BASIC DESIGN STUDY REPORT
ON
FISH NET MACHINE SUPPLY PROJECT
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

MARCH 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 14108

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PREFACE

In response to the request of the Government of the People's Republic of Bangladesh, the Government of Japan decided to conduct a survey on Fish Net Machine Supply Project and entrusted the Survey to the Japan International Cooperation Agency. The JICA sent to Bangladesh a survey team headed by Mr. Yoshinori Shimozaki, Chief of the Fishing Efficiency Laboratory, National Research Institute of Fisheries Engineering, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries from December 12 to December 23, 1982.

The team had discussions with the officials concerned of the Government of Bangladesh on the Project and conducted a field survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the People's Republic of Bangladesh for their close cooperation extended to the team.

March 1983

Keisuke Arita

President

Japan International Cooperation Agency

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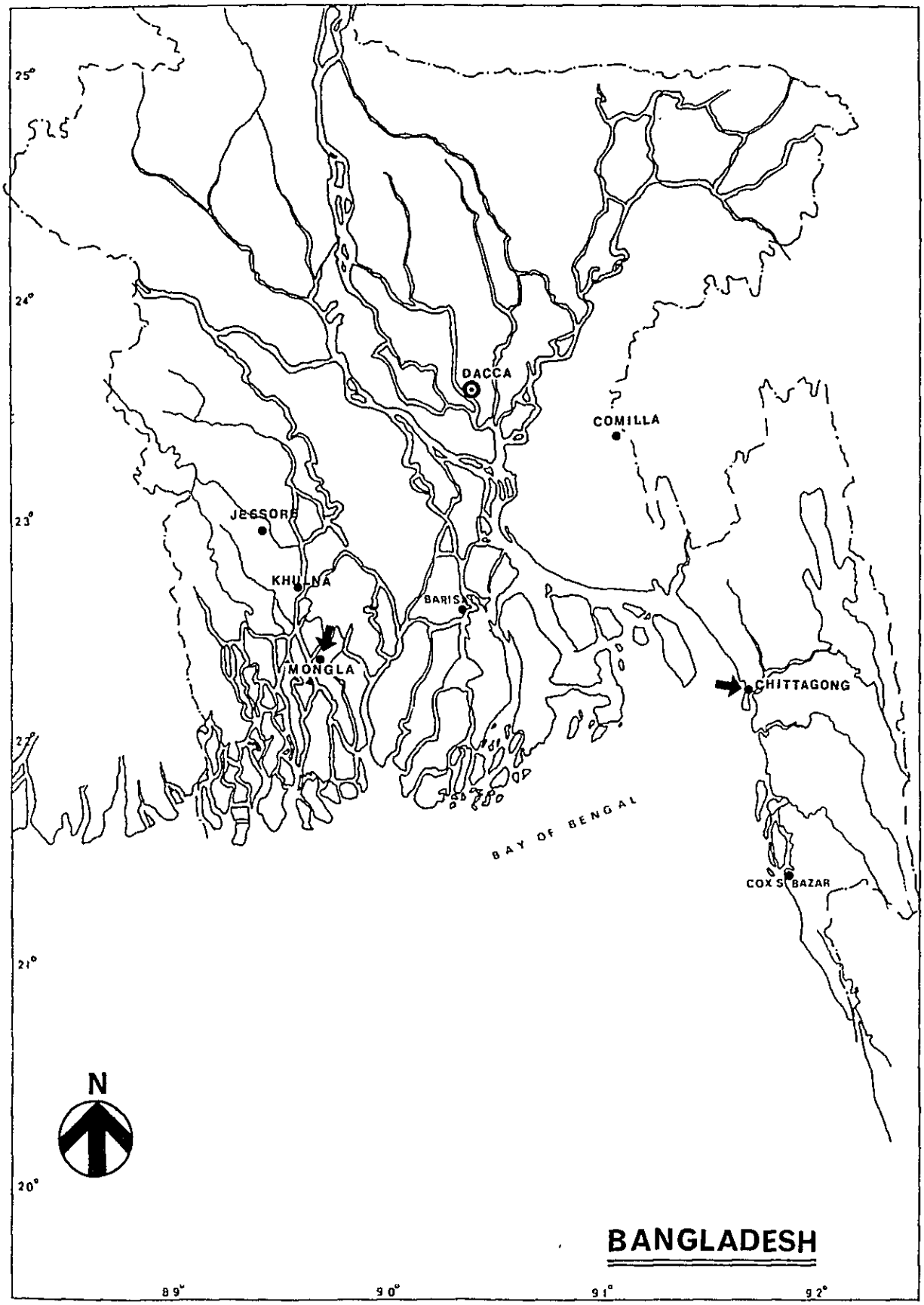
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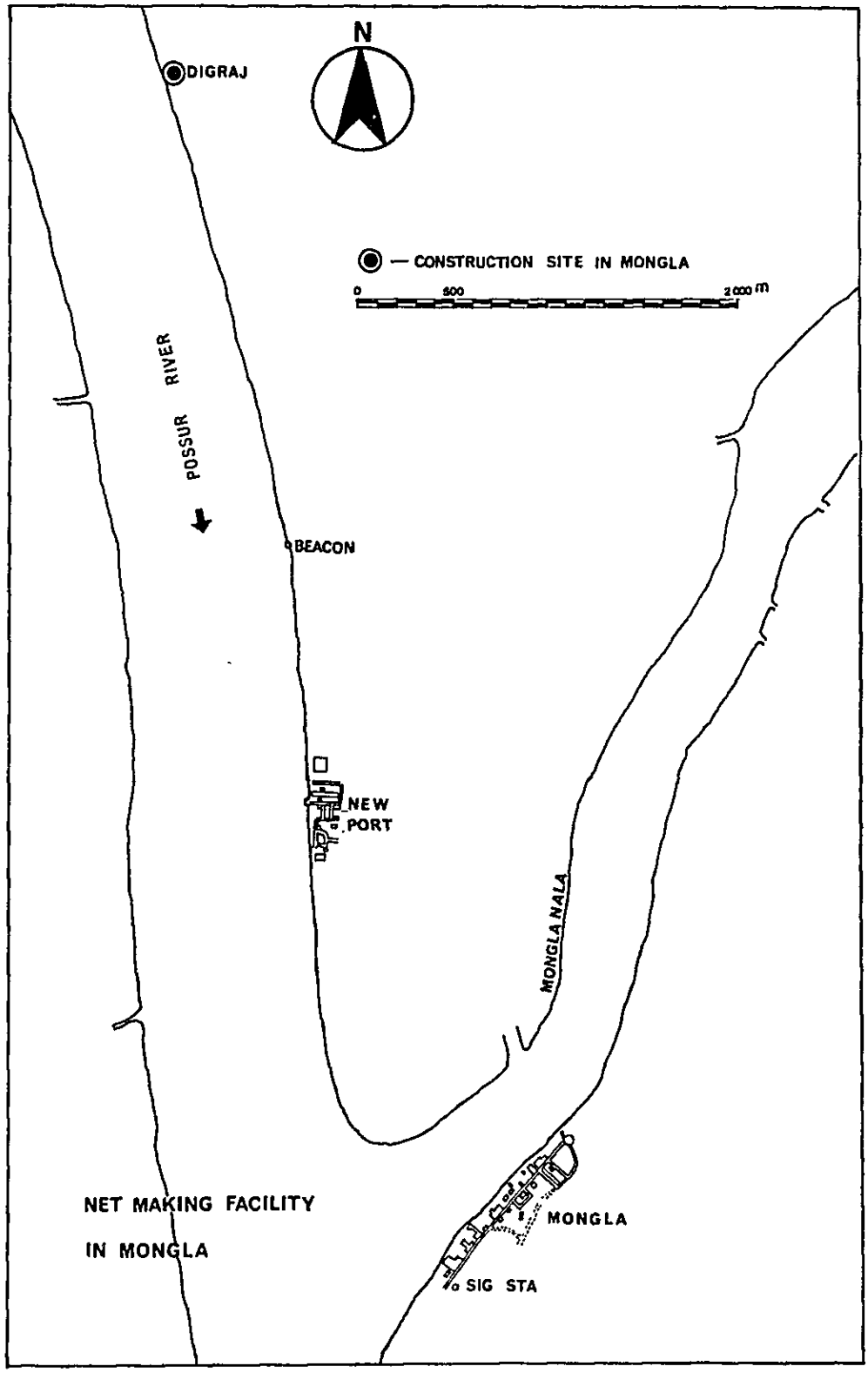
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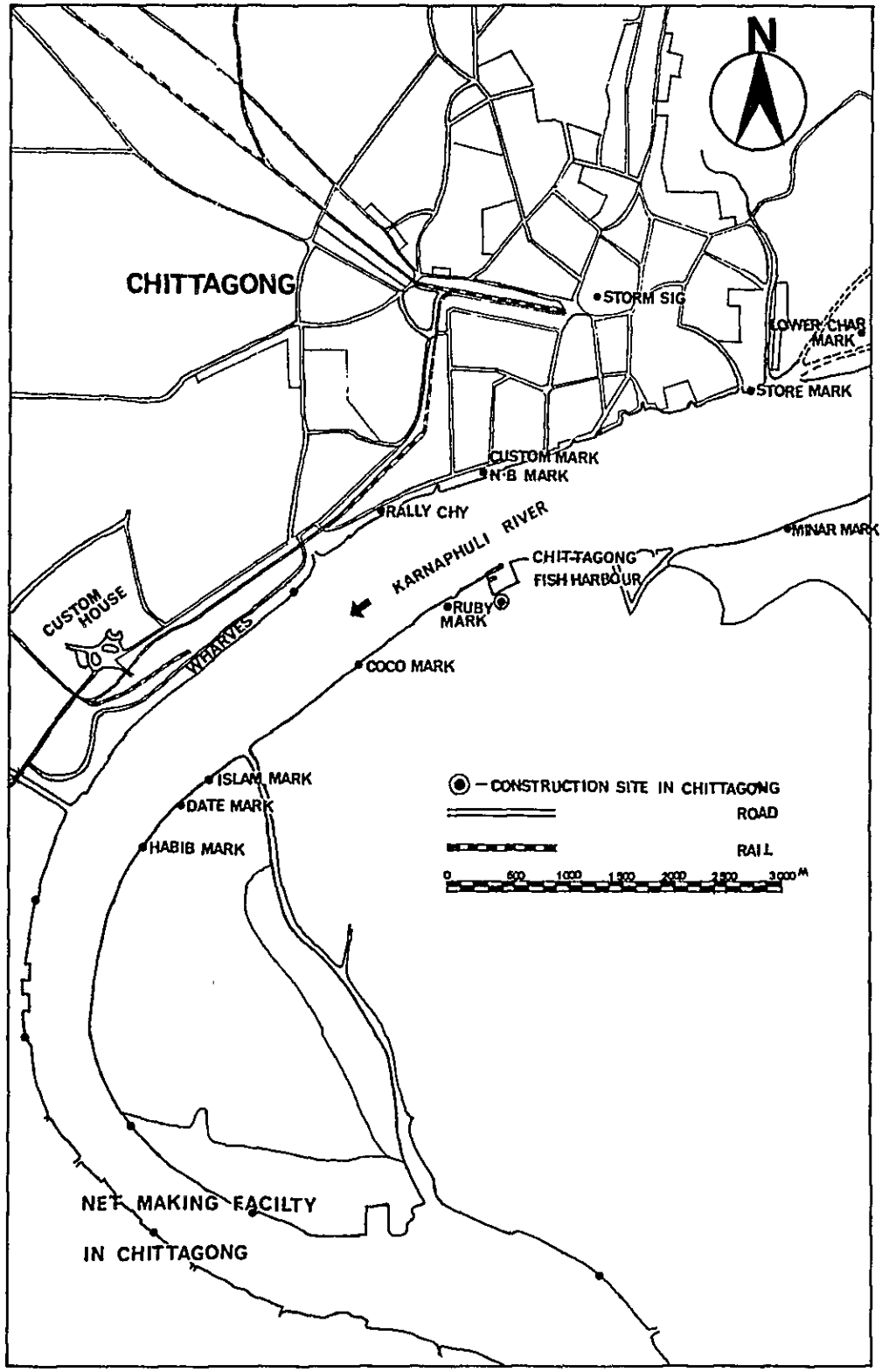
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SUMMARY

Fish production in the Peoples' Republic of Bangladesh in 1979/80 totaled 646,800 tons, broken down: 122,000 tons from marine fisheries and 524,800 tons from inland fisheries.

This production fell far short of meeting the minimum nutritional requirements of the Bangladesh people. Per-capita consumption of fish products in 1974/75 was 28.7 g per day, but declined steadily to 19.9 g in 1979/80. Bangladesh has traditionally relied on its fisheries to provide some 70-80% of its animal protein intake. It has been estimated that 73 g of fish per capita would be required to sustain minimum nutritional levels.

The Government of Bangladesh, during the Second Five-Year Plan (1980/81-1984/85) has set as one of its national objectives the attainment of "food self-sufficiency within the shortest possible time", and has made clear its intent to supply the requisite amount of nutrition to its people.

Within this Plan, fisheries production will have to be increased from the present 646,000 tons to 1,330,000 tons by 1984/85. Fisheries offer much greater potential for broadening the production base than meat or dairy products, and so the fisheries sector has been accorded a particularly high growth target by the Plan.

In order to double fish catches, it will be necessary to expand the supply of net gear, which is the primary fishing method used in the country. For this purpose the Second Five-Year Plan has allocated, as part of the investment by the governmental sector, some 300 lakh Taka (about US$1,300,000) to the construction of net making facilities, under the auspices of the Bangladesh Fisheries Development Corporation (BFDC).

Based on this Plan, BFDC, which has an existing plant for fish netting at Comilla, is building new fish net production facilities at Chittagong and Mongla, in which net making machines and peripheral equi - ment will be installed.

The supply capability for fishing nets made by machine currently accounts for only 3-4% of the estimated total net requirements of 1,500 tons per year, but this share is expected to increase to about 15% in response to future demand growth.

For purposes of implementing this Plan, the Government of Bangladesh has requested a grant-in-aid from the Government of Japan to supply net making equipment for which it would otherwise have to expend valuable foreign exchange.

According to the BFDC Plan, facilities of about 590m^2 each are being constructed at Chittagong and Mongla, with 6 net making machines to be installed at each location. At full utilization, the facilities should produce a combined total of about 200 tons a year of netting for trawl nets, gill nets, and seine nets. Construction of these facilities is moving ahead smoothly according to plan and should have been completed by February, 1983.

Implementation of the BFDC Plan for net production facilities has been accorded the highest priority in the development planning of the Government of Bangladesh. In this connection, early implementation of the Fish Net Machine Supply Project (hereafter called the Subject Project) is strongly desired to meet the objectives of the BFDC program.

The types of nets in general use in Bangladesh include: polyethylene twine for use mainly in trawl nets and in set bag nets, and nylon multi-filament twine for use in gill nets.

Nylon multi-filament netting, both hand and machine-made, are widely used in Bangladesh. At the BFDC plant at Comilla, 3 of the 4 functional units are operated on a 3-shift basis around the clock. These machines use mainly 210 D/3 to 210 D/9 nylon multi-filament twine and produce 20-30 tons of netting for gill net a year.

Polyethylene netting has not previously been manufactured in Bangladesh.

In addition, for purposes of effectively catching the undeveloped pelagic resources in the Bay of Bengal, to which major importance has been attached, it is expected that there will be increased usage of netting made from nylon mono-filament material.

Given the above conditions, the basic design approach for the subject Plan has been built on the following two pillars:

1) The program will constitute an extension of existing technology, introducing only processes that represent a continuation of present levels of technology.

2) The program attempts to work as much as possible within the constraints of the original BFDC Plan, particularly with regard to financial requirements.

As netting material, we have focused on polyethylene, which is 30% cheaper than nylon and has a lower specific gravity; nylon mono-filament; and nylon multi-filament twine. Machine production is particularly advantageous for polyethylene and nylon mono-filament twine.

Since there will be separate facilities at two locations, we have divided production between them. Chittagong will be equipped to produce netting from polyethylene and nylon mono-filament in addition to that from nylon multi-filament twine. Mongla, on the other hand, while confining itself to the use of nylon multi-filament twine, will concentrate its efforts on the production of products beyond the production capacity and product range of the existing Comilla facility.

Accordingly, the items of equipment required to implement the subject plan will be as shown in the following table:

Type of Equipment	Chittagong	Mongla	Use
Net Making Machine(A)	1 Unit	-	For polyethylene and thicker nylon twine
" " (B)	1 Unit	2 Units	For both multi-filament & mono-filament nylon B type only is capable of making polyethylene nets
" " (C)	1 Unit	1 Unit	
" " (D)	2 Units	2 Units	
Bobbin Winder (for A)	1 Unit	-	For thick material
" " (for B)	1 Unit	2 Units	For both multi-filament & mono-filament nylon
" " (for C)	2 Units	2 Units	
" " (for D)	1 Unit	1 Unit	
Spool Winder	5 Units	5 Units	For use with thicker material and for general use
Lengthwise Stretcher	1 Unit	1 Unit	
Depthwise Stretcher	1 Unit	-	For polyethylene, nylon mono-filament use (including a boiler attachment to furnish steam)
Centrifugal Separator	1 Unit	1 Unit	For resin processing

As to the time period needed for project implementation, considering the standard 6-month delivery period for Japanese net making equipment, we feel a total of 13 months should be allowed through pilot operation and final delivery.

The BFDC, which is the central implementing organ for this Project, is a public corporation under the jurisdiction of the Ministry of Agriculture and Water Resources. This organization has complete independent authority with regard to implementation of the subject project. It will, accordingly, bear full responsibility for independent operation after completion of the facilities.

BFDC was most conservative in estimating the costs of facility operation arriving at a total estimate of 29,288,000 Tk/year. The estimated operating costs for the specific facilities selected, based on our Basic Design Study, work out to 300 lakh Tk, a figure almost the same as that in the original BFDC Plan.

We have also tried to assess the social impact of this Project on the cottage net making industry in Bangladesh following implementation and the expected increase in the supply of machine-made nets. With the subject Project, the new facilities will be producing products from materials for which machine production is advantageous. The projected annual output from the facilities from 1985/86 onward, the target date for becoming fully operational, will total 220 tons. However, this figure would still amount to only about 14.7% of the present estimated annual demand for fishing nets of 1,500 tons. And, when one considers that total demand itself will be rising, we may conclude that the subject Project will have only a minimal adverse impact on the hand-made netting industry.

Based on our financial analysis, we project an internal rate of return (IRR) of 17.3%. And, our break-even analysis also indicates that the facilities can be expected to be profitable at or above an annual production volume of 131,440 kg and annual sales of 21,168,194 Tk. It is clear, then, that the facilities can be self-supporting. We conclude, therefore, that the subject plan is sound and appropriate even from a financial standpoint.

In conclusion, we would like to recommend that the distribution and sales network for fishing nets in Bangladesh be expanded in step with the implementation of the subject Project. At present, there is no distribution problem, since sales go through the various branches of BFDC located throughout the country. However, in order to cope with the future increase in production and to help expand the usage of more efficient netting incorporating new materials, a more

suitable distribution and sales network should be established outside BFDC in consultation with other concerned organizations. It is essential to provide for inventories in the distribution pipeline so as to permit the maintenance of stable operations at the subject facilities.

SECTION 1 INTRODUCTION

Bangladesh has a total area of some 144,000 km^2, with a population (as of May, 1981) of 87,050,000. Some 16,000 km^2 of this area is comprised of inland waters. Another roughly 28,000 km^2 are inundated for 4-6 months a year, primarily during the monsoon season. During this period, the land is covered with low-lying water and can be used seasonally for aquaculture.

The country's 200-mile zone within the Bay of Bengal covers an area of 43,200 km^2, the bulk of which has depths of 50 m or less.

With this kind of fishing environment so readily at hand, fisheries have traditionally played a major role in providing animal proteins to the people of Bangladesh. Over a period of declining per-capita calorie intake owing to population growth, the country has had to rely on fish products for 70-80% of its animal protein supply and so looks to an increase of fish production as a means of maintaining this nutritional pattern.

In the Second Five-Year Plan from 1980/81 to 1984/85, the primary objective in fisheries development is the raising of national nutritional levels through increased fishery production. In this ambitious Plan, the intent is to expand the present level of fish production-- estimated at 647,000 tons in 1979/80 (of which marine fisheries comprised 122,000 tons and inland water fisheries 524,000 tons)-- to a level of 1,334,000 tons in fiscal 1984/85 (marine: 222,000; inland water: 1,114,000 tons).

