U.S. TRADE AND DEVELOPMENT PROGRAM
PROJECT DEFINITION REPORT

NATURAL GAS FRACTIONATION AND OLEFINS PROJECT

ASSAM INDUSTRIAL DEVELOPMENT CORPORATION
Guwahati, Assam, India

Frank S. Chalmers, Consultant
Washington, D.C.

PN-AA2-935

FRANK S. CHALMERS
CONSULTANT
2022 COLUMBIA ROAD, N.W. #401
WASHINGTON, D.C. 20009-1349

202-331-1248

October 22, 1986

U.S. Trade and Development Program
U.S. Department of State
1621 North Kent Street, Room 302
Rosslyn, Virginia 20523

Attention: Mr. Daniel D. Stein
Regional Director

PROJECT DEFINITION REPORT
ASSAM NATURAL GAS & CRACKING PLANT

Dear Sirs:

Attached is my report on the Assam, India project for the utilization of natural gas fractions as petrochemical feedstocks.

The Assam Industrial Development Corporation, Ltd. (AIDC) is taking a lead position on behalf of the Government of Assam to develop industry which will utilize their natural gas resources. Much of the associated gas now available as a by-product of oil production is being flared. A new administration, elected in Assam less than a year ago, is intent on eliminating the flaring of valuable gas and in creating jobs in the form of industry which will utilize the recovered gas.

A number of groundwork studies already have been done by AIDC. Among the several projects identified by those studies is a petrochemical complex based on the cracking of ethane and propane recovered from natural gas which has been gathered for other purposes. Such a complex, which is the focus of this report, has been under discussion for over two years. Assam seems to have no set preconceptions nor obligations to any U.S. contractor or others regarding this complex. They do seem ready to move forward if the project can be shown to be viable.

The present Managing Director of AIDC, Mr. Buragohain, apparently has been in his present position for a number of years. He seems to have a good track record for helping to establish new industry and for rescuing sick industries in Assam and appears eager to work with the new administration. Most other members of the AIDC Board of Directors have been appointed since the recent election. Lists of the old and new Boards of Directors of AIDC are contained in Annex H of this report.

One of the new AIDC directors, Mr. Bhuyan, seems to have the confidence and trust of the new administration. Mr. Bhuyan is the owner of a small steel mini-mill in Guwahati. He was in constant attendance at our meetings in Guwahati and demonstrated

a studied knowledge of the gas fractionation and cracking complex parameters. Mr. Bhuyan assisted in guiding our meetings to the conclusions stated in this report and was instrumental in arranging meetings with and obtaining the concurrence of both the Commissioner of Industries and the Minister of Industries before Mr. Buragohain and he signed the Memorandum of Understanding contained in Annex B of this report.

The plan as proposed by this report calls for recovering ethane and heavier hydrocarbons both from 2.6 MMSCM/D of natural gas presently collected by OIL and sold to local industries and from 1 MMSCM/D soon to be collected for sale to a combined cycle gas turbine power plant. If all of the hydrocarbons removed from the rich gas are diverted to petrochemical feedstock or LPG uses, then about another 0.5 MMSCM/D of rich natural gas will have to be added to the total stream to make up for the shrinkage of heating value of the gas caused by hydrocarbon removal. This addition would commit essentially all of the OIL gas now being flared and might also use part of the ONGC gas now flared. A much larger volume of rich gas is expected to be available for fractionation and subsequent use as fuel by 2000 AD.

Export earnings for this project will be as import substitutions and through the upgrading of present commodity exports. An example is the tea industry. Assam now ships some 350,000 tonnes/year of tea in an estimated 70 million fiberboard boxes. Those boxes were made of wood, then of plywood. Recent new laws in India prohibit the cutting of trees which has resulted in logs now being imported for the manufacture of plywood. Substitutes for plywood and fiberboard are being sought for use in tea cartons. A local plastics industry could open the way to prepackage that tea for consumer use before it leaves Assam thus increasing its value.

There is very little likelihood that any adverse impact on the U.S. markets might occur as a result of the construction of the plants contemplated in this report. All production from these plants is intended for local Indian markets. In addition, ethylene plants in the United States already are running at over 98% capacity. A shortage of ethylene both in the United States and abroad is predicted by the early 1990s (see Annex H).

The cost of the feasibility study defined in this report is estimated to be about $ 500,000. The foreign component of the total investment for these facilities is estimated to be $ 85,000,000 of which United States suppliers should get about $ 60,000,000. The resultant multiplier is within TDP guidelines.

I recommend that TDP should fund this feasibility study.

Yours very truly,

Frank S. Chalmers

Frank S. Chalmers

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Order Number TDP-36-PG-05

UNITED STATES OF AMERICA
TRADE AND DEVELOPMENT PROGRAM
PROJECT DEFINITION REPORT

ASSAM INDUSTRIAL DEVELOPMENT CORPORATION LTD. (AIDC)
UTILIZATION OF NATURAL GAS FRACTIONS AS PETROCHEMICAL FEEDSTOCKS

RECOVERY OF ETHANE AND PROPANE FROM NATURAL GAS, CRACKING TO PRODUCE ETHYLENE AND PROPYLENE AND PRODUCTION OF ETHYLENE AND PROPYLENE DERIVATIVES

OCTOBER 1986

Frank S. Chalmers, Consultant
Washington, D.C.

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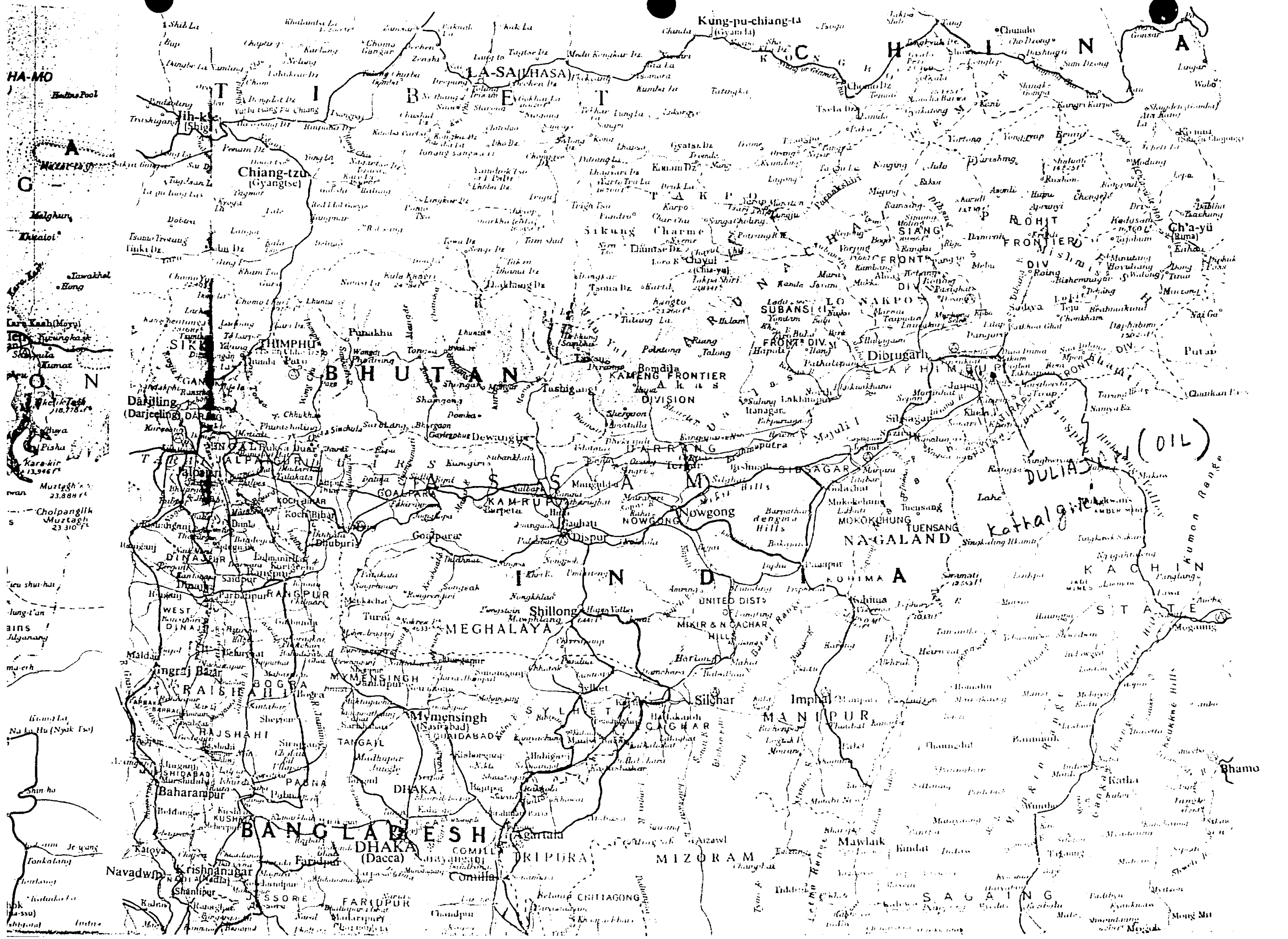

CHINA
TIBET
Kung-pu-chiang-ta (Gyamda)
LA-SA (LHASA)
Jih-k-tse (Shigatse)
Chiang-tzu (Gyangtse)
Ch'a-yü (Rima)
SIKKIM
BHUTAN
THIMPHU
Punakha
Paro
Tashigang
Dewangiri
Darjiling (Darjeeling)
Jalpaiguri
JALPAIGURI
KAMENG FRONTIER DIVISION
SUBANSIRI FRONTIER DIV
SIANG FRONTIER DIV
LOHIT FRONTIER DIV
Bomdila
Dibrugarh
Sibsagar
SIBSAGAR
DARRANG
Tezpur
Nowgong
NOWGONG
KAMRUP
GOALPARA
Gauhati
Dispur
Dhubuiri
Koch Bihar
ASSAM
NAGALAND
MOKOKCHUNG
TUENSANG
KOHIMA
Kohima
INDIA
MEGHALAYA
Shillong
UNITED DISTS OF MIKIR & N CACHAR HILLS
MANIPUR
Imphal
Silchar
CACHAR
SYLHET
MIZORAM
Aizawl
TRIPURA
Agartala
BANGLADESH
DHAKA (Dacca)
DHAKA
Mymensingh (Nasirabad)
MYMENSINGH
TANGAIL
Comilla
Faridpur
FARIDPUR
RAJSHAHI
BOGRA
RANGPUR
Rangpur
DINAJPUR
PABNA
KUSHTIA
JESSORE
CHITTAGONG
WEST DINAJPUR
Maldah
Ingraj Bazar
MURSHIDABAD
Baharampur
Krishnanagar
NADIA (Nadia)
Navadwip
KACHIN STATE
SAGAING
Myitkyina
Bhamo
Katha
Mawlaik
Kindat
Mogaung
Putao
(OIL)
DULIAJAN
Kathalguri

I. Introduction

India approached three-quarters self-sufficiency for crude oil during 1984-85 by producing almost 29 million tonnes of the 39 million tonnes of petroleum consumed. Over 20 million tonnes of oil production came from Bombay High, India's only off-shore field which is located west of Bombay in the Arabian Sea. The remaining 8.85 million tonnes was produced from on-shore oil fields in the States of Gujarat, located to the north of Bombay, and Assam, located in the north eastern region of India to the north of Bangladesh.

Assam was the first area of India to produce petroleum. Oil was discovered there in 1867. Oil India Ltd. (OIL) and the Oil and Natural Gas Commission (ONGC), both undertakings of the Government of India, are producing oil and gas in Assam today. OIL expects to continue its present petroleum production rate of about 3 million tonnes per year in Assam through the year 2000 while ONGC says it plans to increase its present annual 2.2 million tonnes of production there to 4 or 4.1 million tonnes by the year 2000.

All of the oil produced in Assam is brought to the surface by the pressure of natural gas in the formations. This means that by-product natural gas must be flashed off as an unavoidable consequence of oil production. About 40 percent of this associated natural gas now flashed from the oil is beneficially utilized. The remainder is wasted to flares as it has been for some 30 years. Fields of non-associated gas have been discovered in Assam but they will remain closed-in and held as reserves by government edict as long as the associated gas continues to be flared.

The Government of Assam seems intent on utilizing their presently flared natural resources to create a petrochemicals industry and there is every indication that the Government of India will give its approval to the proposed project.

The present Government of Assam is comprised of young, energetic and capable leaders who banded together at the university in Guwahati before they came to power in an election less than a year ago. Their dissatisfaction with the previous government may answer the question as to why nothing has been done before now if the concept of this ethylene complex is as good as it appears. Certainly this new administration has strong incentives to move forward resolutely to create new jobs, new industry and new earnings as soon as they are convinced that their path is well founded. Since this new group took power through democratic means at the ballot box, the government in New Dehli must give it every reasonable support or risk being accused of promoting civil unrest. Support from the central government therefore is virtually assured for this project if a feasibility study shows it to be viable. This is even more true because the project is designed to utilize natural resources now being wasted

in order to create a new seed industry and corresponding jobs.

Assam has a beginning nucleus for a petrochemical industry. There are three petroleum refineries located at Digboi, Guwahati and Bongaigaon. The latter refinery has a small petrochemical complex associated with it. Assam Petrochemicals Ltd. recently completed a plant to produce 100 TPD of methanol and makes urea formaldehyde resins and molding powder at Namrup. Hindustan Fertilizer Corporation, also at Namrup, this year is scheduled to complete a 600 t/d ammonia plant, a 1200 t/d urea plant and associated facilities valued by HYDROCARBON PROCESSING at US$ 300 million.

Petroleum, natural gas and other raw materials seem to be abundant in Assam. Surplus natural gas is being flared. Production of petroleum and associated natural gas is forecast by ONGC to increase over the next decade from the present 5.5 million standard cubic meters per day (MMSCM/D) to perhaps 9 or 10 MMSCM/D. That could be overly optimistic according to an article on ONGC reproduced in Annex H of this report.

If there is adequate and proper development of transportation and other infrastructure in the region, Assam and its six surrounding mountainous sister states of Meghalaya, Tripura, Mizoram, Manipur, Nagaland and Arunachal Pradesh could become an industrial hub in northeastern India.

II. Project Description

The project that is suggested for a feasibility study by this report would process a total of about 4.1 MMSCM/D of associated natural gas to remove ethane, propane and heavier hydrocarbons. The residual 3.6 MMSCM/D of lean gas after fractionation would be utilized in existing facilities and facilities previously approved for construction. Some LPG would be extracted and separated from the ethane and propane and added to that which is now produced by OIL. The ethane and propane would constitute charge stock for a cracking plant to produce ethylene and propylene as intermediate products. Those would be further processed in downstream units to manufacture chemicals or plastics to meet market needs in Assam and surrounding states.

Much of the associated natural gas now collected for use in Assam is in the Namrup area. Oil India Ltd. (OIL) operates a plant which recovers propane and butane as liquefied petroleum gases (LPG) from some 2.6 million standard cubic meters per day (MMSCM/D) of associated natural gas near Duliajan. That processed gas is used for power plant fuel, tea garden fuel, ammonia-urea and methanol feedstocks and the like. The LPG is used as cooking and space heating fuel. In addition, OIL has allocated another 1.0 MMSCM/D of natural gas soon to be collected for a gas turbine combined cycle thermal power plant (200 MW gas turbines plus 80 MW waste heat steam turbines) to be built near Kathalguri about 15 Km from Duliajan.

Cryogenic fractionation of these combined natural gas streams after the existing extraction of LPG would yield some 131,000 t/y ethane, 62,000 t/y propane and 31,000 t/y butane. In order to hold a constant heat content in the gas supplied to downstream users, the extraction of ethane and heavier hydrocarbons will require that an additional quantity of associated gas be collected and processed which would increase these numbers by between 10 and 15 percent. Flexibility in allocation of feedstocks could be achieved by transferring substantial quantities of propane and butane by pipeline to the existing LPG plant to be bottled as cooking and space heating fuel or all of the ethane and most of the propane might be charged as feedstock to cracking furnaces.

Plans are already being discussed in Assam to collect the balance of the associated natural gas which is now flared and to use that gas as fuel in a new gas-turbine power plant. Recovery of ethane and heavier components from that gas eventually would provide feedstock sufficient to either substantially increase the size of the contemplated initial ethylene/propylene olefins plant or to replicate it perhaps at a reduced size. The possible production of additional associated natural gas, or of non-associated gas, would make further resources available for future expansion. Economies of scale would favor an increase in plant size, especially in a plant initially designed to facilitate expansion. Alternatively, the reliability of supply inherent

with two ethylene plants connected by a product pipeline would greatly facilitate attracting private investment capital for downstream plants which would manufacture ethylene derivatives. Such a product pipeline also would tend to decentralize the sites of downstream plants throughout a defined industrial corridor. Private financing and operation of downstream plants and the dispersion of those plants in order to provide a broader geographical base of employment are desired by the Government of Assam. The technical and economic choices need to be resolved by feasibility study options.

A key to the feasibility of this project will be an initial market study to determine which possible products could be sold in what quantities in the seven sister states and in the remainder of India after the Nagothane complex and realistic planned additions at Nagothane and elsewhere are in production. The market study should include transportation to identified markets. River transportation possibilities may become a factor in due time but probably will be beyond the reasonable scope of the immediate study. The Assam Industrial Development Corporation (AIDC) has agreed that Assam will fund a local contractor to perform the bulk of this market study provided a U.S. contractor directs and supervises that work as a part of the TDP funded feasibility study. The objectives of the market study will be to delineate the downstream units by products and capacities, to select not more than four such process units to be included in the U.S. contractor's detailed feasibility study and to determine the aggregate reasonable quantity of ethylene and propylene which could be consumed by the downstream units. Determination of a time scale for the quantity of olefins which reasonably could be utilized and marketed in Assam and neighboring states is necessary in order to avoid the unsavory consequence of flaring product from an excessively large ethylene plant at great cost for some period of time rather than alternatively continuing to flare equivalent natural gas temporarily.

A technical and economic feasibility study is to be prepared by a U.S. contractor covering the cryogenic gas separation plant for recovery of ethane and heavier hydrocarbons, the olefins cracking plant and four downstream process units to transform the olefin plant production into marketable products. Those four process units are to be identified and defined during the market study phase. The intermediate products for the four process units should be selected with the intention of creating opportunities for additional downstream processing or manufacture in the region.

A great amount of work has been done by AIDC and others on the concept of a gas fractionation and cracking plant during the last several years. The most recent summary assessment of the situation as prepared by AIDC is included as Annex E of this report. Notes prepared by AIDC which reflect their understanding of our meetings in Guwahati are included as Annex D of this report.

Dowerah & Associates of Guwahati had prepared a report titled, "A Report On Collection And Supply Of Natural Gas From Oilfields In Assam For Gas Seperation Cum Cracking Unit" for AIDC which is reproduced in Annex G of this report. The U.S. contractor should review the Dowerah report and satisfy itself as to the conclusions therein which set the location and suggested initial size basis for the proposed ethylene plant.

A report prepared by AIDC and titled, "Proposed Plan For Utilization Of Petroleum Feed Stocks - Natural Gas And Other Hydro-Carbon Fractions Available Within The State Of Assam, During Seventh Plan Period" by AIDC is reproduced in Annex F of this report. That AIDC report, which refers to the seventh 5-year plan for India, gives the earlier thinking of AIDC regarding the ethylene complex as well as other non-related petrochemical units. Tentative selections, sizes and costs of downstream units in the ethylene complex which are included in the appraisals and estimates sections of this report are based on corresponding sections of that AIDC report.

Two terms encountered in those reports and other Indian source documents are crores and lakhs. Crores means tens of millions. Costs might be stated to be say Rs. 10 crores which means Rupees 100,000,000 or about US$ 8 million. Similarly, lakhs means hundreds of thousands. Thus 1.5 lakhs is often written as 1,50,000 corresponding to our notation of 150,000.

The average gas composition of the associated natural gas now produced by OIL which would be utilized for this project is as follows.

	Rich Gas	LPG Stripped
C_1 Methane	88.1%	88.5-90.0%
C_2 ethane	6.2	7.2- 6.3
C_3 propane	3.2	3.2- 2.5
C_4 butanes	1.0	nil
C_5	0.3	nil
C_{6+}	0.2	nil
Carbon dioxide	0.6	1.0- 1.0
Nitrogen	0.4	0.1- 0.2
trace organic sulfur, no H_2S		
	100.	100. 100.

III. Technical and Economic Appraisal

The classical elements essential for the technical and economic success of a petrochemical venture are the economic availability of raw materials of appropriate quality, availability of sufficient capable labor at competitive wage rates, adequate land, markets for products and transportation to reach those markets. These all appear to be present for the proposed ethylene complex in Assam. The only real questions seem to be the appropriate economic choice of scale for the facility to be installed initially and the selection of an appropriate product slate.

The gas separation and olefins cracking plants central to this study are the keystones for most petrochemical plants throughout the world today. A reliable and sufficient supply of ethylene and its coproduct propylene is a fundamental precursor to the creation of a complex of downstream industrial petrochemical manufacturing operations. Technology for the production of ethylene and propylene from ethane and propane and for the production of ethylene and propylene derivatives such as polyethylene, polypropylene, ethylene oxide, ethylene glycol, ethanol, and ethanolamines to name but a few, is well proven and widely available. Similarly, technology for the recovery of the named feedstocks from the natural gas found in Assam is widely used.

The Government of India is seriously interested in utilizing the resources of India as the foundation for an industrial base. This is demonstrated by the Maharashtra Gas Cracker Complex under construction at Nagothane which is intended to utilize the associated natural gas components from the Bombay High field to produce ethylene, propylene and their derivatives. That project is said by HYDROCARBON PROCESSING magazine to be valued at US$ 1.3 billion, to include a 300,000 tonnes/year (t/y) ethylene plant, a 100,000 t/y propylene plant and down-stream units for 215,000 t/y LD polyethylene, 50,000 t/y ethylene glycol, 5,000 t/y ethylene oxide, 60,000 t/y polypropylene, a carbon black unit and the usual utilities and other associated offsite facilities. The capacity of the Nagothane project is near the lower end of the generally accepted world scale for internationally competitive ethylene plants in fully developed countries. The location of the complex at Nagothane, near the enormous resources of Bombay High and near the markets of the relatively sophisticated and accessible Bombay industrial area, can be seen to easily justify a 300,000 t/y initial plant there. The Maharashtra Complex will receive ethane and propane feedstock from a gas fractionation plant at Uran. Lean gas from Uran will be used for fertilizer production at Thal Vaishat first with any surplus to be made available for electric power generation at Bombay.

Assam, somewhat isolated and a subcontinent away from

Bombay, has a limited infrastructure and industrial base. The potential market represented by the 25 million inhabitants of Assam and its six sister states in Northeast India has yet to bloom. Although the Government of Assam is intent on developing its resources and there seem to be sufficient resources to ultimately support a world scale plant, local factors including transportation and access to markets appear to indicate that only a less ambitious size ethylene plant could be justified now. Circumstances of natural gas collection and utilization now and in the near future indicate feedstock will be economically available which could support an initial ethylene plant capacity of about 100,000 to 150,000 t/y. Considerably more feedstock could be made available but collection pipeline networks are not yet in place and it might be difficult to economically transport products from a larger plant to available markets in the near future. Provision for expansion or replication of the initial plant within a few years should be included as part of the feasibility study based upon a presumption that transportation limitations will be overcome and that local downstream industries will emerge within that time frame.

The extensive broad gauge railroad system of India terminates at Guwahati. A narrow gauge railroad extends from Guwahati east past Namrup and Digboi to Lido and Saikhoa Ghat. The traffic on that narrow gauge railroad may be approaching its rolling stock capacity if not also the rail capacity.

Water transportation is a possibility. The Bramaputra River parallels the railroad westward for the length of Assam from Saikhoa Ghat through Guwahati, around the Shillong Plateau of Meghalaya State, turning south into Bangladesh where it becomes the Jamuna River which then joins the Ganges River and flows to the sea. The Assam Industrial Development Corporation (AIDC) staff believes the minimum depth of the Bramaputra River from Guwahati all the way to the sea is 30 to 40 feet during the dry season and perhaps 100 feet during the rainy season. A map of India shows elevations above sea level of 445 feet near Digboi and 223 feet just upstream from Guwahati. This tends to support the theory that the river may be navigable for ocean going or self unloading barges up to Guwahati or to Jorhat or perhaps even to Dibrugarh near Namrup. There is no evidence of any barge traffic at Guwahati now.

IV. Scope of Work for Feasibility Study

The feasibility study for the Assam Natural Gas Separation and Ethylene Cracker Complex is to include technical, economic and financial assessments of the proposed facilities based upon marketing studies to be performed by others but directed and guided by the feasibility study contractor. The facilities to be included are a gas separation unit to recover ethane, propane and butanes from collected wellhead natural gas, a cracking and purification unit to produce ethylene and associated products and four downstream units to be selected to manufacture sellable products from the ethylene and related materials.

Details of the feasibility study work program are to be performed in accordance with requirements spelled out in a Memorandum of Understanding dated October 1, 1986. That memorandum was signed on behalf of Assam by Mr. N. Buragohain, Managing Director, Assam Industrial Development Corporation Ltd. (AIDC), an undertaking of the Government of Assam, and for the U.S. side by Frank S. Chalmers, Consultant to TDP. Witness signatories were Mr. Sanjit Gupta, Senior Commercial Advisor, American Consulate General, Calcutta, and Mr. P. K. Bhuyan, a local industrialist and member of the Board of Directors of AIDC.

The intent of the terms of the Memorandum is to obtain a feasibility study for a plant or plants of conventional design to recover and to convert components of now wasted natural gas into marketable chemical products. A marketing study is to be performed by a local firm in Assam under contract to AIDC. Supervision and direction of that study shall be included in the scope of work of the U.S. contractor that performs the feasibility study under a grant from the Trade and Development Program (TDP) of the United States Government.

The specific chemical products for which process units are to be included in the feasibility study are to be selected jointly by the Indian firm performing the market study and the U.S. contractor for the feasibility study. The number of those downstream process units has been set arbitrarily at four (4) for the sole purpose of defining the level of effort required to perform the feasibility study. The level of effort is reflected in the recommendation of this report as to the size of the suggested TDP grant.

The feasibility study should be based on a common location for both the gas separation plant and the cracking and recovery plant. Downstream processing units which manufacture marketable chemicals from ethylene probably may be located at other sites connected by pipeline to the ethylene plant. The intent is for the parent ethylene supply facility to be built and owned by the State of Assam while the downstream units are to be financed, owned and operated either jointly with or solely by private investors. Each downstream unit therefore should be estimated as an incremental stand-alone facility complete with its own

independent utilities systems. The ethylene product pipeline concept conforms to that plan nicely.

The primary focus of the feasibility study and the companion market study is to determine and match the potential near term market in the Assam region with the availability of feedstocks contained in natural gas now or soon to be collected there. The objective of the feasibility study is to determine if recovery, cracking and processing to produce olefins and derivative products on a scale supported by such available feedstocks and market is economically viable.

Technical and economic descriptions and analyses are to be included and are to contain sufficient information for the Government of Assam to form rational bases for decisions. Quantities of raw materials, intermediate products and by-products, waste streams if any, utilities to be consumed or produced and operating and maintenance labor are to be included in such forms that others can adjust those figures on an annualized basis for variations in operations.

Costs, including potential additional costs during startup, are to be discussed in narrative form in the study report. The economic evaluations and financial data should include a sensitivity analysis for the ranges of recoverable components in the natural gas comprising 6-8% ethane, 2.5-4.0% propane, and 1-2% butane and heavier.

The contractor and AIDC officials should consider themselves free to modify or change the methodology contained in the Memorandum of Understanding at the time the contractor's team visits Assam as changed conditions and data may dictate, subject to the approval of TDP.

Estimate of Feasibility Study Cost

Two Project Persons to Assam for Two Weeks each:	
Transportation.....$	5,000
Per diem (28 days at $71.50).....	2,000
Time charges (2 people at $10,000/man month)	10,000
Market Study Director to Assam Twice for 1 Week	
Transportation.....	5,000
Per Diem (14 days at $71.50/day).....	1,000
Time charges included in Home Office Services	
Home Office Services: Technical and Economic Analysis, Prepare Draft Report, Revise Draft and Issue Final Report -	
Marketing Study Direction (400 hrs x $50/hr)	20,000
Gas Separation Plant (800 hours at $50/hr)	40,000
Ethylene Plant (3,000 hours at $50/hr)	150,000
Downstream Units (4 x 1200 hrs at $50/hr)	240,000
Miscellaneous and Contingency.....	27,000
TOTAL	**$ 500,000**

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V. Investment and Operating Costs

The objectives in performing the technical and economic feasibility study described in this report are to determine and then to evaluate a reasonably optimum plant configuration and product slate in light of available raw materials, markets and infrastructure restraints. Assumptions must be made in order to define a plant configuration so that estimates can be made for the costs of that plant. Such estimates are needed in order to make a preliminary evaluation of the eventual project. The preliminary evaluation is needed so that a rational decision can be made as to whether or not to fund the feasibility study. The following assumptions therefore have been made to address these needs without intent to prejudice the eventual results of the study.

Assume that feedstocks of 131,000 t/y ethane and 46,000 t/y propane are produced by a gas separation plant and that these are fed to a cracking plant which makes 115,000 t/y ethylene, 45,300 t/y propylene and 16,700 t/y of other materials such as tars and fuelgas which are presumed to be burned in the unit as fuel.

Assume the downstream plants are as follows. These units and the prices of individual commodities are generally as described in the Project Profiles included by AIDC in their Proposed Plan for Utilization of Petroleum Feedstocks, a copy of which is included as Annex F in this report.

Ethylene Oxide/Glycol Units -
- Charge stock: 18,200 t/y ethylene at Rs. 6400/t
- Products: 5,000 t/y merchant ethylene oxide at Rs. 18,000/t
  20,000 t/y ethylene glycols at Rs.14,000/t

2-Ethyl Hexanol Unit -
- Charge stock: 15,300 t/y propylene at Rs. 5330/t
- Products: 15,000 t/y 2-ethyl hexanol at Rs. 17,000/t
  1,700 t/y n-butanol at Rs. 12,500/t
  5,200 t/y iso-butanol at Rs. 13,000/t

Polyethylene and polypropylene units -
- Charge stocks: 96,800 t/y ethylene at Rs. 6400/t
  30,000 t/y propylene at Rs. 5330/t
- Products: polyethylenes
  63,000 t/y LLDPE & HDPE at 16,500/t
  30,900 t/y LDPE at Rs. 14,500/t
  polypropylene
  29,000 t/y at Rs. 15,500/t

Investment costs for these process units are estimated to be about as follows.

