EXECUTIVE SUMMARY

0.1 BACKGROUND OF STUDY

0.1.1 The Department of Scientifc and Industrial Research (DSIR) is currently engaged in the preparation of the the National Register of Foreign collaboration (NRFC). The main objective of this is to carry out analysis of the imported technologies and to evaluate the status of implementation of collaborations.

0.1.2 For implementation of the NRFC scheme, DSIR has selected a number of industries for 'Technology Status Studies'. The study of the Ammonia industry has been carried out by Humphreys & Glasgow Consultants Pvt. Ltd. (H&G), and its results are presented in this report.

0.1.3 The scope and objectives of the study were defined on the basis of guidelines given by DSIR. Data was collected from various ammonia producing units in India through correspondence and by visits to eight plants. Information about the latest developments on international level was sought from a number of leading foreign ammonia technology licensors. Information was also obtained from consultancy organisations and from published literature.

0.2 FEED STOCKS FOR MANUFACTURE OF AMMONIA:

0.2.1 Initial ammonia plants were based on Calcium carbide, followed by electrolysis of water as a source of hydrogen, and liquefaction of air as a source of nitrogen. The source of hydrogen was then changed over to fuel oil and finally to natural gas and naphtha. Natural gas is an ideal feedstock, which is cheap, easily transportable by pipelines and relatively pure.

0.3 PRODUCTION AND CAPACITY UTILISATION:

0.3.1 Production and capacity utilisation for the nitrogenous fertiliser industry has shown a significant increase over last seven years. Production increased by as much as 2.5 times while capacity utilisation improved from 53% in 1980-81 to 79% 1986-87.

0.4 DISTRIBUTION OF AMMONIA CAPACITY:

0.4.1 Amongst the operating plants, maximum ammonia capacity exists in Gujarat (21.9% of total installed capacity), followed by Maharashtra (15.6%). As regards to the plants under implementation, maximum capacity is being set up in Uttar Pradesh amounting to about half of the total capacity under implementation.

0.4.2 Maximum operating capacity exists in the public sector (56%) followed by the private sector (27%) and the co-operative sector (17%). However, among plants under implementation, 60% of the capacity lies in the private sector, resulting in public sector's share as 49% followed by the private sector with 35% and the co-operaive sector with 16%.

0.5 **IMPORT OF AMMONIA:**

0.5.1 There has been an almost steady increase in ammonia imports from an insignificant amount of 5190 tonnes in 1973-74 to 495, 296 tonnes in 1986-87.

0.6 **DEMAND-PRESENT/PROJECTED:**

0.6.1 There is expected to be a large gap between demand and production of about 300,000 MT by the year 1995. Also additional capacity needs to be crfeated for the plants to be shut down.

0.7 **TECHNOLOGY:**

0.7.1 A lot of effort has been put towards development of low energy ammonia technologies. Some of the leading technology suppliers include ICI, Kellogg, Haldor Topsoe, Braun & KTI.

0.7.2 A comparative statement of energy consumption for the different technologies is given below:

CONSUMPTION PER MT OF AMMONIA
(BASED ON NATURAL GAS)

	Haldor Topsoe	Kellogg	ICIAMV	KTI	Braun
Feed and Fuel (Million Kcal)	7.0	7.0	6.831	6.95	6.8*
Steam (Tonnes)	0.0	N.A.	0.0	0.0	Export
Cooling Water (CM)	270	N.A.	181	N.A.	95
Electricity (KWH)	9	N.A.	122	190	38
D.M. Water (CM)	N.A.	N.A.	1.01	N.A.	0.9

N.A. = Not available

* = After credit for steam export

NOTE :Above data are based on identical plant battery limits

(SOURCE : TECHNOLOGY SUPPLIERS)

0.7.3 This study also review the status of following technologies:

1. 'LEAD' Process by Humphreys & Glasgow
2. Lurgi process for ammonia from coal
3. Linde/Texaco process for partial oxidation of heavy oil
4. Krupp-Koppers process for gasification of coal
5. Prenflow process for gasification of coal

In addition, the latest concept in ammonia technolgoy, the ICI - LCA process, has also been covered in this report. The LCA process, which is designed for medium scale plants (450 TPD), separates for the first time, the ammonia manufacturing process from the complex heat recovery systems essential to acheive low energy consumption. ICI claims that the LCA process, designed for Indian conditions, can achieve an overall energy efficiency of 7 million Kcals/tonne ammonia.