The Government of Bangladesh has established the following guidelines for purposes of achieving this objective:

1) With 90% of arable land already under cultivation in Bangladesh, it will be necessary in future years to intensify land use as a means of expanding agricultural output. This fact will inevitably mean the imposition of ever more stringent controls on the country's inland fisheries. Thus, in order to increase the produc-

tion of inland fisheries, the focus will be on the priority development of aquaculture.

2) With respect to marine fisheries, efforts will be made to motorize small coastal fishing vessels. At the same time, efforts will be made to raise productivity through a diversification of fishing techniques and to develop the coastal fisheries within 30 nautical miles of shore. In addition, trawl vessels are to be introduced with freezing facilities so as to maintain year-round operations in existing fishing grounds for shrimp and other species.

3) There will be intensive development of seed production facilities, ice-making facilities for temperature control, unloading facilities at fishing ports, and related fishery facilities.

With respect to the domestic supply of fishing nets-- one of the basic catching means in Bangladesh--, there is a growing need, in accordance with the above program, to provide a supply of various types of standardized machine made nets of stable quality as a means of responding to the diversification of fishing methods. By broadening the range of available net types, it is hoped to displace the large imports of netting and finished nets which totaled 29 tons, valued at 2,170,000 Tk, in 1977/78.

To this end, the Second Five-Year Plan provides for an investment of 3.1 billion Tk during the Plan period on the part of the Department of Fisheries (DOF), the government agency concerned with fisheries, and the Bangladesh Fisheries Development Corporation (BFDC). Of this total, 30 million Tk have been allocated for the construction of net making facilities by BFDC.

Based on this Second Five-Year Plan, BFDC is in the process of constructing fish-net manufacturing facilities at Chittagong and Mongla. As of mid-December, 1982, construction was about 65% complete at the former and 35% complete at the latter site. The Chittagong facility was to be completed during January, 1983; the Mongla plant during February.

The Government of Bangladesh has asked the Government of Japan to provide a grant-in-aid to cover the purchase of various types of net making machines for installation at the above facilities. In response to this request, the Government of Japan, through the Japan International Cooperation Agency (JICA), dispatched a Basic Design Study Team to Bangladesh, whose objective was to conduct various studies relating to the vetting of the BFDC Plan for the establishment of net production facilities and, based on these findings, to develop a basic plan for effectively implementing the grant-in-aid for the net making machines required to carry out the BFDC Plan.

The Basic Design Study Team was headed by Mr. Yoshinori Shimozaki, Chief of the Fishing Efficiency Laboratory, National Research Institute of Fisheries Engineering, Ministry of Agriculture, Forestry and Fisheries, the Government of Japan.

The Team carried out its investigations from December 12 - 23, 1982 via discussions with related organizations. A Minutes of Discussions were exchanged incorporating the survey findings.

We have appended, in Appendix I - IV following the body of this reports, a copy of the Minutes of Discussions, the names of the members of the Study Team, the survey itinerary, and the name of discussants.

SECTION 2 THE BASIC PLAN

2-1 Basic Policy

Before proceeding to a discussion of the Plan, we shall first summarize below the background of the project, as presented in the preceding Section:

1) The subject project is a high priority core project, as contained in the Second Five-Year Plan.

2) There is ample room for expanding the production of Bangladesh's fisheries through raising the efficiency of catch methods, the introduction of aquaculture, and intensive management of the resource. There is also a social need for increasing the supply of fish proteins.

3) Polyethylene netting has already been substantially diffused in Bangladesh.

4) Demand for gill nets of nylon mono-filament is expected to increase sharply in future years.

5) The production capacity of BFDC's Comilla plant is believed to be close to peak capacity.

6) Construction of the new fish net making facilities is proceeding smoothly.

From the above, we have developed a plan on the basis of the following philosophy:

1) We plan to apply or develop existing technical levels. BFDC currently operates a net making plant at Comilla. Thus, the production methods and processes to be introduced will center on an extension of the technology presently being applied at Comilla so as to avoid any operational problems. We will not adopt any

complex systems that would require a major departure from present technological levels.

2) The Plan developed by BFDC has been carefully reviewed by that organization and, after several revisions, has been approved by the Pre-Evaluation Committee. The construction of facilities is being carried out in accordance with that Plan.

   If a grant-in-aid is received from the Japanese Government to implement this program, all possible care should be exercised to assure that implementation of the project will not have any impact on the overall costs or scheduling of the BFDC Plan.

3) The Second Five-Year Plan, which provides the background for this project, has expressed, as one of the national goals, an intent to double present fish production levels in order to fill the demand for animal protein food and raise the nation's nutritional standards. These targets are certainly keyed to the very strong socio-economic needs of the Bangladesh people. Since the project is expected to fulfill an important role in achieving these goals, we have taken great care to develop a program that will faithfully reflect the survey findings and can be implemented smoothly.

2-2 Description of the Plan

2-2-1 Estimated Demand

In developing this Plan, a primary requirement was to fully clarify the extent of anticipated demand for fish nets in Bangladesh.

According to the BFDC Plan, the demand for netting in Bangladesh is estimated at 1,600 - 2,300 tons per year. This figure was estimated on the basis of the following assumed usage pattern: viz., that the average annual consumption of netting per fishing vessel among the country's 3,000 motorized vessels is 400 lbs.; among non-powered vessels, 200 lbs.

However, data on the consumption rates for fishing gear are not available in Bangladesh. Furthermore, the above assessment of fleet size is only approximate. Actually, as there is a large volume of small-size fish nets being used for inland water fisheries, it is reasonable to assume the possibility of a wide variation in the above estimated demand figures.

Demand for netting can be estimated in three ways:

1) After estimating the total volume of netting being used for the various types and scale of fishing gear available in Bangladesh, demand is estimated by multiplying the number of nets by the depletion rate.

2) At present, Bangladesh imports all of the synthetic twine used in fishing nets. Estimates, therefore, may be made from the volume of imports of raw materials for fish nets and of fish netting.

3) Applying to Bangladesh the known relationship between the catch by net fisheries and the total demand for fish netting.

Of the above approaches, the most reliable is 1) but, at the present time, there are no detailed data on the number of fishing gear in Bangladesh. And, since the types of fishing gear are extremely varied, it is difficult to estimate on the basis of this approach.

With regard to the second method-- estimating from the volume of imports of netting material--, according to Bangladesh import statistics*, total imports of netting and netting materials in 1978/79 were as follows:

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* Bangladesh Bureau of Statistics, Foreign Trade Statistics of Bangladesh (1976/77 - 1978/79), August 1982.

BSTC Code	Product	Quantity (kg)	Value (Taka)
6575108	Nylon twine	1,097,976	49,441,863
6575901	Fishing nets	672	70,920
6575902	Nets and netting	-	-

Nylon twine is believed to be consumed almost exclusively for fishing nets. In addition to the above, imports of nylon yarn for textile use in 1978/79 totaled 2,446.9 tons, valued at 171 million Taka and, out of this total, a small portion may possibly have been used for producing nylon twine for netting. Thus, we may estimate the total actual demand for fishing nets in Bangladesh as of 1978/79 at not less than 1,100 tons a year, with current demand presumably above this level.

The third method--using the relationship between the catch in a certain area and the demand for fishing nets in that area-- can be employed by looking at the case of Japan, where all sorts of applicable data are available.

Fish production and production by net fisheries in Japan from 1978-1980 were as follows:

(In 000 tons)

	1978	1979	1980
Total catch	10,822	10,590	11,122
Catch by net fisheries	8,627	8,522	8,855

(For details, cf. Appendix VI)

The statistical data show the following figures for netting production in Japan during the corresponding period:

(In tons)

	1978	1979	1980
Total shipments	36,944	38,409	38,179
Exports	3,703	4,283	3,017
Net domestic shipments	33,241	34,126	35,162

(For details, cf. Appendix VIII)

The fluctuation in the number of powered net making machines for fish net use in Japan during the above period was within a 2% range, while the operating rates of these machines were kept almost constant at about 80-85%.

From this, we may deduce that there was no supply-demand gap in fishing nets during the subject period. And, considering the virtual absence of fishing net imports into Japan in these years, we may conclude that, during the subject period, the volume of domestic shipments was almost identical to the demand for fishing nets.

If we now take a macro look at the presumed relation in Japan between catch volume and fishing net demand, we have the following:

	1978	1979	1980	3-year average
Catch by Net Fisheries (1000 tons)	8,627	8,522	8,855	8,668
Demand for Netting (tons)	33,241	34,126	35,162	34,193
Netting Demand per Ton of Catch (kg)	3.86	4.00	3.97	3.94

In the case of Japan, under the present fishery production structure, there appears to be an estimated demand for 3.94 kg. of netting a year per ton of catch by the net fisheries.

If we now apply this relationship directly to Bangladesh and assume that 80% of its total present catch of 646,000 tons is from net fisheries, then the volume of annual netting demand in Bangladesh can be estimated at:

646,000 tons x 0.8 x 3.94 kg = 2,036 tons

However, in order to estimate netting demand from this relationship, we must allow for the fact that, given the over 80% proportion of inland fisheries in the total Bangladesh catch, the average size of fishing gear in the country tends to be smaller than in Japan. While this aspect cannot be analyzed quantitatively, it seems difficult to conclude that the Japanese relationship would carry over exactly to Bangladesh. The figure obtained from Japanese data, however, may be considered as an indication of the maximum demand for fishing nets in Bangladesh.

Consequently, the BFDC's estimate of 1,600-2,300 tons of annual netting demand in Bangladesh seems a somewhat optimistic figure. But the estimating approaches in (2) and (3) would appear to confirm an estimated annual demand at about the 1,500 ton level.

To satisfy this demand, Bangladesh at present has to rely almost exclusively on hand-made netting. Machine-made netting is currently supplied by the 20-30 tons annual production at the BFDC Comilla plant plus an estimated 20 tons output from the Chittagong plant of the Provincial Fishermen's Cooperative Society (BJMSS)-- for a total annual supply of 40-50 tons in all.

Relating this to the estimated total annual demand of 1,500 tons, it is clear that products made by net making machine hold a share no greater than 3-4%. The present Plan projects that, after the new net making facilities are completed and fully operational, the share of machine-made nets will rise to about 10-15% of the total demand.

It goes without saying that, at these facilities, products made from machine-made netting will be in a more advantageous position than

those made from hand-made netting and that the new plants will concentrate their energies on products desired by the final user.

Specifically, production at these facilities will focus on netting made from polyethylene, nylon mono-filament, and thicker multi-filament twines, which have higher hardness ratios and in which, with hand-made netting, knots are hard to tighten. Particularly in the case of multi-filament twine netting, machine-made netting will favour the products which require no knot slippage and uniform and highly precise mesh sizes.

Taking the above demand estimates into consideration, we may now summarize the kinds of netting and netting materials that are expected to be produced at the new facilities.

Material	Usage
Nylon multi-filament twine	Thicker twine will be used than at the Comilla plant. Production will be geared to netting for gill nets used in the marine fisheries.
Polyethylene twine	This netting is widely used in trawl nets and set bag nets, utilizing imported material. Machine-made netting will improve quality and decrease production cost, thereby broadening demand. However, in view of the uncertainty in demand, only the Chittagong plant will produce polyethylene netting. Net making machines must be selected that are capable of processing thick nylon multi-filament material.

Nylon mono-filament	In addition to gill nets made of nylon multi-filament as presently used, demand is expected to grow for nylon mono-filament gill nets. Accordingly, the machines will be able to process not only nylon multi-filament twine but also nylon mono-filament. However, for the time being, production of nylon mono-filament netting will be limited to the Chittagong facility, since this plant will be equipped with a depthwise stretching unit.

2-2-2 Optimum Production Processes and Equipment Composition

(1) Characteristics of Materials:

In considering the production process, we have summarized below the characteristics of the three types of netting material: nylon multi-filament twine, as presently used in Bangladesh; polyethylene twine; and nylon mono-filament.

a) Nylon multi-filament:

This yarn is made by collecting very fine filaments; a number of yarns are twisted into strands, which are in turn twisted into nylon multi-filament twine. Since this twine is very soft and easy to handle, it is the material most widely used in Bangladesh for netting. Making nets from this material is also relatively easy but, since the material is extremely soft and has a tendency to curl, the knots may loosen. It is, therefore, necessary, right after making the net, to impregnate the net with resin so as to provisionally fix the knot.

When the nets are further heat-treated, if the temperature exceeds 120° C, they may become yellowish, so that excessive increases in temperature should be avoided.

The knot strength of nylon netting is somewhat greater than for other materials, so that its uses are quite varied.

b) Polyethylene twine:

A few relatively thick mono-filament yarns are twisted into strands; the strands are then further twisted into polyethylene twine.

Like nylon mono-filament, this twine has a greater rigidity than nylon multi-filament twine, and the various parts of the net making machine area through which the twine passes must be larger than in the case of nylon multi-filament twine. Conversely, with a uniform cross-section area, while nylon multi-filament twine passes through without difficulty, it is difficult for polyethylene twine to move through the machine. Thus, when making netting from polyethylene twine in a net making machine selected to process nylon multi-filament twine, a grade of polyethylene finer than nylon must be used. And since the material is rigid and the knots difficult to tighten, it is necessary, after the netting is produced, to apply stretch and heat treatment for additional tightening.

In other respects, polyethylene is cheaper than nylon and has a lower specific gravity, while durability is about the same. It is, therefore, suitable for netting intended for large-size fishing gear.

c) Nylon mono-filament:

In contrast to nylon multi-filament twine, which is made

from very fine filament, mono-filament is a single thread extruded fairly thickly. Like polyethylene, it is rigid and has a smooth surface. Knots, thus, are hard to form and slip easily, making double knotting mandatory. Also, in order to stabilize the knots, depth wise stretching and heat treatment process are required.

This material is used mainly in gill nets, owing to the following characteristics:

1) Transparency is high, making it hard for fish schools to detect the nets.

2) Since the nets have low pile and a low water absorption relative to nylon multi-filament twine, the nets have a low swelling ratio.

3) Required netting weight is also relatively low.

These favorable attributes make nylon mono-filament highly suitable for gill nets.

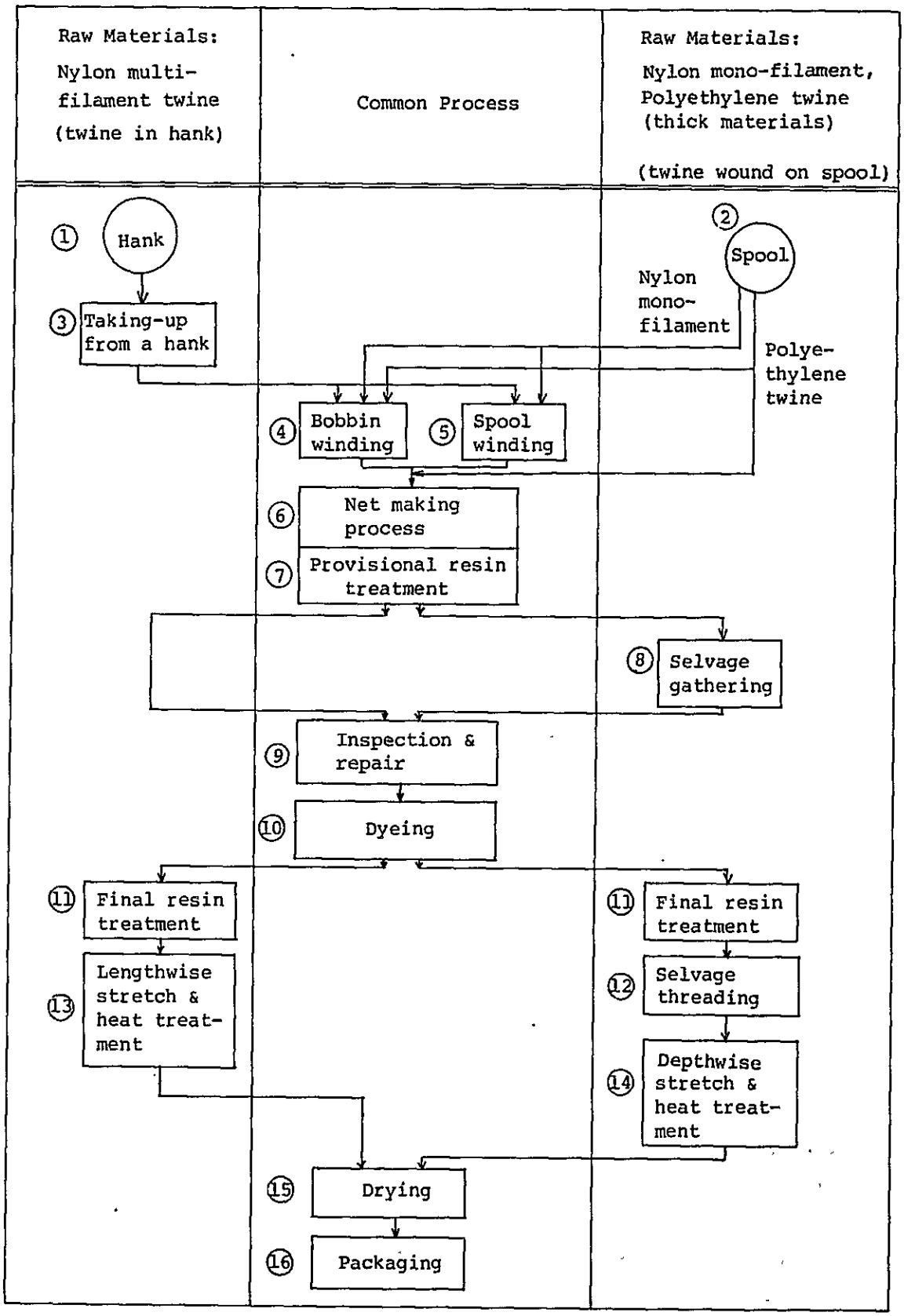
(2) Review of the Production Process:

In reviewing the manufacturing processes for fishing nets, a particular concern is the specific type of raw material to be processed. In this plan, we shall examine the production process in the new facilities with reference to the processes presently in use at the BFDC Comilla plant.

The processes for the new facilities are described in the following chart. When the type of material used is nylon multi-filament, the production process starts from hank take-up; when the raw material is nylon mono-filament or polyethylene, it starts from bobbin or spool winding.

The following notes are keyed to the numbers on the next chart:

Net Making Process Chart



1) Presently, at Comilla, nylon multi-filament twine is being purchased in hank, requiring the addition of take-up process (3). Despite the addition of this process, the equipment to take up the twine from the hank can be readily attached to the boddin winder or spool winder; thus, no separate unit is needed for this operation.

2) With nylon multi-filament twine netting, knots can easily come loose during transport, inspection, or repair. As a result, provisional resin treatment is applied immediately after net manufacture. This process does not exist at the Comilla plant but will be required as a means of improving product quality.

3) The dyeing process (10) may not be required, since the local fishermen prefer plain nets to the dyed product.

4) The selvage gathering process (8) can also be performed on a specialized piece of equipment but, since this equipment would only be used part of the time, this process will be done by hand rather than by machine.

5) Fine polyethylene twine can move from Process (10) ⟶ (13) rather than Process (10) ⟶ (14)

A general explanation of the process flow is given below:

(1) Hank

The material is received in a hank; thus, take-up process (3) becomes mandatory.

(2) Spool winding

In order to rewind the polyethylene twine onto the spool, a special piece of equipment is required. Thus, material should be purchased in a form that can be directly fed to

the net making machine. It will thus be sufficient to wind the material only around the bobbin. Nylon mono-filament is used after being rewound on both the bobbin and spool.

(3) Taking-up from a hank

In preparation for Processes (4) and (5), nylon multi-filament twine purchased in hank is wound on a large spool by means of a winder. It is desirable that this must be a simple unit attached to the bobbin winder and spool winder.

(4) Bobbin winding

The twine which has been wound around the large spool is then wound around the bobbin for playing out the weft. All types of yarn are compatible.

(5) Spool winding

This is a similar process whereby the twine which has been wound around the large spool is then wound on a paper or plastic tube of a size appropriate for the particular net making machine being used. However, in the case of polyethylene, owing to its particular rigidity, a high torque is required, and so a special spool winder must be used. Since the winding unit herein specified cannot be used, it will be necessary to order already wound polyethylene spools.

(6) Net making

We have specified 4 types and 5 units of net making machine for Chittagong and 3 types and 5 units for Mongla. At Chittagong, all 3 types of twine will be processed: nylon multi-filament, nylon mono-filament, and polyethylene. However, at Mongla, the main concentration will be on nylon multi-filament twine. In anticipation of future demand, we have selected a unit for processing thick material that is capable of also processing polyethylene twine.

⑦ Provisional resin processing

After the netting is manufactured, it is quickly put through a resin immersing unit so as to provisionally stabilize the knots. This is a temporary measure to prevent the knots from loosening during handling in the later processes and to maintain net quality. It is particularly effective with nylon netting. Resins may be both acryl and rosin types, with water-soluble resins widely used.

