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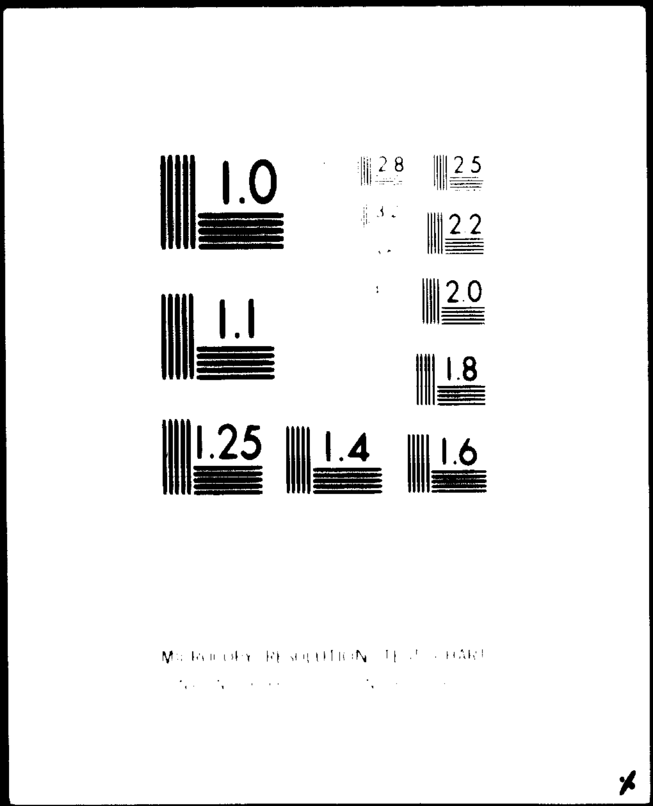

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10. SASMIRA should install alltogether six new standard training courses on the

- operator level:
  -- polymerisation and chips production
  -- melt spinning and yarn engineering
  -- utility engineering

- supervisor/superintendent level:
  -- diploma course in man-made fibre production (full time course)
  -- certificate course in man-made fibre production (evening course)
  -- post graduate diploma course in man-made fibres technology

- management level:
  -- tailor-made short term training courses on request of industries or on incitation by SASMIRA

In addition participants of the already existing courses should be given opportunity to gain a basic knowledge of fibre production.

11. The training courses on the operator level will last six months each and have 10 participants each. The three courses will be performed in sequence so that each course will be repeated after 18 months. This way an average annual output of approximately seven trainees per course, i.e. alltogether 20 operators will be available for the industry. Compared with the number of factories around Bombay only an average of 1 - 2 operators in each of the three fields would be available for each company. According to these firms the actual demands are greater and would justify an increasing number of students per course as SASMIRA's experience grows, particularly in regard to the personnel demands for the planned new fibre plants.

12. Within the training of superintendents/supervisors the Diploma Course in Man-made Fibre Production will last for six semesters and comprise 15 students per semester. One new course will start each year and at an average failure rate of 10 % 12 supervisors will be turned out each year. This means less than one graduate for each of the existing fibre producers. The training program of this course comprise three semesters for imparting fundamental theoretical knowledge and further three semesters specialisation in plant operation.

The Certificate Course in Man-made Fibre Production will be an evening course as a further training opportunity for employees of the fibre industry. A new course will be started each year, each one lasting for two years. Initially the number of participants will be kept at 15 per course. According to SASMIRA and the fibre industry in the vicinity of Bombay the number of applicants will be higher than the initial capacity. The fibre industry is prepared to sponsor participation of their employees in this course.

The Post Graduate Diploma Course in Man-made Fibre Technology is a full time course with a duration of two semesters. It is designed for university graduates in chemical engineering as a specialisation course which should replace post graduate training abroad The number of students will be 10 per semester. According to experience with comparable courses presently performed about half of the students are expected to be sponsored by the state, the other half being sponsored by industry.

Special courses for the management personnel are expected to last for one to ten days covering topics suggested by member firms or by SASMIRA based on its knowledge of generally interesting topics. Such courses may be sponsored by one firm and attended by its staff only (tailor-made courses) or may be offered to all interested firms and announced in SASMIRA's BULLETIN.

13. For performing this training activity SASMIRA should employ eight new instructors including one professor functioning as head of the technical education section within the Fibre Division. These new teachers are to fulfill the following functions:

- Head of Technical Education Section
- Assistant Professor in Polymer Chemistry
- Lecturer in Fibre Chemistry
- Lecturer in Chemical Engineering
- Lecturer in Engineering
- Assistant Lecturer in Chemistry
- Assistant Lecturer in Engineering
- Lecturer in Fibre Physics

14. For the training purposes in the envisaged extend the plant will be utilised during about 2,000 hours a year. The remaining operation time will be 5,200 to 6,000 hours/year depending on the duration of the shut down periods scheduled twice a year. It will be utilised for research purposes and any operation time beside training and research for production of saleable yarn qualities. As a provisional estimate

approx. 2,000 hr/year will be used for training
approx. 2,000 hr/year may be used for research
approx. 4,000 hr/year may be used for production purposes.

15. As jointly expected by the fibre manufacturers and processors, raw material producers and SASMIRA the applied research work will comprise polyamide and polyester fibre production in all stages of polymerisation/polycondensation, melt spinning and filament and staple fibre processing. A number of topics being of particular interest have been identified already in the fields of applied research and also within the frame of technical and advisory services.

16. Applied research work should be performed as contract research sponsored by fibre manufacturers, fibre processors, raw material producers, but also machinery and equipment manufacturers, ancillary industries, commercial companies, ministries and specialised departments (e.g., taxation, customs).

Besides sponsored research independent research tasks should be initiated, formulated and executed by SASMIRA. The results of that kind of research should be distributed to member firms or published in periodicals and during seminars.

SASMIRA should endeavour to carry out research of general interest, the results of which will be made available to all.

17. The Research Section within the Fibre Division should comprise a total staff of eight persons including one scientist being the head of the section. The total staff requirements and functions are:

1 Research Section Head (scientist)
1 Deputy Head (scientist)
2 Senior Scientific Officers
4 Technical Assistants(technicians)

18. The demonstration plant as described in the plant specification will have to comprise

- a dual purpose polymerisation line having polyester-precondensation equipment, lactam preparation equipment and, for both products, one polymerisation autoclave with chips spinning, cutting, extraction and drying equipment; the attainable products must meet the standards for textile and technical yarns
- a versatile melt spinning station, capable to produce textile monofilaments from 10 to 30 den, multifilaments from 20/8 to 150/24 den, industrial yarns from 240/40 to 1260/415 den and a staple fibre tow having a total of 3600 den; the equipment should allow to operate conventional speeds as well as high speed spinning
- a draw twisting and texturising section, meeting in capacity the melt spinning plant and having one draw twister for textile yarns, one for industrial yarns and a versatile texturising unit for draw twisted yarns as well as draw texturising of spun drawn yarns
- a staple fibre processing unit with two drawing stages, washing and spin finish application equipment, crimper, thermosetting unit, cutter and baler; the drawing capacity should be 50,000 den
- laboratory equipment in addition to and complementing SASMIRA's existing facilities in the chemical laboratory and textile laboratory with important items being a gas chromatograph, an infrared spectrophotometer, an high tenacity tensiometer and elongation tester and an USTER yarn eveness tester

19 Potential suppliers for this equipment are ZIMMER AG, F. FOURNE KG, E. BLASCHKE & Co/K. FISCHER KG, and probably, CONNITEX. They should be invited to submit bids.

For detailed engineering work experienced Indian firms are available, e.g., DALAL Engineering working with E. BLASCHKE & Co. or TATA Engineering cooperating with ZIMMER AG.

20. The plant erection work will have to be supervised by the plant manufacturer's engineers and specialists. It must be controlled by the project's Chief Technical Advisor.

21. The plant will be erected on SASMIRA's premises in Bombay. To this end part of the existing textile pilot plant hall - 976 m² - will have to be made available and reconstructed to provide rooms for

- the staple fibre line
- yarn conditioning
- the draw twisters
- the texturising unit
- product storage
- laboratories.

Additional space may be used for lecture rooms or offices.

In addition a new building, approx. 12 by 24 m and 15 m high has to be provided to house the

- polymerisation line (6 x 24 m, three storeys)
- spinning plant (6 x 12 m)
- utility plants
- spinnerets maintenance workshop
- raw material storage
- staircase and lift.

The total area within this building will be 864 m². The final design of the building will have to be based on a preliminary building layout to be provided by the equipment supplier. Basis for this preliminary layout are the proposed plans in this report. Detailed building design is the task of SASMIRA; there is sufficient civil engineering capacity as well as construction capacity available in Bombay.

22. Utilities will have to be contributed to the project by India and will be supplied by Indian firms. These units comprise

- water supply facilities including tap water, soft water, deionised water and cooling water: a cooling tower and ion exchange equipment being the main supply facilities required in addition to existing installations
- energy supply, which will have to be secured by doubling the existing connected load to a total of 800 kVA
- steam which will be supplied by an additional boiler fired with light fuel oil and having a capacity of 600 kg/h saturated steam at 10 kg/cm^2
- nitrogen: The equipment comprises a liquid nitrogen storage tank and a purification unit which will be supplied from abroad. Liquid nitrogen will be supplied from manufacturers in Bombay
- Air conditioning unit: This unit being of vital importance for the proper functioning of the plant requires specific design know-how. In India only one firm in Bombay gained sufficient experience to design and construct suitable equipment
- miscellaneous equipment as air compressor, ventilation equipment, storage equipment, bobbin carriages and racks, crane, fire fighting equipment, workshop and office equipment. All of these items may be constructed by or bought from firms in or near Bombay

23. The calculation of project inputs is based on an average fibre thickness of 70 den, 900 m/min spinning speed, a drawing ratio of 3.2 and 180 days a year for nylon filament production, 60 days/year each for polyester filament and staple fibre production.

The resulting output amounts to 46.4 tons/year polyamide filaments and 46.6 tons/year polyester fibres and filaments. The main raw material inputs are approx.

51.1 tons/year caprolactam
34.9 tons/year ethylene glycol
49.9 tons/year DMT

Most important utility inputs are approx.

1.2 million kWh electric energy and
85.6 tons/year light fuel oil for steam production.

Raw material supply does not seem to be a problem. It was stated by the Ministry of Petroleum and Chemicals that the project would be supplied with priority from indigenous production. Equally with utilities and auxiliary materials there are no shortages to be expected.

24. A total of 68 workers and scientific staff will be required for the project working in three sections:

- The technical education section will have seven staff members and one section head, all of them performing training duties.

- The research section comprises seven scientists, scientific officers and technicians plus one scientist as section head. Organisation, performance and evaluation of research tests at the demonstration plant will be their duty.

- The production section will have 44 plant operators and workers plus a supervisory staff of 7 and one production manager as section head. This staff has to operate the plant for training, research and production purposes.

25. Fellowships should be granted to the future heads of the production section, research section and the Fibre Division. This additional training should be performed with capable fibre producers in Europe or the USA. The firms must be approached officially by the project administrator (UNIDO). There is no statement obtainable yet whether such fellowships may be granted.

26. Three advisors should be provided to assist the Indian project staff in establishing the project:

- Chief Technical Advisor with an engineering degree, experienced in synthetic fibre production, over a period of 48 months to assist the Head of the Fibre Division

- Technical Advisor with engineering degree, experienced in fibre production and plant operation, for a period of 24 months to assist the Head of the Production Section

- Technical Advisor with engineering degree, experienced in applied research related to synthetic fibres for a period of 24 months to assist the Head of the Research Section

27. The project time schedule comprises three project phases:

- The project starting phase comprising the preparation of requests for bids, their evaluation and the contracting for plant equipment; the duration of this phase will be about three months

- The project construction phase during which buildings and plant will have to be designed, constructed and erected. This period is expected to last about two years. The plant should be erected in steps, first the spinning and take-up unit, immediately thereafter the draw-twisting and texturising units, then the staple fibre line and finally the polymerisation plant. This timing of the erection work would allow to start up the spinning and drawing units prior to the final completion of the plant using chips bought from one of the fibre manufacturers

- The project operation phase comprising the implementation of the training and research programs. This phase is expected to start after two years of project preparation and plant construction, i.e., with the third project year. It will last for two years. After that time the expatriates work will be terminated.

28. The project investments include plant equipment, utilities, buildings and land.

Three available offers for the equipment mention prices of

6,645,000 DM resp. 2,889,000 US $ for Fourné equipment, cif Bombay
6,902,000 DM resp. 3,000,000 US $ for Blaschke Equipment, cif Bombay
8,714,000 DM resp. 3,788,000 US $ for Zimmer equipment, cif Bombay

This estimated prices refer to the extended scope of delivery and represent the price level for ordering by end of 1975 or beginning of 1976; they are however no binding offers of the three firms.

29. Investment cost (including foremost equipment cost comprising also detailed engineering, erection, start-up and contingencies), investment related personnel costs (comprising fellowships, expatriates) and operation costs as well as their allocation are indicated in the following tables.

INVESTMENT COSTS

	Indian Contribution Rs	UN and German Contribution US $	Total US$
1. Land and existing building	1,003,500	-	128,700
2. Building and construction costs	1,505,700	-	193,000
3. Plant equipment and erection	4,804,000	3,369,000	3,985,000
4. Utilities and accessories	3,900,000	-	500,000
Total	11,213,200	3,369,000	4,806,700

INVESTMENT RELATED PERSONNEL COSTS

	Indian Contribution Rs	UN and German Contribution US $	Total US $
1. Fellowships	- *)	33,000	33,000
2. Expatriates	74,900	360,000	369,600
Total	74,900	393,000	402,600

*) Wages during fellowship assignments are included in the operation costs

OPERATION COSTS

	Indian Contribution Rs	UN and German Contribution US $	Total US $
1. Raw materials	3,187,600	-	408,670
2. Utilities	532,000	-	68,200
3. Personnel	739,200	-	94,770
4. Repair and maintenance	1,046,500	-	134,200
5. Insurances	93,000	-	11,930
Total	5,598,300	-	717,870

1 US $ = 7.80 Rs   1 US $ = 2.30 DM   1 DM = 3.30 Rs

30. Related project information is provided on

- organisation of SASMIRA after project integration
- status and expected development of SASMIRA's finances
- eventual project extensions for textile engineering
- eventual project extensions for yarn engineering

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1. Project Targets and Justification

The immediate target of the proposed project is to provide at the premises of SASMIRA a demonstration unit for the development of the production and use of nylon and polyester fibres for textiles as well as the simultaneous production of the staple fibres and filament. The plant will not be used as a production unit on a commercial scale but the fibres produced will be used for end product development. Part of the output may be sold to cover some of the operating costs for the plant.

The demonstration plant will primarily be used

- to provide facilities for the training and upgrading skills of personnel in synthetic fibre technology
- to provide facilities for experimental work especially in the polymer-to-yarn processes for synthetic fibres and for the development and application of process and product technology in this field
- to provide a focus for the collection and dissemination of technical data on synthetic fibres

In the long range the project aims are to encourage and accelerate the production and use of synthetic fibres as textile fibres in order to reduce India's dependance on imported cotton and other raw materials for the textile industry.

The project is destined to carry out systematic programs of experimental work and training, to establish technical and advisory service in synthetic fibres to the textile industry, and to collect technical information, act as a non-artisan consultant and provide an impartial communication system between fibre producers, textile mills, the textile trade and consumers to ensure that all efforts in this fields are optimally directed.

The weighting, significance and scope of the project activities determined and formulated in the previous project studies and evaluations were confirmed during numerous discussions with fibre manufacturers and processors, raw material manufacturers, governmental agencies and the SASMIRA which were held recently.

It was found that there is a definite need for a training and research institution for the synthetic fibres sector. Such an institution, which would be the only one of its kind in South-East Asia, would emphasise India's importance as the second-largest fibre manufacturer in Asia. The institution would have to reach a level of training and research which is in keeping with India's significance and which goes beyond the present facilities and level of knowledge in the Indian synthetic fibres industry.

The expectations which the various groups of interested parties connected with the SASMIRA project are described in the following, and evaluated in a list of priorities and weighting of the planned activities. The introductory description of the development of the Indian synthetic fibres industry over the past two years is intended as background information.

1.1. Situation of the Synthetic Fibres Industry

The synthetic fibres industry of India is at present going through a phase of rapid growth. Since 1973, the time of the previous project evaluation, practically all production licenses granted at that time have led to manufacturing activities, the exceptions being insignificant. This means that the projects were realised considerably earlier than within the period of five years forecast at that time. The installed capacities for filaments and fibres have increased by some 60 % during the past two years. Capacity utilisation has on the other hand increased relatively slightly. The main reasons given for this are difficulties in obtaining supplies. The market, at the moment, places no limitations on the fibre industry. Synthetic fibres are among the leading products which are illegally imported into India. It is estimated that these imports at least equal present domestic production.

Nylon filaments continue to dominate in the production structure; this situation could first change when the large-scale polyester fibre project in Bongaigaon is realised. At present, India produces and processes no other synthetic fibres than polyester and polyamides; there are however plans for producing 16,000 tons/year of acrylic fibres. As the production processes are fundamentally different, this production sector has only few points of contact (and these exclusively in the processing sector) with the SASMIRA project. Acrylic fibre production is therefore not investigated in this report

1.1.1. Polyamide Plants

Since 1973, the number of polyamide fibre manufacturers has increased by three to a present total of ten factories with a total installed capacity of 24,780 tons/year (cf. Table 1). This means that the installed capacity has increased by more than 85 % over the last two years. The additional capacities are almost equally distributed to nylon tire cord (5,890 tons/year) and nylon filaments (5,550 tons/year); they represent capacity growths of some 55 % for filaments and over 150 % for tire cord.

During this investment phase, practically all production licenses granted to existent companies were taken up. In addition, existent firms have been granted Letters of Intent for a further 7,700 tons/year. The time necessary to realise these will depend largely on administrative processing.

Annual production on the other hand has increased only slightly: from some 11,000 tons in 1972 to about 11,700 tons/year in 1974. The main reasons for this is that the additional capacities were still in the starting-up phase during 1974 and therefore achieved only a small output, or were first completed during the first quarter of 1975. Supplies of raw materials, primarily caprolactam, are not always adequate, and can therefore be held partly responsible for the lower capacity utilisation rates. It is however expected that the raw materials supply situation will be eased when the start-up difficulties with the caprolactam plant in Baroda have been overcome.

Table 1: Existing Polyamide Factories in India, 1975

No.	Name	Location	Start-up	Installed Capacity (tpa)			Production 1974	Licence Issued	Letter of Intent Issued	Potential Total Capacity (tpa)
				Filament	Tire Cord	Staple Fibre				
1	J.K.Synthetics Ltd.	Kota	1962	3,840	1,600	900	3,650	-	-	6,340
2	Nirlon Synthetics Fibres and Chemicals Ltd.	Bombay	1962	2,520	2,190	-	2,650	-	1,320	6,030
3	Garware Nylons Ltd.	Poona	1962	2,390	-	-	1,300	-	1,450	3,840
4	Modipon Ltd.	Modinagar	1968	3,500	-	-	2,160	-	340	3,840
5	Century Enka Ltd.	Poona	1969	720	-	-	800	-	1,600	2,320
6	Shree Synthetics Ltd.	Ujjain	1971	1,100	-	-	330	-	1,000	2,100
7	Stretch Fibres Ltd.	Nagpur	1972	540	-	-	310	-	-	540
8	Baroda Rayon Corporation Ltd.	Udhna	1974	1,080	-	-	500	300	2,000	3,380
9	Shriram Fibres Ltd.	Madras	1975	-	2,200	-	-	-	-	2,200
10	National Rayon Corporation Ltd.	Kalyan	1975	-	2,200	-	-	-		2,200
Total				15,690	8,190	900	11,700	300	7,710	32,790

Table 2: Future Polyamide Factories in India, 1975

No.	Name	Location	Licence Issued	Letter of Intent Issued	Potential Total Capacity (tpa)
1	Industrial Development Corporation Orissa Ltd.	Bhubaneshwar	-	2,100	2,100
2	Assam Industrial Development Corporation Ltd.	Ganhati	-	2,100	2,100
3	M.P.Audiogik Vikos Nigam Ltd.	Bhopal	-	2,100	2,100
4	Haryana State Industrial Development Corporation Ltd.	Chandigarh	-	2,100	2,100
5	Mysore State Industrial Investment & Development Corporation Ltd.	Bangalore	-	2,100	2,100
6	Gujarat Industrial Investment Corporation Ltd.	Baroda	-	2,100	2,100
7	Tamil Nadu Synthetic Fibres Ltd.	Madras	2,100	-	2,100
8	Ambika Fibres Ltd.	Hyderabad	2,100	-	2,100
9	Kerala State Industrial Development Corporation Ltd.	Trivandruck	-	2,100	2,100
10	Bihar State Industrial Development Corp.Ltd.	Barauni	-	2,100	2,100
11	Punjab State Industrial Development Corp.Ltd.	Chandigarh	-	2,100	2,100
12	West Bengal State Ind. Development Corp.Ltd.	Calcutta	-	2,100	2,100
13	U.P.State Industrial Development Corp. Ltd.	Kanpur	-	2,100	2,100
Total			4,200	23,100	27,300

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[illegible] AGENCY FOR TECHNICAL COOPERATION LTD
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The Letters of Intent for the production of 2,100 tons/year each of textile filaments which were granted to the thirteen states of the Union in 1971 are also still valid. Two states, Tamil Nadu and Andhra Pradesh, have already founded the necessary firms, and their Letters of Intent habe been converted into proudction licenses (cf. Table 2).

The already-granted licenses and Letters of Intent for a total of 35,300 tons/year of nylon filaments, together with the plants already built, raise India's potential total capacity for nylon fibres and filaments to 60,090 tons/year.

1.1.2. Polyester Plants

Nine firms with a total installed capacity of 27,020 tons/year manufacture polyester fibres and filaments at present. This represents a capacity growth of 47.6 % since 1973. More than 90 % of present capacity are utilised for the production of polyester staple fibres; only 1,760 tons/year of textile filaments can be manufactures at present. Most of this capacity resulted from the conversion of existent nylon spinning plants. India does not manufacture or use technical polyester filaments at present.

Total production in 1974 amounted to 9,420 tons; this was only slightly more than during the previous year. The causes stated are shortages of raw materials and bottlenecks in power and sometimes also water supplies. A further factor is that the plants completed during 1974 were not yet able to make any considerable contribution to the total production of polyester fibres (cf.Table 3).

The nine existent firms hold no further production licenses or Letters of Intent which would enable them to expand their capacities. Three new firms with a total capacity of 43,000 tons/year polyester fibres and filaments are however planned (cf. Table 4).

Table 3: Existing Polyester Factories in India, 1975

No	Name	Location	Start-up	Installed Capacity (tpa)		Production 1974 (tons)	Licence Issued	Letters of Intent Issued	Potential Total Capacity (tpa)
				Filament	Staple Fibre				
1	Chemical & Fibres of India Ltd.	Bombay	1965	-	6,100	1,780	-	-	6,100
2	Nirlon Synthetic Fibres & Chemicals Ltd.	Bombay	1969	360	-	210	-	-	360
3	J.K.Synthetics Ltd.	Kota	1969	360	900	1,080	-	-	1,260
4	Swadeshi Polyester Ltd.	Gaziabad	1970	-	6,100	2,890	-	-	6,100
5	Indian Organic Chemicals Ltd.	Manali	1971	-	6,100	2,400	-	-	6,100
6	Garware Nylons Ltd.	Poona	1974	360	-	80	-	-	360
7	Modipon Ltd.	Modinagar	1974	360	-	180	-	-	360
8	Ahmedabad Manufacturing & Calico Printing Ltd.	Baroda	1974	-	6,100	700	-	-	6,100
9	Shree Synthetics Ltd.	Ujjain	1974	280	-	100	-	-	280
Total				1,720	25,300	9,420	-	-	27,020

Table 4: Future Polyester Factories in India, 1975

No.	Name	Location	Licence Issued	Letters of Intent Issued	Potential Total Capacity (tpa)
1	Punjab State Industrial Development Corporation Ltd.	Chandigarh	-	6,000	6,000
2	Petro Fils Corporation Ltd.	Baroda	7,000	-	7,000
3	Petrochemical Complex	Bongaigaon	-	30,000	30,000
Total			7,000	36,000	43,000

One of the firms (Petrofils Cooperative Ltd., Baroda) is already in the initial phase; about one-half of the licensed total capacity of 7,000 tons/year is to be achieved by the end of 1976, and expansion is to be effected immediately thereafter. The other two State Authorities have until now been granted only Letters of Intent (cf. Table 4). No definite statements were obtainable concerning possible realisation dates for these plants, particularly the large project in Bongaigaon, Assam. Realisation will depend to a large extent upon the speed with which the basic product plants now being built in Assam can go into production, how capacity utilisation in the existent plants develops, and what expansion plans the present manufacturers develop.