0.8 OVERALL STATUS OF THE INDIAN AMMONIA INDUSTRY:

0.8.1 Most of the ammonia plants set up in India until 1968 were on a turnkey basis. In 1966, the Government of India decided to set up a series of single stream 600 TPD ammonia plants. Ammonia plants at Durgapur, Barauni and Cochin were set up through foreign aid which also included supply of equipment. Some of these plants have not performed well due to improper equipment selection. Over a period of time, the performance got worse and some of these plants have been shut down.

0.8.2 Subsequently, Indian fertilizer companies selected reliable technology and proper equipment on the basis of competitive bidding. With the discovery of large reserves of offshore gas, a number of 1350 TPD ammonia plants are being installed based on technology supplied by Haldor Topsoe and M. W. Kellogg.

0.9 TECHNOLOGICAL STATUS OF UNITS VISITED:

0.9.1 Eight ammonia plants were visited by the study-team to investigate their technolgoical status in detail. The units visited included two fuel oil-based plants (NFL, Panipat and GNFC, Bharuch), three naphtha based plants (IEL, Kanpur; MFL, Manali; and ZACL, Goa), two gas based plants (IFFCO, Kalol and RCF, Thal), and one coal based plant (FCI, Talcher).

0.9.2 The capacity utilisation (averaged over last five years) of the ammonia plants varied from plant to plant; 36% to 94% for naphtha based plants, 56% to 81% for fuel oil-based plants, 44% to 92% for gas based plants and only 20% to 42% for coal based plants. Specific energy consumption also showed wide deviations with reference to the process, the feedstock and the year of installation. The best performance was recorded by the gas-based plant of IFFCO, Kalol with 8.98 Kcal/tonne of ammonia.

0.9.3 As expected, specific investment costs are highest for coal based plants and lowest for gas based plants. Almost all plants have installed adequate effluent treatment facilities. The report also describes the design deficiencies reported by the various plants and the modifications carried out to rectify them. It also deals with problem areas regarding specific equipment, the R & D efforts and the modernisation and expansion plans.

0.10 STEPS TOWARDS SELF RELIANCE :

0.10.1 Though production of ammonia started in India in 1943, the industry gained momentum only in the 1960s. Public sector/engineering organisations like PDIL, FEDO, EIL and private organisations such as Humphreys & Glasgow, Power Gas entered into know-how agreements with well-known process licensors. In this process, the Indian companies were able to absorb imported technology and adapt it to indigenous needs.

0.10.2 There is considerable R&D activity in the industry but it is mostly plant oriented, and is directed towards solving plant operational problems, pollution and environmental control, better water management, utilisation of by-products and waste products, energy conservation and effective use of indigenous raw materials.

0.10.3 Indian engineering organisations have successfully indigenised process technologies which they recieved from foreign process licensors. Today, they can undertake detailed design and engineering, procurement, construction and commissioning activities independenely.

0.10.4 In an effort towards industrialisation, the country has built-up a large capacity to manufacture diverse forms of machines, equipment, catalysts etc. As a result, foreign exchange cost of setting up of fertilizer plants has come down from more than 60% in the mid-sixties to about 20% in the plants presently being set-up based on natural/associated gas. As regards to catalysts, the country can manufacture a variety of catalysts required for the production of ammonia.

0.10.5 The plants built before the mid 70 's are highly energy inefficient viz-a-vis present day start and considerable potential exists for modernisation in order to reduce the energy consumption. The various techniques available for revamping/modernisation of old ammonia plants range from small-scale debottlenecking to major retrofitting. A variety of retrofit options are available which can be incorporated in different combinations.

0.10.6 Modifications of old ammonia plants as Trombay and Nangal are under implementation. Gorakhpur plant of FCI is actively considering modernisation of its plants built in 1969. A number of other fertilizer manufacturers such as Madras Fertilizers Limited are also considering modernisation of their ammonia plants.