⑧ Selvage gathering

This process is used when applying depthwise stretching & heat treatment. When the netting comes out of the net making machine, the twine at both ends of the netting emerge in a slack condition without forming a complete mesh. This twine is called "selvage"; the selvage twine is threaded through the selvage and bundled. This threading can be done mechanically or by hand, but in this plan, it will be done manually.

⑨ Inspection and repair

Quality is checked by spreading out the netting, with mending done wherever feasible. This operation is entirely by hand.

⑩ Dyeing

The dyeing process is done by immersing the net in a specified dyestuff solution under normal heat and normal pressure. There exist very large dyeing units but, since we do not anticipate a large demand for dyed netting, we have not provided for a specialized vessel for dyeing use.

For use on nylon netting, acid type dye is most commonly used.

(11) Final resin treatment

In this process, the netting is put in the centrifugal separator with the resin. The resin is immersed uniformly by rotating.

(12) Selvage threading

The twine is passed through the gathered selvage (Process (8)). However, for purposes of stretching with the depthwise stretching & heat setting unit (Process (14)), a stainless steel rod is passed through the selvage. This stainless steel rod is used for attaching the gathered selvage on the hooks of the machine.

(13) Lengthwise stretching & heat treatment

This is a machine for continually heat treating netting which has been resin treated (Process (11)). During this process, the size of the mesh is adjusted and knots are stabilized (by heat hardening the resin and correcting any looseness or slippage). The treatment is done in high temperature dry air. This unit is used mainly for nettings of fine twine; nettings of thick twine are treated by Process (14).

(14) Depthwise stretching & heat treatment

Process (13) is carried out in hot dry air, but Process (14) will be performed in a chamber full of steam. It is applied mainly to nettings of thicker twine. Also, when the mesh size is severely restricted, lengthwise treatment is followed by depthwise treatment.

(15) Drying

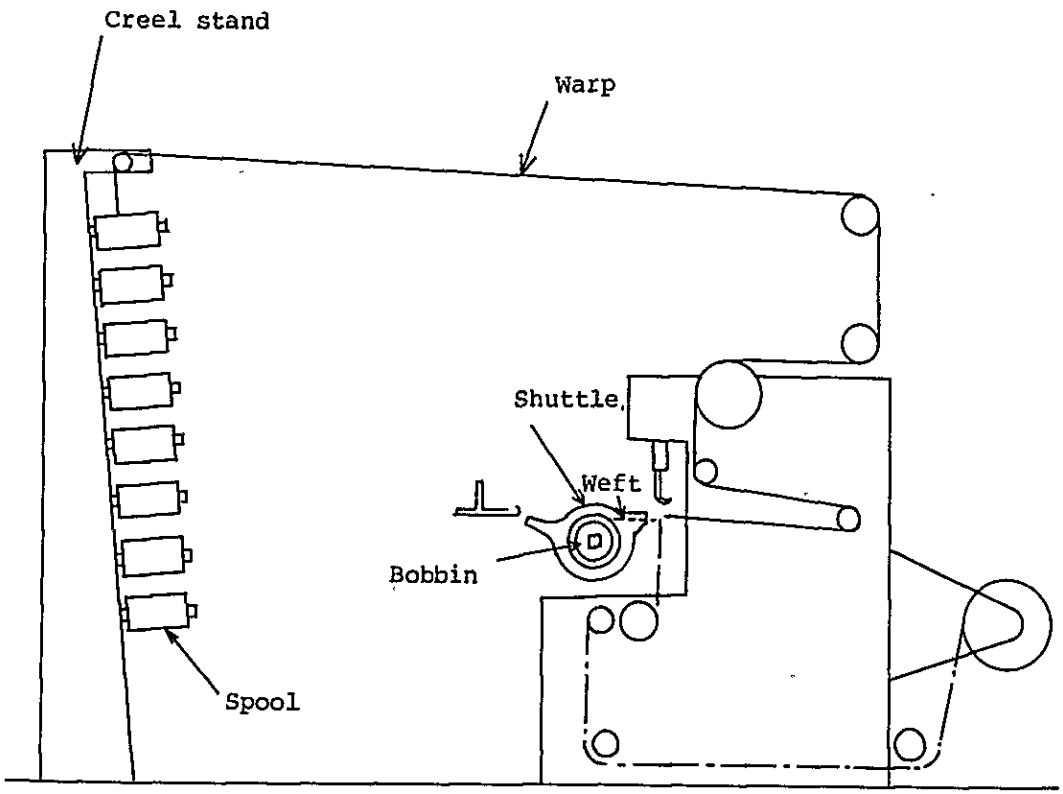
Before packaging, the netting is fully dried out-of-doors.

⑯ Packaging

The product is put in predetermined packages for shipment.

The nomenclature for the main components of the net making machine may vary, depending on the form, type, and manufacturer. We have, therefore, shown in the following chart the names of the various components, as used in this report.

Main components of net making machine



(3) Division of Production Activity:

As is apparent from the preceding explanation of the net making process, there are basic differences between the process used for nets of nylon multi-filament twine and those of polyethylene and nylon mono-filament. These differences are based on the type of raw material-- whether or not taking up from a hank is required-- and whether the netting material requires depthwise stretching and heat treatment.

Thus, in the present plan, we have elected not to locate production lines using different processes in the same facility. We have divided the production processes between Mongla and Chittagong, with different product types and properties assigned to each location.

Specifically, products at Mongla will concentrate on netting using primarily medium-fine nylon multi-filaments, as is the case at the existing Comilla facility. This plant will produce a stable supply of gill nets, which are understood to be in greatest demand in Bangladesh.

The Chittagong plant will also be capable of producing polyethylene netting-- not previously produced in Bangladesh-- and netting of thick nylon or of nylon mono-filament so as to be in a position to meet future new demand as well. A structure will be developed capable of providing a stable supply of netting of a quality equal to or superior to that which has hitherto been imported.

(4) Equipment Composition:

Given the decision to use different production processes at the Mongla and Chittagong facilities, the types and composition of equipment at the two plants will be different, as per the following summary:

Type of equipment	Chittagong	Mongla	Explanatory remarks
Net making machine (A)	0	-	° For use with polyethylene - but can also be used with multi-filament nylon thick material ° Single knot
Net making machine (B)	0	0	° For use with both nylon multi-filament and mono-filament. ° Single and double knot. ° To be used for thicker materials than those produced at Comilla plant. ° The "B" unit can also be used to make polyethylene nets.
Net making machine (C)	0	0	
Net making machine (D)	0	0	
Bobbin Winder (A use)	0	-	° For use with thick material.
Bobbin Winder (B use)	0	0	° For use with both nylon multi-filament and mono-filament.
Bobbin Winder (C use)	0	0	
Bobbin Winder (D use)	0	0	
Spool Winder	0	0	° For thick material ° For general use
Lengthwise stretching & heat setting unit	0	0	
Depthwise stretching & heat setting unit	0	-	° Factory floor must be reinforced for installation. ° A boiler is required to steam.
Centrifugal separator	0	0	° For resin treatment

2-3 Basic Design

2-3-1 Specifications for Fish Net Manufacturing Equipment

Based on the conclusions reached in the previous section, we have developed concrete specifications for the equipment as follows:

1) Net making machines:

After consolidating the types of netting to be produced we have developed specifications to satisfy the requirements for the net making machines, based on the basic raw materials to be used and twine thickness.

Types of Netting to be Produced

Using the data on netting types obtained during our field survey, we may now summarize the range of equipment specifications on the basis of the individual specifications of the fishing nets, as shown in the following table:

Polyethylene Twine Netting

Use	Twine Thickness	Mesh Size (mm)	Mesh Depth	Knot Type
Trawl Nets (1)	400 D/30-400 D/60 (Ø1.8 - Ø2.75)	40 - 400	37 - 400	English knot
Trawl Nets (2)	400 D/18-400 D/36 (Ø1.4 - Ø2.1)	60 - 200	50 - 312	"
Trawl Nets (3)	400 D/24-400 D/36 (Ø1.6 - Ø2.1)	80 - 300	80 - 324	"
Trawl Nets (4)	400 D/24-400 D/60 (Ø1.6 - Ø2.75)	80 - 200	90 - 324	"
Trawl Nets (5)	- (Ø1.6 - Ø2.3)	45 - 200	-	"
Set Bag(1) Nets	- (Ø1.0 - Ø2.2)	20 - 160	-	"
Set Bag(2) Nets	- (Ø1.0 - Ø2.2)	20 - 160	-	"
Range	400 D/9-400 D/60 (Ø1.0 - Ø2.75)	20 - 400	37 - 400	"

We believe that a commercial grade of polyethylene twine (with a diameter of ø3.0 mm) will be used within the above thickness ranges. We have broadened the range to 400 D/9-400 D/72 (ø3.0).

From the above table, the specifications for the A-type net making machine will be as follows:

Type of Equipment	Twine Thickness	Mesh Size (mm)	Mesh Depth	Knot Type
Type A	400D/9-400D/72	20 - 400	37 - 400	English knot

Nylon Netting

Use	Twine Thickness	Mesh Size (mm)	Mesh Depth	Knot Type
Trawl Net (2)	210 D/30 (Ø1.15)	40	262	English Knot
Trawl Net (3)	210 D/30 (Ø1.15)	40	400	" "
Trawl Net (4)	210 D/30 (Ø1.15)	40	400	" "
Shrimp Trawl Net (6)	- (Ø2.0 - Ø2.3)	35 - 200	-	" "
Gill Net (1)	210 D/3-210 D/6 (Ø0.35-Ø0.45)	73.5 - 98	-	Double English Knot
Gill Net (2)	210 D/6 (Ø0.45)	100	182	" "
Gill Net (3) For Hilsa	210 D/3-210 D/9 (Ø0.45-Ø0.55)	73.5 - 98	-	" "
Gill Net (4) For Indian Salmon	210 D/45 (Ø1.5)	73.5 -147	-	" "
Range	210 D/3-210 D/45 (Ø0.39-Ø1.5)	35 - 200	182 - 400	English Knot & Double English Knot

Since there is a limit to the twine thickness that can be fed to a particular type of net making machine, we have established a range of 3 types based on twine thickness, resulting in the following sets of specifications:

Type of Equipment	Twine Thickness	Mesh Size (mm)	Mesh Depth	Knot Type
Type D	210 D/3 - 18	73.5 -100	182	English Knot, Double English Knot
Type C	210 D/6 - 24	-	(200)	"
Type B	210 D/12- 45	40 - 147	400	"

Detailed data on the types of netting that can be produced with the above types of net making machines are given in Appendix VII.

2) Bobbin winder, spool winder:

Based on the net making machines satisfying the above specifications, the volume of netting that will be produced is as shown below. (Cf. Appendix IX for details.)

Poduction of Netting

Type of Equipment	Chittagong		Mongla
Machine A	Polyethylene	15,861 kg.	-
" B	Nylon multi-filament	11,779	37,049 x 2 = 74,098kg.
	Nylon mono-filament	2,874	-
	Polyethylene	4,898	-
" C	Nylon multi-filament 16,898 x 2 =	33,796	22,508 x 2 = 45,016
	Nylon mono-filament 1,167 x 2 =	2,334	-
" D	Nylon multi-filament	11,014	16,797
	Nylon mono-filament	1,591	—
Total		84,147 kg.	135,911 kg

From this netting volume, we may calculate the warp and weft lengths and arrive at the number of spindles to be wound.

On the basis of the required total number of spindles, we can then determine the required number of spindles for each type of twine. Taking into consideration the number of net making machines and, after allowing a suitable margin of safety, we find we require a total of 5 bobbin winders and 5 spool winders at each facility.

However, in satisfying the required number of spindles, we must allow for the possibility of variation in the number of units. (Details are shown in Appendix X)

3) Lengthwise stretching and heat setting unit:

The most important element in determining specifications for the lengthwise stretching and heat setting unit is the required stretching load. Setting the target twine thickness at nylon multi-filament 210 D/3-45, and selecting the netting requiring the largest stretching load, we have computed the required stretching load to process this netting. On this basis, we have specified a stretching load of about 1,500 kg. (For details, cf. Appendix XI).

4) Depthwise stretching and heat setting unit:

This unit is intended to process the types of twine that cannot be processed on the unit described in 3)-- viz., thick nylon, polyethylene, and nylon mono-filament.

Selecting nylon multi-filament twine netting, which has the highest tensile strength amoung the various types of netting, we have calculated the load required to stretch the twine by 20%. On this basis, the required load works out to 22,000 kg but, allowing a small margin of safety, we have proposed a unit with a stretching load of about 25,000 kg.

Turning now to stretch direction and treatment length, since the unit is to be placed in an area of limited length within

the Chittagong facility, we have selected the shortest possible unit with an overall length of about 15 m and treatment length of 10 m. (Details are given in Appendix XII).

5) Boiler:

The boiler will have a capacity matching the specifications of the depthwise stretching and heat setting unit described in 4)-- viz., 800 kg/h of actual evaporative capacity.

6) Centrifugal separator:

This unit is to be used in the final resin treatment and in dyeing. We have selected a unit capable of one-time processing of up to 2 rolls of 210 D/30, 50 mm mesh netting material. From this, we arrive at an interior basket diameter of about 1 m and a capacity of 300 litres.

The following table summarizes the specifications developed above:

Summary of Specifications

Name of Equipment	Specifications	Chittagong	Mongla
1) Net Making Machine (A)	° Twine : Polyethylene multi-filament about 400D/9-72. Nylon multi-filament about 210D/18-150 ° Number of Shuttles: approx. 150 ° Mesh size (mm): approx. 40 - 400 ° Knot : Single	1 Unit	-
2) Net Making Machine (B)	° Twine : Nylon multi-filament about 210D/12-45 Nylon mono-filament about Ø0.37 - Ø0.65 Can also be used with polyethylene twine of appropriate thickness ° Number of Shuttles : approx. 300 ° Mesh size (mm): approx. 25 - 200 ° Knot : Double and Single Knot	1 Unit	2 Units
3) Net Making Machine (C)	° Twine : Nylon multi-filament about 210D/6 - 24 Nylon mono-filament about Ø0.28 - Ø0.5 ° Number of Shuttles: approx. 200 ° Mesh size (mm): approx. 19 - 200 ° Knot: Double and Single Knot	2 Units	2 Units

Name of Equipment	Specifications	Chittagong	Mongla
4) Net making Machine (D)	° Twine : Nylon multi-filament about 210D/3 - 18 Nylon mono-filament about Ø0.2 - Ø0.4 ° Number of Shuttles: 400 - 500 pcs. ° Mesh size (mm): approx. 16 - 200 ° Knot : Double and Single Knot	1 Unit	1 Unit
5) Bobbin Winder (for A)	° Pitch : for 14 mm use 3 spindles/unit or equivalent	1 Unit	-
6) Bobbin Winder (for B)	° Pitch : for 14 mm use 3 spindles/unit or equivalent	1 Unit	2 Units
7) Bobbin Winder (for C)	° Pitch : for 11 mm use 3 spindles/unit or equivalent	2 Units	2 Units
8) Bobbin Winder (for D)	° Pitch : for 9.5 mm use 3 spindles/unit or equivalent	1 Unit	1 Unit
9) Spool Winder	° For use with thick material 6 spindles/unit	1 Unit	-
10) Spool Winder	° 3 spindles/unit (12/units)	4 Units (1 Unit)	4 Units (1 Unit)
11) Spool Winder	° 6 spindles/unit	-	1 Unit

Name of Equipment	Specifications	Chittagong	Mongla
12) Lengthwise stretching & heat setting unit	° Stretching load: about 1,500 kg ° Roller width about 1,200 mm	1 Unit	1 Unit
13) Depthwise stretching & heat setting unit	° Stretching load: about 25 tons ° Effective hook width about 1,500 mm	1 Unit	1 Unit
14) Boiler	° Effective steam output about 0.8 tons/hr	1 Unit	—
15) Centrifugal separator	° Basket dimensions: Inner-diameter about 1 m Depth about 0.41 m	1 Unit	1 Unit

Notes to preceding table:

1) The number of bobbin winders and spool winders are as shown above. However, even if the number of spindles/ unit vary, if the winding capacity/unit remains the same, substitution is possible.

2) Attachments for taking up twine from a hank are required for the bobbin winder and the spool winder.

3) In the case of the net making machines and the depthwise stretching and heat setting unit, small size units must be selected so as to fit in the floor areas at the facilities now under construction.

4) The boiler includes a water softener unit.

5) Selvage twiner and a resin immersing device are to be attached to the net making machines.

2-3-2 Deployment Plan

Space requirements may be estimated as follows from the equipment composition. The areas for the equipment at Chittagong and Mongla are, respectively, 178.7 m^2 and 109.8 m^2. However, when we place the equipment on the drawings, the floor space requirements, including operating areas, come to 454.3 m^2 at Chittagong and 344 m^2 at Mongla. Thus, the space required for the equipment at these locations works out to 2.54 times at the former and 3.14 times at the latter.

In our plan, we had originally anticipated use of medium-sized net making machines but, if we were to install units requiring large amounts of floor space, the areas for operations and maintenance would become very confined. This point must be given careful consideration during project implementation.

We offer the following hints regarding the placement plan:

1) Machines should be kept as small as possible.

2) If there is no room for an office inside the facility building, the office should be established elsewhere.

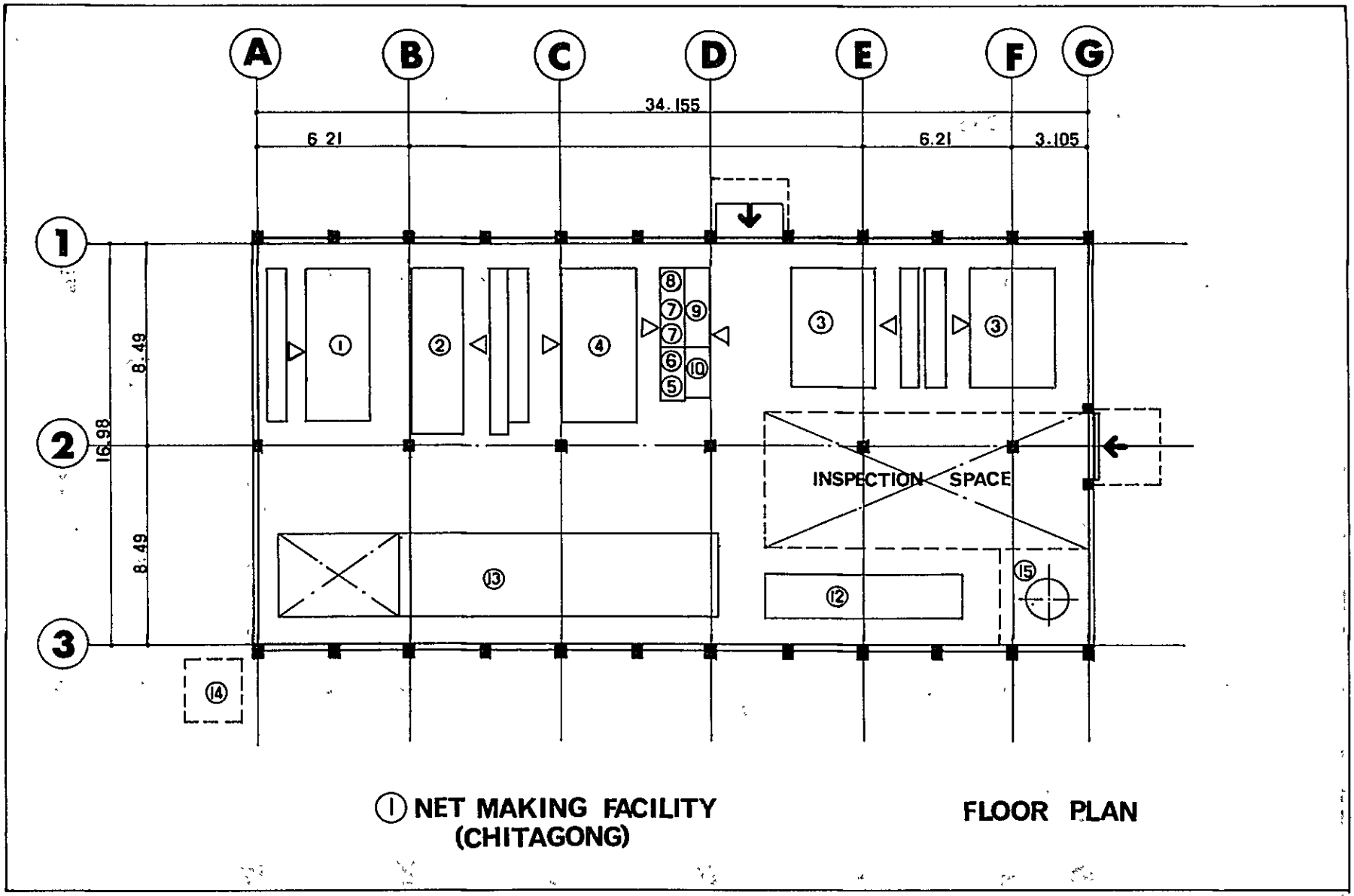
3) The depthwise stretching and heat setting unit slated for Chittagong ideally should have a total length not exceeding 15 m. The boiler supplying steam for this unit should be located outside in a simple enclosure. And, if inspection space is inadequate, it may be necessary to locate this area elsewhere as well.

