Rationalization	-	156
Trombay Debottlenecking	18	18
Total	1,285	249

3. The following additional projects have been planned and work on them has been or is being initiated by the Company. These projects would have a total installed capacity of 873 thousand tons of nitrogen and 375 thousand tons of P_2O_5.

Unit	(in '000 tons of nutrients) Nitrogen	P_2O_5
Korba	228	-
Sindri Modernization	129	-
Trombay IV	75	75
Trombay V	130	-
Paradeep	311	300
Total	873	375

4. The total capacity of 2,534 thousand tons of nitrogen and 660 thousand tons of P_2O_5 in operation and in various stages of implementation would place strains on the financial, managerial and technical resources of the Corporation. These strains have been further accentuated by (a) the relatively low utilization of capacity already in operation, (b) the problems that have been faced in commissioning and bringing to full utilization of capacity new projects like Durgapur, and (c) delays that are occurring in completing the projects under implementation, especially those nearing mechanical completion like Barauni and Namrup Expansion.

5. The capacity utilization of the five manufacturing units in operation in FCI during the last three years is summarized below:

(production in '000 tons of N)

Unit	Capacity	1971/72 Production	%	1972/73 Production	%	1973/74 Production	%
Sindri	90	63	70	56	62	59	66
Nangal	80	56	70	53	66	62	77
Trombay	81	66	84	70	86	65	80
Gorakhpur	80	76	95	69	86	64	80
Namrup	45	30	67	35	78	36	80
Total	376	291	77	283	75	286	76

The five operating units of FCI lost a total of 48.2 thousand tons of nitrogen due to power cuts and fluctuations in the year 1973/74. Allowing for this loss in production, the overall utilization of capacity would be about 89 percent. Nangal and Gorakhpur accounted for the major loss in production due to power cuts and fluctuations.

6. Several steps have been initiated and implemented in the recent past to improve the levels of capacity utilization in the five units. These are briefly summarized below:

Sindri

1. Installation of a supplementary naphtha gasification unit to improve syn gas availability.

2. Installation of lean gas generators to release coke oven gas for improving levels of production.

3. Naphtha injection in the gas reformation section to supplement gas availability.

4. Extensive renovation work in progress to achieve improved stream factors.

5. A rationalization program to replace natural gypsum from Rajasthan by Phosphogypsum.

6. A modernization program to replace existing coke/coke oven gas-based ammonia facilities.

Nangal 1. An expansion program is under implementation to replace electrolytic hydrogen based ammonia.

Trombay 1. Extensive modifications/improvements to remove design/engineering deficiencies.

2. Changeover of carbon dioxide recovery system from hot potash to Benfield.

3. Installation of naphtha gasification unit which would supplement gas availability for ammonia production.

4. Use of imported ammonia/ammonia from other domestic sources for supplementing fertilizer production.

5. Debottlencking of the NPK and urea plants.

Gorakhpur 1. Modifications have been or are being taken up to improve plant reliability.

2. An expansion project is under implementation taking advantage of available installed spares.

3. An in-plant power generation unit of 12.5 MW capacity is proposed to be installed to minimize losses due to power interruptions.

Namrup 1. Based on plant operating experience, steps have been taken to remove bottlenecks. There are still some problems in maintaining sustained operation in the sulphuric acid and ammonium sulphate plants. There is also a proposal to introduce an LT conversion catalyst in the ammonia plant.

FACT

7. The Fertilisers and Chemicals (Travancore) Ltd. has an operating unit in Udyogamandal, Kerala, with an installed capacity of 82,000 tons of nitrogen. The Company has also been commissioning the ammonia/urea complex at Cochin. This plant, which faced considerable difficulties during the commissioning period, is now operating at around 50% of the installed capacity. The Company is also implementing a Cochin II project which would add to capacity by 40 thousand tons of nitrogen and 114 thousand tons of P_2O_5. The Udyogamandal plant of FACT has been operating at less than 50% of the installed capacity.

(production in '000 tons of N)

Year	Installed Capacity	Production	Percentage
1971/72	82	40	49
1972/73	82	31	38
1973/74	82	39	48

8. The following steps have been taken to improve production:

(1) Installation of a spare phosphoric acid reactor.

(2) Installation of thickener for gypsum slurry used for ammonium sulphate production.

(3) Modifications and improvements to economize on inputs by improving efficiencies.

(4) Replacement of acid coolers, drying towers and absorption towers in old sulphuric acid plants.

(5) Supplementing rock phosphate grinding facilities.

(6) Phosphoric acid concentration facilities.

Plants Being Commissioned

9. The two public sector projects at Durgapur and Cochin faced considerable difficulties and delays both in their completion and their commissioning. These two projects, which were mechanically completed in October 1971, have not yet been stabilized for commercial production due to the various problems that were encountered during commissioning. Failures occurred during commissioning in the various sections of the ammonia plant and it was not until late 1973 that the plants could be brought to trial production. Even though these plants have operated through short periods at around 50% of the rated capacity, it has still not been possible to operate these plants at reasonable production levels on a sustained basis. The FCI have entered into an agreement with Tecnimont for carrying our an end-to-end technical survey of the Durgapur plant and recommending improvements, changes and modifications necessary to stabilize production. The recommendations of the Tecnimont study would be available in about two months.

10. The Barauni and Namrup expansion projects are nearing mechanical completion and are due for commissioning during the year 1974. These two projects are based on technologies similar to those adopted in Durgapur and Cochin and have also obtained the major equipment supplies from Italy. Special precautions are therefore being taken to ensure that the problems encountered in commissioning Durgapur/Cochin do not recur at Barauni/Namrup. Already several modifications and changes which were required at Durgapur have been carried out at Barauni and Namrup. Based on the findings of the Tecnimont end-to-end survey, at Durgapur, some further changes may be considered desirable at Barauni/Namrup.

11. The large number of projects under implementation by the Fertilizer Corporation of India includes two major groups based on relatively newer technologies. These are the projects for the production of ammonia based on coal (Ramagundam, Talcher, Korba) and those based on heavy petroleum fractions (Haldia, Nangal Expansion, Sindri Modernization, Trombay V). Special care is required in the case of these projects to ensure technical reliability and ease in commissioning. Special detailed studies on these aspects at this stage can

identify likely difficulties and bring out changes or amendments necessary to minimize delays and problems likely to be encountered during the commissioning.

12. Considering the importance of maximizing utilization of installed capacity, expediting plants nearing completion and commissioning them with speed, it is proposed to set up a Coordination Group with the following terms of reference.

(a) Review the progress and performance of the various FCI/FACT units.

(b) Assess measures necessary to facilitate fuller utilization of capacity.

(c) Assess steps required to commission plants nearing completion and bring them up to reasonable levels of production.

(d) Assess the technological soundness of the process schemes and equipment used in the projects and carry out changes and modifications required to improve reliability and ease of commissioning.

(e) For the above purposes, have the necessary studies carried out by FCI/FACT engaging where required consultants and/or specialists.

(f) Assess the conclusions of such studies and, based on the assessment, recommend schemes for modification involving additional equipment and supplies, if necessary.

(g) Monitor the progress of the various studies and modification schemes and assess periodically the progress and results.

13. The Coordination Group would have the following composition:

(i) Adviser (Fertilizers) Covenor
Ministry of Petroleum and Chemicals

(ii) Director, Projects (Mr. K. S. Sarma), Fertilizer Corporation of India

(iii) Group Manager, Planning and Process Design (Mr. D. G. Rao)
Planning and Development Division
Fertilizer Corporation of India

(iv) General Manager (Dr. K. S. Gill)
FACT Engineering Design Organization
Fertilisers and Chemicals (Travancore) Ltd.