0.11 CONSTRAINTS IN THE PROCESS OF SELF-RELIANCE:

0.11.1 Indian design and construction companies are now capabie of rendering complete enegineering services for ammonia plants except for the know-how packages for the critical process steps including technologies for partial oxidation, coal gasification, H_2S and CO_2 removal and synthesis loop. Though India has come a long way in acheiving self sufficiency in hardware supplies for the fertilizer industry, about 20% of the plant and machinery are still being imported.

0.11.2 While there are some problems in the supply of natural/associated gas, transport is the major constraint for the supply of naphtha, fuel oil,. LSHS and coal to the ammonia plants spread all over the country. The poor quality of coal has been the major constraint in achieving smooth operations of both the coal based ammonia plants at Talcher and Ramagundam. High aromatics content of naphtha from the Bombay High Crude may create constraints in optimum capacity utilisation of the ammonia plants. R&D programmes to develop primary reforming catalyst for this duty may be initiated.

0.11.3 Indian consultancy organisations have absorbed and assimilated the process technologies for Ammonia plants upto 600 TPD capacity and are confident to set up plants on their own. PDIL claims that Indian consultancy organisations can independently design, install and commission ammonia plants of 1350 TPD capacity by taking marginal assistance in specific areas from foreign sources. Indian Consultancy Organisations feel that they have not been given their due share of responsibility in the execution of ammonia plants being constructed presently.

0.12 RECOMMENDATIONS:

0.12.1 In India, a number of ammonia plants built before 1970 are highly inefficient with respect to specific energy consumptions when compared to the state-of art plants now being built worldwide. However, these plants cannot be closed down and new plants built in view of the huge investment required. Therefore, old plants should be modernised by revamping major energy consuming sections. Some of the options available are improved CO_2 removal processes, use of hydraulic turbines for energy recovery, primary reformer modifications, use of molecular sieves, replacement of ammonia converter internals and recovery of hydrogen from purge gas.

0.12.2 Major equipment fabrication companies in India should improve upon their existing fabrication techniques, to be able to manufacture all the heavy equipment required for ammonia plants which are presently being imported, e.g. ammonia converters.

0.12.3 The primary reformer catalysts available in India, as well as in the international market, are not suitable for reformation of naphtha with aromatic content as high as 30%, a level envisaged in naphtha from the Bombay High Crude. Since this problem exists only in our country, R&D programme for development of suitable catalysts should be initiated to bridge this technology gap. However, it may be noted that catalysts are available in the international market to handle naphtha with high aromatics (e.g. CRG catalyst) in a separate processing step.

0.12.4 Two process technologies were selected for plants set up at Thal and Hazira as well as for new plants being set up in the seventh five year plan. In recent years, developments have taken place in other process technologies, which have made them attractive in terms of energy consumption as well as capital costs. While selecting process technology for new plants, the Owners should have the option to call for international competitive bidding so as to select the best available technology. This will also enable Indian private sector companies who have experience of design and engineering of ammonia plants to bid along with their foreign principals, thus hastening the process of absorption and assimilation of the best technologies availabel in the international market. It should be carefully analysed as to which components of ammonia technology should be imported as some sections are indigenously available.

0.12.5 A number of Indian plants have become old and the operational efficiency has reduced. Out of India's 8.5 million tonnes annaul capacity, approximately 1.5 million tonnes annaul capacity is provided by plants build in the '50's and '60's. It is, recommended that 'Life Extension' programmes may be taken up for some of these plants thus benefitting the country by way of increased and efficient production at low investments vis-a-vis setting up a new plant. However, even though revamping will extend life to some extent, in the long run new capacity has to be built up to replace these plants.

0.12.6 Technology (such as ICI's LCA Process) now exists to provide smaller Ammonia plants (say 450 MTPD) with investment cost as well as energy consumption per Tonne NH_3 equal to or better than for mega plants (1350 MTPD plus). Such plants have some advantage as they do not require : huge investment; large localised power and water requirements; product distribution problems; and enormous costs of downtime.

Smaller plants would offer : low investment cost; small local power and water requirements; many plants widely dispersed close to the consumer would overcome distribution problems; and multi-streaming would reduce cost of downtime.