Gas Separation Plant	US$ 30. million
Ethylene/Propylene Plant	100. million
Utilities and Offsites	26. million
Subtotal government owned units	US$ 156. million
Ethylene Oxide/Glycols Units	US$ 30. million
2-Ethyl Hexanol/Butanols Unit	43. million
LLDPE/HDPE Polyethylenes Unit	53. million
LDPE polyethylene/Polypropylene Unit	50. million
Utilities and Offsites	35. million
Subtotal privately owned units	US$ 211. million
TOTAL CAPITAL INVESTMENT	**US$ 367. million**

The total annual sales revenues generated from these investments would be as follows.

5,000 t/y merchant ethylene oxide x Rs.18,000/t =	Rs. 90,000,000
20,000 t/y ethylene glycols at Rs.14,000/t =	280,000,000
15,000 t/y 2-ethyl hexanol at Rs. 17,000/t =	255,000,000
1,700 t/y n-butanol at Rs. 12,500/t =	21,250,000
5,200 t/y iso-butanol at Rs. 13,000/t =	67,600,000
63,000 t/y LLDPE & HDPE polyethylenes at 16,500/t =	1,039,500,000
30,900 t/y LDPE polyethylene at Rs. 14,500/t =	448,050,000
29,000 t/y polypropylene at Rs. 15,500/t =	449,500,000
Total Annual Sales Revenues	Rs. 2,650,900,000
Which at Rs. 12.70 per US$ is	**US$ 208,730,000**

Thus the annual sales revenues of the complex are over 56.8% of the capital investment estimated to be required.

Essentially the only raw materials consumed by the complex will be extracted from natural gas now valued at Rs. 230 per thousand standard cubic meters. The volume shrinkage during extraction of ethane and heavier is about 175 million cubic meters per year. This works out to an annual value of Rs. 40.25 million or US$ 3.2 million which is about 1.5 % of investment.

Total annual operating costs as a percentage of investment might be about as follows.

Depreciation	7.0 %
Interest on investment	10.0 %
Insurance	0.5 %
Repairs and maintenance	2.0 %
Utilities	3.0 %
Raw materials	1.5 %
Labor	0.8 %
Total	24.8 %

Income available to repay investment therefore would be about 56.8% - 24.8% = 32.0% for an indicated payout period of slightly over 3 years. This is certainly within what appears to be a viable range.

VI. Estimates of Total Foreign and U.S. Business

Total Foreign Business

The estimated foreign component of capital investment for each unit and for the total are as follows.

Gas Separation Plant	US$	7. million
Ethylene/Propylene Plant		25. million
Utilities and Offsites		6. million
Subtotal government owned units	US$	38. million
Ethylene Oxide/Glycols Units	US$	7. million
2-Ethyl Hexanol/Butanols Unit		8. million
LLDPE/HDPE Polyethylenes Unit		13. million
LDPE polyethylene/Polypropylene Unit		12. million
Utilities and Offsites		7. million
Subtotal privately owned units	US$	47. million
FOREIGN COMPONENT OF TOTAL INVESTMENT	**US$**	**85. million**

Estimate of U.S. Business

Suppliers of engineered apparatus and equipment in the United States are much more competitive today than they were before the recent decline in the value of the dollar relative to other major currencies. Assuming reasonable support from the U.S. Eximbank which has expressed interest in this project, at least half of the foreign origin materials for this petrochemical complex in Assam should be sourced from the United States. The export potential from the United States for this project at hand is therefore between $43 million and $85 million with a probable value of perhaps $60 million. In addition to the initial potential for exports, there also is a possibility for at least that much again in exports as follow-on work. Additional downstream process units are expected to be added in Assam in future years as part of what may well become a blossoming petrochemical industry there.

VII. Sources of Financing

Funds for all domestic costs of the proposed petrochemical complex can be made available from Indian banks and other domestic sources. Offshore purchases will need to be financed offshore.

Officials in Assam asked about the possibility of funds being made available by the World Bank. That is highly unlikely because the normal lead time necessary for World Bank project funding is three to four years from the date of request by the host country with documented establishment of priority for the project by the country's central government. Such a long lead time seems to be quite out of reason for the project at hand.

The U.S. Export-Import Bank is a more likely source of funds for this project. It currently offers loans at 7.4% in India and the loan officer for India says they are interested in trying to do more business there. Officials at AIDC tell us they feel that approval of this project by the central government of India is almost certain. They also tell us that such approval carries an almost automatic assurance that a borrower will be allowed to convert Rupees into hard currency as may be necessary to service foreign loans. It is only a short step from there to having the Government of India guarantee repayment of loans which have been guaranteed in turn by the Government of Assam. Such guarantees are routinely required by the Eximbank. Another factor favoring Eximbank financing is that its current interest rate is considerably less than that now asked by the World Bank which makes it more attractive to the borrower.

There also may be private banks which wish to participate in the financing of these process units in Assam.

VIII. Recommendations

This project is almost certain to proceed to construction and operation if a feasibility study shows it to be viable. The probability is high that the project will prove to be viable if a study is performed. A likely value for the exports to be generated from the United States by the construction of this project, if the feasibility study for this project is performed by a U.S. contractor, is $60 million. The estimated cost for the feasibility study, with a tight budget, is $500,000. The resultant multiplier of 120 is very favorable by the usual TDP guidelines. If one considers the future potential for follow-on exports to Assam as the petrochemical industry in Assam grows from the nucleus to be created by this proposed petrochemical complex, the motivation for funding this feasibility study becomes even more compelling.

All of the products from this proposed complex are expected by definition to be utilized in the northeastern portion of India. No overseas shipments are anticipated to be made from this first facility. Hard currency would be generated by import substitution and by upgrading the value of products now exported such as by improving the packaging of tea.

It is recommended that the Trade and Development Program should support the feasibility study, described in this report, which has been requested by the Assam Industrial Development Corporation, Limited, an undertaking of the Government of Assam.

UNITED STATES TRADE AND DEVELOPMENT PROGRAM

NATURAL GAS FRACTIONATION AND OLEFINS PROJECT FEASIBILITY STUDY

DRAFT INVITATION TO BID

Assam Industrial Development Corporation
Mr. N. Buragohain, Managing Director
R.G. Barua Road, Guwahati - 781 024
Assam, India
Telex: 02 35210.AIDCORP
Cable: UDYOG
Telephone: 87731/87732

R - **Assam Natural Gas Fractionation and Olefins Project.** The Assam Industrial Development Corporation (AIDC), an undertaking of the Government of Assam, India, invites submission of qualification data from interested U.S. firms and/or joint ventures of U.S. firms that are qualified on the basis of past experience and performance to carry out a feasibility study on a natural gas fractionation and olefins project.

The project will involve facilities for cryogenic fractionation of natural gas, cracking of recovered hydrocarbons to olefins, and processing of the olefins to manufacture derivative chemicals. The fractionation unit is to process about 4 million standard cubic meters per day (MMscm/d) of natural gas to recover about 144,000 tonnes per year (t/y) ethane, about 69,000 t/y propane and about 34,000 t/y butanes and heavier hydrocarbons. The ethane and most of the propane are to be cracked to ethylene and propylene with heavier hydrocarbons possibly returned to an existing LPG bottling plant. Derivative products, to be selected by a market study, are to be manufactured in four downstream process units.

The work program for the study will include the following elements: (1) A market study will be performed by an Indian contractor based in Assam and funded by AIDC under the direction and guidance of the U.S. contractor. (2) Ethylene and propylene derivative products which can be manufactured in not more than four process units and that are marketable in quantities corresponding to the available feed stocks for the cracking plant are to be selected based upon that market study. (3) Preliminary designs are to be prepared for the gas fractionation, cracking, olefins recovery, and downstream process units and for their associated utilities and offsites. (4) A technical and economic feasibility study is to be prepared for all of the facilities

described above with each of the downstream process units separately described and analyzed together with its associated utilities and offsites. (5) A draft report and a final report are to be prepared and submitted which contain sufficient information for the Government of Assam and others to form rational bases for decisions. It is anticipated that the study will be completed in approximately 6 months. All documents and presentations are to be prepared in English. The U.S. contractor will be paid in U.S. dollars from a $ 500,000 grant to the Assam Industrial Development Corporation from the U.S. Trade and Development Program (TDP), International Development Cooperation Agency. No portion of the study may be subcontracted to a non-U.S. firm.

Selection for the contract covering this study will be carried out by AIDC in accordance with a two-step process. First, interested firms should submit qualification materials to AIDC at the above address in Assam, India. Those qualification materials should demonstrate experience and technical competence in comparable work, professional qualifications of personnel proposed to be assigned to the work, organizational knowledge of and experience in applicable technology, and familiarity with the type of construction work involved under conditions similar to those found in Assam. The qualification materials must be received by AIDC in Guwahati within 30 days after the date of publication of this notice.

After receiving the qualification materials, AIDC will evaluate them and prepare a list of highly qualified firms based upon the following evaluation and selection criteria: (a) experience and technical competence in comparable work; (b) professional quality of proposed personnel; (c) knowledge and experience in application of appropriate technological procedures and techniques; and (d) familiarity with similar work under similar conditions with preference given to such familiarity in India.

Highly qualified firms will be notified and will be provided with a more detailed statement of work. They will then have six weeks from notification to prepare and submit a detailed proposal to AIDC. The highly qualified firms will then be ranked by AIDC on the basis of the four criteria listed above and their proposals. Contract negotiations with the highest ranked firm will commence promptly on completion of the ranking.

AIDC reserves the right to reject all proposals and reserves the right to contract with the selected firm for subsequent work related to the project. Firms agree by their response to this announcement to abide by the procedures established for this procurement.

MEMORANDUM OF UNDERSTANDING

Feasibility Study Work Program for
Natural Gas Separation & Cracker Plants
and Downstream Process Units

The Assam Industrial Development Corporation Ltd. (AIDC) an undertaking of the Government of the State of Assam, India, has requested the Trade and Development Program (TDP) of the United States Government to provide funding for a feasibility study on the separation and utilization of natural gas produced in Assam. This memorandum sets forth an agreement on the following workprogram for the feasibility study which is based upon an understanding between the TDP Project Definition Team and other parties to this document as set forth below. All parties to this agreement understand that the present Memorandum of Understanding is an unofficial agreement. A final agreement on the Assam Natural Gas Separation and Cracker Plant Project and on the work program must be negotiated by TDP officials and by officials of AIDC and approved by the governments.

The State of Assam now produces some 5.5 million standard cubic meters per day of natural gas. Much, if not all, of this is co-produced with some 6 to 6.5 million tonnes per year of oil. Gas wells have been discovered but are for the most part held in reserve. About 40 per cent of the associated natural gas now produced as a by-product of current oil production is consumed usefully. Oil production in Assam is expected to increase during the balance of this century and the production of associated gas is expected to rise correspondingly to 9 or 10 million standard cubic meters per day.

The Government of the State of Assam is intent that their very high quality natural gas resources should be used efficiently for industrial purposes rather than flared as at the present time. This gas could be used effectively as the base for a Petrochemical Industry in Assam. A first step towards creating such an industry would be to extract the ethane from a portion of the available natural gas,

Cont'd.

to manufacture ethylene from that ethane in a cracking plant, then to convert the ethylene to selected useful products in downstream plants.

About 2.6 million SC M/D of associated natural gas is now gathered by Oil India Ltd. (OIL) near Duliajan and processed to separate liquified petroleum gases (LPG), for cooking and space heating uses. The portion of this gas remaining after removal of LPG is now utilised as ammonia feed stock by Hindustan Fertilizer Corporation and as fuel by the Namrup Thermal Power Station, by the Assam Gas Company grid for Tea processing and by OIL for internal requirements. An additional 1.0 million SCM/D will be collected by the Oil and Natural Gas Commission (ONGC) within the next two years at Kathalguri, about 15 Km from Duliajan, for use as fuel for gas turbine driven electric generators. The fuel gas remaining after removal of LPG by OIL plus the gas gathered by ONGC is expected to contain approximately 131,000 tonnes/year of ethane (C_2), 62,500 t/y propane (C_3) and 31,500 t/y butane (C_4) in addition to the fuel value of the Methane. These apparently commercial quantities of valuable chemical hydrocarbons could be readily recovered in a single processing facility.

The undersigned parties to this Memorandum of Understanding agree as follows regarding a Feasibility Study for a Petrochemical Plant to utilize these hydrocarbons. The feasibility study shall include both market studies and process units to recover the ethane and the propane and heavier hydrocarbons, to convert the ethane to ethylene, to convert the ethylene to one or more useful products and to recycle the propane and heavier hydrocarbons to the OIL LPG Stream or other products. The overall feasibility study will be directed and performed by a United States Contractor to be funded by a TDP grant. Detailed work on Marketing studies involving Supply and Demand within India will be performed by an Indian Consulting Firm funded by the Government of Assam but working under the direction and guidance of the U.S.Contractor.

The Marketing Study portion of the Feasibility study will include a Survey of all products which

Cont'd.

might reasonably be derived from ethylene such as ethylene oxide, glycol, amines, polyethylenes, polyvinyl chlorides and the like. An initial product slate will be selected based upon most favourable returns and which would require not more than four process units downstream of the ethylene plant. Net market demands and prices will be established for each potential product.

The feasibility study contractor will prepare preliminary designs and flow diagrams for the ethane and heavier recovery and separation process unit, the ethane to ethylene cracking and associated processing unit and for the four downstream processing units selected during the marketing study phase of work. The contractor will prepare Technical and Economic Analyses of each Process unit including narrative descriptions, estimates of capital and operating costs, sensitivity analyses for economically important variables and proforma cash flow tables to demonstrate investment timing requirements and the returns on investments. Risks and costs will be discussed by contractor. Requirements for additional raw materials, suitability of available raw materials and requirements for utilities such as electricity, fuel, water and steam will be analyzed.

It is agreed that the feasibility study report will include the following technical information and analyses:-

A plot plan will show the lay out of process units and Major equipment items within each unit.

Preliminary type process flow diagrams will be included showing principal equipment items, major valves and key instrumentation.

A narrative process description of each process unit.

A list of major equipment items showing approximate sizes and including a description of any special materials of construction.

Lists of utilities consumptions.

Description of quantities and qualities of products.

Cont'd.

- 25

Estimates of labour required for operation and maintenance.

List of equipment and materials expected to be procured offshore.

Descriptions or texts of any guarantees offered by process licensors.

Description of any process sources of air or water pollution.

It is agreed that the following economic and financial feasibility information will be included in contractor's report for each of the process units:

Estimate of direct investment costs by subdivision of each process unit.

Estimates of indirect investment cost including the following:-

1. Engineering
2. Expatriates at site
3. Construction Expense
4. Contractor fees
5. Contingency
6. Licensing fees
7. Start-up costs
8. Interest during construction
9. Working Capital
10. Estimates of consumption rates; and cost of raw-materials, utilities and labour.
11. Overhead costs

At Guwahati, Assam October 1, 1986

(FRANK S. CHALMERS)
CONSULTANT TO TDP, USA

1.10.86

(N. BURAGOHAIN)
MANAGING DIRECTOR
ASSAM INDUSTRIAL DEVELOPMENT CORPORATION LTD.

WITNESS

1. (Sanjit Gupta)
   Senior Commercial Advisor
   American Consulate General,
   Calcutta.

2. (Shri P.K.Bhuyan)
   Director
   Assam Industrial Dev.
   Corporation Ltd.

ANNEX C

LIST OF PARTICIPANTS AT CALCUTTA AND GUWAHATI MEETINGS

At the Consulate General of the United States in Calcutta on Monday, September 29, and Friday, October 3,1986:

Mr. Walker Diamanti, Consul General of the United States

Mr. James F. Cole, Economic/Commercial Officer

Mr. Sanjit Gupta, Senior Commercial Advisor

At the Assam Industrial Development Corporation, in Guwahati, Assam, during the week of September 29, 1986, and at Government House, Guwahati, October 1, 1986:

Mr. N. Buragohain, Managing Director, AIDC

Mr. P.K. Bhuyan, a Director of AIDC and Managing Director, Eastern Steel & Alloys Co., Ltd., Guwahati

Mr. Das, head of technical staff at AIDC

Mr. Gushami, engineer on AIDC staff

Mr. Basanta Kumar Dowerah, managing Partner, Dowerah & Associates, Guwahati

Mr. J.P. Rajkhowa, Commissioner of Industries, Indian Administrative Service, Guwahati

Mr. Digen Bora, Minister of Industry, Guwahati

ANNEX D

DISCUSSION NOTES RECORDED BY AIDC

30/9/86

SALIENT FEATURE OF DISCUSSION WITH MR. F.S. CHALMERS & MR. S. GUPTA

The question of setting up a Gas Fractionalisation Plant to extract ethane and other heavier hydro-carbons from the natural gas of the oil fields of Oil India Ltd. and ONGC in Upper Assam was discussed.

Ethylene from ethane

The general discussion, prima facie, subject to detailed technical and marketing study seems to indicate a feasible project. In this regard, Mr. Chalmers' views are tampered with caution. He is of the opinion that the 1st phase of the project should not be too ambitious. The 1st phase should be of a size from which future expansion can take place. Minimum level for such an unit may be 70,000 to 1,50,000 tonnes of ethylene/annum.

Min. Viable Unit

The above concept fits in nicely to the concept of extracting ethane (6% of So) and other heavier hydro-carbons of the natural gas now being collected a single point for utilisation by OIL for HFC, Namrup Thermal, etc. The quantum of this gas is around 2.6 m/m^3/day.

1st Phase

Extraction of ethane from gas collected in one point.

Also, $1m/m^3$/day gas will be collected at one point in Kathalguri to generate 280 m watt of electrical power.

So, a total of (2.6+1.0) = $3.6m/m^3$/day of gas is readily available for ethane extraction.

This should yield over 1,00,000 tonnes of ethylene/annum - enough to start the first phase of the project.

contd..2...

2nd Phase

2nd Phase of the project can be based on gas now being flared up.

Cost

On the face of it such a project will cost 400 - 500 Crores spread over a period of say 4/5 years.

Advantage of Phase I

The above concept has a great advantage because the gas is already available collected at one point and already utilised.

Only one component namely ethane (and heavier hydrocarbons) will be taken out from this gas.

(Taking out of 6%-7% ethane will not effect the present utilisation of the gas by HFC, Namrup Thermal Plant, etc. The new power generation Unit at Kathalguri envisages use of lean gas only. Also, the expansion units of HFC is based on lean gas).

Feasibility & Technical Study

TDP will have to undertake a detailed feasibility study based on gas composition as available and all other relevant data. Also, a Market Survey will have to be undertaken based on TDP's guidelines for the use of the finished product of the project.

Also, simultaneously, the Government of India should be moved for necessary clearance to extract ethane component (6% to 7%), from the gas now being collected at a single point by OIL for utilization. Also, from the gas to be utilised in the Kathalguri electric generation project.

ANNEX E

AIDC's SITUATION ANALYSIS

OIL, GAS, PETROCHEMICALS AND RELATED FIELDS

Oil resources including natural gas must form a major basis towards industrial and economic growth of the State. Proper utilisation of these resources can bring about an immediate transformation to the quality of living in this region. Cheap and sustained power from gas based electric generating units can open up possibilities for effective irrigation facilities all over the State bringing about an agricultural revolution. Medium and small sector industries can come up in a big way from the downstream petrochemical products based primarily on gas and naptha. Spinning and weaving complexes based on yarn from polyester staple fibre, all over the State can form a backbone for economic upliftment of the State. In this context and in the context of article 7 of the Assam Accord, proper safeguards against wastage and exploitation of oil resources specially of natural gas to the detriment of the State, must be ensured in the national as well as regional interest. Towards this, the following is suggested :

1. Regarding Natural Gas of the Oil Fields of Upper Assam

Natural gas is referred to as associated gas when it is produced alongwith Oil. The present generation of associated gas as available from various sources is as below :

From Oil India Limited(OIL)

Total associated gas production	: 4m/m^3/day
Collected at a single point for utilisation	: 2.6m/m^3/day
Flared	: 1.4m/m^3/day

From O.N.G.C.

Total associated gas production	: 1.7m/m^3/day
Collected at a single point for utilisation	: 1m/m^3/day
Flared	: 0.7m/m^3/day

contd..2..

From the above, it is clear that the problem of proper utilisation of the natural gas should be viewed in two different lines :

(a) Regarding gas which is collected at a single point for utilisation by OIL ($2.6 m/m^3/day$)

Petrochemical from ethane

This gas is utilised now to feed the Hindustan Fertilizer Corporation, Namrup, Namrup Thermal Power Station, the gas grid of Assam Gas Co., OIL's own requirements etc.

The ethane component of this utilised gas should be separated immediately for setting up of a Petrochemical complex based on Ethylene which is a building block for various downstream items like HDPE, LDPE, etc. which can be utilised by medium and small sector industries. Ethane forms about 6% of the total gas component.

1m/m³/day for kathaguri power generation project.

(b) Regarding flared up gas alongwith non-associated Gas.

Immediate comprehensive plan must be initiated to collect the flared up gas in one point. It is estimated that about $4m/m^3/day$ of flared up and non associated gas will be available for utilisation. This gas then must be separated into fractions of :

methane	C1(88-90% termed as lean gas)
ethane	C2 6.7%
propane	C3
butane	C4
others	

Power generation from lean gas.

C1, i.e., methane should then be utilised for power generation, as fertilizer feedstock and as an energy source. Govt. has already sanctioned gas based generating sets to be run on methane to generate about 200 MW of power. For this $1m/m^3/day$ of lean gas is already reserved.

...3..

The balance remaining lean gas of the natural gas should be utilised to generate an additional 300 MW of additional power. Gas generating units for electricity have tremendous advantage as its project implementation period is the shortest amongst power generating projects. These units will be able to give cheap and sustained availability of power within a very short period and this is the most vital ingredient for development in agricultural and industrial fields.

Balance remaining lean gas after use for generating of power should be utilised as a feedstock for fertilizer and as a source of energy in the gas grid of Assam Gas Co.

Petro-Chemicals

A Petrochemical complex should be planned which does not require sophisticated industrial infrastructure and which can accelerate the growth of small and major scale industries based on it. In choosing the end products emphasis should be given to the consumer/industrial requirement of N.E.Region so that it's end product can cater to these needs.

2. Proper utilisation Naptha from Guwahati Refinery & B.R.P.L.

(1) BRPL now sells about 1,20,000 M.T. of S R N Naptha to Fertilizer Units. This Naptha must be utilised for production of Benzene and its derivatives (Aromatic Complex). This will open up possibilities for setting up medium & small scale industries like detergent industries, pesticides, plastics etc.

Benzene Plant

contd..4..

PET chips from BRPL

(ii) The original product pattern of BRPL do not encourage medium/small sector industries. Even now BRPL should change its product composition within feasible limits and should produce Polyester chips (PET chips) alongwith Polyester Staple Fibre which is its main products component. Production of PET chips from the available polymer will make units like Polyester Filament Yarn viable.

3. New Refinery as per Assam Accord :

Assam Oil Division's proposed expansion proposal incorporating Naptha Cracker Unit.

The New Refinery should incorporate a proper Petrochemical range of products with Naptha Cracking facilities which only can bring about a rapid industrial and entrepreneurial growth to the region.

Assam Oil Division's proposed expansion incorporates a Naptha cracker to produce Ethylene, Propylene etc. which are the building blocks for establishment of small, medium & large sectors of industries. This expansion is in the interest of the state because of its proposed range of products and need to be supported.

4. Sale of Petroleum Products within the State :

The selling point of all petroleum product must be within the State of Assam before it is distributed to areas outside the state using the existing network system. Necessary steps in this direction need to be taken immediately. The State in losing over

contd..5..

100 crore in the form of Sales Tax annually, which is its legitimater due. If necessary, a tank farm should be set up near Bongaigaon for this purpose.

5. Time Limit :

A time period of 2 years must be fixed within which period flaring of gas need to be stopped by utilising the gas primarily for power generation and other forms of energy requirements. The Petrochemical Complexes which needs longer implementation period can be commissioned as and when they are ready.

6. Pricing Policy of Gas & NGL :

A long term pricing policy of Gas and Natural Gas Liquid should be fixed immediately by the Petroleum Ministry keeping in view long term development of this region. (Mixture of propane and higher hydrocarbons is normally referred as Natural Gas Liquid).

PROPOSED PLAN FOR UTILISATION OF PETROLEUM FEED STOCKS - NATURAL GAS AND OTHER HYDRO-CARBON FRACTIONS AVAILABLE WITHIN THE STATE OF ASSAM, DURING SEVENTH PLAN PERIOD.

BY

ASSAM INDUSTRIAL DEVELOPMENT CORPORATION LTD.
(A GOVT. OF ASSAM UNDERTAKING)

DEPARTMENT OF INDUSTRIES
GOVT. OF ASSAM, DISPUR
GUWAHATI-781 006

1. INTRODUCTION

Assam is endowed with reserves of crude petroleum oil and associated as well as free natural gas. These reserves are being worked by Oil India Limited (OIL) and Oil & Natural Gas Commission (ONGC), both Government of India undertakings. Assam also has three refineries for processing of crude oil located at Digboi, Guwahati and Bongaigaon. It further has a small petrochemical complex at Bongaigaon linked to the refinery. OIL is recovering LPG (Butane-Propane mix) and Natural Gas liquids from the associated natural gas at Duliajan. Assam thus has a number of petroleum based organic feed stocks available within the State which could be further gainfully utilised.

2. AVAILABILITY OF DIFFERENT FEED STOCKS

Assam is the pioneer state in India in producing crude oil indigenously. The first indigenous discovery of the crude oil was in Assam in 1867. Since then more and more new oil fields are being discovered and developed in the state. The two central sector undertakings namely Oil India Ltd.(OIL) and Oil & Natural Gas Commission (ONGC) are operating in the state for exploration, production and transportation of crude oil. In the process of carrying out their business of oil exploration & production the OIL and ONGC have strucked substantial reserves of natural gas. The natural gas are found in two forms i.e. Associated and free gas. The free gas is found in gas reserve and as such could be tapped for use as and when required. The associated gas on the otherhand is found alongwith the crude

Contd.....

oil in the wells. The production of associated gas cannot be controlled without affecting the production of crude oil.

2.1 AVAILABILITY OF FREE GAS

The estimated free gas reserves in Assam are around 24000 Million standard cubic metre (MMSCM). Almost the entire quantity of these reserves is in the oil fields of Oil India Ltd. This reserves, it is estimated could sustain an average production of about 3.3 MMSCMD and 2.2 MMSCMD for 20 and 30 years respectively.

2.2 AVAILABILITY OF ASSOCIATED GAS

The associated gas is dissolved in crude and is freed when crude is produced and pressure is released. Based on the present average gas to Oil ratio (GOR), there is large resources of associated gas in Assam. With the corresponding increase in oil production, the associated gas production would rise proportionately. The present total production of associated gas in Assam from OIL and ONGC fields is around 5 to 5.5 MMSCMD. The table below indicates the plan for production of associated gas by OIL and ONGC.

Year	OIL + ONGC '000 SCMD(Avg.)
1984-85	5832
1985-86	5844
1986-87	5678
1987-88	5398

Contd.....

Year	OIL + ONGC '000 SCMD(Avg.)
1988-89	5154
1989-90	5061
1990-91	5006
1991-92	4966
1992-93	4907
1993-94	4841

Under the accelerated programme made in 1981; OIL would retain its production of crude at about 3 million tonnes per annum whereas ONGC would step up to 4-4.1 million tonnes per annum from the present production rate of 2.2 million tonnes per annum. According to the accelerated plan of 1981, the production of associated gas in Assam both by OIL and ONGC till 2000 AD will be as below :

Likely associated gas production,1000 SCMD

	O I L			O N G C		
Year	Gross	Loss	Net	Gross	Loss	Net
1984-85	4594	134	4460	1525	153	1372
1985-86	4547	144	4430	1601	160	1441
1986-87	4385	144	4241	1597	160	1437
1987-88	4082	125	3957	1601	160	1441
1988-89	3832	124	3708	1607	161	1446
1989-90	3742	134	3608	1614	162	1453
1990-91	3677	132	3545	1625	162	1461
1991-92	3597	102	3495	1634	163	1471
1992-93	3533	106	3427	1644	164	1480

Contd....

	O I L			O N G C		
Year	Gross	Loss	Net	Gross	Loss	Net
1993-94	3457	105	3352	1654	165	1489
1994-95	3379	108	3271	1664	166	1498
1995-96	3321	106	3215	1675	168	1507
1996-97	3339	107	3232	1679	168	1511
1997-98	3346	107	3234	1683	168	1515
1998-99	3411	100	3311	1685	169	1516
1999-2000	3508	80	3428	1685	169	1516

According to the report by gas task force, Oil Industry Development Board, Deptt. of Petroleum, Ministry of Energy, New Delhi the prognosticated gas availability for both OIL and ONGC are reproduced below :

GAS AVAILABILITY (PROGNOSICATION)

O. I. L.

Year	Associated Gas	Free Gas	Total Gas
1983-84	4.1	-	4.10
1984-85	4.46	-	4.46
1985-86	4.46	-	4.45
1986-87	4.46	-	4.46
1987-88	4.46	3.0	7.46
1988-89	4.46	3.0	7.46
1989-90	4.46	3.0	7.45
1990-91	4.46	3.0	7.46
1991-92	4.46	3.0	7.46
1992-93	4.46	3.0	7.46
1993-94	4.46	3.0	7.46

Contd-----

Year	Associated Gas	Free Gas	Total Gas
1994-95	4.46	3.0	7.46
1995-96	4.46	3.0	7.46
1996-97	4.46	3.0	7.46
1997-98	4.46	3.0	7.46
1998-99	4.46	3.0	7.46
1999-2000	4.46	3.0	7.46

GAS AVAILABILITY (PROGNOSTICATION)

O. N. G. C.

'MMCMD'

Year	Associated Gas	Free Gas	Total Gas
1983-84	1.27	0.14	1.41
1984-85	1.56	0.14	1.70
1985-86	1.68	0.15	1.83
1986-87	1.76	0.16	1.92
1987-88	1.92	0.18	2.10
1988-89	2.12	0.20	2.32
1989-90	2.37	0.22	2.59
1990-91	2.38	0.25	2.63
1991-92	2.40	0.29	2.69
1992-93	2 45	0.33	1.78
1993-94	2.53	0.33	2.86
1994-95	2.60	0.34	2.94
1995-96	2.62	0.34	2.94
1996-97	2.62	0.34	2.96
1997-98	2.74	0.35	3.09
1998-99	2.76	0.35	3.11
1999-2000	2.79	0.35	3.14

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3. PRESENT UTILISATION OF GAS

The utilization of gas in our country has always lagged behind its production thus resulting in flaring of large quantities of this nonrenewable source of energy. In Assam the flaring of gas has been necessitated because of the lack of infrastructure, as well as the fact that the present consumers have not made their commitments and new enterprises where the gas could be utilised have not come up.