4) With regard to the depthwise stretching and heat setting unit, since a horizontal force parallel to the floor will be applied to the floor, it will be necessary to increase and reinforce the thickness of the concrete at that spot permitting a bearing load of some 50 tons.

Also, depending on the unit, it may be necessary to attach to the wall a device for raising the lid of the depthwise stretching & heat setting unit, thereby necessitating reinforcement in that section of the wall.

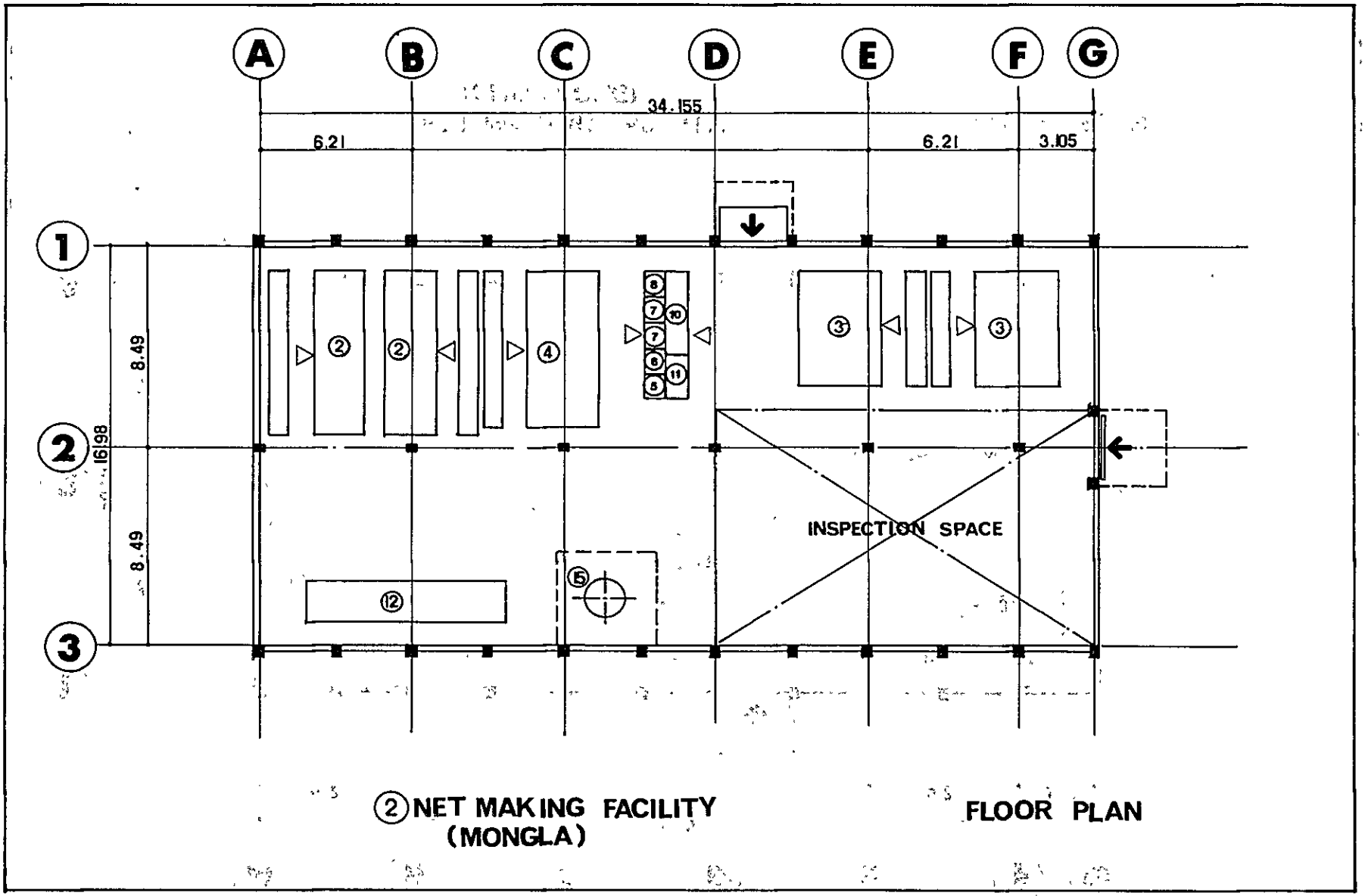
In the following charts, we have shown the suggested equipment deployment plans for Chittagong and Mongla. These plans, however, should be reexamined after specific equipment types have been selected prior to making a final determination as to layout.

The numbers shown in the deployment plans correspond to the numbers shown for the various types of equipment in the summary of specifications given earlier.



① NET MAKING FACILITY (CHITAGONG)

FLOOR PLAN



② NET MAKING FACILITY (MONGLA)

FLOOR PLAN

SECTION 3 PROJECT PLAN

Based on the assessment in the previous Section, we now discuss, with regard to the project plan for the facilities targeted for introduction, the implementation plan, the allocation of responsibility between Bangladesh and Japan, the personnel plan, administrative and maintenance costs, and the operating plan.

3-1 Implementation Plan

If this project is implemented on the basis of a grant-in-aid from Japan, its implementation will be in accordance with the procedures prescribed in the Japanese Grant-in-Aid System.

The following procurement methods may be considered for the net making units, which form the core of this project:

1) Country of manufacture for the net making machines and other equipment :

In Japan, there are 3 major producers of net making machines all of which have over 40 years of history and have developed from the fishing net manufacturer as the parent body.

As of 1981, the number of powered net making units for fishing net use in Japan totaled: 15 flat-knot units; 1,020 English knot units; 229 Japanese minnow-knot units; 403 knotless units, and 74 Raschel units, for a total of 1,981 units*. (Cf. Appendix XIII)

Almost of all of these units are Japanese-made, with the exception of certain older type units made in West Germany.

We recommend the procurement of net making units for this program from Japan, considering its long export history in this field and the international competitiveness of Japanese products

*Textile Statistical Yearbook, 1981, edited by the Research and Statistics Department of the Secretariat of the Minister of International Trade and Industry; 1981

in terms of both quality and price.

2) Procurement methods and scope of contract:

Various types of procurement methods can be considered, but it would be desirable to procure the units on the basis of a competitive tender among selected parties, limiting the bidding to manufacturers at a certain level of experience, creditworthiness, and financial soundness. The pre-qualification evaluation must be done for the designated tender of the applicants from net making machine manufacturer of Japanese nationals.

With regard to the scope of the contract, the contractor should be willing to bear final responsibility for his equipment through test operations and operational guidance. This approach, we feel, will be highly effective in increasing the benefits from the equipment grants, and so it would be appropriate to make this service part of the overall contract, in accordance with the division of responsiblities shown in the Section 3-2.

3) Consulting services :

Consulting services required for implementation of this project, which are to be covered by the Japanese government's grant-in-aid program, will naturally the responsibility of the Japanese side. However, the consultants will be assiting the BFDC in effectively implementing this porject. The scope of consulting services will be as follows:

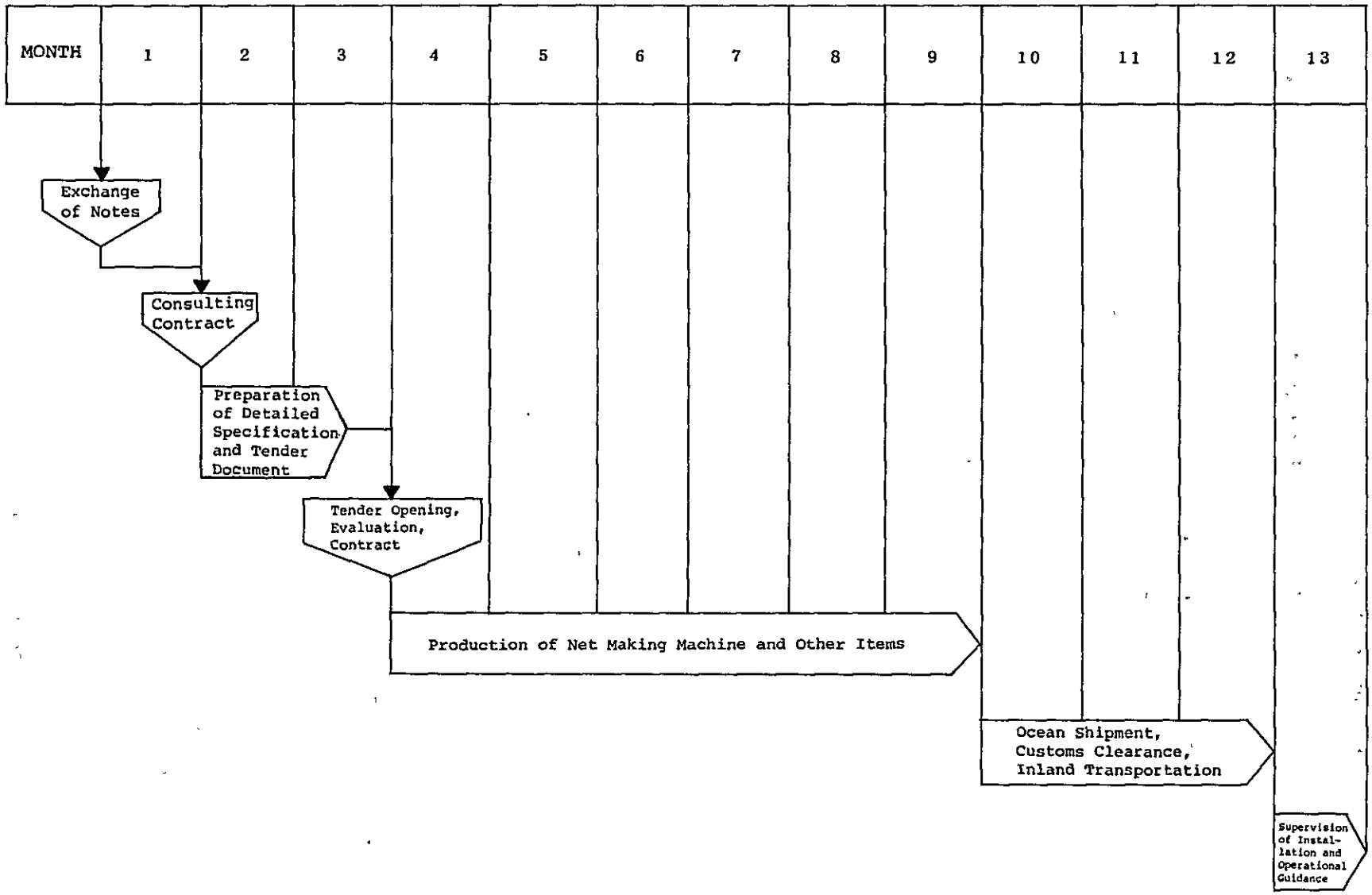
1) Preparation of detailed equipment specifications
2) Preparation of tender documents
3) Assistance in carrying out and evaluating the tenders
4) Inspection during the equipment manufacturing process; performance check on completion
5) Inspection at the time of final delivery of the equipment
6) Discussions and cordination assistance relative to the above with concerned organizations

4) Implementation stages:

The following chart outlines the expected stages of implementation for this project.

The standard delivery period for this type of net-making equipment in Japan is six months. To this should be added another four months to cover ocean shipment, operational guidance, and final delivery; another two months will be required from the signing of the consulting agreement through the awarding of tender. As to the time of shipment from the port of disembarkation in Bangladesh to the final locations, it is essential to avoid the southwest monsoon season from May to August.

Project Flow Chart



3-2 Respective Responsibilities the Bangladesh and Japanese Governments; Costs of Executing Bangladesh's Functions in the Project

(1) Project scope :

The subject plan is to be carried out by means of a grant-in-aid from Japan to the provision of fish net making equipment as part of the BFDC Plan for the construction of fish net producing facilities. The scope of this program will be as follows:

1) Provision of the net making machines
2) Provision of peripheral equipment such as bobbin winders
3) Shipment of the above equipment from Japan to Bangladesh and delivery to the final facilities at site.
4) Installation supervision for the equipment
5) Pilot operation and delivery of the equipment
6) Provision of other services required to implement or supervise the above

(2) Items to be carried out by Bangladesh and by Japan:

The division of responsibility for implementing this program will be as shown below:

	Item	Bangladesh	Japan	Comment
(1)	Construction of facilities for Mongla and Chittagong	*		in progress
(2)	Reinforcement of foundation to permit installation of equipment	*		to be done after equipment is finalized.
(3)	Bringing in 100 KVA power; all internal distribution including necessary appliance	*		in progress
(4)	Water supply and piping	*		in progress
(5)	Waste-water disposal	*		in progeess
(6)	Provision of phones, furniture and instruments	*		
(7)	Supply of net making equipment and all related items (including replacement parts)		*	
(8)	Ocean shipment and insurance, Japan to Chittagong, for net making equipment		*	
(9)	All costs relating to discharge of the net making equipment at Chittagong, customs clearance, payment of necessary duties, and handling charges	*		
(10)	Storage of equipment following customs clearance, payments of storage costs	*		
(11)	Inland transport and insurance from Chittagong to the facilities.		*	
(12)	Unloading and placement of equipment at each facility, unpacking, installation, wiring, piping	*		
(13)	Supervisory service for installation, wiring and piping		*	about 0.5 man/ month at each facility
(14)	Test operation of equipment, operational guidance		*	about 0.5 man/ month at each facility
(15)	Consulting services related to above		*	

3) Estimated costs for the Bangladesh functions:

The following table gives estimates of the various costs for the functions to be shouldered by the Bangladesh side.

	I t e m	Quantities	Amount	Remarks
1)	Items (1),(3),(4) and (5) are all included in the 34.8 million Tk construction projects under way			
2)	Foundation reinforcement for equipment (2)	15m^3 of concrete @27,000 (including labor)	(in thousand yen) 405	for depthwise stretch and heat treatment at Chittagong
3)	Phone, furniture, instruments (6)			390,000 Tk provided for this purpose in BFDC plan
4)	Duties (9) and storage costs (10)	Duty: Equipment for Chittagong CIF x 15% Equipment for Mongla CIF x 5% Clearance etc: CIF x 3%	(in thousand yen) 26,963	In the BFDC plan 2,149,000 Tk has been included for duties and 398,000 Tk for customs clearance
5)	Cartage and installation of equipment (12)	Skilled labor 80 persons @30 Tk. Unskilled labor 300 persons @20 Tk	(in thousand yen) 1,097	BFDC's plan already provides 300,000 Tk for installation

With the exception of the floor reinforcement for depthwise stretcher in item 2) all of the above costs are already provided for in the budget contained in the BFDC Plan. We estimate that the reinforcement construction will be no more than 1% of the total construction budget and so recomnend that the design plans be amended accordingly.

3-3 Personnel Plan

Personnel has already been fully considered in the BFDC Plan. However, considering the differences in the basic set-ups at the Chittagong and Mongla facilities, there have been small changes from the original Plan in equipment deployment patterns. We have, therefore, modified the personnel requirements as follows.

(1) Plant personnel

Plant personel required for both Chittagong and Mongla is estimated as follows.

Facilities / Level / Process	Chittagong			Mongla		
	Unskilled labor	Skilled labor	Engineer	Unskilled labor	Skilled labor	Engineer
Preparatory Stage Process						
Bobbin winder	2	1		2	1	
Spool winder	2	1		2	1	
Net Making Process			1			1
5 net making units of each location		5			5	
Inspection & Repair Process		1			1	
		5			5	
Finishing Process			1			1
Dyeing, resin treatment	1			1		
Heat treatment,	2	1		1	1	
Drying and packaging	2			2		
Other	5			5		
Transport						
Personnel for one-shift operation	14	14	3	13	14	3

We shall next consider personnel requirements under a 3-shift operational structure. Our calculations assume that inspection, repair, and finishing operations will be done only during the day shift (7-hours) that these operations will be suspended during the night hours. The reasons for suspending these operations during the night are as follows:

1) Since the treatment capacity in the finishing stage is large, losses from idle time under a 3-shift operation can be quite high, leading to a decline in productive efficiency.

2) If inspection and repair operations are done at night, they can cause wide fluctuations in product quality.

We have thus tripled only the number of persons involved in the preparatory and net making processes. A summary of the personnel required for a 3-shift operation is given below:

Facility / Level	Chittagong			Mongla		
	Unskilled labor	Skilled labor	Engineer	Unskilled labor	Skilled labor	Engineer
Plant personnel for 3-shift operations	22	28	3	21	28	3
Total	53			52		

(2) Office, supervisory, other personnel

Occupational categories other than plant workers at the subject facilities are as follows:

Facility	Chittagong	Mongla
Manager (General coordinator)	1	1
Controller	1	1
Office personnel (typist, cashier)	2	2
Shipping coordinator	1	1
Production coordinator	1	1
Messenger	3	3
Watchman	1	1
Total	10	10

Total staff requirements, then, are as follows:

Facility	Chittagong	Mongla	Combined Total
Plant personnel	53	52	105
Official administrative personnel	10	10	20
Total	63	62	125

Labor Costs

Annual labor costs for the above personnel structure would be as calculated below:

(In Yen)

	Number of persons	1984 - 85	1985 - 86
Manager	2	813,120	910,800
Controller	2	211,600	292,600
Office personnel			
Cashier	2	149,600	156,640
Typist	2	131,780	131,780
Shipping coordinator	2	149,600	156,640
Messenger	6	285,780	290,400
Watchman	2	95,260	96,800
Production coordinator	2	149,600	156,640
Sub Total	20	2,056,340	2,192,300
Engineer	6	443,300	465,080
Skilled worker	56	3,689,840	3,837,680
Unskilled worker	43	2,412,300	2,477,697
Sub Total	105	6,545,440	6,780,457
Grand Total	125	8,601,780	8,972,757
		(781,980 Tk)	(815,705 Tk)

(3) Appropriateness of the Personnel Deployment Plan

We have assessed the appropriateness of the above personnel plan. For purposes of comparison, we have based our assessment on the following statistical relationships: a) personnel per net making machine; b) the ratio of office and administrative personnel to total staff requirements; and c) the ratio of production personnel. The results of our analysis are shown in the following table.

	*1 In Japan	*2 Comilla Plant	BFDC Plan	Chittagong	Mongla
Number of net making machine	2,105 (1,981)	3	12	5	5
Total Staff	8,710 (6,009)	51	111	63	62
Office staff and administrator	-	16	21	10	10
Plant staff	-	35	90	53	52
(a) Staff/unit	4.14 (3.03)	16.7	9.25	12.6	12.4
(b) Ratio of office/administration staff (%)	-	31	19	16	16
(c) Ratio of plant staff (%)	-	69	81	84	84

*1 Data for Japan from Textile Statistical Yearbook, 1971; figures without parentheses are for 1971; those inside parentheses are for 1981.

*2 We have assumed that 3 units are functional at Comilla and that they operate on a 3-shift/day basis

From the above table, we may draw the following conclusions:

1) With regard to criteria (a), the figure for Japan is only a third that of Chittagong and Mongla. This is presumably due to the fact that Japanese plants work on only one shift and are equipped with large-size production units.

2) The (a) value for the Comilla plant is high relative to that shown in the BFDC Plan. However, the difference is not so great vis-a-vis the Chittagong and Mongla facilities. The personnel indices for the Chittagong and Mongla plants fall midway between those for Comilla and the BFDC Plan.

3) The ratio of office and administrative personnel is somewhat lower for Chittagong and Mongla than for Comilla and the BFDC Plan. But this situation may change with an increase in production volume, and under the influence of local labor practices.

The personnel plan viewed on the basis of the above criteria, may well change under actual operating conditions to meet particular requirements, but, the plan on the whole, seems to be quite workable.

3-4 Maintenance and Operating Costs

Maintenance and operating costs for the two facilities have been computed as follows:

1) Power Requirement:

Power requirements for the Chittagong and Mongla facilities are shown below. In view of the large number of machines using motors, we have set the power factor at 0.775. The following formula shows the relationship between power factor, electric power, voltage, and current.

