OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

08249

RESTRICTED

DP/ID/SER.A/165
30 May 1978
English

ASSISTANCE TO INDIAN PETROCHEMICALS CORPORATION LIMITED, BARODA

DP/IND/73/010

INDIA

Technical report: Operation of the olefin works at Baroda

Prepared for the Government of India by the
United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Heinz von Leibitz-Piwnicki,
expert in petrochemical plant operations

United Nations Industrial Development Organization
Vienna

id.78-2745

Explanatory notes

A comma (,) is used to distinguish thousands and millions.

References to "tons" are to metric tons, unless otherwise stated.

The following abbreviations are used in this report:

DNT	dinitrotoluene
IPCL	Indian Petrochemical Corporation Limited
LDPE	low density polyethylene
PBR	polybutadiene rubber
PE	polyethylene

ABSTRACT

At the request of the Government of India to the United Nations Development Programme (UNDP), an adviser in petrochemical plant operations was sent to Baroda to assist the Indian Petrochemical Corporation Limited (IPCL). The mission was part of the project "Assistance to Indian Petrochemical Corporation, Baroda" (DP/IND/73/010) of which the United Nations Industrial Development Organization (UNIDO) is the executing agency.

In his report the adviser suggests three possibilities for the operation of the olefin works, each with three variations. He points out that it is likely that the olefin works will run at the minimum load and with low severity cracking conditions for some time. On the basis of his findings his recommendations were:

To establish a production cell (production control centre)

To establish a management committee to co-ordinate production possibilities with market requirements

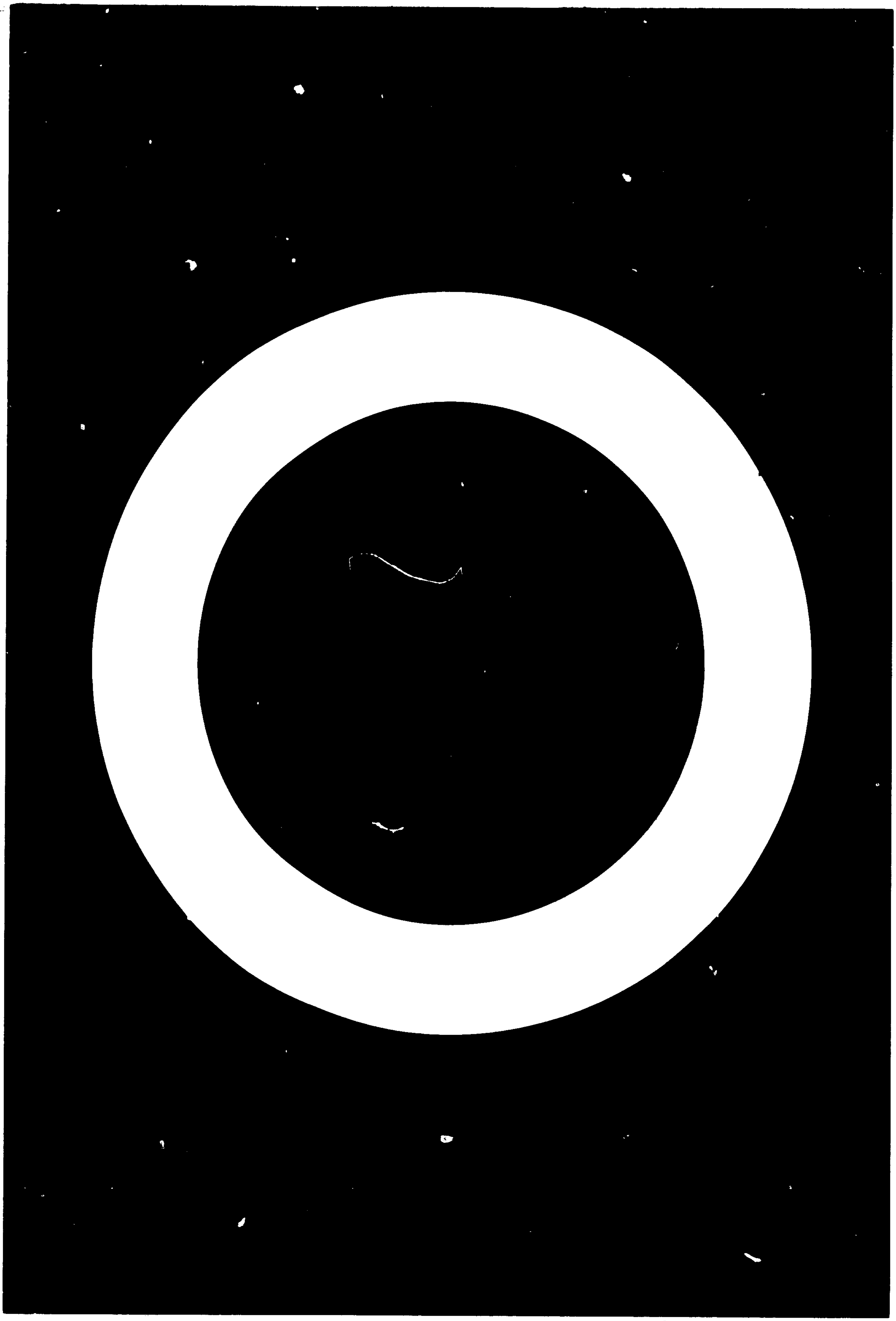
To give sole responsibility for the remaining construction work to the manager of project engineering

