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ASSISTANCE TO THE SYNTHETIC RESIN PLANT, CHITTAGONG

IS/BGD/74/001

BANGLADESH

TERMINAL REPORT

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

United Nations Industrial Development Organization

id. 76-8503

United Nations Development Programme

ASSISTANCE TO THE SYNTHETIC RESIN PLANT, CHITTAGONG
IS/BGD/74/001

BANGLADESH

Project findings and recommendations

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

Based on the work of Janusz Lozinski, thermosetting plastics technologist

United Nations Industrial Development Organization
Vienna, 1976

Explanatory notes

The monetary unit of Bangladesh is the taka. During the period covered by this report, the value of the taka in relation to the United States dollar ($) was $1 = taka 14.70.

A full stop (.) is used to indicate decimals.

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

In tables, a dash (-) indicates that the amount is nil or negligible.

A slash between dates (e.g. 1973/74) indicates a financial year.

References to tons are to metric tons.

The following abbreviated forms are used:

BFCPC	Bangladesh Fertilizer, Chemical and Pharmaceutical Corporation
BITAC	Bangladesh Industrial Technical Assistance Centre in Chittagong
ECI	Eastern Chemical Industries
M-F	melamine-formaldehyde
SRC	Synthetic Resin Complex
SRP	Synthetic Resin Products
U-F	urea-formaldehyde