(Current) x (Voltage) KVA = (Electric Power) KW/Power Factor

Required KVA

	Chittagong	Mongla
Required KW	78.05	57.7
Required KVA	approx. 100	approx. 75

(Details are shown in Appendix XIV)

The power distribution facilities at Chittagong can deliver 750 KVA via 2 transformers., of which 500 KVA are being used by facilities within the fishery complex. This leaves 200 KVA for distribution to adjoining plants, and we anticipate that this amount will be made available to the new facilities.
In addition, in the transformer room, there is a 700 KVA generator room for back-up use, indicating ample reserve power for this facility.
At Mongla, on the other hand, a 750 KVA transformer station is presently under construction, while back-up generators (2 units at 700 KVA each) have also been installed. Within the Mongla compound, there are also ice-making, freezing, and refrigeration facilities whose power requirements may be estimated collectively at 500 KVA. Thus, with a 200 KVA surplus, there is an ample power reserve at this facility.

2) Appropriateness of the Power Consumption Estimates:

We have attempted to determine the appropriateness of the power consumption data at Chittagong and Mongla on the basis of the 1971 Textile Statistical Yearbook. According to these data, the total number of net making machines in Japan at the time (shown in the figures as the average number of operating units per month) came to 2,150 machines, while net production totalled 28,157 tons, and power consumption came to 20,187,000 KWH.

Using these figures, we have calculated the total power consumption per unit and the power requirements per ton of netting production. We have next calculated the respective values for Chittagong and Mongla, as follows. We have postulated the operating rate for the net making machines at 80%, for the bobbin winders and spool winders at 60%, and all other items of equipment at 20%. The results of our analysis, showing production and power consumption at Chittagong and Mongla, are as follows:

	Chittagong	Mongla	Remarks
Production (ton/year)	84	136	—
Power consumption (KWH/year)	64,806	66,801	based on 3 shifts
Power consumption (KWH/year)	24,514	22,267	based on 1 shift

In the following table, we have developed comparative values for Japan, Chittagong, and Mongla. The figures in parentheses indicate values for one-shift operations.

	Japan	Chittagong	Mongla
ⓐ Number of net making machines	2,105	5	5
ⓑ Production (tons/year)	28,157	84 (38.6)	136 (45.3)
ⓒ Power Consumption (KW)	-	16.8	15.3
ⓓ Power Consumpiton (KWH/year)	20,187,000	64,806 (24,514)	66,801 (22,267)
ⓔ Power Consumption per Unit (KWH/year)	9,590	12,961 (4,903)	13,360 (4,453)
ⓕ Power Consumption per Ton of Products (KWH/year)	717	772 (635)	491 (491)
ⓖ Production per Unit (tons)	13.4	16.8 (7.7)	27.2 (9.1)

Comparing the figures in the above table relating to one-shift operations, we may draw the following conclusions:

1 The values for Item ⓔ at Chittagong and Mongla (i.e., in parentheses) are smaller than for Japan. This, however, is because we have held down utilization ratios as well as the size of equipment at the new facilities.

2 The values for Items ⓕ and ⓖ tell us that production will be small relative to power consumption. But this may also be considered a function of productivity deriving from differences in equipment scale. As operations stabilize and the labor force becomes more skilled, these values can be expected to improve.

3) Water Supply:

Water consumption for fishing net production will be greater at Chittagong, owing to use of the boiler. Water must be secured in quantities appropriate to the steam generating capacity of the boiler. Water will also be required to some

extent in the resin immersion and dyeing processes, with estimated requirements as shown below. Overhead water tanks with a capacity of 20,000 gallons (roughly 90 tons) have been erected at both Chittagong and Mongla.

1 For Boiler (at Chittagong only)

Steam Generation (Volume of Water)	1,000 kg/hr
Pressure Supplied (Incoming Water Pressure)	1.5 - 3.0 kg/cm^2

2 For Dyeing

	Chittagong	Mongla
Netting to be dyed (kg/day)	40*	130
Required Volume (ℓ/day) (1 kg of dyestuff to process 1,000 kg netting. Normally 0.02% liquid is used. Thus, ⇒ 5ℓ/1 kg netting)	200	650

* Set at 20% of nylon multi-twine products

3 For Resin Treatment

	Chittagong	Mongla
Volume of netting to be resin-treated (kg/day)	260*	320
Required Volume (ℓ/day) (1 kg of resin to process 50 kg of netting. Normally 1/10 diluted liquid is used. Thus, ⇒ 0.2 ℓ/1 kg netting)	52	64

* Set at 50% of total output

Allowing a safety margin of 20% in water consumption, daily water requirements will be as follows:

Requried Water Volume per Day

(Approximate)

Chittagong	Mongla
1.5 tons	0.9 ton

4) Fuel Consumption:

Among the various items of machinery, the only unit requiring the use of light or heavy oil will be the boiler at Chittagong. Light oil and both A-grade and B-grade heavy oil can all be used as fuel for the boiler. However, from the standpoint of ease of supply, A-grade heavy oil should be selected. We have, accordingly, estimated requirements on the basis of A-grade heavy oil.

With a boiler rated al 0.8 ton/hr effective steam generation, the hourly consumption of heavy oil would be about 74.4 ℓ/hr. Fuel consumption for the boiler, based both on 100% utilization (7 hours per day) and 20% utilization, are shown below.

	Per day	Per year (208 days)
Consumption (ℓ) at 100% utilization	521	108,368
Consumption (ℓ) at 20% utilization	104	21,632

For the time being, it would be more realistic to assume a consumption level based on a 20% utilization rate. On this basis, the fuel consumption will come to 21,632ℓ per annum.

5) Power and Fuel Costs Combined:

Combined power and fuel costs, as calculated above, are as follows. We have not calculated a cost for water, since BFDC will be pumping water from its own wells.

Power Costs

	Chittagong	Mongla	Total
Power Consumption (KWH/year)	64,806	66,801	131,607
Unit Cost (Tk/KWH)	3	3	3
Total Cost (Tk/year)	194,418	200,403	394,821

Unit Cost: 3 Tk/KWH

Fuel Costs (only at Chittagong)

	Per Day	Per Year (208 dyas)
Consumption (ℓ)	104.2	21,674
Unit Cost (Tk/ℓ)	8.8	8.8
Total (Tk)	917	190,731

Unit Cost: 40 Tk/gallon = 8.8 Tk/ℓ

3-5 Operating Plan

The salient characteristic of fishing net production in Bangladesh is the overwhelming proportion of hand-made netting in total output. Even after the facilities to be introduced through this program are completely operational, it is expected that the share of machine-made netting will still be only 10-15% of total demand.

Given this situation, the products which must dominate the new facilities, equipped with large numbers of powered net making machines and various items of peripheral equipment, will obviously be netting that can be made only by machine or netting which gains a substantial advantage from being machine made.

As we have seen in the previous section, the netting to be produced at the subject facilities will be made from nylon multi-filament twine, nylon mono-filament, and polyethylene twine. Nylon mono-filament nets are not yet being used in Bangladesh. Polyethylene, though widely used, has not yet been manufactured locally. Nevertheless, considering the near term demand trends, we have decided to introduce production facilities for these materials.

It is vital that major attention be paid to the following two points in establishing an operational plan for facilities facing the above demand conditions and equipped with the designated production equipment:

(1) A priority production structure should be adopted geared to demand patterns; and

(2) A flexible operating structure should be established keyed to utilization rates.

With respect to(1), machine production will be advantageous for nylon mono-filament and polyethylene netting. And, with demand expected to grow within the near future, these are naturally products which should be produced under this plan. However, we must remember that

these items are being produced for the first time in Bangladesh; they can be looked upon as new products in the sense that they utilize new types of materials. Thus, despite the latent demand for these products, we anticipate that a certain amount of time will be required to convert this potential to actual demand.

For the time being, therefore, an effort must be made to understand local demand trends in this field. Production must be carefully adjusted for those products that are prone to imbalances in supply and demand owing to seasonal fluctuations in net demand-- i.e. production must be geared to products for which current demand is strongest. Linking maintenance and operations to effective use of the facilities will be the surest way of expanding the penetration of new and more efficient net fishing gear in Bangladesh.

With respect to (2)-- a flexible operating structure--, based on the adoption of priority production structure, personnel and materials must both be allocated on a priority basis in accordance with the above production system. It is important to establish an operating structure in which the production system can be flexibly changed.

Fortunately, under our plan, the character and product range of the facilities at Chittagong and Mongla will be quite different. Thus, personnel and raw materials can be shifted on the facility with the higher operating rate, as determined by demand trends. It would therefore, be most efficient for the facilities to be managed under this kind of structure.

With regard to the facility at Chittagong, since a depthwise stretching and heat setting unit as well as other peripheral equipment are to be installed, we recommend that a batch production method be used for concentrated treatment and processing when ample inventories have accumulated of semi-processed materials requiring the use of such equipment.

It is important to establish a personnel deployment structure for this peripheral equipment that is capable of responding to production

fluctuations through the addition of temporary staff as circumstances require.

We shall next examine the areas of raw material procurement costs and final product sales in connection with the operation of the subject facilities.

When the facilities are fully operational, annual netting production will be as already shown in the second paragraph of Section 2-3-1: viz., 20,759 kg of polyethylene; 195,200 kg of nylon multi-filament; and 6,799 kg. of nylon mono-filament, for a grand total of 220,058 kg.

We assume that the cost price of nylon multi-filament twine will be 52 Tk/lb shown in the BFDC Plan and that polyethylene twine will be 30% less and nylon mono-filament, based on price variations on the Japanese market, about 10% less than nylon multi-filament. Accordingly, the purchase costs for these materials will be as shown below.

Type of Twine	Unit Cost (Tk/lb)	Volume (kg)	Total Cost (Tk)
Polyethylene Twine	37	20,759 (45,826 lb)	1,695,599
Nylon Multi-filament Twine	52	192,500 (424,945 lb)	22,097,140
Nylon Mono-filament Twine	47	6,799 (15,009 lb)	319,553
Total	-	220,058 (485,780 lb)	24,112,292

Similarly, with regard to the sales value of the final netting, we have applied the 75 Tk/lb. figure shown in the BFDC Plan for nylon multi-filament netting. With respect to polyethylene netting, considering the addition of the depthwise stretching and heat treating process, we may assume that the selling price will be only 25% below nylon multi-filament (rather than 30% less). Nylon mono-filament netting, reflecting fluctuations in raw material cost, will probably sell at 10% below nylon multi-filament.

On this basis, projected annual sales by type of netting will be as follows:

Type of Netting	Unit Cost (Tk/kg)	Volume (kg)	Total Sales Value (Tk)
Polyethylene	123.62 (56 Tk/lb)	20,759	2,566,228
Nylon Multi-filament	165.6 (75 Tk/lb)	192,500	31,878,000
Nylon Mono-filament	147.9 (67 Tk/lb)	6,799	1,005,572
Total	-	220,058 (485,780 lb)	35,449,800

The above projections for raw material cost are about 5%, or 1,172,000 Tk higher than that contained in the original BFDC Plan. Similarly, the projected sales volume is 7.4% or 2,449,000 Tk above the figure shown in the Plan.

SECTION 4 PROJECT EVALUATION

Based on the evaluation in the previous Section, we may note the following three differences between the original BFDC Plan and the subject Plan based on the Basic Design Study:

1) Whereas the original BFDC Plan provided for 6 net making machines each at Chittagong and Mongla, the subject Plan provides for 5 units at each location. At Chittagong, the subject Plan would establish facilities capable of producing netting from polyethylene twine and nylon mono-filament, including the addition of a depth-wise stretching and heat setting unit.

2) Based on the specifications of the equipment selected, annual production has been set at 220 tons per year, some 21 tons higher than the 199 tons projected by the BFDC Plan for 1985/86. This higher output is due to the production of netting using thicker twine, such as polyethylene.

3) Personnel requirements in the subject Plan have been set at 125 persons, 14 more than in the BFDC Plan. This reflects the importance attributed in the subject Plan to the preparatory and finishing processes, for which extra staff has been provided. As the skill levels improve in these operations, it will probably be possible to trim the staff involved therein.

Apart from the above, there are no major differences between the two Plans.

Based on the subject Plan, we have prepared a financial analysis along with a break-even analysis in order to assess the suitability of this program.

4-1 Financial Analysis

We shall examine here the benefits and costs associated with the subject Plan. (Cf. following Table).

(In lakh Taka)

Fiscal Year	Initial Investment	Operating Costs	Total Costs	Costs after a 13% Discount	Total Profits	Profits after a 13% Discount
1981-82	21.15	0.50	21.65	18.83	-	-
82-83	175.94	7.44	183.38	138.80	-	-
83-84	9.90	88.99	98.89	65.11	103.50	68.15
84-85	-	317.10	317.10	181.66	371.00	212.54
85-86	-	317.10	317.10	158.04	371.00	184.91
86-87	-	317.10	317.10	137.50	371.00	160.87
87-88	-	317.10	317.10	119.62	371.00	139.96
88-89	-	317.10	317.10	104.07	371.00	121.76
89-90	-	317.10	317.10	90.54	371.00	105.93
90-91	-	317.10	317.10	78.77	371.00	92.16
91-92	-	317.10	317.10	68.53	371.00	80.18
92-93	-	317.10	317.10	59.62	371.00	69.75
93-94	-	317.10	317.10	51.87	371.00	60.69
94-95	-	317.10	317.10	45.13	371.00	52.80
95-96	-	317.10	317.10	39.26	371.00	45.93
96-97	-	317.10	317.10	34.15	371.00	39.96
97-98	-	317.10	317.10	29.71	371.00	34.76
98-99	-	317.10	317.10	25.85	371.00	30.24
1999-2000	-	317.10	317.10	22.49	371.00	26.31
2000- 01	-	317.10	317.10	19.56	371.00	22.89
01- 02	-	317.10	317.10	17.02	371.00	19.91
Total	206.99	5,804.73	6,011.72	1,506.13	6,781.50	1,569.70

a) Net Present Value (NPV) : (+) 63.57

b) Benefit/Cost Ratio (BCR) : 1.13 - 1

c) Internal Rate of Return (IRR): 17.34%

The construction schedule and initial investment have been taken from the BFDC Plan; the production volume has been set at 5% higher than that developed in our basic design study.

The benefit/cost ratio (BCR), based on a 13% discount factor, is as shown in the above Table.

Based on these calculations, the net present value (NPV) in the 2001/02 fiscal year will be 6,357,000 Tk. The benefit/cost ratio works out to 1.13 - 1, the internal rate of return (IRR) to 17.34%.

These values are somewhat below those shown in the BFDC Plan, but the former are based on an operating plan that can be realized without strain. The subject Plan, therefore, is deemed to be highly realistic and to have ample economic utility.

We feel, therefore, that there is considerable significance in implenting the project.

4-2 Break-even Analysis

4-2-1 Under the BFDC Plan

In order to compute the level of sales at which profits equal costs -- i.e., the break-even point--, we must first allocate total costs as between "fixed" and "variable" costs.

Variable costs are those that fluctuate directly with increases or decreases in production, such as fuel and raw material costs.

Fixed costs are those which represent fixed outlays unrelated to increases or decreases in production, such as labor costs, interest paid, and depreciation.

It is customary to divide power and water costs into basic charges and usage charges, with the former constituting a fixed cost and the latter a variable cost item.

In this analysis, the ratio of variable to fixed costs works out to 80-20.

There are additional cost categories that may be classified as either fixed or variable, such as repairs, telephone, insurance, postage, and advertising and promotion. Considering the fact that break-even point analysis is a form of variance analysis, we have chosen to allocate costs on the basis of the variable criterion. Thus, the above items have been considered as semi-fixed costs and so allocated to fixed costs.

We have shown below, for the BFDC Plan, the allocation of total costs for the 1985/86 fiscal year between the fixed and variable categories.

(Unit:Lakh Taka)

Cost Category	Variable Costs(V)	Fixed Costs(F)	Total Costs
Raw Materials	229.50	-	229.50
Fuel	0.20	-	0.20
Power	0.24	0.60	0.30
Labor	-	7.38	7.38
Depreciation	-	34.80	34.80
Repair	-	2.00	2.00
Telephone	-	0.15	0.15
Insurance	-	3.78	3.78
Postage	-	0.13	0.13
Advertizing	-	0.05	0.05
Miscellaneous	-	5.37	5.37
Interest	-	9.22	9.22
Total:	229.94	62.94	292.88

Setting sales value as S, variable costs as V, fixed costs as F, unit selling price as P, and sales volume as m--- the ratio $\frac{V}{S}$ = the ratio of variable costs to sales and $\frac{V}{m}$ = variable costs per unit of product.

In the BFDC Plan, sales (S) are projected at 330 lakh Taka, variable costs (V) at 229.94 lakh Taka; fixed costs (F) at 62.94 lakh Taka, and unit sales price (P) at 75 Taka/lb.. With a projected sales valume (m) of 440,000 lbs., the variable costs-sales ratio;

$$\left(\frac{V}{S}\right) = \frac{229.94}{330} \times 100 = 69.682$$

Variable costs per unit of product

$$\left(\frac{V}{m}\right) = \frac{22,994,000}{440,000} = 52.259 \text{ Taka/lb.}$$

The break-even point on the basis of sales value (Xv) may be calculated as follows:

$Xv = F \div (1 - \frac{V}{S})$. Thus,

$Xv = 62.94 \times 100,000 \div (1 - 0.6968) = 20,758,575$ Tk.

The break-even point based on sales volume is developed as follows:

$$Xq = F \div (P - \frac{V}{m})$$

$$Xq = 62.94 \times 100,000 \div (75 - 52.259)$$

$$= 276,768 \text{ lbs.}$$

$$= 125,376 \text{ kg.}$$

Thus, in the 1985-86 fiscal year, if a 75 Tk/lb selling price can be maintained, profit may be expected with an annual sales volume of 125,376 kg or over and an annual sales value of 20,758,575 Taka or more.

4-2-2 Subject Plan

There are certain minor differences between our Basic Design Plan and the Plan formulated by BFDC. The following table presents the allocation of total costs between their variable and fixed components, based on the findings of the Basic Design Study.

(Unit: Lakh Taka)

Cost Category	Variable Costs (V)	Fixed Costs (F)	Total Costs
Raw Materials	241.10	-	241.10
Fuel	1.91	-	1.91
Power	3.16	0.79	3.95
Labor	-	8.40	8.40
Depreciation	-	34.80	34.80
Repair	-	2.00	2.00
Telephone	-	0.15	0.15
Insurance	-	3.78	3.78
Postage	-	0.13	0.13
Advertising	-	0.05	0.05
Miscellaneous	-	5.37	5.37
Interest	-	9.22	9.22
Total:	246.17	64.69	310.86

The projected total sales volume comes to 220,058 kg (485,779 lbs.), broken down as follows: polyethylene-- 20,759 kg; nylon multi-filament twine-- 192,500 kg; and nylon mono-filament-- 6,799 kg.