To speed up the realization of the PVC plant

To re-establish the laboratories and workshops of the Training Centre

To change the present system of maintenance services

To change the present system of promotions



CONTENTS

INTRODUCTION

The project "Assistance to Indian Petrochemical Corporation Limited, Baroda" (DP/IND/73/010), of which the United Nations Industrial Development Organization (UNIDO) is the executing agency was approved by the United Nations Development Programme (UNDP) in August 1974. Its objectives are to train and advise the technical personnel of the Indian Petrochemical Corporation Limited (IPCL) in operations, inspection and maintenance of petrochemical plants.

The IPCL is engaged in erecting and commissioning petrochemical plants at Baroda. Its main activities are as follows:

(a) Production of petrochemicals such as ortho- and paraxylene, DMT, olefins, thermoplastics, polybutadiene synthetic rubber and acrylonitrile;

(b) Marketing and distribution of products;

(c) Establishing a research and development programme.

The duties of the adviser in plant operations were to assist the IPCL on all aspects of the operations of petrochemical plants to ensure their efficient operation and identifying problems likely to be encountered (see annex I).

I. FINDINGS

At the time of consultant's arrival all the plants were in full construction and far away from commissioning. Commissioning dates had not yet been established. On the other hand the construction experts for the olefin works and the start up people were already present. The likelihood of the downstream plants going into operation during the consultant's appointment period was remote because of delays in the olefin works. Therefore the consultant concentrated his efforts on keeping in contact with the heads of the downstream production departments and emphasizing the importance ot time-limits for commissioning dates. The downstream plants are now ready for commissioning. The exceptions are the acrylic fiber plant and the acrylonitrile plant which can be commissioned only later this year.

It is recommended that for the remaining construction work, i.e. acrylic fiber plant, acrylonitrile plant, and the last two heaters of olefin works,a clearer distribution of responsibilities should be established. The whole responsibility for the construction work up to the moment of handing over the finished parts of the future plant to the Operations department for precommissioning should rest entirely with the manager of project engineering. He can make full use during the construction period of the future plants' maintenance people. The operations people will have a unique possibility of studying in situ their future plant and should prepare operation and emergency manuals for the operators.

Some chemico-technical problems that appeared during the construction period were dealt with in previous reports.

Special consideration should be given to the future running possibilities of the olefin works. Three running possibilities, each with three variations are given in annex II.

