CHAPTER 5

SELECTION OF THE PLAN

CONCERNING MOST SUITABLE PRODUCT MIX

CHAPTER 5. SELECTION OF THE PLAN CONCERNING MOST SUITABLE PRODUCT MIX

5.1 Conditions for Selection of the Most Suitable Plan

The main reasons that KRC is suffering from the low production are:

One is caused by the deterioration of the equipments and the other is caused by the small demand of the final products.

At the beginning, the main market for this plant is stressed on West Pakistan. However after the independence of Bangladesh, they lost this market.

Because the demand of textiles in Bangladesh is mainly spinning yarn of staple fibre such as cotton due to its temperature, climate and social custom, the present demand of rayon filament and cellophane does not arrive at more than total 5 T/D despite KRC's strong sales promotion and effort for diversification of products.

For export market, because of considerable high cost of bamboo pulp production and other self-supply materials due to small production scale, rayon filament and cellophane are not competitive with the international market price. Accordingly for the present small export, KRC is totally disregarding "cost and profit" and shows red ink. Therefore KRC cannot continue its operation relying solely on export market.

On the other hand, Bangladesh imports large amount of cotton, rayon staple fiber and polynosic as mentioned in Chapter 1. Rayon staple fiber and polynosic are made from common materials with rayon filament and cellophane by way of basically same production process. Namely viscose production equipment, and chemical plants such as rayon pulp plant, caustic soda plant, sulphuric acid plant and carbon disulphide plant are convertible to the production of staple fiber by some addition and modification of machinery and equipment.

Further it is very advantageous that KRC can apply fully operation know-how and technique, which have been accumulated themselves according to the training and supervising by Japanese experts since commissioning, to this new project.

In conclusion the survey team have studied based on the assumption that all or most of the existing rayon filament and cellophane production plants should be replaced by staple fiber plant of viscose process.

5.2 Planning for the Most Suitable Product-Mix

Paying regard to the above-mentioned conditions, the survey team have planned and studied the following three kinds of product-mix.

1) Rayon staple fiber 20 T/D (mono-production)

KRC stops the production of rayon filament and cellophane and converts to the concentrated mono-production of rayon staple fiber utilizing the existing plant as much as possible.

2) Rayon filament and cellophane 5 T/D
Rayon staple fiber 15 T/D) total 20 T/D
(Parallel-production)

The existing capacity of rayon filament and cellophane of 15 T/D is to be reduced upto 5 T/D and by utilizing its balancing capacity a 15 T/D rayon staple fiber plant is installed.

3) Rayon filament and cellophane 5 T/D
Polynosic staple fiber 15 T/D) total 20 T/D
(Parallel production)

The same principle as 2) is to be applied to rayon filament and cellophane plant. A 15 T/D polynosic staple fiber plant is installed.

5.2.1 Comparison Study of Three Plans

Following are their outlines and characteristics:

1) Rayon staple fiber 20 T/D (mono-production)

Total replacement of rayon filament and cellophane plants by rayon staple fiber

plant. This plan meets the demand of rayon staple fiber in Bangladesh although it neglects the hitherto effort of KRC's sales promotion, which has some good results for marketing of rayon filament and cellophane.

As mentioned in Chapter 2 and 4 total production capacity of bamboo pulp is average 16 T/D. Considering the reactivity (marcelization, deplolymerization velocity, sulphurization, etc.) it is desirable to blend 30% of imported wood pulp. Therefore, 20 T/D production scale is suitable. Also the production capacity of chemical plants of caustic soda, sulphuric acid, carbon disulphide, etc. meet 20 T/D rayon production paying regard to the minimum investment as mentioned in Chapter 2.

On the other hand there is no problem regarding the capacity of utilities such as steam, electricity, water.

The merits of this plan are as follows:

a) KRC can manage with one line of viscose preparation plant and utilize some equipment of cellophane plant in aging process. Therefore regarding viscose preparation plant, minimum installment of new equipment suffices.

b) There is no problem of marketing 20 T/D staple fiber considering domestic demand. Further they can save the foreign exchange to be spent for import of staple fiber.

c) The production know-how of rayon filament is extremely similar to that of rayon staple fiber which enables smooth reshuffling of personnel to new plant and utilization of their accumulated technology.

On the contrary there are many demerits in this plan. Following are main ones:

a) KRC has developed and promoted by efforts the domestic market of rayon filament and cellophane since Bangladesh's independence and discontinuance of their production will cause temporary confusion in domestic market and also will cause import of rayon filament and cellophane.

b) It is very regrettable that KRC will lose the accumulated technology for rayon filament and cellophane production, and also will loose basic technology for synthetic filament and plastic film which may become useful in future.

c) KRC has bought many spare and maintenance parts using precious foreign exchanges in order to rehabilitate the existing plant partially, which will come to nothing.

d) The rayon staple fiber production requires less employees, larger than rayon filament production due to its continuous process. This will force some employees to lose works which is not only contrary to the employment policy of Bangladesh Government but also cause serious influence to the residents in Chandraghona as well as those of Chittagong Hill Tracts.

2) Rayon Filament and Cellopahne 5 T/D
Rayon Staple Fiber 15 T/D) total 20 T/D
(Parallel production)

This is a plan to produce 5 T/D of rayon filament and cellophane and, in addition, to produce another 15 T/D of rayon staple fiber utilizing surplus capacities of such plants and facilities as bamboo pulp plant, chemical plants, acid recovery facility. Thus, the production of 20 T/D in total is considered to be a limit as was mentioned.

The followings are merits of this plan:

a) This plan enables to continue stable production of rayon filament and cellophane (total 5 T/D) as it is. Accordingly this will not cause confusion in industrial circles of textile and packaging and enlargement of the market in the future can be expected.

b) There is no problem in marketing 15 T/D staple fiber considering the domestic market.

c) During the construction work of this new staple fiber plant KRC can continue the production of rayon filament and cellophane minimizing the loss of suspense of the production.

d) The production know-how of rayon filament is extremely similar to that of rayon staple fiber which enables smooth reshuffling of personnel to new plant and application of their accumulated technology.

e) KRC can keep the foundamental technology for making synthetic filament and plastic film.

f) KRC can maintain employment of labours now hired at KRC.

However the following demerits are pointed out:

a) Due to the difference in manufacturing conditions of viscose for rayon filament and rayon staple fiber, two separate lines are necessary after aging process for rayon filament (including cellophane) and rayon staple fiber respectively.

b) The viscose aging equipment for cellophane can not be converted and additional new equipments are necessary in viscose preparation process.

c) Due to the differences in circulation system of acid bath for spinning and in composition of acid recovery, two separate lines becomes necessary.

Then complete new installation of equipments for rayon staple fiber line is required.

d) The cost of equipments for rayon staple fiber plant does not differ much between production capacities of 20 T/D and 15 T/D. Therefore regarding total investment cost this plan is a little more costly than that of 20 T/D plant of mono-production of staple fiber.

2) Rayon Filament and Cellophane 5 T/D
Polynosic 15 T/D) total 20 T/D
(Parallel production)

Polynosic is an improved type of viscose rayon staple fiber and made from almost same materials as ordinary rayon staple fiber by changing some manufacturing conditions. Polynosic has remarkable merits in strength and characteristics in wet condition because of high polymerization and of fiber structure. Polynosic is similar to cotton and most suitable for blending with cotton or as substitute for cotton.

Each characteristics for rayon staple fiber, high wet moudlus and polynosic are compared in Fig. 5-1. It shows also stress and strain curve for the above four.

The followings are merits for this plan:

a) Same merits can be said for the parallel production of rayon filament and cellophane 5 T/D as mentioned in the second plan.

b) Because of its similar characteristic to cotton, polynosic production may enjoy higher added value and meet Bangladesh fiber demand more or less.

However following demerits can be found:

a) The exclusive process line for polynosic after spinning process, as is also necessary for ordinary rayon staple fiber, is required. However, due to its low productivity, equipment cost will be higher by 25 to 30% compared to that of ordinary staple fiber.

b) As the composition of viscose for polynosic is completely different from that of rayon filament and cellophane, absolutely separate line is required after slurry process including alkali line.

c) The viscose for polynosic should have high polymerization degree and high viscosity and then the capacity of manufacturing equipment comes down. Further, the additional cost will be required for the necessary accessories and piping.

d) Due to the scale-up of equipments, considerable expansion of building for viscose preparation process and processes after spinning, is required.

e) Polynosic has extremely limited allowance for optimum manufacturing condition therefore pulp with high reactivity is required as materials. However, bamboo pulp manufactured has following demerits in spite of its merit.

Merit: high content of α-cellulose

Demerit: There exist some defects due to craft pulp and characteristics of bamboo fiber especially in reactivity.

Therefore, for polynosic production, bamboo pulp should be blended with

high-quality soft wood pulp at higher ratio (may be bamboo pulp 30%, high quality soft wood pulp 70%).

Total consumption of bamboo pulp comes to as follows for this plan:

for rayon filament, cellophane:

5 T/D x 1.24 T/T x 0.7 = 4.34 T/D

for polynosic:

15 T/D x 1.1 T/T x 0.3 = 4.95 T/D

Total 9.29 T/D

This means that KDM is obliged to lessen the operation rate of bamboo rayon pulp production.

This is not only contrary to raison d'être of Karnaphuli Complex but also gives serious influence to the present bamboo project (growing, lumbering, collection) further affecting to such problems as employment and stabilization of national life.

f) Polynosic production induces following matters:

(1) over production of dilute caustic soda solution
(2) increasement of consumption of sulphuric acid
(3) decreasement of recovery of sodium sulphate
(4) cost up of raw materials
(5) Increase in production cost

g) High experienced technology for operation and process are required compared with rayon staple fiber and rayon filament production. Accordingly, special training should be given to the staffs and workers.

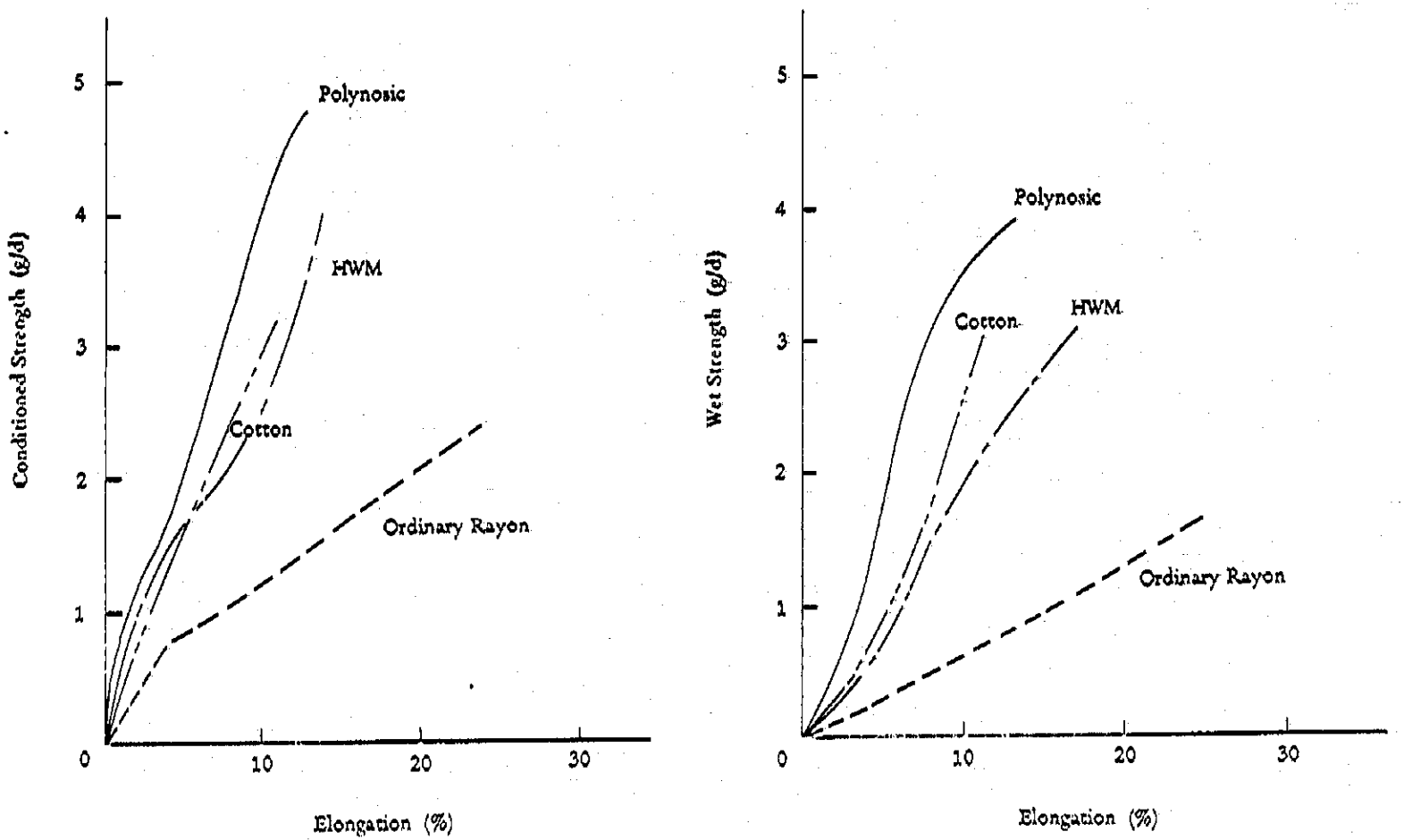
5.3 Conclusion

Comparison of three alternatives was made by mentioning merits and demerits. The first plan has the fatal demerit of increasing unemployment drastically which is contrary to

Table 5-1 Properties of Cellulosic Fibers

	Polynosic	HWM-A	Cotton	Ordinary Rayon
Denier, d	1.2	1.2	1.3	1.5
Dry strength, g/d	4.7	4.3	3.4	2.9
Wet strength, g/d	3.7	3.2	3.9	1.8
Dry elongation, %	11	14	8.0	18
Wet elongation, %	14	16	12.0	25
Dry knot strength, g/d	2.4	1.9	2.9	1.5
Wet modulus at 5% elongation, g/d	1.5	0.7	1.1	0.2
Wet elongation under 0.5 g/d load, %	2.1	3.5	3.1	10
After 5% NaOH treatment wet strength, g/d	3.4	2.3	3.6	1.0
Wet elongation under 0.5 g/d load, g/d	3.5	9.2	3.8	–
Degree of polymerization	500	380	2,100	300
Degree of orientation, % (X-ray method)	93	92	71	86
Degree of crystallinity, % (X-ray method)	48	45	70	35
Degree of dyeing, %	68	–	45	57
Moisture regain, %	12.5	13.5	7	13.5
Water retention, %	68	69	55	105

Fig. 5-1 Stress-Strain Curves of Various Cellulosic Fibers



CHAPTER 6

SCHEME OF INSTALLATIONS

CHAPTER 6. SCHEME OF INSTALLATIONS

6.1 Summary of the Scheme

Based on the following proposal recommended in the previous Chapter 5 "Selection of the Optimum Production Plan", summary of the scheme is described in this Chapter.

Proposal:

Total 20 T/D Production (Parallel production)	Rayon Filament & Cellophane	5 T/D
	Rayon Staple Fiber	15 T/D

6.1.1 Sorts of Products and Production Capacity

Among three sorts of products, rayon staple fiber, rayon filament and cellophane, major portion of the production will be occupied by rayon staple fiber. As rayon filament and cellophane will be produced only depended upon the limited domestic demand and unexpected requirement of export the quantity of production of both rayon filament and cellophane is planned to be 5 T/D at maximum.

Repair of rayon filament spinning machines is now proceeding under KRC's management. This repair might result in higher installed capacity than 5 T/D for rayon spinning. However, in this scheme, total maximum quantity of production of both rayon filament and cellophane is recommended to be 5 T/D as was written before, taking limitation of delivery capacity of the rayon pulp into consideration.

It is observed, however, that the machinery and equipment as listed in the feasibility study report may be capable of producing upto 22 T/D (i.e. 15 T/D of rayon staple fiber and 7 T/D of rayon filament/cellophane) with the technical skill and knowledge possessed by the KRC employees and sustained effort made by KRC.

6.1.2 Scope of BMR & E Works

Scope of BMR work in this scheme is as follows:

1) Viscose process facilities for rayon filament

2) Spinning process facilities for rayon filament (including acid circulation and recovery processes, and anhydrous sodium sulphate production process equipment). Rayon filament spinning machines themselves are excluded from the object because of the repair work having been proceeded by KRC independently.

3) Rayon pulp plant
All facilities for bamboo chip handling process before the cooking digester, for recausticizing process, and for soda recovery process are excluded from the object, because KPM is taking steps to execute repair work for these process facilities making use of Swedish funds.

4) Caustic soda and chlorine plant

5) Hydrochloric acid palnt

6) Carbon disulphide plant

7) Sulphuric acid palnt (Lurgi-contact process)

8) Chlorine dioxide plant

9) Water treatment plant (SR, SB clarifier system)

10) Service house (Refrigerator)

11) Building of the rayon filament plant

12) Building of the carbon disulphide plant

Among equipment, electrical devices, instruments, pipings and wiring materials, parts, miscellaneous materials, etc., which are included in the items from 1) to 12) above described, what the survey mission as well as relevant personnel of KRC and KPM considered necessary to be added will be covered by BM works.

But, such BM works applied mainly to viscose making process for rayon staple fiber production shall be assisted by field services of erection and operation supervisors sent from the contractor. Further, with regard to expansion and modification of the buildings of the rayon filament plant and the carbon disulphide plant, basic drawings shall be supplied.

Objects of expansion work in this scheme are as follows:

1) Spinning and finishing process facilities for rayon staple fiber (excluding acid circula-

tion and recovery process equipment).

Since some parts in the existing acid circulation and recovery section are to be converted into facilities for rayon staple fiber production or to be utilized in common as filament and staple fiber production facilities, provision, modification and installation of machinery and equipment for the acid bath system are regarded as BM works.

As for facilities for spinning and finishing processes for rayon staple fiber, technical documentation, erection supervision, operation supervision and training of KRC's personnel are within the scope.

6.2 BMR Plan of the Existing Facilities

6.2.1 Scope of BMR Works

With regard to viscose processing facilities for the rayon filament and cellophane plants, repairs and replacement are restricted to specific items of equipment, since those facilities have been a little corroded or damaged, as a whole. However, considerable modifications are necessary for viscose processing equipment, as some of these existing equipment are to be converted to facilities for rayon staple fiber production in the expansion scheme.

That is to say, there are two categories in machinery and equipment for viscose making process for rayon staple fiber production. The first category is applied to such existing machinery and equipment as the slurry steeping and shredding system, the alkali cellulose measuring equipment, the xanthator, the dissolver and the deaerator, which are partially modified to be utilized for rayon staple fiber production. The second category is applied to additional equipment and machinery such as the continuous ageing machine, the alkalicellulose transport system, ripening tanks, the automatic filtration unit, the refrigerator, electrical appliances and instruments. Since these two kinds of machinery and equipment are closely and mutually related in aspects of specification and arrangement, such procedures as provision, modification and installation of machinery and equipment for viscose making process, are regarded as BM works.

Concerning spinning process facilities for rayon filament, spinning machines, equipment and acid circulation and recovery equipment which contacted directly to acid are corroded and damaged due to attack of acid. Therefore repair and/or replacement of equipments like the

above are included in the scheme. As for spinning machine, KRC has already taken necessary steps for repairing by purchasing parts with its own fund and about 5 T/D of rayon filament is being produced by this spinning machine. Considering present status mentioned above, repair of spinning machine is excluded from this scheme. Besides, major apparatuses necessary for maintenance and inspection of the spinning machine for rayon filament are included in the scheme, because it is considered that the acknowledgement of the importance of good maintenance for the machine hereafter is thoroughly necessary.

Cellophane casting and finishing process facilities are excluded from the scheme of repair, as KRC seems to be possible to maintain present performance with its own adequate maintenance.

Machinery and equipment for the acid bath circulation and recovery system for rayon staple fiber are to be provided, modified and installed as a part of BM works, because additional equipment shall be balanced with the existing equipment most of which will be repaired and modified. The BMR works for these two kinds of equipment, old and new, should be carried out in close relation.

As equipment and installations in the anhydrous sodium sulphate plant have been considerably corroded and damaged their parts and materials for replacement or repair are required. Particularly, the existing receiver of evaporated bath has been heavily, damaged, and therefore it has been concluded to be replaced. For such purpose, a new body of receiver shall be installed.

In spite of general exhaustion of the carbon disulphide plant in operation for more than one decade, scope of repair work is limited to necessary items. Besides, a switch panel and some meters are to be replaced by new ones, since they are heavily corroded.

Trouble in the existing water treatment plant is mechanical disorder in the SB type clarifier. Therefore, the improvement for getting rid of troubles on the SB clarifier is included in the plans.

With regard to refrigerators, two compressors made by Mitsubishi Heavy Industries are heavily damaged and now out of work. As one of them seems to be difficult to repair, it is considered to be adequate that one compressor shall be scrapped but another one shall be repaired. Together with the above refrigeration compressor, one compressor made by Hitachi, which is under operation, and a chilling unit for process cooling, the overall refrigeration capacity

can cover the total demand on plant cooling of KRC, even after expansion of the rayon staple fiber line.

In the rayon pulp plant, such processing facilities as bamboo chip making, handling, recausticizing and soda recovery are excluded from this scope, as these items are to be repaired by KPM by using of the Swedish fund. The rest of pulp making process included in this scope is such main stream of process as cooking, washing, screening & bleaching and sheet making.

The caustic soda and chlorine plant has been suffered from corrosion of cells, corrosion and leak of brine pumps and tanks, and shortage of spare parts for the rectifier and its circuits, etc. Therefore, parts and materials necessary for repair and replacement are to be supplied.

In the sulphuric acid plant, equipment are heavily corroded due to attack of sulphuric acid and sulphur dioxide gas. Therefore, equipment and parts made of special materials and instruments for replacement are to be supplied. Ventilation systems for the instrument room are to be provided by KPM by using the Swedish fund. Accordingly, the ventilation system is excluded from this BMR plan.

Although machine and equipment in the hydrochloric acid plant are corroded, nevertheless it is still continuing production, even though instermittently, owing to proper maintenance by KRC personnel. Thus, equipment and parts made of special materials and functional parts are to be supplied.

In the chlorine dioxide plant, almost all facilities are corroded. However, as main parts of facilities have not got any fatal damage yet, the plant seems to be operable for the time being, if, KRC could maintain facilities in adequate conditions as a part of the scheduled maintenance. Therefore, parts and equipment necessary for repair are to be limited to only instruments and a blower made of special materials.

Regarding the power plant (owned by KPM), the repair and replacement of obsolete boilers and turbines in order to improve efficiency of steam generation and subsequent power generation are scheduled. As these are to be executed by the Swedish fund, the reapir and replacement of machinery and equipment in the power plant are excluded from the plan.

Summing up the aforementioned plan of repair and replacement, it can be said that KRC and KPM personnel well know about relevant facilities and equipment since they have

operated the plant for long time after its establishment and therefore, they can find most effective measures for rehabilitating the plant performance with minimum investment, and can list up necessary items to be taken up. Consequently, KRC will be able to import parts, and materials necessary for repair, and fix exhausted equipment by competent maintenance staffs of KRC and KPM. The parts and materials for the aforementioned repair works are as per PART (I) and (II) of Appendix I.

6.2.2 Problems Involved in BMR Works

There are various kinds of problems involved in repair works which unavoidably contain unknown technical factors. Major items among those problems are mentioned hereunder:

1) As objects of repairing works are those equipment which have been operated under severe conditions for many years, they probably involve invisible defects. It is practically difficult to point out invisible defects exactly with observational inspection, and itemize objects to be repaired.

2) At present, most of exhausted equipment and facilities are being operated under severe conditions of poor maintenance, which is bringing further exhaustion of equipment every day. It might be said that the situation mentioned above will expand scope of repair day by day.

3) In repair works, there frequently happens such a case as existing old parts and materials are mechanically combined with new ones. In this case, equipment repaired can not always be equal to new equipment in reliability and performance.

The problems aforementioned suggest the probability of further expansion of the scope of BMR works and increase in BMR cost during the period of BMR works.

For such additional repair work, another additional and extra fund should be particularly provided.

Besides, since almost all the new instruments for replacing are to be installed to the plants within the corrosive atmosphere (for example, H_2SO_4 plant, ClO_2 plant, etc.), the control room equipped with instrument shall be well ventilated with clean fresh air and be kept up in clean condition in order to prevent instruments from being corroded again.

6.3 Plan of Installations for BM & E

6.3.1 Basic Idea for Engineering of BM and E Project

There is no significant difference between rayon staple fiber and rayon filament production, in their viscose making process, and acid bath circulation and recovery process. In spinning and finishing processes of rayon filament and staple fiber, there exists considerable difference in basic process, and consequently, their machinery and equipment are a little different.

In addition, the capacity of the existing facilities, which has in total 15 T/D of deisgned capacity for producing rayon filament and cellophane, shall be reduced to maximum 5 T/D resulting in some idle machinery and equipment in the existing plant. Taking these conditions into consideration, the plan of installations for BM and E has been projected based on the following three ideas:

1) By making use of the existing facilities for viscose making process and acid bath system effectively, installations of new machinery and equipment for BM and E is to be restricted at the minimum.

2) By avoiding expansion of the exsting building to the utmost, most of machinery and equipment for BM and E shall be installed in the building, and they shall be layed out so that the length of piping for utilities and major chemicals from the existing facilities can be minimized.

3) Special consideration is to be taken in order that qualities of rayon filament and cellophane may not be affected by the BM and E project.

In this respect, machinery and equipment for viscose making process for rayon staple fiber production are to be laid out next to the facilities of viscose making facility for rayon filament. And, a few high performance equipment are to be laid out in process area in order to minimize spaces. Thus, expansion of the building can be minimized. Therefore, provision of equipment for viscose making process as well as installation can be regarded as BM works.

With regard to spinning and finishing processes for staple fiber production, machinery and equipment to be supplied are specially designed so as to make them fitted with the reserved

narrow space within the one span at the northern end of the existing spinning room of rayon filament. As these machinery arranged in a line are all new, it is resonable to consider their provision and installation as expansion work.

An outline of process equipment layout for rayon filament and rayon staple fiber production is made on Fig. 6-1. Besides, after studying capacities of each plant for utility and chemical supply, the following schemes are concluded:

1) Production capacity of the rayon pulp plant can be increased up to 16 T/D by improving and repairing equipment of cooking processes, etc. Thus, the demand of rayon pulp after expansion, can be met by blending of 30% of imported pulp.

2) Total demand of sulphuric acid for such plants as the rayon plant, the chlorine plant and the chlorine dioxide plant can be met because the new sulphuric acid plant (by Lurgi's contact method system) is repaired and rehabilitated up to 28 T/D in its capacity.

3) For the caustic soda plant, the production capacity of the plant can be considered to be about 13.5 T/D, on caustic soda basis (with 12 cells' operation) after repair. On the other hand, total requirement of caustic soda will be about 18 T/D for the rayon plant, the rayon pulp plant, the carbon disulphide plant, and the water treatment plant. Furthermore, the paper pulp plant and the aluminium sulphate plant require considerable amount of caustic soda.