1.1.3. Caprolactam and DMT Plants

India has been in a position to manufacture its own raw materials for polyamide and polyester fibres since 1974. The Indian Petrochemical Corporation Ltd. (IPCL) has been producing DMT with a plant capacity of 24,000 tons/year since the beginning of this year (cf. Table 5). A total output of 13,300 tons DMT was achieved during the nine months of production of the 1974/75 business year. According to the analyses of the know-how partner, product quality reached international standards. The production target for 1975/76 is to meet the demands of all polyester fibre manufacturers, demands which are estimated as amounting to 20,000 tons. According to the IPCL, this production figure can be reached without difficulty, whilst higher production figures would call for better power supplies and a more suitable naphtha composition.

If these difficulties can be mastered and the full rated capacity achieved, the IPCL could satisfy the maximum raw materials demands of all existent polyester fibre plants. The planned further development of fibre capacities will temporarily make India dependent on imports once more, at least until the Indian Petroleum Corporation Ltd.'s DMT plant in Bongaigaon goes on stream (cf. Table 6). This is expected to happen in about 1979/80.

Table 5: Existing Fibre Raw Material Plants in India, 1975

No.	Name	Location	Start-up	Inatalled Capacity (tpa)	
				Caprolactam	DMT
1	Indian Petrochemical Corporation Ltd.	Baroda	1974	-	24,000
2	Gujarat State Fertilizer Co.Ltd.	Baroda	1974	20,000	-
Total				20,000	24,000

Table 6: Future Fibre Raw Material Plants in India, 1975

No.	Name	Location	Letters of Intent (tpa)	
			Caprolactam	DMT
1	Indian Petroleum Corporation Ltd.	Bongaigaon	-	63,000
2	State Fertilizer Corporation Ltd.	Bongaigaon	50,000	-
Total			50,000	63,000

The Gujarat State Fertilizer Corporation (GSFC) started caprolactam production in August 1974 with a capacity of 20,000 tons/year. 6,500 tons were manufactured by the end of March 1975. The plant is however still having teething problems. The best capacity utilisation rate achieved until now was about 75 %, a value which is expected to be the average capacity utilisation rate for the current business year (April 1975 - March 1976). Even with full capacity utilisation, the GSFC will not be able to completely satisfy the raw material demands of the installed nylon polymerisation and spinning capacities.

The GSFC intends to double its caprolactam capacity, and will soon initiate the formal administrative measures. The question of adequate benzene supplies for the expanded plant has however not yet been clarified. Realisation of this project will probably take at least four years.

A further caprolactam plant is planned as part of the petrochemical complex in Bongaigaon, Assam, as may be seen from Table 6. The State Fertilizer Corporation Ltd. has been granted a Letter of Intent for an annual capacity of 50,000 tons. Realisation of this project also can scarcely be expected before 1979/80.

Assuming uninterrupted operation of the DMT and caprolactam plants, India would be in a position to manufacture all necessary polyester fibre raw materials and about three-quarter of the nylon raw materials for full fibre plant capacity utilisation. The ex works prices including an excise duty of at present 50 % are approx. 4,500 US $/ton caprolactam and approx. 2,400 US $/ton DMT; these prices are however well above the present world market levels.

1.2. Expectations of Fibre Manufacturers

In numerous discussions, the Indian synthetic fibre manufacturers declared themselves to be interested in principle in all research activities planned for the SASMIRA project. The main interests however differ, depending on whether the companies are large or small.

Large fibre manufacturers are mainly in favour of the training of middle management, i.e., supervisors or superintendents, as there is a shortage of staff with such qualifications in India. The present practice is to have the middle management staff trained during the construction period of a synthetic fibres plant, usually by the licensor (know-how partner). Fluctuation of such labour- stated by the fibre manufacturers as being 3 - 5 % per year, i.e., in average each fibre manufacturer may have to replace about one middle management employee per year - can only be countered by on-the-job training of high school or university graduates. Such training is on the one hand time-consuming and costly and must on the other hand remain limited by internal know-how. The industry expects that labour trained by SASMIRA will need only relatively short familiarisation periods to gain a knowledge of specific plant conditions and problems. This familiarisation period is expected to last no longer than about three months, i.e., one-quarter of the present training period. On the other hand, the industry expects more comprehensive and deeper technical knowledge going beyond the scope of experience of the individual plants which will enable SASMIRA graduates to take a lead in expanding the internal know-how and experience of the plants in which they are employed.

Smaller fibre manufacturers are interested not only in such management staff training but are also very interested in the training of operators, as they - unlike the larger fibre manufacturers - have scarcely any possibility of taking one or two spinning stations out of production to be used for training purposes. As a result, the average operator knows only the dexterities needed for his immediate field of work.

The planned SASMIRA training activities are expected to teach the operators not only purely operative dexterities in the polymerisation,melt spinning and subsequent plants but also a broader understanding of the process and, above all, cost-consciousness and the ability to rationalise. In view of the very high raw material costs, the last two qualities are particularly important.

The critical remark was made that the polymerisation stage of the planned demonstration plant for SASMIRA - which must be designed for discontinuous operation because of the small capacity and above all because of the necessary versatility - would differ from industrial plants, as practically all new plants in India are designed for continuous operation. It was however realised that the target of SASMIRA's training cannot be simply the teaching of operating dexterities, but also an understanding of the process itself. It will however be necessary to build the spinning plant section and the following machines with the exception of the fibre line on an industrial scale.

All partners in discussions expected that highly-qualified teaching staff would be appointed to the SASMIRA project. It was thought that the teaching staff should have extensive practical experience, so as to be able to noticeably help also those trainees who come from the practical fibre production field (advanced training courses). This expectation was voiced not only by fibre manufacturers but also by processors, and is shared by governmental agencies.

Both groups of manufacturers also showed fundamental interest in the foreseen research and development work in the fibre manufacturing and applications fields. Here once again, the aims and tasks stated by large and small manufacturers differ.

The larger manufacturers consider themselves as being capable of solving production difficulties and simpler product development problems themselves. Such problems would for example include:

- trouble-shooting in their own plants
- quality control and maintenance and all stages of polymerisation
- evaluation of economic aspects with respect to process variables
- utilisation/processing of by-products
- evaluation of economic aspects in various stages of melt spinning
- modification of fibres in respect of the number of filaments, cross-section and surface finish
- development, evaluation and standardisation of spin-finished materials (in cooperation with a spin-finish manufacturers)

These firms have the necessary specific manufacturing know-how to be able to solve such problems. Such work is also facilitated by the present capacity utilisation rates, in that idle spinning stations can be utilised for important development tasks. A disadvantage in this respect is the capacity of the production plant units, as such experiments mean high material consumption. This group of manufacturers expects the SASMIRA project to supply mainly ideas and basic informations for further development work. New product developments are placed in the foreground, whereby the manufacturers think mainly of yarn properties which are new to India and which would give the sponsor firm a certain market advantage. Such market advantages are usually seen in the fashion field (for example, the sari market demands frequently-changing finishes and designs) or in better wearing properties of the finished garment.

Large firms can therefore only be expected to commission research on problems which their own research departments and staff cannot solve. The main interest is in production know-how which Indian firms do not yet have, for example, high speed spinning with subsequent draw texturising or colour spinning.

The smaller fibre manufacturers, who are also interested in such new developments, advocate that production problems should also be investigated and production know-how for the standard range gathered. Development work for smaller fibre manufacturers would have to include the transferring of results from pilot plant to production plant scale, a task concerning mainly the above-mentioned new developments, which larger companies usually carry out themselves.

Because of the high raw materials prices in India, all fibre manufacturers showed great interest in all questions of waste recovery, for example, the possibility of spinning polymer waste to yarns for lower stresses (carpet yarns) and, above all, the possibility of depolymerising nylon waste to recover caprolactam.

The larger manufacturers showed no particular interest in the foreseen technical services. Even the smaller firms do not think that such topics will be particularly important initially. In the opinion of the fibre manufacturers, a prerequisite to making use of such services will be that SASMIRA gathers and can pass an experience which can actually be used in production. The conclusion to be drawn is that these services can first be formulated and realised after SASMIRA has been in operation for a number of years.

There are considerable demands for information throughout the entire synthetic fibres industry, from the raw materials production to the processing stage. A "literature service" which would provide abstracts from important international publications on the petrochemical, chemo-technical and textiles technology production stages of synthetic fibres would therefore be very welcome as a technical service.

1.3. Expectations of Fibre Processors

The main expectations of the fibre processors concern the textiles technology stages of the project, i.e., draw-twisting, texturising and staple fibre processing.

In the training field, their interest is concentrated on the middle management level, i.e., the training of supervisors and superintendents. At this level, technical interest mainly concentrates on the textile stages of fibre production. Less interest is shown in the melt spinning process and, naturally, no interest in the polymerisation process. An exception here is that all fibre processors require the improvement and standardisation of qualities in these processing stages.

The planned SASMIRA training program is also expected to extend previous training activites in the mechanical spinning and weaving fields to cover the previous production stages, so that management staff have a better overall view and are rendered capable of more readily recognising fibre and production faults which result from the production process and of proposing efficient ways of avoiding such faults.

A further main training theme should be equipment engineering in the above-mentioned production stages. One of the reasons for this is that individual processors have already commenced machine-building activities in this sector (e.g. texturising machines), that others will follow, and that design improvements and new developments are particularly necessary in this field. On the other hand, it is hoped that SASMIRA graduates will contribute to the introduction of improved maintenance methods, which are particularly necessary in the fibre processing field.

ESTABLISHMENT OF A DEMONSTRATION PLANT
FOR THE PRODUCTION OF SYNTHETIC FIBRES
AT THE SILK AND ART SILK MILL'S RESEARCH
ASSOCIATION IN BOMBAY/INDIA ,

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There is also great interest in the special courses for management staff. These will probably have a technical scope similar to the supervisor training courses. The fibre processors expect the SASMIRA to assist in preparing themes and also to suggest themes.

The fibre processors appear to place less importance in operator training. The only operator demands expected are small demands for the yarn engineering sector; otherwise, interest is concentrated upon the traditional training fields of the SASMIRA.

All fibre processors consider research activities to be very important. They show great interest in all questions connected with quality improvements and the standardisation of fibre and yarn grades. The foreseen target for such work is a sort of standardisation of yarns, which is to lead to uniform processing quality: at present, one of the main processing difficulties is that like yarns from differing fibre manufacturers require different processing methods, or that uniform processing leads to different finished product qualities. The processors are of the opinion that the SASMIRA should follow up this problem as far as the melt spinning or even the polymerisation stage.

According to the processors, the tasks of the SASMIRA should include not only the comparative evaluation of yarns but also the development of better and more uniform preparation methods and the development of spin finishes in cooperation with the manufacturers of textiles auxiliaries.

Further great interest is also shown in all questions of cost reduction and rationalisation in the production and processing sectors. The processors believe the expansion of applicational fields for fibres and filaments and the related expansion of the market to be at least equally important. Such development work should lead to novel finished products (fabrics) and should begin with fibre production, as the possibilities and range for variation in the fibre processing stage are largely known and have been mastered.

The interest of the processors is however not limited to the production process and quality improvement, but also extends to support in the fields of plant maintenance and plant development. SASMIRA is expected to give engineering support here, particularly in the development of machines. The fibre processors group shows possibly the greatest interest of all groups in the tasks for the Technical Advisory Services. A prerequisite is thought to be that the SASMIRA should have first-class technical staff with a comprehensive knowledge which is otherwise not available in India. The processors realise that the necessary experience can only be built up slowly. This means, also in the opinion of the fibre processors, that the advisory services must be regarded as a long-term project aim, and can only be provided on a larger scale after the project has been in operation for some years. Technical services which the fibre processors would particularly welcome are in-plant advice on production problems and support in internal training measures.

1.4. Expectations of Raw Material Producers

India's only raw material manufacturers, the IPCL and GSFC, showed no great interest in the planned SASMIRA activities. As the purely petrochemical production of raw materials differs greatly from fibre production technology and analytical evaluation of raw material quality normally suffices, this attitude is logical and understandable.

Consequently, their training demands would only arise in exceptional cases and would be for graduates of diploma courses who could be employed in the quality control laboratories or applications research. The two manufacturers need only small numbers of such staff, and therefore play a subordinate role in determining the demands for training capacity. Only the realisation of the petrochemical production complex in Assam and the possible expansion of the caprolactam plant of the IPCL would lead to short-term demands for diploma or post graduate staff.

Limited interest was shown for the advanced training courses for management staff. The raw materials manufacturers see only a few attractive topics within the applicational fields of their products. Their interest is directed towards basic fibre products which have not yet been introduced to India, for example, acrylates, which could facilitate diversification in the raw materials sector.

The research capacity to be offered by SASMIRA for the applications sector would probably only be used in exceptional cases. It is thought that the SASMIRA's services would only be called upon in connection with technical service problems and then only in borderline cases which cannot be satisfactorily clarified by analytical methods.

There is no interest in advisory services because of the differences between the fields of endeavour. The raw materials manufacturers would however be interested in the above-mentioned literature and information services, in order to obtain at least limited access to foreign technical literature.

1.5. Expectations of SASMIRA

The need for a pilot plant in India as indepently revealed in numerous discussions with fibre manufacturers, fibre processors, raw material producers and government officials is convincingly confirmed by SASMIRA. As the only research institution for synthetic fibres in India 25 years of experience in servicing the industry have clearly shown that assistance in training, applied research as well as technical and advisory services are still urgently required. Despite the progress made by a number of firms many problems are still not solved and new ones are coming up. In addition cooperation between SASMIRA and the industry has become ever closer during the last decade. Therefore, SASMIRA foresees a large demand for utilising the pilot plant. It is expected that training and research requirements of the industry will even exceed SASMIRA's possibilities, at least for the next five to ten years (five years of the operation).

According to SASMIRA's experience the training programs to be effected with the pilot plant for polyamide and polyester production must aim at improving knowledge and ability on all personnel levels in existing companies and at professionally educating management personnel on the supervision and superintendent level. Some of the technical training should be executed in fulltime courses. Other programs should be arranged as part-time evening courses.

On the operative level it is envisaged that fibre manufacturers will sponsor about 150 participants for training in polymerisation and spinning , mechanical processing and utility engineering. For the same period, but for the supervisor level, at least 75 participants each for a fulltime-diploma course in man-made fibre manufacture and an evening certificate course in man-made fibre manufacture are expected. The forecast for fulltime students of a post graduate diploma course in man-made fibre technology (superintendent level) is conservatively figured at 50. According to SASMIRA training on the managerial level should be performed in tailor-made programs lasting on the average from one day to one week. They are exclusively sponsored by industry with not more than 10 participants at a time.

Aside from the operational level, where participants are solely expected from fibre manufacturers, the other courses might in addition train persons from or for fibre processors, raw material producers, educational institutions (i.e. PhD-thesis), government institutions and trade.

In applied research SASMIRA has made an annual forecast of about 80 to 100 requests from fibre manufacturers, about 10 to 20 requests from raw material producers and about 5 to 10 requests from fibre processors. Other institutions expected to use SASMIRA applied research as well as technical and advisory services on the basis of a pilot plant are government agencies (i.e. customs, tax offices, training institutions, courts, Textile Commission Officer), trade, consulting and engineering companies, ancillary industries and possibly equipment manufacturers. In addition SASMIRA will carry out independent research. It will publish the results in its periodicals and will desseminate information by seminars. An ambitious target is the creation of a data bank on man-made fibres.

Applied research activities are expected to cover the full range of possible problems in all stages of production from polymerisation to spinning and to filament and staple fibre processing. Technical and advisory services will be different for fibre manufacturers (production, maintenance, quality control, personnel recruitment, organisation), fibre processors (production, quality control) and raw material producers (mainly quality control).

1.6. Ranking of Envisaged Services and Priorities

The summary assessment of the statements of all Indian agencies connected with the project clearly show that the t aining tasks will form the most important part of the foreseen project activities. Second place will be taken by the envisaged applied research tasks, whilst the foreseen technical and advisory services take a clear third place. This sequence results from the summation of the unweighted assessments of the individual project tasks by fibre manufacturers, fibre processors, raw material manufacturers and the SASMIRA/CSIR (cf. Table 7). The priorities become even clearer when one includes the significance of the individual viewpoints concerning success of the project in the evaluation. An attempt to do this is made in Table 8 in that the statements of the four groups are given a percentual project relevancy, these percentages are multiplied by the evaluations stated (very important to not important), and the resultant figures are added.

These statements reflect not only the overall priority of the project target "training" but also a special necessity for the training of middle management staff, i.e., supervisors and superintendents. Of approximately equal importance are advanced training courses for management, the so-called "tailor-made courses", which attracted considerable interest but which will probably first be possible when experience has been gathered on the SASMIRA project. According to the statement made, the training of skilled workers takes third place to the two previously-mentioned training targets. This definition of priorities by existent firms does not however allow for the fact that a larger number of small to medium fibre production plants will be established in India in the future. In view of the present state of the art, India will be in a position to make large contributions to the manufacturing of these plants. The efforts towards development and realisation of domestic know-how can however only be successful if training facilities are also made available for skilled workers at the same time. At the present moment, no Indian fibre manufacturer is prepared to give such training for potential competitors.

In the opinion of the Indian synthetic fibres industry, applied research should be given only slightly lower priority than the training tasks. SASMIRA will therefore have to organise and promote such activities from the very beginning.

Table 7: Unweighted Ranking of the Envisaged Services

	EDUCATION				
	OPERATOR'S TRAINING	SUPERVISORS/ SUPERINTENDENTS	MANAGEMENT COURSES	APPLIED RESEARCH	TECHNICAL AND ADVISORY SERVICES
Fibre Manufacturers					
- Larger	2	1	1-2	2	3
- Smaller	1	1	1	1	2-3
Fibre Processors					
- Larger	2-3	1	1-2	1	1-2
- Smaller	2	1	1	1	1-2
Raw Material Producers	4	3	2	3	3-4
SASMIRA/CSIR	1	1	1	1-2	2-3
Summary	12.5	8	8	9	14 5

1 Very important

2 Important

3 Less important

4 Not important

Table 8: Weighted Information on the Importance of Project Tasks for the Interested Parties*)

	Rating of Importance for the Project Tasks in %	EDUCATION			APPLIED RESEARCH	TECHNICAL AND ADVISORY SERVICES
		OPERATOR'S TRAINING	SUPERVISORS/SUPER-INTENDENTS'TRAINING	MANAGEMENT COURSES		
Fibre Manufacturers	45 %					
- Larger units		0.90	0.45	0.68	0.90	1.35
- Smaller units		0.45	0.45	0.45	0.45	1.12
Fibre Processors	35 %					
- Larger units		0.88	0.35	0.52	0.35	0.52
- Smaller units		0.70	0.35	0.35	0.35	0.52
Raw Material Producers	10 %	0.40	0.30	0.20	0.30	0.35
SASMIRA/CSIR	10 %	0.10	0.10	0.10	0.15	0.25
Summary		3.43	2.00	2.30	2.50	4.11

*) Figures derived by multiplying the rankings of services given in Table 7 with the rating of importance (in %) of the parties for the project success.

Technical and advisory services are thought to be a longterm aim and not necessary during the initial stage. This opinion correlates with the necessity of SASMIRA having to gather experience before such activities can be commenced on a larger scale. The propagation of knowledge gained from technical literature will however give this sector a certain importance in the early stages of the project also.

The overall assessment of the project by the synthetic fibres industry showed that mainly the small and medium enterprises have considerable interest in the SASMIRA project. In addition to the priorities given to the project by processors, fibre manufacturers and SASMIRA itself, the Central Government of India includes the SASMIRA project among those whose realisation is to be given priority by the UNDP. This was stated by the joint Secretary of the Ministry of Science and Technology, by the Joint Secretary of the Department of Economic Affairs in the Ministry of Finance, and by the Secretary in the Ministry of Petroleum and Chemicals. We were assured that the Central Government would initiate and carry out the necessary project steps with due dispatch.

2. Project Tasks and Services

In order to fulfil the training and research requirements created with the formation and extension of the fibre and fibre raw material production the semi-commercial demonstration plant for manufacturing synthetic fibres is proposed to serve for

- performing training and upgrading programs for operational, management and research personnel of the fibre producing industry
- performing tasks of applied research, quality control as well as process development and adaption particularly in the fields of polymer-to-yarn processes and for the development and application of more sophisticated process and product technology in synthetic fibre production
- elaborating data for technological advice and consultancy to synthetic fibre processors.

As outlined above training of middle and upper management as well as skilled operators ranks first among the project tasks followed by applied research work and the advisory services. Scope and proposed organisation of this project work, as far as possibly to be elaborated at the present stage of information, is described in detail within this chapter. This description may serve as a guideline to set up more detailed curricula and teaching schedules and furthermore to organise the start of research operations.

2.1. Training

Training in the planned Fibres Division of the SASMIRA is intended to import a basic knowledge of the polyamide and polyester fibre production processes and practical ability in plant operation and monitoring. Further aims are to awake a sense for the need for economy in all stages of fibre production and quality consciousness in all process stages. It is expected that SASMIRA graduates will have a positive influence on their fellow workers with regard to quality and economy consciousness. This expectation is expressed in the readiness of the fibre manufacturers to provide financial support for the planned SASMIRA training program.

The aims of training activities in the Operational Personnel, Supervisory Personnel and Management sectors are described in the following, as are the organisational form of the training courses, the presumably necessary plant utilisation times and the estimated staff demands for the training activities.