Case 1. Full load (131,600 tons of ethylene per annum)

(a) Design severity cracking (24.9 wt.% ethylene on naphtha)

(b) Low severity cracking (23.3 wt.% ethylene on naphtha)

(c) High severity cracking (28.2 wt.% ethylene on naphtha)

and the same three variations of idfferent cracking severities for:

Case 2. 76.3% of full load (101,800 tons of ethylene per annum which corresponds to polyethylene 80,000 tons per annum and ethylene glycol 20,000 tons per annum both running at full).

Case 3. 40% of full load (52,800 tons of ethylene per annum which is the minimum load for a smooth run).

It will take some years before the conditions specified in cases 1 and 2 will be reached. Therefore, it is most important that for the first period of operations the olefin works may run safely at its minimum load of 52,800 tons of ethylene per annum. That means running one polyethylene chain (40,000 tons per annum PE) at full consuming 42,000 tons of ethylene and 13,158 tons per annum ethylene glycol consuming 10,000 tons of ethylene. The remaining 800 tons of ethylene are purified purge-ethylene from the polyethylene plant and are returned to this plant. The proportions of the production could be changed, e.g. 20,000 tons per annum of ethylene glycol and 35,048 tons per annum of polyethylene. Any ethylene consumption under the limits given by these borderline cases means that the ethylene should be sent to the fuel-gas system.

The yields of propylene (polymer and chemical grade) and butadiene under minimum running load and mild cracking conditions are considered. Low yields of ethylene and benzene on naphtha and highest yields of propylene and butadiene are obtained. Unfortunately, these conditions result also in the highest yield of pyrolisis gasoline for which only naphtha raw material prices can be obtained.

The calculation of production of polymer and chemical grade propylene at the lowest possible load of olefin works is based on the full-load production.

In case 3, variation (b), a production of 15,200 tons per annum of propylene polymer grade can be expected. This would be enough for a production of 13,584 tons of polypropylene and 566 tons of atactic material. (Plant capacity at full load would be 30,000 tons per annum.) It is assumed that at the same time 16,892 tons per annum of chemical grade propylene will be obtained, which would be sufficient for a production of 12,153 tons per annum of acrylonitrile. (Plant capacity at full load wiuld be 24,000 tons per annum.) Also, 8,280 tons of butadiene will be obtained which would be sufficient for a production of 8,039 tons of polybutadiene rubber. (Plant capacity at full load would be 20,000 tons per annum.)

Any more severe cracking condition, with a given constant ethylene production, would result in less propylene and butadiene. Considering the examples given above, it is likely that the olefin works will run for some time at the minimum load and low severity cracking conditions. The high quantities of pyrolysis gasoline will have to be accepted. The quantity of butadiene necessary for full production of the polybutadiene rubber plant can be obtained only under mild cracking conditions even if the olefin works would be running at full-load. The production of benzene under mild cracking conditions will be probably sufficient for the production of linear alkylates and polybutadiene rubber. These figures are based on the composition of naphtha feedstock of the olefin works.

II. RECOMMENDATIONS

1. A production cell should be established. It should be on shift work and should have the following tasks:

> To inform the management about plant performance, availability of utilities and any occurences or incidents of importance which may happen. It will have to be established from which degree of importance onward anomalous situations have to be reported to the head of departments, operations manager or to the highest management. It is assumed that the plant managers will be informed directly from the plants about such events.
>
> To take decisions in certain situations, for example, in case of a reduction of availibility of utilities, which of the plants has to reduce its production volume or even to shut down, or which plant should receive less ethylene and propylene. Such decisions should be based on instructions given by the operations manager who sets the priorities

The tasks of the production cell will increase with more plants coming into operation. Time to get acquainted with the duties should be allowed to the production cell. At first only the minimum amount of information, carefully selected, should be transmitted to the cell thus avoiding the unnecessary notifications which could produce merely an overload. A telephone connection with various places of its contacts should be established and a car (jeep) with driver should be at its disposal for any urgent transport.