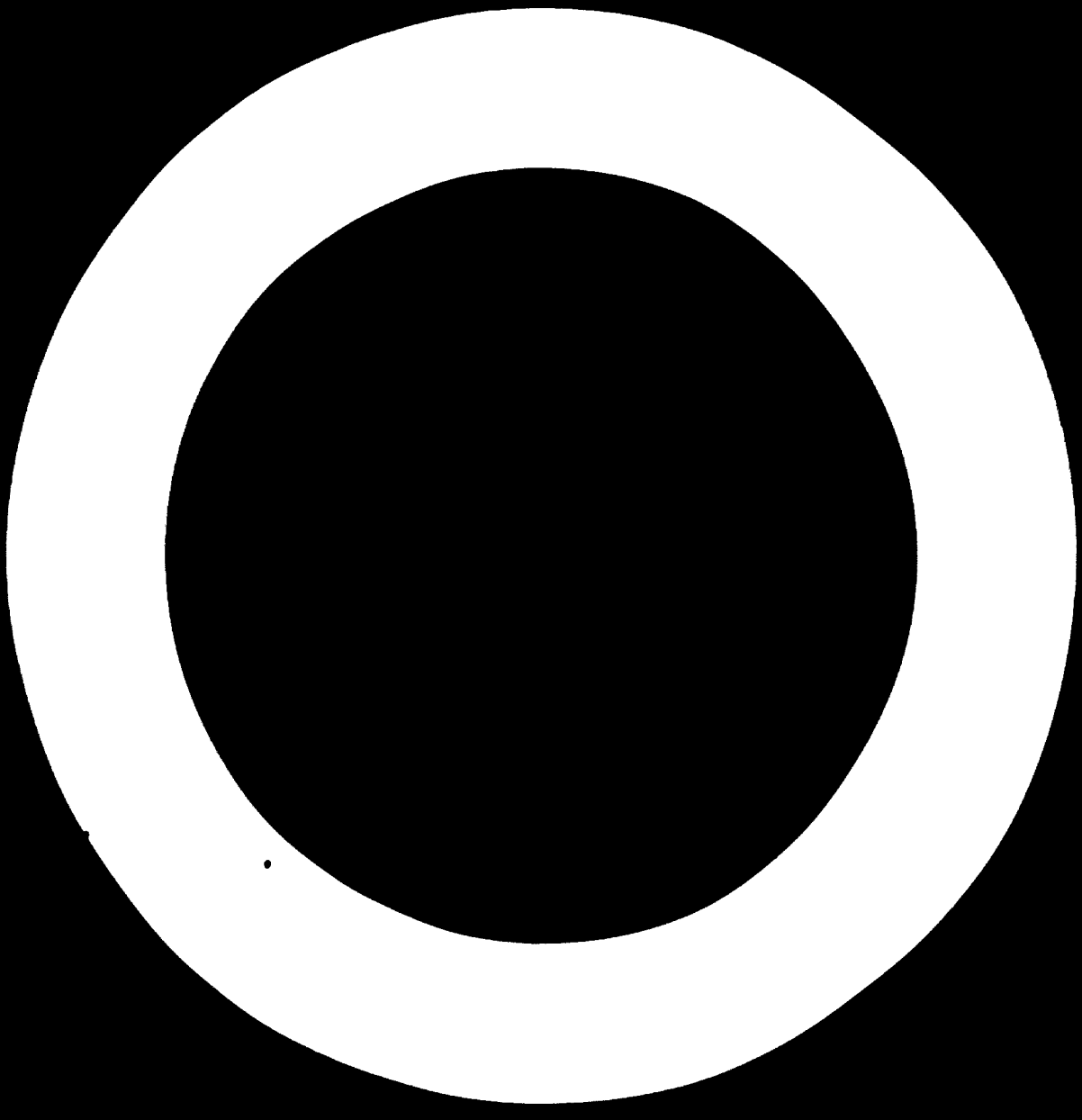
ABSTRACT

The Synthetic Resin Complex (SRC), Chittagong, comprises two facilities: Unit 1 at Rangunia, Chittagong, and Unit 2 at Fouzderhat. In 1974, expert services to investigate an imbalance in the capacities of the production sections of these units were requested from the United Nations Development Programme (UNDP). As executing agency for UNDP project IS/BGD/74/001, "Assistance to the Synthetic Resin Plant, Chittagong", the United Nations Industrial Development Organization (UNIDO) sent an expert on thermosetting resins to consider the problem for six months, starting September 1975. This assignment was extended to June 1976. The project was financed by UNDP with appropriations that totalled $53,685.

It was found that it was necessary to change the production of tableware in Unit 1 to that of technical articles such as jute mill bobbins and electrical parts. Investigation determined the equipment needed to manufacture liquid urea-formaldehyde (U-F) glue, and much assistance was provided in starting up a spray drier to produce glue in powder form. Production of this material was begun, and the operating personnel were trained.

It was determined that Unit 2 could produce, in addition to urea adhesives, urea painting resins, alkyd, phenolic and polyester resins. Market analysis showed that it would be economic to begin production of U-F painting resins and alkyd resins, which would consume the present surplus of formalin produced by Unit 1.

Proposals for further investment were formulated, and a training course for the technical staff was conducted to introduce modern technology, testing and quality control methods. Two persons of management calibre were granted fellowships for study abroad.



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INTRODUCTION

Between 1968 and 1973, Eastern Chemical Industries (ECI) at Rangunia, Chittagong, manufactured formalin and urea-formaldehyde (U-F), melamine-formaldehyde (M-F) glues and moulding compounds.

In 1973 ECI was merged with Synthetic Resin Products (SRP), a company that produced U-F liquid glue. The new company is named Synthetic Resin Complex (SRC) and is controlled by the Bangladesh Fertilizer, Chemical and Pharmaceutical Corporation (BFCPC). What were previously called ECI and SRP are now Unit 1 and Unit 2, respectively, of SRC.

In 1974, when expert services were requested from the United Nations Development Programme (UNDP), it was mainly to investigate and remedy the imbalance in the capacities of the various production sections of Unit 1 (the former ECI). In the meantime, the Synthetic Resin Complex was formed, and it was therefore necessary, in addition, to study and advise on the problem of merging the two units: Unit 1, at Rangunia, which was completed in 1967, and Unit 2, at Fouzderhat, which had not yet been completed. As executing agency for the UNDP project IS/BGD/74/001, "Assistance to the Synthetic Resin Plant, Chittagong", the United Nations Industrial Development Organization (UNIDO) assigned an expert on thermosetting resins to the problem for six months starting September 1975. The assignment was later extended to June 1976. The project was financed by appropriations from UNDP with appropriations that totalled $53,685.

I. FINDINGS

Unit 1, Rangunia

The problem of Unit 1 was relatively straightforward. Owing to a variety of causes, an imbalance in the capacities of the various production sections had been created, as described below:

The section for producing formaldehyde from methanol had a large capacity (4,800 tons/year). It was intended not only to meet the formaldehyde requirements for glues and moulding compounds but to have a surplus (about 2,800 tons/year) for sale.

The section for producing U-F and M-F moulding powders had a total capacity of 1,200 tons/year. However, at the time it was producing only 120 tons/year of U-F and M-F moulding powders. The reason was that the market for these products had shrunk considerably with the separation of Bangladesh from Pakistan.

