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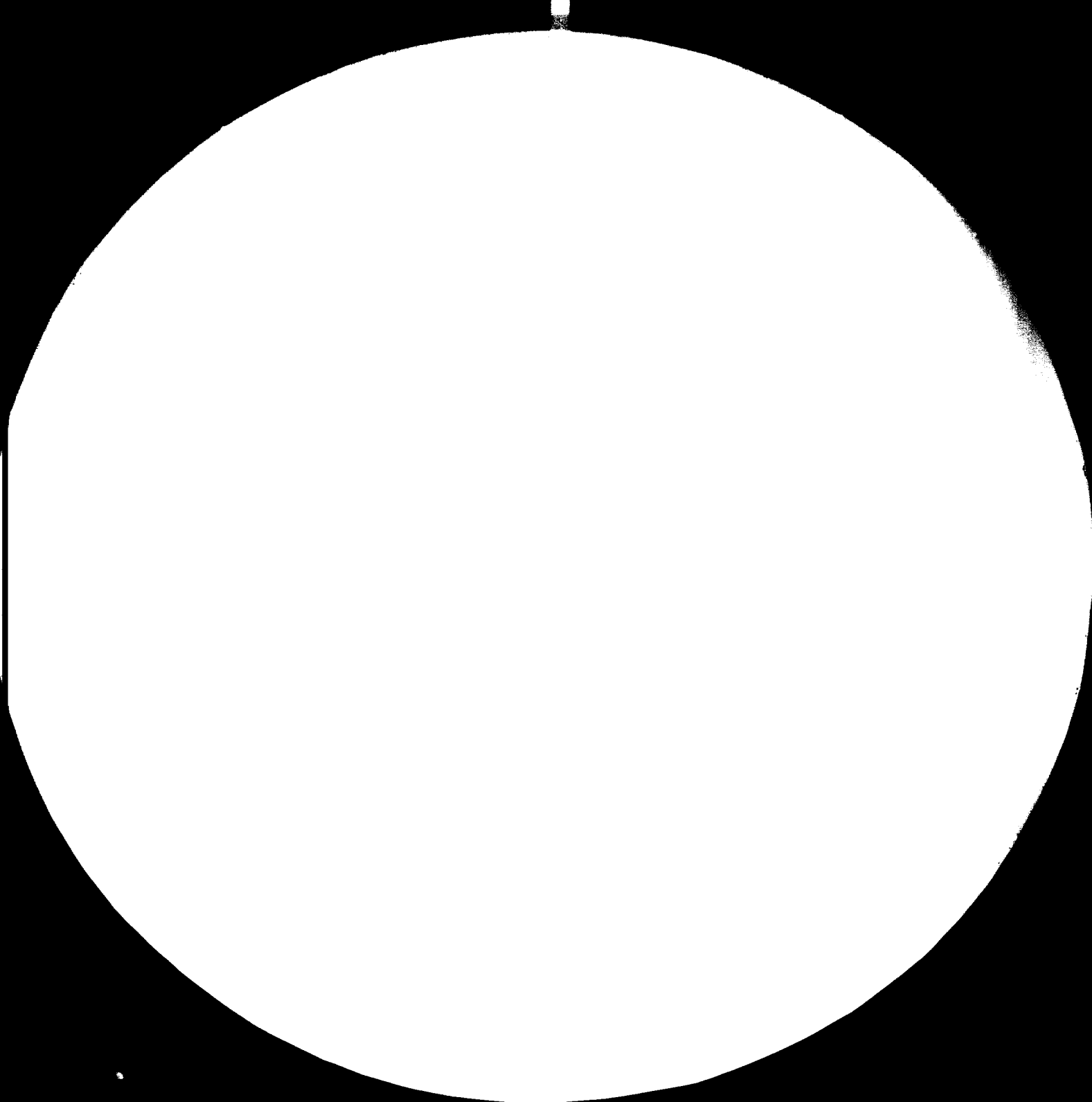
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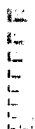
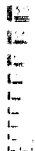
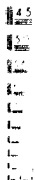
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MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS, 1963-A

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DP/ID/SER.B/214
15 August 1979
English

RESTRICTED

(R)

ASSISTANCE TO PETROBANGLA

DP/BGD/73/067

BANGLADESH

Terminal report

25 MAR 1980

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 B.V. Fenton, technical adviser

United Nations Industrial Development Organization
Vienna

id.79-6481

Explanatory notes

The monetary unit in Bangladesh is the taka (Tk). During the period covered by this report the mean value of the taka in relation to the United States dollar was \$US 1 = Tk 15.40.