The Group would be assisted as necessary by consultants who will be appointed with the approval of IDA. The Coordination Group would carry out the responsibilities indicated in the above terms of reference along the lines broadly summarized below:

14. Selection of a Consultant Since the major areas in which the assistance would be utilized relates to the commissioning of the newer projects and bringing them up to fuller utilization of capacity, the FCI and the GOI would consult the various engineering companies regarding a suitable specialist who has experience

with the commissioning of large fertilizer plants. The specialist so selected would be appointed as consultant to the Coordination Group after approval by IDA. He would be provided with necessary staff assistance by FCI.

15. Studies Relating to Existing Operating Units Dr. K. S. Gill of FACT would carry out a detailed study of the steps that are required to be taken to improve the utilization of capacity at Udyogamandal. He would be assisted in this study by the technical staff of FEDO and the Udyogamandal unit. He could also draw on the experience available with FCI in carrying out these studies. Mr. D.J. Rao of FCI would carryout similar studies in relation to the five operating units of FCI. He would be assisted in these studies by the technical staff of the P&D Division and the individual operating units. These studies, as and when they are ready, would be considered by the Coordination Group and recommendations for remedial measures would be made to IDA and GOI.

16. Studies Relating to Durgapur, Cochin, Namrup and Barauni Based on the experience gained during the trial runs and commissioning of the Durgapur and Cochin projects, the FCI and FACT engineers have identified several areas where modifications and/or changes are necessary before plant operations can be stabilized. As was mentioned earlier, FCI have also engaged Tecnimont to carry out an end-to-end survey of the Durgapur plant. The studies would be started in June 1974 and would take a period of about two months. The major areas of modifications/improvements would be evolved keeping in view the findings of FCI/FACT and the recommendations of Tecnimont. This would be done by the Coordination Group in consultation with IDA. In the case of Barauni and Namrup Expansion projects, the modifications would be carried out in two parts. Such of those changes as were necessary during the commissioning of Durgapur and Cochin are already being implemented. These would have to be carried forward and completed. In addition, when decisions become available on the extent of further modifications to be carried out at Durgapur and Cochin, these would be examined to determine the extent to which similar changes should be carried out at Barauni and Namrup.

17. Procurement Procedures for Equipment and Materials The Bank Group Guidelines and the procurement schedule of the Trombay IV Project Agreement would be followed. Wherever the items of supplies are in the nature of spares, components or replacements, these would be obtained from the original suppliers through direct negotiations. In the case of items available from a limited number of qualified suppliers and for which timely delivery is critical, procurement would be through international shopping with the approval of IDA. The Government of India already has in operation a scheme for a revolving fund of Rs 5 million available as free foreign exchange to cover the emergency requirements of the fertilizer industry. Small items of supplies and services required by FCI and FACT on an emergency basis could be covered from the above fund initially, in anticipation of IDA clearances and IDA reimbursement sought subsequently. This fund is operated by a group of three representing the Ministry of Petroleum and Chemicals, the Department of Economic Affairs, and DGTD. Releases of foreign exchange and clearances of foreign exchange can be processed under this scheme in a few days after receipt of full details of the requirments.

18. Estimated Time Schedule The program may be implemented as per the following indicative time schedule:

(i) Formation of Coordination Group June 1974

Operating Units

(ii)	Availability of studies	July to September 1974
(iii)	Clearances by Coordination Group	August to October 1974
(iv)	Approval by IDA and GOI	August to November 1974
(v)	Ordering	September to January 1975
(vi)	Delivery/Disbursement	January 1975 to June 1976

Durgapur, Cochin, Barauni and Namrup

(i)	Availability of Tecnimont study	August 1974
(ii)	Formulation of recommendations by FCI/FACT	September 1974
(iii)	Clearance by Coordination Group	October 1974
(iv)	Clearance by IDA and GOI	November 1974
(v)	Ordering	November 1974 to January 1975
(vi)	Delivery/Disbursement	February 1975 to June 1976

TENTATIVE LIST OF POSSIBLE USE OF FUNDS AVAILABLE FOR PLANT OPERATIONS IMPROVEMENT

(millions of $)

			Approximate Foreign Exchange Requirement
A.	General Consultant for Coordinating Group		0.50
B.	FCI Plants Nearing Commissioning		
	1. Durgapur		3.00
	Boiler and Steam System	1.00	
	Boiler Feedwater Heater	0.50	
	Other Items including Consumable Materials	1.50	
	2. Barauni		3.00
	Pumps	1.00	
	Heat Recovery System	1.00	
	Other Items including Consumable Materials	1.00	
	3. Namrup		2.00
	Pumps	1.00	
	Other Items including Consumable Materials	1.00	
	4. Consulting Services		0.50
C.	FACT Plant Nearing Commissioning		
	1. Cochin I		3.00
	Boiler and Steam System	1.00	
	Ammonia Condensors	0.50	
	Other Items including Consumable Materials	1.50	
D.	FCI Operating Plants		
	1. Gorakhpur		2.00
	Turbo-Alternator	2.00	
	2. Namrup		0.50
	Modifications to Sulphuric Acid and Ammonium Sulphate Plants	0.50	
	3. Emergency Consumable Materials		1.50
E.	FACT Operating Plant		
	1. Udyogmandal		1.00
	Suphuric Acid Plant and Phosphoric Acid Plant	1.00	
	TOTAL		17.00

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INDIA: TROMBAY EXPANSION PROJECT

PROJECT COST ESTIMATES

1. The basis for the calculation of the project cost is explained below.

A. **Equipment and Spares**: The costs of equipment and spares are estimated on the basis of price quotations received in April 1974 from prospective foreign suppliers, and are shown in the following table:

ESTIMATED COST OF EQUIPMENT AND SPARES
(In Million)

	Rupees			US$		
	Foreign	Local	Total	Foreign	Local	Total
1. Nitrophosphate Plant	42.5	9.0	51.5	5.67	1.20	6.87
2. Nitric Acid Plant	28.5	6.0	34.5	3.80	0.80	4.60
3. Other Equipment:						
- Steam Generation	4.7	7.3	12.0	0.63	0.98	1.61
- Water Treatment	0.4	0.7	1.1	0.05	0.09	0.14
- Cooling Towers	1.4	2.2	3.6	0.19	0.29	0.48
- Bagging & Product Storage	3.0	4.6	7.6	0.40	0.61	1.01
- Raw Material Handling & Storage	2.6	4.2	6.8	0.35	0.56	0.91
- Yard Piping & By-Product Disposal	2.5	2.9	5.4	0.33	0.39	0.72
- Electrical Installation	2.5	3.0	5.5	0.33	0.40	0.73
- Water Supply System	0.4	0.7	1.1	0.05	0.09	0.14
- Storage Tanks for Nitric Acid, Carbon Dioxide & Fuel Oil; Ammonium Nitrate CO_2 Compressor and Rock Grinding Facilities	4.7	6.9	11.6	0.63	0.92	1.55
- Railway Tracks	0.9	1.3	2.2	0.12	0.17	0.29
- Locomotives	0.9	1.3	2.2	0.12	0.17	0.29
- Fire Fighting	0.4	0.7	1.1	0.05	0.09	0.14
- Liquid Effluent Disposal System	0.9	1.2	2.1	0.12	0.16	0.28
4. Spares	8.7	2.0	10.7	1.16	0.28	1.44
Total	105.0[1/]	54.0	159.0	14.00	7.20	21.20

1/ Of this, about US$7.8 million would be the foreign exchange component of equipment to be supplied by India under international competitive bidding.