3.1 The external utilisation of gas in Assam is mainly for fertilizer production by Hindustan Fertilizer Corporation Ltd.(HFCL), Power generation by State Electricity Board (ASEB), production of methanol etc. by Assam Petrochemicals Ltd. (APL) and as a fuel for tea gardens. The internal utilisation of this gas by the Oil India and ONGC is for power generation, gas injections and shrinkage in LPG extraction by Oil India's LPG Plant. The average utilisation of the gas by all these agencies put together comes to about 40% of the total production. At present about 2.5 MMSCMD of gas is being flared in Assam.

3.2 Besides the present above utilisation facilities, Government of Assam through Assam Industrial Development Corporation is going ahead with another scheme based on Natural gas - Methanol expansion project of Assam Petrochemicals Ltd.(APL). This project is aimed to produce 100 M.T. Methanol per day. The consumption of gas by the project will be 0.1 million metre cube per day. The project is in the advance stage of implementation and accoroing

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to the latest estimate, the cost will be around Rs.30.75 crores.

3.3 The Government of Assam is also examining the feasibility of establishment of Sponge-Iron Project based on the latest technology using Natural Gas.

3.4 Assam Gas Company (A Govt. of Assam undertaking) has planned to set up 10 Gas grids, out of which 3 Gas Grids are proposed to be completed during the 7th plan.

4. AVAILABILITY OF OTHER PETROLEUM FEEDSTOCKS

At present there are three refineries in Assam. The present capacities of the refineries are as follows :

		Capacity
1.	Digboi Refinery	0.51 million tonnes/annum of crude
2.	Gauhati Refinery	0.85 million tonnes/annum of crude
3.	Bongaigaon Refinery	1.00 million tonnes/annum of crude

The Digboi and Gauhati Refinery produce conventional petroleum products. The other products like naptha, aromax and petroleum coke are already committed to various consumers. The Bongaigaon Refinery besides producing conventional petroleum products also have the facilities of a petrochemical plant. The basic aim of this petrochemical plant is to produce xylene.

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The Petrochemical plant of BRPL will basically produce p-xylene which will be used in the production of DMT. From DMT, Polyester Staple Fibre (PSF) will be manufactured in a separate plant by BRPL. The production of DMT by BRPL will be 45,000 MT per year. Out of this quantity 31,000 MT will be consumed by BRPL for manufacture of PSF. The surplus quantity of 14,000 MT per annum will be available for processing for other purposes. In the process of production of p-xylene, a quantity of 6,600 MT of o-xylene will also be available for further processing.

At present the maximum availability of naptha at Bongaigaon including supply from Gauhati Refinery is around 2,00,000 tonnes per annum of which about 50,000 TPY (110-140^{o}C cut) is going to petrochemical plant of BRPL for processing. In addition, about 30,000 TPY return naptha is available from petrochemical plant of BRPL after extraction of xylenes. As such the net naptha available for sale from Bongaigaon is maximum of a round 1,80,000 tonnes per year. At present this is being sold as fertilizer feed stock to plant situated outside Assam. The 60-110^{o}C cut naptha available from the Bongaigaon including light reformate from catalytic reformer would be about 1,00,000 TPY. This is one of the major available petroleum feed stocks from Bongaigaon refinery which could be put to gainful utilization for producing high value petrochemical intermediates.

5. PRESENT UTILIZATION PLAN OF DIFFERENT PETROLEUM FEEDSTOCKS

For the proper utilization of various available petroleum feedstocks mentioned above, the

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State Govt. has already taken up the following projects.

(i) Spinning Mills for utilization of PSF

There are three Spinning Mills coming up in the State Sector with total spindlege of about 50,000 (First phase) to produce polyester and polyester blended yarn. Further, another 3 spinning mills are coming up in the Co-operative Sector, which will also consume a sizeable quantity of PSF from BRPL. All the State Sector Spinning Mills are in the field implementation stage and will be commissioned by 1986.

(ii) Polyester Film Project for utilization of surplus DMT

Government of India had granted a Letter of Intent to Assam Industrial Development Corporation for setting up a 2000 MTA Polyester Film Plant. The project is proposed to be set up in the joint sector and the joint sector collaborator has been finalised. Selection of Know-How and detailed engineering consultant is in progress. The project is estimated to cost about Rs.20 crores.

(iii) Polyester Filament Yarn Project for utilization of surplus DMT

With a view to processing all the available DMT within the state, the Government of Assam had proposed to set up a Polyester Filament Yarn project. The project is ideal from the point of view of meeting the requirement of yarn by the handloom

Contd.....

weavers. The Government of Assam is going ahead with the development of Textile Sector in the State based on PSF from BRPL. This project is considered as a part of the total Textile programmes for the state.

Assam Industrial Development Corporation has already applied to the Ministry of Industrial development for grant of a Lettero of Intent for a 10,000 TPA Polyester Filament Yarn Project.

(iv) Phthalic Anhydride Project for utilization of O-xylene

The availability of O-xylene from BRPL would be around 6,600 TPA. The Task Force on BRPL had recommended for setting up a Phthalic Anhydride Project based on O-xylene available from BRPL.

Assam Industrial Development Corporation Ltd. took steps for implementation of this project. An application for approval of the foreign collaboration with M/s Lurgi,West Germany was submitted to Government of India. The decision of the Government is awaited.

6. NEW PROJECTS PROPOSED BASED ON GAS AND OTHER PETROLEUM FEED STOCKS

The availability position of gas feed stocks reveals that there is large surplus of gas in Assam. The ideal proposition to utilize this gas would be to put up facilities for production of high

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value petrochemicals. Since the availability of naptha - the traditional feedstock is restricted because of non availability of crude easily, it could be in the interest of the nation to establish a petrochemical complex based on associated and non associated gas from the oil fields of Assam. The gas price is 2 to 3 times cheaper for the same calofific value, than oil. Thus natural gas offers itself as one of the most sought after feed stocks for manufacture of petrochemicals. Moreover, project cost of a gas cracker is much lower than a petrochemical cracker based on naptha or gas oil. The global trends, therefore, is to build petrochemicals plants based on gaseous feed stocks wherever such feed stock are easily and abundantly available. The utilization of surplus Assam Gas is therefore, proposed by setting up a Gas Fractionation-cum-Separation Complex.

6.1 GAS FRACTIONATION CUM SEPARATION COMPLEX

The project is proposed to separate the various fractions of the gas first and then to separate these components to obtain the basic petrochemical building blocks like ethylene, propylene & C_4-mix. These building blocks are the primary starting rawmaterial for various petrochemical end products such as Ethylene oxide/glycol,PVC,HDPE, LDPE,LLDPE, 2 ethyl hexanol, styrene etc. Considering the demand supply position of these end products, the availability of gas, price of gas, economic capacities, it is proposed to establish the following facilities.

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Capacity : To process 4 MMSCMD of gas in the gas separation cum cracking complex.

Product : Ethylene - 3,30,000-3,45000 tpy
Propylene - 35,000- 45,000 tpy
C_4-mix - 21,000- 24,000 tpy

6.2 AROMATICS COMPLEX

As regards to availability of petroleum feed stocks from BRPL, there is not much scope for establishing economic capacities of either fertilizer complex or naptha cracker because of limited quantity. On the otherhand, the Assam naptha is found to be rich in aromatics. The limited quantity of 1,00,000 TPY (60-110^{o}C cut) naptha from BRPL could be utilized for extraction of aromatics like Benzene, Toulene and production of ethyl benzene.

The project is envisaged to extract the main aromatics benzene and Toulene. Besides these the complex will have the facility for production of ethyl benzene by intensive fractionation of reformed stream from the xylene recovery plant of BRPL. Considering the demand supply gas, availability of feedstock, minimum economic capacity, the project will have the following facilities :

Capacity :

(a)	Benzene	-	35,000 tpy
(b)	Toulene	-	5,000 "
(c)	Ethyl benzene	-	10,000 "

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7. OTHER DETAILS OF THE PROJECTS IN BRIEF

7.1 GAS FRACTIONATION CUM SEPARATION COMPLEX

Estimated project cost	:	Rs. 500 crores
Process technology	:	The latest coryogenic separation technique is proposed to be adopted for separation of the various components of the gas and catalytic cracking process for the gas cracker.
Utilities	:	Power - 12 M.W. Water - 6000 M^3/day
Manpower	:	2000 Nos.
Estimated Return on Investment	:	26% (Before tax)

7.2 AROMATIC COMPLEX

Estimated project cost	:	Rs. 50 crores
Process technology	:	Catalytic reforming process. Hydro-dealkylation process will be used to convert toulene into benzene.
Utilities	:	Power - 1,50,000 k.w. = 1.5 M.W. Water - 3,25,0000 M^3 Steam - 50,000 tonnes
Manpower	:	800 Nos.
Estimated Return on Investment	:	27% (Before tax)

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8. USES OF THE PRODUCTS FROM THE ABOVE TWO PROJECTS

8.1 The main products - Ethylene, propylene and C_4 mix from the Gas Fractionation and Cracking Complex are basically considered as primary building blocks for a host of end petrochemicals. These buildings blocks could be used as starting raw-materials for setting up manufacturing facilities for High Density polyethylene (HDPE), Low Density Polyethylene (LDPE), Ethylene oxide, PVC, Styrene etc; Acetaldehyde, Cumene, Isopropanol, Propylene oxide, Acrylonitrile, Isoprene etc; and Butanol, Butadiene, Isoprene, Amyl alcohol etc.

8.2 From the products of the proposed Aromatics Complex, a number of Benzene and Toulene based Chemical industries would be possible to set up. The important and the feasible amongst them are Linear Alkyl Benzene, Nitro-Benzene, Maleic Anhydride, BHC, Toulene Di-Isocynate, Ethyle Benzene, Styrene and Polystyrene.

The enclosed charts at Annexure I & Annexure II illustrate the various petrochemical products that could be obtained from a Gas Cracker and Aromatic Complex respectively.

9. DOWN STREAM PROJECTS POSSIBILITIES

From the above, it will be seen that the two proposed projects, will basically produce the intermediate chemicals based on which a number of second and third generation of petrochemicals products could be set up in medium scale. A brief details of possible down-stream projects which could be set up

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based on the products from the GAS CRACKING COMPLEX and AROMATIC COMPLEX are enclosed at Annexure III and Annexure IV . The above down-streams projects have been identified considering the factors such as demand - supply position, availability of basic raw materials, economics of scale etc. These Down Stream Projects could either be combined with the respective mother complex or could be set up separately.

9.1 OTHER INDUSTRIAL DEVELOPMENT POSSIBILITIES

With the setting up of these two complexes and their Down-Stream Units, the state and the region for that matter will open up a new market for capital goods and equipment. So far, although the region is associated with a large share of industrial production in the field of petroleum and hydrocarbon processing no projects for producing capital goods and other engineering items have come up. Quite a good number of projects for manufacture of boiler items, controlling/measuring instruments, tanks and vessels, Towers and Heat Exchangers etc. would be possible to be set up. The state Government has planned to identify these projects once the proposed GAS COMPLEX and AROMATIC COMPLEX are cleared.

10. RATIONALITY OF SETTING UP OF THE PROPOSED GAS COMPLEX AND AROMATICS COMPLEX

10.1 Inspite of the best efforts put in by both the central and the State Government, the State of Assam continues to remain as one of the industrially backward states in the country. All the seventeen districts in the state are declared by the Government as industrially backward district. Out of these, ~~three~~ districts fall under the category

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of 'No industry district'.

10.2 Traditionally, the industrial economic development of the State is centred round the tea and plywood industries in the private sector and crude oil in the public (central) sector. Expansion opportunities in the tea and plywood sectors have more or less reached a stage of saturation. The State has, therefore, to look for other available resources/ raw-materials for achieving the desired growth rate in the industries sector. If the past experience could be taken as an indication, it has been observed that private capital is very shy for making any meaningful investment in the State for various reasons. The State Govt.on its part is sparing no efforts to attract private capital into the state in as many diverged field on industrial activities as possible. Therefore, in order to generate a suitable cluture and climate for industrialisation, the state Govt. it is strongly felt, is to take a certain measure of initiative by way investment in certain core areas of industrial activities. The logical steps in this direction would be to set up projects based on the abundantly available Gas and other petroleum feed stocks within the state.

10.3 The Lavraj Kumar Committee set up by the Govt. of India also recommended the optimal utilization of gas as follows :-

Methane (C_1)/Lean gas	- Manufacture of Fertilizers.
C_2-C_3	- Gas Cracker feed stocks for petrochemicals
C_3-C_4	- LPG as fuel
C_5 +	- blended with motor gasoline.

Contd.....

10.4 As stated earlier, petrochemical complex based on gaseous hydrocarbon are cheaper than the ones based on naptha or gas oil. Again, Assam naptha is rich in Aromatics. Hence, the proposed Gas Complex and Aromatics Complex are the ideal choice in terms of the best utilization of Assam natural gas and other petroleum feed stocks from its refineries.

10.5 With the discovery of oil and gas, the industrial scenario of the state of Gujrat has undergone a significant change. Recently, the state of Maharastra is poised for reaping rich dividends from the discovery of oil and gas in Bombay High. Although, Assam is the pioneer State in the country so far as production of crude oil and gas is concerned, much remains to be done for deriving full benefits out of these natural resources so abundantly found in the state.

11. SOCIO-ECONOMIC BENEFITS

The setting up of these two mother projects would open up avenues for establishment of a good number of chemical and other allied industries within the region particularly plastics, paints and solvent based and engineering industries. Some of these units could be taken up by the private enterpreneurs in medium scale.

The estimated employment generation by all these project will be in the order of 5000-7000 persons.

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The saving/earning of foreign exchange would be about Rs.40 crores per annum.

The Task Force on utilization of GRPL products set up by the Government of India has recommended for development of plastic industries in the state. Once these two mother project - Gas Separation cum Cracking Complex and Aromatics Complex are set up, the required raw-materials for plastic based industries will be easily available within the state.

12. PHASEWISE REQUIREMENT OF FUNDS FOR THE ABOVE TWO PROJECTS

A. GAS SEPARATION CUM CRACKING COMPLEX

Total Project Cost	:	500 crores
Proposed Debt/Equity ratio	:	2 : 1
Equity Capital	:	167 crores
Term loan from Financial Institution/ Banks	:	333 crores

Requirement of Govt's equity:

1985-86	:	15 crores
1986-87	:	60 "
1987-88	:	70 "
1988-89	:	22 "

B. AROMATIC COMPLEX

Total Project Cost	:	50 crores
Proposed Debt/Equity ratio	:	1.5 : 1
Equity capital	:	20 crores
Term loan from Financial Institution/ Banks	:	30 crores

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Requirement of Govt's equity :

1985-86	:	3 crores
1986-87	:	7 "
1987-88	:	7 "
1988-89	:	3 "

Total requirement for GAS and AROMATIC COMPLEX is :

1985-86	:	18 crores
1986-87	:	67 "
1987-88	:	77 "
1988-89	:	25 "

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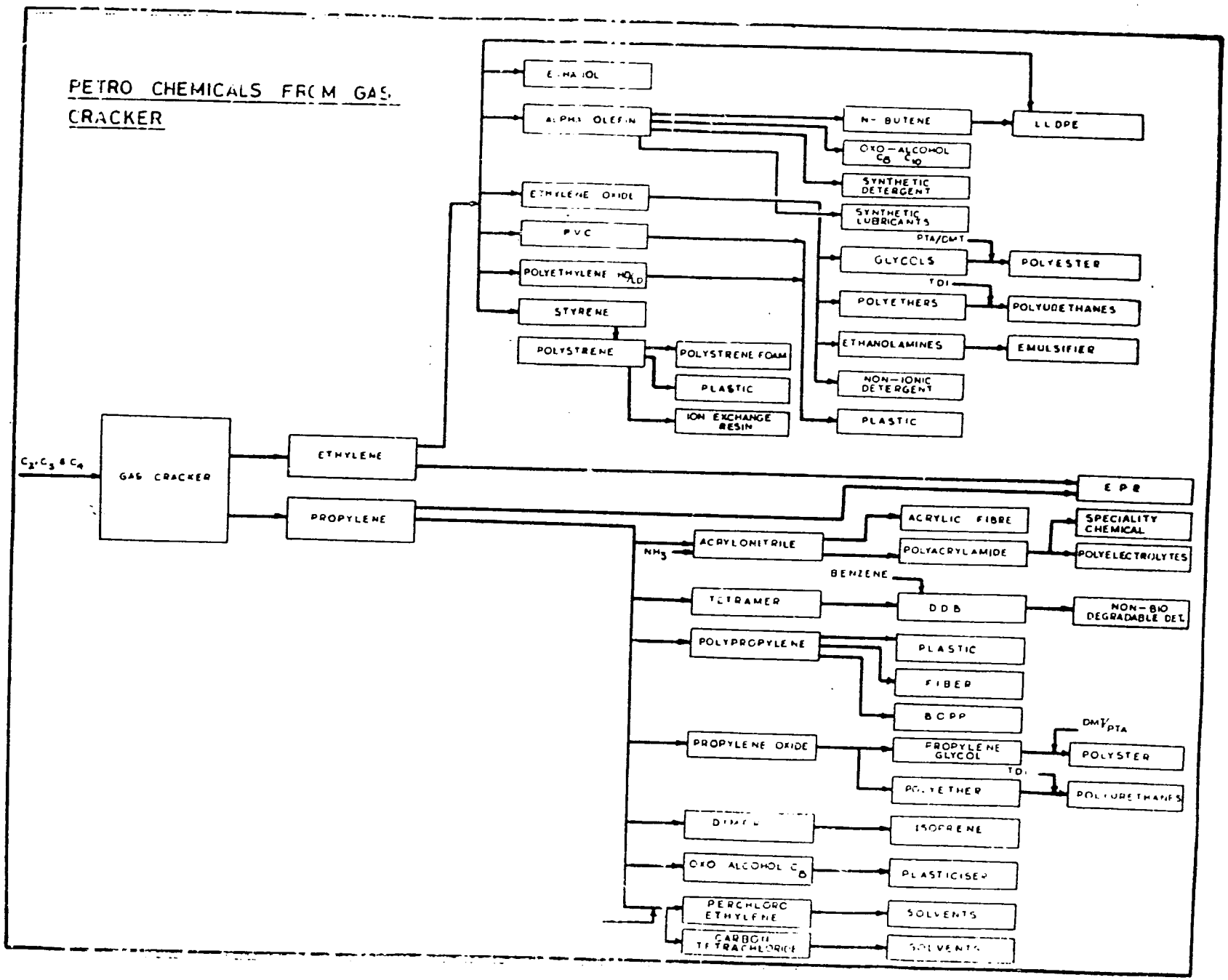
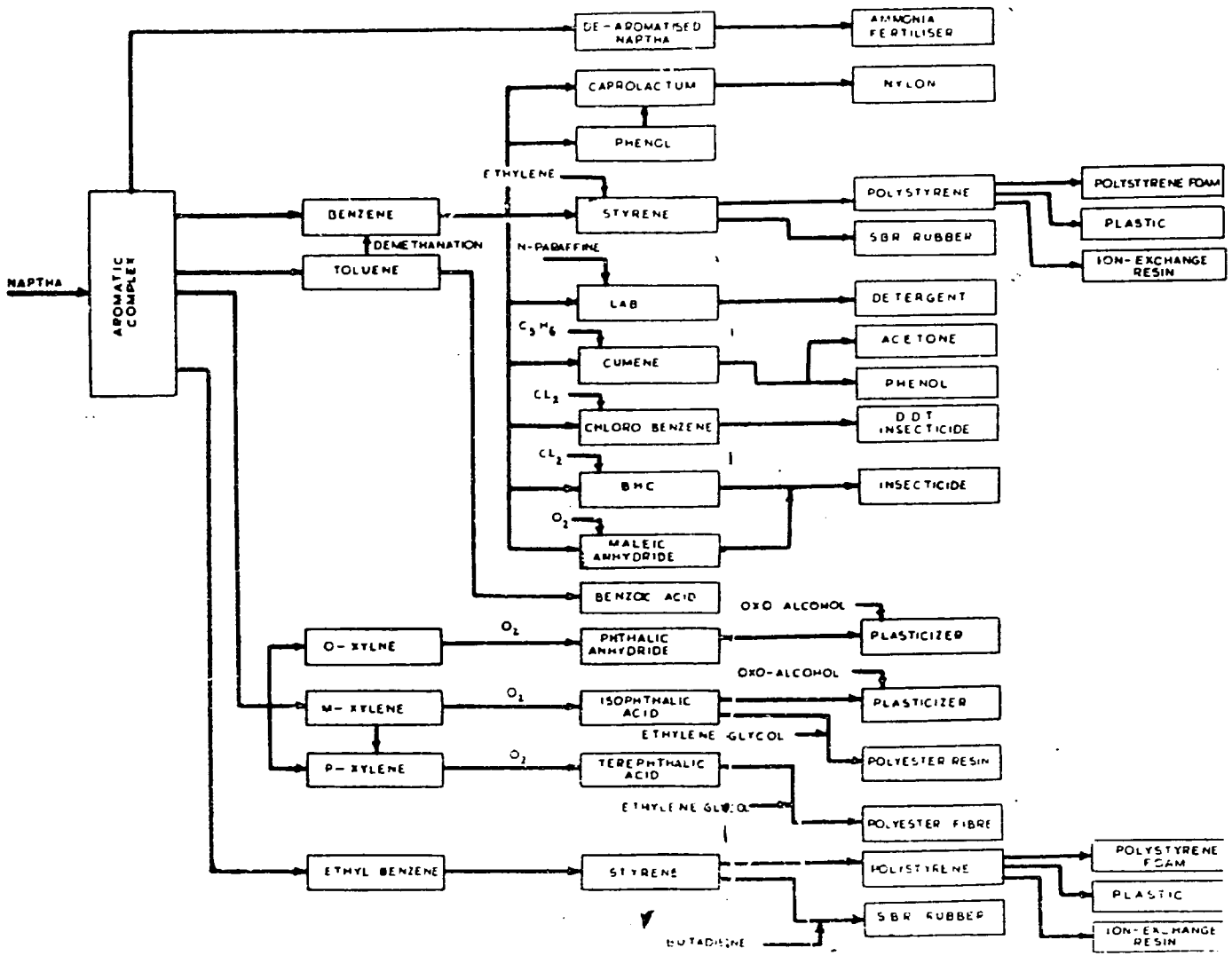
ANNEXURE - I


PETRO CHEMICALS FROM GAS CRACKER
E. HA IOL
ALPHA OLEFIN
N- BUTENE
LLDPE
OXO-ALCOHOL C8 C10
SYNTHETIC DETERGENT
ETHYLENE OXIDE
SYNTHETIC LUBRICANTS
PVC
PTA/DMT
GLYCOLS
POLYESTER
POLYETHYLENE HD LD
TDI
POLYETHERS
POLYURETHANES
STYRENE
ETHANOLAMINES
EMULSIFIER
POLYSTRENE
POLYSTRENE FOAM
NON-IONIC DETERGENT
PLASTIC
ION EXCHANGE RESIN
PLASTIC
C2, C3 & C4
GAS CRACKER
ETHYLENE
EPR
PROPYLENE
ACRYLIC FIBRE
SPECIALITY CHEMICAL
NH3
ACRYLONITRILE
POLYACRYLAMIDE
POLYELECTROLYTES
BENZENE
TETRAMER
DDB
NON-BIO DEGRADABLE DET.
POLYPROPYLENE
PLASTIC
FIBER
BOPP
DMT/PTA
PROPYLENE OXIDE
PROPYLENE GLYCOL
POLYSTER
TDI
POLYETHER
POLYURETHANES
DIMER
ISOPRENE
OXO ALCOHOL C8
PLASTICISER
PERCHLORO ETHYLENE
SOLVENTS
CARBON TETRACHLORIDE
SOLVENTS

A N N E X U R E - II

PETRO CHEMICALS FROM AROMATIC COMPLEX



ANNEXURE - III

PROJECT PROFILE - (1)

ETHYLENE OXIDE/ETHYLENE GLYCOL

1. USES

Ethylene oxide is used for making ethylene glycol for manufacture of surfactants, ethanol amines and explosives. Ethylene glycol is used for making polyester resins, surfactants antifreeze, glycol ethers, explosives etc.

2. PROCESS

2.1 Ethylene Oxide

Ethylene oxide is prepared by vapour phase direct or indirect oxidation of ethylene using as silver catalyst. For oxidation either air or oxygen is used.

2.2 Ethylene Glycol

Ethylene glycol is produced by hydration of ethylene oxide. Ethylene oxide and demineralised water are mixed continuously in a hydrator at high temperature where various ethylene glycols are formed. The products are concentrated in an Evaporator and distilled in various distillations columns and refiners to get MEG, DEG and higher ethylene glycols.

3. PRODUCTS

The products will be 18800 TPY of ethylene oxide of which 5000 TPY would be for merchant sale and balance for captive use. The EGs formed will be 18000 TPY of MEG, 1900 TPY of DEG and 100 TPY of TEG.

4. The raw material required is ethylene. The total requirement per annum would be 18200 TPY. In addition about 185000 NM^3 of air would be required. Utilities requirement per tonne of ethylene glycol for the plant will be as follows :-

Cooling water	:	200 M^3
Power	:	420 KWH
Steam	:	290 kg.

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5. MANPOWER REQUIREMENT

The direct manpower required for ED/EGs would be 150. In addition about 50 people from the common facilities can be apportioned to this plant.

6. TIME SCHEDULE

The project can be executed in about 36 months from start of engineering.

7. PROJECT COST

The project cost based on allocated costs for utilities for this plant is given below.

	Rs.Crores
i) Land and development	0.5
ii) Civil and structurals	1.0
iii) Plant and Machinery	20.0
iv) Technical services	4.0
v) Miscellaneous fixed assets	8.0
vi) Pre-operative expenses	6.5
vii) Contingencies	4.5
viii) Margin money	0.5
TOTAL:	45.0

This would have a foreign exchange component of about Rs.10 crores.

8. PRODUCTION COST AND PROFITABILITY

The production cost and profitability estimates are given below :

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A. Production Cost	Rs.Crores
1. Raw materials	
Ethylene 18200 tonnes @ Rs.6400 tonne	11.65
2. Utilities	
a) Power - 8.4×10^6 KWH @ Rs.0.55 per KWH	0.46
b) Steam - 5800 tonne @ Rs.150 per tonne	0.09
c) Water treatment & misc. chemicals and catalyst	0.50
3. Salaries & Wages - 250 persons @ Rs.20000 per person	0.50
4. Repairs and Maintenance	0.85
5. Insurance	0.22
6. Interest on term loans	3.78
7. Interest on working capital	0.21
8. Depreciation	3.05
TOTAL:	21.31

B. Sales Realisation	Rs.Crores
1.1. Ethylene Oxide - 500 tonnes @ Rs.18000 per tonne	9.00
2. Ethylene Glycols 20000 tonnes @ Rs.14000 per tonne	28.00
	37.00
C. Gross Profit	15.81
D. Return on Investment	5.13%
E. Pay back period	2.4 years

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PROJECT PROFILE - 2.

HIGH DENSITY POLYETHELENE/LINEAR LOW DENSITY POLYETHYLENE

1. USES

Linear Low Density Polyethylene (LLDPE) is now low density polyethylene with linear structure and can be used in agriculture, packaging, chemicals, foods, textiles etc. as moulded products for wire and cable industry for coating and miscellaneous other uses. HDPE is used for making packaging or making household products for pipes, water management, in defence and building and construction.

2. PROCESS

HDPE and LLDPE can be manufactured in the same plant. The plant consists of catalyst preparation, polymerisation and pelletisation/storage.

The rest of the steps are similar to HDPE. Dilutents are recovered and recycled back with make up.

3. PRODUCTS

The total production of 55000 tpy polyethylenes polyester is considered. The ratio between HDPE and LLDPE can be decided based on demand. For this note 40000 tpy HDPE and 15000 tpy LLDPE are considered as the product.

4. RAW MATERIALS AND UTILITIES

The main raw material is ethylene, its require-

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ment being 58200 tpy. The requirement of butene-1 for LLDPE would be about 1800 tpy. The requirement of make up solvent, normal hexane would be about 670 tpy and that of butance would be about 250 tpy.

The specific consumption of utilities is as follows :

	Cooling water Cubic meter	Power KWH	Steam Kg.
HDPE	90	435	60
LLDPE	90	380	60

5. MANPOWER REQUIREMENT

The direct manpower requirement for the plant is 170 and indirect manpower requirement is 80.

6. TIME SCHEDULE

The project can be executed in about 36 months from the start of engineering.

7. PROJECT COST

The project cost for HDPE/LLDPE plant is given below :

	Rs.crores
i. Land and Development	1
ii. Buildings and construction	4
iii. Plant & Machinery	30
iv. Technical Services	10
v. Miscellaneous fixed assets	14

Contd.....

		Rs.crores
vi.	Pre-operative expenses	12
vii.	Contingency	7.5
viii.	Margin Money	1.5
	TOTAL :	80
	Foreign Exchange content	20

8. PRODUCTION COST AND PROFITABILITY

The production cost and profitability estimates are given below :

A. Production Cost

	Rs.crores
1. Raw Materials	
Ethylene 58200 t @ Rs.6400/t Catalyst and chemicals/solvents Cutene 1800 t @ Rs.10000/-	43.78
2. Utilities	
Power 23.1 x 10^6 kwh @ Rs.0.55/kwh Steam 3300 t @ Rs.150/t Misc.	1.82
3. Salaries and wages - 250 persons @ Rs.20000/annum each	0.50
4. Repairs & maintenance	1.36
5. Insurance	0.4
6. Packing expenses @ Rs.200/t	1.10
7. a. Interest on term loans @ 14% p.a.	6.72
b. Interest on working capital @ 18% p.a.	0.63
8. Depreciation @ 6.78% p.a.	5.42
TOTAL :	61.73

Contd.....

PROFITABILITY

		Rs.crores
B.	Sales Realisation	
	- HDPE 40000 t @ Rs.16500/t	66.00
	- LLDPE 15000 t @ Rs.167/t	25.05
		91.05
C.	Gross Profit	29.32
D.	Gross Profit as Return on Investment	36.65
E.	Pay Back	2.3 years.