The compression moulding section, which had a maximum production capacity of 120 tons/year of finished articles, was very small, having been originally intended for only training and pilot-scale operation.

Although the resin production section had a capacity of 1,200 tons/year of U-F liquid glue, it was producing only about 70 tons/year.

The capacities, actual production and sales values of the production sections of Unit 1 in 1973/74 and 1974/75 are shown in table 1.

Table 1. Rated capacity, actual production and sales value of the production sections of Unit 1, 1973/74 and 1974/75

Section	Capacity (1,000 tons)	1973/74 Production (1,000 tons)	1973/74 Sales value (1,000 taka)	1974/75 Production (1,000 tons)	1974/75 Sales value (1,000 taka)
Formalin	4.8	0.26	78.4	0.14	197.2
Urea-formaldehyde liquid glue	1.20	0.03	379.2	0.10	1,203.9
Urea-formaldehyde moulding powder	0.60	0.07	36.9	0.12	134.8
Melamine-formaldehyde moulding powder	0.60	0.05	0.36	0.0019	-
Finished articles	0.12	0.11	2,523.1	0.11	[illegible]1.4

Unit 2, Fouzderhat

Unit 2 had a modern reaction kettle to produce a maximum of 4,500 tons/year of urea-formaldehyde liquid glue. However, it was working at about 1.5 per cent of its capacity, that is, about 70 tons of glue per year. It also had a modern spray drier that could produce a maximum of 1,635 tons/year of glue in powder form.

II. MAIN ACTIVITIES OF THE PROJECT

The main causes of the present imbalance in the capacities of the various production sections in Unit 1 and Unit 2 of the Synthetic Resin Complex in Chittagong were thoroughly analysed. Remedial measures have been formulated and are described in chapter III, Recommendations.

To improve the quality of moulded articles, a special oven has been designed for the convection pre-heating of the powder before moulding. This equipment will be constructed in the workshop of the Synthetic Resin Complex. Tender specifications have been prepared for equipment required for the corrective measures. Recommendations have been made to introduce modern methods of testing. The expert assisted in preparing tender specifications and placing orders for the following equipment, which should raise the quality of U-F and M-F moulded articles. These are:

Tensile strength testing machine
Hardness tester
Pendulum impact tester
Shape stability tester
Gel-time apparatus
Melting point apparatus

Orders for this equipment were placed with suppliers in the Federal Republic of Germany and in Italy.

Special moulds for use in testing the properties of different samples of moulding powder were designed and ordered to be made by the Bangladesh Industrial Technical Assistance Centre (BITAC) in Chittagong. Diagrams and tables needed for the manufacture of resins and compounds were prepared. The Rashig-Kraal method for flow measurement of compounds was introduced. A list of indispensible laboratory equipment was prepared and orders were placed by the manager.

A change in management procedures recommended by the expert led to increases in sales of moulding compounds and tableware by 50 per cent and 25 per cent, respectively. A market analysis was made on the basis of the present production as well as possible future production. Investigations revealed the need to change the product range of Unit 1 from tableware to technical articles such as bobbins for textile and jute mills, spare parts

for bobbins and for electric fans and electrical fittings such as holders and plugs. Unit 1 had been producing tableware exclusively, contrary to the general practice of plastics fabricators, who normally do not allow tableware more than a 25 per cent share of their product range, as the demand for it is limited.

Information obtained from jute mills indicated that they import several million bobbins yearly, and that a substantial amount of bobbin spare parts was manufactured from imported raw materials.

A bobbin of the type most generally used in Bangladesh was chosen, and the expert designed the mould so that the bobbin might be fabricated in Bangladesh from a urea-formaldehyde compound. The mould design was sent to various foreign mould manufacturers for quotations on the cost of supplying them. In addition, moulds were designed for the manufacture of bobbin spare parts. The designs were sent to BITAC, Chittagong, where the moulds would be made. Assuming an annual production of 500,000 each of bobbins, bobbin tops and bobbin bottoms, the expert estimated that 180 tons/year of U-F moulding compound would be consumed.