B. Ocean Freight (C&F Cost): 10% of the total cost (FOB) of imported items. This amounts to Rs 11.0 million (equivalent to US$ 1.5 million).

C. Custom Duties: 40% of the total import cost (C&F) of imported items. They total Rs 46.6 million (US$6.20 million equivalent).

D. Sales Tax: 5% on the locally-supplied items. This amounts to Rs 2.3 million (equivalent to US$0.30 million).

E. Inland Handling Cost: 2% of the total cost of equipment and spares. This is estimated at about Rs 3.0 million (equivalent to US$0.40 million).

F. License Fee, Design, Engineering and Procurement Charges are estimated at Rs 27 million (equivalent to US$3.6 million) broken down as follows:

	Rs Million		
	Foreign	Local	Total
Nitrophosphate Plant	16.5	3.5	20.0
Nitric Acid Plant	6.5	0.5	7.0
Total	23.0	4.0	27.0

G. Erection, Commissioning and Supervision Charges for different facilities are shown below:

	Rs Million		
	Foreign	Local	Total
Nitrophosphate Plant	2.0	17.1	19.1
Nitric Acid Plant	3.0	8.7	11.7
Other Facilities	-	7.2	7.2
Total	5.0	33.0	38.0

H. Technical Assistance Cost for Project Management is based on the assumption that four foreign experts would be required for 90 man-months of service. Foreign training for selected Trombay management and engineering personnel will also be part of this program. The following table shows details of the technical assistance costs:

	Foreign	Local	Total
Foreign Experts	3.7	0.4	4.1
Training & Travel	0.3	0.5	0.8
Other	-	9.1	9.1
Total	4.0	10.0	14.0

I. Civil Works: The cost of civil works is estimated on the past experience in India in building fertilizer plants. The civil works cost on the nitrophosphate and nitric acid plants would be Rs 16.6 million and Rs 7.8 million respectively. Such costs for other facilities of the project are estimated at Rs 54 million.

J. Initial Working Capital: The assumptions for calculating this are given in Table 1.

K. Contingencies: A 5% physical contingency and 15% price contingency based on the total project cost (excluding initial working capital) is provided for. The large price contingency aims at adding escalation for possible price increases during the delivery period.

L. Cost of Housing Colony: Included in the project cost is Rs 3 million (equivalent to US$0.4 million) for a housing colony for employees of the Trombay Expansion Project.

Table 1

INDIA: TROMBAY EXPANSION PROJECT

WORKING CAPITAL REQUIREMENTS

	Assumptions	Amount (Rs Million)
1. Accounts Receivables	35-day sales	33.0
2. Raw Material and Supplies Inventory:		
- Rock Phosphate	100-day requirements	15.0
- Liquid Ammonia	30-day "	8.0
- Triple Superphosphate	100-day "	15.0
- Coal	5-day "	1.0
- Bags	21-day "	1.0
- Catalysts, Coating Agents, etc.	90-day "	5.0
3. Goods in Process		1.0
4. Product Inventories	14-day sales	13.0
5. Cash	0.3% of sales	1.0
Sub-Total		93.0
Less: Accounts Payable	15-day materials and supplies	5.0
Bank Borrowings (75% of Accounts Receivables and Inventories)		68.0
Net Working Capital		20.0

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INDIA: TROMBAY EXPANSION PROJECT

A. DISBURSEMENT SCHEDULE FOR TROMBAY IV
(In '000 US$)

Calender Year and Quarter	Disbursement	Amount Outstanding	Undisbursed Amount
1974 IV	1.0	1.0	32.0
1975 I	1.0	2.0	31.0
II	3.0	5.0	28.0
III	3.0	8.0	25.0
IV	4.0	12.0	21.0
1976 I	5.0	17.0	16.0
II	4.0	21.0	12.0
III	4.0	25.0	8.0
IV	4.0	29.0	4.0
1977 I	2.0	31.0	2.0
II	2.0	33.0	-

B. DISBURSEMENT SCHEDULE FOR PLANT OPERATIONS IMPROVEMENT FOR FCI AND FACT
(In '000 US$)

Calender Year and Quarter	Disbursement	Amount Outstanding	Undisbursed Amount
1974 IV	1.0	1.0	16.0
1975 I	2.0	3.0	14.0
II	3.0	6.0	11.0
III	3.0	9.0	8.0
IV	4.0	13.0	4.0
1976 I	2.0	15.0	2.0
II	2.0	17.0	-

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Industrial Projects Department
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ANNEX 7-1

INDIA: TROMBAY EXPANSION PROJECT

PROJECTED INCOME STATEMENTS FOR TROMBAY*
(Rs Million)

Year Ending March 31	1974 1/	1975	1976	1977	1978	1979	1980	1981	1982
Net Sales Revenue									
Gross sales revenue	377	488	520	593	853	953	1012	1012	1012
Less: excise duty	10	12	12	15	37	47	53	53	53
freight	1	4	4	5	14	19	21	21	21
Net Sales Revenue	366	472	504	573	802	887	938	938	938
Cost of Sales									
Raw materials and utilities	183	237	247	289	450	513	551	551	551
Salaries and wages	21	22	23	24	27	27	27	27	27
Maintenance materials	16	18	19	25	29	29	29	29	29
Depreciation	46	53	53	65	90	91	55	50	51
Deferred revenue expenditure		(1)	(1)	(1)		1	1	2	2
Total Cost of Sales	266	329	341	402	596	661	663	659	660
Gross Profit on Sales	100	143	163	171	206	226	275	279	278
Operating Expenses									
Selling expenses	7	8	9	11	13	15	17	17	17
General expenses	6	8	9	11	18	22	26	26	26
Total Operating Expenses	13	16	18	22	31	37	43	43	43
Net Profit on Sales	87	127	145	149	175	189	232	236	235
Miscellaneous Income (Expense)	8	7	7	7	-	(1)	-	(3)	(6)
Net Profit Before Interest	95	134	152	156	175	188	232	233	229
Interest and Other Debt Charges									
GOI loans	6	13							
Proposed IDA Credit	-	-	9	19	24	23	21	17	13
Total Interest and Other Debt Charges	6	13	9	19	24	23	21	17	13
Less Interest Charged to Construction	-	2	9	19	-	-	-	-	-
Interest charged to operations	6	11	-	-	24	23	21	17	13
Net Profit	89	123	152	156	151	165	211	216	216

1/ Based on nine months actual and three months estimate.