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PROJECT PROFILE - 3.

LOW DENSITY POLYETHYLENE (LDPE)

1. USES

LDPE is the largest volume thermo plastic manufactured in the world. It is quite versatile and can be used for blown and flat film used in agriculture, water management, canal, reservoir lining, mulching, packaging, chemicals, textiles and food; as moulded products for wire and cable industry, for coating etc. The capacity of LDPE plant considered is 30000 TPY.

2. PROCESS

LDPE is almost exclusively made by a high pressure press in either stirredtank or tubular reactors.

3. RAW MATERIALS AND UTILITIES

The main raw material required is ethylene having a requirement of about 1.03 tonne per tonne or 30900 TPY. In addition small amount modulator and initiator are required.

The specific consumption of utilities is as follows:

LDPE	Per tonne of LDPE
Cooling water	200 M^3
Power	1045 Kwh
Steam	115 kg.

4. MANPOWER REQUIREMENT

The direct manpower required for LDPE plant is around 160 and indirect manpower is 90, making a total of 250.

5. TIME SCHEDULE

The project can be implemented in about 36 months from appointment of engineering consultants.

contd....

6. PROJECT COST

	Rs.Crores
The project cost is given below	
i. Land and development	1
ii. Buildings and construction	4
iii. Plant and Machinery	27
iv. Tech.Services	5
v. Misc.fixed assets	12
vi. Pre-operative expenses	9
vii. Contingency	6
viii. Margin money	1
TOTAL	65
Foreign exchange content	15

7. PRODUCTION COST AND PROFITABILITY

A. Production cost

i. Raw Materials		
Ethylene 30900 t @ 6400/-		19.78
Catalyst and chemicals/ solvents		0.85
		20.63
ii. Utilities		
Power 31.35x10^{6}Kwh @ Rs.0.55/kw		1.72
Steam 3450 t @ Rs.150/t		0.05
Misc.		0.20
		1.97
iii Salaries & wages 250 persons @ Rs.20000/annum each		0.50
iv. Repairs & maintenance		1.21
v. Insurance		0.32
vi. Packing expenses @ Rs.200/t		0.60
vii. a) Interest on term loan @ 14% p.a.on 60% of project cost		5.46
b) Interest on working capital @ 18% p.a.		0.42
viii. Depreciation @ 6.78% p.a.		4.41
Total-		35.52

contd.

Profitability	Rs.Crores
B. Sales Realisation LDPE 30000 t @ Rs.14500/t	43.50
C. Gross profit	7.98
D. Gross profit as return on investment	12.28%
E. Pay back	5.2 years.

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PROJECT PROFILE - 4.

2-ETHYL HEXANOL

1. USES

Raw material for the manufacture of

Dioctyl Phthalate(DOP) Chief Plasticizer for flexible PVC Product.

Defoaming and wetting agent solvent for gums, resins and waxes, Solvent mixtures for paints and lacquers.

In India the use is limited at present to DOP as plasticizer.

2. PROCESS

Propylene and synthesis gas (Carbon Monoxide and Hydrogen) on 'OXO-XYNTHESIS' yields butyraldehyde which on 'aldol-condensation' and hydrogenation gives 2-Ethyl Hexanol. The synthesis gas may be obtained by partial oxidation of low cost fuel oil which will directly give the required $CO+H_2$ ratio or natural gas. The oxo reaction is carried out at high pressure and temperature using cobalt carbonyl catalysts. The aldol condensation is a base-catalysed reaction and the final hydrogenation may be done over a nickel catalyst.

3. PRODUCTS

The plant will produce 15000 TPY 2-ethyl hexanol with by-products 1700 TPY n-butanol and 5200 TPY of iso-butanol.

Contd.....

4. RAW MATERIALS AND UTILITIES

The requirement of raw materials per tonne of product is as follows :

Propylene	1.01 t
Synthesis Gas ($CO+H_2$)	1300 m^3
Hydrogen	360 m^3

Synthesis gas will be made from natural gas.

The consumption of utilities per tonne of 2-ethyl hexanol would be as follows :

Power	420 kwh
Steam	2.5 tonne
Cooling water recycling	1300 m^3

There would be recovery of some amount of fuel gas which can be used in the complex.

5. MANPOWER REQUIREMENT

The direct manpower required for 2-ethyl hexanol plant is 120 and indirect manpower is 80, making a total of 200.

6. TIME SCHEDULE

The project can be implemented in about 36 months from start of engineering.

7. PROJECT COST

The project cost is estimated as follows :

		Rs.crores
i.	Land and Development	1.0
ii.	Buildings and construction	3.5
iii.	Plant & Machinery	34.0
iv.	Technical Services	4.0
v.	Misc.fixed assets	6.0

Contd.....

	Rs.crores
vi. Preoperative expenses	9.0
vii. Contingency	6.5
viii. Margin Money	1.0
TOTAL :	65.0
Foreign exchange content	13.0

8. PRODUCTION COST AND PROFITABILITY

	Rs.Crores
A. Production Cost	
1. Raw materials	
a. Propylene 15300 to @ Rs.5330/t	8.15
b. Natural gas 10.8 MMSCM @ Rs.230/MSCM	0.25
c. Miscellaneous chemicals & catalyst	0.60
	9.00
2. Utilities	
a. Power 6.3×10^6 kwh @ Rs.0.55/kwh	0.35
b. Steam 3700 t @ Rs.150/t	0.56
c. Miscellaneous	0.20
Less : credit for fuel	0.25
	0.86
3. Salaries & wages-200 persons @ Rs.20000/annum each	0.40
4. Repairs and maintenance	1.24
5. Insurance	0.32
6. Packing expenses	0.30
Interest on term loans @ 14% p.a. on 60% of project cost	5.46
7. Interest on working capital @ 18% p.a.	0.42
8. Depreciation	4.41
	22.41

PROFITABILITY

		Rs.crores
B.	Sales Realisation	
	2-ethyl hexanol 15000 T @ Rs.17000/tonne average	25.50
	n-Butanol 1700 t @ Rs.12500/- tonne average	2.12
	iso-butanol 5200 tonne @ Rs.13000/tonne average	6.76
		34.38
C.	Gross profit	11.97
D.	Gross Profit as Return on Investment	18.42%
E.	Pay Back Period	4 years

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A N N E X U R E - IV

PROJECT PROFILE NO.1
PHTHALIC ANHYDRIDE (PAN)

1. USES

Phthalic Anhydride (PAN) is an important intermediate required in the production of a number of organic chemicals. Phthalic anhydride is mainly used for manufacture of plasticizers, unsaturated polyester resings and alkyd resins and in dyes and dye intermediate industry. Phthalate Plasticizers such as and dioctyl phthalate (DOP), dibutyl phthalate (DBP),etc. are the common and most widely used ones,especially in PVC resin.

2. PROCESS

Phthalic Anydride (PAN) can be manufactured either from o-xylene or napthalene. In this case since o-xylene isavailable as the feed stock, the process based on it is described. Oxidation air is pre-heated and supplied to a reactor. O-xylene is injectdd in the air stream. The reaction takes place in a reactor in the presence of vanadium pentaoxide catalyst. The hear of reaction is removed by molten salt in circulation and is used for generation of steam. The reactor gases are cooled and PAN is condensed inswitch condensors where sequential heating melts the solidified PAN. The crude product is stored and purified by a batch distillation and packed for sale.

3. RAW MATERIAL AND UTILITIES

The requirement of raw materials per tonne of PAN is as follows :-

O-xylene	:	1020 kg.
air	:	20100 M^3 at 10^oC

contd..

In addition, small amount of catalyst is required for make-up and some sulphur dioxide for maintaining the activity of the catalyst.

The requirement of utilities per tonne of PAN is as given below :

Circulating cooling water, M^3	:	650.0
Process water m^3	:	5.0
Demineralised water m^3	:	4.0
Electric Power, kWh	:	1000.0
Instrument air, Nm^3	:	60.0
Inter Bas, Nm^3	:	4.0
Surplus steam, tonnes	:	2.0

4. MANPOWER

The total manpower requirement for the PAN is estimated to be 180.

5. TIME SCHEDULE

The project can be completed in about 30 months from the date of tying up of finance, project technology and engineering consultant/contractor.

6. PROJECT COST

The project cost estimate for 6000 TPY PAN plant is given below :-

PROJECT COST ESTIMATE	Rs. lakhs
1. Land and Development	20
2. Building and Strucures	44
3. Plant & Machinery	710
4. Technical Services	120
5. Misc.fixed Assets	101
6. Preliminary & Pre-operative expenses	150
7. Contingency	130
8. Margin money	32
	1307

The total cost estimated at about 13 crores with foreign exchange content of 2.25 crores.

contd..

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7. PRODUCTION COST AND PROFITABILITY

The estimate of production cost and general profitability are given below :-

A. Production Cost.

	Rs. in lakhs
1. Raw Materials	
a) O-xylene - 6120 t @ Rs.6000/-	367.20
b) Sulphur dioxide 24 t @ Rs.4000/-	0.96
c) Catalyst	6.00
	374.16
2. Utilities	
a) Fuel Oil-1200 t @ Rs.300/-	36.00
b) Miscellaneous chemicals	1.00
c) Power 7.6×10^6 kwh @ Rs.0.55/kwh	41.80
	78.80
3. Salaries & Wages-180 persons @ Rs.20000/-person per annum	36.00
4. Repairs & Maintenance	24.77
5. Insurance	6.53
6. Packing expenses @ Rs.200/tonn of PAN	12.00
7. Interest	
a) Term loan	109.79
b) Bank loans	15.73
8. Depreciation	88.62
	746.40
B. Sales Realisation - 6000 T @ Rs.14000/t	840.00
C. Gross Profit	93.60
D. Gross profit as Return on Investment	7.16%
E. Pay Back Period	years 7.2

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PROJECT PRO ILE 2 - STYRENE

1. USES

Styrene is polymerised or co-plymerised to produce a number of plastics and elastomers. The current end-use pattern in India is roughly 65% for polystyrene, 25% for styrenebutadine rubber (SBR) and 10% for ABS and other co-polymers.

2. PROCESS

Styrene is made essentially by dehydrogenation of ethylbenzene which may either be recovered from the so-called 'mixed xylenes' or C_8-stream of an aromatics complex, or produced by reaction of ethylene and benzene. The latter may either be carried out in the liquid phase with $AlCl_3$ catalyst or in vapour phase with phosporic acid or silica-alumina catalyst. Ethylbenzene is mixed with steam and fed to reactor. The reactor products are cooled for separation of tar and then styrene and water. Crude styrene is separated and purified by distillation.

3. RAW MATERIAL AND UTILITIES

The raw material required is Ethyl Benzene. Its requirement per tonne of Styrene being 1.10 tonne. Utilities required per tonne of styrene are :-

Power	440 KWH
Steam	4 tonnes
C.Water(rec)	200 m^3

Contd....

4. MANPOWER

Total manpower required for the plant is estimated at 200.

5. TIME SCHEDULE

The project can be executed in 30 months from the date of tying up of finance, technology and engineering consultant/contractor.

6. PROJECT COST

The total project cost is estimated at Rs.9.8 crores as follows :-

		Rs.in lakhs
1.	Land & Development	20
2.	Building & Structures	80
3.	Plant & Machinery	480
4.	Technical Services	80
5.	Misc.fixed assets	80
6.	Preoperative Expenses	110
7.	Contingency	100
8.	Margin Money	30
		980

Foreign exchange content is about Rs.2 crores.

7. PRODUCTION COST & PROFITABILITY

The estimates of production cost and general profitability is given below :-

		Rs.lakhs/year
A.	Production Cost	
	1. Raw Materials	
	a) Ethylbenzene 9900 t @ Rs.12000/t	1188
	b) Misc.Chemicals and Catalyst	50
		1238

Contd....

		Rs.lakhs/year
2.	Utilities	
	a) Power 3.96 x 10^6 kwh @ Rs.0.55/KWH	22
	b) Steam 36000 t @ Rs.150/t	54
	c) Misc.and Water Treatment Chemicals	22
		98
3.	Salaries & Wages 200 persons @ Rs. 20000/person	40
4.	Repairs and maintenance	18
5.	Insurance	5
6.	Interest:	
	a) on term loan	82
	b) on bank loans	13
7.	Depreciation	66
		1560
8.	Sales Realisation 9000 t @ Rs. 20,000/t	1800
C.	Gross Profit	240
D.	Gross profit as return on investment	24.5%
E.	Pay-Back period	Year 3.2

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PROJECT PROFILE 3 - POLYSTYRENE

1. USES

The end-use applications of polystyrene including foamare listed below :-

- Packing
- Household Articles
- Appliances and Electronics
- Furniture and Furnishings
- Toy and Recreation
- Buildings

Packing is probably the single largest outlet for general purpose polystyrene all over the world. Crystal clarity, ease of processing and decorating are its advantages as packaging material. Impact polystyrene is used in the manufacture of radio, T.V., tape-recorders, refrigerators, etc. Foam polystyrene is used in packaging, cold storate, furniture, defence and buildings.

2. PROCESS

The process consists of polymerizing styrene monomer to 30 - 33% in stirred jacketed kettles at about 90^{o}C and then feeding the viscous syrup to the top of a vertical jacked tower. Most of the processes used today use revolving screws or paddles which gently agitate the viscous polymerizing syrup past tubes filled with circulating oil, thereby aiding heat transfer. The tower is operated at atmospheric pressure and a high temperature until mazimu, conversions are attained. Molten polystyrene is pumped from the bottom of the tower and the molten stands cooled and cut into transparent granules or pellets.

Contd.....

3. RAW MATERIALS AND UTILITIES

The raw materials required per tonne of product are :-

Styrene	1 t
Catalyst	Benzoyl peroxide, oxygen or stannic chloride.

The utilities requirement per tonne of product are :-

Electricity	410 KWH
Steam	0.5 tonne
Cooling Water Circulation($T=10^{o}C$)	50 m^3

4. MANPOWER

The total manpower required for the plant is estimated at 150.

5. TIME SCHEDULE

The project can be exacuted in 30 months from the date of tying up of finance, technology and engineering consultant/contractor.

6. PROJECT COST

The total project cost is estimated at Rs.9 crores with a foreign exchange content of Rs.2 crores as follows :-

		Rs.lakhs
1.	Land & Development	20
2.	Building & Structure	60
3.	Plant & Machinery	450

Contd.....

		Rs.lakhs
4.	Technical Services	90
5.	Misc. fixed assets	60
6.	Pre-operative Expenses	100
7.	Contingency	90
8.	Margin Money	30
		900

7. PRODUCTION COST AND PROFITABILITY

The estimates of production cost and general profitability is given below. Cost of Styrene is considered as production cost with 12% return for styrene plant.

		Rs.lakhs/year
A.	**Production Cost**	
1.	**Raw Materials**	
	a) Styrene 5000 t @ Rs.18600/t	930
	b) Catalyst & Chemicals	50
		980
2.	**Utilities**	
	a) Power 2.05 x 10^6 kwh @ Rs. 0.55/KWH	11
	b) Steam 2500 t @ Rs.150/t	4
	c) Water Treatment and misc. chemicals	20
		35
3.	Salaries and wages 150 persons @ Rs. 20000/persons	30
4.	Repairs and maintenance	16

Contd.....

		Rs.lakhs/year
5.	Packing expenses 5000 t @ Rs.200/t	10
6.	Insurance	5
7.	Interest:	
	a) on term loans	76
	b) on bank loans	13
8.	Depreciation	61
	TOTAL :	1246
B.	Sales Realisation 500 t @ Rs. 27500/t	1375
C.	Gross Profit	149
D.	Gross Profit as return on Investment	16.6%
E.	Pay-Back Period	4.3 years

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PROJECT PROFILE - 4 NITRO BENZENE

1. USES

The most important application of nitro benzene is in the manufacture of aniline. It is also used for the manufacture of intermediates for the azo and substituted diazo dyes like bensidine, mentanilic acid, dinitro benzene, m-nitrochlorc-benzene etc. It is also used extensively as a solvent for example in Firedel-Crafts reaction and in the refining of certain lubricating oils.

2. PROCESS

The manufacturing process is based on the recently developed process using only aqueous nitric acid as the nitrating agent.

3. CAPACITY

The capacity of the Nitrobenzene plant considered is 10,000 tonnes per year.

4. RAW MATERIALS AND UTILITIES

The major raw materials required for the manufacture of nitrobenzene are benzene and nitric acid.

The total requirement of raw materials for the plant would be :

Benzene	6400 tpy (0.64 t/t)
Nitric acid (100% basis)	5200 tpy (0.52 t/t)

contd....

The utilities required per tonne of nitrobenzene are

Power	250 Kwh
Steam	1.5 t
C.Water	40 m^3

5. MANPOWER

The total manpower requirement is estimated at 150.

6. Time schedule

The project can be implemented in about 30 months from tying up of the finance, technology and engineering consultants/contractor.

7. PROJECT COST

The total project cost is estimated at about Rs.6 crores with a foreign exchange content of about Rs.75 lakhs. The details are given beow :

		Rs.lakhs
1.	Land & Development	20
2.	Building & Structures	75
3.	Plant & Machinery	260
4.	Technical Services	50
5.	Misc.fixed assets	40
6.	Preoperative expenses	65
7.	Contingency	60
8.	Margin money	30
		600

contd...

8. PRODUCTION COST AND PROFITABILITY

The estimates of production cost and general profitability are given below :-

A. Production Cost

		Rs.lakhs/year
1.	Raw materials	
	a. Benzene 6400 t @ Rs.7000/t	448
	b. Nitric acid 5200 t @ Rs.4000/t	208
	c. Misc.	20
		676
2.	Utilities	
	a. Power 2.5×10^6 Kwh @ Rs.0.55/Kwh	14
	b. Steam 15000 t @ Rs. 150/t	22
	c. Misc.	10
		46
3.	Salaries and wages 150 persons @ Rs.20000/person	30
4.	Repairs and maintenance	10
5.	Insurance	3
6.	Packing 2000 t @ Rs.1200/t	24
7.	Interest : a) on term loans	50
	b) on bank loan	13
8.	Depreciation	41
	TOTAL :	893

contd...

B. Sales realisation NB-10000 t @ Rs.11000/t (avg.)	1100
C. Gross Profit	207
D. Gross profit as return on investment	34.5%
E. Pay back period	2.4 years.

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PROJECT PROFILE 5

LINEAR ALKYLBENZENES

1. USES

Linear Alkylbenzenes (LAB), as the name suggests, are benzene with straight-chain alkyl substituents. The alkyl group usually contains 10-14 carbon atoms. The major application of LAB is in the detergent industry, its sulphonated product being the active component of most detergents, used to the extent of 25-24% in detergent formulations depending on the duty. Unlike the branched chain detergent alkylates used earlier, detergents from LAB are highly biodegradable and for this reason have largely replaced the former in international as well as Indian market.

2. PROCESS

The process consists essentially of two parts; the generation of the alkyl substituent, and its condensation with benzene. The alkyl substituent may be obtained by :-

a. cracking of paraffin wax obtained from refineries,

b. dehydrogenation of n-paraffin fractions obtained from petroleum refining,

c. oligomerisation of simpler olefins, or

d. extraction of n-paraffins from kerosene fraction

e. chlorination of n-paraffin fractions.

3. CAPACITY

Keeping in view the demand, the ranges of investment involved and economics of scale, a capacity

Contd.....

of 30,000 tpy is recommended. The existing plant is also of similar capacity.

4. RAW MATERIALS AND UTILITIES

Typical consumptions per tonne of LAB are :-

Benzene	410 Kg.
n-paraffins	820 Kg.
chlorine	440 Kg.

About 1.24 tonnes of 33% hydrochloric acid, 160 Kg of higher alkyl benzenes and 40 Kg of 'green oil' are obtained as by product.

Both benzene and n-paraffins can be obtained from a refinery/petrochemical complex, for instance the downstream of Bongaigaon refinery. Chlorine will have to be obtained from a chlor-alkali plant. It may be noted that the chlorine requirement corresponds to roughly 45% of the production from a standard chlor-alkali plant (100 TPD caustic soda).

Utilities required per tonne of LAB are :-

Fuel	1.18×10^6 k.cal
Power	120 KWH
Steam	1.46 t
C.Water	110 m^3

5. MANPOWER

Total manpower required for the plant is estimated at 150.

6. TIME SCHEDULE

The project can be executed in about 36 months from the date of tying up of finance, technology and engineering consultant/contractor.

Contd.....

7. PROJECT COST

The total project cost for a 30000 tpy LAB plant is estimated at Rs.58 crores including a foreign exchange content of Rs.12 crores as follows :-

		Rs.crores
1.	Land and Development	0.3
2.	Buildings and Structures	1.7
3.	Plant and Machinery	35.0
4.	Technical Services	3.5
5.	Misc.fixed assets	3.0
6.	Pre-Operative Expenses	6.5
7.	Contingency	6.0
8.	Margin Money	2.0
	TOTAL	: 58.0

8. PRODUCTION COST AND PROFITABILITY

The estimates of production cost and general profitability are given below :-

			Rs.lakhs/year
A.	PRODUCTION COST		
1.	Raw Materials		
(a)	n-paraffins	24600 t @ Rs.5000/t	1250
(b)	Benzene	12300 t @ Rs.7000/t	861
(c)	Chlorine	13200 t @ Rs.1200/t	158
(d)	Misc.Chemicals and Catalysts		75
			2324
2.	Utilities		
(a)	Fuel 35400 x 10^6 k.cal @ Rs.300/10^6 k.cal		106
(b)	Steam 43800 t @ Rs.150/t		66
(c)	Misc.and water treatment chemicals		20
			192

Contd.....

		Rs.lakhs/year
3.	Salaries and Wages 150 persons @ Rs.20000/person	30
4.	Repairs and maintenance	116
5.	Packing expenses 10000 t @ Rs.1200/t(Balance sold in bulk)	120
6.	Insurance	29
7.	Interest:	
	(a) on term loans	487
	(b) on bank loans	84
8.	Depreciation	393
	TOTAL :	3775

B.	Sales Realisation	
	Lab 30000 t @ Rs.16000/t	4800
	HCl 37200 t @ Rs. 600/t	223
	HBAB 4800 t @ Rs.10000/t	480
	Green Oil 1200 t @ Rs.3000/t	36
		5539
C.	Gross Profit	1764
D.	Gross Profit on return investment	30.41%
E.	Pay-Back Period	2.7 years.

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A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OILFIELDS OF ASSAM FOR GAS SEPERATION CUM CRACKING UNIT.

SUMMARY

The enclosed note deals in detail the following aspects :

- Gas Production and disbursement pattern of OIL and ONGC for next 15 years.
- Examination of possibilities of collecting gas at alternative locations to facilitate cracking.
- The costs involved therein.
- Recommendation for the location best suited from cost considerations.
- Technical feasibility of having gas seperation-cum-cracking unit at LPG plant Duliajan.

A brief discussion on the aforementioned aspects is appended below:

Gas Production and Disbursement:

Oil India has detailed information in this regard. Their analysis of past consumption pattern shows only 72% upliftment of the gas earmarked for market and internal consumption

Present level of upliftment is 3100 MSCUMD against overall availability of 4200 MSCUMD. This has prompted OIL to release another amount of 1000 MSCUMD to CEO for power generation. This would result in (a) occasional short supply to market and (b) maximisation of utilization during lean hours. As on today, OIL does not have associated gas to spare. But, meanwhile OIL has discovered a large gas field which would produce, once gas wells are equipped, around 2.4 MMSCUMD from a reserve of 22,400 Billion Cumetres.

ONGC has indicated gas production pattern only for next 5 years. They have a present production of 1.2 MMSCUMD which is expected to go up to 1.6 MMSCUMD in next five years. Against this ONGC has committed 1.488 MMSCUMD to market which includes 0.4 MMSCUMD to CEO. ONGC, identically, does not have any surplus gas.

Based on present production and committed gas volume, major offtake collection points were identified and gas volumes ascertained.

These are

- AGC offtake point Duliajan : 2.38 MMSCUMD
- AGC offtake point moran : 0.36 MMSCUMD
- AGC offtake point Lakwa : 1.00 MMSCUMD
- Collection point Namrup.

Examination of Possibilities of collection & cost involvement

The note elaborates the four possibilities in collecting gas at one central point. The cost invelvements are (a) gas lines (b) compressors for recompression and (c) land and other exigencies.

The gas line sizes are worked out based on gas flow formula and cost figures are based on Assam Gas Company's latest expenses. The Annexture IX presents detailed cost analysis. A glimpse to the figure reveals:

Total capital cost in crores

Duliajan : 21.32

Lakwa : 45.32

Moran : 52.10

Namrup : 11.06

The recommendation, naturally is for cost saving and the location is Namrup.

It is further understood that AGC had intended to set up a petrochemical complex at Namrup beyond Dilli River and the proposal got thwarted.

Though the note is not specific about the location, some survey can be done in AGC selected area and if suitable land can be procured to locate the cracking and petrochemical complex.

Detailed economic analysis is not possible as it calls for (a) a price of C_2 and C_3 liquids that would be seperated out and (b) cost of cracking and price of down stream products which are yet to be identified from marketing aspects.

Feasibility of locating Gas Cracking Unit at Duliajan

Duliajan already enjoys the benefit of having a LPG plant. The total area of LPG plant is around 20 acres. Bottling and bulk filling takes about 16 acres and actual process area is 2.1 acres, So, for expansion around 1.9 acres are available. OIL would be able to accomodate equal sized turbo expanders in this area. But when the question comes for additional space to accomodate

Gas Seperation and cracking unit and its ancillaries, space would be a problem. Moreover, to have cracking unit only for Duliajan gas (amount 2.63 MMSCUMD) would be an uneconomical proposition. To have all the gases from Moran and Duliajan an expenditure of 21 crores is to be incurred for collection only.

Once product line of cracking unit is identified and cost alloted for the total conversion an economic analysis would be possible to ascertain the suitability of Duliajan.

In absence of such data, the technical feasibility was only examined and this negates the proposal of establishing additional plant at Duliajan.

Gas Shrinkage and loss in Calorific Value:

The recovery of C_2, C_3 would entail (a) loss in volume of gas and (b) less in calorific value. Taking base calorific value as 10,000 kcal/cum the following working shows :

- loss in shrinkage would be around 11% of the total gas processed if 90% recovery

of C_2 and C_3 is done. This means additional production of 0.41 MMSCUMD to meet committed gas supply.

- loss in calorific value will be around 7%. To keep base calorific value, another quantum of 0.26 MMSCUMD of gas has to be produced and supplied.

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OILFIELDS OF ASSAM FOR GAS CRACKING AND SEPERATION UNIT

1.0 PREAMBLE:

The upper Assam oilfields that belong to OIL and ONGC, produce alongwith crude, a substantial amount of natural gas. Furthermore, Oil India has the potential of producing non-associated gas or free gas to a large extent which can be tapped whenever there is a shortfall in associated gas. This natural gas is not only a potent fuel but also the source of numerous petrochemicals and fertilizers.

The irony of the present situation is that a major chunk of this wealth of nature has been burnt away over the last 30 years though both Govt of Assam and Govt of India has been persuading a policy of maximising its use. Govt. of Assam, recently has considered the possibility of using natural gas for extracting C_2 and C_3 fractions for onward cracking and final conversion to petrochemical products.

This report endeavours to study various alternatives for collection of the available gas both OIL and ONGC at a centrally suitable location. The sphere of other work attempted alongwith is described in the next paragraphs.

2.0 SCOPE OF WORK

(a) To ascertain from OIL and ONGC, the exact amount of natural gas with composition that would be available at various locations of production and supply for the next 15 years.
(b) To work out alternative modalities for collection of this available quantities of gas for the purpose of utilisation in the proposed "Gas Seperation and Cracker Complex".
(c) To study the cost involvement in step (b) mentioned above and to recommend the most economic way of collection for the purpose of establishment of the gas seperation/cum/ cracker complex at the most suitable location.
(d) To study the feasibility of recovering in situ C_2 and C_3 fractions, in presently operating process plant for LPG.

3.0 GAS PRODUCTION FROM OIL & ONGC

OIL has recently prepared three internal notes on gas, called "Natural Gas Reserves Development Notes" No 1,2 & 3. The first note has dealt extensively with future pattern of gas production while the second is on the pattern of consumption on both internal and external basis. The third note has opened up the vista on the availability of non-associated gases both at Naharkatia and Naharkatia extension area. The detailed

aspects would be discussed in subsequent paras.

ONGC has not undertaken a detailed exercise in the same line. It has prepared a gas forecast for the period of 1985-1990 to supply data for the 7th five year plan. However, subsequent discussions reveal that oil production from the present level is expected to increase over the years. The Gas Oil ratio of ONGC fields being low (around 40-50) the gas production upto 2000 is expected to be above the present level. As regards to non-associated gas, ONGC unfortunately has not made any discovery so far, and therefore, any contribution from non-associated gases to supplement associated gas in case of shortfall would not materialise.

3.1 GAS PRODUCTION STATISTICS FROM OIL

As stated above, a clear cut indication of gas availability for associated gases from 1985 to 2000 has now been made available. Annexure I, has provided the detailed status of gas availability at Naharkatia, Jorajan and Moran. Moreover, in this context, the following things are to be noted:

(a) In all these years, a comparison has been made with the forecasted figures of 1981 which was the basis of the exercise

done by the task force constituted Govt. of India in March '84.

(b) A forecast on the oil production in MTPA has also been made for few years. The oil production figures are indicated in brackets.

(c) All the gas production figures that are predicted are on conservative basis and it's possible to have a higher rate of production in case a bigger strike of oil and/or gas is made in new exploratory areas.

It is also to be noted that the total gas available includes both high pressure (above 10.5kg/cm^2) and low pressure gas L P gas naturally contains higher percentages of C_2, C_3 and C_4 and therefore, a seperate break-up of low and high pressure gas components are provided in Annexure II.

3.2 GAS PRODUCTION FROM NON-ASSOCIATED SOURCES(OIL)

Oil India, during its exploratory work in Upper Assam has discovered major pockets of non-associated gas in Tenghakhat, Mushijan and Deohal areas. The total reserve of this non-associated gas, as per present assessment is around 22,000 Billion Cubic metres.

The following points become pertinent in this context :

(a) The produced non-associated gas from various gas pockets is divided into two categories: (i) Rich Gas: Gas that contains considerable percentage of C_2 and higher hydrocarbons.
(ii) Lean gas : Mostly methane.

(b) To collect and distribute this gas, a network of gas lines is planned with the central offtake point at Tengakhat.

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(c) In later years, once full scale production of non-associated gas would be made either for individual supply and/or to supplyment shortage of associated gas, LPG extraction would be planned at the central gas offtake point at Tengakhat.