Assuming that unit selling prices will be, respectively: 56 Tk/lb, 75 Tk/lb, and 67 Tk/lb, projected sales value (S) works out to 354.5 lakh Taka; variable costs (V) to 246.17 lakh Taka and fixed costs (F) to 64.69 lakh Taka. Thus,

the variable cost ratio:

$$\left(\frac{V}{S}\right) = \frac{246.17}{354.5} \times 100 = 69.44\%$$

variable costs per average unit of product:

$$\left(\frac{V}{m}\right) = \frac{24,617,000 \text{ Tk}}{485,781 \text{ lb.}} = 50.68 \text{ Tk/lb.}$$

Accordingly, the break-even point, based on sales value---

$$\begin{aligned} Xv &= F \div \left(1 - \frac{V}{S}\right) \\ &= 64.69 \times 100,000 \div (1 - 0.6944) \\ &= 21,168,194 \text{ Tk} \end{aligned}$$

and the break-even point, based on sales volume---

$$\begin{aligned} Xq &= F \div \left(p - \frac{V}{m}\right) \\ &= 64.69 \times 100,000 \div (72.975 - 50.68) \\ &= 6,469,000 \div 22.295 \\ &= 290,155 \text{ lbs} \\ &= 131,440 \text{ kg} \end{aligned}$$

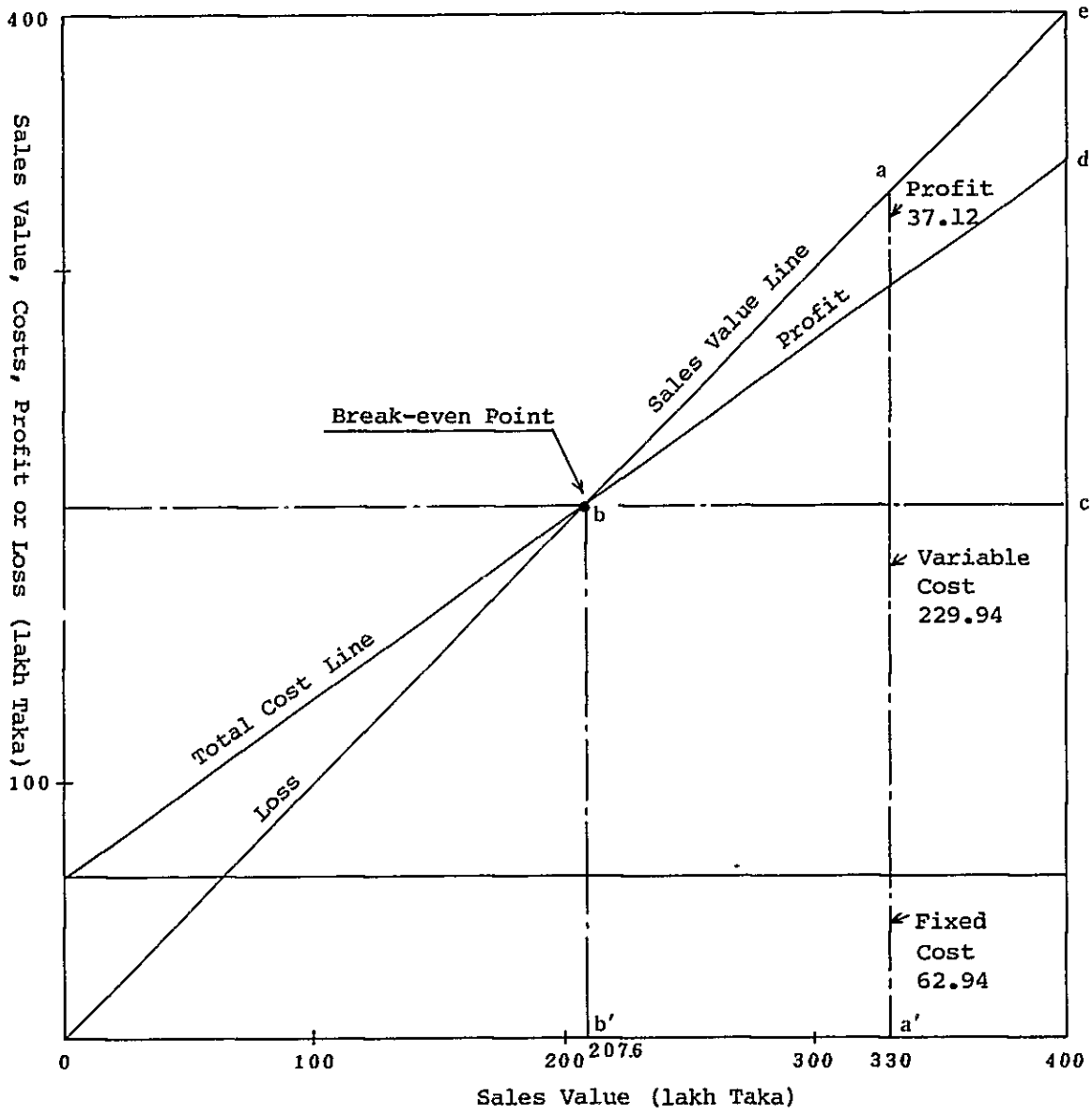
The value (P) is derived by dividing sales (S) in Taka by total production volume (in pounds).

As the above findings show, the break-even point based on sales value rises from 20,758,577 Tk in the BFDC Plan to 21,168,194 Tk in the subject Plan. Similarly, the break-even point, based on sales volume, rises from 125,376 kg (BFDC) to 131,440 Kg (subject Plan). This

indicates that, at the subject Plan facilities, with a total potential annual production of 220 tons at full capacity, the operation will be viable if production can be maintained at 59.7% or more of capacity and if sales value can be maintained at 21,168,000 Tk or more. These relationships are shown in the following two profitability charts.

Profitability Chart (1)

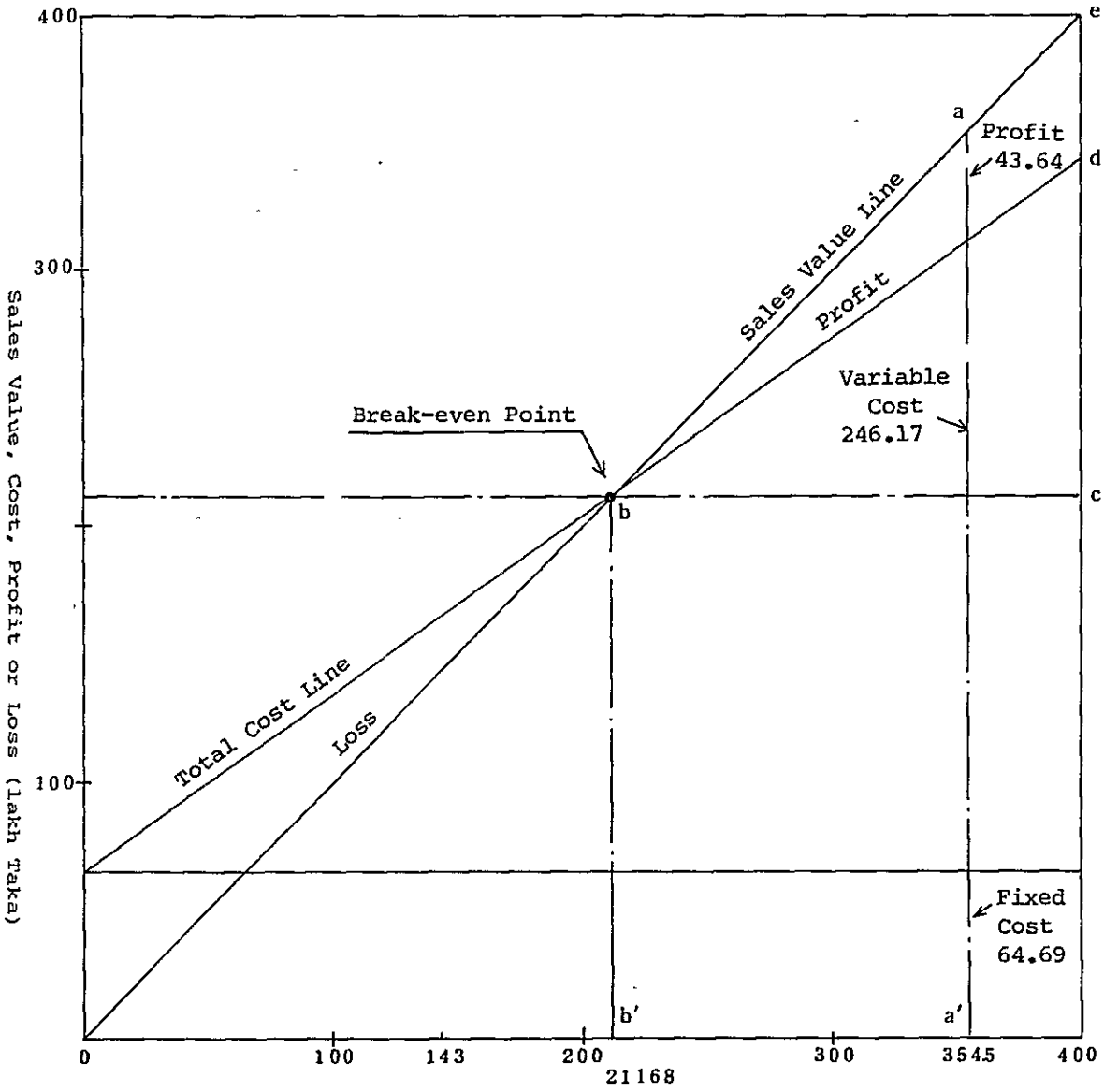
Based on the BFDC Plan



$$\text{Break-even Point Ratio } (\%) = \frac{b-b'}{a-a'} \times 100 = \frac{207.6}{330} \times 100 \fallingdotseq 62.9\,\%$$

Profitability Chart (2)

Based on the Plan by Basic Design Study



$$\text{Break-even Point Ratio } (\%) = \frac{b-b'}{a-a'} \times 100 = \frac{21168}{354.5} \fallingdotseq 59.7\ \%$$

The following observations may be made from these charts:

1) A large b-c area indicates safe and stable operations. This is shown by the break-even ratio. The relation between this value and the stability of operations may generally be expressed as shown below:

Break-even Ratio (%)	Operating Safety Ranking
100	Virtually Bankrupt
90 - 100	Critical
80 - 89	Somewhat Unstable
60 - 79	Stable
Below 60	Highly Stable

The break-even ratios for the BFDC and the subject Plans are, respectively, 62.9% and 59.7%. The above table shows that the proposed operation will be in the "stable" or "highly stable" category.

2) A narrow e-d area indicates low profitability. To raise profitability, an effort must be made to reduce fixed and variable costs and to produce products with a high value-added content.

4-3 Effectiveness and Suitability of the Plan

A wide range of benefits can be expected from the subject Plan, including direct benefits, such as an increased supply of netting, and social benefits, such as providing a stimulus to area employment.

The essential direct economic benefits that can be anticipated will be as follows:

1) The supply capability for netting will be increased to fill the demand for fishing nets in Bangladesh.

2) Based on the production of polyethylene and nylon mono-filament netting, more efficient net gear can be provided than has been hitherto available.

3) Under the subject Plan, there will, as we have seen, be an element of profitability from the BFDC net making operations and the sale of products therefrom. However, this is not a project geared simply to private investment criteria; it has been incorporated in the Second Five-Year Plan as a development project with a very lofty social objective--vis., that of increasing the supply of proteins in Bangaladesh. As a result, implementation of the subject Plan will be both profitable and of major social benefit.

With regard to the first benefit-- doubling fish production--

The Five-Year Plan sets an objective of doubling the present level of fish production to 1,330,000 tons a year. To this end, it will be necessary to increase the supply of net gear, which constitutes the primary fishing method in the country.

As explained in Section 2-2-1 above, the share of machine-made netting in the total supply of fish nets in Bangladesh is still no more than 3-4%. Future increases in the supply of machine-made netting will depend entirely on the new net making facilities provided in the Plan, which will have an indicated production capability of 200-230 tons per year.

With regard to the second benefit-- imporving the effectiveness of fishing gear--

Based on the domestic production of polyethylene netting, which has a lower specific gravity and is lower in cost than nylon, we may anticipate a saving in fuel and energy, particularly in the operation of trawl nets and set bag nets. And the diffusion of mono-filament gill nets can be expected to contribute in a major way to raising the catch efficiency of the marine fisheries, particularly those targeting as yet undeveloped pelagic resources

to which great importance is attached.

With regard to the third benefit, the expected result will be as already described. We expect that, as a program of high social utility, the Plan will be accorded a high priority in Japan's grant-in-aid program.

With respect to the suitability of the subject project, let us examine the Plan from two aspects: possible social impacts from its implementation; and its soundness, as reflected by an ability to recover costs in the course of operations.

One possible social impact from the increased supply of nets made from machine-made netting under the proposed Plan could be the economic pressure that might be placed on the hand-net manufacturing operations now being conducted by small-scale cottage industries.

The detailed condition of these hand-net operations in Bangladesh is by no means clear, and so a quantitative judgement would be difficult on this point. However, even with the new facilities fully operational, the supply at this stage would account for only 15% of the total projected demand for nets in Bangladesh. And production will include polyehtylene and nylon mono-filament types that are difficult to manufacture by the traditional hand process. Furthermore, many of the so-called hand nets are made by the fishermen themselves. If they can be freed from this net making chore, they will have more time available for actual fishing, which in turn should lead to large fish catches and correspondingly larger incomes.

From the above standpoints, we believe that any adverse social impact would be minimal. Thus, the subject Plan, from this perspective, can be deemed quite suitable.

With regard to project soundness from the standpoints of costs, as has already been shown in the earlier financial and break-even analysis, there is every reason to expect that the subject project can be self-supporting, fully able to cover all costs, including those for maintenance and operations. From this aspect too, then, the project can be judged to be most appropriate.

SECTION 5 CONCLUSIONS AND RECOMMENDATIONS

1 Conclusions

No definitive methods exist for estimating the size of the fishing net market in Bangladesh, but total demand can be conservatively estimated at about 1,500 tons a year. Machine made netting at present comprises only 3-4% of this total.

Demand for netting is expected to grow in response to the increase of fishing effort anticipated under the Second Five-Year Plan. The plan to build production facilities with a combined production capacity of 220 tons of netting a year and to install net making machines in these facilities as a means of handling the expected increase in demand has been judged quite reasonable from the standpoint of both its socio-economic benefits and its ability to recover costs.

The fishing nets to be produced at these new facilities, should include the following types: netting using nylon multi-filament twine, which have been manufactured by machine in Bangladesh for some time; and netting made from new materials--nylon mono-filament and polyethylene twine -- for reasons of their low cost, low specific gravity, and high catch efficiency.

BFDC, the implementing organ for this program, already operates a fish net plant at Comilla, which produces primarily netting for gill nets.

The basic philosophy of this Plan has been to incorporate only net making machines and production processes that represent an extension of the production technology presently being applied at the Comilla facility. Thus, no problems of a technical nature are anticipated. However, in order to improve product quality, we have deemed it necessary to include two processes that have been eliminated at the Comilla plant: viz., resin treatment and the application of steam to the depthwise stretching units.

At the new Chittagong facility, a depthwise stretching and heat processing unit will be installed to work primarily with polyethylene and nylon mono-filament materials. The new Mongla facility will handle production overloads at the existing Comilla plant and will be equipped to process nylon multi-filament twine. We have concluded that it would be advantageous to introduce a system of specialization of production at the two new facilities.

The original investment planned under the Second Five-Year Plan, was 30 million Tk. However, in the more detailed BFDC Plan, this figure increased to 34.8 million Tk. The BFDC Plan, however has already been approved by the Pre-evaluation Committee, and construction is currently underway at both Chittagong and Mongla. The construction program is proceeding smoothly, and we anticipate no problems with respect to access, power, or personnel recruitment.

The financial responsiblity of the Bangladesh side in implementing the subject Plan, with the exception of the 405,000 yen for foundation reinforcement for placement of a depthwise stretcher, are all funded in the existing BFDC program. Our investigation has confirmed the feasiblity of this Plan within the existing budgetary parameters. Since the foundation reinforcement budget is very small, we hope that it can be appropriated within the overall constrctuion budget.

Based on the above findings, the subject Plan will play an important role, under the Second Five-Year Plan, in doubling fish production and raising the nutritional levels of the Bangladesh people who must rely on fishery products for some 70-80% of their total animal protein intake. The Plan has been demonstrated to be feasible, significant, and likely to produce effective results.

2 Recommendations

We present below specific recommendations with regard to the marketing structure for products under this programs.

At present, owing to the strong demand for machine-made netting, the

products produced at the BFDC Comilla facility, are being sold to fishermen without any special marketing effort. However, when the new facilities come into production, despite the fact that its total production will account for only a minor portion of total net demand, it will nevertheless represent an 8-10 fold increase over the production at Comilla.

Also, since the new facilities will be manufacturing netting from polyethylene and nylon mono-filament, which have not previously been produced in Bangladesh, there will be a need to develop a publicity and advertising program geared at fishermen.

In this connection, sales should no longer be confined to branches of the BFDC. Relations should be strengthened and net distribution channels expanded, as appropriate, to include the Department of Fisheries, Provincial Fishermen's Cooperatives Society (BJMSS), organizations developing inland water areas, and joint venture companies. While this may entail slightly higher marketing and distribution costs, since this approach will facilitate an increase in overall sales, we may expect it to contribute to the popularization of the new types of nets and to multiply advertising effectiveness, thereby serving to raise operating rates at the subject plants. We, thus, recommend that in tandem with development production operations, the BFDC marketing and distribution structure for fishing nets be improved and enlarged.

In order to add value to the end products, we recommend a training program for the management cadre of the new facilities. It is true that the subject Plan introduces technology that is only an extension of that being employed at the existing BFDC Comilla plant, so that the various types of equipment can be independently operated by the Bangladesh side without difficulty. However, in order to be able to supply products of stable quality and introduce products with a higher value-added content, we urge that, before the new facilities become operational, key personnel undertake a program of training in Japan, particularly with respect to the resin treatment and stretch treatment processes. We feel that such training would contribute greatly to the effective implementation of the subject Plan.

Since technical training is handled under a different system from the grant-in-aid program, we hope that both sides will work together toward realization of the proposed training program.

APPENDICES

Appendix I Copy of the Minutes of Discussions

MINUTES OF DISCUSSIONS
FOR
BASIC DESIGN STUDY ON FISH NET MACHINE SUPPLY PROJECT IN THE PEOPLE'S REPUBLIC OF BANGLADESH.

In response to the request made by the Government of the People's Republic of Bangladesh for Fish Net Machine Supply Project in Bangladesh (hereinafter referred to as "the Project"), the Government of Japan has sent, through the Japan International Cooperation Agency (hereinafter referred to as "JICA"), a team headed by Mr. Yoshinori Shimozaki to conduct a basic design study for 14 days from December 11, 1982. The team had a series of discussions and exchanged views with the authorities concerned.

As the result of the study and discussions, both parties have agreed to recommend to their respective Governments to examine the results of the survey attached herewith towards the realisation of the Project.

Dhaka, December 22,1982

Y. Shimozaki

Mr. Yoshinori Shimozaki
Team Leader
The Japanese Survey Team

Mr. A.H.M. Nurul Huda Chowdhury
Director
Planning & Implementation
Bangladesh Fisheries
Development Corporation
Dhaka.

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Mr. A.H.M. Nurul Huda Chowdhury,
Director
Planning & Implementation
Bangladesh Fisheries
Development Corporation,
Dhaka

Mr. Yoshinori Shimozaki
Team Leader
The Japanese Survey Team

MINUTES

1. The objective of the Project is to provide the necessary net making machines and relevant equipment for the net making facilities under construction in Mongla and Chittagong for the purpose of modernising the fishing industry in the People's Republic of Bangladesh.

2. The sites of the net making facilities for the Project are shown in Annex I.

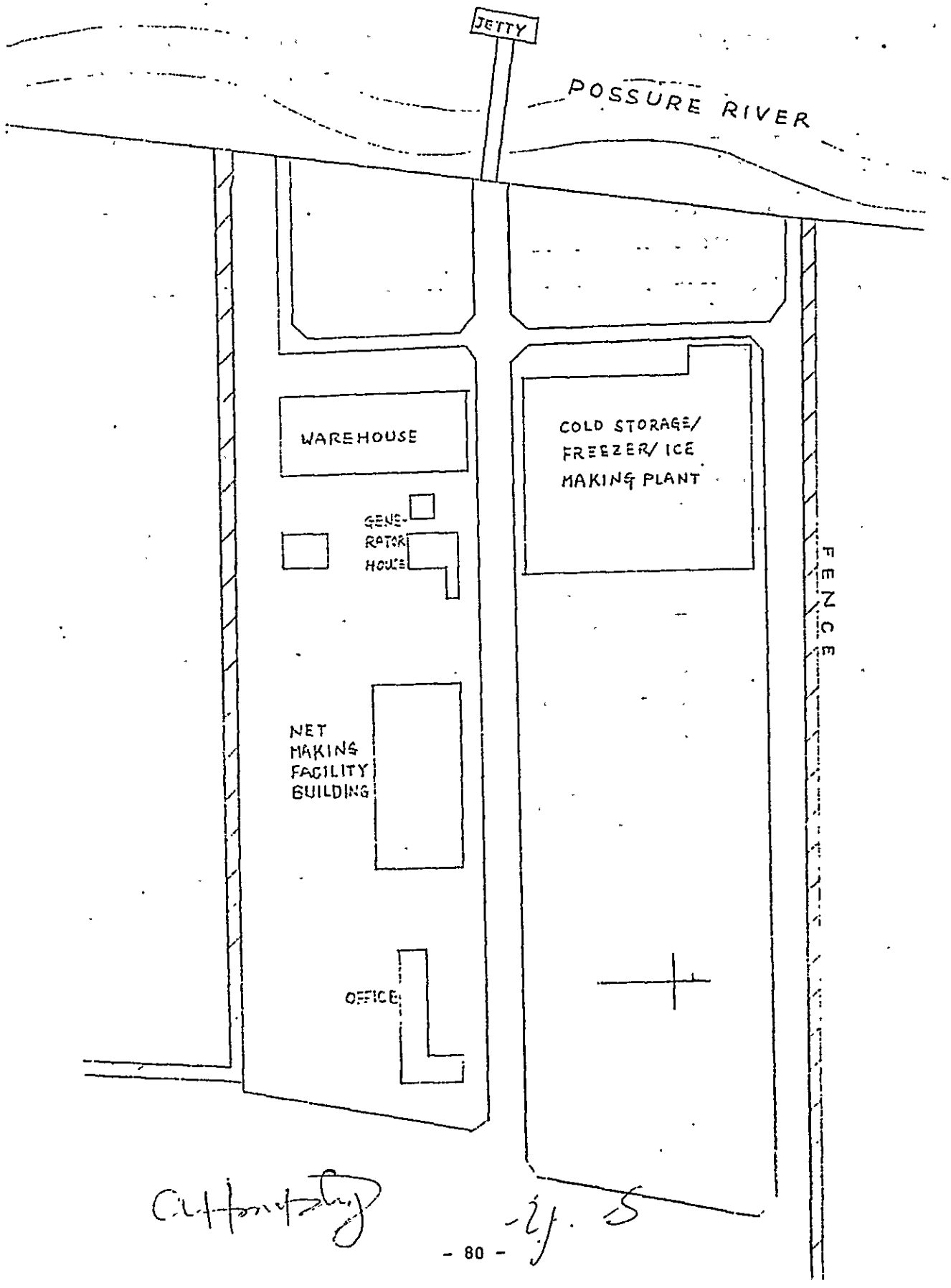
3. The Japanese Survey Team will convey to the Government of Japan the desire of the Government of the People's Republic of Bangladesh that the former takes the necessary measures to cooperate in implementing the Project and provides the net making machines and other items listed in Annex II within the scope of Japanese economic cooperation programme in grant form.