* Excluding Trombay V

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ANNEX 7-2

INDIA: TROMBAY EXPANSION PROJECT

PROJECTED SOURCES AND APPLICATION OF FUNDS FOR TROMBAY*
(Rs Million)

Year Ending March 31	1974	1975	1976	1977	1978	1979	1980	1981	1982	Summary 1975 - 1977	Summary 1975 - 1982
SOURCE OF FUNDS											
Internal Source of Funds											
Net profit before interest	95	134	152	156	176	190	233	237	236	442	1,514
Depreciation	46	53	53	65	90	91	55	50	51	171	508
Deferred revenue expenditure						1	1	2	2		6
Total Internal Source of Funds	141	187	205	221	266	282	289	289	289	613	2,028
Decrease in Net Working Capital	14	4								4	4
GOI Equity Investment & Advances		39	139	67	(15)					230	230
Proposed IDA Credit		15	113	105	15					248	248
Total Source of Funds	155	245	457	393	281	282	289	289	289	1,095	2,510
APPLICATION OF FUNDS											
Increase in Net Working Capital			8	1	31	9	11	(2)	2	9	53
Construction Expenditures											
Trombay IV Project - Construction		52	243	153						448	448
Interest		2	9	19						30	30
Total		54	252	172						478	478
Other construction	30	45	18	21	5	5	5	5	5	84	109
Total	30	99	270	193	5	5	5	5	5	562	587
Debt Service											
Interest											
GOI loans	6	11								11	11
Proposed IDA Credit					[illegible]	[illegible]	[illegible]	[illegible]	13		98
Total Interest	6	11			[illegible]	[illegible]	[illegible]	[illegible]	13	11	109
Amortization											
GOI loans	98	113								113	113
AID loan	21	21	11	21	3					53	56
FCI (proposed IDA Credit) loan						25	25	25	25		100
Total Amortization	119	134	11	21	3	25	25	25	25	166	267
Total Debt Service	125	145	11	21	27	48	46	42	38	177	376
Deferred Revenue		1	1	1						3	3
Total Application of Funds	155	245	290	216	65	62	62	45	45	751	1,015
Accumulated Cash Transferred to Head Office			167	177	216	220	227	244	244	344	1,495
Total Application of Funds	155	245	457	393	266	282	289	289	289	1,095	2,510

* Excluding Trombay V

Industrial Projects Department
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ANNEX 7-3

INDIA: TROMBAY EXPANSION PROJECT

PROJECTED BALANCE SHEET FOR TROMBAY UNIT* OF FCI
(Rs Million)

December 31,	Actual 1973	Forecast 1974	1975	1976	1977	1978	1979	1980	1981	1982
ASSETS										
Current Assets										
Cash	4	1	1	1	2	2	2	2	2	2
Receivables and Advances	41	56	52	53	53	61	78	86	86	86
Inventories	79	99	90	92	142	152	153	163	163	163
Total Current Assets	124	156	143	146	197	215	233	251	251	251
Deferred Revenue & Development Expenditures	3	3	4	5	6	6	5	4	2	-
Accumulated Cash Transferred to Central Office	-	-	-	167	344	560	780	1,007	1,251	1,495
Fixed Assets										
Gross fixed assets in operation	511	590	629	674	1,120	1,141	1,146	1,151	1,156	1,161
Less: Accumulated depreciation	266	312	365	418	483	573	664	719	769	820
Net fixed assets in operation	245	278	264	256	637	568	482	432	387	341
Work in progress	88	39	99	324	21	5	5	5	5	5
Total Fixed Assets	333	317	363	580	658	573	487	437	392	346
Total Assets	460	476	510	898	1,205	1,354	1,505	1,699	1,896	2,092
LIABILITIES AND EQUITY										
Current Liabilities										
State Bank of India - Overdraft	-	-	5	-	-	-	-	-	-	-
Sundry Creditors	68	114	100	100	115	109	119	126	131	114
Long-term debt due within 1 yr.	119	134	11	21	3	25	25	25	25	25
Total Current Liabilities	187	248	116	121	118	134	144	151	156	139
Long-Term Debt										
Government Loans	211	113	-	-	-	-	-	-	-	-
US-AID Loan	77	56	35	24	3	-	-	-	-	-
Proposed IDA Credit	-	-	15	128	233	248	223	198	173	148
Total	288	169	50	152	236	248	223	198	173	148
Less: Long-term debt due within 1 yr.	119	134	11	21	3	25	25	25	25	25
Net Long-term Debt	169	35	39	131	233	223	198	173	148	143
Equity										
FCI Investment	116	116	155	294	346	346	346	346	346	346
Reserves and Surplus (Deficit)	(12)	77	200	352	508	659	824	1,035	1,251	1,467
Total Equity	104	193	355	646	854	1,005	1,170	1,381	1,597	1,813
Total Liabilities and Equity	460	476	510	898	1,205	1,354	1,505	1,699	1,896	2,092

* Excluding Trombay V

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INDIA: TROMBAY EXPANSION PROJECT

PRODUCTION, RAW MATERIALS, UTILITIES, AND EMPLOYMENT

1. The Trombay Expansion Project will have a design capacity of 355,000 TPY of nitrophosphate fertilizer equivalent to 75,000 TPY of nitrogen and 75,000 TPY of P_2O_5 in the ratio of 21-21-0. In addition to the nitrophosphate plant, the project will consist of a 250,000 TPY nitric acid plant which would supply 141,700 TPY to the nitrophosphate plant, 27,100 TPY to the existing nitrophosphate plant of Trombay and sell 10,000 TPY to outside customers. The project also includes expansion of facilities for utilities (i.e., steam and electricity) and product storage and handling.

2. The project is based on ammonia, phosphate rock as well as the phosphate product, TSP or DAP. The entire ammonia needs (97,100 TPY) would be met by a new ammonia plant of Trombay which is scheduled to go into production in 1979. The ammonia needs during the first 18 months of operation of Trombay IV would be imported. As for phosphate rock, part of the needs would be met from the Udaipur mines and part of the requirements would be imported. However, as the local production program is not certain, it is assumed for the purpose of this report that all phosphate rock needed for the project would be imported. The annual requirements of phosphate rock and TSP (or DAP) are 151,200 TPY and 43,710 TPY respectively.

Nitrophosphate Plant

3. The nitrophosphate plant would use nitric acid to react with phosphate rock to form the nitrophosphate fertilizer. The nitric acid would be used in the place of sulfur (it is normally used in the world in producing phosphate fertilizers), which is a scarce commodity in the world. However, the calcium in the phosphate rock will not be removed directly; if left in the product, it would result in low phosphate water solubility. The calcium can be removed through an additional processing step using carbon dioxide from the ammonia plant to react on calcium to produce calcium carbonate which can be easily removed and discarded.

4. After calcium removal, additional ammonia and a small amount of supplemental ammonium phosphate would be added to yield the nitrophosphate of 21-21-0 grade. The plant design would be flexible to add potash to the product at a later time and also produce fertilizers in a wide range of grades with different N, P_2O_5 and K_2O ratios.

Raw Material and Product Movement

5. After the expansion project is completed, Trombay inputs and output would increase as follows:

TROMBAY'S RAW MATERIAL AND PRODUCT MOVEMENT
(000 TPY)

Major Raw Materials (at 90% Operation)	Existing	After Modernization	After Trombay IV
Ammonia	101	128	225
Fuel Oil*	157	171	210
Phosphate Rock	39	132	283
Sulfur	20	20	20
TSP	-	-	44
Potash	55	77	77
Major Products (at 90% Operation)			
15-15-15	210	251	292
21-21-0	-	-	325
Urea	89	116	116
Methanol	16	34	34

* FCI intends to substitute coal for fuel oil.

6. The solid raw materials are received through the Bombay Port and brought to Trombay by rail over a distance of about 16 km. Fuel oil, coal and naphtha are obtained from adjacent refineries and present no handling problems. The phosphate rock handling facilities will be expanded including storage, conveying and grinding facilities. Facilities in general are adequate to handle raw material movements. **Bags for fertilizers will be supplied locally.**

7. Product is transported from Trombay principally by rail. Although product movement by rail could be a problem because of wagon shortages, rail companies have assured FCI that adequate facilities will be provided.