   This means that a considerable quantity of caustic soda will become short under such a circumstance and in the nature of things, the production capacity of the caustic soda plant must be expanded. However, it is practically difficult to import such equipment from Japan, because the plant is based on mercury electrolysis process. In addition, amount of chlorine gas as a by-product of electrolysis will become 12 T/D while 13.5 T/D caustic soda is produced. Such quantity of chlorine gas will be more than the quantity which covers requirement for the pulp plant and the hydrochloric acid plant.

   Thus, over production of chlorine gas in case of increased capacity of the caustic soda plant will impose uneconomical investment and various technical difficulties on KRC by the addition of a chlorine liquefaction plant to treat the extra quantity of chlorine.

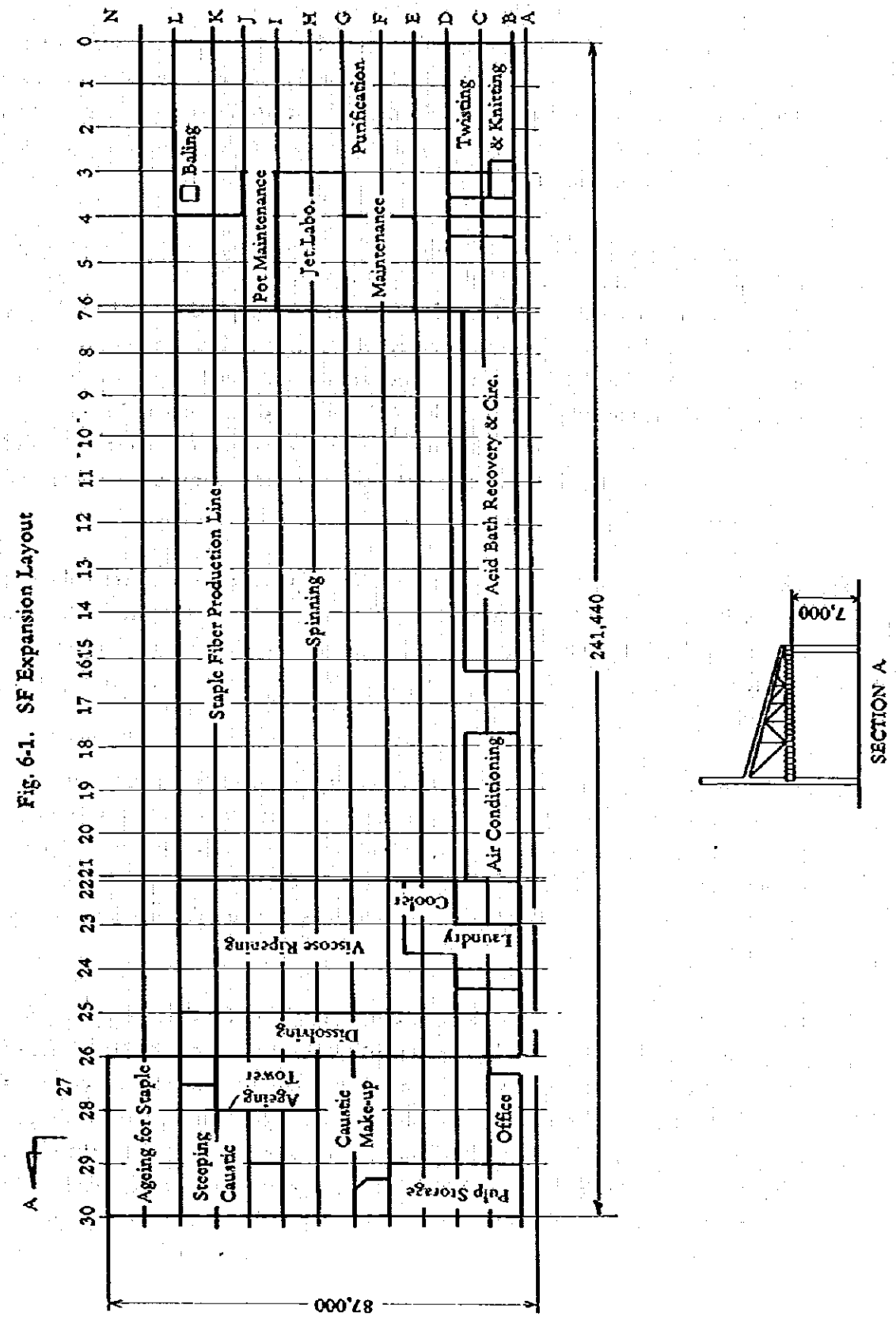


Fig. 6-1. SF Expansion Layout

In order to avoid these difficulties, it is concluded that only repair work of the caustic soda plant are to be done and the quantity of caustic soda (about 11.3 T/D) equivalent to the demand of chlorine (about 10 T/D) is to be produced, therefore, caustic soda in short for rayon, rayon pulp, paper pulp production and other use shall be purchased.

4) Estimated demand of carbon disulphide is 6.8 T/D after expansion of rayon staple fiber production facilities. On the other hand, the production rate of carbon disulphide is around 5.5 - 6 T/D after its repair and replacement of machinery and equipment because of inferior quality of charcoal and it is slightly in short. In order to fill the deficiency, several countermeasures such as improvement of charcoal quality, recovery of carbon disulphide from exhaust air have been studied. However, the addition of an electric furnace with a transformer is recommended based on an over-all judgment on stable operation, certainity in reliability and feasibility.

5) There is enough capacity in the power plant for supplying electric power and steam required after BMR & E. Installations in the power plant are going to be repaired and rationalized by KPM on the Swedish fund. Then, not only increase of supplying capacity of power and steam, but, also reduction of their costs can be expected.

6) There is no problem in quality and quantity of cooling water treated by the SR clarifier. With regard to such treated water as filtered water, soft water, process water, scouring water and deionized water, it is considered that enough quantity and suitable quality of these water can be attained for expanded facilities of the plant, if, repair work for the SB clarifier is done as was mentioned in the item 6.2.1.

7) Regarding refrigeration system, required refrigeration load for the rayon plant after expansion is presumed to be about 750 USRT. However, about 70 USRT out of about 750 USRT is to be provided by a separate line because of requirement of much lower temperature cooling. Consequently, refrigeration load for the rayon plant (including the cellophane plant) becomes about 680 USRT. One Mitsubishi refrigerator (440 USRT) which will be repaired, together with the existing Hitachi refrigerator, can manage the total demand for refrigeration of the plants. Besides, a new refrigerator for low temperatute cooling is destined for sufficient cooling of

viscose dissolving caustic solution in order to absorb economically heat generated by viscose dissolving and for covering cooling capacity of viscose dissolvers.

6.3.2 Contents of BM & E Project

Machinery and equipment necessary for executing the aforementioned ideas for balancing, modernization and expansion project are as per PART (III) and (V) of Appendix I.

In viscose making process of the rayon plant, one of the existing two slurry presses has been reserved for stand-by set. However, in the present BM project, one slurry press is destined for rayon staple fiber production, another slurry press is for rayon filament and cellophane production and then two slurry presses are to be always operated. Consequently, design should be made so that interchangeability of the two slurry presses in supplying alkali-cellulose to either production facility for rayon staple fiber or rayon filament and cellophane, will be provided considering an abnormal case that one of the two presses may become out of order. In addition, a continuous ageing machine, separate piping systems for adding carbon disulphide and dissolving caustic solution and a viscose making facility independent from the existing process facilities, are necessary for rayon staple fiber production, because of composition of alkali-cellulose and viscose different from those for rayon filament and cellophane making.

Besides, viscose grinders for viscose dissolving and automatic filtration units for viscose filtration will be installed taking into consideration the present largest trouble in making rayon filament which means low reactivity of bamboo pulp with caustic soda, and consequently low solubility and poor filtrability of viscose. With these countermeasures, easiness as well as stability of operation and reduction of viscose loss can be attained. The automatic filtration units are rather expensive compared with conventional filter presses, but on account of its automated operation, such advantages as smooth operation, less viscose losses and smaller floor space for installation are involved. Therefore, by adopting of automatic filtration unit, any space for viscose ripening process equipment shall not be required to expand.

Machinery and equipment for such processes as spinning, stretching, cutting, purifying, drying and baling, are quite different from those for rayon filament production, and therefore, it is necessary to purchase and newly install all of them. The relevant machinery and equipment have to be designed with special consideration in order to avoid any expansion of the building. With regard to circulation pumps, tanks and heat exchangers for the purification solution system, their installation will be made in the semi-underground of the spinning room for rayon filament. In this connection, considerable number of floor openings is to be made in one

span at the end of the spinning room for rayon filament. The existing second floor above the location which will be used for the baler is to be eliminated in order to install high baling machine and to provide space for staple fiber in an unexpected case.

Although each independent line is provided for the acid bath circulation and recovery systems for the rayon staple fiber making facility, it is also planned to utilize existing machinery and equipment as much as possible. Particularly, existing vacuum crystallizer and rotary vacuum filter seem to have extra capacity. Consequently, these equipment are to be used in common for both rayon staple fiber and rayon filament production. There is no necessity to expand the existing building for new installations for acid bath process, as the new equipment are to be installed in the space next to the existing installations.

In the carbon disulphide plant, an electric furnace, a transformer, a refrigeration unit and other accessories with parts are to be added. And, as there is no space for additional equipment, building expansion in the area of crude CS_2 is necessary.

6.3.3 Problems Involved in BM & E Works

With regard to the viscose making process equipment for rayon filament, considerable amount of equipment are converted to rayon staple fiber making facility. Therefore, considerations should be taken for avoiding such operational difficulties as undesirable affect on filament quality caused by utilizing the same steeping caustic solution as that of staple fiber, and the reduction of spare time due to reduced number of xanthators and dissolvers, although the production rate of rayon filament is to be reduced to a half of the design base.

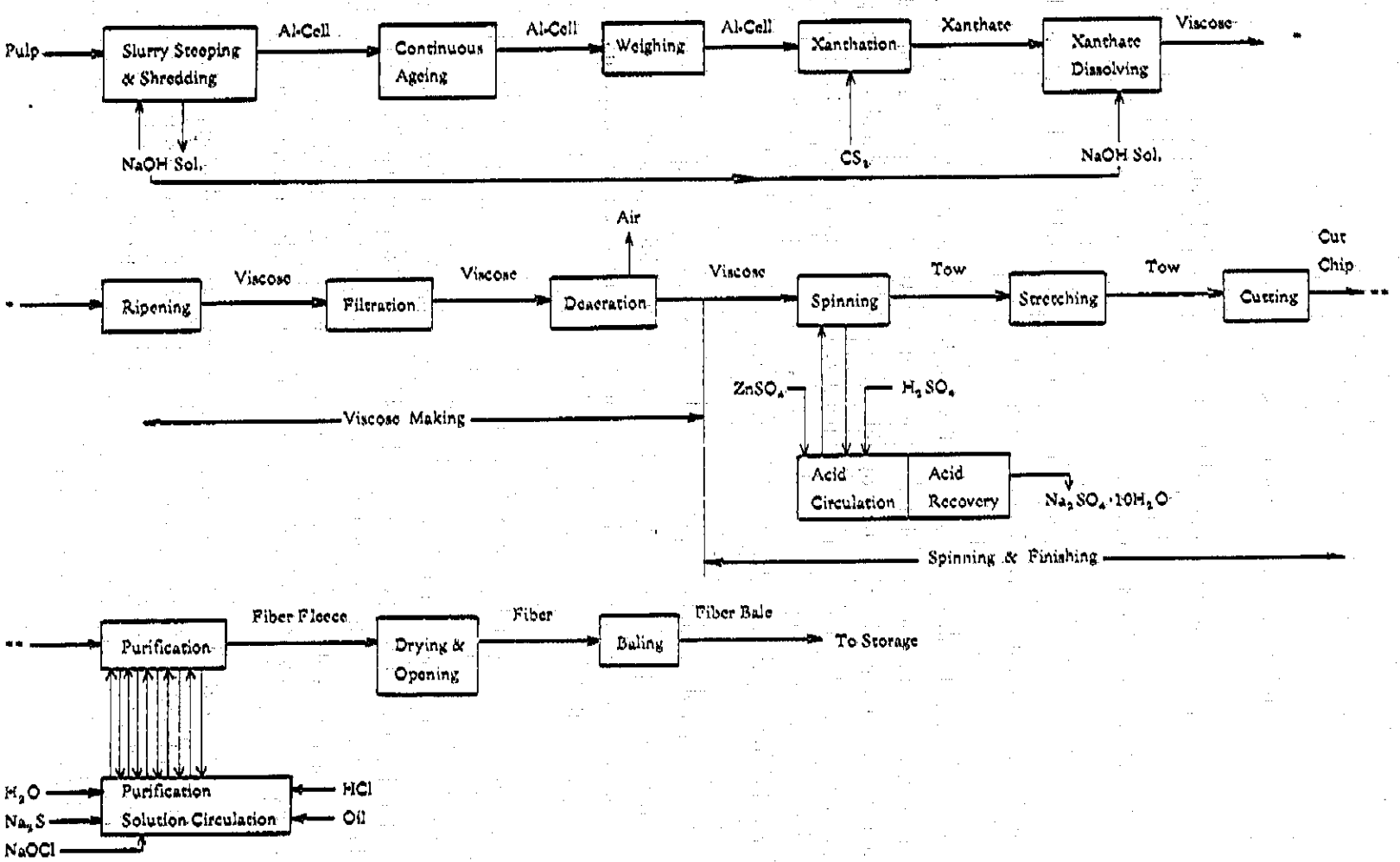
6.4 The Process to be Taken-up

An outline of the process is shown in Fig. 6-2 "Process Diagram for Rayon Staple Fiber Production". This process is roughly devided into the viscose making process and the spinning and finishing process. As mentioned before, the viscose making process for rayon staple fiber production is basically same as that for rayon filament. The spinning and finishing process is fairly different from the one for rayon filament. Particularly, the following points are special features for rayon staple fiber production process:

1) Continuous process

2) Large capacity by simple machinery and equipment

Fig. 6-2. Process Diagram for Rayon Staple Fiber Production



3) Less material and utility consumption

4) Low labour cost for a ton of product

Features of the process taken up are as described hereunder.

6.4.1 Viscose Making Process

The continuous ageing machine has a horizontal box and is equipped with a plate conveyor, and the uniformity of ageing is raised up.

For dissolving cellulose xanthate well, both the dissolvers and viscose grinders are used at the same time and dissolution is accelerated. At this time, viscose temperature tends to increase due to the heat generated by the agitator of the dissolver and viscose grinder as well as reaction heat. In order to prevent the temperature rise of viscose and the lower solubility and dispersion of cellulose xanthate, the dissolving caustic solution is preliminary cooled down prior to feeding to the dissolver. (Refer to the item 6.3.1 - 7)

As the filtration of viscose has been the biggest problem in viscose making process for rayon filament, it is concluded to use an automatic filtration unit in order to improve low filtrability, to reduce losses of viscose and further to facilitate smooth operation and for space saving. (Refer to the item 6.3.2)

6.4.2 Spinning and Finishing Process

As the spinning machine taken up is equipped with large diameter and multi-holes nozzles, it is highly efficient. Spun filaments comming out of each spinning position, are collected into a thick tow in the second hot bath getting such physical and chemical treatments as stretching, regeneration and stabilization while they are proceeding through the bath to a stretching roll. After stretching, the tow is fed into staple cutter where it is cut into cut chips.

Cut chips piled on a conveyor underneath are carried away and sprincled down into the sluice pan where flowing hot water opens chips. Hot water with floating open chip flows toward a conveyor net of the purification machine and there it passes down through the net on which fibers are left as fleece. The fiber fleece proceeds on the conveyor net and gets purification by several chmical treatments such as sulphur compound removing, bleaching, souring, washing and finishing oil application while it proceeds under shower pans. This net conveyor

system of purification can handle rather bigger amount of fibers than other systems.

Fiber fleece after application of finishing oil is continuously squeezed for dehydration and fed into a staple fiber dryer. There are two types in staple dryers, namely apron conveyor type and rotary suction drum type. Superior type of the staple dryer between the two is considered to be the rotary suction type in view of drying efficiency, plenty of experiences in actual operation and less floor space. Therefore, this scheme takes up the rotary suction drum dryer. In any case, drying of rayon staple fiber is done more easily than that of rayon filament big amount of fiber can be dried in a short period of time.

Baling is a particular process for staple fiber production. The staple fiber pneumatically and continuously transported is accepted and accumulated for baling. Then, a predetermined amount of the fiber is fed in time for baling into the hopper of the machine, and pressed and baled staple fiber comes from the machine. This system of baling requires such manual works as setting wrapping sheet as well as steel straps or wire, wrapping, strapping, clamping straps. But, rest of works are proceeded automatically without any stagnation.

Purification solution system which supplies and recirculates chemical solution to and from the purification machine, and acid bath circulation and recovery system are similar to those for rayon filament production. However, those systems for rayon staple fiber are rather simple and more effective than those for the filament.

6.4.3 Summary

As mentioned in the items 6.6.1 and 6.6.2, the superior process which makes use of aforementioned advantages is taken up in viscose making, spinning and finishing area. It means;

1) Continuous process

2) Process suitable for large capacity production

3) Large capacity with simple installations

4) Less material, chemical and utility consumption on account of high efficiency involved in continuous process

5) Automated filtration equipment in viscose making process as well as continuous

spinning and finishing processes contributing to reduction of material handling and operational works which save less labour charges.

6.5 Countermeasures for Public Hazard

Although the factory is situated at Chandraghona city, as a matter of fact, the town, schools, a hospital, a theater and mosques are involved in the Karnaphuli Complex in which KRC is included. In addition, factory site is surrounded by river Karnaphuli as shown in Fig. 2-1, and is separated from other towns and villages. The government of Bangladesh has regarded the Karnaphuli Complex as a key facility for developing the special administrative district, Chittagong Hill Tracts, and has been paying careful attentions there. For this reason, the matter of a public hazard has not been claimed, though it is personally discussed occasionally.

On the other hand, countermeasures of water pollution by waste water from the pulp plant were adopted by Swedish engineers based on their technology of the year 1950's, and preventive measures against air and water pollution by the rayon plant were taken in projecting the plant by using Asahi's technology established in the year 1960's. For instance, in the rayon plant, a waste water neutralization pond capable of treating 1,500 m^3/H rayon waste water was provided, and a gas stack which is as high as about 30 m and destined to blow away effluent gases into high sky to disperse and dilute, was built up.

Dilution of waste water with overwhelming amount of river water and dispersion effect of exhaust gases by means of the tall stack, were preventing river water of the Karnaphuli and ambient air of the Chandraghona from abnormality, when the survey was carried out.

In the factory, there was considerable smelling of corrupted bamboo around the chipper house and sulphides around the cooking house, and smelling of chlorine and hydrogen chloride around the caustic soda-chlorine plant, the chlorine purification plant and the hydrochloric acid plant. Around the sulphuric acid plant, there was a smell of sulphur dioxide gas, and hydrogen sulphide gas was in the carbon disulphide plant as well as the spinning room. Major cause of such smelling is considered to be incomplete operation of exhausted and incomplete plants such as the caustic soda and chlorine plant, the hydrochloric acid plant, the sulphuric acid plant, etc. Therefore, after repair of these plants, making use of proposed proper equipment and instrument, plant operation will become normal then most of those smelling will be much reduced.

Besides, it was unfortunate to know that the KRC did not have any of suitable

instruments for analysis of exhaust gases and waste water, and measurement and analysis of the effluent were not made at that time. Accordingly, no data for the subject was obtained.

Taking the aforementioned situations into consideration, the following countermeasures are incorporated in the scheme of BMR & E:

1) In rayon staple fiber production process, consumption of carbon disulphide is to be reduced to the minimum by means of elaborating the optimum process condition. Generally, consumption of carbon disulphide for rayon staple fiber production is in the range of 0.3 - 0.32 T/T product which means 10 - 20% less than the consumption for rayon filament, 0.34 - 0.39 T/T product, and therefore, rayon staple fiber production is advantageous in view of a public hazard. However, due consideration should be given to further reduction of the aforementioned consumption which is important for better operation of the plant without pollution.

2) By means of operating two sets of the main exhaust fan after repair and maintenance, reduction of hazardous gas concentration in the spinning room and wider dispersion of exhaust gas as well as better dilution of it can be expected. In this project, it must be noted that only 5 T/D of production capacity is to be added to the existing design capacity 15 T/D. (10 T/D in rayon filament and 5 T/D in cellophane). Further, the rayon filament production process which generally requires considerable number of the spinning machines, is to be cut down and one spinning machine for rayon staple fiber which normally generates comparatively less exhaust gas are to be installed. Consequently, taking such fact that presently sufficient volume of exhaust gas is blown out with one main exhaust fan operated, into consideration, there is no doubt about getting much better environmental condition after putting two fans into operation.

3) Leakage of hazardous gases in the caustic soda and chlorine plant, the hydrochloric acid plant and the sulphuric acid plant will obviously reduced after BMR of these has been completed with supplied equipment and instruments. Consequently, BMR project shall be promoted without any delay.

4) Viscose losses will be reduced by utilizing automatic filtration units in viscose making process. With this cutting down of viscose losses, biochemical oxygen demand (BOD) in waste water from the rayon plant will be reduced and improved.

5) Reduction of acid losses is expected by means of BMR for the acid bath circulation and recovery system.

Besides, it must be taken into consideration that effluent water from the pulp plant plays an important role in water pollution. Speaking of an actual status in Japan, for instance, impurities isolated by kraft pulp process reaches as much as 120 kg for 1 ton pulp product in BOD load. On the contrary, impurities in waste water from the rayon plant turns out to be in the magnitude of 30 kg for 1 ton rayon product in BOD load. As the daily production of pulp including that for paper is tentatively estimated as approximately 80 T/D, total impurities coming out of the pulp plant will be 9.6 T/D in BOD load against which impurities from the rayon plant, where about 20 T/D rayon products will be produced, will be only 0.6 T/D in BOD. Thus, BOD load in waste water from the rayon plant is only 6% of the total BOD load.

As KPM is going to undertake necessary steps of BMR for the soda recovery boiler, etc., which will prominently reduce BOD load of waste from the pulp plant, quality of river water will be improved significantly.

CHAPTER 7

CONSTRUCTION PLANT

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7.1 Capability of Bangladesh of Manufacturing Necessary Machinery and Equipment for the Project

For the plant construction, one of the ways to construct the plant economically and quickly is to procure the necessary machinery and equipment in the country where the plant is to be constructed.

Those complicated machines requiring high technique or special materials may have to be imported, but those machines which do not require such high technique or special materials; open tank, chute, frame, support and duct etc. could be manufactured and procured in Bangladesh by supplying basic specifications and/or drawings, more economically and quickly.

And by manufacturing and procuring these machinery and equipment locally, KRC could save foreign funds and also could give useful helps to the local industries.

For attaining the above purpose, the capabilities and facilities of the maintenance shop of KPC and KPM and also of two neighbouring machinery manufacturers were investigated collecting necessary data for evaluating their capabilities. The results are shown in the Tables from 7-1 to 7-3.

KRC's maintenance shops could be used as a work shop for simple equipments or parts, as their technical level is comparatively high and suitable for such purpose. BITAC Works, near Chittagong is also one of the useful machinery manufacturers for the above-mentioned purpose. There seems to be other two or three machinery manufacturers with some capabilities. Accordingly, there are no problems in finding such supporting work shops for the project.

7.2 Inland and In-site Transportation & Storage of the Equipment

The unloading of the equipment in Bangladesh is carried out at Chittagong port and there are no problems as to the unloading facilities. During the War of Independence, the port facilities suffered considerable damages, but are now reconstructed having the better capacities than the one which had unloaded the equipment of paper plant, steel plant and rayon filament and cellophane plant in the past. Even those comparatively delicate precision machine like steam turbine weighed about 50 - 60 metric tons can be unloaded without difficulties.

Table 7-1 Facilities Available for Local Procurement

Machines in K.P.M. Workshop

1.	Lathe Machine	11 Nos.	(Very big & small)
2.	Milling Machine	2 Nos.	
3.	Shaper Machine	2 Nos.	
4.	Planner Machine	1 No.	
5.	Drilling Machine	3 Nos.	
6.	Tools Grinder Machine	2 Nos.	
7.	Hydraulic Press Machine	1 No.	
8.	Hydraulic Pipe Bender Machine	1 No	
9.	Arc Welding Machine	6 Nos.	
10.	Gas Welding Set	3 Nos.	
11.	Bend Saw (For Metal Cutting)	1 No.	
12.	Power Hack Saw Machine	1 No.	

Foundry & Heat Treatment

1.	Electric Furnace for Heat Treatment	2 Nos.
2.	Oil Fired Furnace for Heat Treatment	1 No.
3.	Black Smith Hearth	1 No.
4.	Cupola Furnace	2 Nos.
5.	Crussible Furnace	2 Nos.

K.P.M. Workshop usually takes up all types of repairing of machine parts of Paper Mills in their very big workshop. They perform fabrication of M.S. Tanks, Pipes Supports and many other things as required in both the Mill of K.P.M. & K.R.C. They also take up foundry work for casting various parts of machinery, like Pump casing, Impellers, Bearing Housing etc. except very complicated parts in their cupola and crusible furnaces. The K.P.M. Workshop can take up those big jobs which can not be taken up by K.R.C. Workshop.

Table 7-2 Facilities Available for Local Procurement

Machines in K.R.C. Workshop

1.	Lathe Machine	4 Nos.
2.	Milling Machine	1 No.
3.	Shaper Machine	1 No.
4.	Drilling Machine	2 Nos.
5.	Shearing Machine	1 No.
6.	High Speed Cutter Nc.	1 No.
7.	Gas Welding Set	1 No.
8.	Arc Welding Machine	12 Nos.
9.	Tool Grinder	2 Nos.

Major repair works coming from different sections are done in KRC. Workshop which includes hard facing, re-conditioning of the metal (ferrous and non-ferrous) parts. We also make new metal spares as per requirements from different sections such as shaft, pulley, bush bearing, flange, valve pin, bracket, filter cover etc.

Different types of gears are manufactured here such as spur gear, bevel gear, worm gear upto 2 ft. dia.

Fabrication of big and small sizes of tanks for our plant are done here. Specially M.S. pipe lines of different fluids e.g. viscose, water (hot or cold) and high pressure steam line necessary fabrication and maintenance, repair works are done.

Table 7-3 Typical Company and Facilities Available for Local Procurement

B.I.T.A.C. (Bangladesh Industrial Technical Assistance Center)

1.	Jig Grinder	1 No.
2.	Jig Borer	1 No.
3.	Surface Grinder	3 No.
4.	Milling Machine (Small)	4 No.
5.	Shaper	3 No.
6.	Lathe Machine (Small)	8 No.
7.	Grinder	4 No.
8.	Boring Machine	2 No.
9.	Hobbing Machine	2 No.
10.	Slotting Machine	1 No.
11.	Plainer	1 No.
12.	Band Saw	1 No.
13.	Bending Machine (Max. t = 6)	1 No.
14.	Furnace (1 Ton)	1 No.
15.	Crane (Max. 2 Ton)	1 No.
16.	Nitrating Facilities (incl. Electric Furnace)	1 No.
17.	Plating Facilities (Kampschulte Co.)	