References to tons (t) are to metric tons.

The following abbreviations have been used in this report:

ERL Eastern Refinery Ltd.
LPG liquefied petroleum gas
TEL tetraethyl lead

Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO).

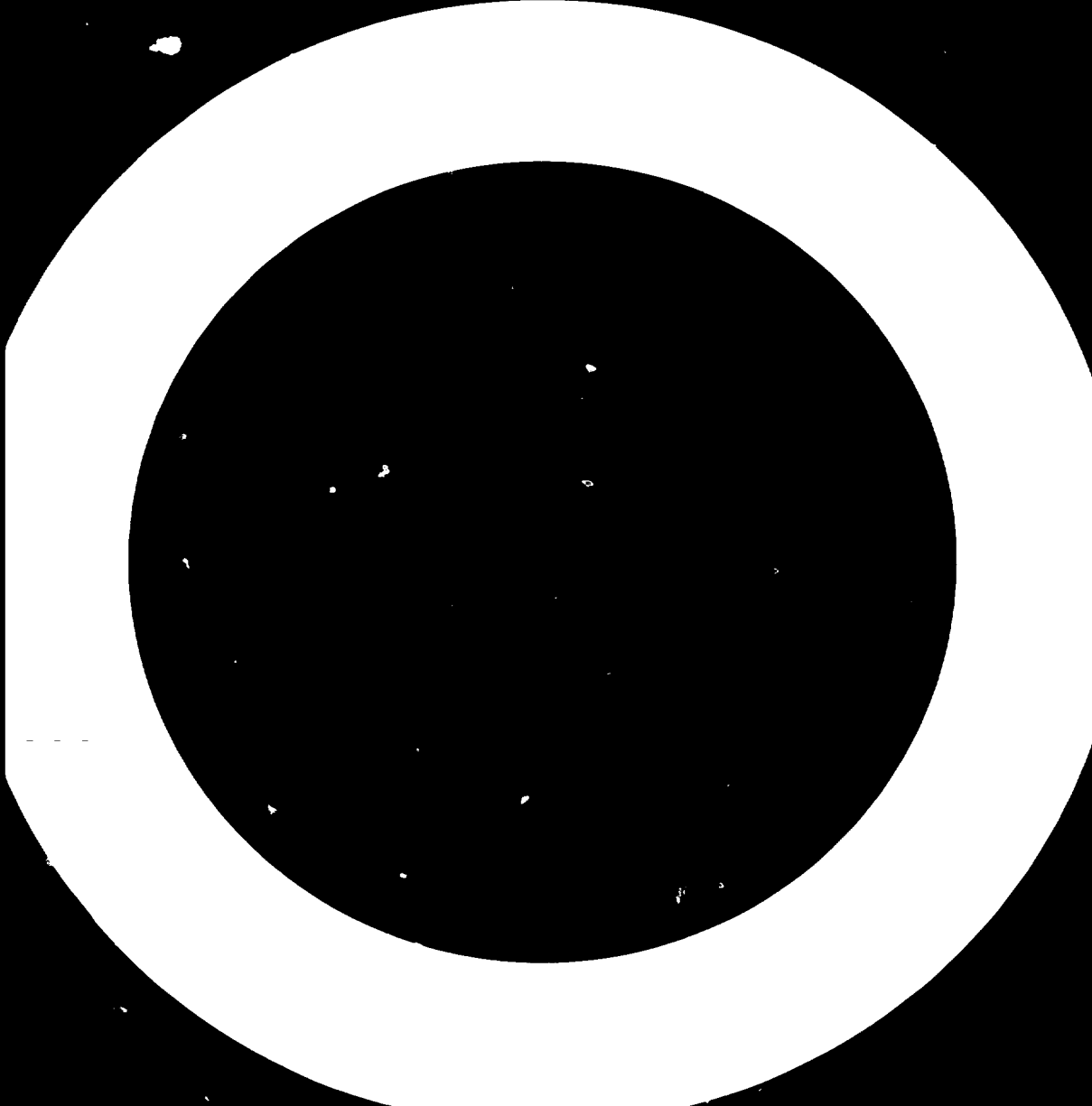
ABSTRACT

Following a request by the Government of Bangladesh to assist the Eastern Refinery Limited, Chittagong, in improving the efficiency of the refinery operations and management, the United Nations Development Programme (UNDP) approved in September 1975 the project "Assistance to Petrobangla" (DP/BGD/73/067) for which the United Nations Industrial Development Organization (UNIDO) was designated as executing agency.

The technical adviser started his assignment of two years on 30 October 1976. He found that the entire plant was in a very poor state of repair mainly due to lack of maintenance and heavy corrosion. Since its first operation in 1968 the plant had been shut down 35 times resulting in a utilization of only 50% of the rated capacity. At the time of the adviser's arrival only the distillation unit and the merox units were in operation. Under the supervision of the adviser the plant was completely overhauled and many machines and much equipment had to be replaced. The success of the work done is reflected by two facts: out of 324 days of possible operating time in 1978, the refinery was shut down only for 6 days, and at the same time a net profit was achieved which allowed the company for the first time to pay a dividend to share holders. The adviser further assisted in the design and implementation of new projects such as a bitumen plant, new crude-oil storage tanks, a new crude discharge line, an LPG treatment plant and a new boiler plant.

In his recommendations for a higher efficiency of the operations he emphasizes the need for day-to-day maintenance to reduce the shut-down time for the annual overhaul. A stock of all essential spare parts should be kept. He also recommends the introduction of closer supervision of the labour and the improvement of time keeping at all levels. Finally, the service of young engineers with theoretical background should be better utilized by allowing them to do more practical work in the plant.

Five fellows have been sent abroad for specialized training under the project and four further fellowships (for a total of 24 m/m) will be implemented in 1979 and 1980.



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INTRODUCTION

Project background