Utilities

8. The expansion project requires only a marginal increase in utilities but the timely supply could be critical, particularly of electricity. The additional utilities required are: (a) Power - 9MW to be purchased from the Tata Power Co. which is capable of meeting this additional need. However, necessary transforming equipment must be procured and installed which could take up to three years unless the equipment is purchased from international sources; (b) water - 760 M^3/Hr (4 million gallons per day). The Maharashtra Government has made a commitment to supply the additional requirements. As the water supply in Bombay as a whole is being expanded, no major difficulty is foreseen; (c) steam - 70 tons per day. Additional boiler capacity will be installed to provide sufficient steam for Trombay. At present the steam capacity is limited.

Employment

7. Trombay has a present staff of about 2,400 which appears somewhat high. The expansion project should increase the staff by about 440 (20%) and also enable Trombay to better utilize the existing employees. Indirect

employment effects from the project are limited primarily to increased marketing activities. Trombay's management appears to be capable and Trombay has experienced no significant labor problems. Workers with industrial experience are available and FCI has an excellent training program to provide the specific skills needed to run a modern chemical factory.

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INDIA: TROMBAY EXPANSION PROJECT

PROJECTED INCOME STATEMENT FOR TROMBAY IV
(In Rs Million)

	1977	1978	1979	1980	1981	1982
Net Sales:						
-Nitrophsophate	-	182.7	274.0	328.8	328.8	328.8
-Nitric Acid[1/]	17.6	35.1	35.1	35.1	35.1	35.1
Sub-Total	17.6	217.8	309.1	363.9	363.9	363.9
Cost of Goods Sold:						
Materials, Supplies and Utilities	7.0	139.2	201.9	239.5	239.5	239.5
Labor	1.0	3.6	3.6	3.6	3.6	3.6
Gross Profit	9.6	75.0	103.6	120.8	120.8	120.8
Operating Expenses:						
Selling & Administrative Expenses	4.0	7.0	10.0	12.0	12.0	12.0
Maintenance	3.0	4.0	7.0	9.0	9.0	9.0
Depreciation	8.0	41.4	41.4	41.4	41.4	41.4
Operating Profit (Loss)	(5.4)	21.6	45.2	58.4	58.4	58.4
Financial Charges	-	24.0	23.0	21.0	17.0	13.0
Net Profit (Loss) Before Taxes	(5.4)	(2.4)	22.2	37.4	41.4	45.4

1/ Including sales to the existing NPK plant of Trombay and outside sales.

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INDIA: TROMBAY EXPANSION PROJECT

INPUTS FOR FINANCIAL RATE OF RETURN AND SENSITIVITY ANALYSIS
(In Rs Million at 1978 Prices)

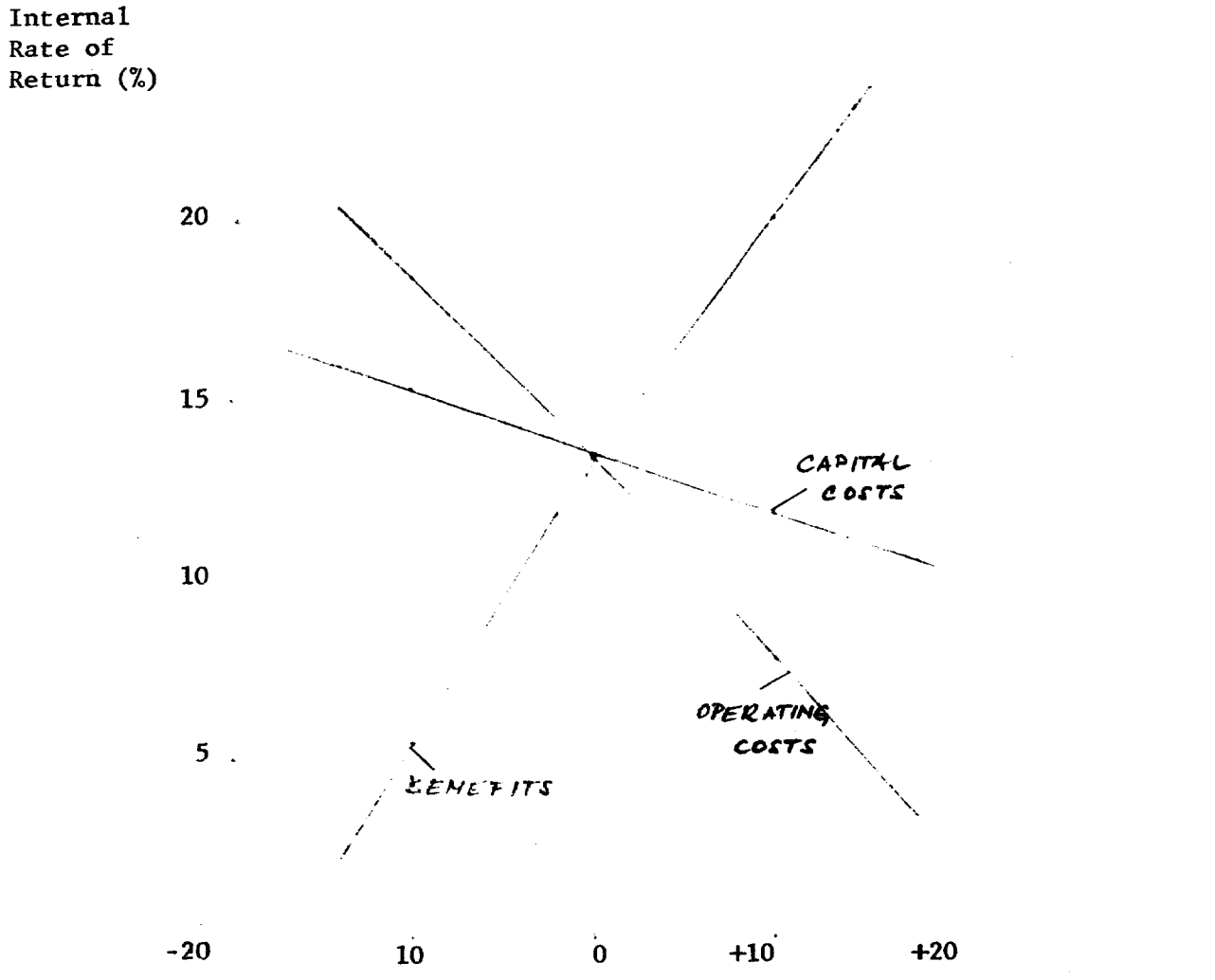
Year	Investments[1/]	Working Capital	Operating Costs[2/]	Revenue
1975	52.0	-	-	-
1976	243.0	-	-	-
1977	133.0	20.0	15.0	17.6
1978	5.0	-	156.2	217.8
1979	5.0	-	226.2	309.1
1980	5.0	-	268.9	363.9
1981	5.0	-	268.9	363.9
1982	5.0	-	268.9	363.9
1983	5.0	-	268.9	363.9
1984	5.0	-	268.9	363.9
1985	5.0	-	268.9	363.9
1986	5.0	-	268.9	363.9
1987	5.0	-	268.9	363.9
1988	5.0	-	268.9	363.9
1989	5.0	(20.0)	268.9	363.9

1/ Excluding interest during construction

2/ Excluding taxes, depreciation and financial charges.