General Electric Company, Dacca, indicated that about 70,000 electric fans were being manufactured by various factories in Bangladesh. The expert found that, in the manufacture of these fans, many parts, which at present were being made at great expense from imported raw materials, could be made more cheaply with U-F compound. Examples of such parts are fan blades, regulator covers and base plates and starter covers. It was estimated that, for each fan, about 1.5 kg of parts could be made from U-F compounds. On this basis, about 100 tons/year of this material compound could be consumed. Furthermore, a total of about 50 tons/year of U-F compound were being imported by many small private factories that manufacture mainly electrical fittings. This was an obvious potential domestic market.

The expert prepared a complete technical inventory of equipment for the production of U-F liquid glue in Unit 2. The main reasons for the low yield of glue were found to be as follows:

> The use of steel drums for the transportation of formalin was found to disturb the polycondensation process through the release of iron ions from the drums into the formalin, resulting in a reduction of storage life of the glue made from it.

There was negligence in the use of proper production equipment; for example, proper measuring tanks were not used for measuring out formalin. The main formalin storage tank had not been used owing to severe leakage at its bottom. After careful examination, the scale of repair needed was determined.

To remedy these shortcomings, a temporary arrangement for the transportation of formalin was made. One of the two measuring tanks would be used for this purpose, though its capacity would be sufficient for only a single production batch. An unused truck could be repaired and used for formalin transportation. In order to achieve full production (continuous operation), the expert emphasized the need to provide a special 5.5 ton aluminium tank fixed on to the body of this truck. It should also be provided with a pump to transfer the formalin from it to the storage tank.

The expert found that the resin plant in Unit 2 was capable of manufacturing not only U-F adhesives, but also U-F painting resins, alkyd resins, polyester resins and phenolic resins. After analysis of the market potential it was found that it would be feasible to produce U-F and M-F painting resins, as well as alkyd resins. The market potential for these resins was estimated to be 1,000, 2,000 and 3,000 tons/year for 1976, 1977 and 1978 respectively.

The expert believed that it would be advantageous to venture into the production of alkyd resins, which are the major synthetic resins now used in surface coatings such as enamels for kitchen appliances, hospital equipment, refrigerators and automobile parts. Since these enamels are produced by the combination of alkylated urea and melamine resins with alkyd resins, the production of the latter would consume fair quantities of the former.

However, since urea resins are water soluble while alkyd resins are not, production in small batches of both types of resin in the same reaction vessel would involve frequent cleanings, which would be uneconomic. The expert therefore recommended the production of substantial quantities of one type of resin before switching over to the other resin type.

A production schedule for U-F glue in powder form, U-F painting resins and alkyd resins has been worked out. This product diversification would meet the demands of the market as well as solve the problem of utilizing the surplus formalin from Unit 1.

A formula for manufacturing U-F painting resins was worked out. Preparatory work should be started as soon as the necessary laboratory equipment has been delivered.

A great deal of assistance was given by the expert during the start-up of the spray-drier plant in Unit 2. This was difficult and time consuming largely because the air heater of the machine had serious defects owing to faulty installation and poor design. The result was that the air temperature could be raised only to 90°C instead of 160°C to 210°C required. The solution of this problem involved all of the work described below:

A device was constructed for the recovery of steam after circulation in the air heater. This device will permit considerable economies of water (up to 50 per cent)and fuel.

Assistance was given in the installation of the control panel and in its electrical wiring.

The connexions of the water feed line were modified and the diameter of the pipe changed.

Necessary adjustments were made to the glue tank and its connexions with the glue feed line.

The copper pipe lines, one for measuring pressure inside the chamber and the other for measuring steam pressure, were installed.

The atomizer was properly installed after its correct position had been determined.

The motor for the atomizer was re-positioned so that the inlet could be opened.

The position of the rotary pipe inside the chamber was adjusted to keep if from rubbing against the chamber walls.

The locks of the chamber door were placed correctly so as to allow the chamber door to be closed tightly.

The cooling fan of the atomizer was adjusted and a duct made for outside air supply.

The performance of all parts of the spray drier was tested and found to be satisfactory. The production of glue in powder form was begun and the operating personnel were trained.

A training programme for the technical staff was prepared and conducted. Its aim was to introduce modern process technology, testing and quality control methods. The course was designed for skilled technicians who were involved in process and product control. Tables and diagrams required for their routine work were prepared.

The expert assisted in the selection of candidates for training abroad under the fellowship component of the project. It was recommended that first the Production Superintendent of Unit 1 and later Assistant Chemist of Unit 1 should be sent abroad for training.