(d) The total cost of this development work including installation of LPG plant, gas lines would come to around Rs.183.0 crores. The sanction of Govt of India for this project is being awaited for.

(e) Govt of India, however, categorically states that in no case production of non-associated gases would be made in near future to suppliment any shortfall of associated gas.

Annexure III provides a break-up of Gas Production and condensate production statistics. It is estimated to be around 2.4 MSCUMD over next 15 years starting a '0' point of the project life.

3.3 GAS PRODUCTION STATISTICS FROM ONGC

In para 3.0, it has already been mentioned that ONGC does not have any detailed working in gas availability for next 15 years. What it has, is a prognostic, prediction for next 5 years. However, it also made clear that oil production being expected to the rising, gas production, being low will always remain at a level higher than present level.

The following aspects are to be taken note of:

(a) The GOR of ONGC wells is generally low in comparison to OIL fields. Gas Production from ONGC is only around 1.15 MMSTDCUMD.

P3

(b) ONGC does not have any non-associated gas sources. Therefore, no allowance would be made for making up any shortfall of gas produced from associated sources.

3.4 UTILIZATION PATTERN OF GAS From OIL

This availability of gas figures presents only one side of the whole picture. As consumption of gas is varied and distributed at various production centres the need for its effect has also to be taken account of. This utilisation of gas also will present the present nature of flaring of gas that has created an opinion for further utilization.

OIL's internal utilisation pattern of gas based at the present level is enclosed in Annexure IV and the overall utilization of gas based on actual (72%) is provided in Annexure V.

As can be seen from the two appendices, it can be noted that about 28% of the total associated gases would have remained surplus, because of (a) lower upliftment of gas by market and (b) lower internal consumption. This figure comes to around 1160 MCUMD.

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Based on this statistics of 72% utilization, OIL has now decided to release a further amount of 1.0 MMSCUMD for CEO (Central Electrical Authority) from Kathalguri for power generation.

Now coming to the agreed market commitment on daily maximum basis, the details are provided in Annexure VI. However, please note that the new commitment of 1.0 MMSCUMD is not included therein.

3.5 UTILIZATION OF GAS : ONGC

Against the production of an increased rate of 1.15 to 1.685 MMSCUMD for next 5 years or so, the present consumption is mostly flaring or as ONGC puts it using gas for evaporation of formation water.

The following tabulation provides a glimpse of present and future consumption pattern. Annexure VII gives associated gas production in 1985-90 against anticipated oil production.

	Internal Consumption (MMSCUMD)	Remarks
1985-86	0.36	including evaporation
1987 and onwards	0.36	Including evaporation

From, 1987, it is programmed to stop evaporation of water by this crude method. Since 1987, it is planned to stop evaporation of water by burning of gas.

External Consumption:

Agency	Year		
	1985-86		1986-87
ASEB	.295	--- .230 Maibela	0.17 (addl. commitment)
		--- .065 Geleki	0.295
HFC	--		0.45 (March '86)
HPC	--		0.12 (end '96)
CEC	--		0.4 (87-88)
Pea Gardens	0.023		0.023
AGC (housing)	0.03		0.03
			1.488

As can be seen the committed gas exceeds the gas presently under production. ONGC has overcommitted gas to an amount of 0.4 MMSCMD for CEC based on present low level of market upliftment.

3.6 COMPOSITION OF NATURAL GAS

The Composition of natural gas produced from OIL and ONGC is important for mass balance and computation of produced C_2 & C_3 fractions. However, it is also known that prediction of gas composition for on-coming years is an impossible task. The production pattern of the field, contribution of non-associated gas from time to time as well as increased production of associated gas because of gas cap wells complicate any attempt for prediction. The only glimpse we have today about the future pattern of gas composition are :

(a) Published notes of OIL on both associated and non-associated gases.

(b) Type of rich gas and lean gas presently produced from associated and non-associated fields of OIL.

(c) ONGC, as it does not produce or will not produce any non-associated gas in near future, the situation is somewhat better. For the computation, the gas composition

given by ONGC can be used for at least first few years.

Annexure VIII provides the composition of gas presently available in upper Assam oilfields and unless non-associated lean gas is mixed, this composition specially C_2, C_3 fractions are not likely to vary too much. Therefore, any material balance done on $C_2 + C_3$ of 11-13% of the total gas would not go off the mark very much.

Any extraction of hydrocarbons higher than C_2 would, however, not only affect the change in gas composition in increased methane content but also (a) would entail change in calorific value of the processed gas (b) reduce gas volume to a certain quantum requiring addition of additional amount of gas, to keep the commitment level.

A detailed exercise would be done at a later stage for working out the effect of such change in composition.

4.1 COLLECTION POINTS OF NATURAL GAS

OIL India Ltd.:

Oil India oilfields encompass a vast area and both entry points of gas as well as exit or consumption points are numerous and widely spread. But, there are the following collection points where the gas collection

and distribution are considerable.

Such points are :

- Well 16 offtake point - Otherwise known as AGC offtake point
- Kusijan offtake point - This is for Doom Dooma gas grid
- MGG gas offtake point
- Moran AGC offtake point

The actual gas flow network which provides amount of gas available and mode of dispersal could not be enclosed herewith as OIL refused to part with this confidental document.

Nevertheless, the main collection points that are of our interest are :

(a) Well 16 offtake point : The OIL LPG plant is operating from this location taking around 2.2 MMSCUMD of gas. The expected concentration of gas in next two years would be around 2.63 MMSCUMD, when the gas supply to CEO would commence at Kathalguri from Well 16 offtake point.

(b) Moran AGC offtake point : The Moran oilfield has the major gas collection point at Moran Oil Collecting Station - known as AGC gas offtake point. This collection and distribution point provides around 0.36 MMSCUMD

gas to HFCL through AGC.

Sketch No 1 shows the line configuration from NHK W/16 offtake point and Moran to Namrup where gas is being carried by AGC.

ONGC:

ONGC, till recently, has no specific gas collection points. Their field likewise is widely spread but interconnecting lines too are not available.

However, ONGC, has now undertaken a scheme to connect up all the producing GGS's with gas lines and is providing compressors to boost up gas so as to facilitate cross flow and final collection at Lakwa. Sketch 2 shows the present plan and possible gas flow pattern of ONGC Lakwa.

4.2 EXPECTED FLOW OF GAS FOR NEXT 15 YEARS

Based on above and other information available, the following table is prepared to indicate amount of gas available at major collection points of OIL and ONGC:

Gas Figures are in MSCFD

	NHK AGC offtake point	MRN AGC offtake point	Lakwa AGC offtake point
85-86	2630	360	648
86-87	2380	360	1000
87-88	2380	360	1000
88-89	2380	360	1000
89-90	2380	360	1000
90-91	2380	360	1000
91-92	2380	360	1000
92-93	2380	360	1000
93-94	2380	360	1000
94-95	2380	360	1000
95-96	2380	360	1000
96-97	2380	360	1000
97-98	2380	360	1000
98-99	2380	360	1000
99-2000	2380	360	1000

As seen from the above, the gas quantities available at each offtake point do not constitute enough quantity of gas for having a gas cracking unit as economics show that unless gas is available above 3.5 MMSCUMD, a cracker-cum-seperation complex is not viable.

This automatically indicates that arrangement would have to be made to collect at various

offtake points to collect preferably at one place. The total amount of gas would therefore be around 3.8 MMSCUMD which if could be collected at an optimum cost would be viable for gas cracker units.

4.3 ALTERNATE LOCATIONS FOR COLLECTION

It has been stated that major gas collection points are at Duliajan Moran and Lakwa. Meanwhile, AGC has already laid lines from Duliajan and Moran to transport gases for Namrup complex. Utilization at Duliajan is presently restricted to internal utilization and the future commitment of gas to Nathalguri for CEO. Moran has very small use of gas for teagardens and the injection requirement has already been taken account of.

As far as ONGC is concerned the preparatory work is going on for laying connecting lines and except around 0.5 MMSCUMD (0.4 MMSCUMD for CEO and 0.1 for internal + Tea gardens), rest amount of gas would flow towards Namrup complex vide the proposed AGC line.

Sketch No 3 shows the lines coming to Namrup complex from various major gas collection points of OIL and ONGC. The new flow of gas from all these collection points would be

as follows :

Duliajan	: :	2.38 MMSCUMD
Moran	: :	0.36 MMSCUMD
Lakwa	: :	1.00 MMSCUMD
	Total	3.74 MMSCUMD

This would be the net gas flow to Namrup complex from OIL and ONGC. These figures would remain more or less constant unless there is a major short fall in associated gas production.

Based on above, it is now imperative that all steps would need to be taken to collect all the gases from the major offtake points.

4.4 CRITERIA FOR SELECTION OF SITE FOR GAS CRACKING PLANT

For this exercise, the criterion for selecting a location for the proposed Gas Cracking Unit would be only from the gas availability point of view and therefore this study is limited to 4 places.

- Duliajan
- Lakwa
- Moran and
- Namrup

Sketch No. 4 represents the line configurations and location of compressor statistics for each alternative.

It is understood that to take all the gas to one location say Lakwa, the following aspects are to be considered - One adequately sized compressor station with adequate number of machine (with suction and discharge pressure considerations) at Namrup to boost the gas coming to Namrup from Moran and Duliajan. Details for suction pressure however is needed to be done for exact sizing of required standby machines. Once gas is compressed, gas lines to carry this gas from Namrup is to be designed and considered. Once stripping of C_2 + fractions are done, recompression of gas to an elevated pressure is required so that gas can again be transported back to Namrup. This has only one exception and that is in case of Namrup.

In Annexure IX all the compressor details and line size specifications are provided. Alongwith the present costs are provided for having these installed and laid. Over and above these fixed costs give some idea of revenue expenditure and they are also

provided. The basis of these informations are from AGC.

4.5 STUDY OF THE ALTERNACIVES

The following aspects become pertinent when a detailed study is undertaken for the selection of the best location for having the Gas Separation - cum - Cracker Unit

- Except Mamrup location, in each case it would be necessary to install one compressor station at Mamrup station to boost the gas and another station at Location to recompress process gas to flow back.
- Mamrup is the only location where all streams of gas are available from the major offtake points though at different pressure levels. The need, nevertheless, exists for one compressor station. The lines required are also of smaller diameter and lesser length. The cost for all these comes to a small fraction in comparison to costs in other locations.
- Having the plant at Duliajan LPG plant would have the advantage of availability of infrastructure, handing and transporting

facilities, But, this advantage would again nullify any scope of developing a region through industrialisation.

- Lakwa and Moran, for all practical purposes would not be suitable for any extraction plant because of high cost in transporatation and compression. This statement is made despite the fact that the Gas Cracking unit, if would have come at Lakwa (Nazira) or Moran, these two industrially backward areas would have bloomed.
- Namrup suffers from an inadequacy of suitable location for establishing a plant and downstream products. A considerable plot of land would be needed if the proposed cracker unit is proliferated by numerous petrochemicals products. This aspect would need a closer scrutiny. It may be a subject of a seperate study.

4.7 RECOMMENDATIONS :

The final recommendations for locating the proposed 'Gas Cracker-cum-Seperation

Unit" are based on the following considerations :

- Namrup and Duliajan are the two places out of the four locations where the possibilities of establishing the units are existant.
- Duliajan already has one LPG plant but cost saving from infrastructure, communication aspects, Namrup is equally attractive.
- Namrup has the unique privilege of being the terminating point of all the three streams of gas through at different pressure levels. Moreover, major cost saving would be affected once the saving in compression and gas lines is achieved.
- The Gas Cracker unit is a massive capital intensive unit. This being so, to make it economically viable, major areas like collection of gas, distribution of products are to be made economical. Namrup can only offer economically competitive collection of gas to the extent of 3.5 MMSCMD. Based on all above, it is recommended that the proposed plant of "Gas Cracking and Seperation Unit" is located in the vicinity

of Namrup complex by acquiring an appropriate space.

5.1 FEASIBILITY STUDY OF EXTRACTING C_2 & C_3 FRACTIONS AT LPG PLANT (DULIAJAN)

Over and above the exercise given, an additional exercise was desired which desired a "Feasibility Study" on extracting C_2 and C_3 hydrocarbons at Duliajan LPG plant.

The Duliajan LPG plant is designed to process around 2.21 MMSCUMD of associated gas for affecting a recovery of around 60,000 TPA of LPG and 12-13,000 TPA of Condensate. Presently, the capacity is low as regards to LPG extraction as condensate quantity produced is 50-60 TPD, a considerable amount higher than the anticipated. OIL is presently planning to install an unit to extract condensate before the actual process of LPG extraction.

As stated before, the installation of the Gas Cracker Unit at Duliajan has the advantage of an already available infrastructure. The streams of gas that are available would be Ex LPG plant : 2.07 MMSCUMD.
Additional Oil Gas : 0.36 MMSCUMD

Gas stream from ONGC : 1.0 MMSCUMD

Gas stream from Moran OIL : 0.36 MMSCUMD

Now, when the question of feasibility arises, the questions comes to the mind

- Technical feasibility
- Economic feasibility

Another two aspects also become pertinent :

- Whether the gases ex OIL would be processed or
- All the gas streams from Lakwa, Moran as well as Duliajan would be processed.

3.2 TECHNICAL FEASIBILITY

a) Gas available from OIL only :

As indicated by OIL, a total amount of 2.63 MMSCUMD would flow to W/16 offtake point out of which a fraction would flow to Nathalguri for DEG power generation.

The composition of this gas would be, as indicated by OIL:

C_1 : 85%, C_2 : 6-8%, C_3 : 3-5%, C_4 : 1-2%

C_5 + rest.

So, based on the calculations provided in Annexure X, the extraction of C_3 and C_4

is LPG plant from 2.21 MMSCUMD is

C_3 : 30,000 TPA

C_4 : 30,000 TPA

By extending the calculation to cover additional 0.42 MMSCUMD and C_2, C_3 and C_4 we have additional production:

C_2 = 35,000 TPA

C_3 = 23,000 TPA

C_4 = 5,500 TPA

Part of this i.e.

C_3 : 5500 TPA and C_4 : 5500 TPA can be sold as LPG. The rest would be used for cracking.

So, the technical feasibility depends on :

(a) Possibility of extending present LPG plant to cater for 2.63 MMSCUMD

(b) Erection of an Gas Cracker-cum Seperation Unit to obtain a total product of 113,000 tons per year with rich gas of 0.42 MMSCUMD and stripped gas (ex LPG) of 2.21 MMSCUMD.

(c) Possibility of having downstream products.

The detailed replies to these queries are not known. OIL has to study, the feasibility of extending their LPG plant which it

is known that they are contemplating. As regards to process only 2.63 MMSCUMD that too partly lean gas is not viable.

Another important aspect that becomes very much pertinent is that HFCL stacked a claim of incurring losses because of the extracting of LPG from the process gas. In case, further extractions made from the process gas of Phase I and II HFCL project, it is almost certain that HFCL would object to accept the highly stripped gas i.e. gas with methane more that 95%. As this would be an apple of discord, it is unlikely that process of only Dulhajan gas would be feasible.

Based on aforesaid the technical feasibility of basing C_2 and C_3 extraction on Dulhajan gas only appears to be unattractive.

The economic feasibility is therefore not considered.

<u>Technical Feasibility from all streams of gas (ex ONGC + OIL) for stripping at Dulhajan.</u>

This aspect of stripping C_2 and C_3 for all the streams of gas that come to Namrup complex would have the following implications :

(i) Stripping of NHK gas as shown in case (a)

(ii) Stripping of MORAN OIL gas ;

(iii) Stripping of ONGC gas from Lakwa.

The expected production of C_2, C_3 C_4 fraction is worked out in Annexure XI

As can be seen from the annexure : XI

Total C_2 = 131,000 TPA

C_3 = 62,500 TPA

C_4 = 31,000 TPA

Considering LPG production also feasible from this extra gas (over and above the presently extracted LPG), we can get additional PLG of

C_4 = 31,000 TPA

C_3 = 31,000 TPA

with a 50 : 50 mixture.

The remaining liquid would be

C_2 = 131,000 TPA

C_3 = 31,500 TPA

5.3 OBSERVATIONS

The observations that can be made from

this study and accompanying computation of various quantities of gas.

(a) The LPG quantum would almost double up. As such the present LPG plant over would somehow accomodate such an expansion.

(b) The accompanying C_2 and C_3 would need to be crygonically seperated and the cost estimates for such a plant is not at hand.

(c) The production of C_2 and C_3, as appears from theoratical computation of sonsiderable quantity, but considering the enormous cost of collection and re-distribution, the economics of collection at present LPG site do look attractive.

5.4 CONCLUSIONS

- Though the technical feasibility of extracting C_2 to C_4 in this exercise, other constraints like
  - Space limitations for C_2, C_3 extraction plant
  - Exhorbitant cost in lines & compressors
  - Non-acceptability of stripped gas by HFCL

would be the deterrants for taking a positive decision in this end.

Now, as the various cost elements are known once the project finalisation as regards to identification of end products and the cost

structure, are done, a positive decision in this regard may be taken.

The loss in calorific value and shrinkage of the processed gas after recovery of C_2 + fractions would need additional quantity of gas to the extent of 12-14% of the total gas. This aspect and the cost of such gas need to be taken note of.

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A REPORT ON COLLECTION AND SUPPLY OF

NATURAL GAS FROM OILFIELDS IN ASSAM

WAYMOUTH FORMULA : TO CALCULATE GAS LINES SIZES.

$$Q = 3.22 \frac{To}{Po} \left[\frac{(P_1^2 - P_2^2)\, d^5}{GTLfta} \right]^{0.5}$$

Q = std cuft/hour

L = lenght in miles

d = inside diameter (inch)

P = pressure psia

G = Gas gravity

T = average Temp. ^{o}R

$$f = \frac{0.032}{d^{1/3}}$$

Annexure - 1.

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OIL FIELDS OF ASSAM.

Associated Gas Availability Forecast
Gas Availability (1000 std Cum/d)

Year	PRE Note No.102 Nov.'85	Note on Gas Injection Oct. 1984	Present Note Dec. '85
1985-86	4403	4890	4276
86-87	4221	4980	4835
87-88	3957	4750	4706
88-89	3708	4370	4635
89-90	3608	4330	4552
90-91	3545	4160	4552
91-92	3495	4030	4414
92-93	3427	3980	4539
93-94	3352	3980	4470
94-95	3271 (3.03)	4000 (3.53)	4452 (4.04)
95-96	3215	4070	4651
96-97	3232	4110	4608
97-98	3239	4270	4642
98-99	3311	4300	4638
99-2000	3428 (2.7)	4310	4656 (4.55)

Note:- Figures in brackets indicate crude MTPA

-- PRE Note No. 102 was used for reports by the Task force in Gas availability in the country, March 1984.

Annexure - II.

A REPORT ON COLLECTION AND SUPPLY OF
NATURAL GAS FROM OIL FIELDS OF ASSAM.

Break-up of HP & LP gases
OIL oil fields (All figures are in MST cumD)

Year	HP gas (above 10.5 kg/cm^2)	LP gas (Below 10.5 kg/cm^2)
1985-86	1942	2334
86-87	2204	2631
87-88	2153	2553
88-89	2144	2491
89-90	2037	2515
90-91	2054	2498
91-92	2007	2407
92-93	1969	2445
93-94	2080	2459
94-95	1996	2474
95-96	1954	2516
96-97	2034	2574
97-98	1829	2813
98-99	1543	3095
99-00	1313	3333

Annexure - III.

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OIL FIELDS OF ASSAM.

Gas Production (Non-Associated)
From OIL oil fields

Area	Gas Production Rates MMstd cuM/day			Condensate Production Rate
	Lean	Rich	Total	KLPD
NHR-Main	0.087	0.335	0.422	20
Zaloni	0.038	0.118	0.156	10
Madhuting				
Tipling	0.230	--	0.230	--
Santi	0.163	--	0.163	--
Lankashi				
Kathalguri	0.406	--	0.406	--
Nagajan				
Jorajan	0.099	0.404	0.503	15
Deohal	--	0.075	0.075	5
Tangakhat	--	0.656	0.556	50
	1.023	1.488	2.511	100

Annexure - IV.

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OIL FIELDS OF ASSAM.

OIL's Gas Consumption Pattern

Summary of OIL's Internal Consumption

Year	Gas inj. NHK+JRN	Moran	Total	Internal utilization other than injection.
1985-86	835 + 100	165	1125	305
86-87	835 + 100	165	1125	305
87-88	835 + 135	165	1160	872
88-89	835 + 135	165	1160	872
89-90	800 + 170	165	1160	872
90-91	751 + 219	165	1160	872
91-92	751 + 246	138	1160	872
92-93	532 + 280	138	1160	953
93-94	532 + 280	138	1160	953
94-95	532 + 280	102	1160	953
95-96	532 + 280	83	1160	953
96-97	532 + 280	55	1160	953
97-98	532 + 280	55	1160	953
98-99	532 + 280	55	1160	953
99-2000	532+ 280	55	1160	953

All figures are in Mscumd

These figures are more or less in line with the figures considered in the report of the task force March'84

Annexure - V.

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OIL FIELDS OF ASSAM.

UTILIZATION PATTERN

Year	Overall Associated gas availability	Associated gas utilization 72%			Net Associated gas availability.
		Internal OIL	Market	Total	
1985-86	4276	1390	1727	3117	1159
86-87	4835	1390	2366	3756	1079
87-88	4706	1463	2366	3829	877
88-89	4635	1463	2366	3829	806
89-90	4552	1463	2366	3829	723
90-91	4552	1463	2366	3829	723
91-92	4414	1463	2366	3829	585
92-93	4539	1521	2366	3887	583
93-94	4470	1521	2366	3887	583
94-95	4452	1521	2366	3887	565
95-96	4651	1521	2366	3887	764
96-97	4608	1521	2366	3887	764
97-98	4642	1521	2366	3887	755
98-99	4638	1521	2366	3887	751
99-2000	4656	1521	2366	3887	769

All fitures are in Mscumd

Based on the above, upper limit of utilization in a day is 5219 MS cum/d (95% of maximum committment).

Lower limit is 2160 MS cum/d(40% of maximum commitment).

Annexure - VI.

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OIL FIELDS OF ASSAM.

Agreed Market Commitment of Gas on Daily Maximum Basis. (1000 std Cum/day).

Place of Utilisation	Organisation	NHK+JRN	MRN	Total
Digboi	IOC	222	--	222
Namrup				
HFCL Phase I + II		679	291	970
HFCL Phase III		723	69	792
APL Phase I		42	--	42
APL Phase II		96	--	96
ASEB		804	--	804
Duliajan AGL		55	--	55
Tea gardens				
DDGG		138	--	138
TGG Phase I		55	--	55
TGG Phase II		38	--	38
MGG		--	55	--
Minor		19	--	19
		2871	415	3286

These figures given are as per report of the working group of N.E. region Gas utilization.

Annexure - VII

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OILFIELDS IN ASSAM.

ONGC GAS & OIL PRODUCTION

	Associated Gas (MMSCUMD)	Oil Production (MTPA)
1985	1.15	2.5
1986	1.27	2.6
1987	1.4	2.8
1988/89	1.525	3.1
89/90	1.685	4.1

Annexure - VIII.

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OILFIELDS OF ASSAM.

Composition of Natural Gas

Present (1985-90)

	Oil India W/16 offtake point	Moran	ONGC
	%	%	%
C_1 :	85	82	85
C_2 :	6-8	7-9	7
C_3 :	3-5	4-6	4
C_4 :	1-2	1-2.5	2.3
C_5 & above :	rest	rest	rest

Future

(1991-2000)

C_1 :	87	84	85
C_2 :	5	5-7	7
C_3 :	2-4	3-5	4
C_4 :	1-2	1.5-2	2.3
C_5 :	rest	rest	rest

In case of OIL, the post-1990 gas streams would increasingly higher content of non-associated gasses.

Annexure IX

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OIL FIELDS IN ASSAM

STUDY OF ALTERNATIVES AND COST ANALYSIS FOR SELECTING LOCATION FOR GAS CRACKER UNIT

(Gas volumes are in MMSCMD)

Fixed Cost

EQUIPMENT PIPELINE INSTALLATION ETC.	1st Alternative All gas flow to Duliajan Comp Station and Namrup Duliajan. Gas Compressed : 1.30		2nd Alternative All gas flow to Lakwa Comp Station at Namrup Comp Station at Lakwa		3rd Alternative All gas flow to Moran Comp Station at Namrup Comp Station at Lakwa		4th Alternative All gas flow to Namrup Comp Station : Namrup Total gas : 3.64	
Compressor Station at Namrup :	Quantity	Cost Rs. in lakhs	Gas Compressed : 2.74 Quantity	Cost	Gas Compressed : 3.38 Quantity	Cost	Quantity	Cost.
1. Compressors x 2 stage 0.66 MMSCMD capacity:	Comp Nos. 4	466	Comp Nos 6	699	Comp Nos 7	815	--	--
2. Compressor Shed & Pipe work	Comp Shed + fittings :	50	Comp Shed + fittings	100	Comp Shed + fittings	120	--	--
3. Other Compressor accessories	other accessories	20	other accesso-ries	40	other accesso-ries	50	--	--
Compressor Station at Location			Comp Nos 6	699	Comp Nos	915	Comp Nos 7	815
1. Compressor x 2 stage 0.66 MMSCMD capacity	Comp Nos. 4	466						
2. Compressor Shed & Pipe work	Comp Shed + fittings	50	Comp Shed + fittings	100	Comp Shed + fittings	120	Comp Shed + fittings	120
3. Other Compressor accessories	other accessories	20	Other accesso-ries	40	other accesso-ries	50	other accesso-ries	50
Gas Lines from Namrup								
1. Line sizes	a) 400mm x 30 km	250	a) 400mm x 56 km	485	a) 400mm x 56 km	485	300mm x 2 km	10.5
	b) Land	50	b) 300mm x 56 km	352	b) 400mm x 56 km	485	Land	4.0
	c) Laying costs	120	Land	100	Land	100	laying cost	18.0
			Laying cost	340	Laying cost	400		
Gas Lines from location								
1. Line sizes	a) 400mm x 30 km	250	a) 400mm x 56 km	485	a) 400mm x 56 km	485	400mm x 2 km	19.5
	b) Land	50	b) 300mm x 56 km	352	b) 400mm x 56 km	485	Land	5.0
	c) Laying costs	120	Land	100	Land	100	Laying cost	12.0
Miscelleneous		200	Laying cost	340	Laying cost	400		
			Miscelleneous	300	Miscelleneous	300	Miscelleneous	50.0
Total		2132		4532		5210		1106

CALCULATIONS ON QUANTUM OF RECOVERY

a) Total gas 80 MMSCUFD (2.21 MMSCUMD).

C_4 fraction : 1.5% (aveg)

Molecular weight of C_4 = 58

So, weight in tonnes/day $= \frac{80 \times 10^6 \times 58 \times 1.5}{100 \times 379 \times 2200} = 83$ tonnes/day

= 30,470 T/year

= 30,000 TPA (say)

Mixing with 50% of C_3

C_3 recovered = 2% of the gas

C_3 weight in tonnes = 30,000 TPA.

b) Total gas 95 MMSCUFD (2.63 MMSCUMD)

For additional recovery of LPG from 15 MMSCUFD we have :

C_4 fraction : 5500 TPA

C_3 fraction : 5500 TPA

For recovery of C_2 and some C_3 through gas seperation of entire 95 MMSCUFD

$C_2 = \frac{95 \times 10^6 \times 30 \times 7}{100 \times 379 \times 2200} \times 365 = 87332$ TPA

say 85,000 Tons per year (including losses)

$C_3 = \frac{15 \times 4 \times 10^6 \times 44}{100 \times 379 \times 2200} \times 365 = 11556$ TPA (say 11,000 TPA)

and

$C_3 = \frac{80 \times 1 \times 10^6 \times 44}{100 \times 379 \times 2200} \times 365 = 7392$ TPA (say 7,000 TPA)

So, additional recovery total :

C_2 = 85,000 TPA, C_3 = 23,500 TPA and C_4 = 5500 TPA

Annexure - XI

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OILFIELDS IN ASSAM.

CALCULATIONS

To ascertain the quantities of C_2, C_3 and C_4 extractable from the gas streams of OIL and ONGC

Gas Processed from OIL (Duliajan)

Already calculated vide para 10.0 (a) the production is forecasted as :

$C_2 + C_3 + C_4$: 114,000 TPA

Gas processed from Moran (OIL, Moran)

C_2 = 13657 TPA	=	13000 TPA
C_3 = 12519 TPA	=	12000 TPA
C_4 = 4951 TPA	=	4500 TPA

Gas processed from Lakwa (ONGC)

C_2 = 33094 TPA	=	33000 TPA
C_3 = 27736 TPA	=	27000 TPA
C_4 = 21022 TPA	=	21000 TPA

A REPORT ON COLLECTION AND SUPPLY OF NATURAL GAS FROM OILFIELDS IN ASSAM FOR GAS SEPERATION CUM CRACKING UNIT

PREPARED FOR

ASSAM INDUSTRIAL DEVELOPMENT
CORPORATION LTD.
GUWAHATI

BY

DOWERAH & ASSOCIATES
C/o 22, INDUSTRIAL ESTATE
GUWAHATI—21

ANNEX h

Ethylene-capacity shortage looms in early 1990s, new study shows

The U.S. olefins industry may soon face a situation that several years ago would have been almost unthinkable—the looming possibility of an ethylene supply/capacity shortfall in the early 1990s. Total active U.S. ethylene capacity is about 34 billion pounds per year. With close to 6 billion pounds of capacity shut down temporarily during 1982-1983, the net result was that the industry operated fewer units more efficiently over that period. Chem Systems, Tarrytown, N.Y., estimates that the effective industry operating rate was about 80-85% during 1981 and 1982 and above 95% since 1983 (see Table).

Ethylene use is forecast by Chem Systems (in a new 400-page study) to reach 35.7 billion pounds by 1990, and 40.6 billion pounds by 1995, representing a 2.5% average annual growth rate for the 1985-1995 period, slightly lower than forecast GNP growth over the same period.

"Some ethylene capacity temporarily shut down in 1982-1983 was back in operation by 1985. Also, the newer, heavy liquids crackers built during the late 1970s have never really been run at maximum conditions. Many of these units may be able to operate 10 to 15% above their nameplate capacity. Running these plants above their rated capacities plus some additional debottlenecking may add as much as 3.0 billion pounds per year of capacity to what will be available in the late 1980s. This should be sufficient to delay until the early 1990s the potential shortfall facing the U.S. ethylene industry (Fig. 1).