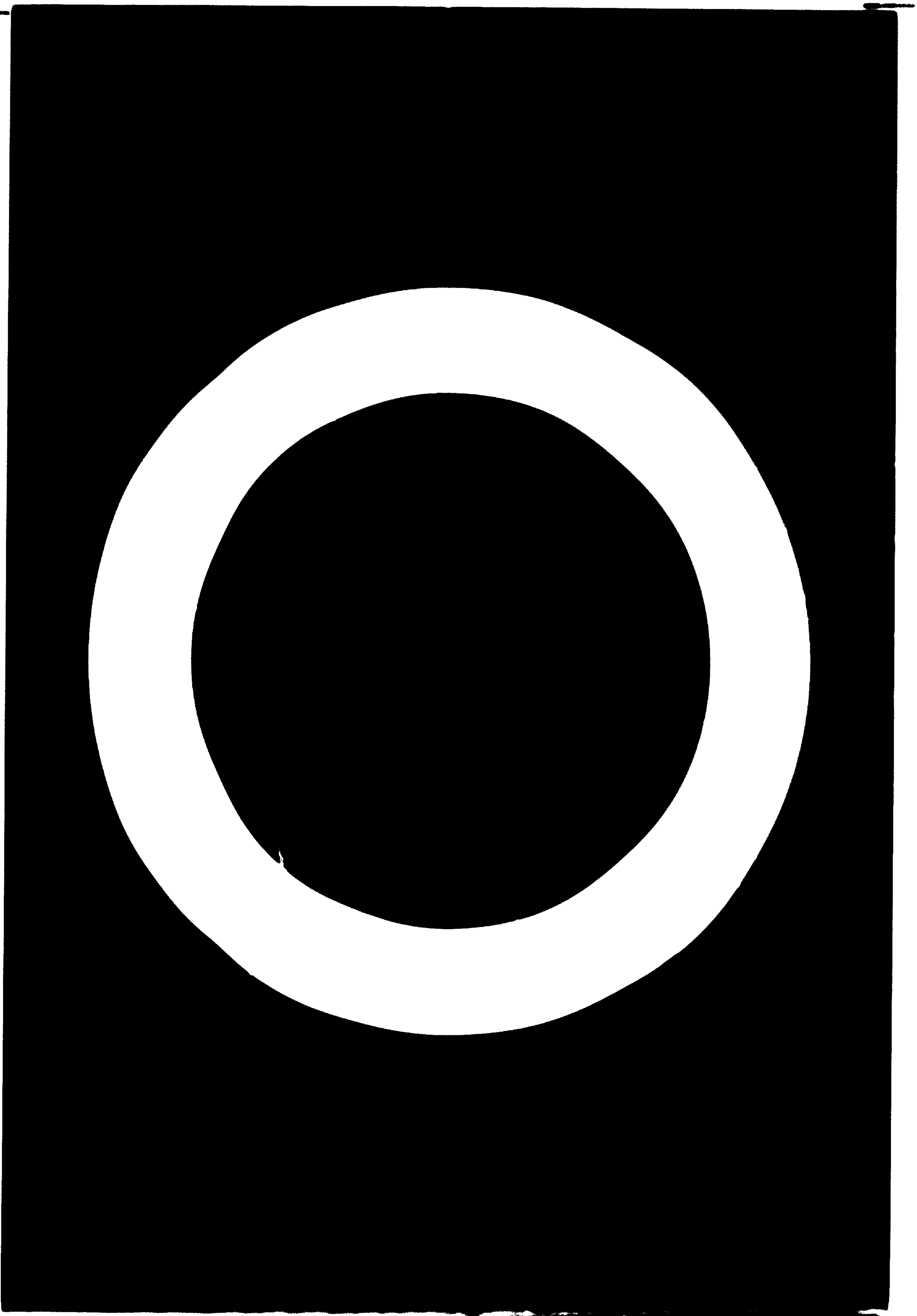
2.1.1. Functions and Services

The SASMIRA Fibres Division will make it the only research institute in South-East Asia and Middle East which offers training courses including practical work in the fields of polyamide (nylon 6 and nylon 66) and polyester fibre manufacturing. The planned courses cover the qualification range from plant operator to post graduate.

The diploma study courses which SASMIRA already offers for the "man-made textiles" sector are recognised by the Board of Technical Examinations, Maharashtra State (BTE) and the Textile Institute of Manchester, UK. The planned training courses utilising pilot plant will be so designed that they also meet the requirements of the institutions.

The expansion of the training progress is mainly intended to meet the needs of the fibre manufacturers, and will include training courses on the

- operative level, i.e., the training of operators and foremen
- supervisor/superintendent level, i.e., the training of middle management staff, based on a university education
- managerial level, i.e., the advanced training of executive staff



2.1.1.1. Operator Level

The present operator training program of SASMIRA includes three courses in fibre processing, warp knitting and wet processing. The duration of the courses is 3 - 6 months; most participants come from the fibre processing sector.

The planned pilot plant is to facilitate three further courses for the fibre production sectors:

- polymerisation and chips production
- melt spinning and yarn engineering
- utility engineering

These three 6-month courses with 10 participants each will be full-time (five days per week) and are designed to impart practical knowledge of the operation of a polyester/polyamide fibre production plant. The accent on the practical aspects of training will be achieved in that trainees will be given practical tasks connected with the operation, cleaning and maintenance of the plant over a period of about 5 months, and the result recorded. The theoretical part of the course is to be no longer than 4 weeks, and is to give trainees an insight into the process and material flow aspects.

This theoretical training phase will also give an insight into the preceding process stages and explain measures of achieving a given quality and economising in work processes (reduction of reject rates, material recovery).

According to the fibre manufacturers, each factory needs an average of about four operators per year. In comparison, an average of seven operators are to be trained in each of the three above-mentioned fields during the early stages of training at SASMIRA. This would mean that in each of the three fields 1 - 2 men per year would be available for the factories around Bombay alone. According to these firms, actual demands are greater and would justify an increasing number of students per course as SASMIRA's experience grows, particularly as no allowances have been made for the demands of planned new fibre plants.

Polymerisation and Chips Production

The students of these courses are to be instructed in the operation of the plant units for polymerising caprolactam to nylon 6 and polycondensing DMT and glycol to polyester, and in the operation of chips production and treatment plant. To ensure a better overall insight, students will also be instructed in melt spinning, staple fibre and filament production. Particular emphasis will be placed on the observance of quality and economy standards.

Melt Spinning and Yarn Engineering

This course will concern the manual dexterities needed for the operations extrusion, spinning flow, taking up, finishing, draw twisting, texturising and cone-winding of filament production and the operations extrusion, spinning flow, stretching, washing, drying, finishing, crimping and cutting in staple fibre production.

Utility Engineering

The practical training given during this course will qualify the trainees to operate and maintain the utility plants steam generator, diphenyl plant, process water plant, cooling water supply, nitrogen supply and air conditioning plant. Training will give the students the opportunity to practice the provision of the utility qualities required by the process in an economical manner. The safeguarding of supplies by means of preventive maintenance will be demonstrated, utilising concrete tasks.

The theoretical part of the course, once again, of four weeks' duration, will give an insight into the process which the utilities serve. Simple quantitative calculations as a basis for daily, weekly and monthly demand estimates will be carried out. The functions of the utility plants of the Fibres Division are also to be briefly described using flow charts.

2.1.1.2. Supervisor/Superintendent Level

At present, the SASMIRA offers 7 full-time courses and 4 evening courses leading up to academic qualifications:

Full-Time Courses

- Diploma Course in Man-Made Textile Technology (DMTT)
- Diploma Course in Man-Made Textile Chemistry (DMTC)
- Diploma Course in Knitting Technology (DKT)
- Post Graduate Diploma Course in Wet Processing of Man-Made Textiles
- Post Graduate Diploma Course in Textile Management and Marketing
- Post Graduate Degree of Research by University of Bombay
- Post Graduate Degree for Textile and Clothing

Evening Courses

- Certificate in Weaving of Man-Made Fibre Fabrics
- Certificate in Wet Processing of Man-Made Textiles
- Diploma in Textile Management
- Diploma in Marketing of Textiles

The Fibres Division will supplement the range of courses with three courses covering the field of fibre production: one full-time diploma course, one evening certificate course and one post graduate course. The duration and choice of subjects for all three courses will be such that the requirements for state recognition of the examinations are met.

Diploma Course in Man-Made Fibre Production

Like the present diploma courses, this course will have six semesters (three years). The entry qualifications for the max. 15 students will be the Secondary School Certificate (SSC) with chemistry as obligatory subject. Three months of industrial practice is obligatory for all diploma courses.

A new course will begin each year. The first three semesters will be utilised to impart fundamental theoretical knowledge (English, Mathematics, Chemistry, Physics); this part of the course follows the same pattern as the diploma courses already held.

In the following three semesters, students are to deepen their theoretical knowledge and carry out practical tasks on the pilot plant. This part of the training course will for example include the following activities:

- During the 4th. semester, observation of the degree of polymerisation during the polymerisation process by means of viscosity measurements at various temperatures, and evaluation of these; water analyses are also to be carried out, and distillation curves and drying diagrams prepared. After having carried out the measurements, the students are to prepare reports and discuss the relationships between the influencing magnitudes and the results. Plant demonstrations in various production stages are to supplement the lectures.

- During the 5th. and 6th. semesters, the tasks at the plant will concern fibre and filament production, whereby the effects of the factors treated in the polymer chemistry, fibre technology and chemical engineering lectures will be demonstrated and explained against the background of practical operation. Ten hours per week of practical work are foreseen in all three semesters of the specialised training course. This to ensure that the supervisors trained by SASMIRA will have a fundamental knowledge of the production of polyester/polyamide fibres which need only be supplemented by familiarisation with the peculiarities of the production plants at their later places of work.

The diploma course will provide industry with about twelve graduates per year, this assuming an average failure rate of 10 % in interim and final examinations. As India at present has 15 fibre manufacturers, this means less than one graduate per year is available to each factory. Also unaccounted for are the demands of raw materials manufacturers and fibre processors for such graduates, to carry out applied research and/or customer services tasks. The industry confirms that this graduate output will not meet demands for new management staff, and emphasises that specialised staff who have undergone practice-orientated training in the Fibre Division of the SASMIRA will be given preference when engaging new staff.

Certificate Course in Man-Made Fibre Production

This evening course lasts two years, being held twice weekly during the evening, and a new course will be started each year. Initially, the number of participants will be limited to 15 persons. The course is to give those employed in industry the opportunity of improving their level of qualification. The emphasis of the course will be upon practical training, which will be the same as given in the diploma course. The courses will omit the fundamental subjects taught during the first three semesters of the diploma courses. The entry qualification will be the SSC.

The practical tasks of the first year will give an insight into the process and material flows in plants for the production of fibres, and filaments. The processes will also be demonstrated. After having received instructions, the students will then carry out physical and chemical measurements with raw and auxiliary materials, intermediates and finished products (viscosity, tinting value, conductivity). Students will also carry out short tasks in the polymerisation/polycondensation process field. The students are to analyse the results of work from the viewpoints of achieving certain qualities and economical utilisation of materials.

During the second year of training, students will perform certain functions in the melt spinning, yarn engineering and utility engineering fields. Apart from this production work, they will also carry out maintenance tasks. During these activities, they are also to take cost aspects into account (service lives of wear parts, increasing of service life by maintenance, stand-by capacity, spare parts stocking). At the end of the training course, the students will carry out quality control and will make proposals concerning modifications of the production process when quality standards are not reached.

The number of applicants will be far greater than the number of students that can be admitted. As most of the applicants are employed, the service area will be limited to the vicinity of Bombay. Attendance of the courses must be agreed with the employers of the participants (shift-work!). In most cases, this permission to attend the course will guarantee employment at a higher level after successful completion.

Particularly the employees of fibre manufacturers in the vicinity of Bombay will be able - as is already the case for fibre processors' employees- to attend SASMIRA courses during the morning and work during the afternoon.

Post Graduate Diploma Course in Man-Made Fibres Technology

This full-time course will have a duration of two semesters; the number of students will initially be limited to ten persons. The entry qualification is a degree in chemical engineering.

Apart from scientific and economic theory, the first semester's instruction will include a demonstration of polyester/polyamide fibre production at the pilot plant. Practical training during this period will include physical and chemical materials testing.

During the second semester, students will be instructed in the operation of the process monitoring and controll equipment. Serial experiments are to be carried out to reveal the interdependencies between operating conditions and output variations. Preventive maintenance tasks are to produce ideas on optimation of plant operation. As a diploma thesis task, the students will be required to prepare a layout study on the basis of a given production program for a polyester/polyamide fibres and filaments plant in which the problems of material flows, operation, maintenance and variability of the program are allowed for.

Central Government recognition for this course is the aim.

In comparable courses held at the present time, about 50 % of the students are sponsored by the state, the other half being sponsored by the industry. Initially, all students of the Post Graduate Diploma Course in Man-Made Fibres Technology will be sponsored by the industry. Coupled with each scholarship will be the assurance of employment by the sponsor firm after successful completion of the course.

At present, there is a certain degree of unemployment among domestically-educated university graduates, as middle and higher management staff are usually trained overseas. The Indian Government wishes to counter this situation with specialised training measures, and will therefore make grants to some of the candidates, as is the case with the present very successful training courses. All participants in these courses were guaranteed employment before completiton of their training.

2.1.1.3. Management Level

SASMIRA provides 1 to 10-day courses for managerial staff. The topics are either suggested by member firms, or are formulated because frequent enquiries have shown them to be of general interest. It is therefore possible to hold courses which are sponsored by one firm and attended only by staff of this firm (tailor-made courses) or courses which are offered to all members and previously announced in"SASMIRA's BULLETIN" in due time, i.e., up to one year before the commencement date.

The establishment of the Fibres Division effects that the course program, which until now has been mainly designed for fibre processors, will also meet the needs of the fibre manufacturers. Additional courses which have a concrete bearing on the management of the Production Section of the Fibres Division are to be offered. Problem complexes which the SASMIRA has already identified as being of general interest in this connection include topics from the fields of vertical and horizontal organisation, economy control, quality control, production program optimation, and utilisation of resources. The participants in these courses - probably no more than 10 per course - will be mainly staff of raw materials and fibre manufacturing firms and, to a lesser degree, fibre processors' staff. In order to minimise the absence of management staff from their firms, the SASMIRA will increase the number of courses held outside Bombay.

2.1.1.4. Participants of Existing Courses

In the past sometimes, it has been found difficult to afford participants in SASMIRA courses the opportunity of visiting a fibres plant. Most firms refused to allow visitors to inspect their plants for reasons of secrecy. Inspections of the pilot plant are foreseen to give course participants an insight into the production of polyamide/polyester fibres and filaments. This affects practically all courses provided by SASMIRA at present. During the inspection tours, process stages, material flows and possibilities of production variation are demonstrated at the plant. Second visits later concentrate on special plant sections, in order to describe chemical, physical, technical or economic details. Questions concerning plant element design, layout variations and problems of servicing and maintenance can be discussed during these short inspection tours.

For educational and safety reasons, the size of visiting parties is limited to a maximum of 10 persons. It should also be made possible for congress delegates and interested persons from the industrial and administrative spheres to inspect the plant. This is regarded as a public relations measure towards positively influencing the official attitude to the use of man-made fibres in India.

2.1.2. Operation

The planned program for training in synthetic fibres manufacturing will change SASMIRA from a purely textile engineering to a chemotechnical teaching institution. This expansion to a new field of endeavour will call for careful preparation and reorientation of the teaching program and course organisation. Some of the new courses will overlap with present courses, and will make careful harmonisation of individual activities within the given and future capacity framework necessary. A period of about two years will be available for reorientation and preparation when the technical prerequisites are being fulfilled.

The fundamental data on the implementation of the planned training courses, course timings and the main topics are described in the following. From these data, one can derive the probable pilot plant utilisation time for teaching purposes, which do not exclude the possibility of simultaneous utilisation for research or production. These data also serve as a basis for estimating staff requirements in the new teaching sector of the SASMIRA.

2.1.2.1. Courses

As may be seen from the description of the training functions and services, SASMIRA will introduce six new courses, namely:

- operative training courses
  -- polymerisation/polycondensation and chips production
  -- melt spinning and yarn engineering
  -- utility engineering

- supervisor/superintendent training courses
  - -- diploma course in man-made fibre manufacturing (full-time course)
  - -- certificate course in man-made fibre manufacturing (evening course)
  - -- post graduate diploma course in man-made fibre technology (full-time course)

The following description of subject matter and the teaching program outlines the framework within which the individual curricula will have to be developed during the plant construction period. For the operative courses, the following gives only a catalogue of topics, from which practical work tasks with instruction must be developed on the basis of the plant details. The scope of such work tasks is demonstrated by means of an example.

<u>Operative Training Course in Polymerisation/Polycondensation and Chips Production</u>

Catalogue of Topics:

- Classification of the synthetic fibres and description of their characteristic properties
- Description of the polyamide and polyester fibres and filaments production processes
- Description of the plant sections for the production of fibres and filaments, plant inspections
- Inputs for polyester and polyamide fibres and filaments production
- Description of the material flows of the various processes, economical utilisation of materials and energy, quality control
- Accident prevention measures and safety regulations
- Intensive practical training at the plant sections for polymerisation and polycondensation
- Intensive practical training at the plant sections for the production and treatment of chips
- Practical training at the plant sections for melt spinning/extrusion, spinning and take-up
- Practical training at the plant sections for the production of staple fibres and filaments
- Instruction on critical plant elements and discussion of plant operation from the viewpoints of improvement of economy and quality

Practical training will include the setting of tasks which can be solved by operating the plant. The tasks will cover the operating conditions which prevail during starting-up, closing-down, increasing the throughput, variation of input qualities, cleaning, servicing and maintenance. Production report forms from which one can determine the student's success in solving the given tasks will be prepared.

An example of such an operational task, namely "the production of nylon-6 chips in standard quality for tire cord" is given below by describing the individual steps to be performed:

a) Charging the melter with carpolactam, taking samples for laboratory analysis, recording of material consumption and melting temperature curves

b) Dosing of catalysts, accelerators, etc.; recording of material consumption, agitation time and rate

c) Discharging of the melt through filters into the prepared polymerisation autoclave. Recording of filtering times, filter charges, autoclave preheating times and temperature

d) Polymerisation under specified conditions, discharging of the polymer through spinning heads, cooling bath, chip-cutting and storage. Plotting of temperature, pressure and viscosity values versus reaction time

e) Filling the extractor with chips, triple washing under specified conditions, transferring to the vacuum drier. Recording of water consumption, washing temperatures and times, taking of samples for the laboratory

f) Drying of the chips under specified conditions, discharging into storage vessel, sampling, weighing of the yield. Recording of drying temperature, pressure, moisture content, time, monomer content of the dried chips

g) Brief description of deviations from specified values, with explanations of the effects on product quantity and quality

Preface

On 12 April 1975, the UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION in Vienna requested FGU-KRONBERG Gesellschaft für Unternehmensberatung und Projektstudien mbH to elaborate an expertise on the

ESTABLISHMENT OF A DEMONSTRATION PLANT
FOR THE PRODUCTION OF SYNTHETIC FIBRES
AT THE SILK AND ART SILK MILL'S RESEARCH
ASSOCIATION IN BOMBAY/INDIA

This report is part of the assistance rendered by the UNITED NATIONS DEVELOPMENT PROGRAM to the Government of India. It should be regarded as the first stage of establishing a demonstration plant for the production of synthetic fibres. Since the project will be jointly financed by UNDP/UNIDO, the Federal Republic of Germany and India the report must indicate which assistance is required respectively.

The commission includes collection and evaluation of project related data. In particular, the expertise covers

- project targets and justification
  -- situation of the synthetic fibres industry
  -- expectations of fibre manufacturers, fibre processors, raw material producers and SASMIRA
  -- ranking of envisaged services and priorities

- project tasks and services
  -- training
  -- research
  -- probable plant utilisation

- project implementation and operation
  -- equipment
  -- buildings
  -- utilities
  -- material inputs
  -- personnel
  -- time schedule and work plan

- project financing
  -- investments and operational costs
  -- probable revenues
  -- allocation of funds

- related project information
  -- organisation chart of SASMIRA after project integration
  -- current status and expected development of SASMIRA's finances
  -- eventual project extension for fibres processing

Operative Training Course in Melt Spinning and Yarn Engineering

Catalogue of Topics:

- Classification of the synthetic fibres and description of their characteristic properties
- Description of the polyamide and polyester fibres and filaments production processes
- Description of the plant sections for fibre and filament production, plant inspections and demonstrations
- Inputs for polyester and polyamide fibres and filaments production
- Description of the material flows of the various processes, economical utilisation of materials and energy, quality control
- Accident prevention measures and safety regulations
- Intensive practical training on the plant sections for extrusion, spinning, finishing, take-up, draw-twisting and texturising (draw texturising) for filaments
- Intensive practical training in texturising and the following operations
- Intensive practical training on the plant sections for extrusion, spinning, drawing, washing, drying, finishing, crimping and cutting of staple fibres
- Instruction on critical plant sections and discussion of plant operation from the viewpoints of economy and quality improvement

Practical training will be - as shown in the case of the course first mentioned - based on formulated tasks whose solution will necessitate the operation and control of individual plant sections under differing operating conditions. The work stages are to be recorded in production reports which allow a nominal/actual comparison of the specified and achieved data.

Operative Training Course in Utility Engineering

Catalogue of Topics:

- Classification of the synthetic fibres and description of their characteristic properties
- Description of the polyamide and polyester fibres and filaments production processes
- Description of the plant sections for fibre and filament production, plant inspections and demonstrations
- Inputs for polyester and polyamide fibres and filaments production
- Description of the material flow of the various processes, economical utilisation of materials and energy, quality control
- Accident prevention measures and safety regulations, handling of protective devises and equipment
- Operation and maintenance of utility equipment, pipelines and fittings (handling of valves and controls, connecting up pipelines, use of lifting tackle and materials handling equipment, operating and monitoring power transmission equipment)
- Intensive practical training on steam generators, diphenyl plant, process water supply system (ion exchanger), cooling water supply system, nitrogen purification and supply system, air conditioning, energy supply system
- Intensive practical training in spinning head cleaning and maintenance
- Instruction on critical points of the supply systems, preventive maintenance, plant observation (water quality)

Training must be as practice-orientated as possible, i.e., pure theory teaching will not be given. Descriptions of processes, quantities, materials and power flows should be given near plant to facilitate transferting instruction to practice. In this course also, the intensive practical training phase will include the solving of tasks by operating, maintaining and servicing these plant sections in question. Reports which show time and material consumption should be prepared for each task carried out.

Diploma Course in Man-Made Fibre Manufacturing

The timetable for the first three semesters of this course is identical with the present basic training stage of the "Diploma in Man-Made Textile Technology" (DMTT) courses[1]. The same combination of subjects is a prerequisite to state recognition by the BTE Maharashtra.