The Eastern Refinery Ltd. (ERL) went into production in May 1968. Prior to that, 12 engineers were sent to France for two years to gain experience. Of these 12, only two remained: Dr. Rahman, the present General Manager and Mr. S.T. Jamil, Planning Manager. The latter is at present in the United Kingdom on a fellowship and is due to return in August 1979. The company was nationalized in 1972 with the advent of the Republic of Bangladesh, and was denationalized in 1977. It is now run as a subsidiary of Bangladesh Petroleum Corporation who owns 70% of the shares. The remaining 30% are owned by the Burmah Oil Company.

ERL has had a number of managers, none of whom remained long. There has thus been a lack of continuity. War and civil commotion have both had bad effects resulting in loss of staff and labour.

Serious troubles with crude oil supply have resulted in long periods of shut-down and there have also been numerous breakdowns. In 1974, the services of an expatriate Technical Manager were obtained on contract from Creusot Loire of France and he remained until June 1976. This was extremely costly, being at a rate of \$US 117,000 for the first year and \$US 134,000 for the second plus a remarkable amount of fringe benefits. Judging by the overall condition of the units in November 1976, it cannot be said that this expenditure was profitable in any way.

Early in 1977, it was decided that, since the reforming unit would be shut down for some time, it should be inspected by outside experts. These experts were commissioned from the Institut française du petrole. Two inspectors arrived but one could only stay for one week. The other remained for a second week. Only part of the unit could be inspected in that time and instructions were given to ERL staff to complete the job. Previously expert assistance had been obtained from the suppliers (Foster Wheeler) to inspect the crude furnace, but when the work was done, no proper report was issued, and since then they have declined to assist further.

The units in the refinery were supplied and built as a turnkey project. Even so, the plant is somewhat less than could have been expected. For example, no spare pumps were installed with the unit, although three were sent out later to be installed by the refinery personnel. These were still in

the stores in 1977 and have only now been installed. The UNDP Bangladesh Energy Study published in 1976 criticizes the shortages severely under item 2.1.1 where it is said:

"In Bangladesh, where the timely supply of spare parts is a serious problem, any factory should be designed with double equipment for every basic component subject to frequent outrages such as pumps. The original design of the refinery was unsatisfactory from this point of view. A second basic deficiency is the poor instrumentation."