Employees: 175 including 10 officers.

Available jobs: Welding. (Al, SUS, Pressure vessels possible)
Precision machining. (1/2,000 inch precision possible)
Casting and forging. (Max. 2 Ton)
Pipe bending and expanding.
Plating.
Sheet metal work.

M Saleh Engineering Co.

1.	Surface Grinder	1 No.
2.	Internal Surface Grinder	1 No.
3.	Milling Machine	2 No.
4.	Shaper	1 No.
5.	Lathe	5 No.
6.	Radial Borer	1 No.
7.	Power Saw	1 No.
8.	Bending	2 No.
9.	Forging Hammer (U.S.S.R.)	1 No.
10.	Crank Press (160 Ton. U.S.S.R.)	1 No.
11.	Electric Welder	Set
12.	Gas Welding Equipment	Set

The Transportation of equipment shall be made by Dawood Shipping Corp. Ltd. utilizing their barges coming up the Karnaphuli river. Accordingly most of the unloading at the Chittagong port shall be made with the heavy life barge or the crane equipped on the cargo ship, directly to these barges.

These barges are presently used for the transportation of imported pulp, paper of KPM, rayon filament and cellophane of KRC to and from their works and port. Therefore the transportation cost of machinery and construction materials would be considerably saved by utilizing the same facilites. The capacity of barges is maximum 200 tons, and therefore is enough for the transportation of plant equipments. The landed cargo can be transported by means of trucks or trailers but the maximum capacity of trailer is still limited to about 50 tons and those of ordinary truck is 10 tons, and also the special chartered trailer or truck have to be used. Therefore land transportation can only be utilized for special light and emergency cargo.

The cargo transported to the jetty with barges will be unloaded with the mobile hoist to the factory and stored into the bonded warehouse with the mobile cranes or forklifts for the custom clearance.

As shown in Fig. 2-1, there are many go-downs in the site and the custom cleared cargo shall be stored in them. Those small cargo transported with trailers or trucks also will be stored in bonded warehouse once and then stored in the go-down of site after custom clearance.

In Bangladesh, May to June is rainy season and during the season the outdoor storage becomes impossible, and high humidity and temperature of the season will cause rusting and deterlioration of the equipment. Although the equipment will be packed with export specification and enough anti-rusting measures are taken, still it has to be stored at the place well ventilated.

The in-site transportation from the go-down to the erection points shall be made with mobile crane, forklift, etc. their capacities being 10 tons and 5 tons respectively.

7.3 Erection Work

As is already stated in the report, in this plan a part of viscose making process facilities for rayon filament and cellophane production shall be utilized for rayon staple fiber production. And also the acid circulation and recovery system of the existing plant shall be used or partly used for the rayon staple fiber production.

Therefore, though the main part of the erection work is for the erection of the rayon staple fiber plant, works for facilities which are diverted for rayon staple fiber production or are used in common, for the production of filament and staple fiber are also important.

The outline of erection work plan is described hereunder:

7.3.1 Confirmation and Checking of Completion of Building and Civil Works

Investigation and confirmation of the works of expansion and conversion of buildings and civil works as mentioned hereunder shall be made firstly and then the next works shall be started:

1) The expansion of building works for the new installment of continuous ageing machine.

2) The conversion works of building for alkali-cellulose pneumatic transportation and weighing facilities.

3) Conversion works of viscose ripening room.
(Conversion works for the installation of the automatic filtration unit, filtration medium recovery system, the special refrigerator for direct cooling.)

4) Necessary reinforcements, openings, corrosion-proof tiling and sewage works for the floor of one spun located in the north end of rayon filament spinning room where the spinning and finishing process equipment of rayon staple fiber shall be installed.

5) Conversion works for the space where baling machine of rayon staple fiber is installed (including 2nd floor).

6) Necessary reinforcement and or openning works on the installation position of acid circulation and recovery equipment for rayon staple fiber.

7) The expansion works of the building for extra space for a new electric furnace in carbon disulphide plant.

8) Conversion works for the clarifier and brine tanks of caustic soda plant.

9) Necessary civil works for SB type clarifier.

7.3.2 The Installation of Equipment for Rayon Staple Fiber Plant

The main works of the erection works and their scopes are as mentioned hereunder:

The main equipments to be installed:

Continuous Ageing Machine	1 set
Xanthater, Dissolver	2 sets each
Blender, Ripening Tank, Feed Tank	1 set
Automatic Filtration Unit	1 set
Flash Deaerator	1 set
Spinning Machine	1 set
Stretching Machine	1 set
Cutter	3 sets

Purification Machine:
(including purification solution circulating equipments)

Dryer	1 set
Baling Machine	1 set
Acid Circulation Equipment	1 set
Acid Recovery Equipment (Evaporator)	1 set
Electric Furnace for Carbon Disulphide	1 set
Transformer for the above	1 set
Refrigerator for Process Cooling	1 set
Storage Tank for CS_2	1 set

Total weight of equipment:

Rayon staple fiber plant	ca. 530 tons (net)
CS_2 manufacturing process	ca. 40 tons (net)

Man-hour for the erection:

Rayon staple fiber plant	ca. 5,400 man day
CS_2 manufacturing process	ca. 450 man day

After the completion of erection works, the wiring, piping, ducting, additional works for support, frame and operation deck, heat insulation, lining, painting works and etc. have to be done, but all such work have to be done without interferring the operation of rayon filament process. Scale of such works are considered to be as mentioned hereunder.

Total weight of necessary material:	ca. 150 tons (net)
Man-hour:	ca. 7,400 man day

7.3.3 Repair, Replacing, Interconnecting and Deficient Works (to check and fulfill the works which were unwillingly neglected)

BMR works for rayon filament plant and auxiliary chemical plants shall be executed by using the equipments, parts and materials listed on the Equipment List Part (I) (II), Appendix 1. BMR works which will not give any interferences to the operation of rayon filament and auxiliary chemical plants would better to be executed before the expansion works of rayon staple fiber. Interconnecting works of newly installed equipment in rayon plant and in auxiliary chemical plants with the existing equipment is recommended to be completed in haste by ample preparation and stopping the supply of utilities and chemicals. The scale of repair and interconnecting works is estimated to be as mentioned hereunder (not including rayon pulp plant).

Total weight of necessary parts and materials:	ca. 320 tons
Man day:	ca. 8,400 man day

The works in the rayon pulp plant is estimated to be 1,500 man-day and this man-day is included in the planned estimation.

After the completion of the interconnecting works such deficient works as the heat insulation, painting, furnishing work of support, cover and protection fence, leakage test, insulation resistance test, air test and sequence test shall be done in the preparation for test run. During this period the utilities and chemicals are continuously supplied to the rayon filament plant so that the rayon filament can be produced.

So-called deficient works is usually executed very carefully by utilizing check point lists, since it means total inspection of whole works, and takes more man-day than it looks like. And usually the unfinished or insufficient work would be found during the inspection and it is necessary to reserve one or two months for fulfiling or repairing of such insufficient works.

7.3.4 Erection Cost

Total man hour necessary for the erection of rayon staple fiber plant and its related works is 13,300 man-day and that for BMR and interconnecting work is (including rayon pulp plant) 9,900 man-day, totaling 23,200 man-day.

In practice, it is necessary to have rigger or helper, and also the management staffs who will control and supervise the works on the side of KRC, and when estimating the man-hour of such workers as 8,100 man-day and 3,000 man-day respectively, the total man-hour for the workers becomes 31,300 man-day and those of management staffs becomes 3,000 man-day.

As to the deficient works, man-hour decreases since the mechanical works reduces, while supervising or controlling function becomes very important which needs man-hour in this respect. Thus it is estimated worker's man-hour as 3,440 man-day and 500 man-day for control and supervision works.

It was assumed that skilled labour's cost as TK 800/man-month, and the ratio of skilled and normal labourers as 20%/80%. And labour cost for management staffs is estimated as TK 1,200/man-month:

Under such estimate stated above the approximate estimation of labour costs for the erection work at site would be;

(1) Erection of new equipment, related works, repairs, interconnecting works:

$$\frac{23,200 + 8,100}{25 \text{ days}} \times (0.2 \times 800 + 0.8 \times 500) + \frac{3,000}{25 \text{ days}} \times 1,200 = \text{TK } 845,000$$

(2) Deficient works:

$$\frac{3,440}{25 \text{ days}} \times (0.2 \times 800 + 0.8 \times 500) + \frac{500}{25 \text{ days}} \times 1,200 = \text{TK } 101,000$$

(3) Consumable materials for the erection:

Cost for lumber, rope, steel wire, cement, etc. and expenditures for the procurement and rent of machineries etc. are estimated as about 15% of labour cost of the works. (TK 144,000).

Total [(1) + (2) + (3)] = TK 1,090,000

7.3.5 Erection Period

The period from the completion of civil and building works to the beginning of test run can be estimated as 7 to 8 months by taking into consideration the contents of works stated in the paragraph 7.3.2 - 3. But such period might considerably varies by the number of workers available and the degree of minuteness of plan made by the management staffs.

The period of the erection works in BMR & E works can be seen in Fig. 7-1 "Master Schedule for BMR & E Project of KRC."

7.4 Civil Works, Modification and Expansion Work of Buildings

7.4.1 Civil Works

The civil works include concrete tank works within the rayon plant, foundation works, additional works for the brine clarifier of caustic soda plant, additional works of reinforced concrete structure necessitated by repair works of SB type clarifier and foundation work for the additional equipment in the auxiliary chemical plants.

The quantity of reinforced concrete necessary for the above mentioned works is estimated roughly as 190 m^3 for the structures, 263 m^3 for the foundation. Provided the unit price of reinforced concrete is TK 2,600/m^3 for structure, TK 2,550/m^3 for foundation, expenditure will be TK 494,000 and TK 672,000 respectively, TK 1,166,000 in total. This cost includes the labour cost of TK 168/m^3 of reinforced concrete works and is equivalent to the 5.25 man-day of skilled labour whose labour cost is TK 800 month.

Therefore, in case the necessary materials such as concrete, gravel, mild steel etc. are available whenever they are needed, the execution of civil works can be done without idle time.

5.25 x (190 + 263) = 2,380 man-day

7.4.2 Modification and Expansion Works of Building

Expansion of buildings is done in two places. One is in the area where the continuous ageing machine for the viscose making process of rayon plant will be installed; Section

26 - 30/L - N shown on the drawing Fig. 6-1 of rayon staple fiber palnt. This area is located in a flat house having floor space of about 460 m^2. The other place to be expanded are, crude carbon disulphide section of carbon disulphide plant where the additional electric furnace and transformer shall be installed. This expanded part should have two stories having total area of about 600 m^2.

The modification works shall be made in the following area: ripening room for viscose, floor of spinning room for circulation system of purification liquid, baling machine room and its second floor. In the viscose ripening room the modification works shall cover the following:

- Opening of ceiling for the maintenance of the automatic filters
- Openings for ventilation
- Special refrigerators room
- Change of washing machine room
- Room for recovery system for filter media, etc.

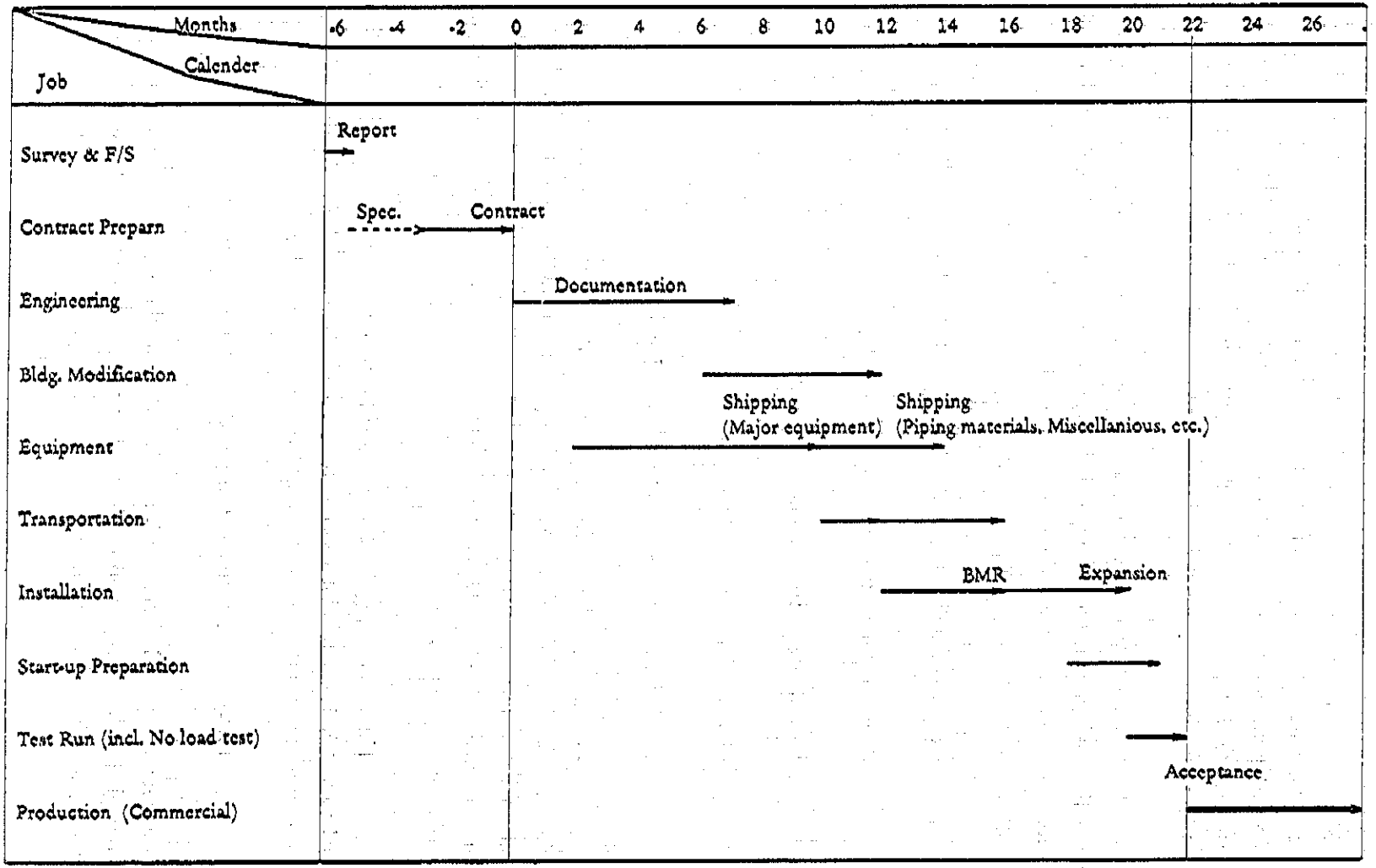
Concerning the modification of floor of spinning room for circulation system of purification liquid, the details are as stated in paragraph 6.3.2 and also the details on the modification of baling machine room is as stated in the same paragraph, which is therefore, omitted from explanation. The area of floor which falls into the modification works are roughly estimated as about 275 m^2.

The costs necessary for the modification and expansion of the buildings are estimated to be TK 1,000/m^2 for modification and TK 1,700/m^2 for expansion, and therefore the total costs needed for the modification and expansion amounts to

$$1{,}000 \times 275 + 1{,}700 \times (460 + 600) = \text{TK } 2{,}080{,}000$$

To estimate the period necessary for the building works is rather difficult since the works are intermingled with the civil works. However, if the building contractor could proceed the work according to the concrete plan made under the ample discussion and consensus with the civil works contractor and KRC, it would be possible to complete the works within 5 or 6 months. Please refer to Fig. 7-1 as to the period of civil and building works.

Fig. 7-1 Master Schedule for BMR & E Project of KRC



7.5 Test Run

Test run will be started, after the completion of erection works. After having various test run, such as unloaded operation of mechanical equipmetns, operation with water, loaded operation with materials and chemicals, performance guarantee test is carried out to prove the guaranteed conditions of the contract. Hereunder, the contents, period, manhour and costs etc. of the test run shall be stated and estimated from the informations available at this moment.

7.5.1 Contents and Period of Test Run

After the completion of rayon staple fiber plant by deficient works with which the equipments were checked and completed mechanically in every respects,

- The thorough cleaning has to be made by which the cleaness of the equipment is confirmed.
- Power is given to all the moving mechanical parts.
- No load running is made for checking whether or not the mechanical equipments will run normally and have no trouble at all, also for letting the moving part well fitted for the long operation (break-in running).
- Every abnormalities are checked, by checking the following points.
    - o Power consumption at the no load operation
    - o The degree of vibration at the rotating and reciprocating parts
    - o Abnormal heat of the bearings
    - o Abnormal sound

The causes of abnormalities shall be checked and eliminated, and break-in running is made for the normal equipment to attain the stable running.

For the section where individual machine or equipment had finished its no load test running and where the liquid will be will be treated in the system, the test run with water shall be done. That is water is sent to the system and all the moving parts of the system are actuated. During such test run with water, foreign matters (such as gravel, piece of metals and waste clothes etc.) and dust may be flowed with water stream and come into the moving part of machinery, and equipment may be damaged or severely abrased or the piping may be clogged. To avoide

such troubles, thorough internal inspection and cleaning of the mahcinery, equipment and pipings have to be made during the aforementioned "deficient works."

The purposes of test run with water are

- to find the leakage of piping and equipment
- to find wrong piping and wiring
- to estimate the necessary power for the actual operation
- to inspect the equipments which could not be operated without liquid
- to make break-in running

The test run with water is particularly important works which has to be executed before the load test. Next using raw materials and chemicals and chemicals provided during the operation preparation period for the plant, the "test run with actual load" will start. This actual load test run should be proceeded by feeding small amount of raw materials and chemicals at the first stage, and by treating and adjusting small mechanical troubles, the raw materials and chemicals are gradually increased. Together with such operation, the slight adjustment of the respective conditions of process shall be amde in order to come nearer to the guaranteed condition of the contract.

At the final stage of the "test run with actual load," the "guarantee performance test run" shall be executed in order to achieve the guarantee figutes, and the result of the test will be evaluated by the both parties of contract who attended the test. The test run will be finalized by signing the protocol on the achievement of the guaranteed figures. The schedule of the test run as a whole is shown in Fig. 7-2.

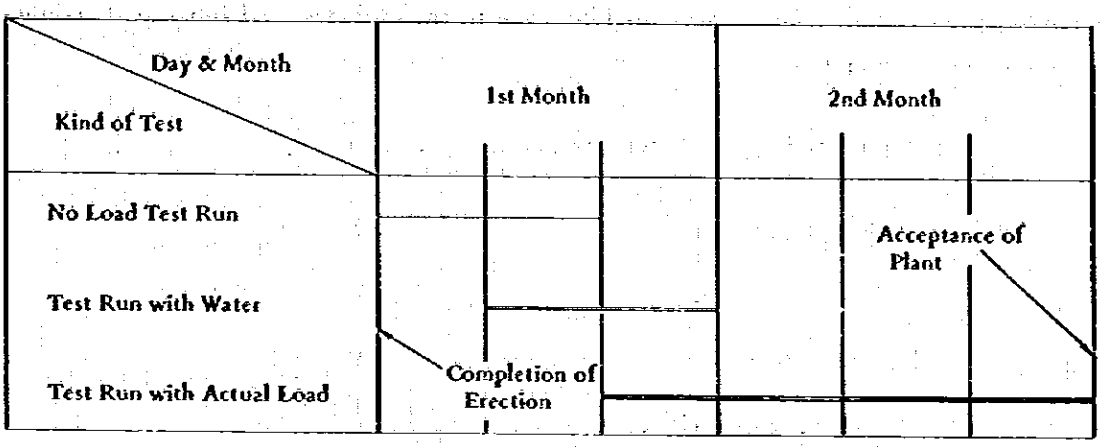
7.5.2 Cost of Test Run

The cost of test run for the rayon staple fiber includes costs of raw materials, chemicals, utilities, manhour, superviser's fee etc. necessary for the test run.

7.6 Construction Schedule

The whole schedule of the Project is as shown in Fig. 7-1 "Master Schedule for

Fig. 7-2 Test Run Schedule



BMR & E Project of KRC," which is planned to have final acceptance in the period of 22 months after the signing of the contract.

BMR of the plant shall be started from 12th month and some of the repair works could be finished within 1 or 2 month. But, the complicated BM works such as for rayon filament plant will take about 20 months for the completion.

Therefore, it is important to sign the contract at earliest opportunity, so that to renovate the tired old equipment to have the stable and effective operation of the plant and to start at earliest opportunity the manufacturing of staple fiber which will bring various benefits to the enterprise.

7.7 Training

For the production of rayon staple fiber, it is necessary to train KRC personnel for the operation of rayon staple fiber production. However, the principle of producing rayon staple fiber is same as that of rayon filament and viscose production, acid circulation and recovery system can be utilized for both processes, namely staple fiber and filament. Therefore, the training cost of the personnel can be considerably curtailed compared to the general case, since KRC staffs have enough experiences in producing rayon filament for about 10 years.

Accordingly, the training shall be made mainly on the specific technology, equipment and quality control for rayon staple fiber production including the newest technology on the viscose production. The training shall be given to the engineers and functional training to the workers is not necessary.

The recommended plan of training is given hereunder:

Operation engineer	2
Instrument engineer	1
Maintenance engineer	1
Quality control engineer	1
Total	5
Period	2 months

7.8 Operation

The personnel required for the operation of rayon staple fiber is stated in Table 7-4. The list is made for the case when only rayon staple fiber is produced. Therefore in case rayon filament is produced in parallel, the number of higher supervising staffs could be curtailed.

The quality of rayon staple fiber produced under this plan will be as stated below:

Dry strength	2.6 g/d	(Min.)
Wet strength	1.5 g/d	(Min.)
Dry elongation	18 %	(Min.)
Wet elongation	22 %	(Min.)
Finess variation	4 %	(Max.)
Staple length variation	4 %	(Max.)

This quality is suitable for the blended spinning with cotton and 100 % staple fiber spinning.

Table 7-4 Manning Plan for 15 T/D Rayon Staple Plant

		Section chief	Superintendent	Shift foreman	Shift worker	Day worker	Total
Manager	Viscose preparation section	1	2	3	45	10	61
	Spinning & finishing section	1	2	6	54	10	73
	Maintenance & workshop section	1	1	3	9	29	44
	Technical control and laboratory section	1	1	0	0	20	22
	Total	4	6	12	109	69	200

(Remark) i) The above estimation is based on the system of 3 shifts by 3 teams.

ii) The estimation includes no spare personnel for absentees.

iii) Number of personnel for administration department as well as utility service department are not estimated.

CHAPTER 8

CAPITAL REQUIREMENT

CHAPTER 8. CAPITAL REQUIREMENT

8.1 BMR & E Cost

8.1.1 Basis of Calculation

The BMR & E cost was calculated on the basis of the following conditions:

1) The exchange rate of currency shall be as follows:

US$1.00 = ¥200.00 = TK15.40

2) The machinery and equipment shall be supplied from abroad on the CIF basis, while civil engineering works, installation and test run to be operated in situ shall be carried out boy the Bangladesh Party under guidance of the supervisor dispatched by the supplier of the machinery and equipment.

3) The materials needed for construction shall be procured in Bangladesh as a rule, but those which are difficult to procure in situ such as the following material shall be supplied from abroad.

Plastic materials for lining, lead sheet for the same purpose, hard lead, heat insulate on materials, paints, special steels, fire bricks.

8.1.2 Scope of BMR & E

The scope of BMR & E is as shown in Chapter 6.

8.1.3 Breakdown of BMR & E Cost

The breakdown of BMR & E cost is as shown in Table 8-1.

Table 8-1. BMR & E Cost (End-1979 Basis)

(Unit: 1,000)

Item	Foreign Exchange		Local C	Total
	(¥)	(TK)	TK	TK
Engineering Fee	269,100	20,720		20,720
Machinery & Equipment (FOB)	2,806,645	216,112		216,112
Construction Materials (FOB)	65,540	5,047		5,047
Ocean Freight & Marine Insurance	100,000	7,700		7,700
Import Duty			6,426	6,426
Inland Transport & Handling Charge			3,876	3,876
Civil Work			1,166	1,166
Building Work			2,079	2,079
Erection			1,090	1,090
Supervising	117,000	9,009		9,009
Contingency	100,000	7,700	1,500	9,200
Total	3,458,285	266,288	16,137	282,425

(Note)

(1) The cost shown in the table was estimated on an assumption that the contract for supply of the machinery and instruments will be signed in September, 1979 and that all of the machinery and instruments will be ordered early in 1980.

(2) The cost in foreign currency was estimated in Yen on an anticipation that the machinery, instruments, materials to be imported and guidance by supervisors will be ordered to a Japanese contractor.

(3) The import duty rate of 2.5% applicable to machinery and instruments for national projects in Bangladesh was assumed based on the intention of the Ministry of Industry and explanation by BCIC.

8.2 Other Costs

1) Test Run Cost

Two months of test run for the newly constructed part for production of rayon staple fiber was assumed, and the cost was calculated on the following basis:

Raw material: Cost for the raw materials to be used

Utility: Cost of utilities to be used

Supervisor: 10 man-months (foreigners)

Labour: 180 man-months

Table 8-2. Test Run Cost

Item	Foreign Exchange		Local C	Total
	¥	TK	TK	TK
Raw Materials	13,596,414	1,046,925	0	1,046,925
Utilities			1,187,588	1,187,588
Supervising Fee	21,000,000	1,617,002		1,617,002
Labour			144,000	144,000
Total	34,596,414	2,663,927	1,331,588	3,995,515

(Note) The cost of test run materials to be purchased domestically was assumed to be set off by the sale of the products turned out in test run.

2) Preoperation Cost

Preoperation cost of 125 million Yen (TK 9,625,000) for foreign currency and TK 500,000 for domestic currency was estimated.

3) Training Cost

The cost for training operators abroad was estimated to be 4.5 million Yen and TK 115,000 in foreign and domestic currencies respectively.

4) Operation Guidance Cost

Guidance by a foreign supervisor for six months after starting operation was assumed and 14 million Yen was estimated as the cost.

5) Working Capital

The working capital of the amount shown in Table 8-3 was estimated.

Table 8-3. Working Capital

Item	Foreign Exchange		Local C	Total
	'000 ¥	'000 TK	'000 TK	'000 TK
Imported Raw Materials (2 months)	54,444	4,192		4,192
Local Raw Materials (1 month)			2,149	2,149
Product (0.5 month)			6,019	6,019
Total	54,444	4,192	8,168	12,360

8.3 Total Capital Requirement

The amount of the total capital requirement estimated is shown in Table 8-4.

Table 8-4. Total Capital Requirement

(Unit: 1,000)

Item	Foreign Exchange		Local C	Total
	¥	TK	TK	TK
BMR & E Cost	3,458,285	266,288	16,137	282,425
Test Run Cost	34,596	2,664	1,332	3,996
Preoperation Cost	125,000	9,625	500	10,125
Training Cost	4,500	347	115	462
Operation Guidance Cost	14,000	1,078	0	1,078
Sub-total	3,636,381	280,002	18,084	298,086
Working Capital	54,444	4,192	8,168	12,360
Total	3,690,825	284,194	26,252	310,446

(Note) As the interest for the period of construction, TK 32,254,000 will be required in addition.