The chemotechnical training will be given during the 4th. to 6th.semesters, whereby the subjects of chemical engineering, fibre technology, polymer chemistry and process control will be emphasised. The scope and grouping of the individual courses during the last three semesters are shown in Table 9. Within the individual subjects shown there, the main fields of knowledge to be covered are as follows:

- Inorganic Chemistry
  - -- Atomic structure and periodic table
  - -- Electronic configuration of elements and properties based on it
  - -- Chemical bonding - ionic, covalent and covalent and co-ordinate bonds, dipole moment; hydrogen bonding, ionisation
  - -- General chemistry of important metals and non-metals
  - -- Practicals: Volumetric analysis; gravimetric analysis

- Organic Chemistry
  - -- Classification of organic compounds
  - -- Chemistry of aliphatic compounds
  - -- Chemistry and derivatives of alicyclic compounds and their derivatives
  - -- Chemistry of non-ionic compounds and their derivatives
  - -- Chemistry of hetrocyclic compounds such as pyridine, tiophene and furan
  - -- Chemistry of common industrial chemicals
  - -- Brief introduction to polymeric compounds
  - -- Introduction to chemistry, properties of natural fibres; cotton, wool and silk
  - -- Practicals: Purification of organic compounds. Identification of organic compounds. Separation of mixtures. Preparation of simple organic compounds

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1) For details cf. SASMIRA: Technical Education Programme in Man-Made Textiles, June 1972, pages 25 - 37

Table 9: Teaching Program for Diploma Course in Man-Made Fibre Manufacture, Semester 3 to 6[1]

Teaching Subject	Teaching Scheme[2]		Examination Marks	
	Lectures	Practicals	Theory	Practicals
4th Semester				
Inorganic Chemistry	3	3	100	50
Organic Chemistry	3	3	100	50
Physical Chemistry	3	3	100	50
Chemical Engineering I	4	4	100	100
Statistics	3	-	100	-
Economics of Man-Made Textile Industry	2	-	50	-
Total 4th Semester	18	13	550	250
5th Semester				
Polymer Chemistry I	4	4	100	100
Fibre Technology I	4	4	100	100
Chemical Engineering II	4	4	100	100
Industrial Organisation and Management	2	-	50	-
Total 5th Semester	14	12	350	300
6th Semester				
Polymer Chemistry II	4	4	100	100
Fibre Technology II	4	4	100	100
Instrumentation and Process Control	3	3	100	50
Industrial Engineering	3	-	50	-
Project Assignement	-	5	-	100
Total 6th Semester	14	16	450	350

1) Cf. Technical Education Programme in Man-made Textiles, SASMIRA's Institute of Man-made Textiles, June 1974, p.27-52

2) Number of lessons per week, each 45 min

- Physical Chemistry
  - -- Physical chemistry of gases, liquids and solids
  - -- Properties such as viscosity, optical activity, parachor with respect to molecular structure
  - -- Modern theories of acids, bases and pH and colloids
  - -- Laws of thermodynamics
  - -- Catalytic and photochemical reactions
  - -- Practicals: Experiments on reaction kinetics. Determination of viscosity, surface tension, refractive index, optical rotation

- Chemical Engineering I
  - -- Definition of unit operations, such as flow of fluids, mixing, filtration, centrifuging, distillation and absorption, adsorption, extraction, humidification and de-humidification, crystallisation and drying
  - -- Utilities: Treatment of water for various uses, introduction to different utilities
  - -- Practicals: Heat transfer and heat exchanges. Evaporation, distillation and drying. Agitation and extrsction. Water analysis

- Chemical Engineering II
  - -- Laws governing fluid flow. Methods of measurement of flow rate of fluids. Pipe fittings, pumps, blowers, compressors and vacuum pumps. Storage and handling of fluids
  - -- Heat transfer by conduction, convection, radiation and its application to various unit operations
  - -- Practicals: Flow of liquids and measurement of rate of flow; filters, compressors, blowers and pumps

- Polymer Chemistry I
  - -- Classification and composition of petroleum and its products
  - -- Roll of petrochemicals in fibre manufacture
  - -- Outline of manufacture of various monomers
  - -- Polymerisation process in general and formation of linear polymers; addition and condensation polymers; ring formation. Degree of polymerisation; molecular weight of polymers and length-bredth ratio of polymers; ionic and free radical polymerisation; effect of catalysts and inhibitors; chain termination; end group analysis; orientation and crystallinity of fibres, their influence on properties of fibres; chemical constitution and fibre properties
  - -- Practicals: Polymerisation process; analysis and identification of monomers

- Polymer Chemistry II
  - Degradation of polymers by thermal, mechanical, chemical and other agents
  - Melting of polymers, glass transition, temperature of polymers, cold flow, fibre formation, viscosity in molten state and in solution
  - Stereo-chemistry of polymers, structural study by various types of spectra
  - Relationship between polymer structure and chemical and physical properties; recent developments in synthetic fibres
  - Practicals: Determination of molecular weight of polymers; end-group analysis of polymers; melting point of polymers

- Fibre Technology I
  - Man-made fibre spinning operation, wet, dry and melt
  - Mechanism of formation of filaments by various spinning methods
  - Manufacture of regenerated cellulosic fibres and acetate rayons
  - Detailed manufacture of nylon 6
  - Practicals: Spinning process for nylon 6

- Fibre Technology II
  - Detailed manufacture of nylon 66 and polyethylene terephthalate
  - Outline of manufacture of other synthetic fibres such as acrylic, polyvinyl chloride, olefin, polyvinyl alcohol, polyurethane fibres
  - Introduction to glass fibres and metallic yarn
  - Drawing, heat-setting, finishing and winding of filaments
  - Staple fibre formation
  - Blending of staple fibres and spun yarn preparation
  - Texturising of filament yarn
  - Practicals: Introduction to operations covering the above topics

- Statistics

  - -- Histograms and frequency polygons; measures of location, mean, median, mode; measures of dispersion-range, mean deviation, standard deviation, coefficient of variation
  - -- Correlation: Lines of regression coefficient of correlation, theoretical frequency distributions - binominal poisson and normal populations and random samples tests of significance, 't' test for a single mean, comparison of two means; standard error, confidence intervals, 'z' test for comparing variance

- Economics of Man-Made Textile Industry

  - -- The meaning of economic law; demand and consumption, the law of diminishing utility
  - -- The factors in production and their combination, labour and natural agents, increasing and decreasing returns, capital, its influence and the condition of its accumulation
  - -- Interest and profits, causes of the rate of wages, general theory of the value of money, the value of foreign bills, principles of taxation
  - -- History and development of man-made fibres, development of man-made textile industry, with particular reference to India
  - -- History of tariff protection to man-made textile industry
  - -- Program of development under five year plan
  - -- Raw material position, production, consumption, import, export of man-made fibre and fabrics
  - -- Development of international trade in man-made fibre and fabrics, with particular refer›nce to India
  - -- Impact of man-made fibre and fabrics on consumption pattern of textile materials
  - -- Marketing of man-made fibres and fabrics in India

- Industrial Organisation and Management

  Definition of industrial organisation; types of organisation - advantages and disadvantages; definition of management; scope and functions; scientific management; principles of foremanship, task of foreman, place of foreman in industry; brief study of Factories Act; industrial psychology, personnel management and training industrial welfare; safety principles, common causes of accidents and their precaution; principles of textile costing; costing for control and budgeting; simple examples of calculation of cost per unit of production of yarn and cloth

- Instrumentation and Process Control
  - -- Instruments for measurement of process control variables, such as pressure, temperature, level flow, static characteristics of measuring instruments; record of process variables including transmission and indication
  - -- Modes of control; control valve section; working of pneumatic and electronic controllers
  - -- Control loop and its components; control system structure applicable to synthetic fibre manufacture; spinneret design
  - -- Practicals: Practicals will cover the above topics

- Industrial Engineering
  - -- Factors for locating a plant; principles of plant layout and material handling; advantages of good plant layout; organising an industrial engineering department; industrial engineering techniques for improving productivity in man-made textile industry; principles of job evaluation and merit rating; inspection and quality control, statistical quality control; operation research techniques; machine interference, linear programming and inventory control

- Project Assignment
  - -- Candidates are expected to submit a dissertation on a project pertaining to manufacturing process of fibre with review of appropriate literature

Certificate Course in Manufacture of Man-Made Fibres

The timetable for the two years of training which is shown in Table 10, reveals that about half of the time is for theoretical and practical training each:

Table 10: Teaching Program for Certificate Course in Man-Made Fibres

Teaching Subject	Teaching Scheme[1]	Examination Scheme Marks
First Year:		
General Chemistry	1	100
Polymer Chemistry I	1	100
Chemical Engineering	2	100
Laboratory Practice	4	100
Total First Year	8	400
Second Year:		
Polymer Chemistry II	1	100
Fibre Technology	2	100
Instrumentation and Process Control	1	100
Laboratory Practice	4	100
Total Second Year	8	400

1) Number of lessons of 45 min each per week

The mentioned branches of study comprise essentially the following subject matters:

- General Chemistry
  - -- Laboratory operations: Acidimetry, alkalimetry, element classification and periodic table; important metals and non-metals and compounds
  - -- Atomic structure: Theory of valency, chemistry of water and its analysis

- Polymer Chemistry I
  - -- Classification of organic compounds
  - -- Saturated and un-saturated hydro-carbons and derivatives
  - -- Aromatic hydrocarbons and derivatives
  - -- Introduction to hetrocyclic compounds

- Polymer Chemistry II
  - -- Fibre classification
  - -- Condensation and addition polymerisation
  - -- Chemical constitution and fibre properties
  - -- Degradation of polymers by various agents

- Chemical Engineering
  - -- Properties of steam, principles of boiler plants, tests for boilers
  - -- Materials of construction, metals, alloys, non-metals used in industry
  - -- Conveyance and storage of materials and their general principles
  - -- Flow of liquids, behaviour of metals with different chemicals, preservation of surfaces with coating
  - -- Principles of heat transfer and refrigeration as utilised in industry

- Laboratory Practice
  - -- Volumetric and gravimetric estimation
  - -- Identification of compounds and fibres
  - -- Introduction to simple operations involved in fibre manufacture

- Fibre Technology
  - -- Wet, dry and melt spinning operations
  - -- Manufacture of viscose rayon, acetate rayon, polyamide and polyester fibres
  - -- Filament and staple fibre formation
  - -- Drawing, heat-setting, finishing of filaments

The working program has been executed by

- Dr.rer.pol. Dieter Unverzagt
- Ing.grad.Egon Becherer
- Dipl.-Ing. Hans Jörg Kahlenberg

The authors visited Delhi, Bombay, Gaziabad, Modinagar, Kalyan, Poona, Madras, Baroda, Surat and Ahmedabad in May and June 1975. They also travelled to Montreal (Dupont), Vienna (UNIDO), Bonn (Fourné), Frankfurt (Zimmer), Stuttgart (Blaschke), and Berlin (K. Fischer) to update available data and collect additional information.

All figures (prices, costs) are stated in Rs (Indian Rupees), DM (German marks) or US $ (American Dollars). The conversion rates applied are 1 US $ = 2.30 DM and 1 DM = 3.30 Rs. Throughout the report the metric system has been used.

It is assumed that the basic data and results of the report "Demonstration Plant for the Production of Synthetic Fibres (Polyamid and Polyester) at the SASMIRA in Bombay/India" effected by FGU-KRONBERG in December 1973 are well known. Therefore, the current expertise deliberately omits general project information and background data.

The study group extends its gratitude to all those who supported their work by provision of data and participation in discussions.

- Instrumentation and Process Control
  - -- Measurement of temperature, pressure, level, flow, humidity
  - -- Indicating and recording instruments
  - -- Instruments and process control for fibre manuafacture

- Laboratory Practice
  - -- Plant operation, maintenance and quality control

Post Graduate Diploma Course in Man-Made Fibres Technology

The time planning of this specialisation course is indicated in Table 11. The teaching scheme clearly reveals the domination of the practically oriented teaching subjects.

Table 11: Teaching Program for Post Graduate Diploma Course in Man-Made Fibres Technology

Teaching Subject	Teaching Scheme		Examination Marks	
	Lectures	Practicals	Theory	Practicals
First Semester:				
Mathematics, Statistics & Design of Experiments	2	-	100	-
Economics of Man-Made Textile Industry	2	-	100	-
Physics of Man-Made Textiles	2	4	100	50
Chemistry of Raw Materials and Monomers	3	4	100	100
Chemistry of Polymers I	2	4	100	100
Chemistry and Technology of Man-Made Fibres I	2	4	100	-
	13	16	600	250
Second Semester:				
Industrial Organisation, Management and Marketing	3	-	100	-
Instrumentation and Process Control	3	3	100	50
Chemistry of Polymers II	2	3	100	50
Chemistry and Technology of Man-Made Fibres II	3	8	100	100
Manufacture of Man-Made Textiles	2	3	100	50
In-plant Training	-	3	-	100
	13	20	500	350

- Mathematics, Statistics and Design of Experiments
  - -- Mathematics and statistics: Simple, double, triple and line integrals; Stock's and Gaus' theorems; equation of heat flow; simple fourier series; solution of one dimensional unsteady and two dimensional steady state heat flow
  - -- Multiple correlations and determination of partial correlation coefficients; errors of correlation; significance of correlation coefficients; finite differences; different types of frequency curves and their application; analysis of periodic curves
  - -- Elementary probability errors and random aampling; sampling errors; test of significance for large and small samples; regression; analysis of variance; nomograms, interpolations of curves; utilisation of slide rules
  - -- Design of experiments: Analysis of variance (one way, two way and three way classification) with industrial applications; statistical qualification and control charts for mean and range

- Economics of Man-Made Textile Industry
  - -- History and development of man-made fibres; development of man-made textile industry in India
  - -- Tariff protection to man-made textile induatry
  - -- Program of development under five year plans
  - -- Economics involving raw material; production, consumption, import and export of man-made fibres fabrica
  - -- Development of international trade in man-made fibres and fabrics, with particular reference to India
  - -- Impact of man-made fibres and fabrics on conaumption pattern of textile materials
  - -- Marketing of man-made fibrea and fabrics
  - -- Impact of taxation on industry

- Physics of Man-Made Textiles
  - -- Gross and fine structure of natural as well as man-made fibres; structure of cellulose and protein fibres; crystalline and amorphous region; effect of fibre atructure on fibre properties
  - -- Mechanical properties: Tensile properties, elastic deformation and recovery, creep and relaxation, bending of fibres; shear modulus; creaae-recovery; impact phenomenon of textiles; abrasion resistance; stretching and ita effects; streas strain relation in textiles

-- Electrical properties: Dielectric constant; electrical resistance; static electricity; dipole moment

-- Thermal properties: Theory of heat transmission; transmission of heat and water vapour in textiles

-- Application of optics to textiles: Refractive index of fibres; polarisation of light and transmission of polarised light through crystals; briefringuence; dichroism; spherullites; scattering of light and its applications

-- Use of X-rays, electron microscope, polarising microscope and infra-red spectroscopy to study fibre structure; simple applications of nuclear physics to textiles

-- Practicals: Physical testing of man-made textiles

-- Testing of fibres and yarns; determination of staple length, denier and count of man-made fibres using torsion balance and vibrascope

-- Identification of various fibres using microscope

-- Determination of denier and count of man-made fibre - staple and filament yarns;tensile strength of yarns; turns per unit length; eveness of yarns by Seriplane and Uster Eveness Tester; moisture regain

-- ISI specification and BISFA rules for grading of rayon yarns

-- Testing of man-made fibre fabrics: Ends and picks; identification of warp and weft yarns; crimp of warp and weft; weight; thickness; tensile strength; bursting strength; stiffness; abrasion resistance; crease-recovery angle; air permeability and thermal conductivity

- Chemistry of Raw Materials and Monomers

  -- Chemistry and properties of natural fibres, cotton, wool and silk; chemistry of cellulose; selection and preparation of wood pulp for regenerated cellulosic fibres; cotton linters for pulp preparation; introduction to auxiliary chemicals such as sodium hydroxide, carbon disulphide, sulphuric acid, titanium dioxide, zinc sulphate, copper sulphate, ammonia, acetic acid, acetic anhydride

  -- Role of petrochemicals in synthetic fibres; monomer preparations for different synthetic fibres; manufacture of caprolactam, hexamethylene diamine, adipic acid, ethylene glycol, dimethyl- terephthalate; introduction to monomers for acrylic, polyvinyl alcohol, polyvinyl chloride, polyolefine and other fibres

  -- Practicals: Practicals cover identification and analysis of monomers and raw materials

- Chemistry of Polymers I
  - -- Polymerisation process and formation of linear polymers; addition and condensation of polymers; ring formation; degree of polymerisation; molecular weight and length - breadth ratio of polymers; ionic and free radical polymerisation; mechanism of polymerisation; reactions; effect of catalysts and inhibitors; chain termination; group analysis; orientation and crystallinity of fibres, their influence on properties of fibres; chemical constitution and fibre properties; formation of graft-copolymers
  - -- Practicals: Determination of molecular weight of polymers; melting point of polymers; end-group analysis of polymers

- Industrial Organisation, Management and Marketing
  - -- Management: Structure and size of industry or business; types of business organisations; joint stock company; partnership, sole trader and other types of combinations
  - -- Management of large-scale industrial concerns; line and functional organisation; delegation of functions; recruitment of staff; promotion of staff
  - -- Principles of marketing; purchase, sales and stores; efficiency, finance, planning, control, etc. taking into consideration management in scientific concerns(especially textile mills) and improvement in productivity
  - -- Communication of ideas and collection and interpretation of data in industrial administration
  - -- Direct and indirect expenses; selling, purchase and distribution expenses; premium or bonus system; idle time; fixed and variable expenses; methods of costing and recording; graphic methods; principles of budgetory control
  - -- Principles of work-study and its application in man-made textile industry; job evaluation and merit rating; planning and progress
  - -- Factory Act; training of workers; prevential of industrial hazards; prevention of breakdowns, and maintenance; trade union activities and compensation laws; industrial psychology and personnel welfare

- Instrumentation and Process Control
  - -- Instruments for measurement of process control variables, such as pressure, temperature, level flow, static characteristics of measuring instruments; record of process variables including transmission and indication
  - -- Modes of control; control valve selection; working of pneumatic electronic controllers

-- Control loop and its components; control system structure applicable to synthetic fibre manufacture

-- Application of Indian and international standards and codes of practice for pressure vessels, storage tanks, lined vessels and pipe flanges

-- Practicals: Practicals will cover the above topics

- Chemistry of Polymers II

  -- Degradation of polymers by thermal, mechanical, chemical and other agencies

  -- Melting of polymers, glass transition, temperature of polymers, cold flow, fibre formation, viscosity in molten state and in solution

  -- Stereo-chemistry of polymers structural study by various types of spectre

  -- Relationship between polymer structure and chemical and physical properties; recent developments in synthetic fibres

  -- Homopolymerisation and copolymerisation reactions; mechanism of copolymerisation; polymers resistant to high temperatures; other speciality fibres; blending of polymers; linear polymers as substitute for metals

  -- Practicals: Degradation of polymers, spectral analysis of polymers

- Chemistry and Technology of Man-Made Fibres I

  -- Classification

  -- Spinning operations such as wet, dry and melt spinning; fundamental aspects of wet and dry spinning operation

  -- Manufacture, constitution, properties and uses of regenerated cellulosic fibres such as viscose and cuprammonium rayon, modified and high tenacity rayons, cellulose acetate rayons

  -- Spinning baths for ordinary and modified rayons

  -- Delustering and dope dyeing of regenerated cellulosic fibres

  -- New technology developments in regenerated cellulosic fibre manufacture

- Chemistry and Technology of Man-Made Fibres II
  - -- Fundamental aspects of melt spinning operation; manufacture, constitution, properties and uses of polyamide, polyester and polyacrylonitrile, polyvinyl alcohol, polyvinylchloride, polyolefin and other synthetic fibres
  - -- Manufacture of bicomponent and biconstituent fibres; manufacture of fibres with non-circular cross-sections, delustering and dope dyeing of synthetic fibres
  - -- Introduction to glass fibres and metallic yarns
  - -- Drawing, heat-setting, finishing and winding of filaments; staple fibre formation

- Manufacture of Man-Made Textiles
  - -- Manufacture of spun yarns and blends of man-made fibres; importance of staple length and denier of man-made fibres; conditioning and static problems with man-made fibres and blends
  - -- Preparatory process for weaving; importance of tensile, humidity and static control for various man-made fibres
  - -- Manufacture of bulk and stretch yarns; introduction to weaving of fabrics from man-made filaments, spun yarns, blended and stretch yarns
  - -- Fabric structure and cloth construction; industrial and special fabric production; brief introduction to knitting
  - -- Practicals: Practicals will cover the above topics

- In-plant Training
  - -- Maintenance, quality control and plant layout

2.1.2.2. Personnel

The fundamental subjects which are to be taught during the first three semesters of the diploma courses can be intergrated into the SASMIRA's present teaching program and taken over by the existent staff.

Further teaching staff - a total of eight - will however have to be engaged for the practice-orientated subjects in the 4th to 6th semesters of these courses and the corresponding subjects of the certificate courses, post graduate courses and operators' training. The subjects in question are

- Chemical Engineering I and II
- Polymer Engineering I and II
- Fibre Technology I and II
- Instrumentation and Process Control

Seven teachers for the above-mentioned subjects will be required to have a certain experience of teaching and above all practical experience in fibre chemistry and fibre manufacturing. A professor of chemistry and technology of man-made fibres should be responsible for teaching activities within the future Fibres Division of SASMIRA.

These new instructors are to fulfil the following functions:

- Head of Technical Education Department (Professor)
- Assistant Professor in Polymer Chemistry
- Lecturer in Fibre Chemistry
- Lecturer in Chemical Engineering
- Lecturer in Engineering
- Assistant Lecturer in Chemistry
- Assistant Lecturer in Engineering
- Lecturer in Fibre Physics

One of the lecturers should act as course manager for the four or five courses (one Operative Training Course, one or two years of the Diploma Course, one Post Graduate Diploma Course, and one Certificate Course) which are simultaneously held during a semester. The assistant lecturers should be alternatively appointed to assist the manager of the Operative Training Course.

All teaching staff will assist in the preparation and performance of the tailor-made courses at management level, which are to be arranged on instructions from the Head of Technical Education.

The lecturers and the assistant professor will give lectures and practical courses, and will prepare practical tasks along guidelines given by the Head of the Technical Education Section. The assistant lecturers will supervise performance of the practical tasks in their field at the demonstration plant. They should also check the results on the basis of the reports prepared by the students. The assistant lecturers should suggest inprovements in the practical tasks to the lecturers.

The assistant lecturers will support the lecturers and the assistant professor in the formulation and preparation of practice tasks and lectures (for example, assist in preparing seminar papers).

The following requirements will be made on the key figure in the Technical Education Section, the Section Head, Technical Education, who will carry out the functions given below:

<u>Section Head Technical Education</u>

Educational background:
- PhD in Chemistry and Technology of Man-made Fibres with 5 years experience in teaching or research

Main functions:
- Coordination of all technical education and with the research and production section
- Planning of plant utilisation for technical training
- Detailed scheduling of all courses (time tables, topics)
- Interviewing and selecting cacidates for training
- Teaching
- Asigning the staff to individual training subjetcs
- Recruiting partime instructors
- Supervision of all technical education
- Evaluation of students performance
- Participation in lectures, seminars and group meetings
- Contribution of articles in publications
- Survey of literature and disseminations of information to staff members
- Organisation and supervision of laboratory work
- Procurement of instruments, chemicals and other items required for research

He will be responsible for an assistant professor being his deputy, four lecturers and two assistant lecturers.

The deputy section head should have a degree in polymer chemistry and experience in teaching or research. He will have to assist in all functions mentioned for the section head and teach his subject as the lecturers do.

Lecturers

Educational background:
- Post graduate (MSc) or chemical engineer degree with teaching experience

Main functions:
- Teaching
- Elaboration and performance of the practical assignments
- Participation in seminars and expert group meetings
- Contribution of articles in publications

Assistant Lecturers

Educational background:
- Fresh graduates (BSc) or even MSc

Functions:
- Assistance to lecturers in tutorial and practical work

2.1.2.3. Plant Utilisation

The plant operating hours which are available for training purposes will be mainly utilised for operator training. This is to be given during the morning, five days per week, throughout the year. With four hours of practical training per day, the annual total for the plant is 960 operating hours.

The afternoon will be reserved for the course at the supervisory and management levels and for broadening textiles engineering training. The total number of hours of plant utilisation will approximate the figure for operator training (cf. Fig. 1 and 2).

Summary

1. India's fibre industry which represents the background to the SASMIRA project did considerably expand during the last two years.

Now a nylon capacity of 24,780 tons/year is installed and letters of intent for further 35,010 tons/year are issued. The polyester fibre capacity amounts to 27,020 tons/year, mainly for staple fibres. Licences and letters of intent are issued for further 43,000 tons/year.