4. The Government of the People's Republic of Bangladesh will take the necessary measures listed in Annex III on condition that the grant assistance by the Government of Japan is extended to the Project.

5. Both sides confirmed that the Japanese Survey Team explained the Japanese grant aid system and Bangladesh side understood it.

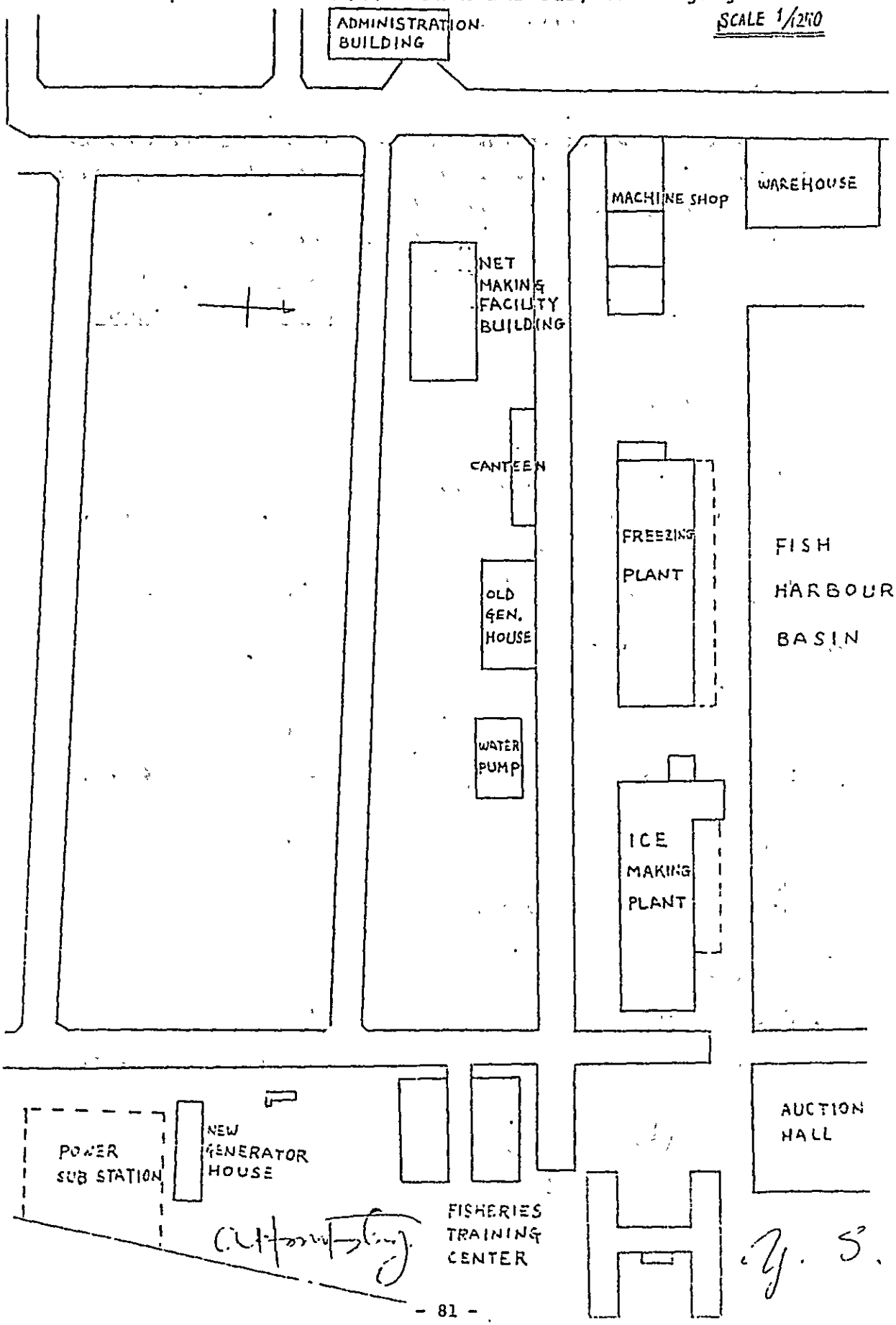
ANNEX - I No. 1 Site of Net Making Facility in Mongla

Digraj, Mongla, Khulna SCALE 1/1000



ANNEX - I No. 2 Site of Net Making Facility in Chittagong
P.O. - Fish Harbour, Chittagong

SCALE 1/1200



ANNEX II

Items requested in the order of priority by the Government of the People's Republic of Bangladesh, the cost of which will be borne by the Government of Japan within the scope of Japanese grant-aid system are as listed below :

		To be installed in Chittagong	To be installed in Mongla
1.	Net making machine for Polyethylene & Nylon twine of thicker diameter	1 No.	-
2.	Net making machine for Nylon multi and monofilament twine of fine diameter	1 No.	2 Nos.
3.	Net making machine for Nylon multi and monofilament twine of small diameter	1 No.	1 No.
4.	Net making machine for Nylon multi and monofilament twine of middle diameter	2 Nos.	2 Nos.
5.	Bobbin winder	5 Nos.	5 Nos.
6.	Spool winder	4 Nos.	4 Nos.
7.	Lengthwise stretching and dry heat-setting machine	1 No.	1 No.
8.	Depthwise stretching and steam heat-setting machine	1 No.	-
9.	Boiler for depthwise stretching machine	1 No.	-
10.	Centrifugal separator	1 No.	1 No.
11.	Spare parts and tools	1 lot	1 lot.

ANNEX III

Items to be undertaken by the Government of the People's Republic of Bangladesh are as follows:

1. To complete the construction works of buildings, offices, warehouses, workshops and other buildings of the net making facilities and to provide electricity, water supply, sewerage and other facilities necessary for the operation of the 2(two) facilities in Mongla and Chittagong, before shipment of machinery from Japan.

2. To ensure prompt unloading and customs clearance at the port of disembarcation in Bangladesh, and prompt internal transportation therein of the machinery purchased under the grant.

3. To assume all customs duties, internal taxes and other fiscal levies imposed in Bangladesh on Japanese nationals with respect to the supply of the products and the services for the Project.

4. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services for the Project, permissions, licences and other authorisations necessary for their entry into Bangladesh and stay therein for the performance of their work.

5. To maintain and use properly the machinery purchased under the grant.

6. To bear all the expenses necessary to maintain the operation of the net making facilities.

Appendix II Members of the Basic Design Study Team

Mr. Yoshinori SHIMOZAKI	Team Leader	Chief, Fishing Efficiency Lab., National Research Institute of Fisheries Engineering, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries
Mr. Toshihiro OBATA	Project Coordinator	Second Training Division, Training Affairs Department, Japan International Co-operation Agency
Mr. Naohiko NAKAJIMA	Net Factory Management	Fisheries Engineering Co., Ltd.
Mr. Koichiro NAKAMURA	Equipment and Facilities	Fisheries Engineering Co., Ltd.

Appendix III Survey Itinerary

DAY	DATE	ITINERARY	DESCRIPTION
1	Dec.11 (Sat)	Tokyo $\xrightarrow{KL864}$ Bangkok	
2	Dec.12 (Sun)	Bangkok $\xrightarrow{TG321}$ Dacca Japanese Embassy JICA Office	Courtesy visit to Japanese Embassy and JICA office. Discussed on the itinerary.
3	Dec.13 (Mon)	Dacca BFDC (Bangladesh Fisheries Development Corporation) Planning Commission External Resources Division	Discussion with the chairman on the request and survey items. Courtesy visit and confirmation of the request.
4	Dec.14 (Tue)	Dacca BFDC Min. of Agriculture & Water Resources	Discussion on the plan. Courtesy visit to the Joint Secretary.
5	Dec.15 (Wed)	Dacca → Comilla → Dacca	Visited the BFDC Net Factory at Comilla.
6	Dec.16 (Thu)	Dacca $\xrightarrow{BG411}$ Chittagong	Visited the site for the Net Making Facility, other facilities relevant to the fish harbour.
7	Dec.17 (Fri)	Chittagong $\xrightarrow{BG414}$ Dacca	Investigation on fishing gear and fishing net. Obtaining informations from JICA experts.
8	Dec.18 (Sat)	Dacca	Data analysis and discussion within the team.

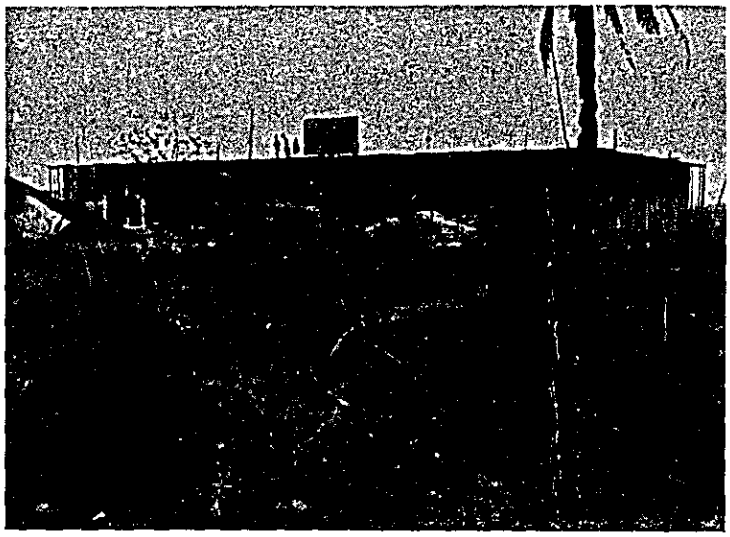
DAY	DATE	ITINERARY	DESCRIPTION
9	Dec.19 (Sun)	Dacca $\xrightarrow{BG461}$ Jessore $\longrightarrow$ Khulna $\longrightarrow$ Mongla	Visited the site for the Net Making Facility and other facilities.
10	Dec. 20 (Mon)	Mongla $\longrightarrow$ Khulna $\longrightarrow$ Jessore $\xrightarrow{BG464}$ Dacca	Visited the port facilities Mongla. Discussion within the team.
11	Dec.21 (Tue)	Dacca BFDC Min. of Agriculture & Water Resources	Discussion on the contents of the plan, the draft of the Minutes of Discussions. Courtesy visit to the Additional Secretary.
12	Dec.22 (Wed)	Dacca BEDC Japanese Embassy	Signing of the Minutes of Discussions. Reporting of the outline of the Project.
13	Dec.23 (Thu)	Dacca $\xrightarrow{BG072}$ Bangkok	
14	Dec.24 (Fri)	Bangkok $\xrightarrow{TG740}$ Tokyo	

Appendix IV Name of Discussants

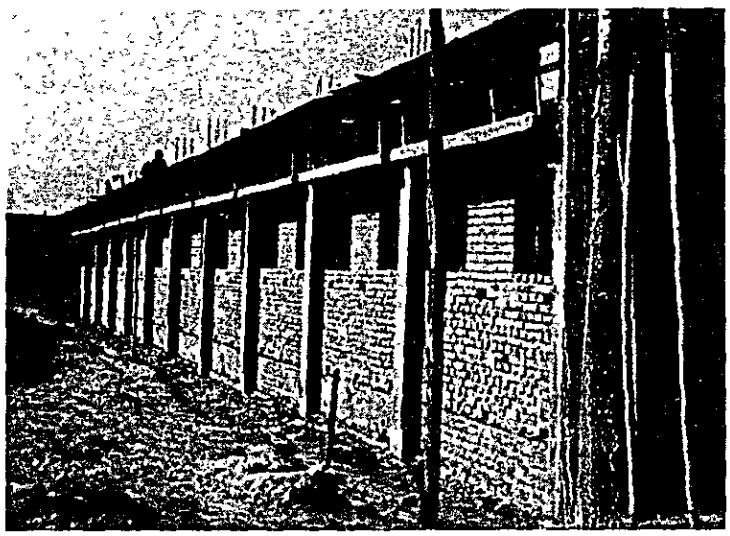
NAME	ORGANIZATION	TITLE
Brig (retd) Gyasuddin Ahmed Chowdhury	Bangladesh Fisheries Development Corporation (BFDC)	Chairman
A.H.M. Nurul Huda Chowdhury	"	Director Planning & Implementation
A.S. Mallick	"	Manager Planning
M.A. Hye	"	Manager Purchase
A.S. Mohiuddin Ahmed	"	Manager Implementation
Shahjaman Ali	BFDC Comilla Factory	
Mahbubur Rahman	"	
M. Muzaffar Hussain	BFDC Chittagong	General Manager
Kazi Shahid Uddin Ahmed	"	Manager Administration
Ashraf Ali	"	Senior Workshop Engineer
Shamsul Islam	"	Manager Trawler
Shalecidul Islam	"	Manager Purchase
Rabig Ahmed	"	Chief Accountant
A.S. Alam	BFDC Mongla	Project Manager
Harm A. Rashid	"	Electirc Foreman
Snee Kociparam Poiswas	"	Ref. Foreman
A. Latif	"	Accounting Officer
Joshiunddin Bhuiyan	"	Project Engineer
Youssouf Ali	Ministry of Agriculture & Water Resources	Additional Secretary
Mohammed Ahsanullah	Planning Commission	Deputy Chief
Saiful Haque	External Resources Division	Deputy Chief
A.K.M. Abul Basher	"	Research Officer

Appendix V Survey Photographs

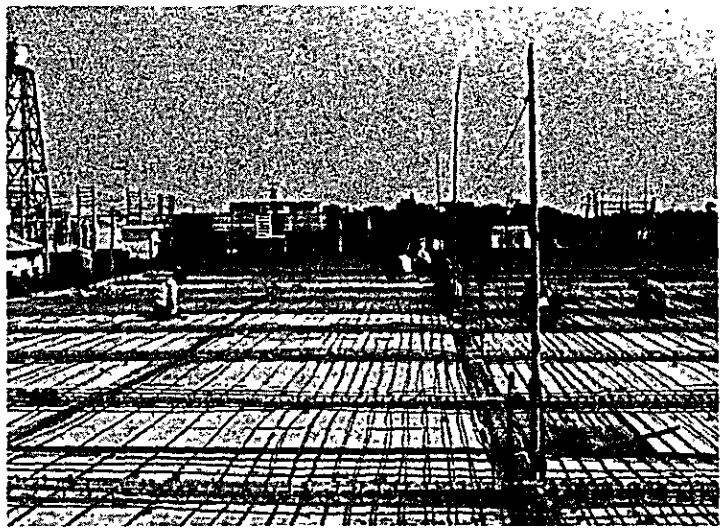
Facility Construction in Chittagong (As of mid Dec. 1982)



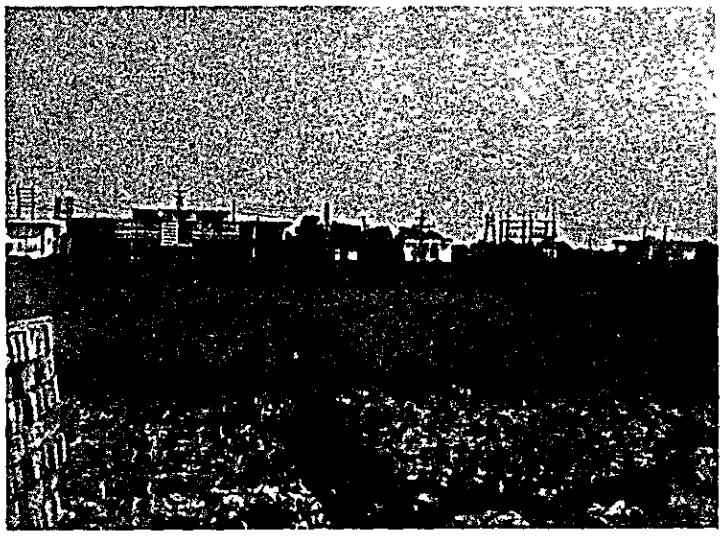
Front view



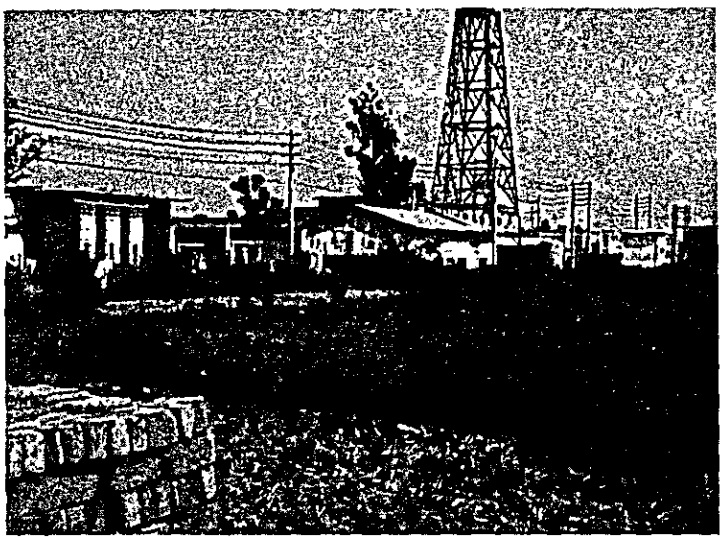
Southern side view



Roof reinforcement



Training center, power sub-station in Fish Harbour Complex



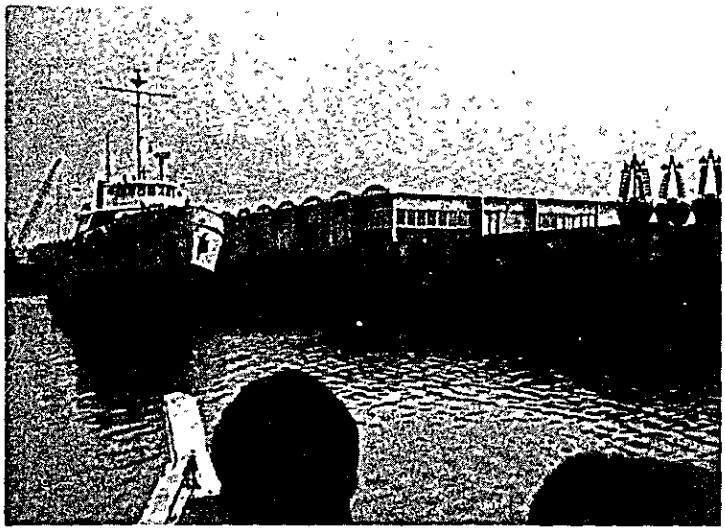
Water supply facility

Facility Construction in Mongla (As of mid Dec. 1982)

Column concrete casting

Completed foundation

Elevated water tank



New port
in Mongla

BFDC cold
storage
and jetty in
front of the
facility

Fish selection area (Chittagong Fish Harbour)

Gill net, mainly used for Hilsa fishing

Traditional fishing gear, with non-motorized boat (A kind of Lift Net)

Signing of the Minutes of Discussions (Dec.22, 1982)

Appendix VI Fish Production by Net Fishery in Japan

Catch by Type of Fishery

(Unit: 1,000 tons)

Kind of Fishery	1978	1979	1980
Crab Mothership Fishery	12	12	3
Mothership Trawl	556	543	554
Two-boat Trawl	198	199	199
Trawl	886	822	874
Small Trawl	885	913	860
Purse Seine	3,119	3,074	3,268
Saury Stick-held Dip Net	326	259	177
Salmon and Trout*1	41	42	39
Others*2	614	705	844
Fixed Net	375	402	462
Other Fishing Boat Fishery*3	1,615	1,551	1,575
Catch by Net Fishery (A)	8,627	8,522	8,855
Total Catch (B)	10,828	10,590	11,122
(A)/(B) x 100	79.7 %	80.5 %	79.6 %

(Source: Fisheries White Paper 1981)

*1 This may include catch by Japan Sea Trout Long Line Fishery, but the amount is negligibly small.