8.4 Procurement of Required Fund

1) Foreign Currency Portion

a) Cost relating construction ¥3,636,381,000 (Equivalent to TK 280,001,000)

The amount was assumed to be raised by a long-term borrowing. The source of fund, the amount and the conditions for the long-term borrowing have not been decided yet at the moment, and the calculation was made on the following assumptions:

Source of fund:

The yen credit will be given from Japanese Government to Bangladesh Government who in turn accommodate BCIC with the amount.
The interest for relending will be 9% per annum.

Terms of payment:

Equal annual payment in 10 years after 5-years grace period.

(Note) The following assumption was made for the long-term borrowing plan and terms of payment:

	BCIC → Bangladesh Government	Bangladesh Government → Japanese Government
Amount of loan (Rate)		
First year	78%	78%
Second year	22%	22%
Grace Period	5 years	10 years
Actual period of payment	10 years	20 years
Total period of payment	15 years	30 years

b) Working capital ¥54,444,000 (Equivalent to TK 4,192,000)

The amount is assumed to be raised from the fund on hand.

2) Domestic Currency Portion

a) Cost relating construction TK 18,084,000

The amount is assumed to be raised from the fund on hand.

b) Working capital TK 8,168,000

The amount is assumed to be raised from the fund on hand.

8.5 Interest during Period of Construction

The interest during the period of construction is needed as shown in Table 8-5 in addition to the amount shown in Table 8-4.

Table 8-5. Interest during Construction

(Unit: '000 TK)

	1st Year	2nd Year
Already Drawn	0	218,382
Opening Debt	0	218,382
Interest on Opening Debt (9%)	0	19,654
Drawn During Year	218,382	61,619
Interest on Current Drawing (4.5%)	9,827	2,773
Total Interest for Year	9,827	22,427
Interest During Construction	32,254	

8.6 Capital Disbursement Plan

The plan for disbursemet of the capital is shown in Table 8-6.

Table 8-6. Capital Disbursement Plan

('000)

Time	Start of Construction		1st Year		2nd Year		3rd Year	
Item	For. Exch. (¥)	Loc. C (TK)	For. Exch. (¥)	Loc. C (TK)	For. Exch. (¥)	Loc. C (TK)	For. Exch. (¥)	Loc. C (TK)
BMR & E Cost	691,657	3,227	2,074,971	6,455	691,657	6,455		
Test Run Cost					34,595	1,332		
Preoperation Cost	5,000	500	60,000		60,000			
Training Cost			4,500	115				
Operation Guidance Cost							14,000	
Sub-total	696,657	3,727	2,139,471	6,570	786,253	7,787	14,000	
Working Capital					54,444	8,168		
Total	696,657	3,727	2,139,471	6,570	840,697	15,955	14,000	
Amount in TK	(53,643)	3,727	(164,739)	6,570	(64,734)	15,955	(1,078)	

(Note) The foreign currency portion of BMR & E cost is assumed to be disbursed 20% when the construction is started, 60% in the first year (10 months), and 20% in the second year respectively, and its domestic currency portion, 20%, 40%, and 40% in the same period respectively.

8.7 Increase in Capital Requirement Due to Delay in Construction

The amount of capital required was estimated on an assumption of the cost escalation factors of 8% per annum with the foreign currency portion and 9% per annum with the domestic currency portion.

The cost shown in Table 8-1 was estimated based on the conditions described in (Note) (1) of the table and the assumption for cost escalation factors.

A delay of actual signing of the contract from the time assumed in said note will delay the construction schedule, and this will in turn increase the capital requirement. The total capital requirement will increase into the amount shown as follows by a delay of half a year or a year.

Capital Required in Case of 6-Month Delay ('000 TK)

	Foreign Exchange	Local Currency	Total
Construction cost & working capital	295,562	27,171	
Interest during construction	32,766	-	
Total	328,328	27,171	355,499

Capital Required in Case of 12-Month Delay ('000 TK)

	Foreign Exchange	Local Currency	Total
Construction cost & working capital	306,930	28,090	
Interest during construction	34,300	-	
Total	341,230	28,090	369,320

CHAPTER 9

PROJECT EXECUTIVE ORGANIZATION

CHAPTER 9. PROJECT EXECUTIVE ORGANIZATION

9.1 Organizations Concerned

9.1.1 Planning of Project

The present project was planned by cooperation of BCIC and KRC.

9.1.2 Examination of Project and Approval

The present project was examined and duly forwarded by the Ministry of Industries to the Planning Commission. The project was discussed in the Project Evaluation Committee (PEC) also and has been placed as one of the national projects to be implemented during early part of the Second Five Year Plan (starting from July 1980).

The Project Evaluation Committee (PEC) is the most powerful functional committee in the matters of development activities of the country, based on whose recommendation a development project is finally taken up for implementation or abandoned. The PEC consists of representatives from different ministries under the Chairmanship of Planning Commission.

In the present case, foreign currency is needed for execution of the project, and it is procured by ERD (the External Resources Division) under the Ministry of Finance, and its disbursement is authorized by EFD (the External Finance Division).

ERD was formerly under the Ministry of Planning, but it is now under the Ministry of Finance since the reorganization in 1978. The Ministry of Finance was formerly under direct supervision of the President of the State, but it is supervised by the Minister of Finance since the reorganization.

9.2 Project Executive Organization

9.2.1 Ministry of Industries and Bangladesh Chemical Industries Corporation

The present project is executed by KRC under guarantee by BCIC, and the Ministry of Industries is the administrative agency responsible for it.

Two corporations, BSFIC (Bangladesh Sugar and Food Industries Corporation) and BSEC (Bangladesh Shipbuilding and Engineering Corporation), belong to the Ministry of Industries besides BCIC, but BCIC is by far the largest of the three speaking of the number of officers, the scale of plants owned, etc. The organization chart of BCIC is as shown in Fig. 9-1.

The kind and the number of plants owned by BCIC are also shown as follows:

Type of Industry	Nos.
Fertilizer	3
Paper	2
Newsprint Paper	1
Pulp	1
Rayon	1
Paper Board	1
Hard Board	1
Particle Board	1
Paper Conversion	2
Pharmaceuticals	1
Chemicals	2
Cosmetics	1
Soap, detergents	2
Rubber and PVC	4
Match	4
Ceramics	1

9.2.2 BCIC and KRC

The principal function of BCIC is as follows:

i) To plan projects,

ii) To submit the plans to MOI for approval,

iii) To procure fund necessary for execution of the projects,

iv) To supervise execution of the projects planned,

v) To make adjustment between the plants owned and the government,

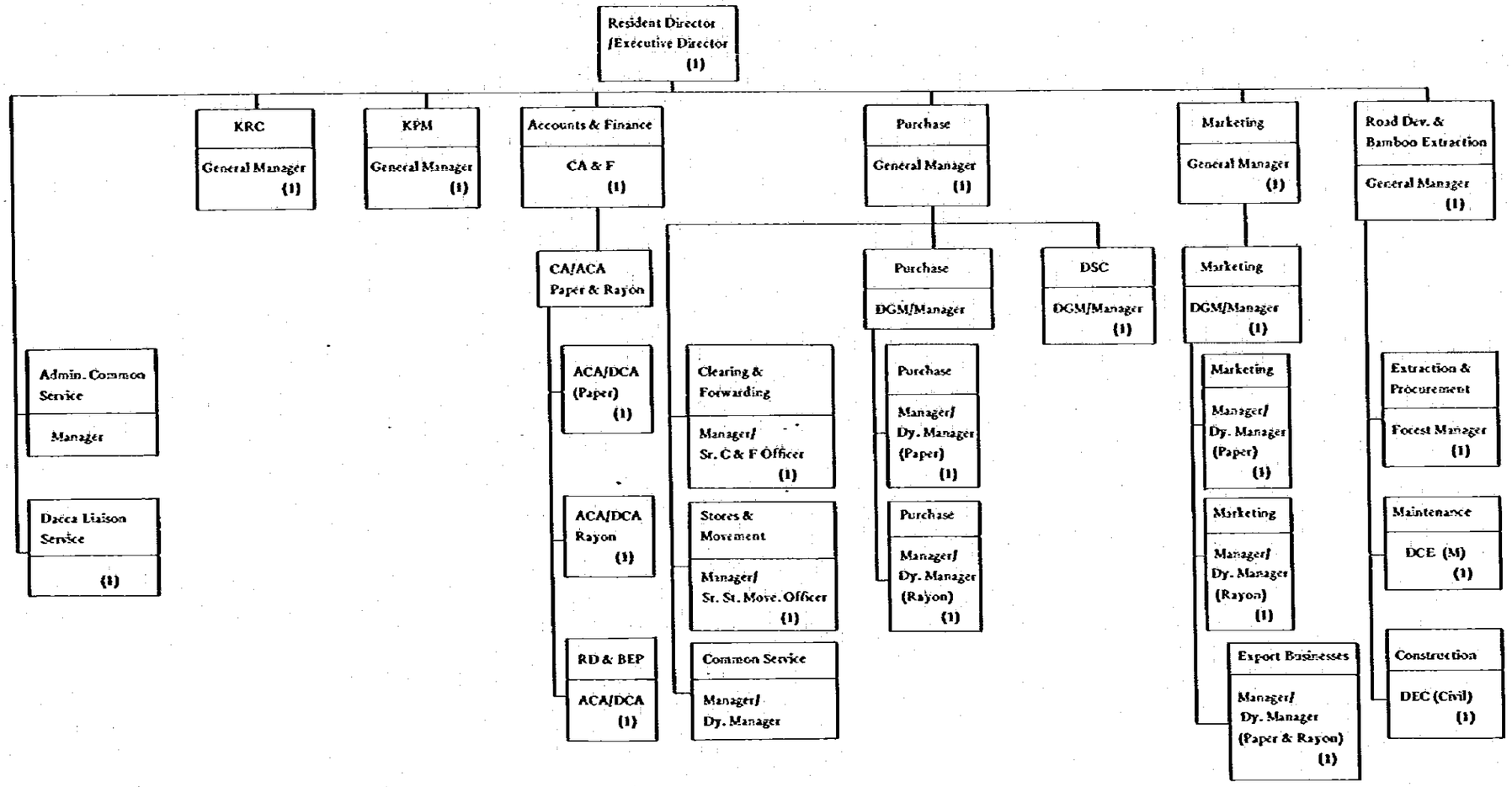
vi) To check the projects in operation.

KRC and KPM are both members of Karnaphuli Paper & Rayon Complex. They are in such an organizational relationship in the Complex to each other as shown in Fig. 9-1, and KRC receives dissolving pulp produced by KPM as raw material of viscose, while the former owns an electrolytic plant of sodium chloride and supplies to the latter a part of the chlorine and alkaline chemicals it produces, and the operation of the electrolytic plant is entrusted to the latter. Besides, the welfare facilities for employees of both of them belong to the latter.

The present project was planned by BCIC under an all-out cooperation by KRC. Help by KRC staffs who have rich technical experience in operation and maintenance of the existing plants will be available in implementation of the present project. Organization of a special project team for the construction is being planned.

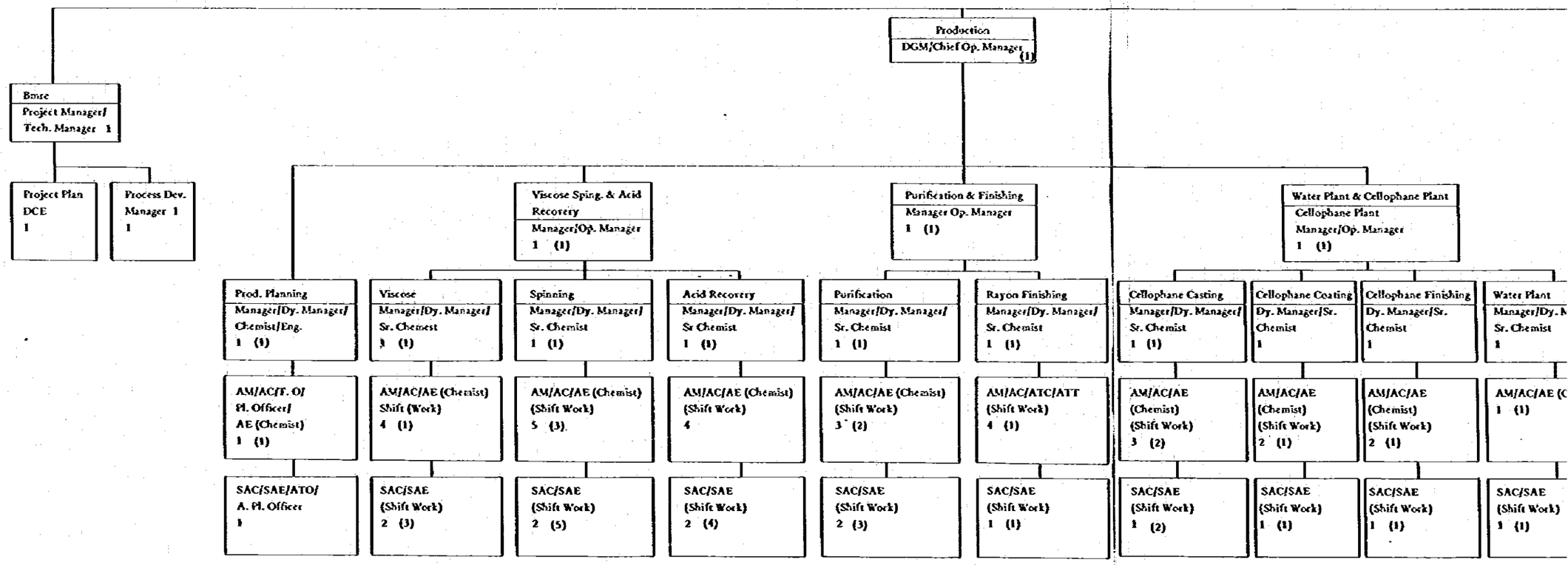
Personnel are often interchanged between BCIC and KRC and some of them hold offices of the two organizations concurrently. The organization of KRC is shown in Fig. 9-2.

Fig. 9-1. Organogram for Karnaphuli Paper & Rayon Complex



(1) Number inside parenthesis indicate present strength

Fig. 9

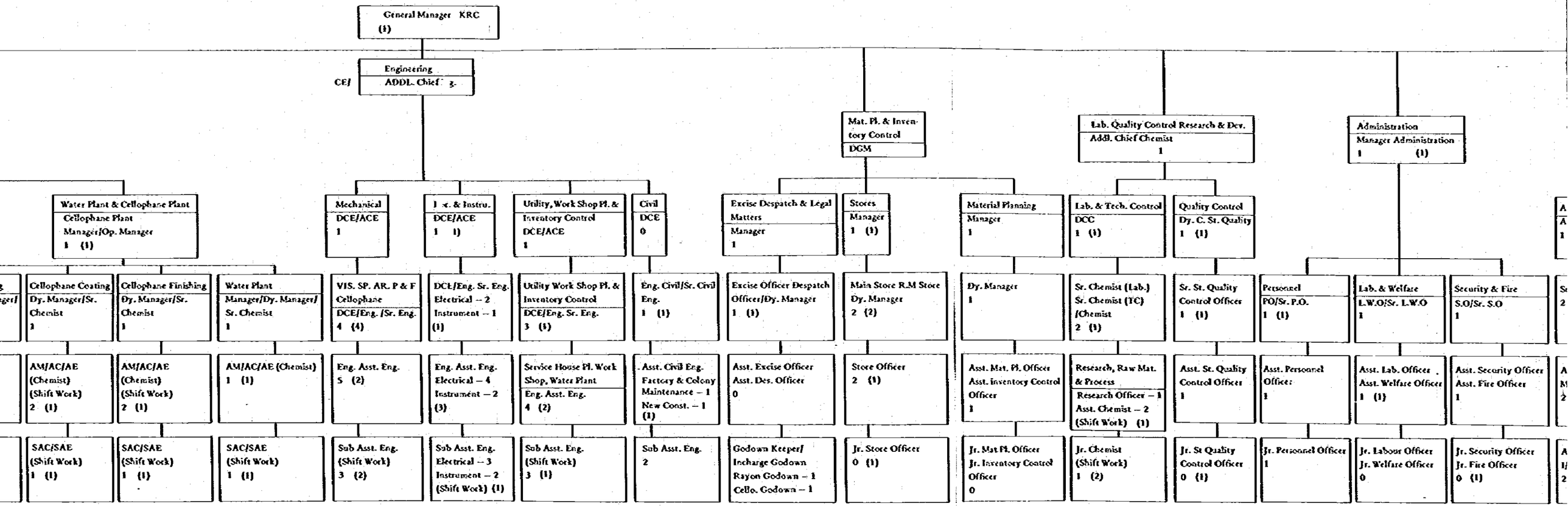


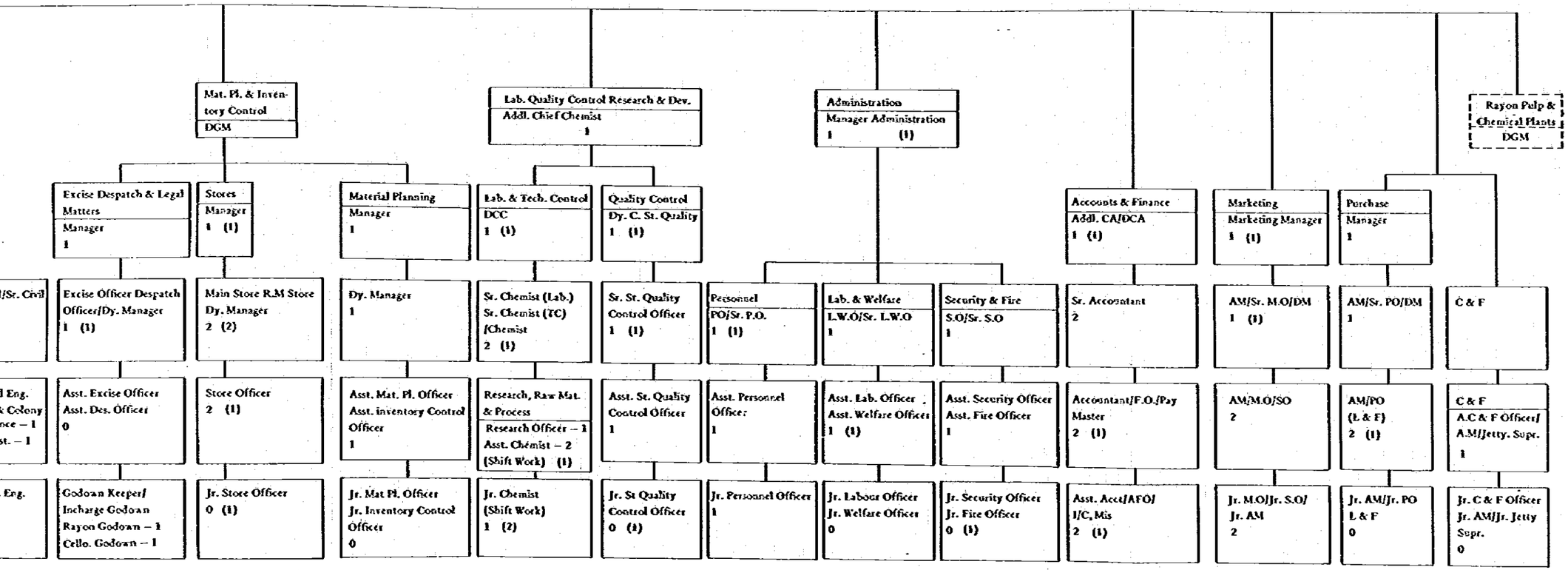
Notes: In the proposed organogram provision has been kept for upgrading some of the vital postes & these may be filled up in future for the greater interest of the organisation as & when exceptionally suitable candidates are available.

Number in parenthesis indicate existing strength

These Plants Belong to KRC but at pres

Fig. 9-2. Proposed Organogram Karnaphuli Rayon & Chemicals




Mat. Pl. & Inventory Control
DGM
Excise Despatch & Legal Matters
Manager
1
Excise Officer Despatch Officer/Dy. Manager
1 (1)
Asst. Excise Officer
Asst. Des. Officer
0
Godown Keeper/ Incharge Godown
Rayon Godown – 1
Cello. Godown – 1
Stores
Manager
1 (1)
Main Store R.M Store
Dy. Manager
2 (2)
Store Officer
2 (1)
Jr. Store Officer
0 (1)
Material Planning
Manager
1
Dy. Manager
1
Asst. Mat. Pl. Officer
Asst. inventory Control Officer
1
Jr. Mat Pl. Officer
Jr. Inventory Control Officer
0
Lab. Quality Control Research & Dev.
Addl. Chief Chemist
1
Lab. & Tech. Control
DCC
1 (1)
Sr. Chemist (Lab.)
Sr. Chemist (TC)
/Chemist
2 (1)
Research, Raw Mat. & Process
Research Officer – 1
Asst. Chemist – 2
(Shift Work) (1)
Jr. Chemist
(Shift Work)
1 (2)
Quality Control
Dy. C. St. Quality
1 (1)
Sr. St. Quality Control Officer
1 (1)
Asst. St. Quality Control Officer
1
Jr. St Quality Control Officer
0 (1)
Administration
Manager Administration
1 (1)
Personnel
PO/Sr. P.O.
1 (1)
Asst. Personnel Officer
1
Jr. Personnel Officer
1
Lab. & Welfare
L.W.O/Sr. L.W.O
1
Asst. Lab. Officer
Asst. Welfare Officer
1 (1)
Jr. Labour Officer
Jr. Welfare Officer
0
Security & Fire
S.O/Sr. S.O
1
Asst. Security Officer
Asst. Fire Officer
1
Jr. Security Officer
Jr. Fire Officer
0 (1)
Accounts & Finance
Addl. CA/DCA
1 (1)
Sr. Accountant
2
Accountant/F.O./Pay Master
2 (1)
Asst. Acct/AFO/ I/C, Mis
2 (1)
Marketing
Marketing Manager
1 (1)
AM/Sr. M.O/DM
1 (1)
AM/M.O/SO
2
Jr. M.O/Jr. S.O/ Jr. AM
2
Purchase
Manager
1
AM/Sr. PO/DM
1
AM/PO (L & F)
2 (1)
Jr. AM/Jr. PO L & F
0
Rayon Pulp & Chemical Plants
DGM
C & F
C & F
A.C & F Officer/ A.M/Jetty. Supr.
1
Jr. C & F Officer
Jr. AM/Jr. Jetty Supr.
0

CHAPTER 10

FINANCIAL EVALUATION

CHAPTER 10. FINANCIAL EVALUATION

Financial conditions of KRC after BMR & E is completed will be examined in this Chapter.

The time of start-up of production after completion of BMR & E is assumed to be July 1, 1981, and the products and amounts of production are as follows:

	Production Capacity	Amount of Production (T/Y) 1st Year	Amount of Production (T/Y) 2nd Year and Onward
Rayon filament/Cellophane	5 T/D	1,650	1,650
Rayon staple fiber	15 T/D	3,465 (70%)	4,455 (90%)

The amount of production of rayon filament and cellophane means the total production of the both. However, for the sake of simplicity of calculation for financial evaluation, rayon filament only was assumed to be produced instead of parallel production of rayon filament and cellophane.

10.1 Production Cost

10.1.1 Depreciation of Equipment

KRC is operating their existing plants for production of rayon filament and cellophane, and a new plant for rayon staple fiber will be constructed in addition. Therefore, depreciation must be considered on both of the plants, existing and new.

1) Residual Book Value, Evaluated Value and Depreciation of the Existing Plant

i) Residual Book Value

The existing plant was completed in 1967 and more than 10 years have passed since then. It will have been in operation for 14 years at the end of June, 1981

when BMR & E of the present project will be completed. Since the period of depreciation is 10 years for machinery and equipment and 25 years for buildings, the depreciation of the former would have been finished if it has been carried out by the fixed depreciation method. Actually, however, the accumulated depreciation of the machinery and equipment of the plant as of June 30, 1978 is about 37% of the original value and the written down value as of June 30, 1978 is about 63%, according to the books of account of KRC. This is a result of their method of calculating depreciation in the following way.

The decide the amount of depreciation for each unit plant in proportion to the production by the unit plants in the term. KRC had been compelled to operate at a reduced rate for many years during and after the independence war, and this led them to give the residual values of TK 133,086,162 for the machinery and equipment and TK 22,507,861 for the buildings which are quite too high as compared with the actual value.

Table 10-1 shows the book value of the existing plant as of June 30, 1978.

ii) Evaluated Value

The residual book value of the machinery and equipment of the existing plants would already be nothing if the depreciation had been carried out properly, although the production capacity was lowered inevitably by the force majeure war. However, the machinery and equipment do retain some value actually, although its accurate appraisal is difficult. The survey team gave the following estimation for the value:

(a) The original costs of the machinery and equipment of each of the units of existing plant are shown in Table 10-1. The costs of "the construction machineries and equipments" and "other machineries and equipments" in the table were allocated to each of the unit plants, and modified costs of the unit plants were obtained.

Based on the modified costs, estimated values of the unit plants were obtained by multiplication of a certain factor F respectively to be decided by the following formula:

$$F = BC / A$$

Table 10-1. Karnaphuli Rayon & Chemicals Limited
Statement Showing Written Down Value of Fixed Assets

Particulars	Cost As on 30-6-78	Accumulated Depreciation Up to 30-6-78	Written Down Value as on 30-6-78
Group "A" – Plant & Machinery:			
1) Rayon Plant			
Rayon Spinning	53,445,391	17,981,383	35,464,008
Rayon Purification & Finishing	29,714,530	11,516,464	18,198,066
Sub-Total:	83,159,921	29,497,847	53,662,074
2) Dilphane Plant			
Dilphane Casting	14,300,515	5,634,273	8,666,242
Dilphane Coating	6,200,941	2,358,483	3,842,458
Dilphane Finishing	3,827,143	1,510,117	2,317,026
Sub-Total:	24,328,599	9,502,873	14,825,726
3) Others/Common Plants			
Viscose Process	28,220,611	11,018,798	17,201,813
Water Plant	9,295,494	3,590,676	5,704,818
Sulphuric Acid Plant	3,865,493	1,415,617	2,449,876
Carbon Di-Sulphide Plant	5,498,126	2,140,793	3,357,333
Chlorine Di-Oxide Plant	2,943,776	1,020,202	1,923,574
Rayon Grade Pulp Plant	37,718,513	14,279,672	23,438,841
Caustic Plant	10,663,362	3,992,448	6,670,914
Chlorine Plant	686,336	307,425	378,911
HCL Acid Plant	473,862	208,927	264,935
Other Machineries & Equipments	4,658,021	2,114,332	2,543,689
Construction Machineries & Equipts.	1,190,022	526,364	663,658
Sub-Total:	105,213,616	40,615,254	64,598,362
Total:	212,702,136	79,615,974	133,086,162
Group "B" – Buildings:			
1) Rayon Plant			
Rayon Spinning	7,556,767	2,301,489	5,255,278
Rayon Purification & Finishing	5,038,378	1,534,021	3,504,357
Sub-Total:	12,595,145	3,835,510	8,759,635
2) Dilphane Plant			
Dilphane Casting	2,029,082	622,097	1,406,085
Dilphane Coating	870,269	269,386	609,883
Dilphane Finishing	472,918	145,401	327,517
Sub-Total:	3,381,269	1,037,784	2,343,485
3) Others/Common Plants			
Viscose Process	5,425,034	1,654,936	3,770,098
Water Plant	4,351,852	1,323,016	3,028,836
Sulphuric Acid Plant	454,803	133,196	321,607
Carbon Di-Sulphide Plant	3,511,862	1,069,152	2,442,710
Chlorine Di-Oxide Plant	8,237	1,837	6,400
Rayon Grade Pulp Plant	–	KPM Assets	–
Caustic Plant	1,248,871	415,640	833,231
Chlorine Plant	87,716	29,149	58,567
HCL Acid Plant	178,172	59,360	118,812
Other Buildings	1,218,812	394,332	824,480
Sub-Total:	16,485,359	5,080,618	11,404,741
Total:	32,461,773	9,953,912	22,507,861
Group "C" – Other Assets:			
Office Machineries & Equipments	1,104,268	607,765	496,503
Furniture & Fixture	312,802	219,961	92,841
Land	45,284	36,793	8,491
Road	41,150	–	41,150
Vehicles	506,902	433,820	73,082
Work-in-Progress	258,079	–	258,079
Grand Total:	247,432,394	90,868,225	156,564,169

Source: KRC

where A: original production capacity
B: actual production capacity
C: corrosion factor of the machinery or equipment

(0.3 for those of remarkable corrosion and 0.5 for others)

(b) Estimated Plant Value

The values of each of the plants estimated by said method are shown in Table 10-2.