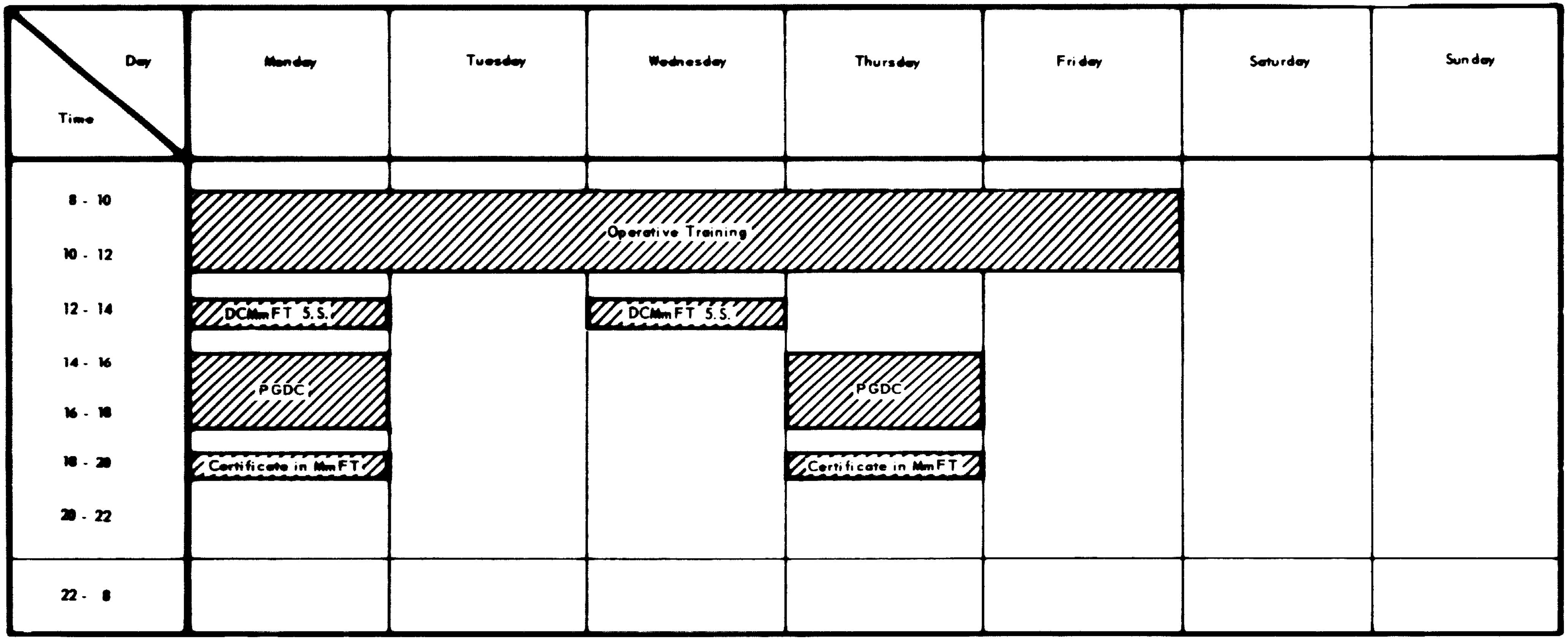
Raw materials are being produced now in the country with capacities of 24,000 tons/year of DMT and 20,000 tons/year of caprolactam. The latter unit being still in its starting phase. Letters of intent are granted for further 50,000 tons/year caprolactam and 63,000 tons/year DMT. The existing units will be able to supply most of the present maximum demand, the licensed capacities will secure raw material supplies in the long run.

2. Fibre manufacturers, processors, raw material producers and SASMIRA confirmed the need of a demonstration plant for fibre production. Training of supervisors and superintendents, management courses and operator courses are regarded as most important project tasks followed by applied research works. Technical and advisory services rank well behind this tasks.

3. Larger fibre manufacturers are mainly in favour of the training of middle management staff where a fluctuation of about 3 to 5 % requires in average replacements of at least one middle management employee in each of the existing fibre plants. Operators training in these companies is mainly effected by on the job training. Smaller fibre units also stress operators training too since they hardly can afford to provide the facilities necessary for the in-plant training. Both groups are equally much interested in short term management courses.

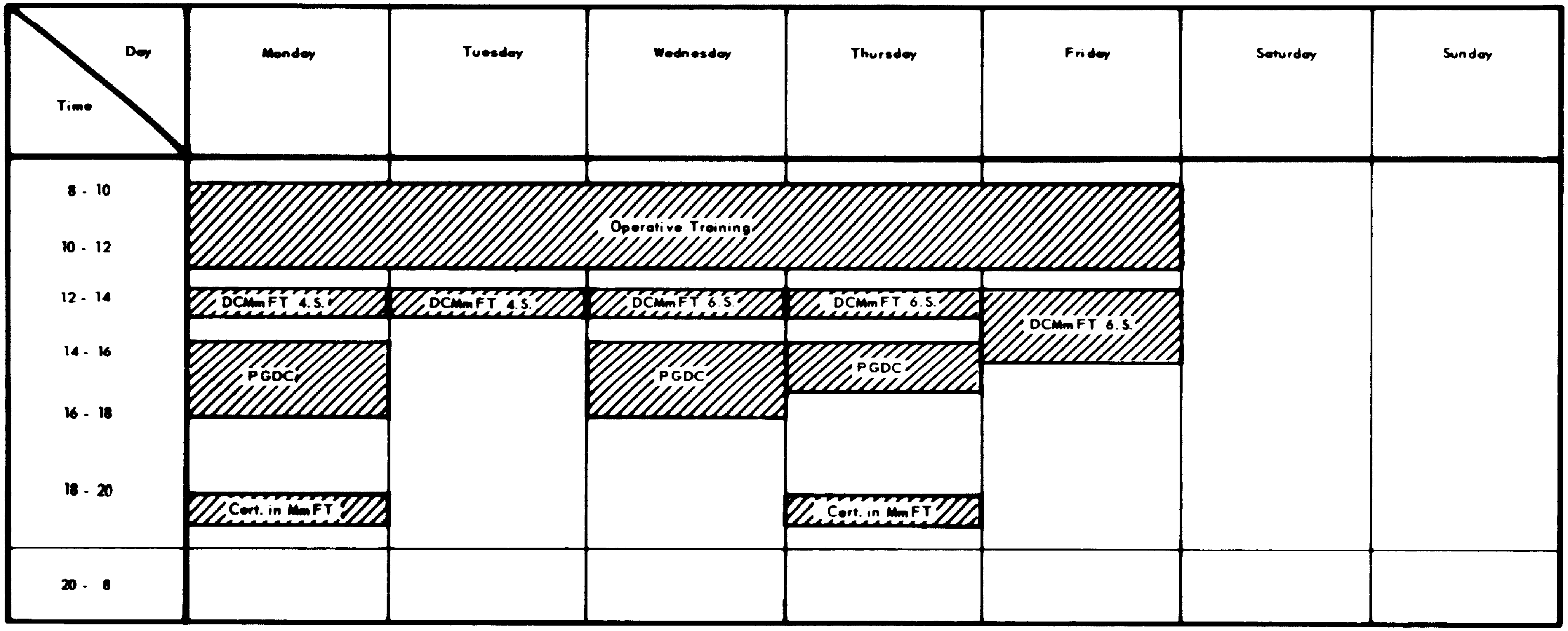
4. Almost the same structure of interests and expectations exist with the fibre processors. Middle management training and courses for upper management rank first in priority. Their technical interest concentrates in the textile stages of fibre production as well as in equipment engineering in all stages of yarn fabrication. Their demands for operators are relatively small and limited to the yarn engineering processes within the fibre plant.

Fig. 1: Tentative Training Schedule during Summer Semester



DCMmFT 5. S. = Diploma Course in Man-made Fibre Technology, 5.th Semester
PGDC = Post Graduate Diploma Course in Man-made Fibre Technology
Cert. in MmFT = Certificate Course in Man-made Fibre Technology

Fig. 2: Tentative Training Schedule during Winter Semester



DCMmFT 4. S. = Diploma Course in Man-made Fibre Technology, 4.th Semester
PGDC = Post Graduate Diploma Course in Man-made Fibre Technology
Cert.in MmFT = Certificate Course in Man-made Fibre Technology

The grand total of plant operating hours which will be needed for training purposes will therefore be roughly 2000 hours/year (cf.Table 12). This figure includes an allowance of 20 hours/year for the tailor-made courses which will be held when necessary.

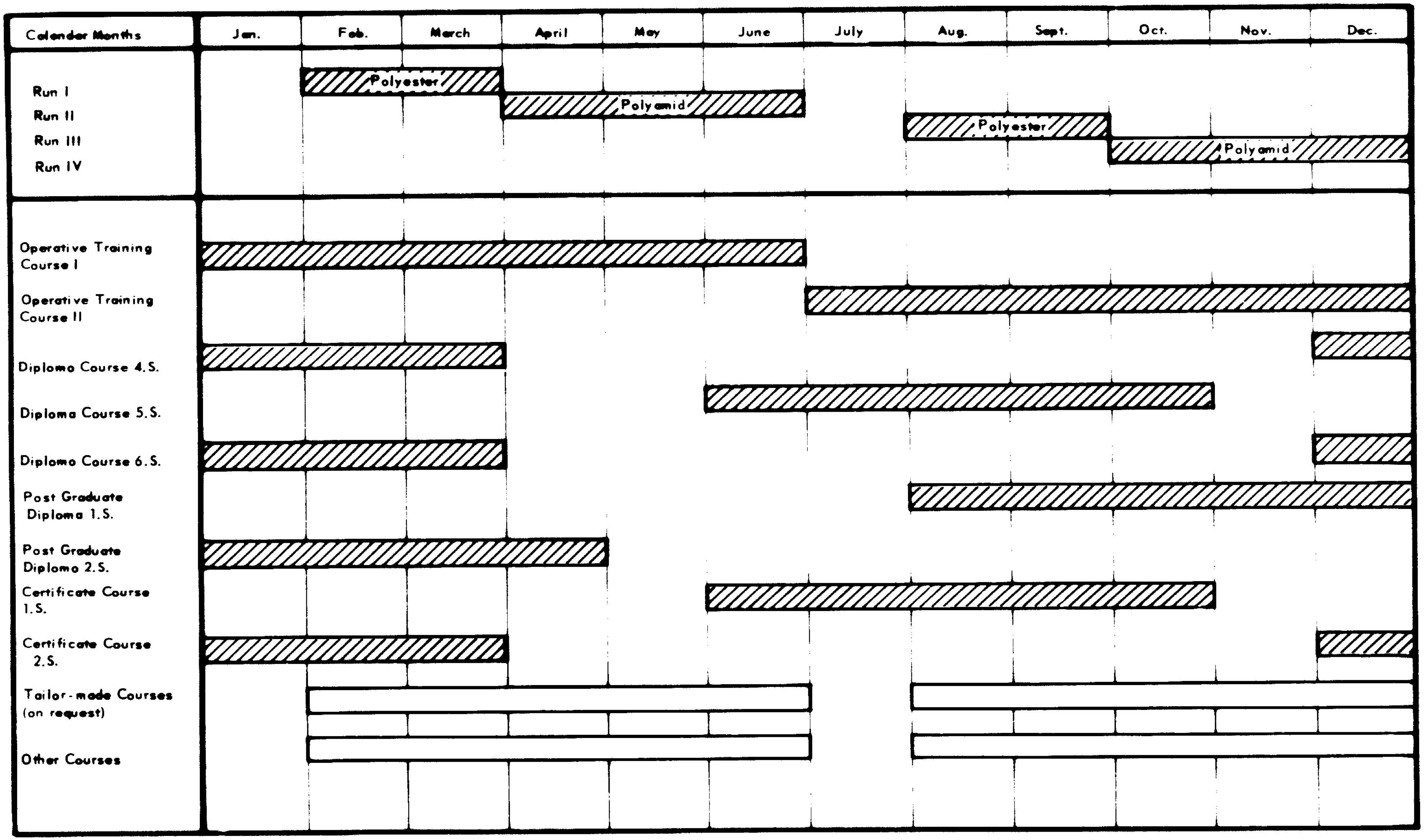
Also included is plant down time, during which plant maintenance and, if necessary, also repair measures can be taught and demonstrated. The down time should be halved, for example, 30 days each in January and July, in order to be able to offer both semesters of a year demonstrations. Further short periods of down time will result from switching over from polyester to polyamide, this being foreseen once in each semester (cf. Fig,3). The intention behind changing the product only once per semester is to obtain relatively long running times for each product and thus achieve relatively uniform product quality. Also desired is that each student sees the changeover work and the production processes of the two products.

The teaching program leaves some weekdays, the weekends and the evening and night hours open. These hours may be used for other project tasks, e.g., research work if the unusual daytime does not create personnel problems. In addition, one should - at least as a long-term aim - attempt to achieve the greatest possible degree of overlapping of training and research acitivities, for example, by flexibility in selecting the subjects of practice tasks.

Table 12: Tentative Plant Utilisation for Training Purposes

Training Course	Number	Duration		Semester	Training Hours per Week	Total Plant Utilisation hours/year
		Months	Weeks			
Operative Training Course I	1	6		-	20	480
Operative Training Course II	1	6		-	20	480
Diploma Course in Man-made Fibre Technology	1					
4th. Semester		5		Winter	4	80
5th. Semester		4		Summer	4	64
6th. Semester		5		Winter	8	160
Post Graduate Diploma Man-made fibre Technology	1	5 4		Winter Summer	11 8	220 128
Certificate Course in Man-made Fibre Technology	1	5 4		Winter Summer	4 4	80 64
Tailor-made Courses	5		2	-	2	20
Existing Courses	45		1	-	4	180
Total						1,956

Fig. 3: Tentative Annual Schedule of Plant Utilisation for Training Purposes



2.2. Research

As jointly expected by fibre manufacturers, fibre processors, raw material producers and SASMIRA research is the second of the main tasks to be performed by the pilot plant. This function covers both applied research activities in the fields of polymerisation, spinning, filament and staple fibre processing as well as technical and advisory services to fibre manufacturers and processors, but also to raw material producers and other institutions. Most research work can be either executed on a sponsored or an independent basis.

2.2.1. Applied Research Activities

The applied research work comprises polyamide and polyester still being the most important products for the Indian synthetic fibres industry. Need for outside research not only exists with fibre manufacturers and equally with fibre processors but in addition with caprolactam and DMT producers.

2.2.1.1. Polymerisation

In the field of polymerisation sponsored and independent research will be required by fibre manufacturers as well as by raw material producers. Separated investigations for polyamide and polyester might predominantly include

- grading of raw materials for standardisation
- comparative evaluation of existing as well as new imported and indigeneous monomers
- finalising of polymerisation conditions such as temperature, pressure, nitrogen, water, catalysts, time
- utilisation of adequate terminators for polymerisation reaction
- comparative evaluation of existing as well as new imported and indigeneous chemicals such as terminators, catalysts and additives
- use of different types of catalysts and stabilizers
- modifications by copolymerisation and by suitable additives
- coloration by dope dyeing

- delustering of fibres at the polymerisation stage
- extrusion of polymerisation melt in suitable form such as chips and pellets
- evaluation of economic aspects (quantity, quality, cost) with respect of variables as well as chemicals used in the process
- assessment of unreacted monomers to evaluate the efficiency of the polymerisation reaction
- recovery of monomers for reutilisation
- drying of polymer chips
- quality control and maintenance at all stages of polymerisation
- equipment and instrumentation assessment

The research examples for filament, staple fibre and tire cord production will generate results in the field of product development for raw industrial producers and in the field of raw material processing for fibre manufacturers.

2.2.1.2. Spinning

Applied research in spinning will mainly be needed by fibre manufacturers, to a considerably lesser extent by raw material producers. It again covers filament, staple fibre and tire cord of polyamide or polyester. Sponsored and independent research activities might comprise

- effect and standardisation of variables such as temperature, time, utilisation of nitrogen, speed and filtration
- addition of delusterant
- coloration by dope dyeing
- comparative evaluation of extruder systems
- control of filament cooling systems
- mechanical modification of fibres such as number of filaments, cross section and surface
- investigation of spinning of polymer mixtures
- development of economic nylon carpet yarns
- quality control and maintenance at various spinning stages
- equipment and instrumentation assessment
- evaluation of economic aspects with respect to various stages of spinning operation
- estimation of waste percentage and reutilisation of waste

2.2.1.3. Filament and Staple Fibre Processing

Independent and sponsored research in processing will be overwhelmingly done for fibre manufacturers, but to some degree for raw material producers and fibre processors, too.

For filaments (textiles and tire cord) major research assignments might be:

- Filament winding and storing
- Effect and standardisation of variables such as temperature, humidity, speed, tension, time, twisting and drawing
- Effect and standardisation of the draw ratio, with respect to ultimate property (product quality)
- Evaluation and standardisation of spin finish application (antistatic, lubricating)
- Comparative evaluation of existing as well as new imported and indigeneous spin finishes
- Investigation and standardisation of texturising process variables
- Standardisation of heat setting at different stages
- Standardisation of winding operations and cone sizes
- Quality control and maintenance at all processing stages
- Equipment and instrumentation assessment
- Evaluation of economic aspects with respect to various stages of processing
- Estimation of waste percentage at different stages and reutilisation of waste

With regard to staple fibre processing important research items might be:

- Effect and standardisation of variables such as speed, drawing, tow size, denier, crimping, setting and cutting
- Evaluation and standardisation of preparation and finishing (antistatic, lubricating)
- Quality control and maintenance at all processing stages
- Equipment and instrumentation assessment
- Evaluation of economic aspects with respect to various stages of processing
- Estimation of waste percentage at different stages and reutilisation of waste

As far as new products are concerned typical research measures might be:

- Development of blends of different permutations and combinations
- Filament and staple fibre blending (i.e., cor spun yarn)

2.2.2. Technical and Advisory Services

In most cases applied research activities and technical as well as advisory services will be closely connected. To achieve meaningful results they can only be performed jointly. Therefore exclusively such services shall be indicated which are not at all or solely to a small extent connected to applied research. Moreover, all services already performed by SASMIRA with existing facilities and all general information services will not be mentioned.

Technical and advisory services will be rendered to fibre manufacturers, fibre processors, raw material producers and other institutions such as equipment suppliers, ancillary industries, commerce and government institutions.

2.2.2.1. Fibre Manufacturers

Services to fibre manufacturers might include:

- Process fault detecting and investigation at all stages of production
- Assistance in improving the production process with respect to equipment, buildings, utilities and instrumentation
- Assistance in production planning and material handling
- Equipment efficiency evaluation
- Assistance in maintenance planning and execution as well as in waste reduction
- Assistance in improving in-plant training activities
- Assistance in utilising workshop facilities
- Assistance in improving quality and production control
- Assistance in recruiting technical personnel
- Assistance in processing spare parts and raw material
- Assistance in organising in-plant training programs
- Assistance in providing technical services to fibre processors
- Assistance in dispute settling
- Trouble shooting by accepting ad-hoc assignments

2.2.2.2. Fibre Processors

Services to fibre processors might comprise:

- Location of defects with respect to fibre production and raw material
- Assistance in improving the use of existing and newly acquired equipment
- Assistance in various fibre processing stages such as tension control, heat setting, dyeing, preparating, weaving, knitting and texturising
- Assistance in quality assessment of fibre and yarn
- Assistance in producing blended yarns
- Assistance in dispute settling

2.2.2.3. Raw Material Producers

Services to raw material producers might be:

- Assistance in providing technical services to fibre manufacturers
- Assistance in quality control
- Assistance in performing specific R & D activities
- Assistance in dispute settling

2.2.2.4. Other Institutions

Services to indirectly interested institutions in polyamide and polyester production, such as machinery and equipment manufacturers, ancillary industries, trade ministries, taxation and customs departments, Textile Commissioners Office, consulting and engineering companies as well as occasionally research institutions will probably include:

- Assistance in determination and specification of equipment and spare parts
- Assistance in determining quantity and quality of demand for auxiliaries, chemicals and dyes
- Assistance in acquiring technical personnel for equipment and ancillary manufacturers
- Advise on determining appropriate measures regarding import substitution, taxation and licensing
- Dissemination of data on product properties and characteristics

5. The raw material producers are not greatly interested in the training of operators and supervisors because of the different production technology. There is, however, an interest in management courses on specific topics. SASMIRA confirmed the need for training activities using a semi-commercial pilot plant.

6. Fibre manufacturers place fundamental interest in the foreseen research and development work. The larger ones consider themselves as being capable to solve production difficulties and simpler development problems themselves. They expect SASMIRA to supply the basis for further development work in their own laboratories and to introduce more modern production technologies into India's industry. Smaller fibre producers, equally interested in new products development require that the results of such work must be transferable into production without much additional development work in their own plant. They further advocate that also production problems in the standard range should be investigated.

7. Fibre processors consider research activities to be very important They stress the activities here should be concentrated on quality improvement of fibre and yarn as well as quality standardisation. In this regard SASMIRA should function as an impartial communication center between fibre producers and processors. Besides this activity the field of product development , i.e. the extension of applicational fields for fibres and filaments, cost reduction and rationalisation and also equipment engineering covering maintenance and design problems should form an important part of SASMIRA's applied research activities.

8. Raw Material producers would probably use the future research capacity of SASMIRA only in exceptional cases, for instance in boarder line cases with technical service problems. SASMIRA expects the applied research activities to cover the full range of possible problems in all manufacturing stages from polymerisation to filament and fibre processing. It expects a total of about 100 to 130 research requests, out of which 80 to 100 may be directed towards the fibre manufacturing industry, the remaining requests coming from fibre processors and raw material producers.

9. The technical and advisory services are not regarded to have priority among the project tasks. This activity should be kept for a later stage when SASMIRA already has gathered substantial production know how exceeding the present state of art of the Indian fibre producers.

2.2.3. Operation

Scope and organisation of executing applied research activities as well as technical and advisory services vary to some degree if they are sponsored assignments or independent SASMIRA research targets.

Aside from training and production personnel specific staff has to be nominated for research positions.

2.2.3.1. Sponsored and Independent Research

The scope of the expected research tasks as outlined above covers all future fields of endeavour of SASMIRA from polymer production to textiles production. These fields of activities should be covered in individual steps in which the tasks are as closely defined as possible, in order to quickly obtain results which can be utilised in practice.

In the case of sponsored research, the problems of these individual tasks will be outlined by the sponsors. SASMIRA's tasks will be to transform such problem descriptions into a feasible working program. This will necessitate the clear formulation of the task, indication of possible approaches to the solution, and a description of the potentially most successful approach stating the timing and logical sequence of the individual steps.

As sponsored research is to be carried out on a non-profit-making basis, the formulation of the task will simultaneously serve as a basis for the quotation and contract, which must be completed by costing.

The research staff of the future Fibres Division will have to prepare detailed work programs for the individual work stations. These work programs must contain all necessary data for the performance of the experiments. They could take the same form as the tasks set in operators training. It may however be necessary under certain circumstances to describe the operating conditions and formulations in greater detail, giving all known and necessary data. Also to be specified is a schematic which will allows recording and monitoring to ensure that the given experimental conditions are observed.

Performance of the experiments will be responsibility of the establishment staff of the pilot plant. The responsible Scientific Officer should supervise the work or, if the task allows, a Technical Assistant of the Research Department of the future Fibres Division.

Experimental products will be tested in SASMIRA laboratories, which will receive additional equipment for this purpose and for continuous monitoring of pilot plant functioning.

The evaluation of experimental results, the formulation of further experiments and the preparation of project reports from the experimental reports and subsequent testing will be mainly tasks for the future departmental management.

The results of sponsored research may only be made available to the sponsor, because the sponsor bears the costs. This requirement is the main prerequisite to successful sponsonsored research, and SASMIRA will during the course of project work have to prove that it can guarantee fulfilment of this condition. The industry has doubts concerning this;such doubts can only be broken down slowly, by practical proof.

SASMIRA has considerably more freedom in performing independent research tasks, as strict confidentiality need not be observed. Formulating these research activities is the task of SASMIRA itself; problems which SASMIRA knows to be of general interest are selected.SASMIRA will be able to do this because of communication with its member firms during the course of its previous work, the planned sponsored research, colloquia, seminars and also because of the planned management training.

The processing of independent research tasks will be similar to that in sponsored research, but without the quotation and contract formulation stages. Costing and cost auditing should however be carried out in order to be able to estimate the cost/benefit relationship and, above all, to gather experience in costing for sponsored research. A prerequisite will be efficient documentation of such cost data.

The results of independent research are to be made available to all member firms of SASMIRA free of charge; other interested agencies and firms could also be given access to the results against payment. This would necessitate publication of the research subjects and possibly extracts from the results in "MAN-MADE Textiles in India", an official organ of SASMIRA. Detailed publications in technical journals will also be advisable in individual cases.

SASMIRA should endeavour to carry out research of general interest, the results of which will be made available to all.

2.2.3.2. Personnel

All research activities including technical and advisory services will be the responsibility of the research section within the Fibre Division.