These are only two of the many criticisms which could be made. It could also be said that the design is somewhat unconventional and being all welded - in many places quite unnecessarily - it is most difficult to maintain. Much more thought should have been given to piping and plant layout.

Official arrangements

The UNIDO technical adviser arrived at Dacca on 29 October 1976. He was received by UNDP, Dacca and on 30 October was taken to meet various officials of Petrobangla and ERL. After meeting the UNDP Resident Representative on 1 November, he left for Chittagong on 2 November and was taken to his bungalow in the Burmah Eastern Compound. He then reported at the refinery and was introduced to various members of the staff. There was no single counterpart appointed and his subsequent dealings have been with all departments. At this stage, the acting Refinery Manager was Mr. Azim, General Manager of Burmah Eastern. On 17 November arrived the newly-appointed Refinery Manager, Dr. M.A. Rahman who had left the refinery in 1973 to pursue further studies in the United Kingdom for a Ph.D degree.

Running of the mission

From a first impression point of view, it was obvious that house keeping needed improvements. Many small leaks in valves, pumps etc. were observed, piles of rubbish lying around, partly dismantled plant and evidence of severe corrosion particularly in the water-cooling tower and power plant area. Paint work was poor and there was a general atmosphere of lack of day-to-day maintenance and clean up. Only the distillation unit and the merox units were in operation and the refinery was due to shut down in February 1977 for overhaul. For the next few weeks the adviser was largely concerned with technical discussions

principally with S.T. Jamil, Planning Manager and the Technical Services Department headed by Majid Rahimi. In addition, the first job was to find out the cause of the failure of the reforming unit early in October 1976. This unit, after having been shut down for 10 months, had only run from 23 July to 12 August. It was restarted on 13 August and shut on 15 October due to what was thought to be loss of catalyst activity and loss of hydrogen. From a study of the operating data prior to shut-down, the fault was diagnosed as a failure of the stabilizer heat exchangers and this diagnosis unfortunately was found to be correct. As there were no spares on stock a long delay in obtaining them was anticipated and in fact this delay was nearly 10 months. During that time no high-octane gasoline could be produced. The annual overhaul in February 1977 revealed a rather frightening picture and it was obvious that much plant and equipment would need replacement during the next two years. Much of this material was available on site and there was adequate staff and labour. Many recommendations with regard to improving maintenance and operation were made and accepted but in some cases their implementation took far too long.

The distillation unit was restarted on 5 March 1977. It was shut down on 13 July due to supply problems with crude oil and restarted on 24 July. In fact, a cargo of crude oil had arrived but as the lighter ships had no fenders, they were unable to load from the mother tanker due to monsoon conditions. This was the first operation of the Bangladesh Shipping Corporation which had taken over the supplying of crude. On 22 August the reformer unit restarted after replacement of the damaged exchanger bundles. Operation was very shaky at the start due to mechanical troubles. It was again shut down on 2 September because of compressor failure and leaks in piping due to corrosion. Restarted on 26 September, it ran until 3 October. On that day a tube in the pretreatment furnace ruptured. An explosion, followed by a fire, resulted. Fortunately, all the damage was contained in the heater, but all the tubes were ruined. No spares were available and, once again, the reformer plant remained closed while new tubes were obtained. This took 12 months. Finally, the distillation unit shut down on 22 December for its annual overhaul. This was a little early, but there was no crude left and, in any case, the planned quota had already been exceeded. Very much of the adviser's time during 1977 was consumed in assisting the Technical Services Department with various major projects i.e. the bitumen plant, new crude-oil storage tanks, new crude discharge line from tanker jetty, the LPG treatment plant, and the ~~new~~ boiler plant. These were