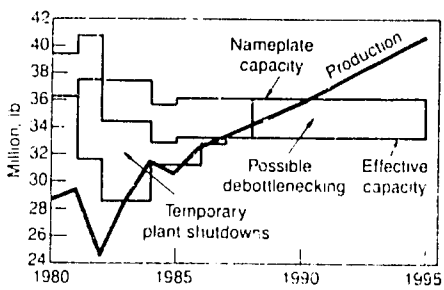

Fig. 1—Supply and demand for ethylene.

"At one time it was felt that incremental global ethylene supply requirements would be met by a continual series of new export oriented projects in energy rich regions." However, now that the first wave of export-oriented projects has been completed, Chem Systems does not foresee an imminent threat of a second wave. "The expected slowdown in additional olefins project development in Saudi Arabia, Canada, and elsewhere is based on 1. unavailability of capital, 2. prolonged effect of the early 1980s recessionary period, and 3. lower crude oil demand and pricing resulting in the loss of the competitive edge for export oriented projects."

TABLE 1—Industry operating rates—U.S. ethylene (Billion pounds)

	1980	1981	1982	1983	1984	1985
Nameplate capacity	39.4	40.8	37.4	37.4	37.4	36.5
Available capacity	39.4	39.5	31.8	32.2	34.2	33.9
Effective capacity	36.2	36.4	29.3	29.6	31.5	31.2
Production	28.1	29.4	24.5	28.7	31.2	30.5
Operating rate, %	78	81	84	97	99	98

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ENTER A NEW INDUSTRIAL ERA

--- AIDC'S SERVICES
ARE AT YOUR DOOR STEP –

aidc

--- IDBI'S REFINANCE SCHEME
IS
HERE TO HELP YOU.

What is Refinance Scheme of IDBI:

AIDC extends term loan requirements of medium scale entrepreneurs in the state with extended refinance facilities from Industrial Development Bank of India

ASSAM INDUSTRIAL DEVELOPMENT CORPORATION LIMITED
(A Govt. of Assam undertaking)
R.G. BARUA ROAD GUWAHATI – 781 024
Ph : 87731/87732 Gram : Udyog Telex : o2 35210 . AIDCORP

Designed by Omega Advertising Agency, Guwahati.

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ENTREPRENEURS' !–

Here are a few questions to you,

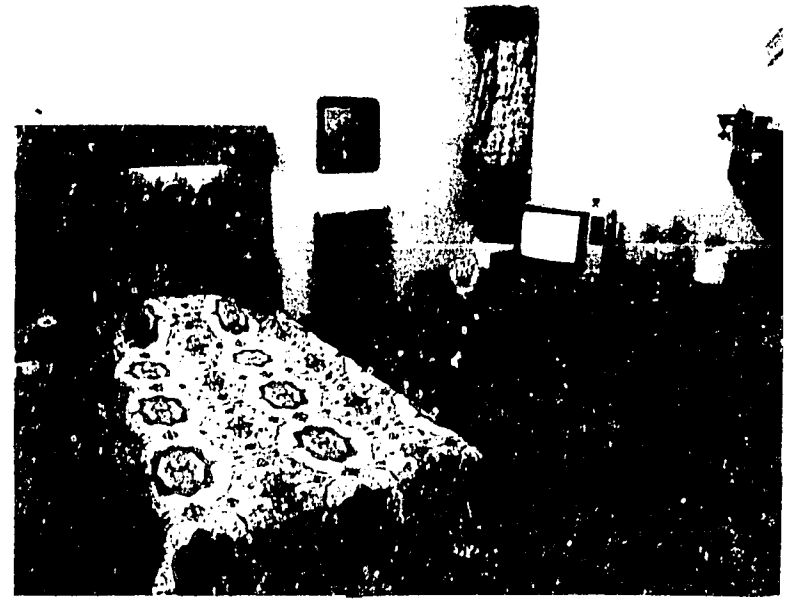
1. Do you want to set up a project in Assam ?
2. Do you have a right project ?
3. Is your project held up because of lack of finance?

—— if your answers are in affirmative, it is THE TIME that you approach the PROJECT FINANCE DEPARTMENT of A I D C.

What are the Industrial Concerns eligible for loan :

The Industrial concerns engaged in

i) Manufacture, preservation or processing of goods
ii) Shipping
iii) Mining
iv) Hotel Industry
v) Transport of passengers or goods by Road, water or by air.
vi) Generation or distributions of electricity or any other form of powers.
vii) maintenance, repairs, testing or servicing of machinery of any description or vehicles, vessel or motor boats, trailor, or factors.
viii) assembling repairing or packing of any article with the aid of machinery or power.



A Hotel Kuber Room.

ix) developing any contigous area of land as Industrial estates.
x) fishing or providing shore facilities for fishing or maintenance thereof.

xi) Providing special technical knowledge or services for the promotion of industrial growth or

xii) research and development of any process of manufacture or a product in relation to any of the afforsaid matters. Under normal circumstances AIDC is not providing financial assistance under this scheme in respect of industries in the negative list in line with the IDBI guide line thereon.

Factory of Luit Asian Plastics (P) Ltd.

Promoters contribution :

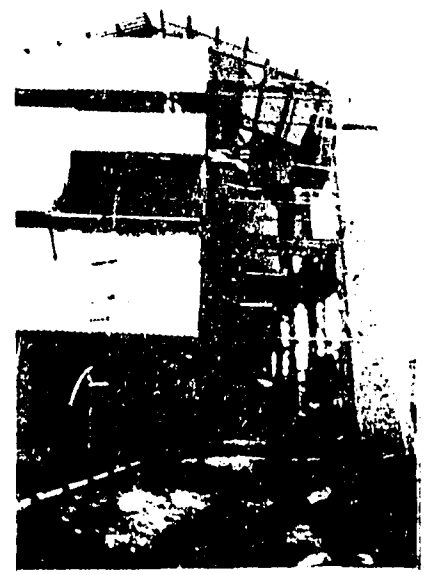
Enterpreneurs seeking term loan assistance from the corporation for setting up an Industry in Assam have to fullfil a minimum contribution of 10% of the total project cost.

Rate of interest: The present rate of interest on term loan is @ Rs. 12½ % per annum.

Repayment period : The loan is normally repayable within a period not exceeding 10 years, which will be determined after assessing the cash generation and repaying capacity of the project.

Seed capital assistance Scheme : The object of this scheme is to finance the gap in equity component after adhering to normal debtequity norm.

Promoters having necessary entrepreneurial traits in industry to set up a project in the medium scale sector for the first time are eligible under the scheme if the project cost is within 3 crores. The maximum amount of seed capital assitance per project is Rs 15.00 lakhs in the form of soft loan with 1% service charge.

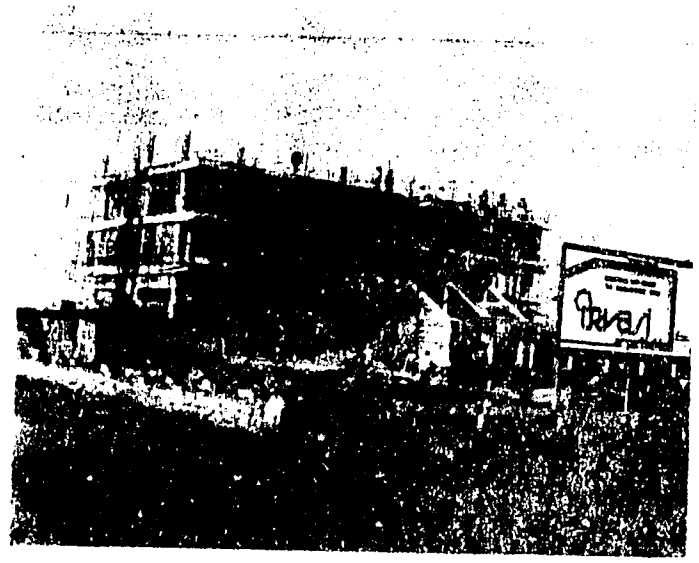


Sati Oil Udyog under construction

Some of the Projects under Refinance Scheme.

1. Carbon Paste Project
2. Rigid PVC Pipe Projects
3. L.P.G. Cylinder Project
4. Edible oil Refinery Project
5. Hotel Project
6. Cigarette Project
7. News paper Publications
8. Special Carbon Projects

The total refinance assistane tot heabove. Project amounts to 693.28 lakhs.



Hotel Urvasi under construction

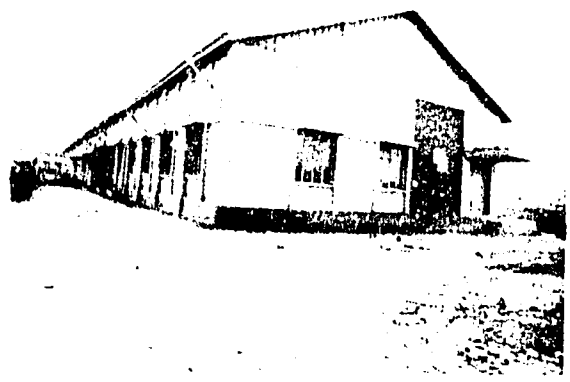
Eligibility norms and other conditions for seeking Assistance.

1) The corporation will normally consider application for term loan from medium scale units whose project cost is Rs 50 lakhs and above subject to a ceiling of Rs 3.00 crores for new as well as expansion diversification modernisation projects and the loan requirement is Rs 30.00 lakhs and above upto a maximum of Rs 90 lakhs per unit. The upper limit of Rs 90.00 lakhs may be considered to maximum of Rs 200 lakhs when financing such a project is agreed jointly by the Assam Fiancial Corporation (AFC) and Commercial Banks. In the case of existing concerns, the total of existing (oustanding balance) and proposed loans under the Refinance Scheme, should not exceed Rs 2 crores. To be eligible for financial assistance under this scheme, the own funds (i.e. paid up capital and reserve) of the company should not exceed Rs 2.50 crores.

North Eastern Cylinder (P) Ltd. project under construction

Procedure : An Industrial concern seeking term loan assistance from the corporation will have to apply in the prescribed application forms available with the corporation. Three copies of the applications duly filled in will have to be submitted to the corporation along with all required documents including the project report. Another two copies seperately will have to be simultuniously submitted to the IDBI. North Eastern Regional Office G.S.Road, Bhangagarh, Gauhati – 781005.

When financial pattern involves more than one financial institutioin the Industrial concerns shall have to apply for financial assistance separately to each institutiuon.



Hotel Rangmahal under construction

INTRODUCTION

Endowed with vast natural resources and power potentiality in the state Assam stands out as one of the ideal places offering vast avenue for setting up numerous industries.

With a view to utilising and exploring the vast industrial wealth of the state and to promote faster industrialisation, Assam Industrial Development Corporation Ltd. comes on the scene. The object of AIDC does not lie alone on setting up industries but also to help developing the socio-economic levels of the state as well. The industrial growth helps the prosperity of the state and its people.

AIDC can claim that its efforts in the above areas are significant as for the first time new industries like Petro-Chemicals, Fertilisers, and Sugar etc. came under its aegis.

BOARD OF DIRECTORS

Board prior to 1985 elections	Current Board October 1986	
1. Shri P.C. Das, IPS, Retd. Director General of Police Govt. of Assam.	1. Shri Digen Bora, Minister of Industries	Chairman
2. Shri J. Hazarika, IAS Special Secy. to the Govt. of Assam Industries Deptt. Dispur	2. Shri J.P.Rajkhowa, IAS Commissioner of Industries, Personal and Special Secretary to the Chief Minister	Director
3. Shri M.P. Bezbaruah, IAS Chairman, Assam State Electricity Board.	3. Shri B.C.Thakwire, IAS Commissioner of Power	—do—
4. Shri P. K. Bora, IAS Financial Commissioner, Govt. of Assam. Dispur.	4. Shri P.K.Bora, IAS Financial Commissioner	—do—
5. Shri H. N. Das, IAS Planning & Devt. Commissioner, Govt. of Assam, Dispur.	5. Shri H.N.Das, IAS Planning & Development Commissioner	
6. Shri B. Himatsingka, Managing Director, India Carbon Ltd., Guwahati.	6. Shri P.K.Bhuyan Industrialist	—do—
7. Shri I. J. Laul, General Manager, I.D.B.I., Guwahati.	7. Shri J.N.Bavina Director RRL Jorhat	—do—
8. Shri N. K. Dutta, Tea Planter, Chowkidingee, Dibrugarh.	8. Shri G.P.Gupta General Manager Industrial Development Bank of India	—do—
9. Dr S. P. Bhattacharya D.D.A. Self Financing Schemes Haus Khas Arvind Marg New Delhi — 110016.		—do—
10. Shri N. Buragohain, A.I.D.C. Ltd., Guwahati.	9. Shri N. Buragohain A.I.D.C.Ltd. Guwahati	Managing Director,

AIDC'S MAJOR AREA OF OPERATION

**Identification, promotion and implementation of medium and large scale industrial projects in the state.

**Implementation of package scheme of incentives offered by the State Govt. for the benefit of entrepreneurs.

**Providing term loan assistance to medium scale industries/projects taking up expansion under IDBI's Refinance Scheme.

**Providing seed capital assistance to eligible new industries.

**Providing financial assistance to eligible new industries.

**Providing financial assistance by way of participation in equity capital to public and private sector undertakings.

**Rehabilitation and Management of sick industries.

**Provide technical, financial and managerial services to entrepreneurs.

**Development of skilled manpower through appropriate training programmes.

PROJECT IDENTIFIED, PROMOTED AND IMPLEMENTED

Projects under state sector

1. Assam Petrochemicals Ltd.

	capacity annum
(1) Methanol	7000 MT
(2) Formalin	12000 MT
(3) U F Adhesive	
(1) 50% Conc	12000 MT
(2) 65% Conc	15000 MT
(4) UF Molding Powder	1000 MT

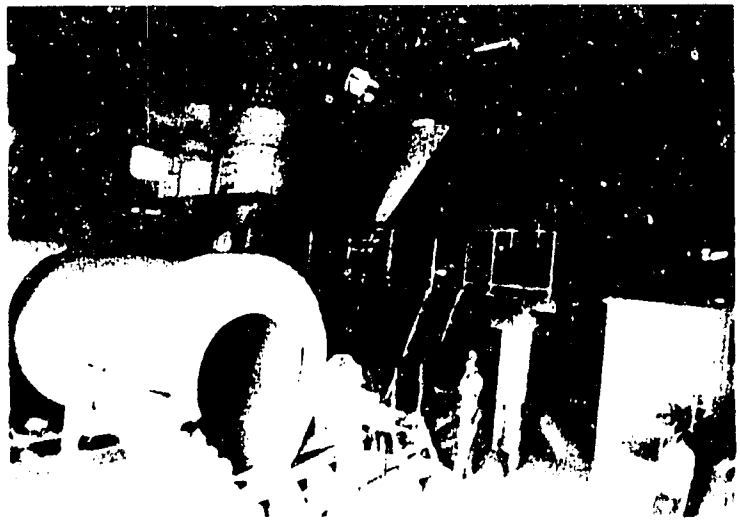
Product:
Methanol, Formaldehyde, Urea, Formaldehyde Resins and Urea Formaldehyde Moulding Powder
Location
Namrup in the District of Dibrugarh.
Date of commission : 1976.

2. Cachar Sugar Mills Ltd.

Capacity (Crushing):
1,250 M.T. of sugarcane per day.
Product Sugar.
Location:
Chargola in the district of Cachar.
Date of commissioning: 1978

3. Fertichem Limited

Capacity:
100 MT per day.
Product:
NPK Granulated Fertilizer.
Location:
Narengi near Guwahati.
Date of commissioning: 1975.



PROJECTS UNDER IMPLEMENTATION

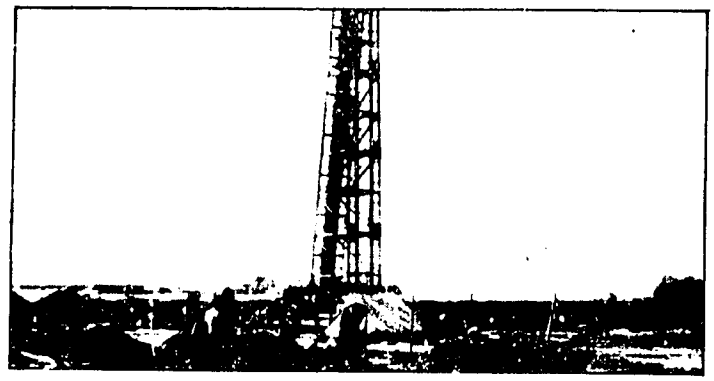
Projects under state sector

1. Spinning Mill

Capacity	17280 spindles
Location	Nathkuchi (Tihu)
Est. Project Cost	7.68 crores
Forms of collaboration	Public Sector
Date of commissioning	End of 1985.

2. Methanol Plant (Expansion Project of APL)

Capacity	100 TPD
Location	Namrup
Project Cost	Rs 30.00 crores
Date of commissioning	June, 1986



Projects under joint sector

1. North Eastern Tobacco Co. Ltd.

Capacity	300 million pcs. per annum.
Product	Cigarette
Location	Guwahati

Date of commissioning
Expected in the year 1985.

2. Polyester Film Project

Capacity	2000 MT per annum
Product	Taps, X-Ray and Photograph Film metalised film, capacitors etc.

Date of commission Expected by 1987.

PROJECTS IDENTIFIED & UNDER PROMOTION

1. A 7,200 TPA Phthalic Anhydride Plant based on Orthoxylene from BRPL with foreign know-how.
2. A 200 TPD Mini Cement Plant at Umrangshu, N.C. Hills, sponsored & financed by North Eastern Council (NEC).
3. 200 TPD paper grade lime plant near Umrangshu sponsored and financed by NEC
4. A 10,000 TPA polyester filament yarn project based on DMT as raw material to be available from Bongaigaon Refinery and Petrochemicals Ltd. (BRPL).
5. A 2000 TPA polyester Film project based on raw materials DMT to be available from BRPL
6. A Ray on Grade Pulp & Viscose Fibre project to meet the demand of blending materials for the spinning mills being set up in the state.
7. A Textile Processing Unit.
8. A finished Leather Project.
9. A Brewery Project.
10. A Jute Mill.
11. A Drug Formulation Unit.
12. A Galvanised plain and corrugated sheet Project.
13. A Gas separation-cum-cracker project based on the associated gas from the Upper Assam Oil Fields.
14. A M.G. Kraft Paper project based on agricultural wastes.

FINANCIAL ASSISTANCE TO PUBLIC SECTOR & PRIVATE INDUSTRIES

So far AIDC provided financial assistance to the following public & private industries.

Public sector Industries

1. Assam Petro-Chemical Ltd.
2. Cachar Sugar Mills Ltd.
3. Fertichem Ltd.
4. Mangaldoi Jute Mills Ltd.
5. Associated Industries (Assam) Ltd (spinning unit)
6. Associated Industries (Assam) Ltd (chemical unit)
7. Assam Conductors & Tubes Ltd.
8. IndustrialPaper(Assam)Ltd.
9. Assam Glass Industries Ltd.
10. Assam Textile Mills Pvt. Ltd.
11. Assam Schanzlin Ltd.
12. Assam Alkali & Allied chemicals Ltd.

Total financial assistance to the above projects amounts to Rs. 13.69 crores by way of loan & shares.

Private Industries:

1. Assam Carbon Products Ltd.
2. Eastern Steel & Alloys Co. Ltd.
3. North-Eastern Hotel Pvt. Ltd.
4. North Eastern Tobacco Company Ltd.
5. Meenaxi Wire Industries (P) Ltd.
6. India Carbon Ltd.
7. North Assam Agro-Industries Co-operative Society (NAAICO) in co-operative sector.
8. Purbanchal Breweries Ltd.
9. Kamrup Paper Mills Ltd.
10. Union Carbon Ltd.

Total financial assistance to the above industries in the private sector amounts to Rs107.77 lakhs by way of loan & shares.

Industries under Refinance Scheme of IDBI

Projects	Loan Sanctioned Rs 60.00 lakhs
1. A Carbon Paste Project	Rs 60.00 lakhs
2. A rigid PVC Pipe Project	Rs 61.50 lakhs
3. A LPG Cylinder Project	Rs 60.00 lakhs
4. An Edible Oil Refinery Project	Rs 60.00 lakhs
5. Four Hotel Projects	Rs 85.00 lakhs
	Rs 47.40 lakhs
	Rs 60.00 lakhs
	Rs 43.00 lakhs
6. A cigarette Project	Rs 36.38 lakhs
7. News Paper Publications	Rs 90.00 lakhs
8. Special Carbon Project	Rs 90.00 lakhs

The total refinance assistance to the above projects amount to Rs. 693.28 lakhs.

TECHNICAL, FINANCIAL AND MANAGERIAL SERVICES TO ENTREPRENEURS

AIDC rendered technical and financial services to a co-operative society in the execution of the Rice Bran Oil Projects at Rowta right from project idea formulation till successful commissioning of the plant. Besides AIDC's multidisciplinary work force renders all assistance and guidance to the promoted companies for successful implementation of their projects.

DEVELOPMENT OF MANPOWER AND TRAINING

AIDC arranges recruitment of personnel of various categories for training in multi-disciplinery fields like engineering & technology, finance and accounts, general management, administrative and personnel management, company secretaryship, material management etc., etc., for manning its various promoted and assisted projects

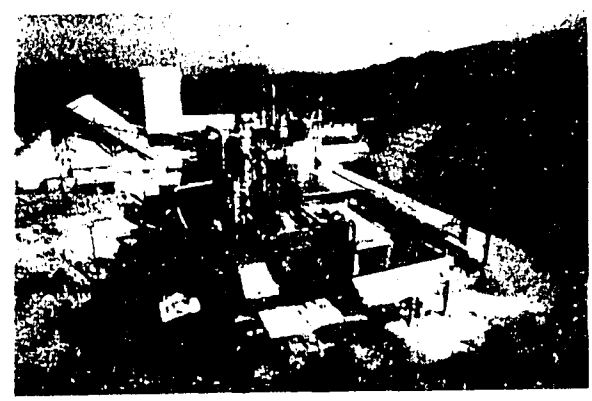
REHABILITATION AND MANAGEMENT OF SICK INDUSTRIES

The Corporation has taken over and rehabilitated the following sick units:

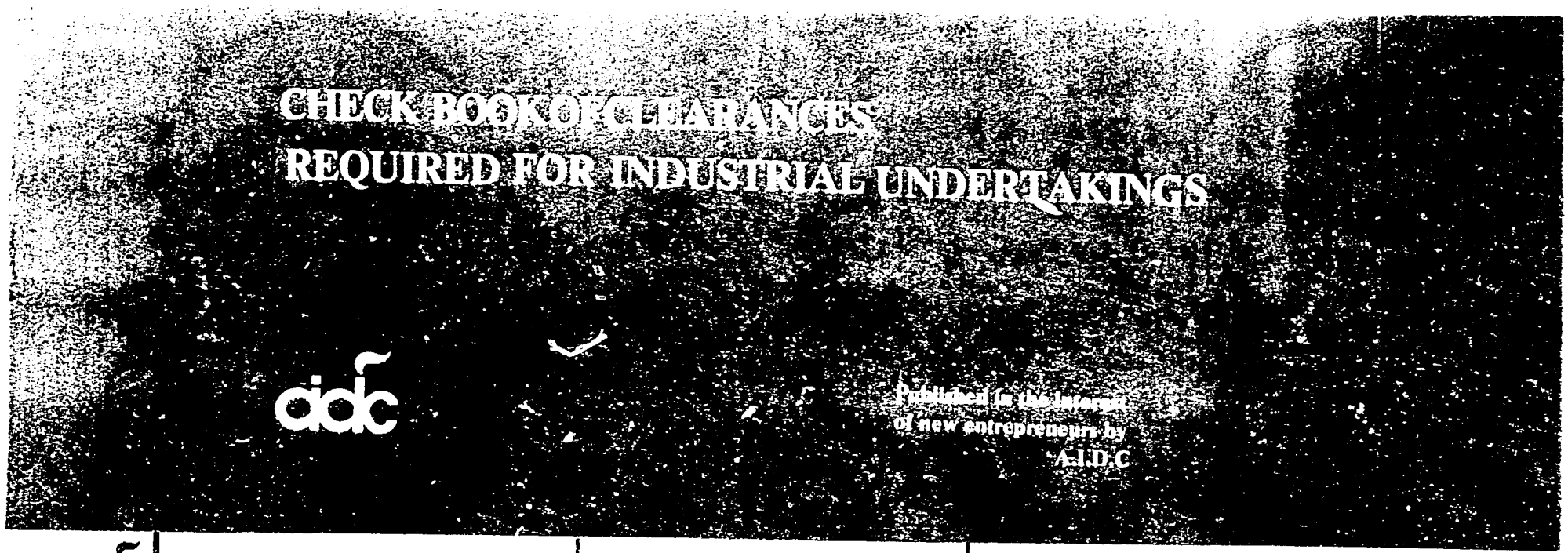
1. Assam Conductors & Tubes Ltd: This unit was taken over in 1972. Subsequently, it was expanded to its present capacity and the unit is running in profit.

2. Associated Industries (Assam) Ltd. Chemical Unit: This unit was taken over in 1974 under Industrial (D & R) Act by Govt. of India and AIDC was appointed as its authorised controller Under the management of AIDC, the performance of the unit has improved substantially and able to generate cash surplus. The Corporation is also planning to recommission the liquid So2 (sulphur dioxide) unit which is the only plant of its kind in the entire North Eastern Region.

Assam Conductors & Tubes Ltd.



Associated Industries (chemical) Ltd.



aidc	Item of Clearance	Whom to Approach	Brief Procedure
1.	**Letter of Intent (LI)/ Industrial Licence (IL)** Required for manufacture of items included in Schedule-I of Industries (Development & Regulation) Act, 1951. Required in the case of projects whose cost is more than Rs. 5 crores and where the foreign exchange outgo is not more than 15% of the ex-factory value of annual production or Rs. 40 lakhs.	Secretariat for Industrial Approvals (SIA), Department of Industrial Development, Udyog Bhavan, New Delhi – 110 001.	LI/IL forms may be obtained from SIA or contact AIDC, R.G. Baruah Road, Guwahati – 781 024, for guidance Application with seventeen (17) spare copies duly filled may be submitted with a crossed demand draft for Rs. 1000/– (Rupees one thousand only) drawn in favour of Pay & Accounts Officer, Department of Industrial Development, Ministry of Industry on State Bank of India, Nirman Bhavan, New Delhi. One copy each to be submitted to Secy. to the Govt. of Assam, Industries Department, Dispur, Guwahati – 6 and Director of Industries, Govt. of Assam, Bamunimaidan, Guwahati – 21.

	Item of Clearance	Whom to Approach	Brief Procedure
2.	**Registration with Director General of Technical Department (DGTD)** Required for manufacture of such items which do not need an industrial licence under the Act mentioned in 1.	The Director General of Technical Development, Udyog Bhavan, New Delhi – 110 001.	DGTD forms may be obtained from the office concerned or contact Assam Industrial Development Corporation Ltd., R.G. Baruah Road, Guwahati – 781 024, for guidance. Eight (8) including seven (7) spare copies duly filled may be submitted with a crossed demand draft for Rs. 250/- (Rupees two hundred and fifty only) drawn in favour of Pay & Accounts Officer, DGTD, on State Bank of India, Nirman Bhavan, New Delhi. One copy each to the Secy. to the Govt. of Assam, Industries Department, Dispur, Guwahati – 6 and Director of Industries Govt. of Assam, Bamunimaidan, Guwahati – 21

	Item of Clearance	Whom to Approach	Brief Procedure
3.	**Change of Location** (a) From a non-backward district to a backward district within the State or from one backward district to another backward district within the State. (b) From a backward district to a non-backward district within the State or from a non-backward district to another non-backward district or from one State to another State.	The Secretariat for Industrial Approvals, Govt. of India, New Delhi (for a change of location in a letter of intent/industrial Licence or DGTD, UDYOG Bhavan, New Delhi (for a change of location in a DGTD registration) Secy. to the Govt. of Assam, Industries Deptt. Dispur, Guwahati – 6.	Forms CL (E) prescribed by the Government of India is required to be filled in and submitted to the Secretariat for industrial approvals. The forms may be obtained from the concerned department. No seperate form is required. A letter addressed to the Secretary of industries justifying the change of location is enough. However, an endrosement of the LI/DGTD registration may have to be obtained from the Secretariat for Industrial Approvals Government of India, New Delhi, after the approval from the Secretary of Industries Govt. of Assam.

aidc	Item of Clearance	Whom to Approach	Brief Procedure
4.	**Import Licence for Capital Goods** Required under import licence policy specified by the Government of India. Details available in the 'Red Book' published by the Ministry of Commerce, Government of India.	Chief Controller of Imports & Exports Government of India, New Delhi.	The list of the equipment may have to be advertised in the 'Trade Journal', wait for forty five (45) days to receive the comments from local suppliers. Later the CG application duly filled in may be submitted. Standard forms may be obtained from the address given at 1.2 above or contact Assam Industrial Development Corporation Ltd., R.G. Baruah Road, Guwahati - 781 024, for guidance.

aidc	Item of Clearance	Whom to Approach	Brief Procedure
5.	**Approval under MRTP** Required for companies covered by Monopolies and Restrictive Trade Practices Act, 1969.	(a) The Secretary, Government of India, Department of Company Affairs, Shastri Bhavan, Dr. Rajendra Prasad Marg, New Delhi – 110001 (b) The Secretary, Monopolies & Restrictive Trade Practices Commission, Travancore House, Kasturba Gandhi Marg New Delhi – 110 001.	The required information in the prescribed forms may be submitted to the officers concerned.

aidc	Item of Clearance	Whom to Approach	Brief Procedure
6.	**Foreign Collaboration** Required under the guidelines and statutory requirement of Government of India.	Secretariat for Industrial Approvals (SIA), Department of Industrial Approvals, Udyog Bhavan, New Delhi – 110 001.	Foreign Collaboration proposals in the prescribed form have to be submitted to the officer concerned and the approvals taken.

aidc	Item of Clearance	Whom to Approach	Brief Procedure
7.	**Incorporation of the Company** Required under the Companies Act, 1956.	Registrar of Companies, Assam Meghalaya, Manipur etc. Morello Building, Shillong.	Obtain a name from the Registrar after submitting five to six alternatives. Prepare a draft Memorandum & Articles of Association and submit it to the Registrar, along with requisite fees. After the approval, get them printed. Submit the same to the Registrar of companies for keeping on record.