The Research Section will be leaded by a scientist with either a PhD-degree in chemical engineering or polymer chemistry and at least five years experience in research, teaching or industry. He will be responsible for one scientist being his deputy, two senior scientific officers and four technical assistants.

Main functions of the Research Section Head will be:

- Coordination of all research and advisory activities within the research section and with the training and production section
- Identification of independent research tasks
- Planning of plant utilisation for sponsored and independent research activities
- Planning of performing technical and advisory services
- Detailed planning of job sequences for individual research tasks and for advisory activities

- Instruction of section personnel in executing research and advisory assignments
- Supervision of research and advisory work
- Control of research performance and results as well as of technical and advisory functions
- Editing of research reports and of advisory recommendations
- Performing of complex research and advisory jobs or at least parttime participation
- Revue of related research publications and participation in seminars
- Procurement of instruments, chemicals and other items required for research

The deputy section head should have PhD-degree in chemical engineering or polymer chemistry and at least three years of professional experience. If fibre research is the specific field of the section head his deputy should specialise in raw material research and vice versa. He will mainly determine the various steps to perform a given assignment. His responsibility will be to appoint project related teams of senior scientific officers and technical assistants. In executing difficult research or advisory jobs he will participate. He will control the individual results and write the final reports. Finally he will train the senior scientific officers and the technical assistants.

One senior scientific officer will be the assistant for fibre research, the other for raw material research. Both will have a BSc in chemical engineering or polymer chemistry and several years of practical experience.

To each senior scientific officer two technical assistants will be attached. They should at least have a BSc degree in chemistry.

This staffing and assignment of functions results in the organisation of the Research Section:

Research Section Head (Scientist)	1
Deputy Head (Scientist)	1
Senior Scientific Officers	2
Technical Assistants (Technicians)	4

2.2.3.3. Plant Utilisation

The utilisation of the pilot plant for research purposes will be determined by a large number of factors. Among the primary determinants will be the number of research tasks to be processed each year. Excessively large fluctuations can be avoided by a variable ratio between sponsored and independent research tasks. A further determinant is the research subject itself, which will make differing plant utilisation necessary. One can in principle assume that experiments in melt spinning and the following plant sections will take longer than experiments in the polymerisation process: polymerisation experiments can usually be carried out within a day (the total throughput time of a batch is longer, but the polymerisation plant is available for the following batch one day later at the latest). Melt spinning experiments must however frequently be continued for several days to achieve larger quantities of a uniform quality.

The relative utilisation of the individual plant sections will be determined by the problem to be solved and the scope of the problem. Unlike the total number of research projects, it cannot be readily influenced.

As a consequence, time requirements for research activities and the resultant plant utilisation cannot be forecast in advance. If one however assumes 100 research assignments per year and an average experimenting time of only 1 day, the minimum plant operating time for research purpose will be between 2,000 and 2,400 hours per year.

In practice,utilisation of the plant for research purposes will have to be planned in from case to case. Utilisation of the plant for teaching purposes and the times of day set limits for time scheduling which can only be broadened by effective coordination. It will be necessary to combine teaching and research tasks by varying the tasks set in the teaching sector as far as is possible without infringing the requirement of confidentiality and as far as is justified by the level of knowledge of the course participants. It may also be necessary to run experiments during the evening or night hours.

2.3. Probable Total Plant Utilisation

2.3.1. Training, Research and Production

The synthetic fibres production process makes it necessary to operate the melt spinning plant in three shifts over long periods. The polymerisation plant, which has a discontinuous mode of operation and can therefore be shut down at any time, must harmonise with this requirement, unless purchased polymer is to be spun. This possibility is ignored in the discussion of plant utilisation.

Figure 3 (Chapter 2.1.2.3.) shows that the pilot plant will have to be operated for at least 10 months per year for teaching purposes, and closed down twice per year to demonstrate and carry out maintenance measures. From this planning, one arrives at an annual plant operating time of at least 7,200 hours which can if necessary be extended to a maximum of about 8,000 hours per year if the semi-annual maintenance periods are shortened.

Some 2,000 hours of plant operating time (1,956 hours/year = 28 % of total hours) are reserved for training purposes. The remaining plant operating time is available for research and production on a modest scale; for both purposes, a total of about 5,200 hours/year, or some 6,000 hours/year if the plant is run whilst the students are on holiday.

Of these hours, some 3,700 lie between 8 p.m. and 8 a.m., and a further approx. 600 hours/year on Sundays.There is therefore a total of about 4,300 hours/year during which the plant must be run mainly for operational reasons. Training activities during these times are not possible; research work could be carried out, but may probably be the exception. During most of this time, it will be possible to manufacture marketable filament qualities under almost industrial conditions. Sales of these products could contribute towards meeting the high plant operating costs which result from raw material prices.

The following very roughly estimated distribution of plant utilisation can be determined from the difference between this operating time component and the operating hours for training purposes:

approx. 2,000 operating hours/year for teaching purposes
approx. 2,000 operating hours/year for research purposes
approx. 4,000 operating hours/year for production

approx. 8,000 total operating hours/year

One must remember in this connection that only the training hours can be forecast with any degree of accuracy, and that the division of the remaining time between production and research is highly variable.

2.3.2. Organisation

The SASMIRA plans to establish a new department, "Fibres Division", to implement the project. In view of its size and significance, this will become SASMIRA's most important department. Its position within the organisation is characterised by the fact that the future divisional head will also be deputy director of the institute.

The Head of the Fibres Division will be the Pilot Plant Manager. His main functions are:

A. During erection period

- Participation in evaluating offers for pilot plant equipment
- Participation in finalising plant and building layout
- Participation in selecting plant erection contractors
- Assistance in detailed plant engineering
- Participation in selecting utility installations
- Continuous follow up of the building and plant erection
- Participation in all phases of plant commissioning
- Participation in recruiting section heads and key personnel
- Detailed planning of main divisional operations for the first year and preparation of the frameworks for divisional activities in the next three to five years
- Elaboration of a manual of operating regulations

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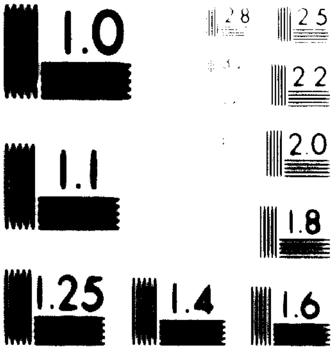

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Chips production equipment

- **Transesterification and precondensation for polyester**

  1 glycol measuring vessel

  1 transesterification autoclave, heatable with reflux column, methanol condensor, stirrer, feeding devices and provisions for taking samples to control reaction progress

  1 methanol collecting vessel with internal cooling pipes

  1 scale for DMT, caprolactam or AH-salt-dosage, 0 - 250 kg

- **Lactam preparation**

  1 lactam melting vessel

  1 melt filter

- **Dull preparation and catalyst dosing**

  3 preparation tanks for additives and catalysts

  1 dull preparation vessel with jet stirrer, steam heating jacket

  1 colloid mill for TiO_2-mixing

  1 filter

  1 storage vessel for TiO_2-suspension with stirrer

  1 dull metering vessel, heating jacket

  2 catalyst-dosing vessels, heating jacket

  1 scale, 0 - 10 kg

- **Polycondensation**

  1 polycondensation autoclave, designed for polyester, nylon 6 and nylon 66, with provisions for taking samples during polymerisation process

  1 vapour condensor

  1 receiver vessel

  1 vacuum steam jet system, 4 - 5 steps, final operation vacuum 0.5 mm Hg

- **Heating system for transesterification and polycondensation**

1 continuous dowtherm heater for transesterification vessel and product pipes, with electric heater, circulation pump and expansion vessel

1 dowtherm heating system for polycondensation vessel, product pipes where required, spinning head and steam jet section units; with electric dowtherm heater, dowtherm cooler and dowtherm expansion vessel

1 dowtherm feeding-collecting tank

1 dowtherm cooler

1 dowtherm separator

- **Chips production**

Both polyamides and polyester will be cast to strings and cut to size of approx. 3 mm. To facilitate transport, the strings should be conveyed to the second floor and the cutter located there. The chips are fed either into a movable chips silo or directly into the extractor. The essential equipment required is:

1 outlet valve

1 spinning head

1 casting trough

1 take-off unit and string conveyors from ground floor to 2nd floor

1 chips cutter, chips size approx. 3 mm (2 - 4 mm)

6 movable chips silos, approx. volume: 2,000 l

- **Chips extraction and drying**

Chips extraction and drying is effected batchwise, the extraction in a semicountercurrent way

3 water vessels	with heating coil, max.temperature 80°C approx. 2 m³, with level indicator
1 receiver vessel	for monomer solution
1 water vessel	for make-up water
1 feeding pump	with by-passes for all vessels, valves (hand operated)

1 extractor

1 water heater, steam heated

1 filter

1 rotation pump

1 chips dryer

1 vacuum pump set	complete with pre-vacuum and high vacuum pump as required for max. pressure [illegible] 1 mm Hg, designed for vacuum drying of polyamide chips and for discontinuous drying and crystallisation of polyester chips

1 complete oil heating system for max. drying temperature 200 °C

2 chips storage vessels	capacity sufficient for 7 days/production

- Control room equipment

1 control system with display panel in central room, comprising all required measuring and control elements, switches, fuses, transformers etc

for all dosing and metering equipment additional instruments are required at the points of installation of equipment

control cabinet with complete internal wiring

- **Accessories**

-- All required piping in polymerisation/polycondensation part for products, raw materials and heating liquids; all required armatures, fittings, and in-line control instrumentation

-- Spare parts for one year's operation per supplier's specification incl. spinnerets for string spinning, filters, filter insets and gaskets

3.1.1.2. Melt Spinning Unit

The melt spinning unit is required to process polyester, nylon 6 and nylon 66 into textile filaments and fibres, technical yarns and staple fibre tow of following thickness ranges:

Textile yarns (polyamides and polyester):
- Monofilaments: 10, 12, 15, 20, 30 den
- Multifilaments: 20/8, 30/8, 40/12, 76/24, 80/24, 100/24, 110/24, 120/24, 150/24

Industrial yarns (polyamide)
- 2[illegible]0/[illegible]0 den, multifilament
- 840/2[illegible] den, multifilament, [illegible]
- 126[illegible]/[illegible] den, multifilament, [illegible]

Staple fibre [illegible]
[illegible] total den with [illegible] between [illegible] and [illegible]

Corresponding to the fibre thickness [illegible], [illegible] pumps will operate within the following [illegible] range:

Minimum output
Fibre titer [illegible] den
Number of spinnerets [illegible] [illegible]

Spinning speeds	[illegible] m/min	[illegible] m/min
Drawing ratio	[illegible]	[illegible]
Extruder output	[illegible] kg/h	[illegible] kg/h

- Maximum output
Staple fibre tow, total titer [illegible] den
Number of spinnerets [illegible]

Spinning speed	[illegible] m/min	[illegible] m/min
Drawing ratio	[illegible]	[illegible]
Extruder outputs	[illegible] kg/h	[illegible] kg/h

Spinning and take up equipment should enable [illegible] speed spinning, high speed spinning, draw winding additional [illegible] spinning operations with take up speeds up to approximately [illegible] m/min.

Characterisation of the required [illegible] spinning equipment

- chips dosage equipment (from movable silos to extruders)
- nitrogen blanketing equipment for storage bin, dosage and spinning equipment

1 spinning extruder and spinning head

with two spinning positions for textile filaments according to above mentioned den-range and technical filaments or staple fibre tow, i.e., the spinning equipment will have to produce either textile filaments from two spinning positions with up to 8 spinnerets each or technical filaments from one spinning position only with up to 4 spinnerets or staple fibre tow from one spinning position with 1 spinneret. In case the above mentioned den-ranges and capacities could be covered by one spinning position only, the equipment may be offered correspondingly along with a justification.

The spinning equipment design has to guarantee that no cracking of polymer material can occur in the equipment while only one position is in operation.

Spinning of coloured yarns should be possible.

The spinning equipment must comprise all necessary machinery incl. spinning pumps, pump drive unit with variable gear, overload safety devices, reluctance motor and steel frame for pump drive assembly, complete heating system for spinning head(s); quench ducts, designed for maximum output with control windows and lightning and complete equipment for quench air supply incl. filter, fan, motor, ducts, spinning tubes

1 switch cabinet
containing all electrical measuring and control instruments for spinning part, cabinet internally completely wired.

1 take-up machine

for undrawn textile and technical filaments and staple fibre tow as specified above

with take up speed variable for usual spinning operation conditions for technical yarns and staple fibre tow and additionally high speed spinning possibilities for textile yarns

with individually driven spin-finish application godets with complete finish circulation system, finish dish etc.

with frequency inverter for godets drive adjustable for a.m. take up speed ranges, complete with control instrumentation, cooling devices etc. as required

1 switch panel
for take up machine with all required indication and control instruments, completely wired, with additional remote speed adjustment and tachometer at the winding machine

Accessories and operating material for spinning and take-up:

- 3 sets of spinning pumps for each required dosage volume
- 2 complete sets of spinnerets for all indicated filament and fibre types sufficient for two years operation
- div. filters, sealings, for spinning packs, sufficient for two years operation
- 1 set of special tools for the spinning plant incl. all tools required for assembly and dismantling of spinning blocks, spinning pumps, spinnerets and the extruder(s) incl. one set of all special disassembling, assembling and aligning devices for the a.m. spinning plant parts
- spares of all gaskets in the melting and spinning machinery sufficient for two years' operation
- complete cleaning equipment for spinnerets, packs etc., suitable also for cleaning chips spinning equipment (for nylon 6, nylon 66 and polyester)

3.1.1.3. Draw Twisting and Texturising

The draw-twisting equipment to be supplied has to cope with the den-ranges mentioned above, i.e., two draw-twisters have to be erected one each for textile and industrial yarns.

1 Draw-twister for textile yarns

For textile yarns (polyester) a two zone hot stretching machine is to be installed, the godet and heater plate temperature should be variable from 50°C to 180°C. For stretching nylon filaments alteration for one step cold drawing is required.

The machine should preferably be equipped with a second set of heated godets and plates for producing completely shrink yarn and for relaxing the yarn in the second zone.

Materials to be processed:	polyester filament, nylon 6 nylon 66-filaments
Filament thickness:	10 to 150 den
Minimum number of spindles:	96
Cop weight:	up to 3.0 kg
Stretch ratios:	for polyester yarns stretch ratios in the first drawing zone: 1.003; 1.03; 1.13; 1.3; 1.6; from 3.0 to 4.2 in steps of 0.08 stretch ratios in the second zone from 2.8 to 4.2 in steps of 0.08. For nylon yarns stretch ratios in one drawing step variable between 1.2 and 4.5 in steps of 0.03. Adjustment of stretch ratios preferably by means of variable PIV gear
Drawing speed:	500 to 1200 m/min, variable in steps of 50 m/min
Spindle speed:	6,000 - 12,000 rpm, variable in steps of 1,000 rpm

The machine should be provided with an individual switch board with control panel and complete internal wiring.

<u>1 Pilot plant draw twister for technical yarns</u>

A two step laboratory hot drawing machine for tyre cord, industrial yarns (e.g. fishnet and carpet yarns).

Materials to be processed:	nylon 6; occasionally also nylon 66 and polyester
Filament thickness:	from 210 to 1260 den
Number of spindles:	16
Stretch ratios in pre-drawing and second drawing zone each:	1:1 to 1:6, adjustable with variable PIV gears
Drawing speeds:	500 to approx. 800 m/min
Spindle speeds:	1500 to approx. 7500 rpm

The machine should be provided with an individual switch board with control panel and complete internal wiring.

1 Draw texturising machine

Materials to be processed:	nylon 6, nylon 66, polyester filaments
Filament thickness:	10 - 150 den
Number of spindles:	192

The unit must allow for draw texturising of spun drawn yarns and alternatively texturising of draw twisted yarns.

Accessories required for draw twisting operation

1,800 draw twisting cops in size and capacity fitting to the offered draw twister design, textile yarns

600 draw twister cops in size and capacity fitting to the offered draw twister design, technical yarns

3.1.1.4. Fibres Processing Unit

A fibre after treatment line of pilot plant size is required for processing fibre tow from the demonstration plant; alternatively unstretched tow supplied from SASMIRA member firms may be processed to fully utilise the capacity provided.

The equipment will have to provide two drawing zones, with electrically heated plates, operating under the following conditions:

Materials to be processed:	polyester, occasionally nylon, possibly in exceptional cases also acrylics
Maximum total tow titer:	50,000 den
Individual fibre titers:	approx. from 0.9 (1.0) to 3.0 den
Speed range of operation:	40 - 180 m/min (after drawing)

The scope of equipment delivery will comprise:

- Take-off creel	two-sided for accepting at least 16 bobbins on each side
- Reed and tow guiding frame	total tow titer, maximal 50,000 den tow titer on each bobbin: 3,600 den
- Roller frame	4 or more godets, max. temperature approx. 200°C ± 1°C, speed range approx. 15 - 90 m/min
- Hot drawing plate	max. temperature 250°C
- Roller frame	as specified above, speed range approx. 40 - 180 m/min
- Hot drawing plate	as specified above
- Roller frame	as specified above
- Tow washing and spin finish application equipment	
- Warp tensioner for crimper	
- Crimper	stuffing box design
- Tow conveyor	
- Drying and thermo-setting unit,	steam heated; max. temperature approx. 180°C
- Dancer godet control	for speed regulation of crimped fibre tow
- Staple fibre cutter	with slotted discs and cutting wheel; staple length variable for cotton type and wool type fibres (1.5, 2, 3, 4.5 inch)
- Pneumatic conveyors	with pneumatic opener and complete staple transport equipment from cutter to baling press
- Baling press for semiautomatic operation	

1 Swith panel comprising all required switching elements, fuses etc. measuring and control instruments for the fibre line, with complete internal wiring.

The deliveries will have to include drive systems, motor(s), variable gears, flanges and clutches, etc. All machinery should be easily accessable and individually exchangeable in short time. Although no additional hot drawing plates are to be included, easy exchange of heating systems should be possible.

Spare parts and accessories for fibre line

3 complete crimping chambers with about 50 insets

4 slotted discs: 2 for cotton type staple length
2 for wool type staple length

Approx. 400 cutting knive blades

1 grinding machine, adjusted for grinding the cutting knive blades

1 grinding machine, adjusted for grinding the crimper side plates

Complete equipment for preparation of spin finish solutions incl. spin finish feeding tank, metering tank, scale

3.1.1.5. Laboratory Equipment

SASMIRA already has extensive chemical and textile laboratory facilities which are used for their present training and research activities in the field of textile processing.

Part of this equipment will be available to furnish the project's laboratories. For the chemical laboratory an ashing oven, a measuring place for moisture determination (C. Fischer method) and a measuring place for the determination of the spin finish oil surface are available and do not have to be included into the project inputs.

Addtional equipment for the chemical laboratory comprises:

1 Measuring place for solution viscosity with
10 capillary viscosimeters Staudinger resp. Ubbelohde type,
3 mm diam., 60 up to 120 mm length
1 glass container
1 thermostate, accurancy 0.2°C

1 Refractometer with heated measuring prismen,
temperature up to 150°C, n_D = 1.3 - 1.7

1 Vibration shaker for up to 20 bottles of 200 cm³ each

1 Vacuum drying cabinet, 40 - 250°C with 2 water vacuum ejectors

1 Analytical scale, 200 g, accurancy 0.1 mg

1 Micro scale, 20 g, accurancy 0.001 mg

1 Gas chromatograph

1 Infrared spectrophotometer

B. During operation period

- Establishment of a well functioning division
- Coordination of the main activities of the three sections
- Planning and coordination of major activities of the Fibres Division
- Permanent supervision of plant operation
- Regular evaluation of performance of all sections
- Participation in solving complex problems within each and/or between sections
- Supervision of budget and cost control
- Cooperation with other SASMIRA departments
- Marketing of Fibres Division activities to attract traditional SASMIRA customers to the new fields of activities of SASMIRA and to win new customers for SASMIRA
- Participation in seminars and guidance in publishing research results

The division will have three sections: "Technical Education", "Research" and "Production", each of which will be managed by a section head. In the Technical Education Section, the section head will be assisted by a total of 6 lecturers and assistant lecturers and an assistant professor. The Research Section will have three posts for scientific and senior scientific officers [illegible] four technicians (technical assistants). The Production Section will have a staff of seven engineers and technicians. The probable establishment of 44 workers and skilled workers to operate the plant will also be subordinated to this section.

The structure of the Fibres Division and the posts in its three sections are shown in Fig. 4.

In addition SASMIRA has to care for sufficient amounts of laboratory glass ware such as test tubes, beakers, glass bulbs, reflux condensors, extraction devices, burettes and for standard laboratory equipment such as burners, heating devices, heatable magnetic stirrers, stands etc. Such standard laboratory equipment is available in India with no difficulty.

For the textile laboratory of the project, the following items

- microscales 0 - 50 mg and 0 - 1000 mg
- motor driven 5-skein winder
- hand tensiometer 3 - 30 g filament tension
- tenacity testers
- single denier tenacity tester
- microtom
- microscopes
- hair psychrometer recorders
- flash light stroboscope
- high temperature laboratory dyeing machine

already are available with SASMIRA.

In addition the following equipment should be included into the supplies:

No.	Item	Example for Type or Brand
1	Vacuum drying cabinet 40 - 250°C	HERAEUS
1	Water ejector vacuum pump 30 mm mercury	Standard
1	Analytical scale accurancy 0.1 mg	Standard
1	Microscale (torsion type, for fine denier determination) 0 - 1 mg, accurancy 0.001 mg	TEXTECHNO, ZWEIGLE, FRANK
	Torque (denier) scale for skein weighing	ZWEIGLE
1	for 10 - 200 den	
1	for 500 - 5000 den	
	Hand tensiometer	ZWEIGLE, SCHMIDT
1	for 10 - 200 g filament tension	
1	for 10 - 400 g filament tension	
1	for 100 - 2000 g filament tension	
1	High tenacity tensiometer and elongation tester ca. 3 - 25 kg	ZWEIGLE, ZWICK, K. FRANK
1	Staple fibre length counter, cotton type, wool type	ZWEIGLE
1	Twist counter, motor driven for tyre cord, textile filaments	ZWEIGLE
1	USTER yarn evenness tester, complete with accessories	ZELLWEGER-USTER

3.1.1.6. Auxiliary Equipment and Accessories

Auxiliary plants and equipment for supplying energy and auxiliary inputs will have to be contributed by SASMIRA. This equipment is specified within the specification of the utilities. Some of the equipment or respectively equipment parts however should be imported and included into the scope of project inputs. This refers to

- liquid nitrogen tank	approx. 2 m^3, complete with insulation, control equipment
- nitrogen vaporizer and purification equipment	capable to produce up to 100 St m^3/day N_2, with O_2 content $\leq$ 3 ppm, starting from standard liquid nitrogen with usually 0.2 % O_2, maximum 0.5 % O_2, complete with all instrumentation (incl. oxygen meter), piping, etc.
- dye preparation equipment	comprising colloid mill, barrel-mixer, laboratory ball mill, high precision scale

- spare parts for all plant equipment, sufficient for 2 years of operation, selection to be done by the plant supplier

3.1.2. Potential Suppliers

Pilot plants of the required size and design may in principle be obtained from all engineering firms for fibre production plants. Well-reputed firms within this branch are:

- ZIMMER AG, Frankfurt, Germany
- LURGI GmbH, Frankfurt, Germany
- CHEMTEX Corp., New York, USA
- INVENTA, Basel, Switzerland
- COGNITEX, Milano, Italy

These firms are however prepared to design and deliver pilot plants only in exceptional cases. The reason for this decision is usually the necessity of revealing the firm's entire know-how and making it accessible to a broad circle of interested parties (training). Only Messrs.Zimmer has declared itself prepared to supply know-how and equipment until now; Lurgi and Inventa refused to build a pilot plant; Chemtex and Cognitex have not yet been approached.