Table 10-2. Estimated Value of Existing Machinery & Equipment

Plant	Original Cost (TK 1,000)	Factor	Estimated Value (TK 1,000)
Rayon Spinning	54,953	5.0 x 0.5/10	13,738
Rayon Purification & Finishing	30,555	5.0 x 0.5/10	7,639
Dilphane Casting	14,705	3.0 x 0.5/ 5	4,412
Dilphane Coating	6,376	3.0 x 0.5/ 5	1,913
Dilphane Finishing	3,935	3.0 x 0.5/ 5	1,181
Viscose Process	29,019	5.0 x 0.5/10	7,255
Water	9,559	6.0 x 0.5/15	1,912
Sulphuric Acid	3,975	28.0 x 0.3/30	1,113
Carbon Disulphide	5,664	5.5 x 0.3/10	935
Chlorine Dioxide	3,027	0.2 x 0.3/0.3	605
Rayon Grade Pulp	38,785	10.0 x 0.3/18	6,464
Caustic Soda	10,965	11.5 x 0.3/17	2,225
Chlorine	706	11.5 x 0.3/17	143
Hydrochloric Acid	487	3.0 x 0.3/3.3	133
Total	212,711		49,668

iii) Depreciation of the Existing Plants

(a) Depreciation of Machinery and Equipment

One tenth of the estimated values shown in Table 10-2.

(b) Depreciation of Buildings

Depreciation of buildings lasts to the final year of the economic life of the present project, since its term is 25 years. Therefore, it is set at one 25th of the original cost. The cost of "other buildings" in Table 10-1 was allocated to each of the unit plants and those of group C were excluded.

The depreciation cost for the existing plants is shown in Table 10-3.

Table 10-3. Depreciation Cost of Existing Plant

(TK 1,000)

Plant	Machinery & Equipment	Building	Total
Rayon Spinning	1,374	314	1,688
Rayon Purification & Finishing	764	209	973
Dilphane Casting	441	84	525
Dilphane Coating	191	37	228
Dilphane Finishing	118	20	138
Viscose Process	726	225	951
Water	191	181	372
Sulphuric Acid	111	19	130
Carbon Disulphide	94	146	240
Chlorine Dioxide	61	1	62
Rayon Grade Pulp	646	-	646
Caustic Soda	223	52	275
Chlorine	14	4	18
Hydrochloric Acid	13	7	20
Total	4,967	1,299	6,266

2) Depreciation of New Equipment

The total cost of the new equipments by BMR & E is TK 282,425,000 as shown in Table 8-1. Although it includes costs for buildings, they are negligibly small; so that the total is considered to be those for the machinery and equipment and depreciated within 10 years at the fixed amount without residual value. This gives the annual amount of TK 28,242,500 whose breakdown is shown in Table 10-4.

Table 10-4. Annual Depreciation Cost

(TK 1,000)

	Existing Plant	BMR & E	Total
Rayon Spinning (S.F)		5,967	5,967
Rayon Finishing (S.F)		5,528	5,528
Rayon Spinning (Fil)	1,688	1,321	3,009
Rayon Purification finishing (Fil)	973		973
Cellophane Casting	525		525
Cellophane Coating	228		228
Cellophane Finishing	138		138
Viscose Process	951	9,613	10,564
Rayon Grade Pulp	646	1,680	2,326
Water	372	386	758
Sulphuric Acid	130	415	545
Carbon Disulphide	240	1,779	2,019
Chlorine Dioxide	62	110	172
Caustic Soda	275	1,444	1,719
Chlorine	38		38
Total	6,266	28,243	34,509

10.1.2 Requirement of Raw Materials and Utilities

The unit consumptions of the raw materials and utilities for production of rayon filament and rayon staple fiber after completion of BMR & E were estimated with consideration of the following factors:

a) The present operating data of KRC.

b) The operating conditions in the rayon filament plant, rayon staple fiber plant and other related plants expected after completion of BMR & E.

c) The operating conditions for production of rayon filament and rayon staple fiber in industrially advanced countries.

Ample consideration was given to the special conditions for using bamboo as raw material.

Table 10-5 shows a summary of the estimated unit consumptions for production of rayon filament and rayon staple fiber.

Table 10-5. Unit Consumption

	Unit	Filament	Staple Fiber
Pulp (Bamboo)	T	0.861	0.77
Pulp (Imported)	T	0.369	0.33
Caustic Soda	T	0.89	0.70
Carbon Disulphide (& Sodium Sulphide)	T	0.39	0.32
Sulphuric Acid	T	1.22	0.90
Zinc Sulphate	T	0.032	0.035
Sodium Hypochlorite	T	0.0075	0.011
LD Oil	Gal.	3.0	3.0
Packing Material	TK	2,383	278
Miscellaneous	TK	968	266
Electrical Power	KWH	9,500	1,800
Steam	T	25	15
Water	T	3,078	1,220
Sodium Sulphate (Credit)	T	(0.66)	(0.64)

(Note) The figures shown in TK are costs in TK estimated for July, 1981.

Based on the figures in Table 10-5, the amounts of primary raw materials necessary were calculated, and the result is shown in Table 10-6. The table includes the estimated unit prices of the materials and utilities in July, 1981 and estimated costs of raw materials and utilities needed for production of a ton of rayon filament and rayon staple fiber respectively.

The unit prices in Table 10-6 as of July, 1981 was calculated from the present prices given by KRC with correction by 7% annual escalation, except steam which was calculated with consideration of the rationalization of the captive power station by BMR.

The figures in Table 10-5 are for production under supply of caustic soda by the sodium chloride electrolysis plant owned by the KRC. However, the production of the caustic soda plant after BMR is 11.3 T/D, which falls short of supplying the total requirement for rayon filament and rayon staple fiber production. Accordingly, a part of the caustic soda must be purchased from outside, and the unit consumptions in such a case are different from those in Table 10-6.

Table 10-6. Original Raw Materials and Utilities Requirement per Ton of Products

	Unit Price in July, 1981 (TK)	Filament		Staple Fiber	
		Unit Consumption	Amount (TK)	Unit Consumption	Amount (TK)
Bamboo Chip	998	2.531 T	2,526	2.264 T	2,259
Imported Pulp	9,468	0.369 T	3,493	0.330 T	3,124
Common Salt	1,183	2.342 T	2,771	1.861 T	2,201
Charcoal	1,480	0.14 T	207	0.115 T	170
Sulphur	2,074	0.941 T	1,952	0.747 T	1,549
LD Oil (Gal.)	11.5	5.84 Gal.	67	5.17 Gal.	59
Sodium Chlorate	10,602	0.00477 T	51	0.0042 T	45
Packing Materials			2,392		318
Chemicals & Others			1,295		560
Electrical Power (KWH)	0.690	14,017 KWH	9,672	3,167 KWH	2,185
Steam	115	39.54 T	4,547	27.1 T	3,117
Water	0.173	4,690 T	811	2,633 T	456

10.1.3 Sales of Byproducts and Purchase of Caustic Soda

Glauber's salt and chlorine are produced as salable byproducts from the plant and they can be sold to KPM and in other domestic market. Their prices were estimated as follows:

Anhydrous sodium sulphate: sold to KPM and outside, unit price TK 2,963/T (July, 1981)

Chlorine: 70% of the byproduct chlorine is assumed to be salable to KPM for TK 3,000/T (July, 1981), while before completion of BMR, the price is TK 4,000.

The internal production of caustic soda will fall short after July, 1981 when production of rayon staple fiber is started, and the price of caustic soda purchased was estimated at TK 4,000 CIF plant (July, 1981).

10.1.4 Other Conditions

1) Maintenance Cost

Maintenance cost of 2% of the cost both of the new and old investment was estimated.

2) Wage

The present wage for the total plant was multiplied by 1.2 and annual escalation of 10% was estimated. 25% of the amount thus obtained was allocated to the production cost of rayon staple fiber while 75% to that of rayon filament.

3) Insurance

0.5% of the present value of the plant was figured.

4) Payment and Interest of Loan

Yearly equal installments for 10 years after 5-year grace period and an interest rate of 9% per annum were assumed, and the repayment schedule for the loan and interest is as shown in Table 10-7. For the existing plant, payment of the interest is included but repayment of the loan was not included in the calculation.

5) Overhead

7% of annual escalation was added to the present amount of overhead.

10.1.5 Total Production Cost

The total production cost is as shown in Table 10-8.

Table 10-7. Repayment of Loan (TK 1,000)

Amount of Loan (New) 280,001

Year	Principal Repayment New	Interest New	Interest Old	Total Repayment	Balance
1	0	9,827	8,100	17,927	218,382
2	0	22,427	8,100	30,527	280,001
3	0	25,200	8,100	33,300	280,001
4	0	25,200	8,100	33,300	280,001
5	0	25,200	8,100	33,300	280,001
6	21,838	25,200	8,100	55,138	258,163
7	28,000	23,235	8,100	59,335	230,163
8	28,000	20,715	8,100	56,815	202,163
9	28,000	18,195	8,100	54,295	174,163
10	28,000	15,675	8,100	51,775	146,163
11	28,000	13,155	8,100	49,255	118,163
12	28,000	10,634	8,100	46,734	90,163
13	28,000	8,114	8,100	44,214	62,163
14	28,000	5,594	8,100	41,694	34,163
15	28,000	3,075	8,100	39,175	6,163
16	6,163	555	8,100	14,818	0

Table 10-8. Total Cost (July, 1981)

(Staple Fiber Plant 100% Operation)

Item	Filament		Staple Fiber	
	1,000 TK	per T (TK)	1,000 TK	per T (TK)
Raw Materials & Utilities		29,784		16,043
Credit (Sodium Sulphate)		-1,956		-1,896
Credit (Chlorine)	1,723	-1,044	5,168	-1,044
Variable Cost		26,784		13,103
Maintenance Cost	3,697		6,146	
Labour Cost	29,105		9,702	
Depreciation	10,920		23,589	
Insurance	546		1,179	
Interest	8,670		24,630	
Overhead	6,593		9,889	
Fixed Cost	59,531	36,079	75,135	15,179
Per Ton Cost		62,863		28,282

1) Relation between the rate of operation and total production cost in case of rayon staple fiber

The relation between the rate of operation and the total production cost in the case of rayon staple fiber is shown in Table 10-9.

Table 10-9. Total Cost per Ton of Staple Fiber by Operation Rate

(TK/T)

Operation Rate (%)	100	90	80	70
Variable Cost	13,103	13,103	13,103	13,103
Fixed Cost	15,179	16,866	18,974	21,684
Total Cost	28,282	29,969	32,077	34,787

2) Relation between rate of interest of loan and total production cost in case of rayon staple fiber

The relation between the rate of interest of loan and the total production cost in the case of rayon staple fiber is shown in Table 10-10.

Table 10-10. Total Cost per Ton of Staple Fiber by Interest Rate

Rate of Interest (%)	9.0	5.0	3.0	1.75
Variable Cost	13,103	13,103	13,103	13,103
Fixed Cost	15,179	13,331	12,407	11,830
Total Cost	28,282	26,434	25,510	24,933

10.2 Financial Analysis

The following assumptions were made for financial analysis, and the case based on such conditions will be referred to as "Base Case".

Life for financial calculation: 10 years

Selling prices of products: as per Paragraph 10.2.1

Rate of operation: Rayon filament is produced at 5 T/D including

	the period of BMR & E. The production capacity of rayon staple fiber is 15 T/D while the rate of operation is 70% in the first year after commencement of operation and 90% in the second year and onward.
Operating days:	330 days per year
Corporate income tax:	exempted for 7 years after commencement of operation and 55% thereafter.
Anticipated date of starting operation:	July 1, 1981

10.2.1 Selling Price of Product

The ex-factory selling prices of products were assumed based on the following considerations:

1) Rayon Filament

The ex-factory selling price of rayon filament at the end of 1978 was TK 52,917/T. By assuming an annual escalation of 7%, the selling price for July, 1981 was calculated to be TK 62,707/T. Assuming that the sales tax is unchanged at TK 3,300/T, TK 59,407/T was obtained as the net sales price.

2) Rayon Staple Fiber

In fixing the ex-factory price of rayon staple fiber, it is necessary to estimate its purchase price in Bangladesh in July 1981.

As the price of rayon staple fiber on the international market fluctuates to a considerable extent depending on the terms of trade, it is very difficult to predict the CIF price for July 1981.

The average price of rayon staple fiber on the international market from January to March 1979 registered US¢ 61.82/lb (from April to June about US¢ 67/lb).

As the freight and insurance total about 6¢/lb, the CIF price in Bangladesh is estimated to be 68¢/lb (TK 10.47/lb). In case the import duty of TK 0.5/lb and the miscellaneous expenses accompanying the import, which is assumed to be TK 0.5/lb, are added, the purchase price of rayon staple fiber in Bangladesh would become TK 11.47/lb (TK 25,489/T). Further, if a 6% annual escalation of price is taken into account, the purchase price in Bangladesh in July 1981 will be estimated at TK 29,212/T.

Rayon staple fiber to be produced at KRC may not be able to compete with the price of the counterpart which Bangladesh purchases on the international market because of KRC's constitutional defects such as the higher prices of main and secondary raw materials, a larger number of employees and so forth. In other words, when the rayon staple fiber to be produced by the present project should be sold at TK 29,212/T, the project would become unfeasible.

However, in Bangladesh it is stipulated in the law that when the selling price of a domestic product falls within 120% of the purchase price on the international market, it is permissible. Accordingly, if the selling price of rayon staple fiber is less than TK 35,000/T, it can be put on sale. Nevertheless, the rayon staple fiber being an essential goods for the people, it is desirable to sell it at the lowest possible price.

On the other hand, in order to secure the minimum profit as an enterprise, the selling price of rayon staple fiber to be produced at KRC must be higher than TK 31,000/T, as is mentioned later in this Chapter.

For the reasons described above, the ex-factory price of rayon staple fiber to be produced by the present project has been fixed at TK 31,000/T. This selling price corresponds to about 106% of the aforesaid purchase price.

10.2.2 International Rate of Return

International Rate of Return (IRR) was calculated based on said conditions, and 8.84% and 7.75% were obtained for IRR (before tax) and IRR (after tax) respectively.

Variation of IRR by variations of the investment, costs of raw materials and utilities and selling price of rayon staple fiber is shown in Figs. 10-1, 10-2 and 10-3.

Fig. 10-1. IRR vs. Investment Cost (After Tax)

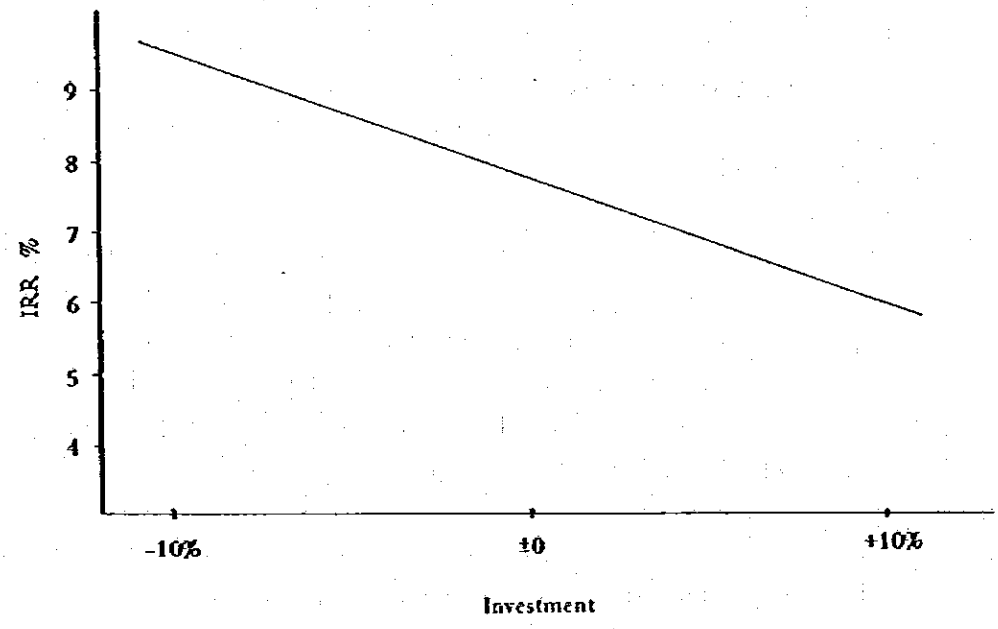


Fig. 10-2. IRR vs. Cost of Raw Materials and Utilities (After Tax)

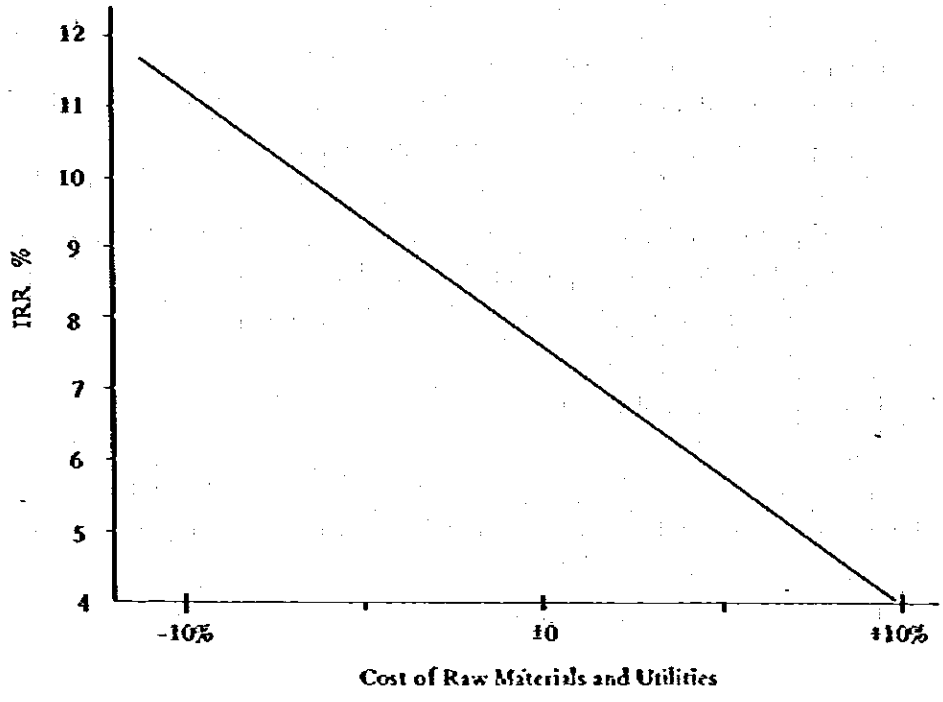
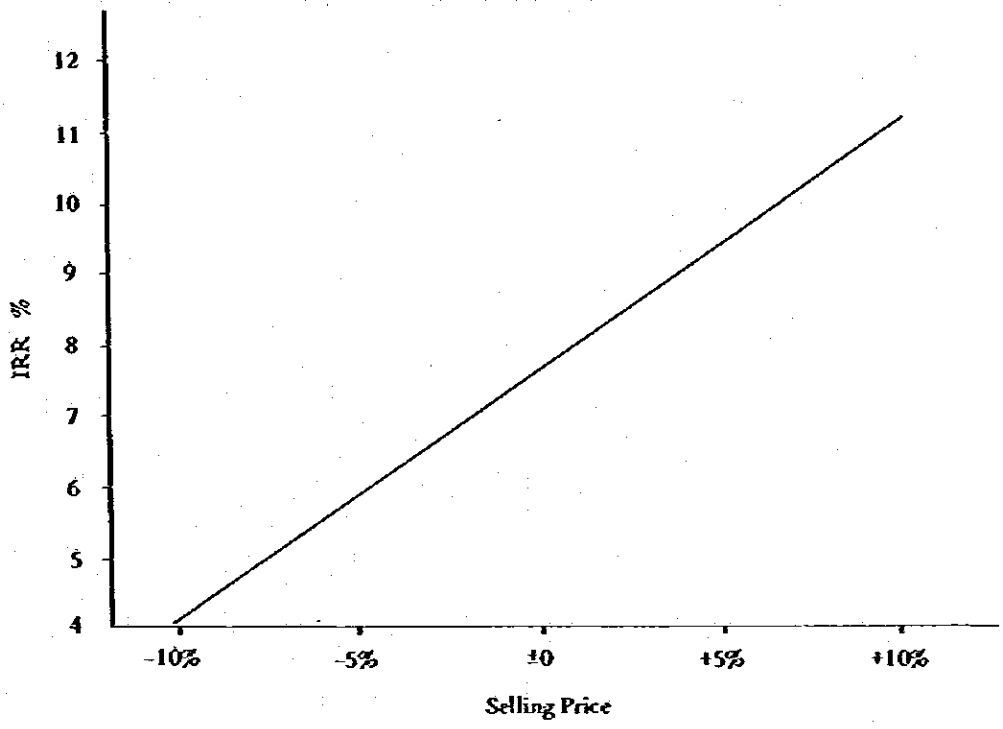


Fig. 10-3. IRR vs. Selling Price of Staple Fiber



10.2.3 Financial Statements

KRC's financial position is shown in Appendix II. In this Report it was unable to make a proforma balance sheet owing to the revaluation of the existing plant; while a proforma profit and loss account and a proforma fund flow are shown in Table 10-11 and Table 10-13 respectively.

10.2.4 Break-even Point Analysis

The interest payment burden in the production of staple fiber will become the heaviest in 1981. The break-even point analysis was made on the basis of the total cost shown in Table 10-8.

The break-even point in Fig. 10-4 was calculated with the annual interest rate of 9%. The rate of operation indicating the break-even point is almost 85%. The 9% interest rate has considerably raised the break-even point. Table 10-14 and Fig. 10-5 show how the rate of interest affects the break-even point.

These analyses clearly indicate how greatly the rate of interest will influence the break-even point. In order to improve KRC's financial position, therefore, it is advisable to make an endeavor to reduce as much as possible the 9% interest assumed in this Report.

Table 10-11.