2. A management committee that will consider production possibilities, market requirements and economical factors, should be established..

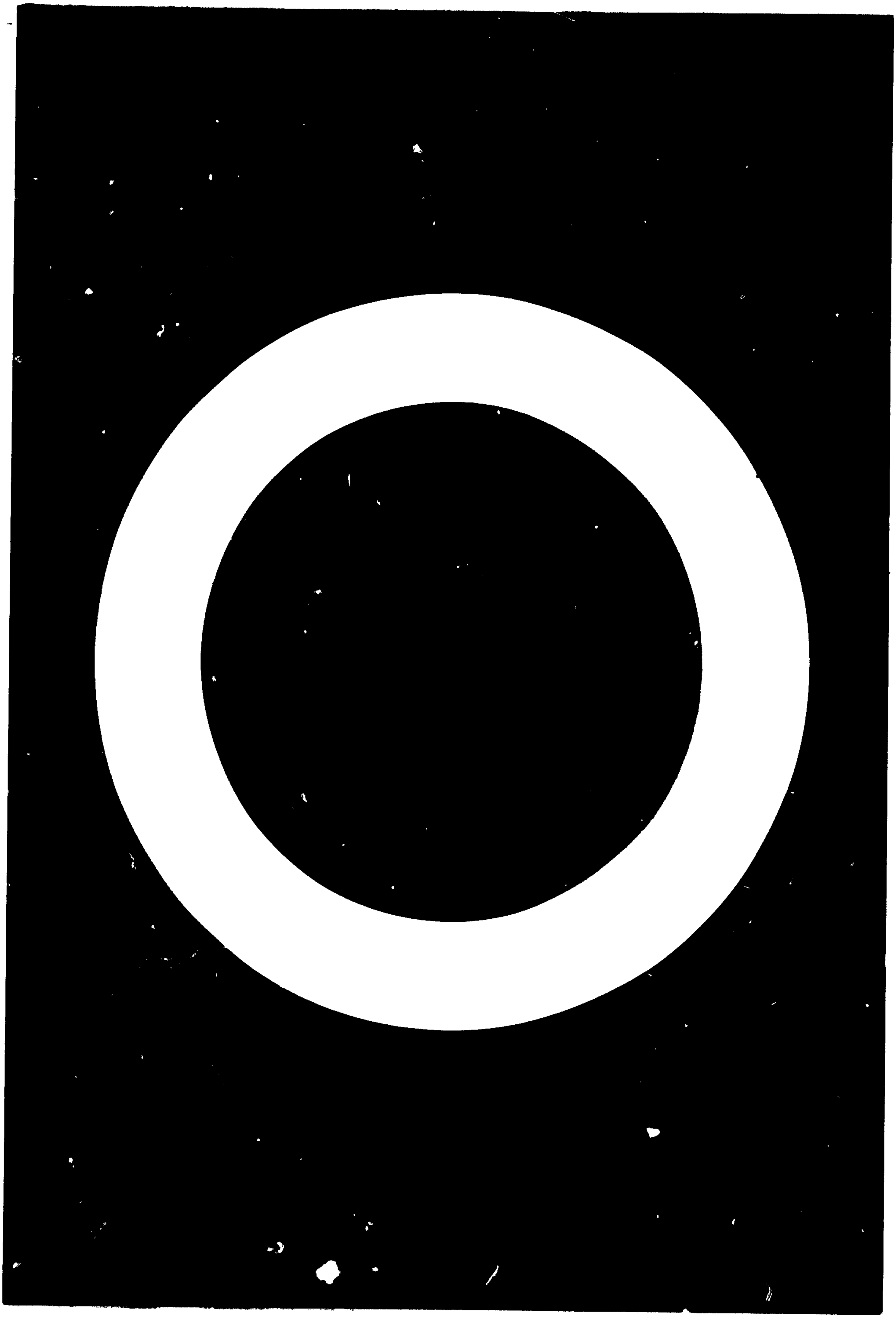
3. For the remaining projects the responsibility during the construction period should rest entirely with the manager of project engineering.