Large-scale fibre manufacturers, for example, Dupont often build such pilot plant themselves for reasons of secrecy. Such firms cannot be regarded as potential suppliers for the SASMIRA prcject.

In addition three German firms have more or less specialised in the manufacturing of smaller fibre production plants on the laboratory and pilot scale. They are

- E. FOURNÊ KG. Impekhoven near Bonn
- E. BLASCHKE & Co.. Endersbach near Stuttgart
- K. FISCHER, Berlin

In reply to preliminary inquiries, these firms expressed an interest in supplying the SASMIRA project, whereby K. Fischer and E. Blaschke submitted a joint bid. Being specialists in the manufacturing of pilot plants, these firms sometimes also act as sub-contractors for the above-mentioned engineering companies.

It is recommended that the tender for supply of the plant be limited to three or at most four firms, and the following firms should be requested to submit bids:

- ZIMMER AG
- F. FOURNÊ
- E. BLASCHKE
- possibly COGNITEX

Messrs. CHEMTEX may be eliminated as it cannot supply sufficient references in India.

3.1.3. Potential Indian Constractors

Indian contractors will have to be awarded with

- building construction work
- plant erection work (eventually incl. detailed engineering) and
- manufacturing, delivery, erection and start up of utility plants.

Potential contractors for building erection as well as for the supply of utility units will be mentioned under the specific headings in Chapters 3.2. and 3.3.

For detailed engineering work and for the plant erection a number of Indian engineering firms proved their qualification in the past while erecting most of the existing fibre plants in India.

For ZIMMER AG the engineering firm TATA Engineering Co., Bombay, is acting as cooperation partner and performing the detailed engineering and erection work for the plants supplied by ZIMMER. Usually this detailed engineering work is supervised by 3 - 4 engineers of ZIMMER headquarters. For reference, TATA Engineering has done this work at Swadeshi's polyester plant in Gaziabad.

The Indian agent of E. BLASCHKE (Optimum Corp.) has proposed DALAL Consultants, Bombay, which are successors of Ralph McParsons Co. of India, for the detailed engineering and construction work. DALAL Consultants gained experience in fibre plant engineering by doing engineering work and supervising the construction of Modipon's nylon plant, Modinagar and the tyre cord plant of Shriram Fibres in Manali.

FOURNÊ so far has not proposed specific engineering companies for the plant erection in Bombay. They will do the detailed engineering work primarily in their home office. In erecting the plant SASMIRA may be assisted either by one of the above mentioned companies or one of the other Indian engineering contractors, for example HUMPHREY & GLASGOW, having broad experience in design and erection of petrochemical plants. They did for instance the erection work for Kalico polyesterfibre plant, Baroda, with equipment supplied by ICI and Simon & Carves. For electrical engineering and installation SIEMENS INDIA, Bombay, has a very good reputation and is experienced as well in installation of chemical plants.

SASMIRA may also be assisted in the plant erection by the engineering division of National Rayon Corporation who did the erection of their nylon tyre cord plant by their own and who in principle would be willing to perform engineering and erection tasks for the SASMIRA project.

Since there are different preferences with the plant suppliers the final choice of an engineering contractor will depend on the decision which plant supplier is to be awarded with the contract. Subsequently an engineering company has to be choosen jointly by the project personnel, SASMIRA and the plant manufacturer.

Erection material, mainly welded structure and standard parts will have to be manufactured individually according to drawings established during the detailed engineering work. There are numerous machine shops in or near Bombay being able to manufacture such light or medium structurals. One or more of them should be employed from case to case. The same applies for the minor equipment items which have to be contributed to the project by SASMIRA, e.g., bobbin carriages, or standard steel vessels which can be obtained from several smaller metal working companies in Bombay, besides from the larger manufacturers as Larsen & Toubro, Bombay.

3.1.4. Supervision During Erection Period

SASMIRA should be assisted during the project construction phase in organising, performing and coordinating all activities required for erection and start up of the plant.

This assistance should preferably be given by the Chief Project Advisor who thus will have to be available from the third project month onwards. His first activity will be to assist in the evaluation of the tenders for plant equipment and in awarding the contracts. Later on the civil engineering work, the tendering and construction of building has to be supervised particularly regarding the harmonisation of building details and plant requirements as well as the timing of the construction work. For the utilities and the equipment items required from Indian manufacturers the requests for bids will have to be prepared in accordance with requirements of the basic plant engineering jointly or in cooperation with the plant manufacturer. Here particular attention has to be paid for the air conditioning equipment, because of its influence on the product quality.

The erection work will be supervised by engineers and specialists of the plant manufacturer. During this period SASMIRA must have available an experienced person to decide on all questionable subjects which may arise. The same applies for all questions in connection with the detailed engineering work of the plant.

This supervision requires one expert - preferably the chief technical advisor - to be located with SASMIRA in Bombay. Any spare time which he may face during this assignment may be used first for the familiarisation with the Indian fibre producing industry which has to be convinced about the capability of SASMIRA and secondly he should elaborate the detailed curricula of all envisaged training courses (cf. Chapter 2.1.).

3.2. Buildings

The demonstration plant is to be built on the SASMIRA premises in the Worli district of Bombay. The present buildings consist of an institute building with laboratories, lecture hall and offices and a factory hall. Part of the hall area is to be reconstructed to allow installation of the demonstration plant. Besides that a new multi-storey building is required. The scope of these building measures is described in the following, with the intention of providing a basis for investment cost estimates and as a guideline for final planning of the buildings by the plant supplier.

3.2.1. Site Conditions

The site owned by the SASMIRA has an area of approximately 11,200 m², being approx. 157 m long and approx. 71 m wide. It is favourably located in Dr. Annie Besant Road, a major North-South highway through Bombay. The approaches present no problems, even for larger trucks. On the site, there is an approx. 12.5 ft (3.8 m)- wide road to the planned plant location.

The distance to the sea is about 100 m; the site is sheltered on the sea side by the approx. 20 - 30 m high Worli Hill.

Connections with public utilities exist (water, power, sewage). Utility capacities could easily be enlarged if necessary.

The four-storey institute building on the site has a total floor area of about 2000 m² and the factory hall an area of about 2,890 m² (approx. 117.5 x 24.5 m). Part of the hall is at present used to house the equipment of the secondary spinning plant, weaving and wet processing plant as well as a workshop and warp and weft knitting machinery. The remaining space is to be used to house the textiles equipment of the pilot plant (fibre line, draw twisting, yarn conditioning, texturising, etc.). The single-storey hall consists of twelve bays with the dimensions 32 x 81 ft (approx. 9.75 x 24.5 m). The hall has a shed roof with a clear height of 27 ft (approx. 8.2 m). Four of the bays in the northern part of the hall, i.e., one-third of the hall area, can be cleared and converted to house the pilot plant.

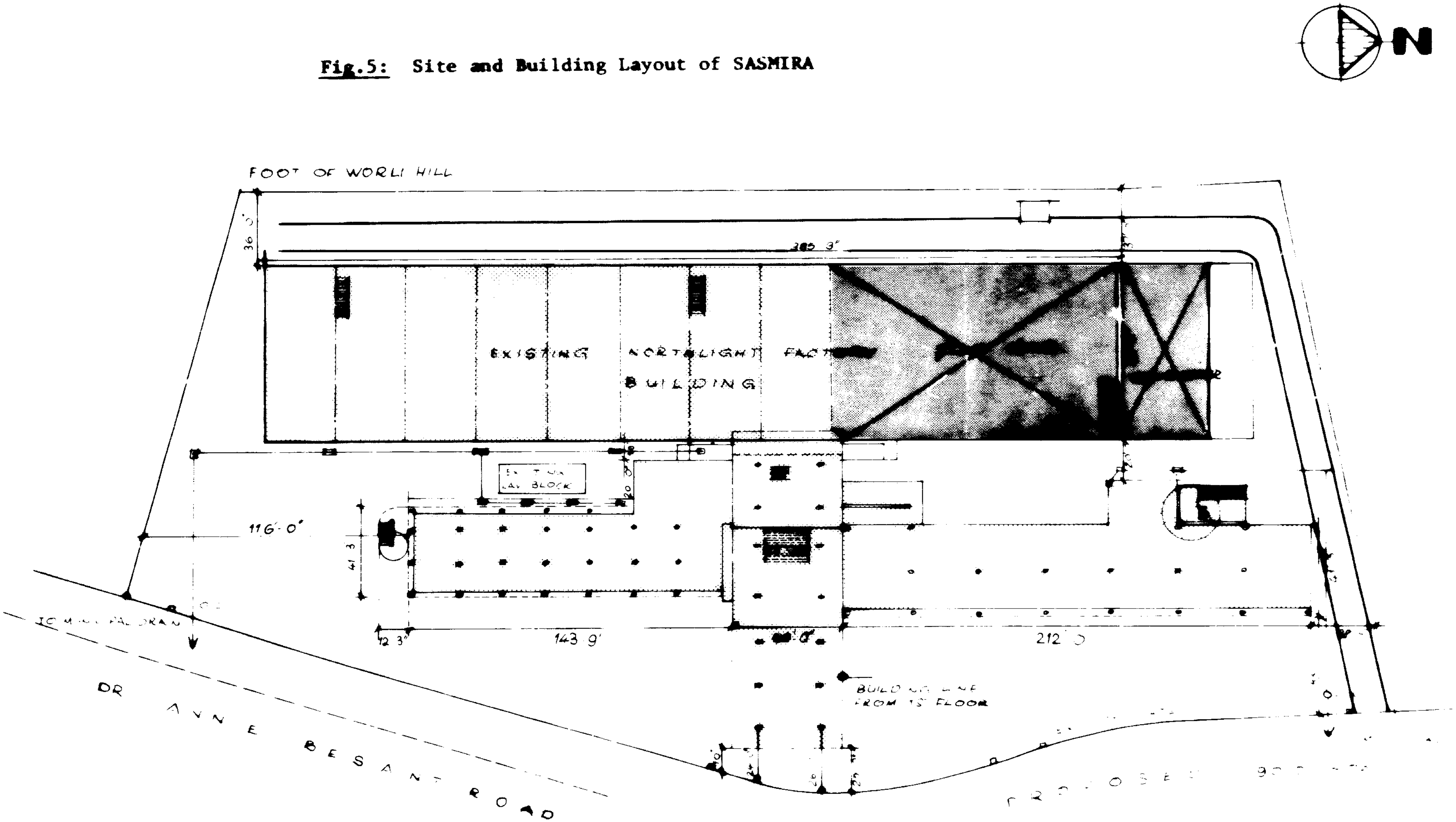


Fig.5: Site and Building Layout of SASMIRA

Next to the hall is a clear area upon which a multi-storey building for the polymerisation plant and melt spinning plant is to be built. The maximum base dimensions of this building will be 6[illegible] x 3[illegible] [illegible] (18.9 x 29.5 m).

According to architects, obtaining a permit to erect the planned buildings will present no problems.

Fig. 5 shows the site and buildings; light shading denotes existent buildings, whilst dark shading shows the part of the hall reserved for the pilot plant and the new building area.

3.2.2 Preliminary Layout

For housing the demonstration plant, buildings with a total floor area of approximately 1,800 m² will be required; 9[illegible] m² thereof are to be located in the existing hall; for the remaining 86[illegible] m² a new building with three floors of 288 m² each is to be constructed.

The principle building layout is dictated by the given site and building situation and has already been briefly described. The following description and explanation is intended to serve the plant supplier as a basis for determining the final building layout which is part of the plant engineering services.

The single-storey area of the hall will have to be converted, and will then house

- the staple fibre plant
- the yarn conditioning room
- the draw twisting machines
- the textile machines (texturising, warp and weft knitting)
- the textiles and the chemical laboratory
- the finished product stores

The remaining space in the converted part of the hall can be utilised for lecture halls, offices and sanitary facilities.

As Fig. 7 shows, this part of the building is subdivided into four longitudinal tracts; each of these is about 6 m wide. The total length is approx. 30 m. The fibre treatment line must be housed within this length. If necessary, this part of the building can be lengthened by half the width of the new building, i.e., to about 43 m.

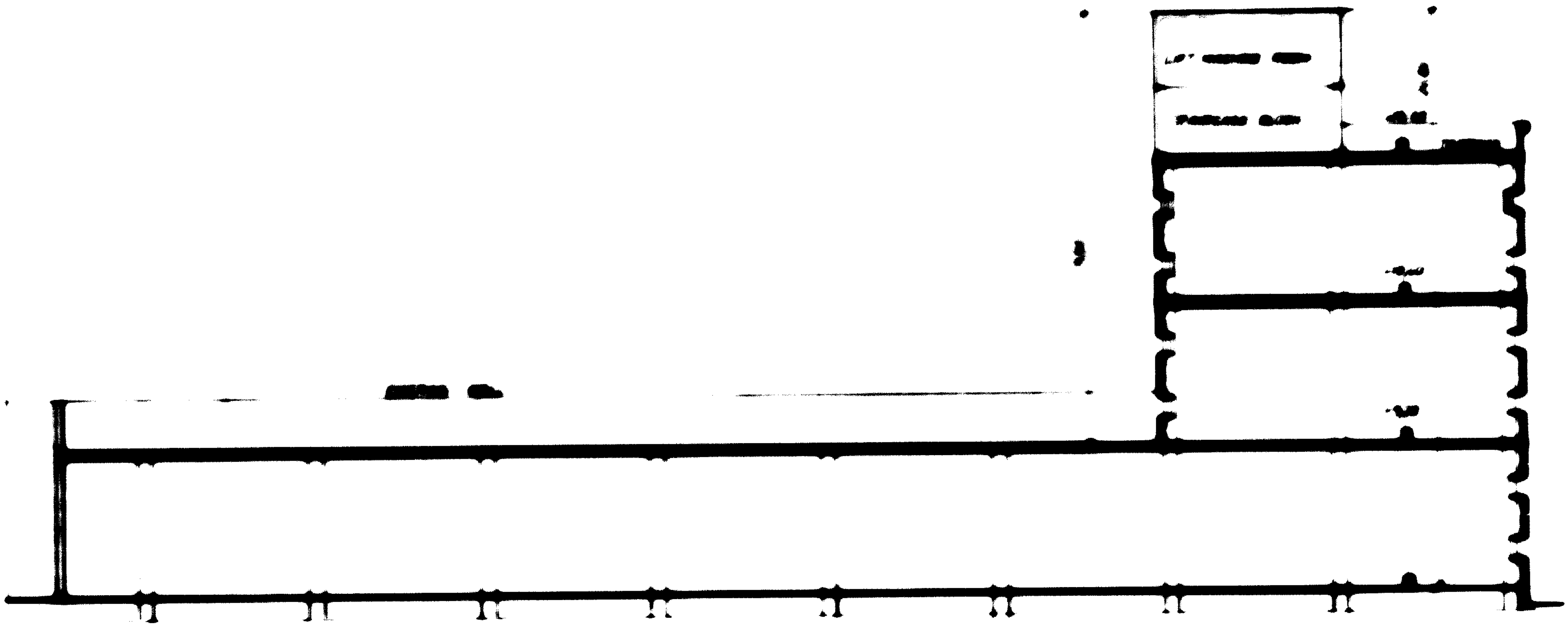


Fig. 6: Proposed Building for Pilot Plant

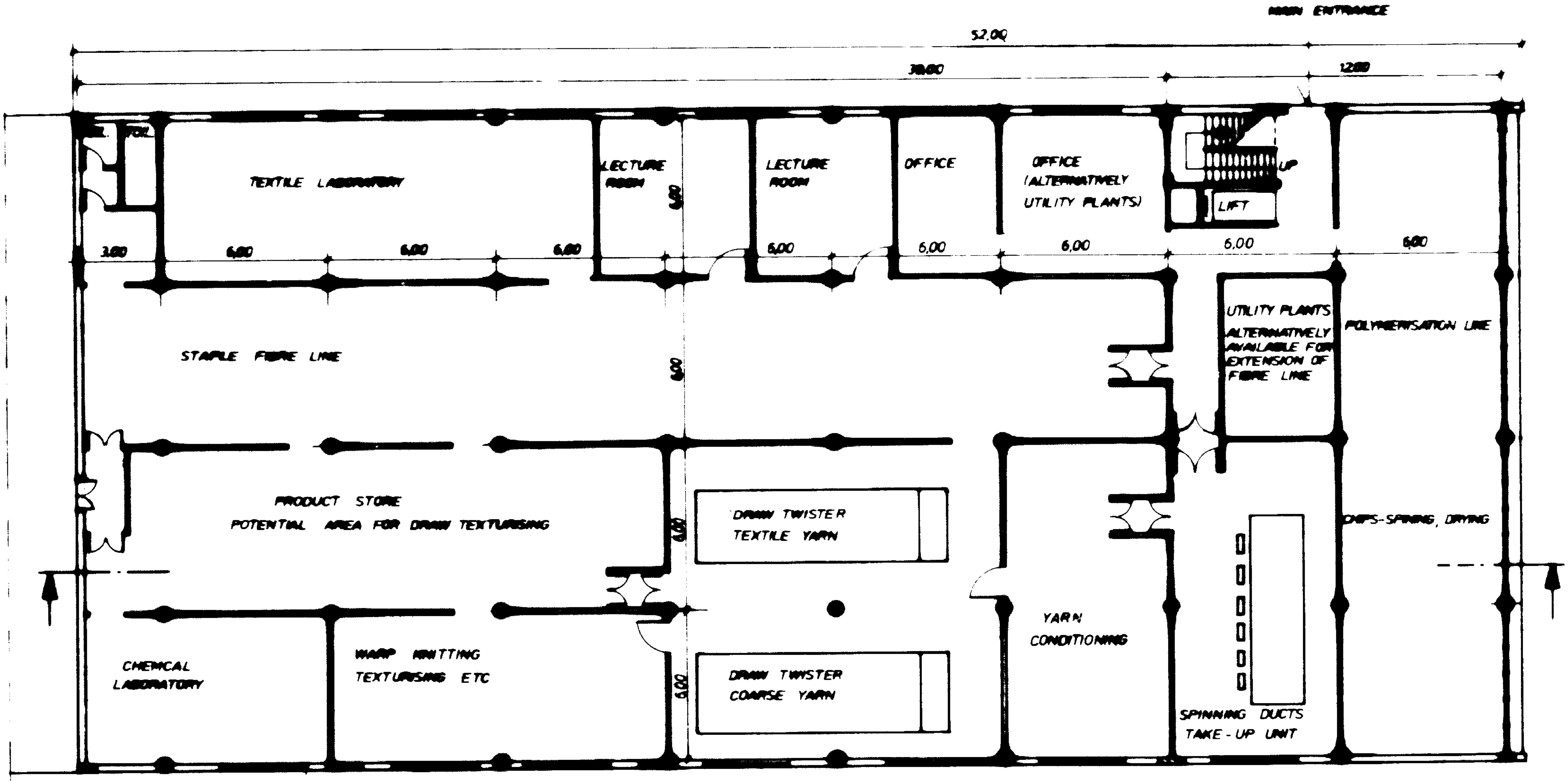
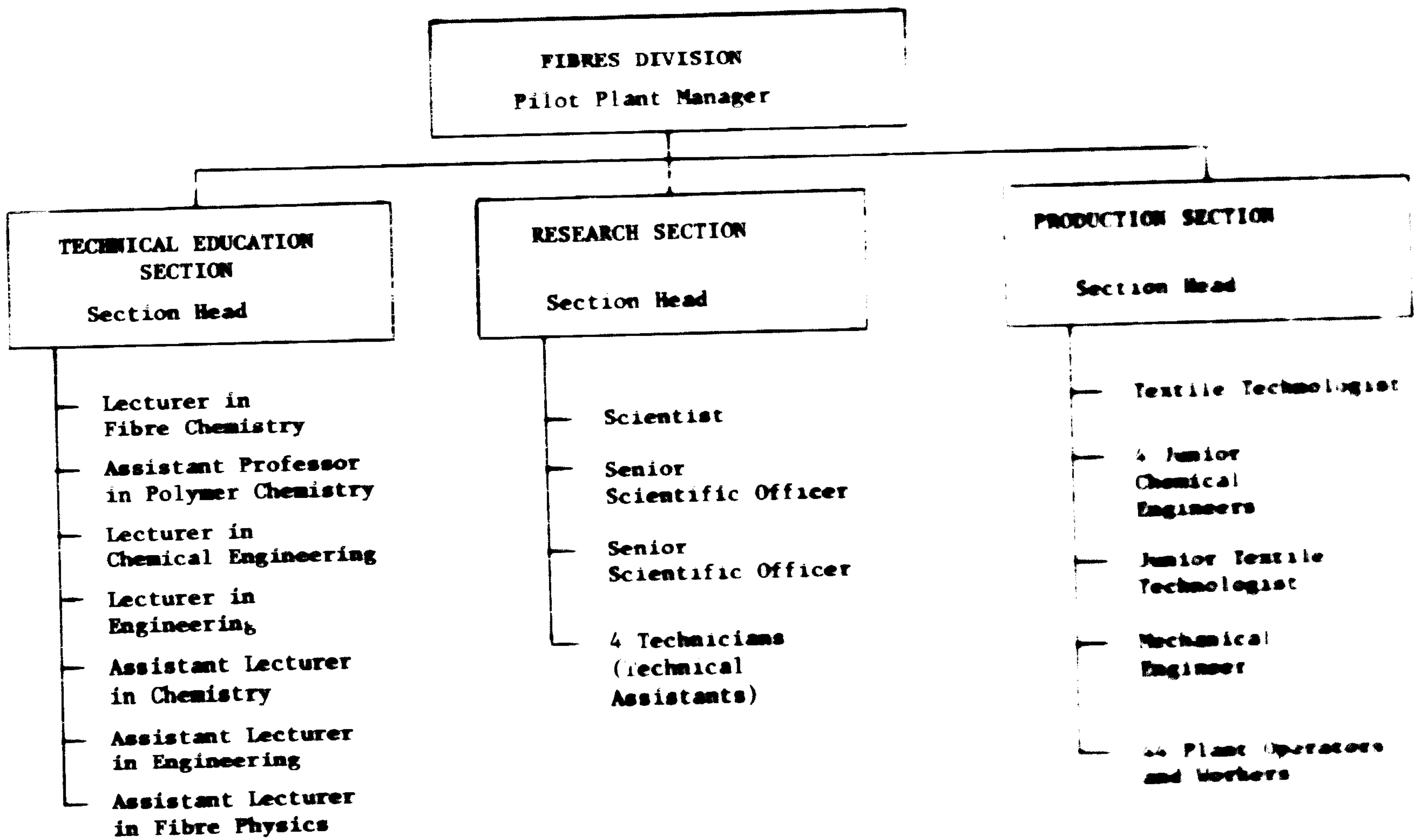


Fig. 7: Proposed Building for Pilot Plant, Ground Floor,

Figure 4: Organisation Scheme of SASMIRA's Fibres Division



In this case, the utility plants would have to be moved to the part of the present hall which is reserved for offices, and the offices would have to be moved into the institute building. This will probably be necessary if the equipment would be supplied by Messrs. Zimmer. The available approx. 39 m hall length will suffice if the plants would be supplied by Messrs. Fourné and Blaschke (according to their statements).