FINANCIAL RATE

OF RETURN

SALES REVENUE

	(YEAR)	0	1	2	3	4	5	6	7	8
(1) RAYON FILAMENT										
RATE OF OPERATION			100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOCALLY										
QUANTITY	(T)		1650	1650	1650	1650	1650	1650	1650	1650
UNIT PRICE	(TK/T)		51649	55303	59407	59407	59407	59407	59407	59407
REVENUE	(1000TK)		84924	91250	98022	98022	98022	98022	98022	98022
(2) RAYON STAPLE FIBER										
RATE OF OPERATION					70.00	90.00	90.00	90.00	90.00	90.00
LOCALLY										
QUANTITY	(T)				3465	4455	4455	4455	4455	4455
UNIT PRICE	(TK/T)		31000	31000	31000	31000	31000	31000	31000	31000
REVENUE	(1000TK)				107415	138105	138105	138105	138105	138105
(3) SODIUM SULPHATE (F)										
RATE OF OPERATION										
LOCALLY										
QUANTITY	(T)		1089	1089	1089	1089	1089	1089	1089	1089
UNIT PRICE	(TK/T)		2588	2769	2963	2963	2963	2963	2963	2963
REVENUE	(1000TK)		2818	3015	3227	3227	3227	3227	3227	3227
(4) SODIUM SULPHATE (SF)										
RATE OF OPERATION										
LOCALLY										
QUANTITY	(T)				2218	2851	2851	2851	2851	2851
UNIT PRICE	(TK/T)		2963	2963	2963	2963	2963	2963	2963	2963
REVENUE	(1000TK)				6572	8448	8448	8448	8448	8448
(5) CHLORINE,ETC.										
RATE OF OPERATION										
LOCALLY										
QUANTITY	(T)		1202	1202	1838	2363	2363	2363	2363	2363
UNIT PRICE	(TK/T)		4000	4000	3000	3000	3000	3000	3000	3000
REVENUE	(1000TK)		4808	4808	5514	7089	7089	7089	7089	7089
REVENUE FROM PRODUCT	(1000TK)		92550	99073	220750	254891	254891	254891	254891	254891
REVENUE (LOCAL)	(1000TK)		92550	99073	220750	254891	254891	254891	254891	254891
REVENUE (EXPORT)	(1000TK)									
TOTAL REVENUE	(1000TK)		92550	99073	220750	254891	254891	254891	254891	254891

S A L E S R E V E N U E

		(YEAR)	9	10	11	12
(1) RAYON FILAMENT						
RATE OF OPERATION			100.00	100.00	100.00	100.00
LOCALLY						
QUANTITY	(	1T)	1650	1650	1650	1650
UNIT PRICE	(	TK/T)	59407	59407	59407	59407
REVENUE	(	1000TK)	98022	98022	98022	98022
(2) RAYON STAPLE FIBER						
RATE OF OPERATION			90.00	90.00	90.00	90.00
LOCALLY						
QUANTITY	(	1T)	4455	4455	4455	4455
UNIT PRICE	(	TK/T)	31000	31000	31000	31000
REVENUE	(	1000TK)	138105	138105	138105	138105
(3) SODIUM SULPHATE (F)						
RATE OF OPERATION						
LOCALLY						
QUANTITY	(	1T)	1089	1089	1089	1089
UNIT PRICE	(	TK/T)	2963	2963	2963	2963
REVENUE	(	1000TK)	3227	3227	3227	3227
(4) SODIUM SULPHATE (SF)						
RATE OF OPERATION						
LOCALLY						
QUANTITY	(	1T)	2851	2851	2851	2851
UNIT PRICE	(	TK/T)	2963	2963	2963	2963
REVENUE	(	1000TK)	8448	8448	8448	8448
(5) CHLORINE,ETC.						
RATE OF OPERATION						
LOCALLY						
QUANTITY	(	1T)	2363	2363	2363	2363
UNIT PRICE	(	TK/T)	3000	3000	3000	3000
REVENUE	(	1000TK)	7089	7089	7089	7089
REVENUE FROM PRODUCT	(	1000TK)	254891	254891	254891	254891
REVENUE (LOCAL)	(	1000TK)	254891	254891	254891	254891
REVENUE (EXPORT)	(	1000TK)				
TOTAL REVENUE	(	1000TK)	254891	254891	254891	254891

PRO FORMA INCOME STATEMENT

		(YEAR)	0	1	2	3	4	5	6	7	8
****REVENUE****											
TOTAL REVENUE	(	1000TK)		82550	99073	220750	254891	254891	254891	254891	254891
****COST****											
(1) RAW MATERIALS											
BAMBOO CHIP											
VALUE	(	1000TK)		3440	3805	11995	14232	14232	14232	14232	14232
IMPORTED PULP											
VALUE	(	1000TK)		5034	5346	16588	19680	19680	19680	19680	19680
COMMON SALT											
VALUE	(	1000TK)		3993	4273	7535	9688	9688	9688	9688	9688
CAUSTIC SODA(IMPORTED)											
VALUE	(	1000TK)				6468	6504	6504	6504	6504	6504
CHARCOAL											
VALUE	(	1000TK)		299	320	931	1099	1099	1099	1099	1099
SULPHUR											
VALUE	(	1000TK)		2813	3010	8589	10122	10122	10122	10122	10122
L.D.OIL											
VALUE	(	1000TK)		97	104	315	374	374	374	374	374
SODIUM CHLORATE											
VALUE	(	1000TK)		73	79	240	284	284	284	284	284
PACKING MATERIALS											
VALUE	(	1000TK)		3447	3689	5049	5364	5364	5364	5364	5364
CHEMICALS & OTHERS											
VALUE	(	1000TK)		1867	1997	4077	4632	4632	4632	4632	4632
(2) UTILITIES											
POWER											
VALUE	(	1000TK)		13930	14915	23530	25693	25693	25693	25693	25693
STEAM											
VALUE	(	1000TK)		6553	7012	18303	21389	21389	21389	21389	21389
WATER											
VALUE	(	1000TK)		1149	1250	2918	3369	3369	3369	3369	3369
(3) OPERATING LABOUR	(	1000TK)		32072	35279	38807	38807	38807	38807	38807	38807
(4) MAINTENANCE	(	1000TK)		3697	3697	9808	9808	9808	9808	9808	9808
(5) INSURANCE	(	1000TK)		313	313	1717	1717	1717	1717	1717	1717
(6) SALES AND ADMINISTRATION	(	1000TK)		14393	15401	16479	16479	16479	16479	16479	16479
(7) DEPRECIATION											
MACHINERY	(	1000TK)		6266	6266	34336	34336	34336	34336	34336	34336
BUILDING	(	1000TK)									
TOTAL OPERATING COST	(	1000TK)		99665	106486	207685	223577	223577	223577	223577	223577
NET OPERATING INCOME	(	1000TK)		-7115	-7413	13065	31314	31314	31314	31314	31314
INTEREST	(	1000TK)		17927	30927	33300	33300	33300	33300	31335	28815
SPECIAL ITEMS	(	1000TK)									
NET INCOME BEFORE TAX	(	1000TK)		-25042	-38340	-20235	-1986	-1986	-1986	-21	2499
INCOME TAX	(	1000TK)									
NET INCOME AFTER INT. & TAX	(	1000TK)		-25042	-38340	-20235	-1986	-1986	-1986	-21	2499

P R O F O R M A I N C O M E S T A T E M E N T

		(YEAR)	9	10	11	12
NET INCOME AFTER INT. & TAX						
TOTAL REVENUE	(	1000TK)	254891	254891	254891	254891
****COST****						
(1) RAW MATERIALS						
BAMBOO CHIP						
VALUE	(	1000TK)	14232	14232	14232	14232
IMPORTED PULP						
VALUE	(	1000TK)	19680	19680	19680	19680
COMMON SALT						
VALUE	(	1000TK)	9688	9688	9688	9688
CAUSTIC SODA(IMPORTED)						
VALUE	(	1000TK)	6504	6504	6504	6504
CHARCOAL						
VALUE	(	1000TK)	1099	1099	1099	1099
SULPHUR						
VALUE	(	1000TK)	10122	10122	10122	10122
L.D.OIL						
VALUE	(	1000TK)	374	374	374	374
SODIUM CHLORATE						
VALUE	(	1000TK)	284	284	284	284
PACKING MATERIALS						
VALUE	(	1000TK)	5364	5364	5364	5364
CHEMICALS & OTHERS						
VALUE	(	1000TK)	4632	4632	4632	4632
(2) UTILITIES						
POWER						
VALUE	(	1000TK)	25693	25693	25693	25693
STEAM						
VALUE	(	1000TK)	21380	21380	21380	21380
WATER						
VALUE	(	1000TK)	3369	3369	3369	3369
(3) OPERATING LABOUR	(	1000TK)	38807	38807	38807	38807
(4) MAINTENANCE	(	1000TK)	9808	9808	9808	9808
(5) INSURANCE	(	1000TK)	1717	1717	1717	1717
(6) SALES AND ADMINISTRATION	(	1000TK)	16479	16479	16479	16479
(7) DEPRECIATION						
MACHINERY	(	1000TK)	34336	34336	34336	34336
BUILDING	(	1000TK)				
TOTAL OPERATING COST	(	1000TK)	223577	223577	223577	223577
NET OPERATING INCOME	(	1000TK)	31314	31314	31314	31314
INTEREST	(	1000TK)	26295	23775	21255	18734
SPECIAL ITEMS	(	1000TK)				
NET INCOME BEFORE TAX	(	1000TK)	5019	7539	10059	12580
INCOME TAX	(	1000TK)		4146	5532	6919
NET INCOME AFTER INT. & TAX	(	1000TK)	5019	3393	4527	5661

INTERNAL RATE OF RETURN (FINANCIAL)

(UNIT= 1000TK)

YEAR	INVESTMENT	NET OPERATING INCOME	SPECIAL ITEMS	INCOME TAX AT 100% EQUITY	DEPRE-CIATION	SALVAGE VALUE	RECLAIMED WORKING CAPITAL	NET CASH INFLOW	DISCOUNT FACTOR	PRESENT VALUE OF NET CASH INFLOW
0	120030	0	0	0	0			-120030	1.00000	-120030
1	171309	-7115	0	0	6206			-172158	0.92810	-159781
2	80639	-7813	0	0	6206			-82336	0.86138	-70936
3	1078	11065	0	0	34336			46323	0.79945	37033
4	0	31314	0	0	34336			65650	0.74197	48711
5	0	31314	0	0	34336			65650	0.68863	45209
6	0	31314	0	0	34336			65650	0.63912	41958
7	0	31314	0	0	34336			65650	0.59317	38942
8	0	31314	0	0	34336			65650	0.55052	36142
9	0	31314	0	0	34336			65650	0.51094	33544
10	0	31314	0	17223	34336			48427	0.47421	22965
11	0	31314	0	17223	34336			48427	0.44012	21314
12	0	31314	0	17223	34336		12360	60787	0.40847	24830

TOTAL=0

INTERNAL RATE OF RETURN = 7.74A %

Table 10-12.

FINANCIAL RATE

OF RETURN

SALES REVENUE

	(YEAR)	0	1	2	3	4	5	6	7	8
(1) RAYON FILAMENT										
RATE OF OPERATION			100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOCALLY										
QUANTITY	(T)		1650	1650	1650	1650	1650	1650	1650	1650
UNIT PRICE	(TK/T)		51469	55303	59407	59407	59407	59407	59407	59407
REVENUE	(1000TK)		84924	91250	98022	98022	98022	98022	98022	98022
(2) RAYON STAPLE FIBER										
RATE OF OPERATION					70.00	90.00	90.00	90.00	90.00	90.00
LOCALLY										
QUANTITY	(T)				3465	4455	4455	4455	4455	4455
UNIT PRICE	(TK/T)		31000	31000	31000	31000	31000	31000	31000	31000
REVENUE	(1000TK)				107415	138105	138105	138105	138105	138105
(3) SODIUM SULPHATE (F)										
RATE OF OPERATION										
LOCALLY										
QUANTITY	(T)		1089	1089	1089	1089	1089	1089	1089	1089
UNIT PRICE	(TK/T)		2548	2769	2963	2963	2963	2963	2963	2963
REVENUE	(1000TK)		2818	3015	3227	3227	3227	3227	3227	3227
(4) SODIUM SULPHATE (SF)										
RATE OF OPERATION										
LOCALLY										
QUANTITY	(T)				2218	2851	2851	2851	2851	2851
UNIT PRICE	(TK/T)		2963	2963	2963	2963	2963	2963	2963	2963
REVENUE	(1000TK)				6572	8448	8448	8448	8448	8448
(5) CHLORINE,ETC.										
RATE OF OPERATION										
LOCALLY										
QUANTITY	(T)		1202	1202	1838	2363	2363	2363	2363	2363
UNIT PRICE	(TK/T)		4000	4000	3000	3000	3000	3000	3000	3000
REVENUE	(1000TK)		4808	4808	5514	7089	7089	7089	7089	7089
REVENUE FROM PRODUCT	(1000TK)		92550	99073	220750	284891	284891	284891	284891	284891
REVENUE (LOCAL)	(1000TK)		92550	99073	220750	284891	284891	284891	284891	284891
REVENUE (EXPORT)	(1000TK)									
TOTAL REVENUE	(1000TK)		92550	99073	220750	284891	284891	284891	284891	284891

S A L E S R E V E N U E

	(YEAR)	9	10	11	12
(1) RAYON FILAMENT					
RATE OF OPERATION		100.00	100.00	100.00	100.00
LOCALLY					
QUANTITY	(T)	1650	1650	1650	1650
UNIT PRICE	(TK/T)	59407	59407	59407	59407
REVENUE	(1000TK)	98022	98022	98022	98022
(2) RAYON STAPLE FIBER					
RATE OF OPERATION		90.00	90.00	90.00	90.00
LOCALLY					
QUANTITY	(T)	4455	4455	4455	4455
UNIT PRICE	(TK/T)	31000	31000	31000	31000
REVENUE	(1000TK)	138105	138105	138105	138105
(3) SODIUM SULPHATE (F)					
RATE OF OPERATION					
LOCALLY					
QUANTITY	(T)	1089	1089	1089	1089
UNIT PRICE	(TK/T)	2963	2963	2963	2963
REVENUE	(1000TK)	3227	3227	3227	3227
(4) SODIUM SULPHATE (SF)					
RATE OF OPERATION					
LOCALLY					
QUANTITY	(T)	2851	2851	2851	2851
UNIT PRICE	(TK/T)	2963	2963	2963	2963
REVENUE	(1000TK)	8448	8448	8448	8448
(5) CHLORINE,ETC.					
RATE OF OPERATION					
LOCALLY					
QUANTITY	(T)	2363	2363	2363	2363
UNIT PRICE	(TK/T)	3000	3000	3000	3000
REVENUE	(1000TK)	7089	7089	7089	7089
REVENUE FROM PRODUCT	(1000TK)	254891	254891	254891	254891
REVENUE (LOCAL)	(1000TK)	254891	254891	254891	254891
REVENUE (EXPORT)	(1000TK)				
TOTAL REVENUE	(1000TK)	254891	254891	254891	254891

PRO FORMA INCOME STATEMENT

		(YEAR) 0	1	2	3	4	5	6	7	8
****REVENUE****										
TOTAL REVENUE	(1000TK)		92550	99073	220750	254891	254891	254891	254891	254891
****COST****										
(1) RAW MATERIALS										
BAMBOO CHIP										
VALUE	(1000TK)		3640	3895	11995	14232	14232	14232	14232	14232
IMPORTED PULP										
VALUE	(1000TK)		5034	5386	16588	19680	19680	19680	19680	19680
COMMON SALT										
VALUE	(1000TK)		3993	4273	7535	9688	9688	9688	9688	9688
CAUSTIC SODA(IMPORTED)										
VALUE	(1000TK)				6468	6504	6504	6504	6504	6504
CHARCOAL										
VALUE	(1000TK)		299	320	931	1099	1099	1099	1099	1099
SULPHUR										
VALUE	(1000TK)		2813	3010	8589	10122	10122	10122	10122	10122
L.D.OIL										
VALUE	(1000TK)		97	104	315	374	374	374	374	374
SODIUM CHLORATE										
VALUE	(1000TK)		73	79	240	284	284	284	284	284
PACKING MATERIALS										
VALUE	(1000TK)		4447	3689	5049	5364	5364	5364	5364	5364
CHEMICALS & OTHERS										
VALUE	(1000TK)		1847	1997	4077	4632	4632	4632	4632	4632
(2) UTILITIES										
POWER										
VALUE	(1000TK)		13939	14915	23530	25693	25693	25693	25693	25693
STEAM										
VALUE	(1000TK)		8553	7012	18303	21389	21389	21389	21389	21389
WATER										
VALUE	(1000TK)		1149	1250	2918	3369	3369	3369	3369	3369
(3) OPERATING LABOUR	(1000TK)		32072	35279	38807	38807	38807	38807	38807	38807
(4) MAINTENANCE	(1000TK)		3697	3697	9808	9808	9808	9808	9808	9808
(5) INSURANCE	(1000TK)		313	313	1717	1717	1717	1717	1717	1717
(6) SALES AND ADMINISTRATION	(1000TK)		14903	15401	16479	16479	16479	16479	16479	16479
(7) DEPRECIATION										
MACHINERY	(1000TK)		6266	6266	34336	34336	34336	34336	34336	34336
BUILDING	(1000TK)									
TOTAL OPERATING COST	(1000TK)		99665	106886	207685	223577	223577	223577	223577	223577
NET OPERATING INCOME	(1000TK)		-7115	-7813	13065	31314	31314	31314	31314	31314
INTEREST	(1000TK)		17927	30527	33300	33300	33300	33300	31335	28815
SPECIAL ITEMS	(1000TK)									
NET INCOME BEFORE TAX	(1000TK)		-25042	-38340	-20235	-1986	-1986	-1986	-21	2499
INCOME TAX	(1000TK)									
NET INCOME AFTER INT. & TAX	(1000TK)		-25042	-38340	-20235	-1986	-1986	-1986	-21	2499

PRO FORMA INCOME STATEMENT

		(YEAR)	9	10	11	12
NET INCOME AFTER INT. & TAX						
TOTAL REVENUE	(	1000TK)	254891	254891	254891	254891
****COST****						
(1) RAW MATERIALS						
BAMBOO CHIP						
VALUE	(	1000TK)	14232	14232	14232	14232
IMPORTED PULP						
VALUE	(	1000TK)	19680	19680	19680	19680
COMMON SALT						
VALUE	(	1000TK)	9688	9688	9688	9688
CAUSTIC SODA(IMPORTED)						
VALUE	(	1000TK)	6504	6504	6504	6504
CHARCOAL						
VALUE	(	1000TK)	1099	1099	1099	1099
SULPHUR						
VALUE	(	1000TK)	10122	10122	10122	10122
L.D.OIL						
VALUE	(	1000TK)	374	374	374	374
SODIUM CHLORATE						
VALUE	(	1000TK)	284	284	284	284
PACKING MATERIALS						
VALUE	(	1000TK)	5364	5364	5364	5364
CHEMICALS & OTHERS						
VALUE	(	1000TK)	4632	4632	4632	4632
(2) UTILITIES						
POWER						
VALUE	(	1000TK)	25693	25693	25693	25693
STEAM						
VALUE	(	1000TK)	21389	21389	21389	21389
WATER						
VALUE	(	1000TK)	3369	3369	3369	3369
(3) OPERATING LABOUR	(	1000TK)	38807	38807	38807	38807
(4) MAINTENANCE	(	1000TK)	9808	9808	9808	9808
(5) INSURANCE	(	1000TK)	1717	1717	1717	1717
(6) SALES AND ADMINISTRATION	(	1000TK)	16479	16479	16479	16479
(7) DEPRECIATION						
MACHINERY	(	1000TK)	34336	34336	34336	34336
BUILDING	(	1000TK)				
TOTAL OPERATING COST	(	1000TK)	223577	223577	223577	223577
NET OPERATING INCOME	(	1000TK)	31314	31314	31314	31314
INTEREST	(	1000TK)	26295	23775	21255	18734
SPECIAL ITEMS	(	1000TK)				
NET INCOME BEFORE TAX	(	1000TK)	5019	7539	10059	12580
INCOME TAX	(	1000TK)				
NET INCOME AFTER INT. & TAX	(	1000TK)	5019	7539	10059	12580

INTERNAL RATE OF RETURN (FINANCIAL)

(UNIT= 1000TK)

YEAR	INVESTMENT	NET OPERATING INCOME	SPECIAL ITEMS	INCOME TAX AT 100% EQUITY	DEPRE-CIATION	SALVAGE VALUE	RECLAIMED WORKING CAPITAL	NET CASH INFLOW	DISCOUNT FACTOR	PRESENT VALUE OF NET CASH INFLOW
0	120030	0	0	0	0			-120030	1.00000	-120030
1	171309	-7115	0	0	6266			-172158	0.91876	-158173
2	80669	-7813	0	0	6266			-82236	0.84412	-69418
3	1078	13065	0	0	34336			46323	0.77555	35926
4	0	31314	0	0	34336			65650	0.71255	46779
5	0	31314	0	0	34336			65650	0.65466	42979
6	0	31314	0	0	34336			65650	0.60148	39488
7	0	31314	0	0	34336			65650	0.55262	36280
8	0	31314	0	0	34336			65650	0.50773	33335
9	0	31314	0	0	34336			65650	0.46648	30625
10	0	31314	0	0	34336			65650	0.42859	28137
11	0	31314	0	0	34336			65650	0.39377	25851
12	0	31314	0	0	34336		12360	78010	0.36178	28225

TOTAL=0

INTERNAL RATE OF RETURN = 8.861 %

Table 10-13. Pro Forma Fund Statement

(Unit: '000 TK)

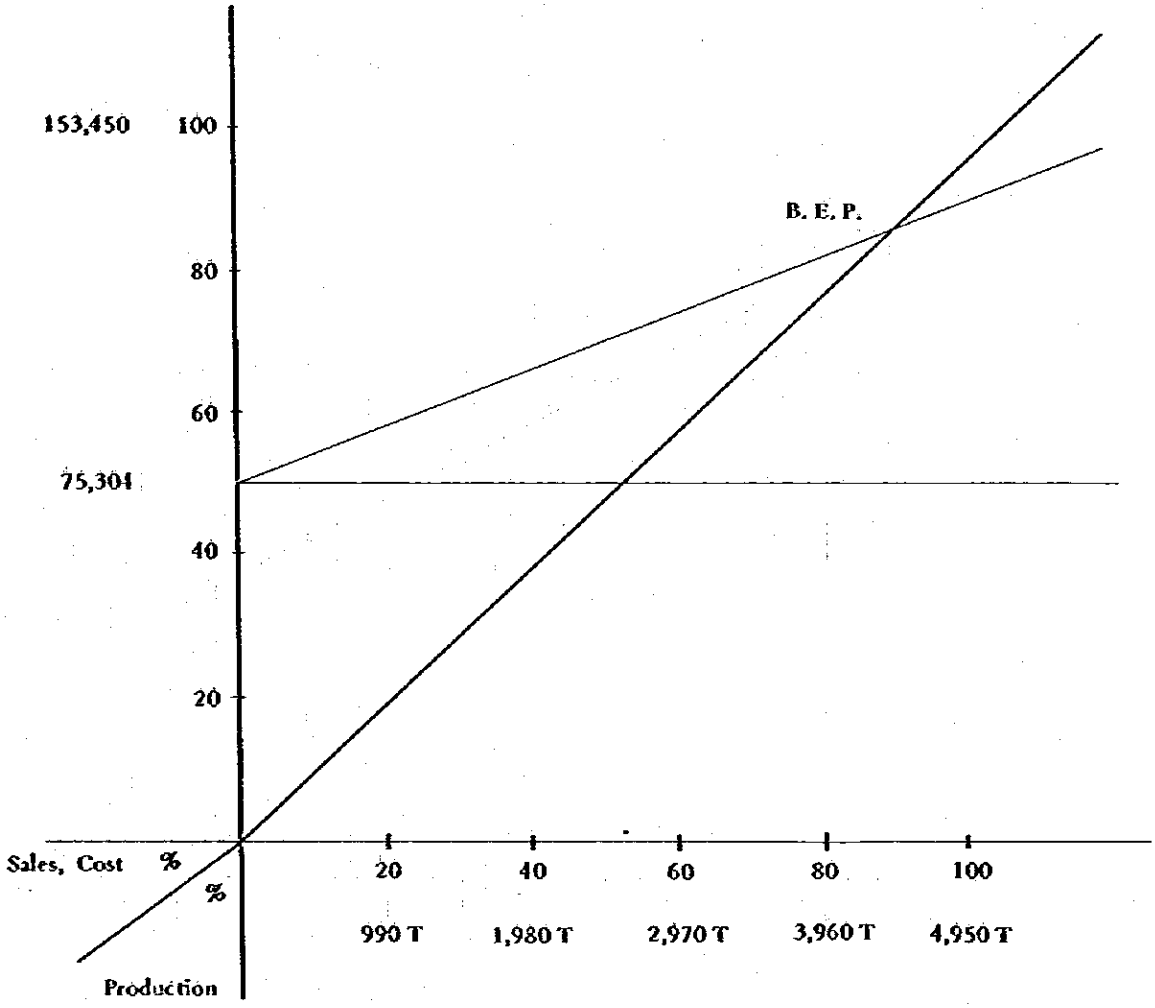
Year	1	2	3	4	5	6	7	8	9	10	11	12
Cash Inflow												
Net Operating Income	−7,115	-7,813	13,065	31,314	31,314	31,314	31,314	31,314	31,314	31,314	31,314	31,314
Depreciation	6,266	6,266	34,336	34,336	34,336	34,336	34,336	34,336	34,336	34,336	34,336	34,336
Total (A)	-849	-1,547	47,401	65,650	65,650	65,650	65,650	65,650	65,650	65,650	65,650	65,650
Cash Outflow												
Interest (Old)	8,100	8,100	8,100	8,100	8,100	8,100	8,100	8,100	8,100	8,100	8,100	8,100
(New)	9,827	22,427	25,200	25,200	25,200	25,200	23,235	20,715	18,195	15,675	13,155	10,634
Principal Repayment (New)						21,838	28,000	28,000	28,000	28,000	28,000	28,000
Income Tax										14,772	14,772	14,772
Total (B)	17,927	30,527	33,300	33,300	33,300	55,138	59,335	56,815	54,295	66,547	64,027	61,506
Balance (A − B)	-18,776	-32,074	14,101	32,350	32,350	10,512	6,315	8,835	11,355	-897	1,623	4,144

Table 10-14. Break-Even Point Analysis on Interest Rate
(Rayon Staple Fiber 1981)

Interest Rate	9%	5%	3%	1.75%
Variable Cost (TK/t)	13,103	13,103	13,103	13,103
Total Fixed Cost (1,000 TK)	75,304	66,078	61,464	58,583
Operation Ratio at Break-Even Point	85.1%	74.6%	69.4%	66.2%

Mark: Unit Sales Price per Ton : 31,000 TK

Fig. 10-4. Break-Even Point (Staple Fiber 1981)



Variable Cost per Ton: 13,103 TK

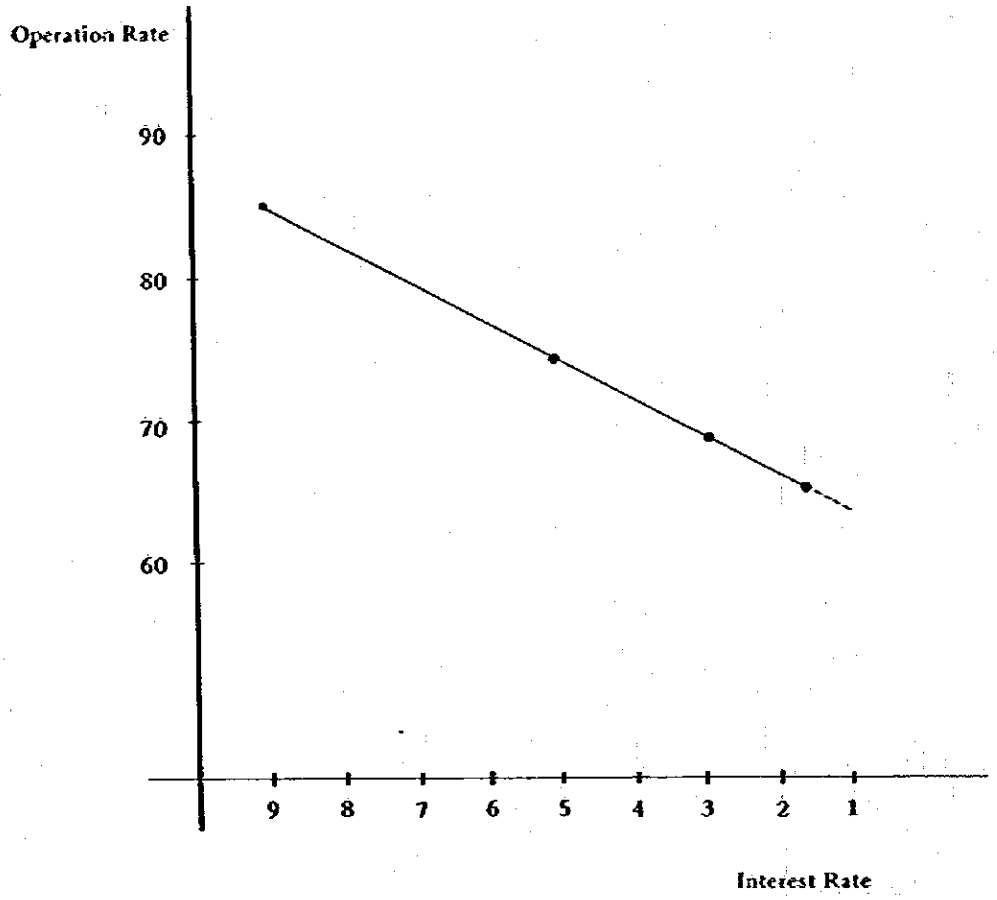
Unit Sales Price: 31,000 TK

Total Fixed Cost: 75,304,000 TK

$$\text{B.E.P.} = \frac{75{,}304{,}000}{31{,}000 \times (1 - 13{,}000/31{,}000)} = 4{,}210\ \text{T}$$

Operating Rate 4,210 ÷ 4,500 = 85.1%

Fig. 10-5. Break-Even Point Analysis on Interest Rate (1981)



10.2.5 Discussion

Speaking of rayon filament, its production is too small as compared with the production capacity, about one third of the latter, and this causes the high production cost. Therefore, a black-ink balance of the plant cannot be expected merely by its production.

The break-even point of rayon staple fiber production lies at about 85% operation, and a considerable profit can be expected at 90% operation.