4. The polyvinylchloride project should be speeded up. The running conditions of the olefin works and especially of its main compressors will be made considerably less burdensome by a higher load.

5. The laboratories and workshops of the Training Centre should be re-established, if possible, in the building where they had been located before.

6. It is recommended that either the maintenance force of the Central Workshop be reinforced or the Central Workshop be allowed to make quick decisions about outside services without asking for tenders. In many cases the money that is believed to be saved is in no proportion to losses by stillstand of production waiting for the maintenance work to be done. This also applies to the precommissioning and commissioning. Similar considerations are valid for the purchasing of materials.

7. In promotions, the concept of seniority versus job suitability seems to favour too much seniority and should be changed. Too big an importance placed on seniority not only creates mediocrity but brings higher qualified people down to mediocrity or induces them to leave the company if an opportunity presents itself. The complexity of the IPCL works requires highly qualified people and does not let much margin to seniority.



Annex I

JOB DESCRIPTION

Post title:	Adviser on plant operations (olefins and associated units)
Duration:	One year
Date required:	April/May 1977
Duty station:	Baroda
Purpose of the project:	To advise the operation manager of Indian Petrochemicals Corporation Limited in the operation of petrochemical plants (olefins and associated units)

Duties: The expert will be expected to:

1. Assist the operation manager of the IPCL on all aspects of operation of petrochemical plants and units such as naphtha cracking plant, benzene butadiene extraction unit, pyrolysis gasoline unit, ethylene glycol unit, detergent alkylate unit, polypropylene and low density polyethylene plants;

2. Assist in forecasting operating and process problems likely to be encountered and in advance planning to ensure trouble-free and efficient operation of these plants.

Qualifications: Qualified chemical engineer with extensive experience in start-ups, shut-downs and operation of petrochemical plants and with long association at top supervisory level with the operation of naphtha cracking plant and/or other associated plants mentioned above. Experience and knowledge about:

- Low temperature operations
- Storage and handling of low boiling liquids
- Construction materials at diverse temperature and pressure services
- Safety in hydrocarbon processing and petrochemical industries
- Plant operations involving catalytic reaction of ethylene and oxygen near their flammability limits
- Operation of distillation columns which produce high-purity organic compounds
- Analysing the complicated instrumentation circuits and explaining them to the operation staff

- Plant operation involving high pressure polymerization with tubular processes
- Latest techniques for production of LDPE and polypropylene with Ziegler catalyst

Language: English

Background information: The Indian Petrochemicals Corporation Limited (IPCL) with its headquarters at Baroda is engaged in erecting and commissioning petrochemical plants at Baroda. Its main activities are as follows:

(a) Production of petrochemicals such as ortho- and paraxylene, olefins, thermoplastics, polybutadiene synthetic rubber and acrylonitrile. It will probably also undertake the manufacture of synthetic fibers in a phased manner;

(b) Marketing and distribution of products from plants under erection and commissioning;

(c) Establishing technical service (customer service) and also initiating a research and development programme designed to provide support to the production programme.

IPCL has already recruited (and will recruit many more) chemical, mechanical, electrical, instrument engineers, supervisors and artisans to operate the above named petrochemical plants. While IPCL expects to recruit personnel of appropriate education, it is essential that they are trained properly to operate plants of the type mentioned since actual in-plant experience in such plants available in the country is still rather limited.