INDIA: TROMBAY EXPANSION PROJECT

SENSITIVITY OF FINANCIAL RATE OF RETURN



Case	Capital Costs	Operating Costs	Benefits	Return
Base Case	100	100	100	13.5%
1.	90	100	100	15.3%
2.	110	100	100	11.9%
3.	100	90	100	18.4%
4.	100	110	100	7.8%
5.	100	100	90	5.5%
6.	100	100	110	20.0%
7.	80% Capacity Utilization			11.3%
8.	10% Increase in Capital Costs Plus 6 Months Delay in Project Execution			11.4%

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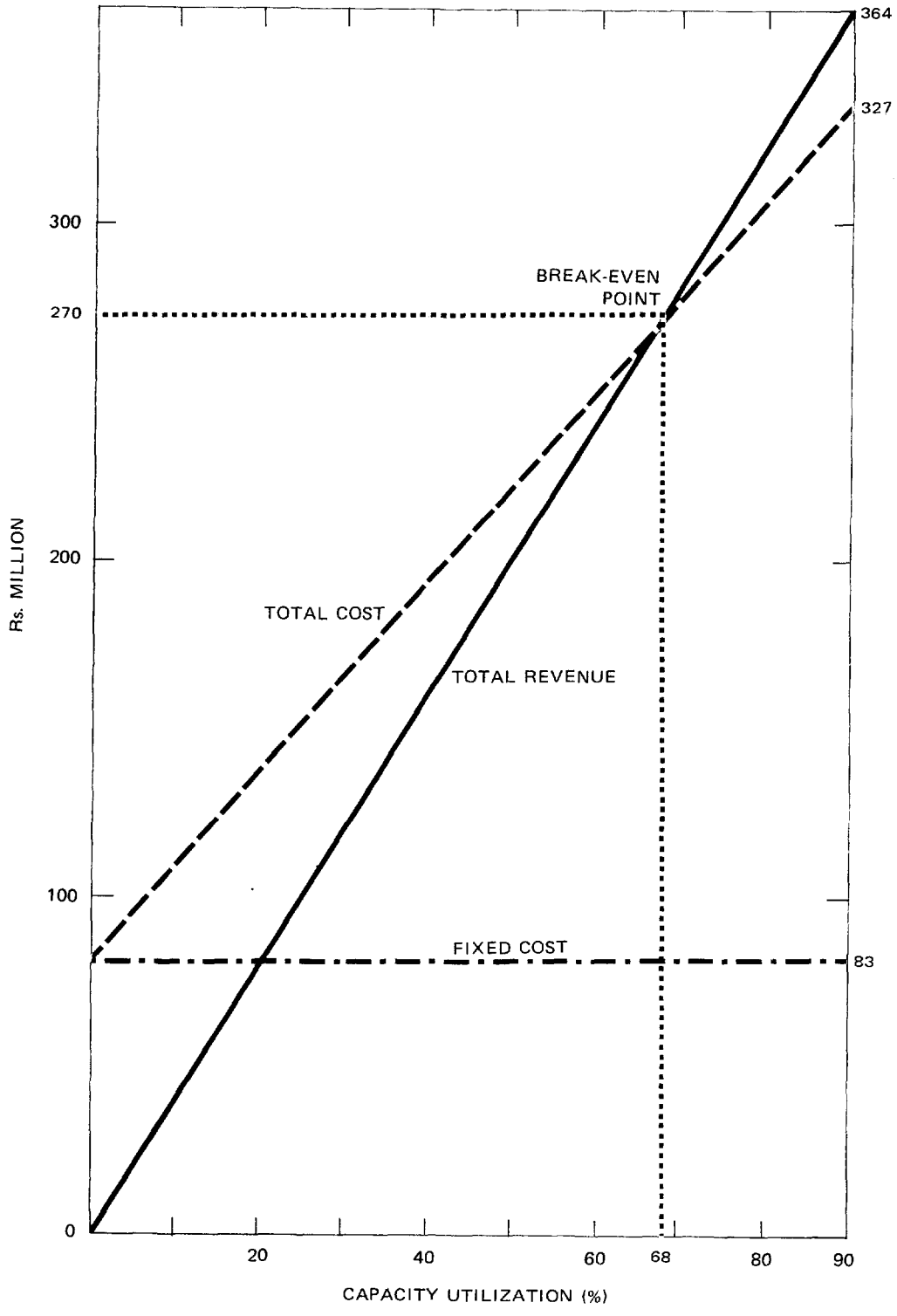
INDIA: TROMBAY EXPANSION PROJECT

BREAK-EVEN POINT

1. The profit break-even point of the Trombay Expansion Project in 1980 is estimated at 68% of its capacity. The year 1980 is selected because it is the first year of full (90%) production. The following table gives details of the break-even analysis:

	In Rs Million		
	Fixed Cost	Variable Cost	Total Cost
	---at 90% capacity---		
Raw Materials and Utilities:			
Ammonia			
97,100 tons @ Rs 1,050/ton	-	102	102
Triple Superphosphate			
43,710 tons @ Rs 1,050/ton	-	46	46
Rock Phosphate			
151,200 tons @ Rs 360/ton	-	54	54
Fuel Oil			
2,000 tons @ Rs 349/ton	1	-	1
Coal			
109,000 tons @ Rs 81/ton	-	8	8
Coating Agents, Catalysts and Chemicals	-	3	3
Bags			
6,500,000 @ Rs 2.5 each	-	16	16
Electricity			
68,800 MWH @ Rs 110/	1	7	8
Water			
5,572,000 M^3 @ Rs 400/	-	2	2
Sub-total	2	238	240
Labor	4	-	4
Maintenance	3	6	9
General Expanses	3	-	3
Selling Expenses	9	-	9
Financial Expenses	21	-	21
Depreciation	41	-	41
	83	244	327
Revenue (90%)			364
Profit Break-Even (Capacity %)			68%
Debt Repayment			25
Cash Break-Even (capacity %)			54%

INDIA
TROMBAY EXPANSION PROJECT
PROFIT BREAK-EVEN POINT
YEAR 1980



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World Bank-8819

INDIA: TROMBAY EXPANSION PROJECT

ASSUMPTIONS FOR ECONOMIC AND FINANCIAL RATES OF RETURN CALCULATIONS

Production Build-Up

1. The nitric acid plant of the project would go into operation on October 1, 1976 and the nitrophosphate plant, on April 1, 1977. The production build-up in the two plants would take place as follows:

Production in Tons

	1977	1978	1979	1980 Onwards
Nitrophosphate	-	180,500	270,700	324,900
Nitric Acid	18,550	115,850	155,225	178,800
of which:				
-For sale to Trombay's Existing NPK Plant	13,550	27,100	27,100	27,100
-For Outside Sale	5,250	10,000	10,000	10,000

Requirements of Raw Materials and Utilities

2. The requirements of main raw materials and utilities for the project are expected to increase as follows with the production build-up:

Raw Material and Utility Requirements

	1977	1978	1979	1980 Onwards
Ammonia (tons)	5,250	58,800	82,700	97,100
TSP (tons)	-	24,280	36,420	43,710
Phosphate Rock (tons)	-	86,700	127,000	151,200
Bags ('000)	-	3,610	5,415	6,500
Fuel Oil (tons)*	-	21,495	32,240	38,690
Power (MWH)	1,000	38,250	57,300	68,800

* FCI intends to substitute coal for fuel oil.