all finalized during the year. The annual overhaul lasted until 5 February 1978 when the distillation unit restarted. A large amount of work was done and, as a result, the plant was subsequently in a much better condition. The quantity of crude processed in March 1978 (114,300 tons) was a record. In April 1978, unionized labour went on strike. The plant was kept running, without difficulty, by the remaining staff. It was possible to provide three shifts of no less than 20 officers each for this purpose. Largely as a result of this, the strike collapsed on 11 April. Excellent work was done by the staff and it is a pity that they are not employed more on practical work. The LPG soda washing plant, designed by the adviser and Mr. Rahimi, went into operation early in June 1978. It operated successfully and, for the first time, LPG was available for the market. This very simple plant, adequate for the present needs, is an example of what can be done locally. Its cost was less than \$US 6,000, whereas a quotation for a complete and more sophisticated plant with an extra capacity of approximately 50% was \$US 117,000. The reformer unit was restarted on 4 October 1978 after repair of the damaged heater had been completed. It had been tried to start earlier but the stabilizer exchangers were found to be leaking. These were the "new" bundles. The tubes were found to be stainless steel instead of Cr/Mo alloy, and quite unsuitable for the purpose. Fortunately it was possible to replace them with tubes removed from a spare for another exchanger. The whole refinery then ran normally until it was shut down for annual overhaul on 25 December 1978. Out of a possible 324 days operating time, shut-down time was only 6 days which includes two days on circulation at the start of the strike. This means that it was 98% in operation which is an excellent result for any refinery. During this last overhaul the services of R.H. Deziel, inspection expert, UNIDO, were obtained for a period of three months. His report has already been accepted and processed.

I. FINDINGS

State of repair of the plant

At present ERL is a market refinery i.e. designed to process crude to products solely for a domestic market. It has a capacity of 1.5 million tons/year of crude. Various Middle East crudes have been processed and at present Murban, Light Iranian, and Saudi Arabian Light are being used.

The following is a short description of the units the plant consists of and their state of repair.

Pretreatment and reforming unit

This unit, which is used for the production of high-octane gasoline is now in continuous operation. Up to 1977, it had no less than 35 shut-downs and an equal number of restarts resulting in a total operation time of less than 50%.

Hydrodesulphurization unit for heating kerosine or diesel oil

This unit was shut down in 1973 and has not run since. No other reason has been given for its discontinued use but high losses, which seems rather unlikely, since this process only removes the amount of sulphur present in the feed, which is approximately 1%. The plant is most simple to run and is essential for obtaining products with a low sulphur content. It is now being overhauled with a view to restarting it after the next annual overhaul. Unfortunately, when it was shut down it was not cleaned out nor has any preventive maintenance been done since. As a result, considerable corrosion has taken place and some pipe work has to be replaced. Since this requires welding, nothing can be done until the refinery is being shut down. The total running time to date is 19,500 hours.

Merox units for sweetening gasoline and kerosine

These units are in regular operation and are reasonably trouble-free.

Steam boilers

The 2-3 t/h steam boilers are in an extremely precarious condition. A new 16-ton boiler is due to be shipped and cannot be put into service too soon. A decision will then have to be made as to whether it will be worthwhile to recondition the old boilers or whether to order a second new one.

Power plant

The power plant consists of four diesel-driven 1100 kW generators. The engines are made by Nordberg, the generators by Schneider. The plant has never been satisfactory. The output at constant load is only 700 kW per set and there was considerable trouble at the start-up. In 1976, set no. 3 failed and severe damage was caused to one cylinder (smashed casing, con rod and piston). This was repaired early in 1977 by refinery engineers but, shortly after, the crank shaft fractured. A spare was obtained from the makers and installed by one of their engineers. Since then it has been operable. The purchase of a new power plant is now being considered.

Tank farm

The total number of tanks is only 26 since products are pumped daily to the various marketing companies' tanks.

There are four floating-roof crude oil tanks of 25,000 m³ each, all in bad condition. This is due to the practice of pumping sea water after each lightering operation resulting in severe corrosion of the bottom plates.

One of these tanks which leaked badly, was cleaned out for inspection and repair in 1977. Numerous holes were found and severe general pitting. After the repairs, the leakage was worse than before and the tank has had to operate with a water bottom. The others are now in the same condition. Two new 50,000 m³ tanks are being built and, when available, the old tanks will be re-bottomed and generally overhauled.

Tetraethyl lead (TEL) blending plant

The TEL blending plant which is required for production of motor spirits operates satisfactorily.

Water treatment plant and cooling tower

The use of the water treating plant was discontinued many years ago for some unknown reason. Since it is situated in the very corrosive atmosphere of spray from the cooling tower and sulphur fumes from the power plant and has received no attention of any kind, it has completely rusted away and is merely scrap.