IRR is by no means high enough, but considering such special situations as purchasing bamboo from the surrounding community by making grants, and paying wage to a far more number of employees than those in industrially advanced countries, the rate is by no means low.

In summing up the results obtained by the financial analysis, a sufficient amount of profit can be expected during economic life by execution of the present project. Therefore, it can be concluded that the present project is feasible from the financial viewpoint.

However, as the financial analysis of the present project clearly indicates, it is considered to be necessary to take the following measures for a steady operation of the textile mill when the present project is carried out.

Recommendations

a) This survey report evaluates the existing facilities of the plant by taking into due consideration their actual production capacities. The figure of IRR would be lowered conspicuously if the book values of the existing plant facilities as inscribed in KRC's financial statements are applied directly to the calculation of the rate of return on investment. In addition, there is the fear that the application would jeopardize the financial situation of KRC after consummation of the BMR & E project.

Accordingly, in order to improve KRC's financial situation and to enjoy benefit from the effects of this project, it is highly desired that the government of Bangladesh would approve the evaluation method adopted in this feasibility study report, and

and would adopt pertinent measures for the actual application of this method.

b) It is observed that the manufacturing cost of rayon staple fiber is substantially high owing to the high relending interest rate which has been assumed to be 9% per annum. Accordingly, the survey team recommend that the utmost efforts be made to lower the relending interest rate in order to stabilize the plant's financial position.

c) According to the results which is shown in Table 10-13, the plant will be faced with deficiency of funds in its early stage because of loss caused by rayon filament production. Therefore, the deficiency of funds should be supplemented by the Government of Bangladesh.

CHAPTER 11

ECONOMIC EFFECT OF THE PRESENT PROJECT

CHAPTER 11. ECONOMIC EFFECT OF THE PRESENT PROJECT

11.1 Economic Significance of the Present Project

11.1.1 National Economic Development Plan

The Government of Bangladesh planned the Two Year Plan (1978/79 - 1980/81) as an amendment to the First Five-Year Plan (1977/78 - 1980/81) for the purpose of its switching over to the Second Five-Year Plan (1981/82 - 1985/86) by reviewing the initial objectives and actual results at the stage of the First Five-Year Plan.

The present project is a national project among the Two-Year Plan indicated as a new program relating to BCIC. This is due to the effects anticipated by the present project being in good agreement with the objectives of the Two-Year Plan.

The Government of Bangladesh intends in this plan to improve the national geographical distribution of industries, especially as a hinterland policy to develop the regions by promotion of such industry that is locally favourable to each of the regions.

KRC is of the largest scale among the plants in eastern part of Bangladesh where industrial development is comparatively advanced, and it is an especially important entity in the hinterland of Chittagong Hill Tracts economically and socially and the dependence of this region on the plant is quite strong. Therefore, the present situation of KRC, incapable of showing a sufficient activity as an enterprise due to deterioration of the present plant, in spite of its favourable situation as regards procurement of raw materials, utilities and labour which are basic requirements for the rayon industry, is a problem. Owing to this fact, the community is not receiving its due convenience from KRC at the present time. Accordingly, the BMR & E project has an economic significance to respond to the requirements by the community.

Objectives of the Two Year Plan (1978 - 80):

In the manufacturing sector the Two Year Plan aims at achieving the following principal objectives:

(i) To accelerate the growth of the manufacturing sector;

(ii) To increase production of essential wage-goods such as coarse cloth and common diseases medicine to ensure their minimum supply to the masses;

(iii) To improve management efficiency of the public sector industrial enterprises;

(iv) To further stimulate the private sector particularly in export and agro-based industries;

(v) To achieve socially desirable equity in income distribution through promotion of small, cottage and rural indsutry;

(vi) To ensure balanced geographical distribution of industries and encourage regional cooperation in industrial development;

(vii) To increase production of capital goods particularly those which have strong linkage with agriculture and physical infrastructure development;

(viii) To promote and support export oriented and import substitution industries.

Strategies and Priorities of the Two-Year Plan

With a view to realizing the objectives, the Plan follows certain strategies and priorities which among others are as follows:

(a) Increase in Industrial Output:

(i) Fuller utilization of existing capacity in industrial units has been given the highest emphasis. This will be ensured through adequate and regular supply of both local and imported raw materials, spares, power and improvement in managerial and technical skills.

(ii) Sick and inefficient industrial units will be improved through balancing and modernization with emphasis on improvement in quality and product diversification. The units having no potential for improvement will be eliminated.

(iii) Aided on-going projects will be assigned high priority to make as many of them productive as possible by the end of the Two Year Plan to enable the economy

to get the promised benefits out of them.

(iv) Efforts to improve management of public sector enterprises will continue through re-organization and decentralization of authority in decision making and better labour-management relationship. Action will also be taken for improvement of management quality through institutional arrangements.

(b) Employment:

Except in areas where modern capital-intensive technology and large-scale operations are guided by overriding technical and economic considerations, choice has been made in favour of labour-intensive technology, and small, cottage and rural industries.

(c) As far as practicable frequent charge of key personnel of Development Ministries/ Divisions/Agencies and Chairman and Directors of Public Sector Industrial Development Corporations should be avoided in the interest of development work.

(d) Location:

In order to promote regional development, locations of industries will be dispersed in different regions through incentives, concessions and administrative directives except in the case of industries where overriding technical and economic considerations do not favour such dispersal.

(e) Public and Private Sector:

In tune with the features of mixed economy, public sector and private sector will co-exist complementing each other. The policy of allowing private sector to play legitimate role in industrial development will be vigorously pursued.

(f) Industrial Research and Quality Control:

Development of skill and technology is an essential element in making industrial growth progressive and self-sustaining. Research for development of skill and technology has been emphasized in the Plan. Quality control measures particularly in the export oriented industries will be strengthened.

(g) Import substitution and export promotion:

Gradual substitution of imports and vigorous expansion of exports are essential for attainment of a self-reliant economy. To support and promote import substitution industries a Committee namely "Import Substitutes Co-ordination Committee" with the Minister in-charge, Ministry of Planning as Chairman has been constituted by the Government. The Committee has already started work to maximise utilization of existing capacities for import substitution and also to explore the new areas for import substitution. The Government efforts towards rapid promotion of exports through diversification of production, cost reduction, quality improvement and promotion of Bangladesh products abraod will be further strengthened.

(h) Fiscal Anomalies Committee should be activised.

(i) Tarriff Commission should be further strengthened and activised.

11.1.2 Economical Character of the Present Project

All of the Bangladesh national projects are classified from the economic effect they should achieve into the following three types, and the present one belongs to type X:

1) Project type-X

The type of projects where tangible benefits can be obtained in the form either of goods or services, and the working capital and profit can be earned as reward through the sales of the goods or service. Most of the industrial projects can be classified as this type.

2) Project type-Y

The type of projects where tangible benefits can be obtained but reward cannot be earned. Irrigation project and bank making project are classified into this type. The benefit in projects of type-X and type-Y is quantifiable.

3) Project type-Z

The type of projects where merely service benefits are obtained that are difficult to

quantify, as the character of the projects. For example, educational and medical projects are classified into this type.

The present project belongs to the type-X and execution of BMR & E Project will result in a rapid and sure recovery of KRC itself. In addition, the community will be provided with unquantifiable benefits such as those described in the next paragraph at the same time, and the project is characteristic also of type-Y and type-Z in this sense.

11.2 Economic Benefit Obtainable by the Present Project

11.2.1 Tangible Benefit

As a result of execution of the present project, rayon staple fiber is produced, 3,465 tons in the first year and 4,455 tons in the second year and onward. Sodium sulphate is also produced as a by-product of rayon staple fiber. Both of the goods are being imported at a cost of valuable foreign currency, and they will be sold for high prices after home production.

Production of chlorine is increased by execution of BMR and its surplus will be sold to KPM.

A large amount of economic benefit will be obtained by these productions (increased production in the case of sodium sulphate and chlorine).

11.2.2 Indirect Benefit

1) Saving Effect of Foreign Currency by Substitution of Import

The present project aims at rehabilitating the existing plant for rayon staple fiber with partial installation of new equipments to enable production of 15 T/D (4,950 T/Y) of rayon staple fiber, while the existing plant for rayon filament and cellophane is left intact.

By execution of the present project, a part of the rayon staple fiber imported at present, 6,000 - 7,000 T a year, will be substituted by the home product. The amount of substitution will reach 4,950 T a year when the plant is operated 100%. The start-up of the plant is expected in July, 1981, and the rate of operation will be 70% and 90% in the first year and the second year and onward respectively. Opera-

tion for 10 years in total is anticipated.

The present calculation was carried out on an assumption of yearly price escalation of 7%, while the same rate was applied as discount rate in calculating the present value.

As for the borrowing of foreign currency, the following conditions were assumed:

Amount of loan:	¥3,636,381,000
Interest per annum: (in yen credit)	1.75%
Principal payment:	Fixed installment for 20 years after 10 years grace period

Case A: Outflow of Foreign Currency by Execution of the Present Project

	Requirement for 3,465 T of S.F. ('000 TK)	Requirement for 4,455 T of S.F. ('000 TK)
Imported Pulp	10,825	13,917
Caustic Soda (if imported)	6,468	6,504
Sulphur	5,367	6,901
LD Oil	204	263
Sodium Chlorate	156	200
Chemicals & Others	1,940	2,495
Electrical Power (80% of cost)	6,057	7,787
Steam (80% of cost)	8,640	11,109
Maintenance	6,146	6,146
Credit	-10,187	-13,098
	35,616 (A)	42,224 (B)

Outflow of Foreign Exchange ('000 TK)

Year	Repayment of Principal	Interest	Import of Raw Material	Discount Factor (7%)
0				1.0
1		3,920		0.935
2		4,900		0.873
3		4,900	A	0.816
4		4,900	$B \times (1.07)^1$	0.763
5		4,900	$B \times (\quad)^2$	0.713
6		4,900	$B \times (\quad)^3$	0.666
7		4,900	$B \times (\quad)^4$	0.623
8		4,900	$B \times (\quad)^5$	0.582
9		4,900	$B \times (\quad)^6$	0.544
10		4,900	$B \times (\quad)^7$	0.508
11	11,200	4,900	$B \times (\quad)^8$	0.475
12	14,000	4,704	$B \times (\quad)^9$	0.444
13	14,000	4,459		0.415
14	14,000	4,214		0.388
15	14,000	3,969		0.362
16	14,000	3,724		0.339
17	14,000	3,479		0.317
18	14,000	3,232		0.296
19	14,000	2,989		0.277
20	14,000	2,744		0.258
21	14,000	2,499		0.242
22	14,000	2,254		0.226
23	14,000	2,009		0.211
24	14,000	1,764		0.197
25	14,000	1,519		0.184
26	14,000	1,214		0.172
27	14,000	1,029		0.161
28	14,000	784		0.150
29	14,000	539		0.141
30	14,000	294		0.131
31	2,800	49		0.115
Value in Year "0"	74,396	49,958	339,178	

Total Outflow: TK463,532,000

Case B: Outflow of Foreign Currency without Execution of the Present Project

The amount of outflowing foreign currency by import of rayon staple fiber of 3,465 T/Y (first operating year) and 4,455 T/Y (second operating year and onward) is calculated as follows:

		Discount Factor (7%)
0		1.0
1		0.935
2		0.873
3	22,963 x 3,465	0.816
4	22,963 x 4,455 x $(1.07)^1$	0.763
5	$(\quad)^2$	0.713
6	$(\quad)^3$	0.666
7	$(\quad)^4$	0.623
8	$(\quad)^5$	0.582
9	$(\quad)^6$	0.544
10	$(\quad)^7$	0.508
11	$(\quad)^8$	0.475
12	$(\quad)^9$	0.444
Value in Year "0"	TK899,696,000	

Saving of Foreign Currency:

By execution of the present project, TK436,164,000 (U.S.$28,322,000) of foreign currency in terms of 1979 value can be saved from flowing out.

2) Export of Rayon Filament and Cellophane

A part of the rayon filament and cellophane produced is exported, as shown in the following table, and they are contributing to acquiring foreign money. However, it is difficult to estimate future trend of the export, and the effect of the present project on the possible increase is neglected in the present report. The actual result of export is shown in Table 11-1.

Table 11-1. Yearwise Export Quantity of Rayon and Cellophane

Year	Export (Unit Tons)	Cost of Production TK/Ton	FOB Export Price TK/Ton	Country
(A) RAYON :				
1972 - 73	365	19,943	11,026	Hongkong, India, Thailand, Japan, West Germany
1973 - 74	428	27,817	14,503	India, Thailand, Japan, Bulgaria, Hongkong, Afghanistan, Barlain, Indonesia
1974 - 75	45	43,662	14,654	Japan, Thailand, India
1975 - 76	278	52,042	20,418	Brussels, Hongkong, Afghanistan, Switzerland
1976 - 77	245	50,188	28,228	Pakistan, Afghanistan
1977 - 78	163	59,882	25,554	Romania, Pakistan, Iran
1978 - 79 (Dec. '78)	-	53,778	-	-
(B) CELLOPHANE :				
1972 - 73	Nil	Nil	Nil	-
1973 - 74	237	28,194	11,245	
1974 - 75	74	38,638	11,139	-
1975 - 76	166	51,403	20,171	-
1976 - 77	24	50,271	20,902	Singapore, Pakistan
1977 - 78	61	48,717	24,197	Sri Lanka, Pakistan, Malaysia, Singapore
1978 - 79 (upto Dec. 78)	88	48,100	24,867	Malaysia, Singapore, Pakistan, Burma

3) Ensuring of Employment Opportunity

The total number of direct employees by KRC is about 3,000 including 100 staff members and about 2,900 labourers as of February, 1979. About 450 people work for the management department and about 2,550 people for production.

Table 11-2. Manpower Turn-Over

Year	Total Strength	New Recruitment	Total Leaving
1979 (up to Feb. '79)	100	-	1
1978	101	19	10
1977	90	5	6
1976	91	4	6
1975	98	-	3
1974	97	-	6
1973	95	5	5
1972	95	-	13
1971	111	-	-
1970	110	2	-
1969	110	2	-
1958	98	15	-
1967	91	2	-

Deterioration of the equipment of KRC is remarkable, and it is proceeding, or even being accelerated, in spite of the effort of KRC staff for maintenance. Due to the idling of the equipment, idling of labour can be seen with a part of the workers; and employment of the 3,000 employees is expected to be difficult in the near future, going hand in hand with the poor financial situaiton and difficulty in paying wage. By execution of BMR & E Project, however, employment of the 3,000 employees will be ensured, probably with some possibilities of additional employment in some of the new departments.

In addition to the direct employment inside the plant, the number of workers for felling and transporting bamboo tht raw material of pulp will increase from the present 2,000 people by execution of the present project, and another 2,000 workers engaged in processing and packaging industries which use rayon and cello-

phane as raw material will be assured of their jobs with additional 500 workers approximately newly required.

4) Other Indirect Benefit

The total length of the roads through which the bamboo is transported for KRC amounts to about 640 km, of which only about 15 km is owned by KRC. KRC owns two schools, one hospital, two stores for daily necessities, three guest houses, six mosques, and three club houses for the staff as their welfare facilities. The roads are maintained owing greatly to KRC, and the roads and welfare facilities are used both by KRC and inhabitants of the region. By execution of the present project, the benefit enjoued by about 20,000 inhabitants in the special region will be ensured in the future.

In Bangladesh, a large part of the rayon is supplied to the hand waieving sector. People engaged in hand wieving that belongs to kraft industry of a cottage scale are poor and have no alternative in changing their occupation. Continued supply of rayon to about 50,000 of such people can be secured by execution of the present project. Besides, many small firms are being operated in Chittagong Hill Tracts who depend on the supply of rayon or cellophane from KRC and the supply is also guaranteed by execution of the present project.

APPENDIX I

ESSENTIAL EQUIPMENT FOR B.M.R. & E. PROJECT

PART (I)

ESSENTIAL EQUIPMENT AND PARTS

FOR REPLACEMENT

Q'ty	Description
	SECTION: RAYON FILAMENT PLANT
	Slurry System
2	Slurry feed pump
2	Flanged press roll
2	Plain press roll
2 sets	Roll bearing ass'y
2 sets	Seal plate
2 sets	Roll seal & cleaner ass'y
	Pnuematic Conveying System (A line)
1	Cooler & heater
	Ageing Tower Ass'y
8	Solenoid valve for servo mechanism
	Alkali-cellulose Conveying System (B line)
1	Alkali-cellulose condenser
	Alkali-cellulose Measuring
1 set	Chain and sprocket
	Xanthation
1 set	Packing, setting bolt, valve seat for dry churn
6 sets	CS_2 charging pipe (reinforced type)
6 sets	Magnet brake for dry churn drive motor
2	Rotor for Nash type pump
2	Rotor for Nash type pump

Q'ty	Description
	Ripening & Filtration System
5 sets	Gear set
12	Gauge glass
	Deaeration System
20	Cock
	Acid Bath
1 set	Lead sheet for repairing of bottom part in No. 2 tank, No. 1 return tank, filtrate tank, and No. 2 acid tank.
1 set	Lead piping materials for repairing of acid bath
	Acid Recovery
1 set	Repairing materials for the 1st evaporator vessel Mechanical seal & shaft sleeve for intermediate acid pump
1 set	Worm gear for rotary vacuum filter
	Jet Laboratory
1	Microscope for spinnerette inspection
1	Projector for spinnerette hole inspection
	SECTION: ANHYDROUS SODIUM SULPHATE PLANT
	Melting
1 set	Repairing materials for melting tank
	Evaporator
1 set	Repairing materials for evaporating vessel

Q'ty	Description
1 set	Mechanical seal & shaft sleeve for forced circulation pump
1	Receiver
	Centrifuge
1 set	Repairing parts, consisting of:
2	Basket
2	Brake pulley
2	Brake lining
5	Ampere meter
1 set	Agitator for settling tank
	Rotary Dryer
1 set	Rotary burner with gear pump for rotary dryer
	SECTION: AIR CONDITIONING
	Spinning Room
240	Air outlet register, VS type
4	Roller bearing for main exhaust fan
	SECTION: CS_2 & Na_2S PLANT
12 sets	Conductive band (For 2 furnaces)
1	Exhaust fan
1	Circulation water pump, with motor, c.i.
2	Caustic soda circulation pump, with motor

Q'ty	Description
	SECTION: WATER PLANT
	SB Type Clearator
1	SB clarifier, ferro-concrete center column, to be modified and reinforced.
1	Inner equipment, to be reinforced and/or replaced.
	SECTION: REFRIGERATION
	Refrigerator-unit, 440 RT for General Cooling
	Repairing parts, consisting of:
1	Oil pump with accessories
1	Oil heater
1	Oil cooler
1	Impeller with accessories
1	Gear (Large)
1	Gear (Small)
1	Gear coupling ass'y
1 set	Bearing ass'y
1 set	Thrust bearing ass'y
1	Lever for vane control
1	Packing and seal for chamber
1	Pipe and flange for oil cooler
1	Standard tools
1	Gas leakage checker
1 set	Condenser
	SECTION: BAMBOO DISSOLVING PULP PLANT
	Cooking
1	Pre-heater for digester, shell & tube type, SUS

Q'ty	Description
1 set	Desuperheater with turbo-pump
1 set	Steam control valve for digester
	Blowing
1	Gear reducer for blow tank
	Washing & Screening
2	Pulp pump, centrifugal, casing c.i.
2	Pulp pump, centrifugal, casing c.i.
	Bleaching & After Screening
1	Pump for 3rd centri-cleaner
1	Agitator, type KR-4, SUS
1 set	Agitator for new Belmer chest, type KR-4, SUS
1	Motor for above
1 lot	Acid proof tile and cement for Midfeather type concrete chest
1	Pinion and gear set for HCl thickener
1	HCl pump, centrifugal, rubber lined m.s.
1	Motor for HCl pump
1	Chlorine mixer
53	Nozzle for Centri-cleaner
	Bleaching Chemical
1 lot	Tile and acid proof cement for NaOCl storage tank
2	NaOCl feeding pump, centrifugal, SUS
1	Constant volume pump, twin plunger type, SUS
1	Motor for Constant volume pump
2	SO_2 blower, NGK type

Q'ty	Description
	Sheet Making
4	Chain stepless gear reducer, type 2SVb-4:1
	Copper flexible pipe with fittings
1 set	Hot water pump with motor
	Various knives for sheet cutting
1	Fly knife gear pinion
1	Motor for conveyor
	SECTION: CAUSTIC SODA & CHLORINE PLANT
	Brine Purification Plant
10	Brine pump, centrifugal gland packing seal, DK-CU type, 30 mH, 36 m^3/h, with enclosed fan cooled motor, 15 KW;
	2 sets - For saturator transfer
	2 sets - For sand filter transfer
	2 sets - For head tank transfer
	2 sets - For dechlorinator supply
	2 sets - For purifier transfer
250 m^2	Lining materials for clarifier (FRP)
1 set	Driving unit for clarifier
1,000 kg	Lining materials for purified brine tank
2,000 kg	Lining materials for filtered brine tanks
1 set	Salt conveyor, Merric type scale, with motor and starter
1 set	Magnetic vibrator
	Electrolysis Plant
440 pcs.	Graphite anode plate, 0.99 m x 0.28 m x 75 mmt
880 pcs.	Graphite stem, 110 mm dia. x 300 mmL
4,000 kg	Graphite pellet, 10 mm dia. x 10 mmL
30 sets	Short circuit switch, 8,000 amp. oil immersed, enclosed type

Q'ty	Description
	Refrigeration
1 set	Refrigeration unit, 25 RT
	SECTION: HYDROCHLORIC ACID PLANT
1 set	Hydrogen blower

PART (II)

INSTRUMENTS NECESSARY FOR REPLACEMENT

Q'ty	Description
	SECTION: PUMP MILL
1 set	Flow indicator for various application
1 set	Level indicator for various application
1 set	Flow integrating recorder for various application
1 set	Temperature indicator for hot water tank
1 set	6-point temperature recorder
1 lot	Wiring and piping materials
2 sets	Temperature recording controller for warm water, complete with control valve
6 sets	Spare controller unit for above TRC
6	Amprifier unit
1 set	Level indicating controller
3 sets	6-point temperature indicator
4 sets	Bobbin resistance for above
2 sets	2-point pressure recorder
2 sets	DP transmitter for above
4 sets	Rayon pulp consistency recording controller for washing, bleaching, after screening plants
1 set	Pressure indicating controller for rayon digester
2 sets	Level controller for 1st stage screen head box, with DP cell
	SECTION: ClO_2 Plant
1 set	Flow indicator for various application
1 set	6-point temperature recorder
1 set	2-point manometer with 5-channels
1 set	Level controller for chilled water
1 set	Panel board in the spot
1 lot	Wiring and piping materials
2 sets	ARC-6-6-4, SO_2 and air mixture
6 sets	Rotameter

Q'ty	Description
	SECTION: RAYON MILL
1 set	Acid flow indicator for various application
4 sets	Flow indicator and recorder with totalizer for steam
1 set	Acid flow recorder
1 set	Level switch for Na_2SO_4 melting tank
1 set	pH-indicating recorder for Na_2SO_4
2 sets	Flow indicator with totalizer for steam
1 set	Multi-point temperature recorder for evaporator, complete with sensing element
1 set	Panel board in acid recovery
2 sets	Flow recorder for NaOH in slurry room
2 sets	Psychrometer for temperature recorder in air-conditioning system
1 set	Panel board in the spot
1 lot	Wiring and piping materials
	SECTION: WATER PLANT
1 set	Turbidity meter for raw water
1 set	Conductivity recorder for deionized water
	SECTION: CS_2 PLANT
2 sets	Flow meter
1 set	Temperature recorder for SC_2 refining unit
2 sets	6-point temperature recorder for furnace
1 set	Panel board in the spot, complete with wiring and relay system
7	Dial thermometer
2 sets	Flow integrator for sulphur distributor
1 set	Alarm for auxiliary tank
1 set	Instruments for refrigerator
6 sets	HT fuse with base
1 set	OCR, CT, PT for HT circuit breaker

Q'ty	Description
	SECTION: SULPHURIC ACID PLANT
1 set	Temperature recorder for furnace outlet
1 set	6-point temperature recorder
1 set	Multi-point temperature indicator
1 set	Flow indicator for outlet air of drying tower
	Flow indicating integrator for H_2SO_4
1 set	Density recorder for SO_2 gas
1 set	Density recording controller for H_2SO_4
1 set	Panel board in the spot
1 lot	Wiring and piping materials
1 set	Cast iron pipes with bend for irrigation cooler and acid circulation line
	SECTION: CAUSTIC SODA & CHLORINE PLANT
1 set	Flow indicator (rotameter) for various application
1 set	Density recording controller for brine
2 sets	Level indicating controller for dilute brine
1 set	pH recording controller for mixing tank
1 set	Instruments for CHl section shown hereunder are to be accommodated in an instrument panel
	Controllers shall be complete with control valves.
10	Thermometer
1 set	Flow indicator
1 set	Pressure indicating alarms
1 set	Level indicating controller
1 set	Flow indicator (rotameter)
1 set	Shut down valve for N_2

PART (III)

ESSENTIAL EQUIPMENT AND PARTS

FOR BALANCING & MODERNIZATION

Q'ty	Description
	SECTION: CAUSTIC SYSTEM
	Caustic Recovery
1	Filter press, c.i.
	Piping, Valve, Cock & Fitting
	Necessary parts and accessories
	SECTION: SLURRY SYSTEM
1 set	Control unit for beam scale, modified
1	PIV, 4Hc-6:1
1 set	Al-cell conveying system with condenser roll The system ensures interchanging delivery of Al-cell with the Rayon Filament line in an emergency case
1	Alkali-cellulose feeder, relocation
1 set	Alkali-cellulose transport pipe with fittings, modified
1 set	Semi-graphic panel
	SECTION: AGEING
	One continuous ageing line to be added to conform Alkali-cellulose quality to staple fiber production
	Piping, Valve, Cock & Fitting
	Necessary parts and accessories for functioning the following ageing machine.
	Continuous Ageing Machine
1	Continuous ageing machine, horizontal square box, with endless belt conveyor, capacity equivalent to 15 T/D staple fiber production

Q'ty	Description
1 set	Control panel
1 set	Measuring instruments
	Alkali-cellulose Pneumatic Conveying System
1	Alkali-cellulose feeder, plastic coated
2 (1)	Blower, 5,000 Nm^3/H, with suction filter
1	Heater & Cooler
1 set	Transport line, plastic tube
1	Cyclone, plastic coated, m.s.
1	Dust collecting cyclone, m.s.
1	Intermediate hopper, m.s.
1 set	Insulating material
1	Alkali-cellulose condenser
1 set	Platform
1 set	Measuring/controlling instrument & panel
1 set	Alkali-cellulose transport pipe with fittings, modified
	Al-cell Measuring
1	Scale hopper, with automatic weighing unit
1	Chute, m.s.
1 set	Control panel
	SECTION: XANTHATION
	Two additional dry churns as well as four dry churns existing are necessary for composing the 15 T/D staple fiber production line
2	Dry churn ass'y 7,000 L, with heat insulation
2	Operating platform, m.s.
2	Hopper for xanthate, m.s.
2	Frame, m.s.
1	Nash pump, with air ejector
2	CS_2 measuring tank
1 set	Piping, valve, cock & fitting

Q'ty	Description
1 set	Measuring instruments & panel

SECTION: DISSOLVING

Two additional dissolvers with viscose grinding devices as well as four existing dissolvers reinforced with viscose grinding devices are necessary for composing the 15 T/D staple fiber production line. Two additional grinders are provided for two dissolvers for rayon filament line.