To update the technical knowledge of management personnel, the expert prepared a list of books and periodicals on aminoplastics for procurement.

Considerable assistance was given in applications engineering concerning the use of urea-formaldehyde moulding compound and glue produced by Synthetic Resin Complex.

Assistance was given to the Bangladesh Bakelite Industry, Chittagong, on the proper use of U-F moulding compound bought from the Synthetic Resin Complex for the manufacture of electrical fittings.

Assistance in the use of U-F glue bought from the Synthetic Resin Complex was given to a Bangladesh furniture producer.

III. RECOMMENDATIONS

Unit 1, Rangunia

The formalin plant

This section is now in very good condition, requiring only proper maintenance and periodic overhaul. Of its capacity of 4,800 tons/year, one half (2,400 tons/year) could be consumed within Unit 1: 1,200 tons/year in liquid glue, the other 1,200 for the production of M-F and U-F moulding compounds. The remaining 2,400 tons/year could be consumed in Unit 2: 1,358 tons/year for powdered glue, which would be produced in the spray-drier, and 1,042 tons/year for the production of urea painting resins.

The moulding powder section

All of the steps listed below must be taken to bring this section up to an acceptable level:

Acquire all of the missing spare parts

Recondition the pulp scooter

Overhaul the kneader

Overhaul and start-up all of the ball mills

Replace the rotating table and worn-out punches of the tableting machine

Start up the granulator so as to be able to supply granules when needed

Replace the obsolete method of flow testing now in use with the Rashig-Krual method

Check the properties of the compounds produced against the requirements of the customers. (In order of importance, these properties are composition, plasticity and curing time.)

The compression moulding section

Before much else can be done here, the needed spare parts must be acquired and the machine shop completed. When these things have been taken care of, 14 presses, with a total capacity of 834 tons, must be purchased, as follows:

1 150-ton unit

1 100-ton unit (or a new head for the existing press No. 12)

3 75-ton units

2 50-ton units

7 37-ton units

All existing presses that are inoperative, whether because they are out of order or are merely not being used, should be disposed of so as to unfreeze the capital invested in them and permit productive use of the space that they occupy.

The resin production section

The resin production section should be given regular periodic overhauls, and a system for the supply of spare parts should be developed so as to reduce the amount of plant down-time.

Miscellaneous

Two air compressors (capacity, 840 litres/minute, maximum pressure, 5.5 kg/cm^2) should be acquired. They would be used in the interoperational cleaning of the moulds.

A new set of moulds to implement the new product range should be acquired. The proper installation of these moulds and their projected annual output, on a three-shift basis, are presented in table 2. Convection pre-heating should be introduced, especially for moulded parts of higher strength, such as jute-mill bobbins and blades for electric fans. Product finishing should be limited to grinding, which should gradually be mechanized. The polishing of the articles should be abandoned.

Table 2. Projected set-up and productivity of the compression moulding section of Unit 1

Moulds for:	No. of cavities	Pieces per cycle	Press size (tons)	Pieces/ year
Jute-mill bobbins	6	6[a]	150	166,000[c]
Bobbin spare parts	4	4[b]	50	500,000[c]
Cover of starter, ceiling fan	3	3	75	144,000[d]
Blades, ceiling fan	2	2	300	300,000[c]
Cover of fan regulator	2	2	75	100,000[d]
Base plate, fan regulator	2	2	75	100,000[d]
Canopy cover, air fan	2	2	75	100,000[d]
Bottom cover ceiling fan	1	1	50	144,000[c]

a/ Three each, top and bottom.
b/ For General Electric Co., Dacca.
c/ Three shifts.
d/ One shift.

Unit 2, Fouzderhat

The spray-drier

A system for the transportation of formalin must be set up. There will be a demand for 11.4 tons/day of it. Of this, 7.2 tons will yield 5 tons of liquid U-F resin, which would be converted into 2.63 tons of powder per 11.5 hours; the remaining 4.2 tons of formalin would be consumed in the production of urea-formaldehyde varnish resins. It would be more economic to produce 10 tons of liquid resin from two batches, which after drying would yield 5.26 tons of powder per 23 hours. Full production on this basis should be reached by the end of 1977, but the following steps must be taken:

Provisionally, for the transportation of formalin, the truck must be repaired and a measure tank installed on it.

Repair work on the formalin storage tank must be completed.