The water cooling tower is in poor shape and needs extensive repair. The air fans are also badly corroded. Some work has been done on these, but far too late.

It is thus seen that there has been insufficient maintenance in the first seven years of the plants life and this is only now being corrected.

Plant operation

Apart from the items covered under the preceding section many suggestions regarding plant operation have been adopted with improved results. However, closer attention to detail is necessary. This particularly applies to losses, which are avoidable. The most important of these is the amount of "off gas" burned at the flare, the chief source being low-pressure gas from the distillation unit. This loss can amount to over 24 tons/day.

In order to reduce this to a minimum it is essential that the overhead cooling equipment, i.e. the aerial condensor and water coolers, be in excellent condition.

The aerial condensers were not properly cleaned at the last overhaul in spite of most urgent requests to do so. This must always be a number one priority. The life of the condensers appears to be about four years and it is proposed to renew them next year. If there is inadequate cooling, the propane/butane does not remain in solution and is released to the flare. If cooling is adequate, the gases are recovered in usable form in the subsequent stabilizing unit either as LPG or as fuel gas. It must be remembered that with the high price of crude oil, on a throughput of 1.3 million tons/year, a loss of only 0.1% amounts to \$US 200,000, so that avoidable losses must be eliminated. The average loss for the period 1968-1976 was 5.17%. In 1977 it was 3.98% and in 1978 2.78%. Of these last two figures approximately 1% was consumed as fuel, so that the true loss is that much less. Even so, there is still room for

improvement but it means a closer watch on operation. Up to the end of June 1979, the total loss was 2.67% i.e. a true loss of about 1.67%. Product quality also needs more supervision to avoid off-specification products being made. There appears to be some rather peculiar ideas prevalent as to how the units operate. Some of these are fundamental and have been corrected wherever possible.

Operators tend to spend too much time in the control room and not enough outside on the units. As a result they tend to rely too much on instruments - which can give wrong readings. If they check the outside visible points, they can see if such things as levels, for example, are correct irrespective of the control room instruments.

The laboratory is an important check on operations and particular attention must be paid to test results, and operational changes should be made when necessary on receipt of tests. This department really operates only as a simple shift test laboratory. No research and development work is done, although there are chemists available. In fact they are rarely seen in the laboratory. The present chemist in charge is in the United Kingdom on a fellowship and it is hoped that on his return there will be an increase in activity and an improvement in the quality of testing.

There is a lot of excellent and modern apparatus but they are rarely being used or are out of order.

II. NEW EQUIPMENT AND INSTALLATIONS

The following projects are being carried out or have been completed.

A new 16" crude-oil discharge pipeline has been designed and installed between the oil tanker mooring (OM-5) and the refinery and is now in operation. The old pipeline (OM-4) is in poor condition as a result of pumping sea water and will have to be replaced as soon as possible.

A soda treating unit for LPG was designed and manufactured in the refinery. It is working satisfactorily and will be sufficient until the LPG sales off-take increases. There have been enquiries regarding the possible supply of propane and butane separately, but it is doubtful if the market is large enough to justify the installation of the special equipment necessary for the fractionation.

A new 16-ton fire tube boiler has been shipped and is most urgently awaited in view of the condition of the two existing 8-ton boilers. Once the new boiler is installed, a decision will have to be taken as to whether the old ones can be reconditioned or a further new boiler will have to be purchased.

Two new 50,000 m³ crude tanks are being installed. Work is much behind completion schedule due to difficulties with the contractors responsible for the foundations. Each foundation has 2,700 sand piles and has to be preloaded with 50,000 tons of sand until stable. The first foundation has stabilized and the preloading sand is being removed. Due to the monsoon rain, progress is rather slow. The second foundation is still being loaded. It is doubtful if the first tank will be ready before early 1980 which means over a year late. As the new tanks are available, all four of the existing tanks will have to be taken out of service and extensively repaired. Advice has been given as to how these tanks should be operated in the future, which is in direct opposition to the current practice. At all costs salt water pumping must cease, and the tank mixers must be operated to prevent settling of sludge. This sludge is nearly all wax and is therefore usable if retained in the crude.