Annex II

PRODUCTION PATTERN OF THE OLEFIN WORKS
(In tons per annum)

	Degree of cracking severity: At full load, Low b/	At full load, Design c/	At full load, High d/	At 76.3% of full load a/, Low b/	At 76.3% of full load a/, Design c/	At 76.3% of full load a/, High d/	At 40% of full load, Low b/	At 40% of full load, Design c/	At 40% of full load, High d/
Feed									
Naphtha	500 000	450 000	400 000	381 500	354 300	305 200	200 000	180 000	160 000
Purge-C_2H_4 from PE plant (to separation plant)	1 600	1 600	1 600	1 600	1 600	1 600	800	800	800
C_2H_4	131 600	131 600	131 600	101 800	101 800	101 800	52 800	52 800	52 800
H_2	6 620	6 880	7 300	5 051	5 249	5 570	2 648	2 752	2 920
For pyrolisis gasoline hydrogenation	2 435	1 936	1 600	1 858	1 477	1 221	974	774	640
Other purposes or fuel gas	4 185	4 994	5 700	3 193	3 772	4 349	1 674	1 978	2 280
Acid gas ($CO_2 \cdot H_2S$) (to sewage)	420	380	340	320	290	259	168	152	136
CH_4 (to fuel gas)	62 380	66 700	72 350	47 596	50 892	55 203	24 952	26 680	28 940
C_3	85 720	77 000	57 110	65 404	65 404	43 575	34 288	30 800	22 844
C_3H_6 Polymer grade	38 000	38 000	38 000	38 000	38 000	29 004	15 200	15 200	15 200
Chemical grade	42 230	33 240	13 930	23 215	23 009	10 619	16 892	13 296	5 572
Mixed C_3 (to fuel gas)	5 490	5 760	5 180	4 189	4 395	3 952	2 196	2 304	2 072
C_4	62 240	46 610	29 340	47 489	35 563	22 386	24 896	18 644	11 736
C_4H_6	20 700	18 100	14 500	15 794	13 810	11 064	8 280	7 240	5 800
C_4-raffinate (to fuel gas)	39 126	26 112	13 230	29 853	19 923	10 095	5 650	10 455	5 292
Vent-gas (to flare)	2 190	2 225	1 509	1 679	1 698	1 150	876	890	604
Recycled to gas separator (contains C_4H_6)	224	173	101	172	132	77	90	69	40
Pyrolysis gasoline	143 880	111 560	88 736	109 780	85 120	67 706	57 552	44 624	35 494
and H_2	2 435	1 936	1 600	1 858	1 477	1 221	974	774	640
C_6H_6	21 500	23 874	21 176	16 405	18 216	19 972	8 600	9 550	10 470
to PBR and linear alkylates	(12 450)	(12 450)	(12 450)	(12 450)	(12 450)	(12 450)	(12 450)	(12 450)	(12 450)
C_6-raffinate } to Gujarat refinery	18 550	12 350	6 200	14 154	9 423	4 731	7 420	4 940	2 480
C_7-cuts } to Gujarat refinery	61 570	44 224	35 824	46 977	33 743	27 334	24 628	17 690	14 330
C_5-cuts } to IPCL boilers	34 550	24 680	15 656	26 362	18 831	11 946	13 820	9 872	6 262
Heavy ends } to IPCL boilers	5 755	4 480	3 552	4 390	3 418	2 710	2 302	1 792	1 421
Vent-gas (to fuel gas)	4 390	3 888	2 928	3 350	2 967	2 234	1 756	1 555	1 171
Pyrolysis fuel oil (sold for production of carbon black)	9 450	11 500	15 400	7 210	8 775	11 750	3 780	4 600	6 160
C_2H_6 (recycled to cracker)	21 150	20 250	19 120	16 137	15 451	14 589	8 600	8 100	7 684

a/ Assuming polyethylene and ethylene glycol running at full (84,000 tons and 15,200 tons).
b/ At 22.3 wt.% C_2H_4 on naphtha.
c/ At 24.9 wt.% C_2H_4 on naphtha.
d/ At 28.2 wt.% C_2H_4 on naphtha.

G-12

79.11.14