A new aluminium tank with a capacity of 5.5 tons of formalin must be ordered and installed on the truck. This will be the basic transportation facility.

All raw materials for the production of urea-formaldehyde glue in powder form must be acquired. (A regular supply of methanol for Unit 1 is assumed.)

Diversification of production

As with the production of resins in Unit 1, the production potential of Unit 2 must be brought within the requirements of the market. As noted, there is a substantial domestic market for varnish resins, and there are possibilites for export as well. In addition, there appears to be a good market (about 1,000 tons/year) for alkyd resins. Consequently, it is suggested that the maximum production capacity of the plant for paint resins, while consuming the excess of formalin from Unit 1, could be attained as follows: maximum capacity of Unit 2, 4,569 tons/year, of which 1,366 tons/year would be used to produce U-F glue in powder form, 2,263 tons/year to produce U-F varnish resin, and 940 tons/year of alkyd resins. Introduction of this plan could begin in 1976, and maximum production should be attained by the end of 1978. The profitability of the powdered glue and varnish and alkyd resins should be very good.

To implement this plan, the following steps must be taken. Pilot laboratory investigations must be undertaken regarding urea-formaldehyde varnish resins and alkyd resins modified with vegetable oils such as soyabean and linseed. These resins should be comparable in quality to the alkyd resins D-1000 and D-1200 that are presently being imported. The next stage would be

to compound alkyd resins with urea-formaldehyde resins. A top-suspended centrifugal separator with a capacity of 1 ton/hour should be purchased and used to clean urea-formaldehyde resin. Test batches of formaldehyde varnish resins and alkyd resins should be manufactured and the quality investigated at a local paint plant.

Staffing requirements

Unit 2 is understaffed from both the administrative and the technical points of view. To begin, the following staff are needed: a middle-level mechanic, a laboratory assistant, a competent typist (with typewriter) and a clerk. At present, Unit 2 may be able to use the help of the electrical and mechanical engineers of Unit 1. However, before the spray-drying plant goes into full operation, the changes indicated below should be made:

Personnel	Present	Required
Chemical engineer	1	1
Production and maintenance workers	6 (2 temporary)	12
Administrative staff	12 (3 temporary)	21
Assistant administrative officer	1	1
TOTAL	20	35

It should be noted that the high number of administrative employees required includes a good number of security guards. It might well be more economic to eliminate the need for at least some of them by building a boundary wall for the Fouzderhat factory.

General

A constant supply of electricity must be ensured. In Unit 1 alone, not only do power failures cause monthly losses that average taka 50,000 but make it impossible to introduce pre-heating technology. After the start-up of full production in Unit 2, the elements of which are based primarily on electrical heating, power failures would be several times more costly.

The main administration of the Synthetic Resin Complex should be moved from Agrabad to Rangunia, in the factory site of Unit 1, and telephone communication with Unit 2 should be installed without delay. This shift would both lower costs and increase efficiency. Suitable new personnel should be recruited before the spray-drier goes on stream.

The quality of the products of Unit 1 depends primarily on the quality and durability of the moulds. Consequently, good, hard chrome-plating of the moulds is essential. To change the present unsatisfactory situation, better use should be made of the generally large technical capabilities of BITAC in Chittagong. This workshop is not presently well fitted for the production of moulds, but it would be if it were supplied with a die-sinking machine with a copying attachment and a universal copying milling machine. BITAC has modern electroplating plant but its staff is inadequate. It should be provided with basic laboratory apparatus to check not only chemical compositions but surface structure and finish. At least one engineer should be sent abroad for training in modern and improved plating techniques. This person could be recruited to fill the vacancy for a qualified chemical engineer that exists at BITAC.

Proposals for investment

The presses required for Unit 1 (total capacity, 834 tons) could be acquired in Japan for about taka 380,000 (approximately $25,850). The centrifugal separator would cost about taka 7,500 (approximately $510). Testing equipment to improve the quality of moulded articles has already been ordered, as noted in Chapter II.

Fellowships

Two fellowships study abroad have already been awarded (annex). Such opportunities should be granted to the Production Supervisor and the Assistant Chemist of Unit 1.