Two new naphtha storage tanks for 17,500 tons each are to be built. The contract for these has been signed. They are required for the storage of excess naphtha which is exported.

A new bitumen plant is now being constructed for the production of up to 70,000 tons/year. All 13 tanks are complete and much of the civil engineering work (foundations, pipe supports etc.) has been done. The civil work is, however, being delayed due to the monsoon. Much of the plant and material has already arrived and work has started on pipe work prefabrication. In addition, a barrel-making plant and an automatic filling plant are also being constructed. It would seem that start-up should be about April 1980. As a result, there will be a big saving in foreign exchange which is now spent on importing bitumen. There will also be extra diesel oil which is much needed and a reduction in excess fuel oil which had to be exported at a loss. This plant should have been part of the original refinery.

A new power plant is proposed, probably consisting of a dual fuel gas turbine coupled to an alternator. There is plenty of natural gas in Bangladesh and it is proposed to bring this by a pipeline to Chittagong. It was supposed to be there by 1980, but it seems that 1985 is more likely. The existing four diesel-driven generator sets would then be overhauled and put on standby.

Several suggestions have been considered for increasing the amount of kerosine and diesel-oil production in the refinery. The sales pattern in Bangladesh is one of low gasoline and high middle distillate. Fuel oil and naphtha have been excess products and have had to be exported. At present, the only way to increase the middle distillate yield is by hydro-cracking and this at present is ruled out because of excessive capital cost. It is doubtful if such a unit could be operated here without considerable expatriate help for some years. Economically, it is probably preferable to import the deficient products as is being done now. There is a suggestion for the construction of a second refinery in Bangladesh by outsiders. This would be an export refinery and would not be in competition with ERL. It would supply the required product deficit and export everything else. Its location would possibly be some 70 miles south of Chittagong where there is adequate water depth for large crude tankers to berth, thus avoiding expensive lighterage.

The present cooling-water supply line in the refinery is beginning to fail due to internal corrosion. It is buried some 2 m underground which is quite unnecessary. Material for a new overhead system is on site and all pipe supports have been constructed. It is hoped that work will now start on the installation of the new line.

A crude desalter is being installed. Once in operation, this should eliminate corrosion due to the formation of hydrochloric acid and also remove any water entrained in the crude. This plant is long overdue. Most of it was on site early in 1976, but it still awaits the arrival of pipe fittings which have only recently been ordered. This is an example of quite unnecessary delay. The project should now be completed immediately. There can be no further excuse accepted.

The old crude discharge line from the jetty to the crude tank will have to be replaced due to corrosion. Work on this is proceeding.

A new medical centre, a canteen and a fire station are in process of construction and should be completed by the end of the year.

III. MANAGERIAL ASPECTS

Productivity

The work output by the daily labour is unacceptably low. The hours of work laid down in the labour contract are 0800-1200 and 1230-1700 i.e. $3\frac{1}{2}$ hours. The extra half hour is intended to cover morning and afternoon tea breaks. However, by the time the workers have arrived at 0800, changed their clothes and been allocated jobs, it is nearly 0900. At 0930 the morning tea break is taken which necessitates workers coming from their place of work to the workshop and then returning after the break. In all, this results in $\frac{3}{4}$ to 1 hour. At 1130 preparations are made for the lunch break at 1200. Officers lunch between 1300-1400. But no workman resumes work before 1400 either. Since the same is repeated in the afternoon session, the actual working day consists of only 4 hours and it is therefore not surprising that jobs take an inordinate length of time. It is surely possible to appoint reliable foremen or some of the junior engineers to ensure that a fair amount of work is done and that workmen are on the job for the requisite time. Not only the labour, but also the officers should improve time keeping. Too many are regularly late in arrival in the morning. Their services should be utilized more for on-the-job work. There are many young engineers full of theory but with little practical experience who seem to spend all their time in offices. It is not without significance that, when labour was on strike, sixty engineers were available to run the plant. At the end of the strike, most of them disappeared again.

There is no doubt about the capability of all personnel here. It may be of interest to record that up to 1942, all process personnel in the Burma refineries was recruited from Chittagong for many years and was found excellent in every way. The present staff needs firm and direct orders not requests or suggestions and whoever gives the order should follow it up to see that the work is done correctly and expeditiously. This means supervision at all stages.