*2,*3 Catch details are not available. The catch by hook and line fishery is seemed to be negligible and the total volume is thus classified into the catch by net fishery.

Appendix VII Types of Netting Produced by Net Making Machine

Types of net used in Bangladesh and their corresponding net making machines are as follow.

	Twine Count	Mesh Size (mm)	Mesh Depth	Length (m)	Machine Type	Remarks
Poly-ethylene (P.E) twine	No. 3/20 (400D/60 ø2.75)	400	54 (37-88)	7.1 (4.6 -12.2)	A	
		200	136 (80-250)	6.3 (3.9-10)		
	No. 3/16 (400D/48 ø2.4)	300	180	5.85		
	No. 3/12 (400D/36 ø2.1)	300	123 (80-150)	-		
		200	273 (264-282)	8.4 (6.9-9.9)		
		160	220 (202-268)	7.5 (6.9-7.98)		
		120	263 (248-290)	7.37 (5.92-8.82)		
		50	-	-		
	—— 400D/40	200	-	-		
	No. 3/8 (400D/24 ø1.6)	80	321 (312-324)	9.96 (9.96)		
		60	-	-		
Nylon multi-twine	210D/96	200	-	-		
	210D/84	115	-	-		
		50	-	-		
		35	-	-		
	210D/45	110 (73.5-147)	247	45.6	↓	
	210D/30	40 (40)	(262-400)	-	B	

	Twine Count	Mesh Size (mm)	Mesh Depth	Length (m)	Machine Type	Remakrs
Nylon multi-twine	210D/24	100	247	45.6	C	Assumed netting
	210D/18	100	247	45.6		
	210D/12	100	247	45.6		
	210D/9	73.5-98	247	45.6	D	
	210D/6	100	247	50.0 (45.6-54.5)		
	210D/3	73.5-98	247	-		
Nylon mono-filament	No. 18 (ø0.70)	90	100	151.5	B	Assumed. netting
	No. 12 (ø0.57)	75	100	151.5		
	No. 6 (ø0.40)	50	100	151.5	C	
	No. 3 (ø0.20)	40	100	151.5	D	
Poly-ethylene (P.E) twine	400D/12	40	300	151.5	B	
	400D/9	40	300	151.5		
	400D/6	40	300	151.5		

Appendix VIII Shipped Amount of Netting by Material in Japan

(Unit: tons)

Raw Material	1977	78	79	80	81
Cotton	41	39	29	18	13
Nylon	17,373	17,681	16,615	17,828	16,796
Vinylon	2,228	2,721	3,471	3,368	2,583
Polyester	3,324	3,601	3,978	4,046	3,724
Polyethylene	10,810	10,671	11,408	10,262	9,061
Polypropylene	206	172	252	194	189
Others	2,189	2,059	2,656	2,463	2,264
Total Shipments	36,535	36,944	38,409	38,179	34,585
Exports	4,314	3,703	4,283	3,017	1,951
Net Domestic Shipments	32,221	33,241	34,126	35,162	32,634

(Source: Textile Stastical Yearbook 1981)

Appendix IX Calculation of Netting Production Output

Number of knot to be made by Net Making Machine;

All the machinery is supposed to be operated under three shifts per day, and working hours during one shift to be seven hours, except Net Making Machine A, which is assumed to be operated under one shift per day.

Total operation days per year will be;

5 days x 52 weeks/year = 260 days/year

With the actual rate of operation set at 0.8, the net operating days/ year will be as follows.

260 days/year x 0.8 = 208 days/year

Therefore, the total knots to be made by each net making machine are calculated as follows.

Type of net making machine	Knot/min.	Efficiency	Knot/day	Knot/year
A	8	0.5	1,680	349,440
B	14	0.50	8,820	1,834,560
C	18	0.56	12,701	2,641,808
D	18	0.57	12,927	2,688,816

The production output of netting can be determined on the above figures. However, the number of rolls of netting of a certain kind to be produced by one machine is assumed to be equal.

Net Making Machine	Fish Net Specification (Length: 500 ft)				Knot/roll	Weight (kg/roll)	Total Knot (knot/roll)	Chittagong		Mongla	
	Twine count	Mesh size (mm)	Mesh depth	Weight (kg/roll)				Roll	Weight (kg)	Roll	Weight (kg)
(Type A)	P.E.										
No. of shuttle 150	400D/60	400		(177.2)	758						
	"	200		(200.6)	1,515						
Knot/year 349,440	400D/48	300	150 M.D.	(141.6)	1,010						
	400D/40	200		(118.1)	1,515						
	400D/36	300		(85.0)	1,010						
	"	200		100.8	1,515						
	"	160		102.8	1,894						
	"	120		(105.0)	2,525						
	"	50		150.0	6,060						
	400D/24	80		78.2	3,788	2,062.6	45,398	7.69	15,861 kg	-	-
	"	60		85.7	5,050						
	Nylon multi										
	210D/96	200		157.8	1,515						
	210D/84	120		149.6	2,525						
	"	50		188.3	6,060						
	"	35		221.9	8,658						
Total weight									15,861 kg		-

Net Making Machine	Fish Net Specification (Length: 500 ft)				Knot/roll	Weight	Total Knot	Chittagong		Mongla	
	Twine count	Mesh size (mm)	Mesh depth	Weight (kg/roll)		(kg/roll)	(knot/roll)	Roll	Weight (kg)	Roll	Weight (kg)
(Type B) No. of shuttle 300 Knot/year 1,834,560	Nylon multi 210D/45	110	200	99.5	2,755	518.9	25,710	22.7	11,779	71.4	37,049
	"	75		105.2	4,040						
	"	50		118.1	6,060						
	210D/30	110		60.5	2,755						
	"	75		64.1	4,040						
	"	50		71.5	6,060						
	Nylon mono No.18	110		25	2,755	126.6	20,324	22.7	2,874	—	—
	"	90		25.6	3,367						
	"	175		26.4	4,040						
	No.12	110		16.1	2,755						
	"	90		16.4	3,367						
	"	75		17.1	4,040						
	P.E. 400D/12	75		44.6	4,040	215.8	34,845	22.7	4,898	—	—
	"	40		53.2	7,575						
	400D/9	75		33	4,040						
	"	40		39.6	7,575						
	400D/6	75		21.2	4,040						
	"	40		24.2	7,575						
Total weight									19,551		37,049

Net Making Machine	Fish Net Specification (Length: 500 ft)				Knot/roll	Weight (kg/roll)	Total Knot (knot/roll)	Chittagong		Mongla	
	Twine count	Mesh size (mm)	Mesh depth	Weight (kg/roll)				Roll	Weight (kg)	Roll	Weight (kg)
(Type C) No. of shuttle 200 Knot/year 2,641,808	Nylon multi 210D/24	100		47.85	3,030						
	"	75		49.5	4,040						
	"	50		54.6	6,060						
	210D/18	100		35.8	3,030						
	"	75		36.7	4,040	335.95	39,390	50.3	16,898	67	22,508
	"	50		39.7	6,060						
	210D/12	100		22.8	3,030						
	"	75	200	23.6	4,040						
	"	50		25.4	6,060						
	Nylon mono No.6	100		7.6	3,030						
	"	75		7.7	4,040	23.2	13,130	50.3	1,167	—	—
	"	50		7.9	6,060						
Total weight									18,065		22,508

Net Making Machine	Fish Net Specification (Length: 500 ft)				Knot/roll	Weight (kg/roll)	Total Knot (knot/roll)	Chittagong		Mongla	
	Twine count	Mesh size (mm)	Mesh depth	Weight (kg/roll)				Roll	Weight (kg)	Roll	Weight (kg)
(Type D) No. of shuttle 400 - 500 Knot/year 2,688,816	Nylon multi 210D/9	100	500	40.8	3,030	246.4	39,390	44.7	11,014	68.2	16,797
	"	75		41.4	4,040						
	"	50		45.0	6,060						
	210D/6	100		26.3	3,030						
	"	75		26.8	4,040						
	"	50		28.1	6,060						
	210D/3	100		12.4	3,030						
	"	75		12.6	4,040						
	"	50		13.0	6,060						
	Nylon mono No.3	100		8.7	3,030	35.6	20,705	44.7	1,591	—	—
	"	75		8.9	4,040						
	"	50		8.6	6,060						
	"	40		9.4	7,575						
Total weight									12,605		16,797

Total Production

(Unit: kg)

Type	Material	Chittagong	Mongla	Total
A	Polyethylene	15,861	———	15,861
B	Nylon multi.	11,779	37,049x2=74,098	85,877
	Nylon mono.	2,874	———	2,874
	Polyethylene	4,898	———	4,898
C	Nylon multi.	16,898x2=33,796	22,508x2=45,016	78,812
	Nylon mono.	1,167x2= 2,334	———	2,334
D	Nylon multi.	11,014	16,797	27,811
	Nylon mono.	1,591	———	1,591
Total		84,147	135,911	220,058

Note: The total output for Chittagong is smaller than Mongla due to the fact that the product for Chittagong includes light material made of Polyethylene and Nylon mono-filament.

Appendix X Capacity Calculation for Bobbin and Spool . Winder

The equation for calculating the capacity for bobbin winder and spool winder will be defined by the simplified equation as follows.

$$L = 2\pi nrT \times S \quad , \quad S = \frac{L}{2\pi nrT} = \frac{L}{\pi nRT}$$

here, L: Required length of twine (m/day)
π: Ratio of circumference (3.14)
n: Revolution of Bobbin
r: Average winding dia. (m) (R = 2r)
T: Required time for winding (min.)

(if 3 shift, T=21 hour x 60 = 1,260 min.
if 1 shift, T= 7 hour x 60 = 420 min.)

S: No. of spindles

The amount of twine drawn out of bobbin for weaving shall be equal to the half of the net weight.

The unit weight of the twine is the mean value calculated from weights of the twines indicated in "Kind of twine".

The results of the capacity calculations are shown in the following pages.

〈Bobbin winder〉

Chittagong

Bobbin winder	for A	for B	for C	for D
Req. twine weight (kg/year)	7,931	9,776	18,065	6,303
" (kg/day)	38	47	87	31
Kind of twine	400D/24-60	210D/30-40, 400D/6-12	210D/12-24, No.6	210D/3-9, No.3
Unit weight of twine (kg/m)	1.58×10^{-3}	0.5×10^{-3}	0.31×10^{-3}	0.132×10^{-3}
Req. length L (m/day)	24,051	94,000	280,645	234,848
Bobbin revolution (rpm)	400	400	400	400
Winding length (m/1 rev.)	$2\pi \times 0.055$	$2\pi \times 0.053$	$2\pi \times 0.048$	$2\pi \times 0.045$
(Winding time T (min.))	(420)	(1,260)	(1,260)	(1,260)
(Efficiency)	(0.5)	(0.65)	(0.65)	(0.75)
Actual winding time T (min.)	210	756	819	945
No. of spindle	0.83	0.93	2.84	2.2

Mongla

Bobbin winder	for B	for C	for D
Req. twine weight (kg/year)	37,040	22,508	8,399
" (kg/day)	178	108	40.4
Kind of twine	210D/30-40	210D/12-24	210D/3-9
Unit weight of twine (kg/m)	0.5×10^{-3}	0.31×10^{-3}	0.132×10^{-3}
Req. length L (m/day)	356,000	348,387	306,060
Bobbin revolution (rpm)	400	400	400
Winding length (m/1 rev.)	$2\pi \times 0.053$	$2\pi \times 0.048$	$2\pi \times 0.045$
(Winding time T (min.))	(1,260)	(1,260)	(1,260)
(Efficiency)	(0.6)	(0.65)	(0.75)
Actual winding time (min.)	756	819	945
No. of spindle	3.54	3.06	2.7

〈 Spool winder 〉

Chittagong

Spool winder	for A	for B	for C	for D
Req. twine weight (kg/year)	7,931	9,776	18,065	6,303
" (kg/day)	38	47	87	31
Kind of twine	400D/24-60	210D/30-40, 400D/6-12	210D/12-24, No.6	210D/3-9, No.3
Unit weight of twine (kg/m)	1.58×10^{-3}	0.5×10^{-3}	0.31×10^{-3}	0.132×10^{-3}
Req. length L (m/day)	24,051	94,000	280,645	234,848
Spool revolution((rpm)	400	400	400	400
Winding length (m/1 rev.)	$2\pi \times 0.035$	$2\pi \times 0.035$	$2\pi \times 0.035$	$2\pi \times 0.035$
(Winding time T (min.))	(400)	(1,260)	(1,260)	(1,260)
(Efficiency)	(0.5)	(0.5)	(0.6)	(0.65)
Actual winding time T (min.)	210	630	756	819
No. of spindle	1.3	1.69	5.1	3.26

Mongla

Spool winder	for B	for C	for D
Req. twine weight (kg/year)	37,049	22,508	8,399
" (kg/day)	178	108	40.4
Kind of twine	210D/30-40	210D/12-24	210D/3-9
Unit weight of twine (kg/m)	0.5×10^{-3}	0.31×10^{-3}	0.132×10^{-3}
Req. length L (m/day)	356,000	348,387	306,060
Bobbin revolution(rpm)	400	400	400
Winding length (m/1 rev.)	$2\pi \times 0.045$	$2\pi \times 0.038$	$2\pi \times 0.038$
(Winding time T (min.))	(1,260)	(1,260)	(1,260)
(Efficiency)	(0.5)	(0.6)	(0.65)
Actual winding time T (min.)	630	756	819
No. of spindle	4.99	4.83	3.9

Thus, the required number of bobbin and spool winder will become as follows.

No. of bobbin winder

Winder Type	Chittagong			Mongla		
	Net Making Machine	No. of Spindle	No. of Winder	Net Making Machine	No. of Spindle	No. of Winder
Bobbin winder (for A)	1	0.83	1	-	-	-
do (for B)	1	0.93	1	2	7.1	2
do (for C)	2	5.68	2	2	6.12	2
do (for D)	1	2.2	1	1	2.7	1

(No. of spindle: three spindles per unit)

No. of Spool winder

Location / Winder Type	Chittagong			Mongla		
	Net Making Machine	No. of Spindle	No. of Winder	Net Making Machine	No. of Spindle	No. of Winder
Spool winder (6 spindle)	for A, Mono	1.3	1	-	-	-
do (12 spindle)	for B, C, D	10.05	1	for B, C, D	13.72	1
do (6 spindle)	-	-	-	do	-	1

Appendix XI Calculation of Lengthwise Stretching Load

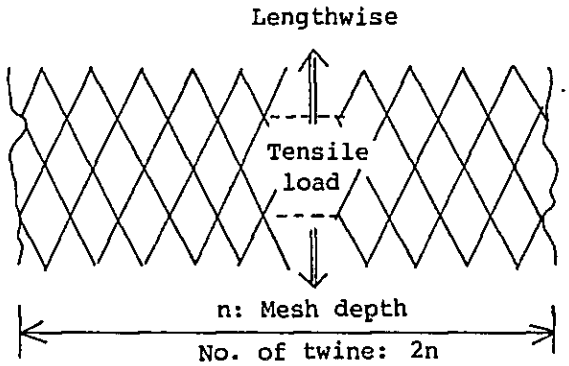
〈Lengthwise stretching & heat setting unit〉

The unit is used for adjusting mesh size and fixing knot of netting. The diameter of nylon multi-twine to be treated by the machine ranges between 210D/3 and 210D/45. The following specification for fish net is used for calculation.

210D/45, Mesh size 100, Length 151.5m

Presumed specification of the twine is as follows.

Item	Characteristic (310 m/kg)
Dia. (mm)	2.4
Weight/unit length (kg/m)	3.226×10^{-3} (310 m/kg)
Tensile strength: To (kg) (dry)	148
Elongation: Eo (%) (dry)	45



If the temperature rises, then, the tensile strength will decrease and the elongation will increase at the rate of -0.1%/degree and +0.4%/degree respectively. The following equations will be given.

(Tensile strength) (Elongation)

$$T_0 \left(1 - \frac{0.1}{100} \times t\right) \qquad E_0 \left(1 + \frac{0.4}{100} \times t\right)$$

T_0: Initial tensile strength (Kg)

E_0: Initial elongation (%)

t : Temperature (°C)

Furthermore, the strength and the elongation of the netting made of the twine preserving above mentioned characteristic, will become 80 - 90% in strength and, 130-140% in elongation of those of twine itself, respectively.

Thus, the strength and elongation value for the netting will be stated by the following equation.

(Tensile strength)

$$T_0 \left(1 - \frac{0.1}{100} \times t\right) \times (0.8 - 0.9)$$

(Elongation)

$$E_0 \left(1 + \frac{0.4}{100} \times t\right) \times (1.3 - 1.4)$$

Accordingly, at temperature t=120°C, T_0=148Kg, E_0=45%, the tensile strength and elongation will be as follows.

Tensile strength : T_0 104.2 - 117.2 $\Longrightarrow$ 110.7 Kg

Elongation : E_0 86.6 - 93.2 $\Longrightarrow$ 89.9 %

Suppose the elongation is proportional to tensile load and the netting will be treated under the condition of 5% elongation, then the tensile load applied to each twine will be calculated as follows.

(110.7 Kg/89.9%) x 5% = 6.2 Kg

The netting under the lengthwise stretching is composed of 200 pieces of twine, so the total load required for the netting is approximately 1,550 Kg, if 25% margin is allowed.

The stretching capacity of the machine, therefore, should be approxmately 1,500 Kg.

Appendix XII Calculation of Depthwise Stretching Load

〈Depthwise stretching and heat setting unit〉

Netting of nylon mono-filament gill net and polyethylene nets requires not only lengthwise but also depthwise treatment. Sometimes nylon multi-twine netting of thicker diameter is also given this treatment.

The strength and the elongation of the twine of the netting to be treated are set below.

Material	Size	Tensile strength (Kg)	Elongation (%)
Nylon multi-twine	210D/96	120	44
Nylon mono-filament	No.18 (ø0.7)	20	-
Polyethylene twine	400D/60	63	32

Of these twines, nylon multi-twine 210D/96 is the strongest.

The required capacity is therefore calculated for the netting made of this twine.

If the specification of the net is;
210 D/96, Mesh size 100mm, 100 Mesh depth, Length 10m,
then, the number of the twine will be (10m/0.05) x 2 = 400 pcs.

If 20% elongation is required, the tensile strength T will be given as follows.

$$T = 400 \text{ pcs} \times 120 \text{ Kg/pc} \times \frac{20\%}{44\%} = 22{,}000 \text{ Kg}$$

The required capacity should not be less than 22,000 Kg from the calculation.

Therefore depthwise stretching & heat setting unit should have a capacity of approximately 25,000 Kg.

Note: Since the floor space to install this machine is limited in Chittagong factory, the total length of the machine should not exceed 15 m.

Appendix XIII Number of Net Making Machines Operating in Japan

(Unit: Set)

Kind of Net Making Machine	1977	1978	1979	1980	1981
Flat Knot	15	15	15	15	15
English Knot	1,384	1,370	1,300	1,285	1,260
Japanese Minnow Knot	209	214	223	229	229
Knotless Knot	359	366	386	396	403
Raschel Knot	70	71	72	74	74
Total	2,037	2,036	1,996	1,999	1,981

(Source: Textile Statistical Yearbook)

Appendix XIV Table of Required Power for Equipment

No.	Equipment	KW/unit*	Chittagong		Mongla	
			No.	KW	No.	KW
1	Net Making Machine A	3.75	1	3.75	-	-
2	do B	3.75	1	3.75	2	7.5
3	do C	1.5	2	3.0	2	3.0
4	do D	2.2	1	2.2	1	2.2
5	Bobbin winder (for A)	0.75	1	0.75	-	-
6	do (for B)	0.4	1	0.4	2	0.8
7	do (for C)	0.4	2	0.8	2	0.8
8	do (for D)	0.4	1	0.4	1	0.4
9	Spool winder (6 spindles)	0.4	1	0.4	-	-
10	do (3 spindles)	0.4	4	1.6	4	1.6
11	do (6 spindles)	0.4	-	-	1	0.4
12	Lengthwise stretching & heat setting unit	30	1	30	1	30
13	Depthwise strethcing & heat setting unit	10	1	10	-	-
13	Boiler	10	1	10	-	-
14	Centrifugal separator	11	1	11	1	11
	Total			78.05KW		57.7KW

* The figure is the rated power consumption.

A