Price Assumption

3. As the prices of fertilizers and their main inputs have been rising steeply since 1972 because of worldwide fertilizer shortages and skyrocketing of prices of petroleum and phosphate rock - the main inputs - the use of present world prices as economic accounting prices would be misleading. The price situation with respect to the fertilizer sector is expected to come to normal in 1978, when the fertilizer shortages are expected to be overcome because of the current acceleration of investment in the fertilizer industry. Oil prices are also expected to come to the

equilibrium level at that time because of the increased development of alternative sources of energy. However, FCI intends to use coal for Trombay IV. Because of these factors, the projected 1978 prices are assumed to value output and inputs as well as equipment and spares for the project.

4. The economic prices of 21-21-0 nitrophosphate and nitric acid, the main outputs of the project, are difficult to determine as they are not commonly traded items in the international market. However, an attempt has been made to determine the economic price of nitrophosphate on the basis of the long-term prices of urea (46-0-0 nutrient content) and diammonium phosphate (18:46:0 nutrient content) which are assumed to be US $110 and US $170 per ton (c.i.f. Bombay port) respectively on the basis of a review of fertilizer prices by the Bank Group.[1] On the basis of urea and DAP prices, the price of the nitrophosphate (21-21-0 grade) is calculated to be US $113 per ton (c.i.f., Bombay port). To this, US $17 has been added to represent the bagging, handling and transportation costs per ton (from the port to warehouses). Thus, the economic accounting price for nitrophosphate is arrived at US $130 (Rs 975) per ton. In the case of nitric acid, the transfer price at the Trombay unit is used as an approximation to the international price (c.i.f. Trombay). The following table compares the economic and financial prices used in the rates of return calculations:

Price Comparison[2]

	Economic		Financial[3]	
	Rs	US $	Rs	US $
Nitrophosphate (21-21-0)	975	130	1,012	135
Nitric Acid (100%)	750	100	1,475[4]	197
Ammonia	950	127	1,050	140
Triple Superphosphate	940	125	1,050	140
Phosphate Rock	345	46	360	48
Fuel Oil*	405	54	350	47
Power (MWH)	120	16	110	15
Bags (per piece)	3.5	0.5	2.5	0.35
Wages and Salaries:				
Workers (Avge. per man-year)	7.500	1,000	7,500	1,000
Supervisors (Avge. per man-year)	15,000	2,000	15,000	2,000

* FCI intends to substitute coal for fuel oil.

1/ Bank "Commodity Forecasts" - memorandum of April 8, 1974.
2/ Per ton except where mentioned.
3/ Excluding excise duties and freight.
4/ For outside sales. The transfer price in the Trombay Unit is assumed to be Rs 750.

Other Assumptions

	Economic	Financial
1. Project Cost (Rs Million)	413.0*	448.0
2. Construction Period	3 Years	3 Years
3. Production Period	12 Years	12 Years
4. Recovery of Working Capital (Rs Million)	50.00	50.00

* Excluding duties and taxes

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INDIA: TROMBAY EXPANSION PROJECT

INPUTS FOR ECONOMIC RATE OF RETURN AND SENSITIVITY ANALYSIS
(In Rs Million at 1978 Prices)

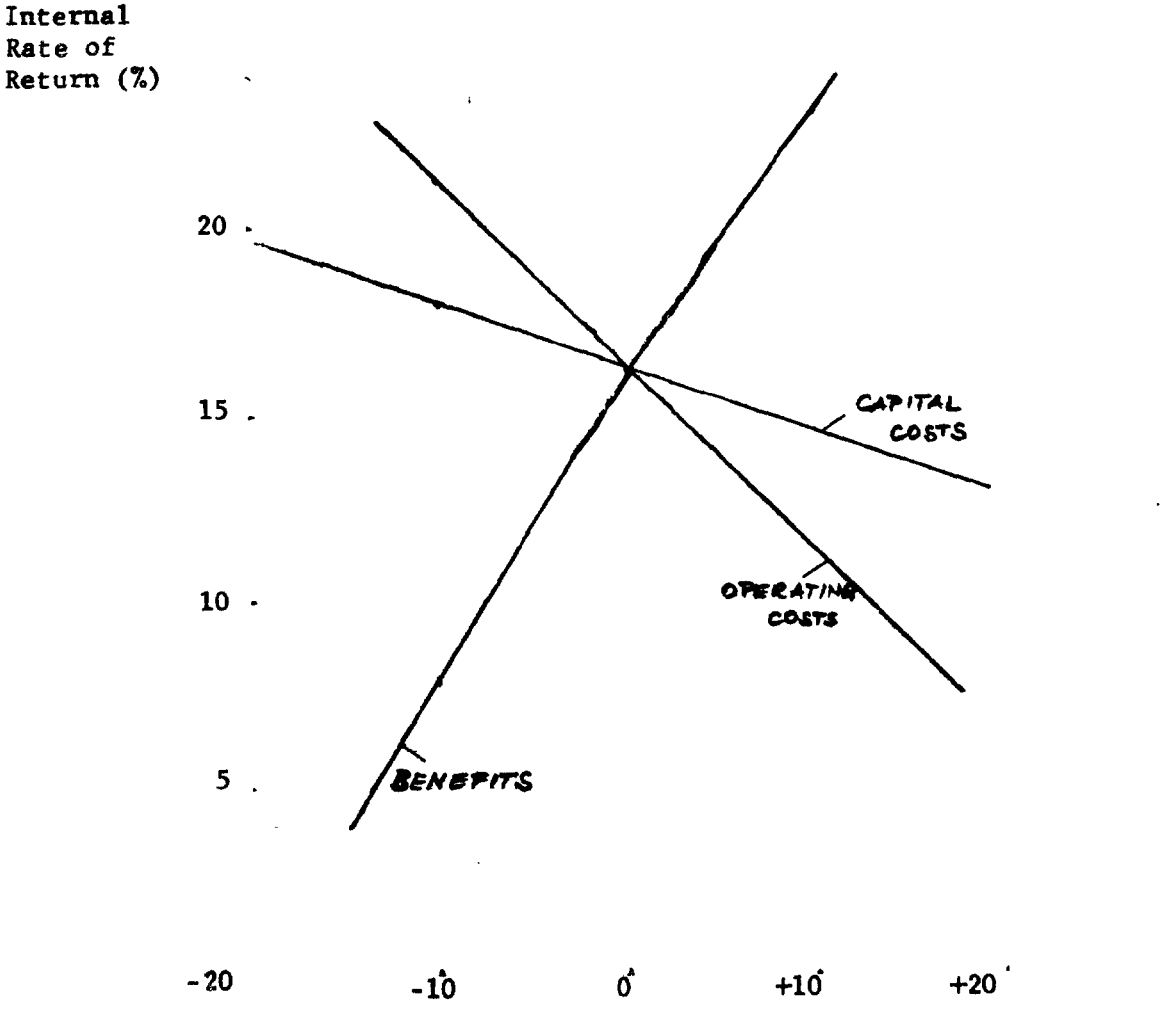
	Investments[1]	Working Capital	Operating Costs[2]	Revenue
1975	42.5	-	-	-
1976	225.0	-	-	-
1977	125.0	20.0	10.5	14.0
1978	5.0	-	152.3	203.8
1979	5.0	-	221.0	291.8
1980	5.0	-	251.6	344.6
1981	5.0	-	251.6	344.6
1982	5.0	-	251.6	344.6
1983	5.0	-	251.6	344.6
1984	5.0	-	251.6	344.6
1985	5.0	-	251.6	344.6
1986	5.0	-	251.6	344.6
1987	5.0	-	251.6	344.6
1988	5.0	-	251.6	344.6
1989	5.0	(20.0)	251.6	344.6

1/ Excluding duties and taxes and interest during construction

2/ Excluding taxes, depreciation and financial charges.