Organization

It is possible that the refinery is too departmentalized and that some benefits would ensue if it were simplified. The inspection expert Mr. Deziel

who has completed a three-months mission under the same project, pointed this out in his report and the adviser agrees with his suggestions.

Stores

The present value of materials in the stores is \$US 2.6 million which is very high even for a refinery situated far from supply sources. There has been considerable overpurchase of some items and, in fact, some of these now in stock are unlikely ever to be used. Some items do not even have counterparts in the refinery. The stores are cluttered up with materials at present. It may be possible to sell off unwanted material and some could be disposed of to other industries such as fertilizer factories and chemical plants. Some effort should be made to reduce dead stocks. Great care should be taken to ensure that while the refinery is adequately covered for essential materials, all overordering should be avoided. Materials stored outside should be protected. At present pipes and plates lie on the ground and during the monsoon they are partly submerged. Raised storage racks should be constructed. With the departure of the bitumen plant erectors, much excellent covered space will become available and this could be utilized for dispersal of stores and relieve the congestion in the main building.

Fellowships

Originally, provision was made in the project for six fellowships for overseas study. Little progress was made in carrying out this plan due to difficulties in finding suitable refineries in which to place the fellows. Finally, the first two fellows were sent to the Gulf Refinery in Texas in May 1978 and they returned in November 1978. Three more fellows are at present with the Burmah Oil Refinery in the United Kingdom and are due back shortly. The project revision now includes provision for four fellows (24 m/m) to be sent for training each year until 1980. At the end of that period, there will thus be a useful number of men with outside experience. In addition, several of the present staff have been abroad on training courses to Algeria, France, Indonesia and Romania on scholarships provided by the host countries or at the refinery's expense so that there will be no shortage of trained staff.

General

It has now been shown, that this refinery can and will operate continuously at high capacity for long periods with minimal shut-downs. This has been achieved by extensive work during annual overhaul but will only be maintained with constant supervision, particularly day-to-day. If this advice is followed, there is no reason why the refinery should not operate satisfactorily for many years to come. Certainly the improvement in the past few years has been the result of the extra work. It is pleasant to record that, for the financial year 1977/78 the company was able to declare the first dividend ever of 10% and that this has been repeated for 1978/79. The following remarks are taken from the Chairman's statement in the annual report for 1977/1978:

"The net profit for the year under report amounted to Tk 13,462,000. Out of this profit Tk 4,850,000 has been appropriated as tax, Tk 5,000,000 for the first time has been proposed as a dividend at the rate of 10% on the paid-up capital. This is a great event since it is for the first time that the company has shown an overall profit.

"During the current year the refinery was closed for a brief period from 13 July 1977 to 24 July 1977 because of dislocation in the delivery of crude oil by the Bangladesh Shipping Corporation. Again on account of fire due to rupture of a tube, furnace F1201 was damaged and as a result the reforming unit was shut down. Production of HOBC was thus stopped. Repair work, although major in nature, has been successfully carried out. Leakage in the crude storage tank 'B' has also been repaired. In spite of these unforeseen difficulties the company, you will be pleased to know, processed 1,041,863 tons of crude oil during the year meeting 90% of the country's demand."

IV. RECOMMENDATIONS

1. Discipline should be tightened up and it should be ensured that everyone is fully occupied.
2. Orders should be given in a clear form, if necessary in writing and it should be ensured that they are being followed. Supervision should be increased at all stages; there is plenty of staff available for this.
3. Day-to-day maintenance should be improved and increased. Anything which needs doing and can be done, should be dealt with immediately.
4. All losses should be kept to the absolute minimum whether by operational control or improved maintenance.
5. The pumping of sea water during crude discharge should be stopped. It is estimated that the cost of re-bottoming the present crude tanks is approximately \$US 650,000 and this could have been avoided. In addition, the old crude line will have to be renewed again at considerable cost.
6. To produce better products, the hydro-desulphurizing plant should be put into operation as soon as possible.
7. A simplification of present departmentalized system should be considered.
8. Young engineers should be allowed to do more practical work. It is of little use to have knowledge if there is no opportunity to apply it.