2	Dissolver, equivalent capacity to 450 kg pump feed, with insulation
8	Viscose grinder with pump
1 set	Measuring instruments

Dissolving Caustic Measuring System

1 set	Autometering system control panel
1	Intermediate tank, 10 m^3 m.s.
2	Pump, c.i.
1	Cooler
1	Oval flow meter
1 set	Piping, valve, cock & fitting
1 set	Measuring/controlling instruments

SECTION: VISCOSE RIPENING

To conform the facilities to different viscose, an independent viscose ripening line is to be installed.

Viscose Blending System

1	Blender, 18 m^3 m.s., with agitator and insulation
2	Gear pump, c.i.
1	Gear pump, c.i., with PIV & G-O motor
1 set	Measuring/controlling instruments and panel

Q'ty	Description
1	Viscose cooler, scraping type
1	Oval flow meter
1	Graphic panel
	Viscose Ripening & Filtration System
2	"A" tank, 12 m^3 m.s.
1 set	Automatic filtration unit, complete with instrumentation
1	Gear pump, c.i., with PIV & G-O motor
1	"D" tank, 12 m^3 m.s.
1 set	Measuring/controlling instruments and panel
	Viscose Deaeration System
	A small deaerator tank is to be installed in the rayon filament line, and existing 60" deaerator tank is to be utilized in the new staple fiber line
1	Gear pump, with PIV & G-O motor
1	Butterfly valve
1	Panel board
1 set	Measuring/controlling instruments and panel
1	Vacuum ejector
1 set	Structural support
1	Hot well tank
1 set	Piping, valve & fitting
	Discharge pump, screw type, with PIV & G-O motor
1	Deaerator, 48", SUS lined
	Spinning Viscose Feed System
1	Feed tank, 20 m^3 with jacket, insulation and agitator
4	Feed pump, screw type, with PIV & G-O motor
6	"Z" filter, rubber lined
6	Drip pan, m.s.
1 set	Measuring instrument

Q'ty	Description
1	Nash pump
1	Drip recovery tank, m.s.
1 set	Measuring instrument
	Filteration Medium Recovery
1 set	Recovery system, semi-automatic
	Piping, Valve, Cock & Fitting
1 set	Connecting piping, parts and accessories
	SECTION: ACID BATH
1	Spinning head tank, 24 m^3 concrete, lead lining
1	Spinning bath heater, carbon
1 set	Supporting structure, platform, stairs
2 (1)	Spinning acid pump
1	Polychloro vinyliden fiber filter, 4 m^2 x 3 sections concrete, lead lined
1	Filtrate tank, 37 m^3 concrete, lead lined
1 set	Connecting piping, parts and accessories
1 set	Supporting structure, platform and stairs
	SECTION: ACID RECOVERY
1 set	Double effect evaporator ass'y, capacity 5.5 T/H evaporation, with heaters, pumps and condensers
2	Acid pump, Si-c.i.
1 set	Piping materials and steel structure necessary for functioning the "ACID RECOVERY" section
1 set	Measuring/controlling instruments
	SECTION: JET LABORATORY
5	Level gauge for pot installation

Q'ty	Description
50 m	Roller conveyor for maintenance room
1 set	Pot motor vibration tester
2 sets	Hand press for pot motor maintenance

SECTION: REFERIGERATION

Refrigerator-unit, 70 RT for process cooling

1 set	Cooling unit for dissolving caustic solution cooling, consisting of:
1	Compressor with motor
1	Evaporator ass'y for special coolant
1	Condenser ass'y
1	Coolant circulation tank
2 (1)	Circulation pump with motor, for coolant
1 set	Control panel
1 set	Piping, valves, fittings for special coolant
1 set	Piping, valves, fittings for limed water
1 set	Heat insulating materials

SECTION: VENTILATION

1 set	Ventilator for the automatic filtration unit
1 set	Connecting ducts for supply air to the spinning, stretching, cutting, and purification section
1 set	Damper for supply duct
1 set	Outlet register
1 set	Main exhaust ducts from the spinning, stretching, cutting, and purification section to the main exhaust fan room
1 set	Duct supporting/hanging steel structure

Q'ty	Description
	SECTION: WATER PLANT
	Limed Water Ass'y
1	Limed water pump
1	Limed water pump
1 set	Piping materials for additional pump
1 set	Valve & fitting for above piping
	SECTION: AUXILIARY LABORATORY
1 set	Measuring/testing instruments
	SECTION: CS_2 STORAGE (IN THE RAYON MILL SITE)
2 sets	CS_2 storage tank, m.s.
	SECTION: CS_2 PLANT
5	Sulphur cock
1	Sulphur distributor
1	Flow integrator for above
1	Electric furnace body
1 set	Fire brick
6	Electrode, 405 dia. x 1,800 L
3	Electrode operating system
3	Nipple joint
1	Charcoal hopper
1	Temperature recorder for furnace, 6 points
3	Sealing tank
1 set	Deck for furnace
1 set	Exhaust duct
1 set	Copper plate with flexible band
1	Rail for hoist
1	Sulphur separator

Q'ty	Description
1	Water spray cooler
1	Brine cooler
1	Sealing column
1 set	Pipe for gas
1	R 12 refrigeration compressor, 24 RT, hermetic seal type
1 set	Accessory for refrigerator
1 set	Steel piping materials
1 set	Valve & cock
1 set	Heat insulating materials
1 set	Platform, stair and support
1 set	500 KVA transformer, with accessories

SECTION: BAMBOO DISSOLVING PULP PLANT

Bleaching & After Screening

1	Jordan type light refiner, conical type Quantity and application will be decided after test result in the actual production line obtained

SECTION: ADDING AGENT SYSTEM

2 sets	Tank, 1.5 m^3, SUS
2 sets	Agitator with motor, SUS
1 set	Spray nozzle, SUS
1 set	Piping materials

PART (IV)

ESSENTIAL EQUIPMENT FOR PRODUCING

RAYON STAPLE FIBER

Q'ty	Description
	SECTION: SPINNING
1	Spinning machine, capacity equivalent to 15 T/D staple fiber production, 80 positions, double sided, each two spinning positions are combined to one godet. Each side is equipped with a second bath trough and a separate motorized PIV for driving godet draw-off rolls and spinning pumps. The machine is supplied with an enclosure having counter weighted sliding access doors on each side. The following parts are supplied with the machine;
90	Spinning pump, high precision gear type, 28 cc/rev., with outer gear
90	Mounting bracket for spinning pump, body c.i.
90	Gooseneck, with connector
120	Spinnerette, Au/Pt alloy
120	Spinnerette holder, hard rubber, with nozzle cap, disc, packing, nut, etc.
1 set	Thread guide ass'y
50	Godet wheel
2	Hand cart for waste fiber
1 set	Materials for hard lead parts and lead plate for lining
	2nd Bath Make-up
1 set	2nd bath make-up consisting of;

Q'ty	Description
	Materials for hot water tank, 5 m^3 m.s.
	Steam injector for hot water tank
	Steam injector for bath supply pipe line
	Pump, c.i.
	Piping, valve, and fitting
	Measuring/controlling instruments
	Enclosure and Ducts
	Materials for enclosure doors, exhaust duct and connecting duct for spinning machine
	SECTION: JET LABORATORY
	The following essential equipment are to be added to the existing laboratory.
2	Dryer
1	Ultrasonic cleaner
	SECTION: STRETCHING & CUTTING
1	Stretching machine, capacity equivalent to 15 T/D staple fiber production, double sided, equipped with draw rolls each side. The Rolls are composite type, including replaceable phenolic resin bodies.
1 set	Lead materials for stretcher
1 set	Materials for enclosure doors, exhaust hood and drip pan
3 (1)	Cutter, capable of cutting up to 900,000 denier tow, centrifugal type, with a pull roll and enclosure cover.

Q'ty	Description
1 set	Chip conveyor, with materials for enclosure cover
1	Strobo-light
	SECTION: PURIFICATION
1	Distribution chute, with swivelling device and cover
1	Sluice pan
1	Purification machine, capacity equivalent to 15 T/D staple fiber production, conveyor type, multiple treatment system including fleece forming device, first washing, desulphuring, second washing, bleaching souring, third washing, and finish treatment sections
1	Squeeze roll ass'y, equipped with chute
1 set	Belt conveyor with beater, from the squeeze roll to the fleece feeding device
1 set	Materials for enclosure, exhaust hood, covers, connecting duct
1 set	Materials for supporting structure, platform
	SECTION: PURIFICATION SOLUTION SYSTEM
1	Materials for sluice bath tank, m.s., plastic lined
2 (1)	Centrifugal pump, Si-c.i.
3 (1)	Heat exchanger, impervious graphite
1	Materials for desulphuring bath tank, m.s.

Q'ty	Description
2 (1)	Centrigugal pump, c.i.
2 (1)	Heat exchanger, m.s.
1	Materials for bleaching bath tank, m.s. plastic lined
2 (1)	Centrifugal pump, Si-c.i.
1	Materials for NaOCl, m.s., plastic lined
1	Materials for souring bath tank, m.s., plastic lined
2 (1)	Centrifugal pump, Si-c.i.
1	Materials for finishing bath tank, m.s., plastic lined
2 (1)	Centrifugal pump, SUS
2 (1)	Heating coil, SUS
1	Materials for hot water tank, m.s.
1	Steam injector
2 (1)	Centrifugal pump, c.i.
1	Dissolving tank, with jacket and agitator, SUS
2 (1)	Storage tank, with jacket and agitator, SUS
1	Centrifugal pump, SUS
2 (1)	Metering pump, volumetric type
1	Materials for washing bath tank, m.s.

Q'ty	Description
2 (1)	Centrifugal pump, c.i.
1	Steam injector
1	Materials for recovered water tank, m.s., plastic lined
2 (1)	Centrifugal pump, Si-c.i.
1	Scale
1 set	Piping, valve, cock & fitting necessary for functioning the "PURIFICATION SOLUTION SYSTEM" and the "PURIFICATION MACHINE"
1 set	Measuring/controlling instruments
	SECTION: DRYING
1	Fleece feeding unit, consisting of a hopper, a lattice conveyor with a comber, a feed conveyor and drive unit.
2	Dryer, capacity equivalent to 15 T/D staple fiber production, suction drum type, with pre-drying zone, intermediate fiber opener, after-drying zone and cooling zone. Air heater can be operated with high pressure steam to get optimum drying efficiency. A fine opener opens dry staple before delivery. Pneumatic transport system, consisting of a chute, a blower, ducts and a static condenser, to feed fiber into a baling machine.
1 set	Intake & exhaust duct
1 set	Materials for supporting structure, operation deck

Q'ty	Description
1 set	Measuring/controlling instruments
	SECTION: BALING
1	Baling machine, capacity 15 T/D in product, pressing force: 100 tons
1	Scale, balance type
2	Hand truck, m.s.
1 set	Oil pump unit
1	Operating panel

APPENDIX II

FINANCIAL STATUS OF KRC

KARNAPHULI RAYON & CHEMICALS LIMITED
Balance Sheet as at 31-12-1978

PARTICULARS		AS AT		FUND POSITION	
		30-6-1978	31-12-78	Sources	Application
A)	**CURRENT ASSETS:**				
	Cash in hand & with Bank	18.83	18.95	-	0.12
	Trade Debtors	5.35	8.31	-	2.96
	Advance, Deposit & Prepayments	220.80	233.86	-	13.06
	Inventories incl. Loose Tools etc.	852.33	802.37	49.96	-
	BCIC Current Account	95.81	68.38	27.43	-
	Sub-Total:	1,193.12	1,131.87	-	-
B)	**CURRENT LIABILITIES:**				
	Bank Loan (LIM/LAM) including provision for Interest	369.23	396.23	27.00	-
	Trade Creditors for Goods & Exps.	225.72	247.79	22.07	-
	BCIC, Dacca	-	-	-	-
	Current Liabilities of BSRS Loan	22.41	24.43	2.02	-
	Interest on Assumed Yen Credit	35.27	39.46	4.19	-
	Creditors for Other Finance	74.36	86.00	11.64	-
	Excise Duty & Sales Tax	66.91	66.91	-	-
	Karnaphuli Paper Mills Ltd.	600.30	563.81	-	36.49
	SRDA Grant	100.76	139.88	39.12	-
	Dawood Corporation Ltd.	95.98	96.84	0.86	-
	Sub-Total:	1,590.94	1,661.35	-	-
C)	Working Capital	(397.82)	(529.48)	-	-
D)	Fixed Assets at Cost	2,471.31	2,533.26	-	58.95
	Less: Depreciation	908.68	954.26	45.58	-
	Net Fixed Cost:	1,565.63	1,579.00	-	-
E)	NET ASSETS:	1,167.81	1,049.52	-	-
	FINANCED AS FOLLOWS:				
A)	Capital & Reserve				
	Share Capital	450.00	450.00	-	-
	Advance against Share Capital	710.00	710.00	-	-
	Marine Risk Reserve	0.57	0.57	-	-
	Tax Holiday	95.70	95.70	-	-
	Profit/(Loss) Account Balance	(1,830.26)	(1,948.55)	-	118.29
	Sub-Total:	(573.99)	(692.28)	-	-
B)	Borrowed Capital				
	4½% Debenture (Agrani Bank)	414.52	414.52	-	-
	Yen Credit (Assumed)	851.74	851.74	-	-
	Yen Credit (Unassumed)	431.38	431.38	-	-
	Grant for Reconstruction and Rehabilitation	4.26	4.26	-	-
	Annual Development Programme	9.90	9.90	-	-
	Sub-Total:	1,741.80	1,741.80	-	-
C)	Equity and Loan	1,167.81	1,049.52	229.87	229.87

KARNAPHULI RAYON AND CHEMICALS LIMITED
Profit and Loss Account for the month of Dec. 78

(Value in Lacs)

PARTICULARS	THIS MONTH		CUMULATIVE	
	Actual	Budgeted	Actual	Budgeted
INCOME:				
Local Sale (Rayon & Dilphane)	100.39	112.53	530.33	598.98
Export Sale (Rayon & Dilphane)	2.57	6.28	21.72	36.70
Chemicals/Recoveries/Services	12.84	16.47	63.26	65.95
Export Rebate/XPL (Rayon & Dil.)	.20	1.10	4.12	6.44
Total Income:	116.00	136.38	619.43	708.07
EXPENDITURES:				
a) Variable Cost				
Raw Materials incl. Packing	42.88	42.88	179.74	171.19
Stores and Spares	14.16	6.28	64.00	37.32
Utilities	36.05	36.28	150.67	152.08
H & T Expenses	.36	.35	3.96	2.10
Sub - Total:	93.45	85.79	398.37	362.69
b) Fixed Cost				
Salaries and Wages	21.22	18.22	127.34	109.32
Depreciation	11.89	12.81	46.37	53.66
Insurance	.68	.68	4.10	4.10
Interest	6.75	6.75	40.50	40.50
Overheads	7.08	7.39	41.19	43.91
Sub - Total:	47.62	45.85	259.50	251.49
Total (A & B)	141.07	131.64	657.87	614.18
Less Stock Adjustment	(26.77)	(0.69)	79.85	124.44
Cost of Sales:	114.30	130.95	737.72	738.62
Profit/(Loss):	1.70	5.43	(118.29)	(30.55)

APPENDIX III

BASIS OF ESTIMATION FOR IMPLEMENTATION

AND FIELD SERVICE COSTS OF BMR & E

Basis of Estimation for Implementation and Field Service Costs of BMR & E

Basic data to estimate the implementation and field service costs listed in Table 8-1, as well as the field service cost given in Table 8-2, are discussed below.

(1) Ocean freight and marine insurance

(2) Inland transport and handling charge

(3) Cost for civil work

(4) Cost for building

(5) Cost for erection work

(6) Fee for erection supervisors

(7) Fee for test run supervisors

(1) Ocean Freight and Marine Insurance

The following costs are described in Table 8-1.

Machinery & Equipment (FOB)	2,806,645 Thousand yens
Construction Materials (FOB)	65,540 Thousand yens
Total	2,872,185 Thousand Yens

According to past experience, the ocean freight and marine insurance fee required for plants of a similar type exported to other countries near Bangladesh were approximately 3.5% of the FOB costs (Machinery & Equipment, Construction materials).

Hence,

2,872,185,000 x 0.035 = 100,526 Thousand yens

Disregarding fractions, the cost for this item was estimated at 100,000 thousand yens.

(2) Inland Transport and Handling Charge

This cost is estimated at 3,876,000 thousand TK in Table 8-1. Experience shows that this cost is approximately 1.5% of the sum of (i) Machinery & Equipment CIF cost, (ii) Engineering fee, and (iii) Cost for supervising.

Based on this assumption, we obtained,

Machinery, Equipment & Construction Materials (CIF)	2,972,185 Thousand yens
Engineering Fee	269,100 Thousand yens
Supervising Fee	117,000 Thousand yens
Total	3,358,285 Thousand yens

3,359,000,000 x 0.015 = 50,385 Thousand yens

Calculating at an exchange rate of TK 1.00 = ¥ 13 and counting up the fractions, we estimated this cost at 3,876,000 TK.

(3) Cost for Civil Work

The cost of civil work is estimated at TK 1,166,000 in Table 8-1, which was calculated based on data given in the tables below.

Volume of Concrete Structures and Machine Foundation (m^3)

	Staple Plant	Filament Plant	Dissolving Pulp Plant	C.C. Plant	CS_2 Plant	ClO_2 Plant	H_2SO_4 Plant	Water Treatment Plant	Total
Concrete Structures	45	-	-	100	-	-	-	45	190
Machine Foundation	195	12	15	5	30	3	-	3	263

Unit Price of Concrete Structures and Machines
Foundation per Unit Volume (TK/m³)

	Material Cost	Casting Frame Fitting Cost	Iron Work Cost	Casting Cost	Total
Concrete Structure	2,380	128	40	64	2,612
Machine Foundation	2,380	64	40	64	2,548

Hence,

Construction Cost for Concrete Structures	190 x 2,612 = TK	496,300
Machine Foundation Cost	263 x 2,548 = TK	670,100
Total		TK 1,166,400

(4) Building Cost

The building cost is estimated at TK 2,079,000 in Table 8-1, which was calculated based on data shown below.

Building Expansion and Modification Area
(Totaled m²)

	Rayon S.F. Plant	Carbon Disulphide Plant	Total
Expansion	463	600	1,063
BMR	272		272

Cost per unit area for 1-storied buildings (including material cost) : TK 1,700/m²

Cost for building modification per unit area (including material cost) : TK 1,000/m²

Hence,

BMR Cost	1,063 x 1,700 = TK 1,807,000
Expansion Cost	272 x 1,000 = TK 272,000
Total	TK 2,079,100

(5) Cost for Erection Work

The cost for erection work is estimated at TK 1,090,000 in Table 8-1. Chapter 7 details the weight of the machines and equipment to be erected and the required man-power, which are summarized in the table below.

Man-power Required for Plant Machine Erection, Replacement and Connection Works (Man-day)

Plant and Work Divisions	Machine Weight (net ton)	Estimated man-power (man-day)			
		Direct Work		Indirect Work	
			Total	Assistant	Supervisor
Rayon S.F. Plant	Approx. 530	Approx. 5,400	13,300	8,100	3,000
CS_2 Plant	Approx. 40	Approx. 450			
Piping, Wiring and Other Construction Works for the Above Plants	Approx. 150	Approx. 7,400			
Dissolving Pulp Plant		Approx. 1,500	9,900		
Rayon F. Plant, C.C. Plant Sulphuric Acid Plant Chlorine Dioxide Plant Water Treatment Plant Connection Work	Approx. 320	Approx. 8,400			
Deficient Work		3,440			500
Total	1,050	26,640		8,100	3,500
	1,050	34,740			3,500

Assuming the wage level,

Skilled workers	TK 800/man-month ... 20%	}	Average, TK 560/ man-month
Ordinary workers	TK 500/man-month ... 80%	}	
Supervisors	TK 1,200 man-month		

and 25-day operation per month, the total personnel expenses will be

$$\frac{34,740 \times 560}{25} + \frac{3,500 \times 1,200}{25} = \frac{23,654,400}{25} = \text{TK } 946,176$$

Add to this TK 144,000 estimated as costs for electric power, expendables, temporary work, leased construction machines, tools, etc., the total cost amounts to,

946,000 + 144,000 = TK 1,090,000

(6) Fee for Erection Supervisors

This cost is estimated at 117,000 thousand yens in Table 8-1. In this estimate, the supervisor fee for BMR work is not included because the guidance work is presumed unnecessary; the estimate covers only the machines for the rayon staple fiber plant and those required for the expansion of the carbon disulphide plant.

The basis of estimation is outlined below.

Division	Qualification	Number	Period of Stay (Month)	Supervising fee (Thousand Yen)
Project manager, airconditioning and main piping	Chief Engineer	1	12	25,770
Spinning - finishing machine	Qualified Engineer Engineer	2 3	8 9.5	12,740 17,860
Viscose production, cooling, baling machine	Qualified Engineer Engineer	2 4	7.5 10.5	12,015 20,130
Ancillary equipment (acid bath circulation, acid bath recovery, purification solution, plumbing work)	Qualified Engineer Engineer	2 1	6 4	9,840 7,370
Electrical equipment, wiring	Engineer	1	3	5,670
Instruments, instrumentation wiring, piping	Engineer	1	3	5,670
Total		17	63.5	117,065

Disregarding fractions, the total cost was estimated at 117,000 thousand yens.

(7) Fee for Test Run Supervisors

This cost is estimated at 21,000 thousand yens in Table 8-2, which was calculated based on the data given below.

Division	Qualification	Number	Period of Stay (Month)	Supervising fee (Thousand Yen)
Viscose production	Skilled Qualified Engineer	3	3	6,360
Acid bath circulation, acid bath recovery	Skilled Qualified Engineer	3	3	6,360
Spinning ~ baling	Skilled Qualified Engineer	3	3	6,360
Total control	Engineer	1	1	2,270
Total		10	10	21,350

Disregarding fractions, the total cost was estimated at 21,000 thousand yens.

APPENDIX IV

PLANT-WISE BREAK-DOWN OF

MACHINERY & EQUIPMENT

BREAK DOWN PRICE LIST

Unit = 1,000
Tk. 1 = Yen 12.987
$ 1 = Tk. 15.4 = Yen 200

Section & Plant for Replacement	Price in Yen	Price in Tk.	Remarks
Rayon Filament (incl. Acid Bath for Filament)	139,930	10,775	
Anhydrous	35,900	2,764	
Air Conditioning	4,250	327	
CS_2 Plant	20,970	1,615	
Water	64,250	4,955	
Refrigeration	20,850	1,605	
DKP Plant	191,820	14,770	
C.C. Plant	170,750	13,148	
Instrument	43,120	3,320	H_2SO_4 pipe included
Total	Yen 691,940 (FOB)	Tk. 53,279	
Insurance & Freight (3.48%)	Yen 24,080		
CIF Price	Yen 716,020	Tk. 55,130	

BREAK DOWN PRICE LIST

Unit: 1,000
Tk. 1 = Yen 12,987
$ 1 = Tk. 15.4 = Yen 200

Section & Plant for Balancing & Modernisation	Price in Yen	Price in Taka.	Remarks	Section & Plant for Expansion (RSF)	Price in Yen	Price in Taka.	Remarks
Pulp Mercellization	193,360	14,889		Spinning & Jet Labo.	205,840	15,850	
Xanthation & Dissolving	182,170	14,027		Stretching & Cutting	109,160	8,405	
Ripening & Filtration	384,305	29,591		Purification & Solution	242,380	18,663	
Acid Bath Circ. & Recov.	184,529	14,208		Drying & Baling	154,200	11,873	
Refrigeration & Ventilation	61,350	4,724		Elect. & Instrument for Spin Baling	96,320	7,417	
Laboratory	36,860	2,838		Piping & Ducting for above Area	41,270	3,178	
Water Plant	12,900	993		Steel Structure	15,440	1,189	
CS_2 Plant & Storage	124,410	9,580		TOTAL	864,610	66,375	
DKP Plant	10,180	784	Jordan Refiner	Insurance & Freight (3.48%)	30,090		
Elect. & Instrument for Visc. Section	78,500	6,045					
Piping for Visc. Section	47,080	3,625		CIF PRICE	894,700	68,892	
TOTAL	1,315,635 (FOB)	101,304		SUPERV. FEE.	117,600		17 persons 63.33MM
Insurance & Freight (3.48%)	45,830			CONTINGENCY	100,000		
CIF PRICE	Yen 1,361,465	Tk. 104,833			Yen 1,111,700	Tk. 85,600	

APPENDIX V

PROCESSING TECHNOLOGY AND EQUIPMENT

FOR RAYON STAPLE FIBER

Processing Technology and Equipment for Rayon Staple Fiber

BTMC's capacity to produce cotton yarn is about 930 thousand spindles, and also BTMC and HLD have enough capacity to consume these yarn for making various cotton fabrics. Rayon staple fiber is a kind of cellulose fiber similar to cotton and is a man-made fiber the character of which can easily be adjusted to desired value.

To produce better blended yarn, it is desirable that their staple length of each component fiber has the same staple length and that the elongation of blended fiber is higher than that of cotton. The staple length of rayon staple fiber can easily be adjusted to the length of the blended cotton. The elongation of rayon staple fiber is higher than that of cotton, therefore good blended yarn can be produced by using cotton and rayon staple fiber, provided that the parameters of both fibers are coincided and optimum operating conditions for blended yarn are applied in manufacturing process.

In the case of producing polyester-cotton blended yarn, the same equipment and manufacturing technology as cotton spinning can not be used because the character of polyester is quite different from that of cotton.

However in the case of producing rayon-cotton blended yarn the same equipment as that of cotton can be used with minor adjustment owing to the abovementioned reasons. Moreover higher efficiency and less waste are expected in rayon-cotton blended yarn production by the reason of uniformity of rayon staple fiber.

The quality of rayon-cotton blended yarn is almost same as that of cotton yarn, provided that the blend ratio of rayon is kept less than 20% and adequate operating conditions are applied. Especially the dry properties are same as that of 100% cotton yarn because the dry tenacity of rayon staple fiber is almost same as that of ordinary Indian cotton.

But properties of rayon-cotton blended yarn are a little inferior to 100% cotton yarn and especially durability for caustic soda of rayon is lower than that of cotton, then in drying and other wet processes the adequate operating conditions suitable for rayon should be applied for blended yarn. Namely the caustic concentration must be below 7% in terms of NaOH and instead of using high caustic treatment $NaClO_2$ bleaching is preferable.

In conclusion, the existent textile processing equipment can be applied for rayon-cotton blended yarn production as long as the adequate operating conditions are kept and 100% cotton yarn can almost be substituted by rayon-cotton blended yarn.