	Item of Clearance	Whom to Approach	Brief Procedure
8.	**Approvals from Chief Inspector of Factories** Required under Factories Act, 1948.	Chief Inspector of Factories, Govt. of Assam, Bamunimaidan, Guwahati – 21.	The drawings of the site plan, building structures and foundations for machinery may be submitted to the officer concerned and approved before starting the civil works. The standard norms prescribed by them for various items of work have to be adhered to by the architect while preparing the drawings.

	Item of Clearance	Whom to Approach	Brief Procedure
9.	**Pollution Control Board** Required under Pollution Control Act.	Member Secretary, Board of Prevention and Control of Water and Air Pollution, Rajgarh Road, Guwahati – 7.	The scheme for the disposal of effluents may be submitted along with the prescribed form, duly filled in to obtain a No objection certificate.

aidc	Item of Clearance	Whom to Approach	Brief Procedure
10.	**Director of Town and Country Planning** Required as per Government orders.	Director of Town Planning, Govt. of Assam. Dispur Guwahati.	The drawings of the site plan along with the survey numbers of adjacent sites and building plans have to be submitted.

aidc	Item of Clearance	Whom to Approach	Brief Procedure
11.	**Projects concerning Directorate of Health Services.** Required as per Govt. orders.	Director of Health Services, Hengrabari, Dispur, Guwahati — 781 006.	The proposals of the project along with the hygienic conditions may be submitted in a prescribed form to obtain clearance.

	Item of Clearance	Whom to Approach	Brief Procedure
12.	**Need – Based Approvals** Appointment of Managing Director for Public Limited Company and fixation of remuneration, other allowance and perquisites. Required under the companies Act, 1956 and rules thereunder.	The Secretary, Company Affairs, Company Law Board, Government of India, New CGO Building, New Marine Lines, Bombay – 400 020.	The company may apply to the officer concerned in the prescribed proforma and get the approvals. The standard norms should be followed for fixing the remuneration and the perquisites of the Managing Director.

	Item of Clearance	Whom to Approach	Brief Procedure
13.	Share holding by Foreign Collaborators, permission for know-how/collaboration and for investment from Gulf countries.	The Controller, Exchange Control Department, Reserve Bank of India, Mint Road, Bombay – 400 038.	The entrepreneur may apply to the officer concerned in the prescribed form along with the Memorandum of Understanding entered into with the collaborator.

	Item of Clearance	Whom to Approach	Brief Procedure
14.	Permission to raise capital under the Capital issues (Control) Act, 1947 and Capital Issue (Application for Consent) Rules, 1966.	Controller of Capital Issues, Ministry of Finance, Government of India, North Block, New Delhi – 110 001.	The company may apply to the officer concerned in the prescribed form for the issue of capital exceeding Rs. 50 lakhs.

	Item of Clearance	Whom to Approach	Brief Procedure
15.	Use and storage of explosives including furnace oil in factory. Required under the Explosives Act, 1884.	Chief Controller of Explosives, Government of India, Department of Explosives, Old High Court Building, Nagpur – 440 001.	The company may apply to the officer concerned in the prescribed form along with details and obtain permission to use and store explosives.

aidc	Item of Clearance	Whom to Approach	Brief Procedure
16.	**Permission to Manufacture drugs/Cosmetics** Required under Drugs and Cosmetics Act, 1940.	Commissioner Food and Drugs Administration, Griha Nirman Bhavan, Bandra (East), Bombay — 400 051.	The company may obtain permission from the officer concerned by submitting the application in the prescribed form.

aidc	Item of Clearance	Whom to Approach	Brief Procedure
17.	Boiler inspection Certificate. Required for any boiler before comencement of production under Indian Boiler Regulations, 1950.	Chief Inspector of Boilers, Kalapahar, Guwahati — 18, Assam	There is no prescribed form. The company may write to the Chief Inspector of Boilers giving the specifications of boiler used and details of the products manufactured. The officer concerned will arrange for an inspection of the boiler before permission is granted.

aidc	Item of Clearance	Whom to Approach	Brief Procedure
18.	**Extractions of Minerals** Required under the Mines and Minerals Development and Regulation Act, 1957 and Mineral Commission Rules, 1960.	Director of Mines & Geology, R.G. Baruah Road, Guwahati – 781 005. Assam.	The entrepreneur may apply to the officer concerned for a Mining Lease. he has to pay the required fee by way of challan in a bank. The officer concerned after verification will issue a Prospective Lease (PL) and will later convert it into a Mining Lease (ML).

ASSAM INDUSTRIAL DEVELOPMENT CORPORATION LIMITED

(A Govt. of Assam undertaking)

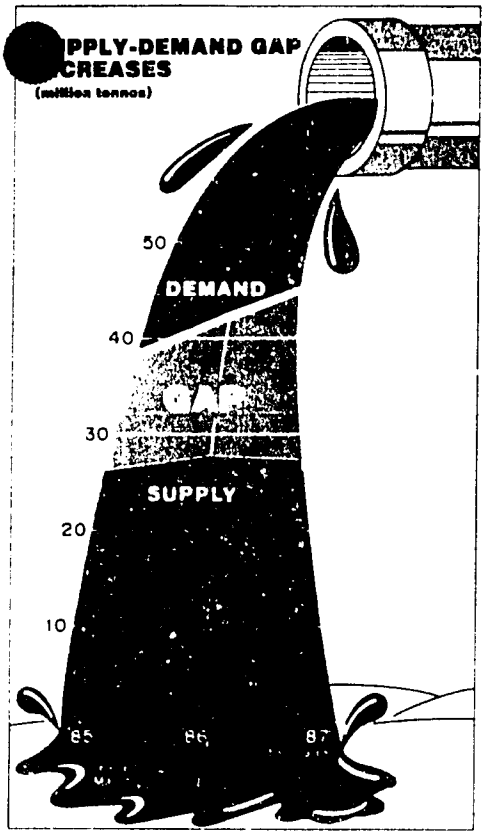
R.G.BARUA ROAD GUWAHATI – 781024

Ph:87731/87732 *Gram : Udyog Telex : 0235210 AIDC IN

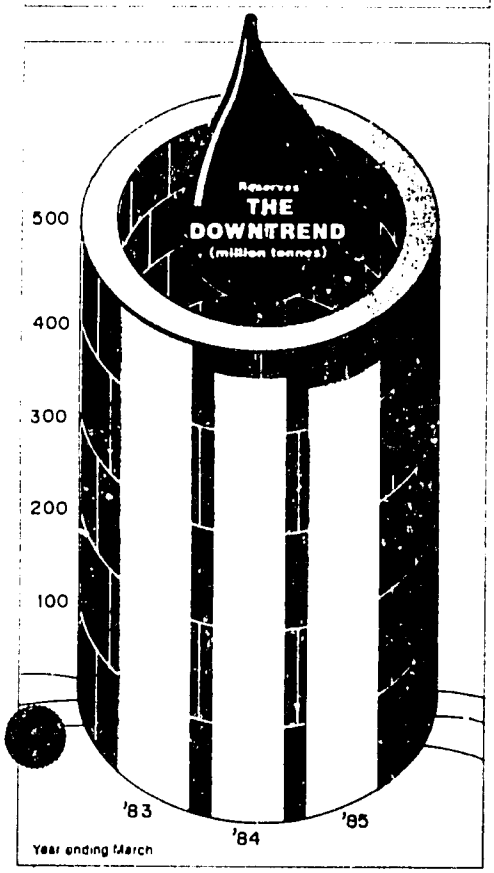
ONGC The Oil

AS INDIA enters a period fraught with uncertainties about the strength of its foreign exchange reserves, the question uppermost in everybody's mind is: will the country continue to maintain a high degree of self-sufficiency in oil? During the international oil crisis of the early 1970s when crude prices sky-rocketed, the Indian economy received a massive jolt. Hopelessly dependent on oil imports, the country was forced to spend each year an amount equal to its total foreign exchange reserves. But in the 1980s there seemed to be a magical

Self-sufficiency is declining...



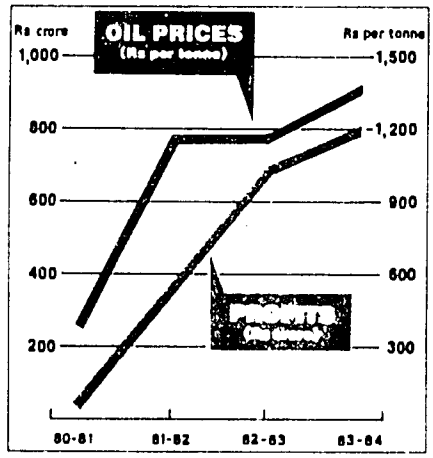
...recoverable reserves are falling...



BARRING some dramatic new discoveries, India's oil bubble which, according to incessantly rosy predictions by the Government, was supposed to balloon into a cocoon of self-sufficiency by the 21st century, could burst within this decade. If present trends continue, the country will neither be self-sufficient in oil nor self-reliant in technology by 2000 A.D. In fact India, after the last few years of heady optimism in this area, once again faces the frightening future of dependency on foreign sources to meet the major share of its domestic requirements.

This admittedly alarmist conclusion is based squarely on interviews with senior experts in this field as well as an investigation of the internal documents of the ONGC—the public sector agency which shouldered almost exclusively the charge of finding new oil to meet India's growing needs, as well as providing indigenous wherewithal for oil exploration and production. During the last five years, under the chairmanship of Colonel S.P. Wahi, ONGC has claimed—through a plethora of publicity releases and glossy brochures—that it has achieved, or come close to achieving, these goals. And during this short time, the five-year-plan allocations for ONGC shot up from about Rs 6,000 crore in the sixth plan to the currently-estimated Rs 12,000 crore—the largest single chunk of resources in the petroleum sector alone. But notwithstanding this staggering increase, of which about Rs 2,000 crore was spent each year during the sixth plan on the hunt for oil and gas, ONGC discovered no significant new structures containing recoverable oil deposits. Most of its efforts were concentrated on Bombay High, which continues to be the milch cow now rapidly being depleted. True, ONGC made profits during this period, and it is also true that it was able to achieve an all-time record in production. But in what can only be described as a public relations blitzkrieg,

...profits reflect high prices...



Mirage

turn around when India's own oil production brought down foreign dependency from 70 to 30 per cent. Was this only a mere reprieve or a long-term trend? In order to make a realistic assessment of what the scenario may be when the 21st century arrives, INDIA TODAY conducted wide-ranging interviews and examined mountains of internal records of the Oil and Natural Gas Commission (ONGC). It is a grim picture. A report from Features Editor INDERJIT BADHWAR assisted by SHEKHAR KUMAR JHA:

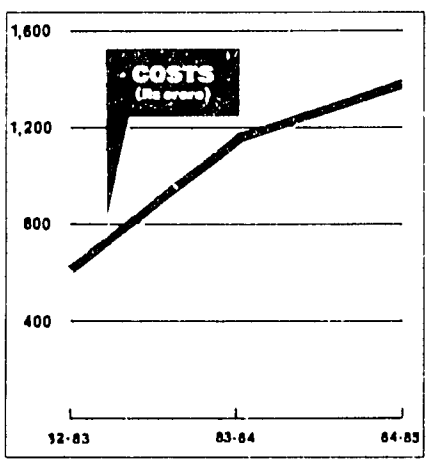
these facts were trumpeted with rapid-fire frequency in order to paint the last five years as a booming success story. What this public relations exercise masked from public view was the sobering reality that the rewards reaped during this brief time-span were a culmination of 20 years of often fruitless labour and that a small portion of Bombay High was—and continues to be—the only flash-in-the-pan saving grace in an otherwise dismal scenario in which production from onshore fields has been more or less stagnant. And in many instances, the ONGC public relations campaign heralded old oil finds as new discoveries, used statistics to make the record look rosier than it was, and claimed success even in the field of indigenisation—a development that is far from the truth.

What follows is an account of ONGC's claims (entitled "claim") along with details of INDIA TODAY's investigative findings (entitled "findings"):

Claim: The increased production during 1984-85 has brought the country nearer towards self-sufficiency.

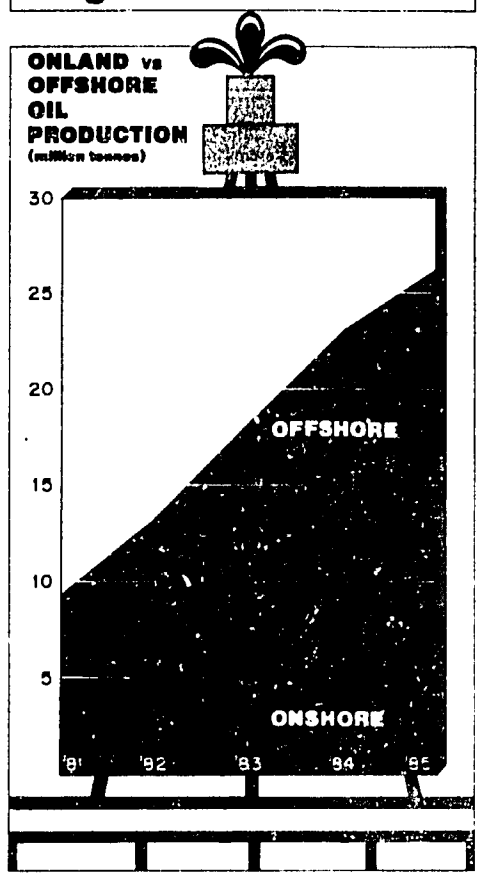
Findings: In the very short run this may be true. During 1984-85 the country achieved an oil self-sufficiency level of 73 per cent (demand: 39 million tonnes; production: 26.26 million tonnes). Of this amount, Bombay Offshore area—the only offshore facility producing oil—contributed about 75 per cent of the total. The remaining amount came from India's two remaining oil sources—onshore fields in Gujarat and Assam. Production from these onshore fields has remained more or less static for the last 15 years and is likely to decline. In the year 2000, India's crude oil requirements are expected to touch 100 million tonnes. To satisfy these needs, oil production will have to increase three-fold. But a negative trend has already set in. During 1985-86—because of an increase in demand and only a small increase in production—the self-sufficiency

...operating costs keep rising...

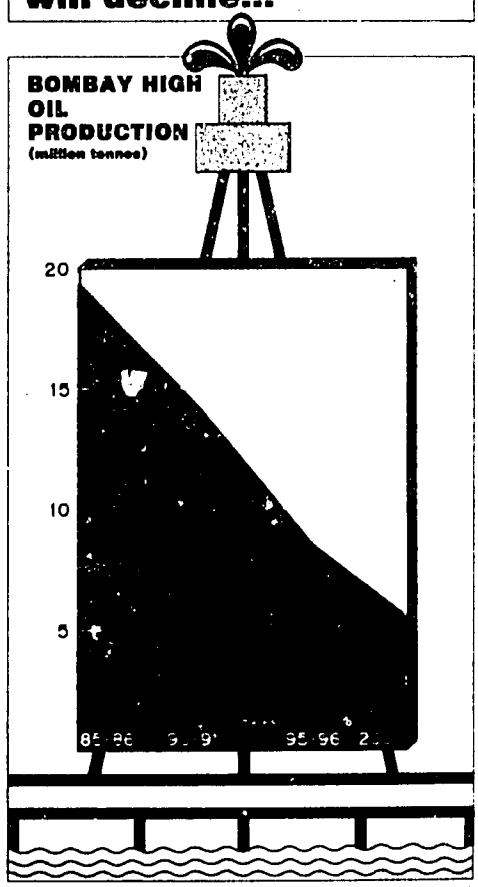


Charts by B K SHARMA

...onshore production stagnates...



...offshore recoveries will decline...



level actually declined by nearly 10 per cent. During 1986-87 the self-sufficiency level is expected to continue to dip by an additional 7 per cent. Beyond this reality lie only grandiose plans and exploration scenarios but no known quantities of commercially exploitable oil.

Claim: **Self-sufficiency in oil has now become an achievable goal on account of sustained accelerated efforts of ONGC.**

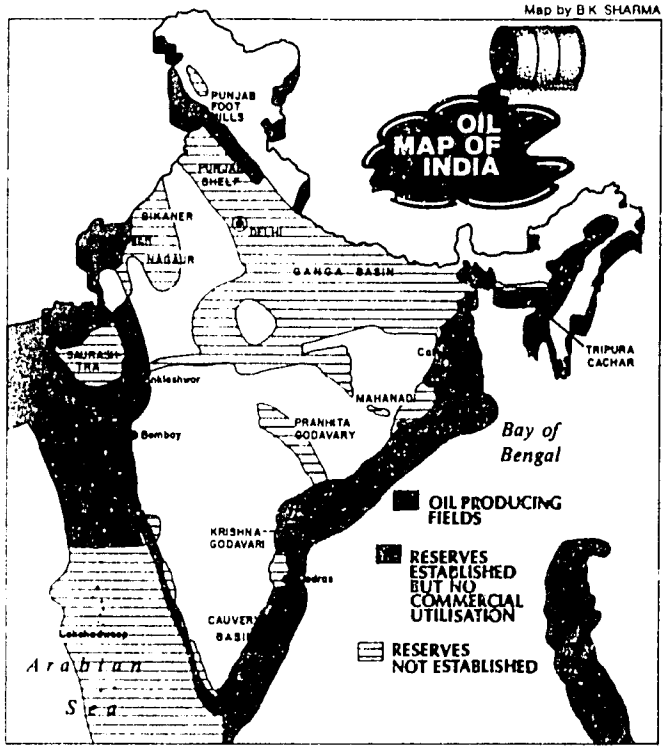
Findings: Recoverable reserves from ONGC's onshore fields, according to the Reserves Estimates Committee, totalled 101.45 million tonnes in 1981, of which 30.69 million tonnes had been extracted by the end of March 1986. This leaves about 70 million tonnes which, if extracted according to the present rate of 6 million tonnes a year, will barely last into the 21st century. This still leaves Bombay High to make up the bulk of the supply to meet India's needs, which are expected to increase annually by over 4 million tonnes for the next 15 years. But Bombay High is already producing to capacity and, according to senior engineers, "has plateaued out".

Moreover, according to a confidential ONGC study, output from Bombay High will dip from the current level of about 20 million tonnes to 5.60 million tonnes by the turn of the century. Even under the most optimistic profile—barring some unexpected major oil find—India's present fields can yield no more than 10 million tonnes of recoverable oil by 2000 A.D.—thereby pushing the country into a 90 per cent oil dependency. During the next four years, India's demands are expected to total about 245 million tonnes. Assuming optimum production—100 per cent of demand, which is quite impossible—more than half of the reserve will be depleted within this period with no new additions in sight.

Claim: **The emphasis on productivity, efficiency, innovative measures and cost-effective operations have again helped ONGC to achieve an all-time record performance in 1985-86.**

Findings: The statement "all-time record performance" suggests that ONGC's entire operation performed exceptionally well in order to set a new oil production record. It is true that ONGC exceeded the original target. But in terms of actual production, the gain over the previous year was only 1.25 million tonnes or a little more than 25,000 barrels of oil per day with about half the increase coming from Bombay High and the rest from the more-or-less stagnant known fields. None of this addition came from any of the new fields.

Map by B K SHARMA



India's oil comes from only 3 Basins

Claim: **Record production of 27.514 million tonnes has been achieved as against the target of 27.11 million tonnes.**

Findings: Here there is a subtle change of emphasis by the ONGC public relations machine. The new pronouncements speak no longer of "self-sufficiency" but of "record performance". This is because the increase in demand had clearly begun to outstrip the small rise in production. In terms of barrels per day, India's needs had soared to 872,486 but domestic production was 555,475.

Claim: **This record production has been made possible by putting some new hydrocarbon bearing structures into production through early production systems, thereby improving well productivity and reducing the number of sick wells....The Sixth Five Year Plan saw increase of oil production from 9.21 million tonnes in 1980-81 to 26.25 million tonnes in 1984-85.**

Findings: Throughout this scenario Bombay High—in particular Bombay High South—was being flogged to death against the advice of senior scientists within ONGC. The dramatic jump in production was due only to one factor—an unexpected bonanza from Bombay High South, which alone contributed nearly 14 million tonnes of oil during 1984-85 to the country's total production of 26.25 million tonnes. Until South began production, the rest of the Bombay offshore oil scene was—and remains—disappointing. Initial offshore production, starting in the mid-'70s, yielded no more than a total of 4.42 million tonnes of oil—a little less than half of India's total production. At that time India imported 70 per cent of its crude requirements. The turn around occurred only because Bombay High South—discovered in the '70s as an extension of the Bombay High field—gushed beyond even ONGC's calculations and produced 33.7 million tonnes during 1981-85 as against the original projection of 24.6 million tonnes. Conversely, the other offshore fields failed miserably in meeting targets. Bombay High North, which had created the original flutter of great expectations, began slipping and fell below originally targeted production. Bombay High East, and a related oilfield Panna, categorised as "new" offshore finds by ONGC, failed to produce a drop of oil during this period, while production from two other offshore structures, Ratna and Heera, have been mere drops in the bucket.

However, Bombay High South is also running into trouble. According to a report prepared by the Institute of Reservoir Studies, ONGC has slowly been killing the goose that has been laying the egg of black gold. Because of the accelerated production of oil from this structure—without the use of water injection techniques used to keep up the pressure of oil flow from the wells—as much as 17 million tonnes of recoverable oil from this deposit has seeped away into pores from which recovery is impossible. The institute had recommended that in order

COLONEL S.P. WAHI

"You have to take risks"

COLONEL S.P. Wahi, 57, who has been the helmsman of the Oil and Natural Gas Commission (ONGC) since 1981, completes his term in office at the end of this month. His latest public sector assignment followed two previous ones at BHEL and the Cement Corporation of India. His assumption of office coincided with India's luckiest oil-breakthrough—the record production of oil from Bombay High South at a time when all other fields were stagnant.

This development, which pushed India into a period of near self-sufficiency, also catapulted Colonel Wahi into the headlines. He is described by friends as an incorrigible optimist, impatient with government regulations, who created a new corporate image for ONGC. Short of stature, balding and moustachioed, he cuts a classic Colonel Blimp figure. He alternates smoking a pipe with cigars, cigarettes, and chewing on an occasional paan.

Wahi's admirers refer to him as the best public sector executive in India while critics denounce him as a slick image-builder. Senior government officials associated with the Petroleum Ministry believe that Wahi has concentrated too much on the organisation and its image rather than on adventurous exploration. "Even though there is constant talk about new strikes and new finds," one senior ONGC official said, "the truth is that we have been going round and round in circles in the same structures and reduced exploration in real terms. The colonel's strategy was to concentrate only in the proven areas, exploit Bombay High to the hilt in order to be able to boast of records in a short time." Added a senior secretary: "For all the claims made, the planning of exploratory wells has been poor and time schedules have never been met."

What Wahi's critics also suggest is that ONGC, which was created in 1959 as a statutory body, has become an entity unto itself with little or no oversight in order to assess strategies and make risk-benefit analyses. Some years ago, a recommendation was made at the cabinet level that a new committee be created for this purpose but no decision was taken. "Outside ONGC," a former Petroleum Ministry official said seriously, "there is no technical competence, no think-tank in other parts of government to monitor the commission in terms of a broad national perspective. There is no second opinion."

But Colonel Wahi stresses that he needs even more independence from the Government in order to function more effectively. "I don't need one penny from the Government any more," he says. "I can manage with my own resources as well as borrowing through the World Bank." ONGC's corporate culture, he says, is different from other such organisations. "because I trained my people to talk in terms of money and not numbers." There is little doubt that the corporate structure has mushroomed into what many say is a top-heavy management structure. ONGC's manpower has shot up from 26,374 to 41,591 during the last five years. The number of officers, about 14,000, far exceed the number of Class IV employees (7,392). The expenditure on employees has gone up during this period from about Rs 54 crore to Rs 148 crore. The average annual expenditure per employee is now about Rs 36,000.

Wahi likes to talk about his management strategy in terms of "strength and weakness analyses", "modern communication systems" and "systems orientation". Every senior manager, he promises, will soon have a computer terminal on his desk. In Dehra Dun, christened, "The Oil Capital of India", by ONGC because its corporate headquarters is located there, a new administrative block is being built which, says Wahi, "will be the highest building in Uttar Pradesh." Also under construction is a training centre and a computer centre, "the most modern in Asia". The corporate lifestyle also includes business lunches, well-appointed guest-houses, a six-seater Dornier aircraft to ferry VIP's. He was interviewed by Features Editor INDERJIT BADHWAR in his New Delhi office:

Q. *What do you consider your best achievements?*

A. We have become the pace-setters and are shoulder to shoulder with any company in the world. We have shown continuous stability and continuous improvement. We are one of the healthiest companies in the world. We were able to do this through making, for the first time, a comprehensive, long-term strength and weakness analysis of the whole operation.

BHAWAN SINGH

"I'm confident we will meet our needs"

Q. *But what about the future? There has been a decline in self-sufficiency. Will we meet our oil needs in the year 2000?*

A. The position is not as desperate as some people say. We have only realised 25 per cent of our prognosticated reserves. And self-sufficiency is also related to expenditures and demand management. We have to manage our demands more efficiently and conserve

energy on a war footing in order to move away from oil dependency. If the economy is uncontrolled, we could face an energy crisis situation.

Q. *But the question remains, what after Bombay High is depleted? Where is the new oil?*

A. You must look at the overall picture. After all, 51 per cent of the world's totally-recoverable oil is in 49 large structures. The balance is in 30,000 fields. The future lies in small fields and not necessarily in huge structures. Seventy-five per cent of our work still needs to be done through an aggressive exploration strategy. The oil game is always a high-stakes scientific gamble and you have to take risks.

Q. *But where in particular do you expect to find the oil to meet the country's projected demands?*

A. Gandhar and Krishna-Godavari are significant finds. I am also excited about Himachal, Tripura, Jammu and Kashmir and Andhra Pradesh. I'm confident we will meet our needs by the year 2000.

Q. *But in many of these fields,* ONGC *has drilled over and over again for more than 20 years without finding any significant recoverable reserves. Why the hope?*

A. Where there is a will there is a way. The real answer, my friend, is perseverence.

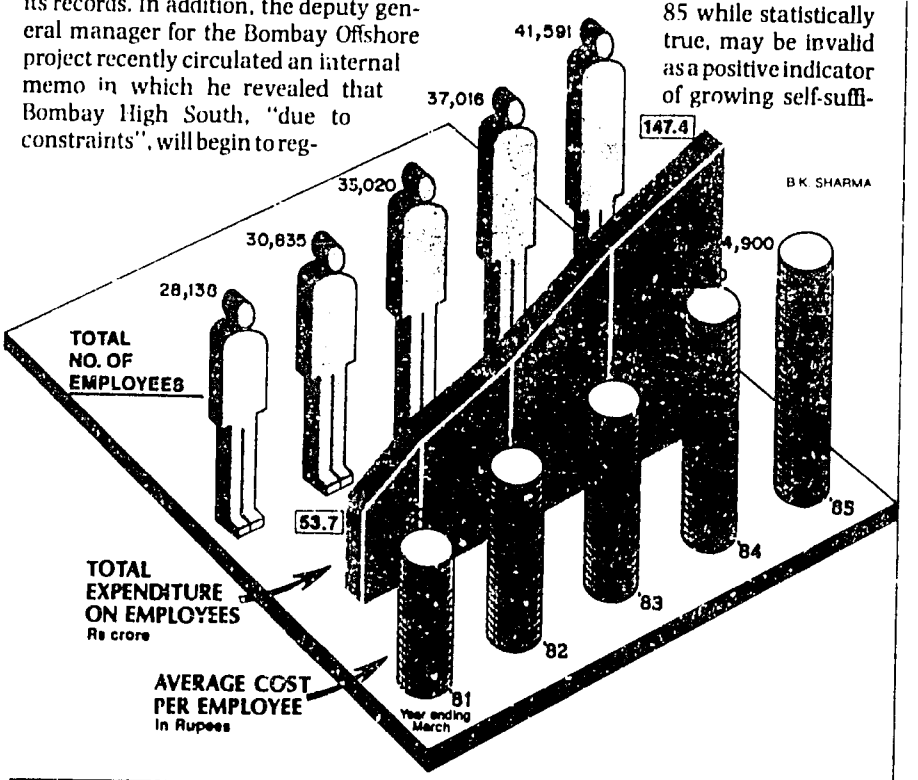
Q. *According to your annual report your cost of production is going high.*

A. More than 87 per cent of these costs are uncontrollable costs incurred through statutory charges, royalty payments, cess and sales tax. And we can still finance our operation from internally-generated funds.

Q. *However, these audited figures show not only your total operational costs going up but also the profits declining as a percentage of your equity.*

A. If we continue to accelerate our hydrocarbon search, the costs will be higher but so probably will be the reward. The result of this investment will show 10 years later. Besides, these accounting methods are geared for engineering-type industries with simple input-output ratios. They are irrelevant to oil because they don't take into account the wealth (oil reserves) which are underground. Today I am investing in areas where there may be no return. But if I make a breakthrough, then all these accounting ratios will be useless.

to prevent this damage to the well, the accelerated oil production should be lowered from the rate of 2,60,000 barrels of oil per day to 1,80,000 barrels until the water injection system for maintaining reservoir pressure could be commissioned. But this recommendation was ignored because it would have entailed a short-fall in production of about 8 million tonnes during 1985-87, a period during which ONGC was claiming its records. In addition, the deputy general manager for the Bombay Offshore project recently circulated an internal memo in which he revealed that Bombay High South, "due to constraints", will begin to register short-falls in production.



ONGC's manpower has shot up in five years

Onshore oil production, confined mainly to Cambay in Gujarat, and to Assam, seemed even less promising for the future. Of Gujarat's 615 wells and Assam's 230 wells, a total of 272—about a third of those in production—were on "artificial lift" by the end of 1985. The "lift" is an emergency procedure in which chemicals and heat are added as stimulant to wells which are getting rapidly depleted and ceased to bubble by themselves. The threat of a sharp decline in onshore production is also borne out by the fact that about 37 per cent of all the producing wells in Gujarat and 28 per cent of those in Assam have now run dry.

Claim: **Recoverable reserves also increased from 328.42 million tonnes in 1980-81 to 450.96 million tonnes in 1984-85. These achievements...have been widely acclaimed as a very significant contribution to the economic progress of the country.**

Findings: Behind the statistics of recoverable reserves—in which ONGC has staked a claim of another record performance—lurks another disappointing reality. Colonel Wahi's claim that these reserves shot up dramatically from 328.42 million tonnes in 1980-81 to 450.96 million tonnes in 1984-85 while statistically true, may be invalid as a positive indicator of growing self-sufficiency. If anything, the last few years have registered a sharp short-fall in reserves. A more revealing comparison would be to begin with the year 1983 when reserves were 482.81 million tonnes. This figure fell to 465.19 million tonnes in 1984 and to 450.96 million tonnes in 1985. This clearly shows that during the very years that ONGC was painting a rosy public relations picture the depletion in India's oil reserves was occurring faster than any additions. A recent report of the Committee on Public Undertakings (COPU) has castigated ONGC for performing considerably below planned targets in all major activities—surveys, exploratory drilling, development drilling, production of crude—during the sixth plan period.