INDIA: TROMBAY EXPANSION PROJECT

SENSITIVITY OF ECONOMIC RATE OF RETURN



Case	Capital Costs	Operating Costs	Benefits	Return
Base Case	100	100	100	16.3%
1.	90	100	100	17.9%
2.	110	100	100	14.7%
3.	100	90	100	21.4%
4.	100	110	100	10.3%
5.	100	100	90	7.9%
6.	100	100	110	23.1%
7.	80% Capacity Utilization			14.4%
8.	10% Increase in Capital Cost Plus 6 Months Delay in Project Execution			14.6%

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INDIA: TROMBAY EXPANSION PROJECT

DIRECT FOREIGN EXCHANGE SAVINGS (1977-82)

(In Rs Million)

	1977	1978	1979	1980	1981	1982
Total Earnings 1/	14.1	180.8	257.3	303.2	303.2	303.2
Less Foreign Exchange For:						
- Raw Materials 2/	9.7	106.0	109.6	129.9	129.9	129.9
- Spare Parts 3/	0.8	1.0	1.8	2.3	2.3	2.3
- Interest	-	20.0	20.0	18.0	17.0	16.0
- Amortization	-	-	17.0	18.0	19.0	20.0
Net Foreign Exchange Savings	3.6	53.8	108.9	135.0	135.0	135.0

1/ Sales revenue calculated on the basis of international prices (c.i.f. Bombay, excluding bagging costs) for bulk supply.

2/ Based on the following assumptions:

(1) Ammonia is imported only during October 1976 to March 1978:
(2) the effective import content in locally-produced ammonia and triple superphosphate used by Trombay is 50% and 30% respectively;
(3) Phosphate rock is entirely imported;
(4) 80% of the catalysts, coating agents and chemicals are imported.

3/ Excluding duties and taxes. It is assumed 25% of the maintenance materials used are imported spare parts.

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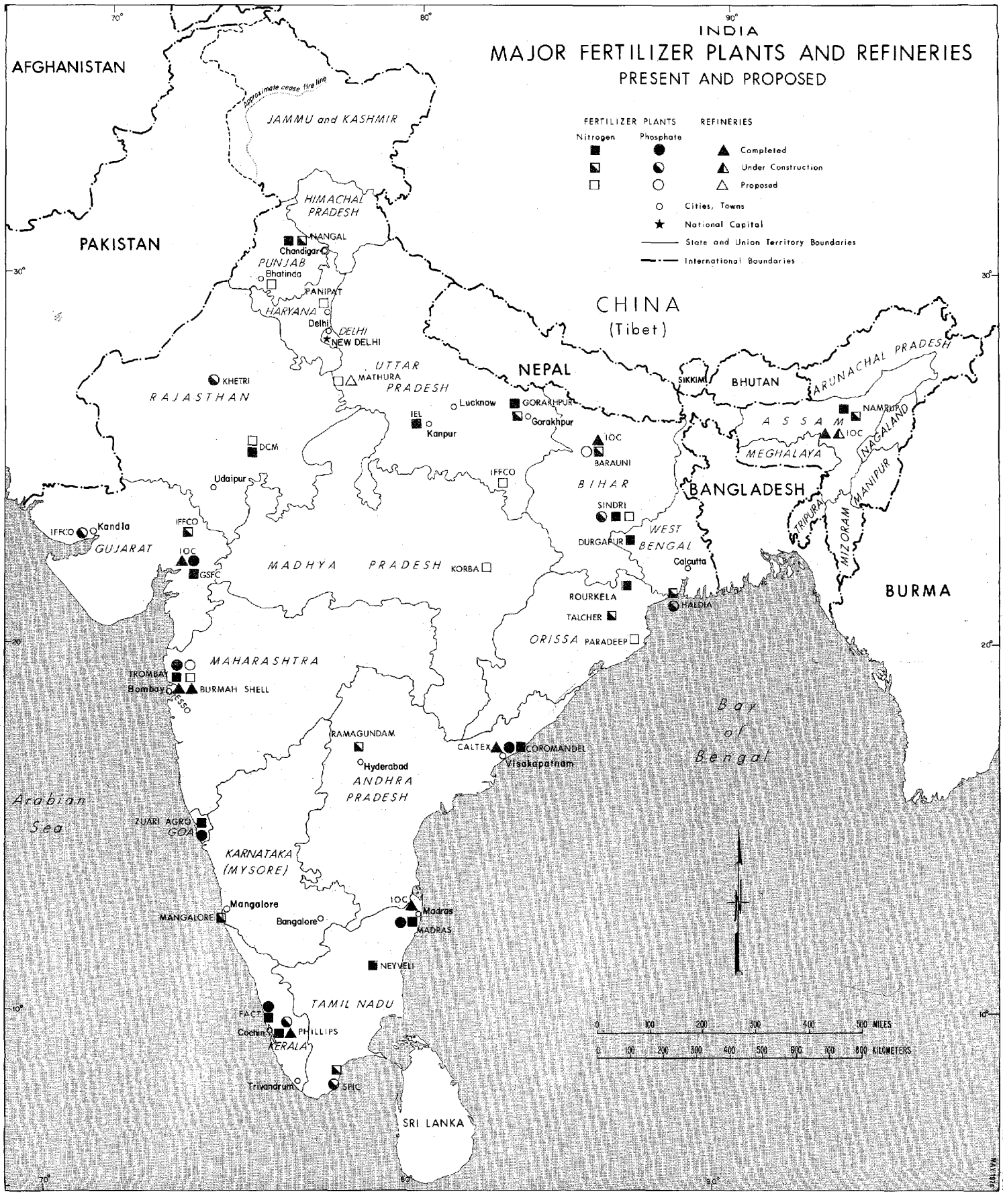
INDIA
MAJOR FERTILIZER PLANTS AND REFINERIES
PRESENT AND PROPOSED
FERTILIZER PLANTS
Nitrogen
Phosphate
REFINERIES
Completed
Under Construction
Proposed
Cities, Towns
National Capital
State and Union Territory Boundaries
International Boundaries
AFGHANISTAN
PAKISTAN
CHINA
(Tibet)
NEPAL
BHUTAN
BANGLADESH
BURMA
SRI LANKA
Approximate cease fire line
JAMMU and KASHMIR
HIMACHAL PRADESH
PUNJAB
HARYANA
DELHI
UTTAR PRADESH
RAJASTHAN
BIHAR
WEST BENGAL
SIKKIM
ARUNACHAL PRADESH
ASSAM
MEGHALAYA
NAGALAND
MANIPUR
TRIPURA
MIZORAM
GUJARAT
MADHYA PRADESH
ORISSA
MAHARASHTRA
GOA
ANDHRA PRADESH
KARNATAKA (MYSORE)
TAMIL NADU
KERALA
Arabian Sea
Bay of Bengal
Chandigar
NANGAL
Bhatinda
PANIPAT
Delhi
NEW DELHI
MATHURA
KHETRI
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BARAUNI
IOC
SINDRI
DURGAPUR
Calcutta
HALDIA
ROURKELA
TALCHER
PARADEEP
NAMRUP
TROMBAY
Bombay
BURMAH SHELL
ESSO
RAMAGUNDAM
Hyderabad
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