Annex

FELLOWSHIPS AWARDED

Name of fellow	M.E.H. Chowdhury	Mustafizur Rahman
Job title	Manager, Synthetio Resin Complex, Chittagong	Chemical Engineer, Unit 2, Fouzderhat
Purpose of training	To improve the quality of the finished produots of the Synthetic Resin Complex	Familiarizaton with methods of synthesis of new kinds of thermosetting resins
Title of oourse	Testing methods and quality control	The formulation, compounding and moulding of thermo-setting resins
Plaoe of study	Rubber and Plastics Researoh Association, Shawbury, England	Loughborough University of Technology, Loughborough, Leics., England
Dates	October 1976 to September 1977	October 1976 to September 1977

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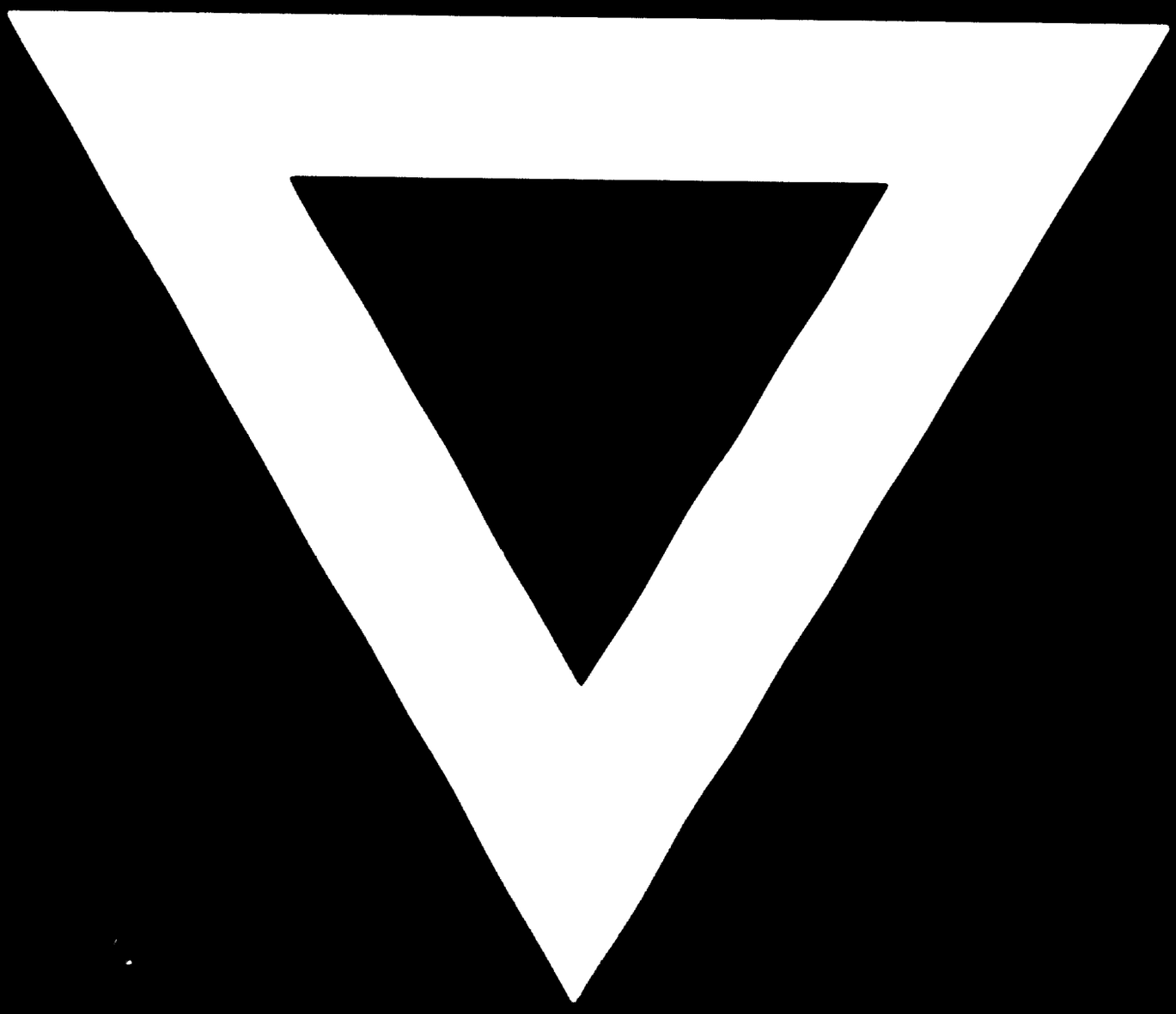

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