Claim: **During the sixth plan period 41 hydrocarbon strikes/discoveries have been made.... The total accretion to the**

existing geological reserves in 1980-85 has been 894 million tonnes of oil and gas.

Findings: These "new" discoveries and strikes as well as plans to establish huge reserves indicate that there has been feverish exploration activity which will usher in a new era of self-sufficiency. The use of phrases such as "hydrocarbon strikes," "prognosticated reserves," "petroliferous structures," "discovery of oil and oil equivalent of gas," used randomly by ONGC in its publications and press releases are, according to accepted international standards, no accurate measures of whether these structures will yield oil for commercial purposes. These terms are of academic value. Prognosticative reserves only give some indication of the volume of work which will be required for further exploration. Geological reserves are more precise indicators of the total oil-bearing potential of a given field, and not all of even those is extractable. The only true yardstick is "commercially recoverable oil"—the amount which can actually be extracted from a given structure economically as well as with available technology. And from any known oil field or "geological reserve", only about 15 per cent—under optimum conditions—is accepted as the commercially recoverable quantity.

Claim: **The "new" discoveries have been in Bombay High, Narsapur, Kaza and Tatipaka in Krishna-Godavari, Narimannam in Cauvery onland, and Karjisan and Pakhajan in Gujarat. Production from the following new structures commenced through the Early Production System (EPS) in 1985: Dahej, Balol, Wasna, Limbodra (all in Gujarat) and Narimannam (Tamil Nadu).**

Findings: In its litany of new and recent discoveries and strikes—in which it is never made clear how much oil is actually commercially recoverable—ONGC has also listed oil fields and pools, some of which were discovered in the '70s. Balol, ONGC's internal documents reveal, was discovered in the early '70s even before Bombay High. Dahej and Wasna figure in an ONGC paper prepared in January 1981. While the ONGC statement promises to produce oil from these structures through EPS, nowhere does it mention the quantity to be recovered. And small wonder. The total recoverable amount from the three fields will barely form a trickle: Dahej, 0.4 million tonnes; Wasna, .56 million tonnes; Balol, .44 million tonnes. According to a report prepared by an ONGC group appointed in 1982, Wasna and Balol were listed as two small oil pools along with 24 other such pools forming less than 2 per cent of the total onland geological reserves.

Narsapur and other Krishna-Godavari structures, recently heralded as potential new finds, were explored and drilled by the international oil giant Chevron which spent more than $30 million between 1982-85 and pulled out after concluding that the field was not commercially viable. And ONGC—despite claiming to have established a geological reserve of 24 million tonnes in this field—has so far not been able to extract even a drop of commercial oil. And total confusion prevails not only about the viability but also the history of this field. Former petroleum minister P. Shiv Shankar stated on October 24, 1982, that oil and gas had been struck in Razole (Godavari basin onshore) and tests were underway to determine commercial viability. But the *ONGC Recorder* stated—and this announcement was carried in Parliament in July 1986—that oil had been struck for the first time in 1986 in the Krishna-Godavari structure in Kaikalur-3. This notwithstanding official pronouncements.

BHAWAN SINGH

Claim: **The strike at Gandhar, discovered in March 1984, is emerging as one of the most prominent discoveries after Bombay High.**

Findings: The real picture of the Gandhar discovery is still hazy. In his Republic Day speech at Tel Bhavan in Dehra Dun, Colonel Wahi estimated that the Gandhar structure contained 100 million tonnes of geological reserves. If this claim is accurate, the recovery of oil (calculated at 13 to 20 per cent of the total reserve) will be in the vicinity of 13 to 20 million tonnes. This, compared to the national demand of more than 40 million tonnes by next year—when Gandhar is likely to be put in production—is no large amount and will not be able to cater to even a year of domestic requirements.

Further, according to ONGC sources, each of the four wells drilled initially contain varying sand structures indicating the field is not homogeneous; it is thus extremely difficult to make an accurate prediction of the reserve at this stage. Officials of ONGC's western region in charge of developing Gandhar maintain that even after having drilled nine wells in the area it is still premature to make any credible assessment of the deposit. ONGC is now planning to dig several other wells in the structure before arriving at a final production plan. Commenting on finds during the sixth plan an inter-governmental sub-group observed in its recent report: "The individual discoveries and finds made during the plan were, in general, small, suggesting that a similar pattern could prevail in the seventh plan as well. The conclusion was that oil production has not branched off from the two onshore areas of Gujarat and Assam as well as from Bombay Offshore and no

significant fields or structures have been added through innovative exploration.

Claim: ONGC expects to establish—for the future—additional reserves of 1,400 million tonnes of hydrocarbon reserves through new exploration.

Findings: This futuristic scenario appears to be a case of old oil in new bottles. According to a break-down this new bonanza will come as follows. Of the new 1,400 million tonnes to be established within the next five years, 810 million tonnes will be established in Category I basins (Assam, Bombay Offshore, and Gujarat), 645 million tonnes in Category II basins (Rajasthan, Cauvery, Krishna-Godavari, Andaman, West Bengal, Himalayan foothills, Ganga valley, Tripura, Nagaland), and the remaining in Category III basins (Kutch, Saurashtra, Kerala-Konkan and Mahanadi). Even senior ONGC insiders are baffled by these projections. By ONGC's own admission, the Category I basins have already begun to exhibit signs of "diminishing returns"—in other words, the flow from these fields can at best be kept constant with the help of artificial measures. In the Category II basins, 25 years of exploration have so far established only 72.2 million tonnes of geological reserves. It boggles the imagination as to how this figure will be expanded to nine times this amount within a span of five short years. Within this category itself, there are four basins—Bengal, Himalayan foothills, Ganga valley, and the Andamans, where even after 20 years of repeated exploration within the same structure, no reserves have been established. And in Category III also, the projections have been made not on the basis of established reserves but only on theoretical geological studies. Following issuance of the COPU report, the petroleum secretary himself admitted that these projections were "probabilistic" exercises and no certain guide to achievement in self-sufficiency within a given time-frame.

Claim: The achievements in the financial year 1984-85, the last year of the sixth plan period, exceeded the previous year's records and have been widely acclaimed as a very significant contribution to the economic progress of the country. Net profit has gone up from Rs 882 crore in 1984-85 to Rs 923 crore in 1985-86.

Findings: There is no doubt that ONGC has made large profits during the sixth plan. But most of these profits were made possible by one major factor—a dramatic increase in the Government's administered prices for ONGC crude. ONGC profits rose dramatically from Rs 46.57 crore in 1980-81 to Rs 375.54 crore in 1981-82—an eightfold rise in profit during a period when production rose by merely one-third, from 9.2 million tonnes to 13.1 million tonnes. What made this possible was the price of oil, which was raised from less than Rs 400 per tonne to Rs 1,180 per tonne. During 1982-83, when production from Bombay High began to soar, the profit rose to Rs 692.87 crore—a fivefold increase. During this year the administered price of crude was raised further to Rs 1,380 per tonne. Despite these figures however, auditors say, the future earning capacity of ONGC does not look too bright and could reflect on the efficiency of the organisation. Between 1983 and 1985 the percentage of ONGC's net income to equity registered a sharp decline. In other words—even as more and more resources were being added to ONGC (equity)—the company's earnings continued to decline.

Foreign rigs in Bombay High

Claim: Cutting down operational costs has helped ONGC save crores of rupees during the last few years.

Findings: Reports show rising costs. Meanwhile, between 1981 and '85, the ONGC cost of crude per tonne soared from about Rs 400 to Rs 877.32 per tonne (from Rs 57.51 to Rs 116.98 per barrel), and the cost of drilling doubled during this period from Rs 4,505 per metre to Rs 8,982 per metre. Overall, the operating costs of ONGC also about doubled between 1983-85 from Rs 634.93 crore to Rs 1,395 crore.

Claim: ONGC has been alive to the need of indigenisation not only to conserve scarce foreign exchange but also to achieve self-reliance.

Findings: The recent COPU report expressed "dismay" at the fact that despite ONGC's claims that its technology is comparable to that of foreign companies and that it has now reached the goal of self-reliance, the amount of foreign exchange being spent by it has been increasing. Foreign exchange expenditures on ONGC's activities increased from Rs 920 crore in 1982-83 to Rs 1,189 crore in 1984-85. According to the confidential minutes of an ONGC board meeting held on January 29, 1985, the commission approved the acquisition of 44 new rigs at a cost of Rs 956.41 crore. The foreign exchange component of these was estimated at Rs 514.36 crore.

Claim: Significant progress has been achieved in the sphere of indigenisation of our material inputs during the last few years. During 1983-85 about 54 per cent of the total purchase of capital equipment and stores made by ONGC was through indigenous sources. This indicates rapid growth of indigenous capability.

Findings: New developments indicate that ONGC may be moving away from the twin goals of self-sufficiency and self-reliance. For example, for the fourth time since the '70s, India has decided to invite "reputable companies" to explore in all the offshore basins, excluding Bombay, covering 27 blocks encompassing an area of 3.59 lakh sq km. The terms are the most liberal India has ever offered. Under the proposed contracts, foreign companies will explore offshore areas (including Krishna-Godavari) on a turn-key basis. ONGC, for all practical purposes, will do nothing more than monitor and share the production and charge royalties. This would spell a critically-diminishing ONGC role in exploring, drilling, and producing oil from India's offshore facilities. But so far, despite ONGC's official claim that it "is now on the international map and a large number of companies world over are watching with interest the strategies adopted by ONGC," such efforts in the past have not attracted many bidders. During the first round 12 years ago, three contracts were signed, while there was only one in the second round. The third round, in the mid-80s, was cancelled because no bidder showed any interest.

Even Bombay Offshore—to be main-

HARI OM GULATI

Wahl presides over a full board

tained under the ONGC aegis—is for the main part a foreign operation in terms of rig supervision, technical expertise and equipment. In order to show that ONGC had taken a big step in the direction of indigenisation, the commission announced that it had started buying rigs and machinery—the main expenditure item in oil production—from Bharat Heavy Electricals Limited (BHEL), another Indian company. But, internal documents show, this was a shell game because the machines provided to ONGC by BHEL contain imported components as high as 77 per cent. According to Indian industrialists, the foreign components in parts they fabricate for ONGC operations is as high as 50 per cent. In 1985, the ONGC annual report noted that the commission had made "a real contribution to the Indian economy... through helping establish a sound base for the manufacture of drilling rigs, offshore supply vessels, cementing units and logging units.... This has created the right environment for the transfer of technology to Indian units." But the following year, the commission's own import substitution group announced that during the seventh plan, greater emphasis would be placed on the charterhire of many of these same items. In other words, these goods and services—mostly available from abroad—will, in the future, simply be leased. In fact, ONGC's charterhire plans caused the director of the Department of Economic Affairs to remark caustically at a recent performance review meeting of ONGC: "India has of late become a residual market for charterhire of drilling rigs."

Claim: **Improving efficiency in drilling operations...have paid excellent dividends.**

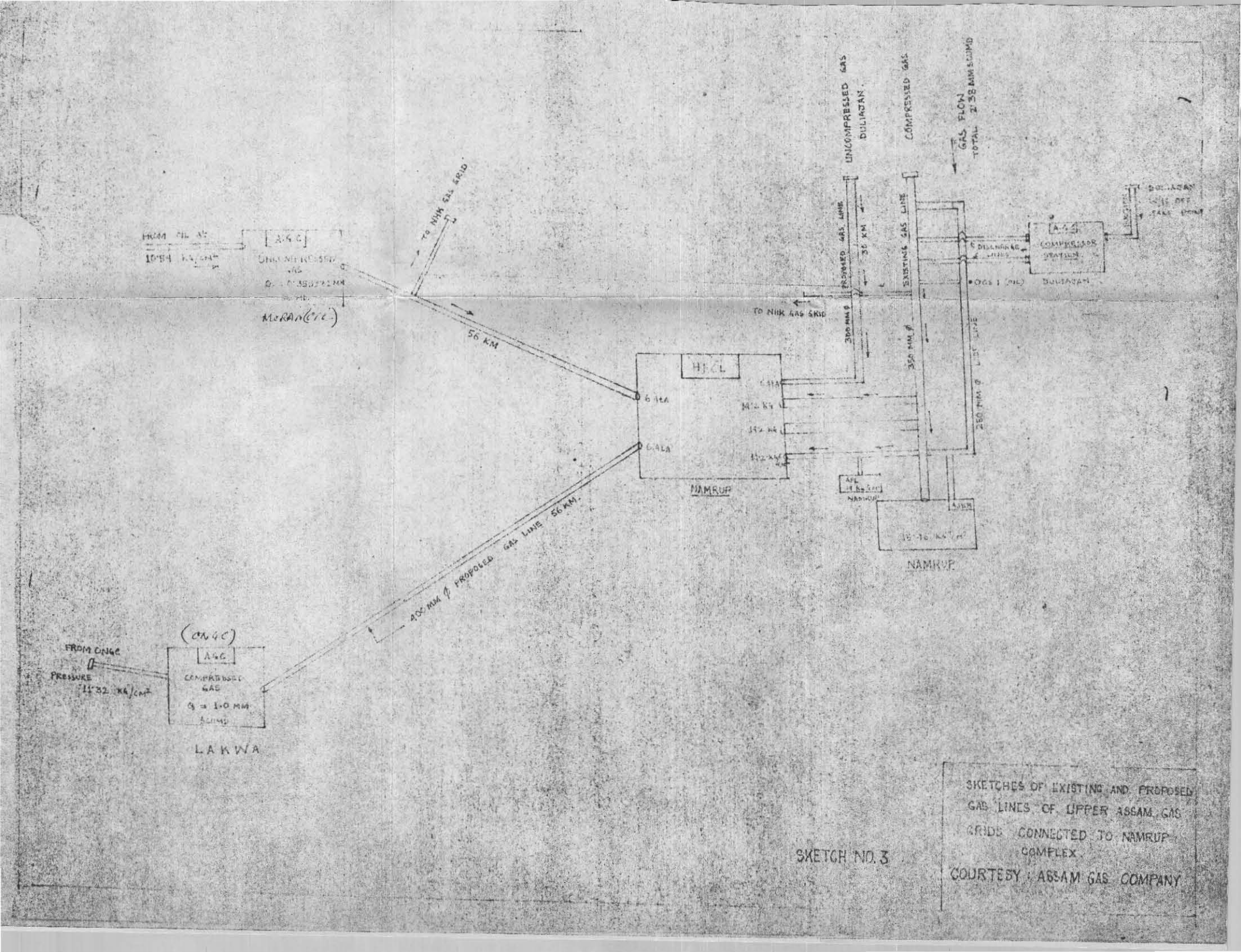
Findings: During the sixth plan, ONGC's drilling, both onland and offshore, fell short of its own targets. Onland ONGC drilled 20 per cent below target. The most serious short-fall was in the Assam field where ONGC, as against a target of 3,00,000 metres was able to drill only 1,91,230 metres. The minutes of a confidential performance review meeting held last year reveal that the petroleum secretary admonished ONGC officials over short-falls in drilling and refused to accept their excuse that the failure to meet targets was the result of non-availability of rigs.

Claim: **Drilling has been streamlined to achieve the maximum efficiency. Mobile rigs have been introduced which have increased cycle speed by 40 per cent.**

Findings: Despite ONGC's claims of improved "rig performance", the bare facts are that six out of eight rigs owned and managed by it and employed at the crucial Bombay High field performed miserably during 1985-86. The overall rig performance at Bombay High would have been disastrous had it not been for the much better performance of foreign rigs managed and operated by foreigners under charterhire. During that year Sagar Vikas burned down in a fire; Sagar Pragati was grounded in April 1985 and towed away to Dubai for repairs and is still out of commission; Sagar Jyoti was grounded in December 1985 because of damage to its legs; Sagar Ratna's legs were damaged in April 1985. It was recommissioned after the legs of another rig were cannibalised for repair purposes; Sagar Shakti, employed to drill a target of 12 wells could very disappointingly drill only eight; and Sagar Gaurav fell far short of required performance expectations. The only two drills which met their performance targets were Sagar Vijay and Sagar Samrat.

Claim: **The number of sick wells has been reduced...and the period of seismic parties (for exploration) has been increased. ONGC has achieved international standards of excellence.**

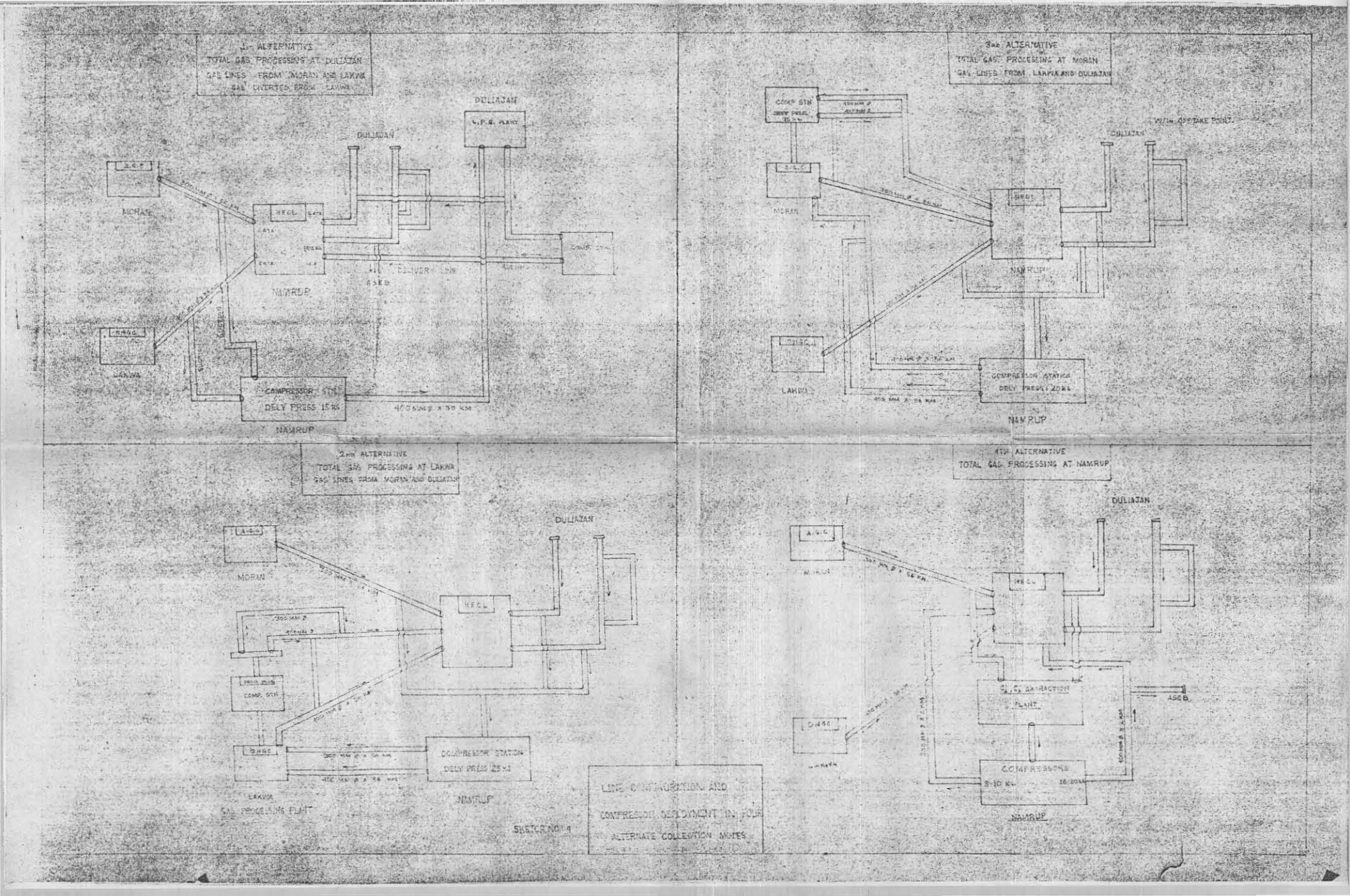
Findings: During a closed-door performance review meeting of the sixth plan, the petroleum minister said ONGC needed to make "substantial improvements" by speeding up seismic surveys, improving the technical audit of the quality of data collected, better interpretation of data and a more realistic determination of drilling programmes "based on vigorous analysis". He also noted that there were a large number of "sick wells" and the time being taken to repair these was "a matter of serious concern". And he also made it clear that in his opinion, the Oil and Natural Gas Commission had a long way to go in order to "attain international levels of excellence".

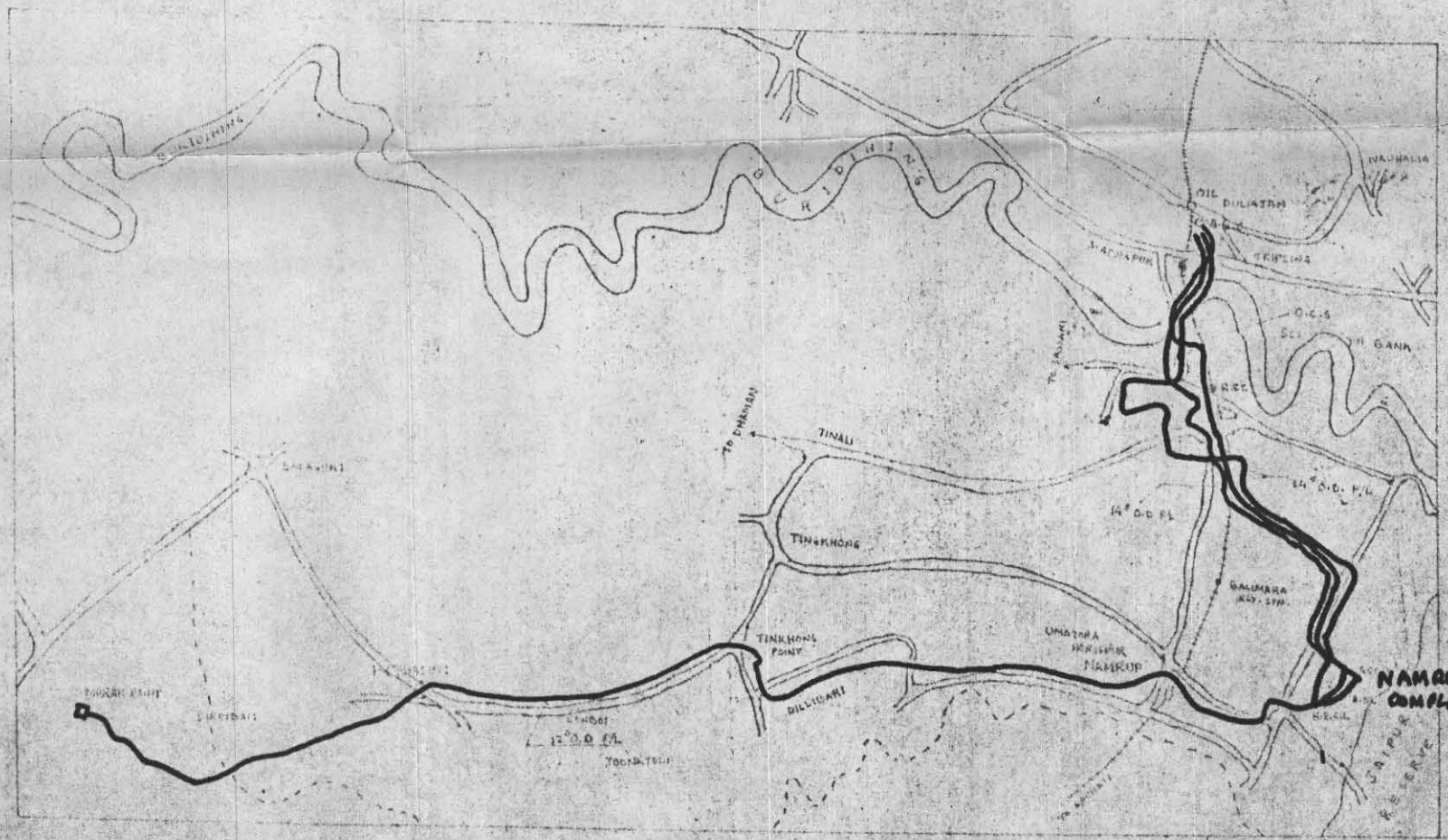


SKETCH NO. 3

SKETCHES OF EXISTING AND PROPOSED GAS LINES OF UPPER ASSAM GAS GRIDS CONNECTED TO NAMRUP COMPLEX.

COURTESY : ASSAM GAS COMPANY


1st ALTERNATIVE
TOTAL GAS PROCESSING AT DULIAJAN
GAS LINES FROM MORAN AND LAKWA
GAS DIVERTED FROM LAKWA
DULIAJAN
U.P.G. PLANT
DULIAJAN
MORAN
A.G.C.
HEGL
NAMRUP
ASEB
DELIVER LINE
LAKWA
COMPRESSOR STN
DELY PRESS 15 Kg
400MM Ø x 30 KM
NAMRUP
3rd ALTERNATIVE
TOTAL GAS PROCESSING AT MORAN
GAS LINES FROM LAKWA AND DULIAJAN
COMP STN
DELY PRESS
15 Kg
With OFFTAKE POINT
DULIAJAN
MORAN
A.G.C.
HEGL
NAMRUP
LAKWA
COMPRESSOR STATION
DELY PRESS 20 Kg
NAMRUP
2nd ALTERNATIVE
TOTAL GAS PROCESSING AT LAKWA
GAS LINES FROM MORAN AND DULIAJAN
DULIAJAN
A.G.C.
MORAN
HEGL
COMP. STN
LAKWA
GAS PROCESSING PLANT
COMPRESSOR STATION
DELY PRESS 25 Kg
NAMRUP
4TH ALTERNATIVE
TOTAL GAS PROCESSING AT NAMRUP
DULIAJAN
A.G.C.
MORAN
HEGL
GAS SATURATION
PLANT
ASEB
COMPRESSORS
8-10 Kg
16-20 Kg
NAMRUP
LINE OF INTRODUCTION AND
COMPRESSOR DEPLOYMENT IN FOUR
ALTERNATE COLLECTION MODES
SKETCH NO. 4



SKETCH NO 1

ASSAM GAS COMPANY LTD

DETAILED DRAWING OF GAS PIPE LINES

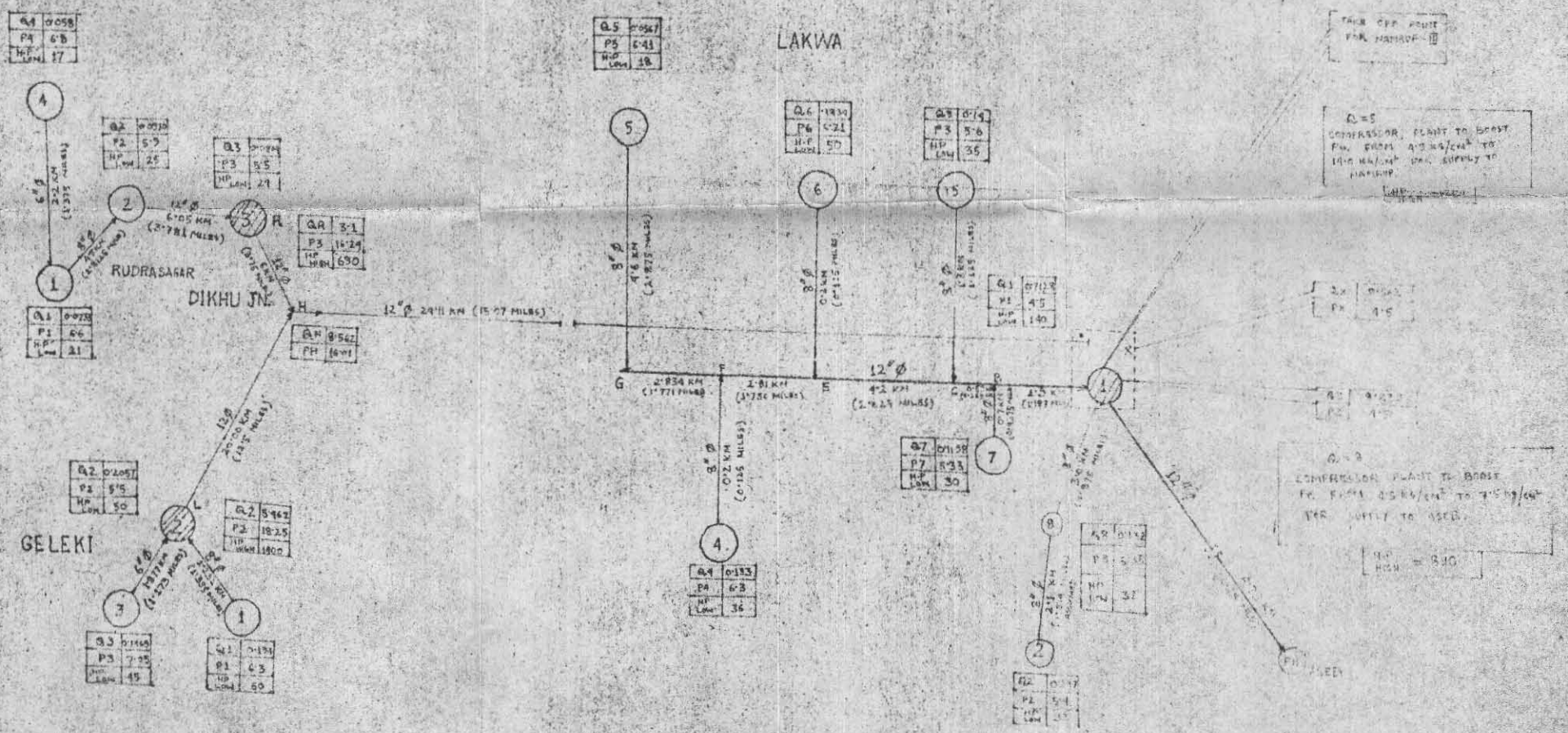
(EXISTING AND PROPOSED)

SCALE:- 1 INCH = 2 MILES

2 CM = 1·27 KM

1. EXISTING PIPE LINES ——

2. PROPOSED PIPE LINES



INTEGRATED GAS GRID SYSTEM

FOR

RUDRASAGAR - GELEKI - LAKWA (MODIFIED)

SKETCH-2