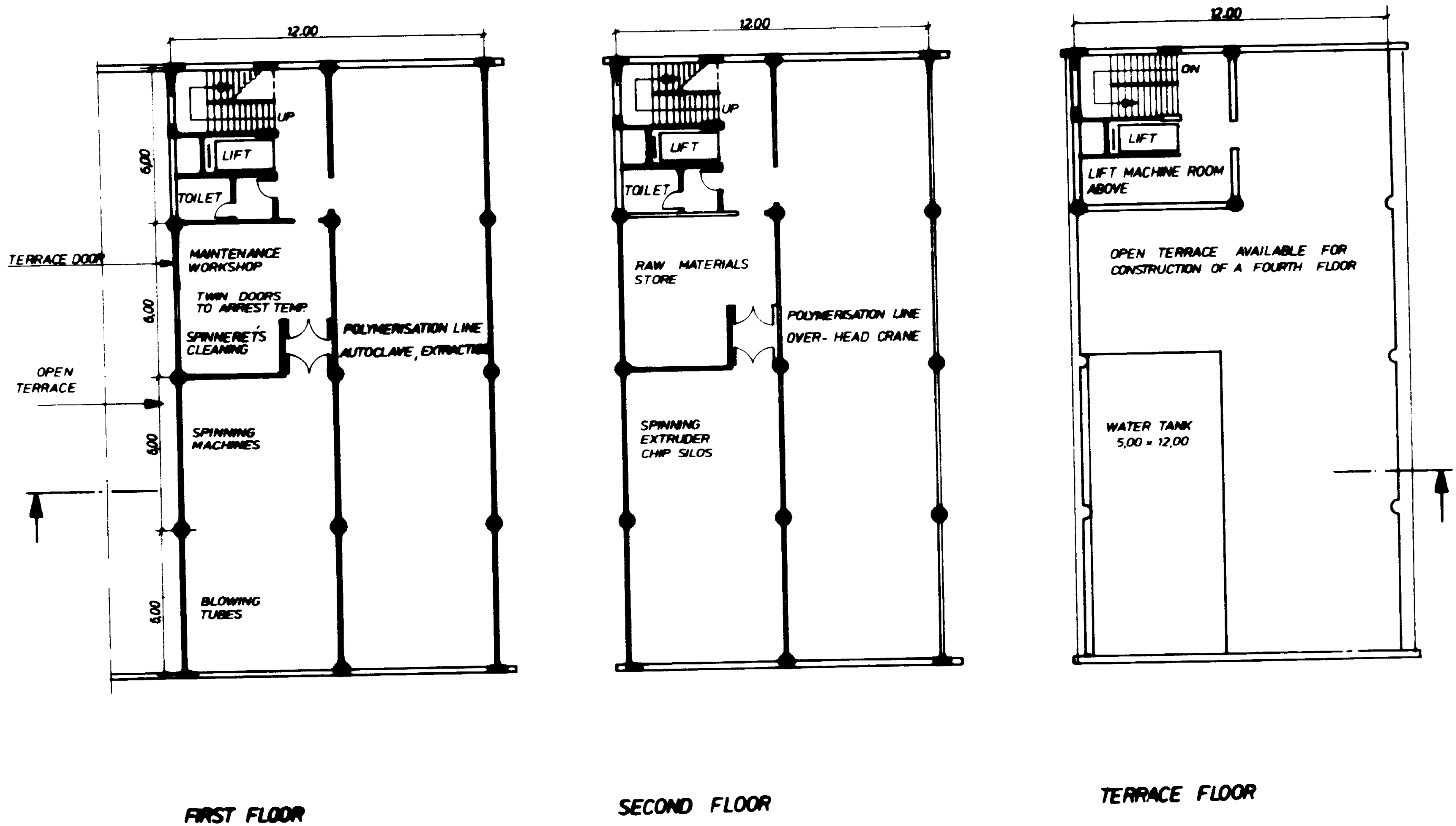
The new building north of the existing hall is to have a base area of 24 x 6 m². This corresponds with the width of the hall, and would allow two tracts, each with a width of 6 m. This arrangement would facilitate later extension by one-third of the base area, by adding a further 6 m-wide tract. Half of the new building for the pilot plant is to house the polymerisation plant, this extending through three storeys with a total height of 15.60 m. The stairway, spinning plant and ancillary rooms must be located in the second part of the building. On the ground floor (cf. Fig.7) will be the 6 x 12 m lower section of the melt spinning plant with the spinning ducts and the take-up machine. Also planned for this floor is the air-conditioning plant and, if possible, the instrument air compressor.

The spinning heads and quench ducts and, depending on building height, also the spinning extruders will be installed on the first floor of this part of the building. Also on the floor will be a workshop for maintenance work, the cleaning of spinning packs and spinnerets, control and assembly purposes (cf. Fig.8).

The second floor will house - if necessary - the spinning extruders, the chips silos and the spinning silos. There will also be 6 x 6 m room for storage of raw material (cf. Fig.8)-

All rooms in the part of the hall which is to be converted are to have air-conditioning. In the production rooms, including the yarn conditioning and texturising shop, climatic conditions dictated by the plant know-how are to be maintained within close tolerances. The same applies for the spinning room on the ground floor of the new building. Air-conditioning of the remaining rooms will improve working and learning conditions. In the textile laboratory, air-conditioning will ensure the reproductibility of measuring data. Partial air-conditioning in the melt spinning room (new building, 1st floor) will improve the working conditions; quench air from the blow ducts will be vented into the spinning room. Effective and economical air-conditioning of the abovementioned rooms will only be possible if the masonry provides sufficient heat insulation and the only access is through locktype twin doors.

Fig.8: Proposed Building for Pilot Plant: Upper Floors



3.2.3. Building Specifications

In the following building specifications, the reconstruction and building measures necessitated by installation of the plant are described separately. In the case of reconstruction work, the description concentrates on the individual constructional measures which will be necessary, summarising the main requirements made of individual components. The specification of the new building section concentrates mainly on a description of the building concept, the main design features, and the main requirements made on individual components by operation of the plant.

- Conversion Work

  The existent hall must be converted in such a way that the individual plant units in the textiles section of the pilot plant are housed in separate rooms and that sufficient insulation is provided to allow air conditioning of these rooms. The scope of the main demolition works and the requirements to be made on the new building sections are described in the following.

- Demolition Works

  -- Dismantling of the textiles processing machines in the northern part of the hall

  -- Dismantling of the partition walls of the spinning shop laboratory and the weft knitting room

  -- Re-erection of the weaving machines, etc. in the southern, remaining part of the hall

  -- Opening of the hall roof by demolition of four shed roof elements in the northern part of the hall

  -- Partial demolition of the northern end wall of the hall to a height of approx.5 m and cutting of slots to accept (presumably) 3 reinforced concrete pillars, as statically necessary; cutting of an additional door in the remaining part of the wall

  -- Construction of 6 windows in each of the side walls, utilising existent window openings

- Building Works

-- Erection of 21 roof beams of reinforced concrete and cutting of bearing points for a reinforced concrete ceiling in the hall walls, as statically necessary

-- Preparation of foundations for approx. 150 m masonry approx. 0.5 m thick and approx. 24 m masonry approx. 0.24 mm thick, incl. demolition and earthmoving work

-- Verification of the bearing capacity of the hall floor; if necessary, reinforcement to withstand a loading of $>$ 2,000 kg/m²

-- Production of approx. 940 m² reinforced concrete ceiling above the hall section which is to be converted; thickness and reinforcement as statically necessary.
Ceiling bearing capacity must be 1,000 kg/m² to allow addition of a further storey, heat insulation of the finished ceiling $\leq$ 0.8 kcal/m².h.°C

-- Production of approx. 24 running metres of masonry, approx. 5.5 m high, 0.24 m thick, heat insulation value $\leq$ 1.2 kcal/m².h.°C, to separate the pilot plant hall section from the non air-conditioned hall section

-- ditto, approx. 2.5 m high as northern closure of the remaining hall between reinforced concrete ceiling and shed roof

-- Production of approx. 150 running metres of partition walls 0.12 - 0.15 mm thick in masonry, without heat insulation properties

-- Roofing work to seal the terrace area, incl. water drainage to suit local conditions

-- Production of at least 4 air locks allowing access to the production rooms as per Fig.7

-- Instllation of air shafts and ducts for the air-conditioning of individual rooms as per plant engineering data: in the draw-twisting room, supply ducts in the floor and exhaust ducts in the ceiling

-- Production of machine foundation as per specifications of the plant supplier

-- Interior finishing works incl.
--- plastering and painting of wall
--- fitting of windows and doors (cf. Fig.7)
--- laying of tandur stone floors

New Building Section for the Polymerisation and Spinning Plant

Type of Construction:

- Reinforced concrete skeleton; in the polymerisation plant section, partially steel skeleton
- Three stories, clear storey height 5.00 m each, with roof terrace, addition of 4 th storey possible
- Infilling of the outer walls and the centre wall between spinning and polymerisation plants in masonry 23 cm thick, heat transmission factor k $\leq$ 1.2 kcal/m² .h. °C
- Window openings in the longer building wall, fitted with shade roofs, no window openings in the spinning room (ground floor)
- Ceilings in the southern part of the building (spinning rooms, stores, workshop, stairway): reinforced concrete as statically necessary, for 2,000 kg/m² in the spinning room and 1,000 kg/m² in all other rooms
- Ceilings in the northern part of the hall (polymerisation plant): steel grids, closed ceilings over certain areas

Main Features of the Individual Rooms:

Stairway:

- Size 6 x 6 m, rising through four storeys to give access to roof terrace
- Two-flight stairway 1.5 m wide, reinforced concrete with tandur stone slab facing
- With lift shaft, built with reinforced concrete ring anchors as statically necessary, base area 2 x 3 m; total height incl. machine room ceiling approx. 21 m; with exit to roof terrace (= potential 4th floor)
- Outside door on first floor to roof terrace over converted hall section
- Single toilets on second floor
- Industrial lift over four storeys, capacity approx. 2.5 tons; machine room at such a height that addition of a 4th storey remains possible

Spinning Rooms:

- Size: 6 x 12 m² base area, on three floors
- Partition wall on ground floor against utility room in masonry 23 cm thick, k $\leq$ 1.2 kcal/m² .h. °C
- Partition wall to yarn conditioning room, no heat insulation properties demanded, construction: as statically necessary

- Openings in ceiling as per detailed plant engineering
- Floors: on ground floor, tandur stone slabs; on upper floors, concrete flooring with floated coat and plastic covering floor prepared for installation of machines as per supplier's specifications and detailed plant engineering
- Walls: cement plaster, painted
- Spinning room, ground floor, air-conditioned as necessitated by process; ditto 1st floor, air-conditioned by venting of quench air; ditto, second floor, not air-conditioned, ventilated to remove machine heat

Utility Room, Ground Floor:

- Size 6 x 4.5 m = 27 m^2
- Walls in masonry, 23 cm
- Flooring of poured-in-place concrete, with floated coat
- Prepared for machine installation as per detailed layout
- The room is to be connected with the ventilation system of the polymerisation plant
- Access from the corridor and from the polymerisation plant is necessary

Maintenance Workshop:

- Size 6 x 6 m = 36 m^2
- Floor with tandur stone slabs; for installation of benches and cleaning machines
- Air-conditioning to improve working conditions
- Walls: cement plaster, painted

Store, 2nd Floor:

- Size 6 x 6 m = 36 m^2
- Specification as utility room

Polymerisation Plant Rooms:

- Size: each 6 x 24 m = 144 m² area, on three storeys
- At ceiling height, double T girders as statically necessary for machine installation; girders with bearing points for machines and apparatus frames
- Floors: steel grids, lying on the double T girders and additional binders; closed ceilings over the control room
- Control room with partition walls, masonry approx. 10 cm thick with windows to plant section, walls plastered and painted, floors: concrete finish with plastic covering
- Access to the stairway on each floor and two steel stairways within the plant room with grid treads, approx. 0.8 m wide; location depending on plant layout
- Outside stairway as escape route, centrally located with easy access from all levels of the plant
- Ventilation: ventilation shafts, prepared for connection of a roof blower, to exchange air and extract vapours and gases
- On the third floor, crane catway over full building width for two-ton overhead crane

The probable overall scope of building works according to the SASMIRA's architects is broken down in Table 13. The unit prices stated therin applied in mid-1975. The probable shell costs calculated with these prices amount to some 750,000 Rs without ancillary costs, installation works and contingencies.

It will not be difficult to find suitable experienced building contractors in Bombay with the necessary equipment for the planned building works. These firms at present have so much capacity free that quick acceptance and execution of orders is certain.

The following firms in Bombay would for example be suitable:

M/S Shah Construction Co. Ltd.
M/S V.P. Construction Co. Ltd.
M/S Despha Construction Co. Ltd.
M/S Bhati Construction Co. Ltd.
M/S Fairdeal Construction Co. Ltd.
M/S Sarkar Construction Co. Ltd.
M/S Ray Builders
M/S Madan Beldeo Comp.
M/S B.A. Mistry Bros.
M/S Rutton Surveyors Comp.

Table 13: Estimated Extent and Costs of Building Activities

Building Activities	Approximate Amount	Unit Price	Total Costs Rs
Excavator Work:			
Excavation in earth for cols and walls	280 m^3	5.50 Rs/m^3	1,540
Breaking up existing masonry walls, concrete flooring for new cols, flooring etc.	80 m^3	35 Rs/m^3	2,800
Removing of rubble packed in flooring for foundation	20 m^2	17 Rs/m^2	340
Subtotal Excavator Work			4,680
Concretor's Work:			
Cement concrete bedding below footing 1:3:6 mix	20 m^3	150 Rs/m^3	3,000
Reinforced cement concrete footings	60 m^3	180 Rs/m^3	10,800
R.c.c. columns	140 m^3	230 Rs/m^3	32,200
R.c.c. flat slab	310 m^3	345 Rs/m^3	106,950
R.c.c. for staircase lift rooms over terrace level	7 m^3	350 Rs/m^3	2,450
Overhead water storage tank	100 m^3	400 Rs/m^3	40,000
Underground water storage tanks	55 m^3	400 Rs/m^3	22,000
R.c.c. walls	40 m^3	400 Rs/m^3	16,000
Concrete bedding in flooring	37 m^3	180 Rs/m^3	6,660
R.c.c. lift walls	25 m^3	400 Rs/m^3	10,000
R.c.c. coping	5 m^3	280 Rs/m^3	1,400
R.c.c. steps	90 pcs.	150 Rs each	13,500
Subtotal Concretor's Work			264,960
Masonry Work:			
23 cm brick walls in superstructure	120 m^3	140 Rs/m^3	16,800
23 cm brick walls in plinth	12 m^3	140 Rs/m^3	1,680
15 cm brick internal partition walls with concrete runners	1500 m^2	22 Rs/m^2	33,000
Subtotal Masonry Work			51,480

Table 13, continued

Building Activities	Approximate Amount	Unit Price	Total Costs Rs
<u>Steel Work</u>:			
Steel windows	230 m^2	180 Rs/m^2	42,400
Steel for R.c.c. work as reinforcement	60 t	2,200 Rs/t	132,000
Steel sections for ceilings in polymerisation part and grates	15 t	4,000 Rs/t	60,000
Subtotal Steel Work			233,400
<u>Carpentry</u>:			
Entrance doors		Lumpsum	1,000
Flush doors (Vineured)	95 m^2	180 Rs/m^2	17,100
Panel doors for toilets	14 m^2	170 Rs/m^2	2,380
Subtotal Carpentry Work			20,480
<u>Plaster and Painting Work</u>:			
Sandfaced plaster in two coats	1400 m^2	10 Rs/m^2	14,000
Cement plaster with neru finish in internal surfaces of walls	2800 m^2	6.20 Rs/m^2	17,360
Cement plaster with neru finish to cols	200 m^2	6.00 Rs/m^2	1,200
Cement plaster with neru finish to slabs with white wash	1560 m^2	4.00 Rs/m^2	6,240
Cement paint in two coats to external surfaces	1500 m^2	3.00 Rs/m^2	4,500
Plastic emulsion paint to internal surfaces	5500 m^2	7.50 Rs/m^2	41,250
Subtotal Plaster and Painting			84,550
<u>Flooring Work</u>:			
.23 thick dry rubble packing	300 m^2	7.00 Rs/m^2	2,100
Polished tandur stone slab finish	1800 m^2	30.00 Rs/m^2	54,000
Waterproofing the terrace	1220 m^2	27.00 Rs/m^2	32,940
White glazed tiles	54 m^2	85.00 Rs/m^2	4,590
Waterproofing the toilets	20 m^2	25.00 Rs/m^2	500
Subtotal Flooring Work			94,130
Grand Total Construction Costs			753,680

3.3. Utilities

To operate the pilot plant according to the envisaged schedule the supply of auxiliary materials, energy and some minor miscellaneous inputs must be secured mainly by installing corresponding supply units. This applies primarily to

- water supply facilities
- energy supply
- steam generator
- nitrogen supply and
- air conditioning and cooling units.

These items will belong to the Indian project contribution and supplies of the relevant machinery will have to come from indigeneous firms. The following chapters indicate the requirements for these plant units and specify on their main technical features. The specifications serve primarily to identify the supply possibilities for the various units in India and for estimating the investment costs. Sizes, capacities and operation conditions must be checked and cleared with the plant supplier before asking for bids from the indicated firms since they vary with the slightly different engineering concept offered by the potential suppliers.

The final specification for these items will be part of the supplier's engineering work.

3.3.1. Water

There are three different qualities of water required for the project operation, namely cooling water, soft water, demineralised water and tap water.

- Cooling Water

  Depending on the plant design cooling water consumption will range between roughly 12 to 15 m^3/h. In addition a cold water system providing approx. 1.5 to 2 m^3/h of 10° - 12°C water and a brine circulation system providing the same quantity of 4°C brine are required and are to be installed along with the air conditioning unit.

3. Project Implementation and Operation

The project is to be implemented in two phases, namely

- the Project Construction Phase and
- the Project Operation Phase

During the longer Construction Phase, all necessary building works will be carried out, all plant equipment delivered, the individual plant sections including the necessary utilities erected, and the plant started up

The Operation Phase of the project will include realisation of the training program and the development of research activities for fibre manufacturers and processors, public agencies and to a lesser extent raw material producers

The following specification gives information concerning the scope of project equipment which, together with probable plant utilisation data, form the basis for the later input and cost estimates and determining staff requirements

Description of technical implementation of the project ends with a work schedule which shows the timing of the main work stages.

3.1. Equipment

The project aims "training" and "applied research" determine the design and size of the demonstration plant. Particularly training in the operational sector necessitates a near-industrial scale of operations and a design of the overall plant approximating the standard plant installed in the Indian fibres industry. Such a requirement can be relatively easily fulfilled in the section for melt spinning and further processing of the filament. Compromises will be necessary in the polymerisation/polycondensation section because of the capacity limits of the demonstration plant, the requirement of versatility, and also the project funds.

According to SASMIRA's information an existing tube well on their premises is capable to supply approx. 3000 g.p.h. = 13.5 m^3/g (cf. Chapter 3.1.). With a cooling tower installed this quantity will most probably suffice, otherwise a second tube well can be drilled; it is estimated that this will provide the same water output as the existing one.

Provisions to be made by SASMIRA for cooling water supply include:

-- tube well pump (as stand-by for the existing one), capacity approx. 15 m^3/h, delivery head approx. 100 m

-- cooling water storage tank (included in scope of building)

-- cooling tower, capacity and operation conditions have to be calculated within the basic engineering work

-- cooling tower pump with stand-by unit, capacity approx. 15 m^3/h delivery head approx. 60 m

-- water chiller and circulation system incl. pump, armatures, piping and controls for 10 - 12°C water; capacity to be calculated within the basic engineering work

-- dto. for 4°C brine (water) circulation system

Potential suppliers for chillers,cooling towers and refrigeration equipment:

- Blue Star Ltd., Bombay, experienced in air conditioning and cooling equipment design and supplier for about 10 fibre plants

- Voltas Ltd., Bombay

- Tap Water

Tap water is required for the chemical laboratory, for feeding the ion exchange plant supplying process water, for cleaning and for sanitary purposes. The daily requirements are estimated to be

-- approx. 7 - 8 m^3 destilled or demineralised water
-- approx. 0.5 - 1 m^3 soft water (permutite water)
-- approx. 2 m^3 tap water

The supply of a total of 10 m^3/day of tap water is guaranteed by the installed municipal supply system amounting to 40,000 gpd (180 m^3/day) and the existing storage tank for that capacity. No further provisions seem to be necessary here.

- **Demineralised and Soft Water**

SASMIRA indicated that tap water could be supplied with approx. 20 - 26 ppm $CaCO_3$[1] which may serve for soft water. For demineralised feed tap water an ion exchange unit with sufficient spare capacity and storage tank must be installed.

Ion exchange plant characteristics are:

product water conductivity	ca. [illegible]
feed water hardness	approx. [illegible] ppm [illegible]
capacity	10 m^3/day
storage capacity	approx. [illegible] m^3/day

Complete unit incl. all required piping, armatures, instruments, pumps if required, completely installed and connected to storage tanks, to be installed by supplier ready for operation.

Potential supplier for ion exchange equipment:

- Ion Exchange (India) Ltd., Bombay

For delivery time a period of [illegible] months should be calculated.

3.3.2. Energy

The energy consumption and required connected load depends on the plant concept, i.e., the breakdown between steam heating systems and electrical heating devices.

It is anticipated that the high temperature heating systems, e.g., for polymerisation, extrusion and spinning head, is effected electrically whereas the melting operations etc. requiring lower temperatures are heated with steam.

Thus energy consumption and the related connected load will be:

- Rated energy consumption — approx. 12 kWh/kg product
- Maximum product output (cf. 3.1.1.2.) — approx. 500 kg/day
- Maximum daily energy consumption — 6000 kWh
- Required maximum load — 250 kW (approx. 300 kVA)

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1) Other sources (Wanson) stated 30 ppm as usual hardness in Bombay

The existing energy supply at SASMIRA's premises is for a maximum connected load of 400 kW, 3 phase 440 V, 50 Hz. This capacity is used only to a minor extent except for those periods when an electric steam boiler requiring about 180 kW is in operation for dyeing and thermopressing operations with fabrics. Since this unit should not be removed despite the boiler required in the fibre plant the electric supply possibilities will have to be doubled totalling in 800 kW.

Municipal distribution grid will allow for this expansion,major difficulties are not to be expected. The installation of additional supply capacity incl. transformers will be done by Bombay Electric Supply and Transport Undertaking, a municipal corporation, the installation costs are included in the consumption rate for electric energy.

The installation of the in-plant power distribution with high power cables is due to SASMIRA. Reliable installation firms are SIEMENS (India) ltd. or PHILIPS (India) in Bombay. The costs are estimated to be roughly 160,000 Rs.

A diesel power set as stand-by unit approx. 100 kVA (max. 200 kVA) would be desirable in order to avoid freezing of polymers in the apparatumes in case of power shut downs in the municipal grid. Such a set should be installed in the long run.

3.3.3. Steam

SASMIRA operates an electric steam boiler with a connected load of 180 kW and an output pressure of 150 psi + ca.10 at (tested pressure: 330 psi). This boiler is used for wet processing (dyeing, heatsetting, etc.) and may not be available for the pilot plant operation all the time. To be more flexible and independent from the municipal power supply the installation of an oil fired boiler by SASMIRA is necessary.

The following characteristics apply for the steam supply:

- Supply capacity

Rated steam consumption conditions	approx. 12 kg/kg product[1] 10 at for DMT melting 3 for other operations
Maximum product output	approx. 24.2 kg/h
Maximum steam consumption	approx. 290 kg/h
Start up heating requirements	200 % of average consumption
Resulting net boiler output	approx. 600 kg/h saturated steam, 10 atm
Maximum boiler capacity	approx. 350,000 kcal/h with average condensate temperature 80°C

- **Boiler characteristics**

1 compact steam boiler	fired with light fuel oil, net steam output approx. 600 kg/h saturated steam, 10 kg/cm^2, fully automatic operation, adjustable for 20 - 100 % of rated output, complete with burner and blower, feed water pumps, steam separator, safety devices, measuring and control instrumentation, completely wired, internal pipings ready assembled average steam:oil ration 12.5:1 (Wanson data) maximum oil consumption approx. 50 kg/h

- **Accessories**

1 condensate tank, operating pressure; max. 10 atm, temperature max. 180°C

1 oil storage, onground tank, incl. level control and overflow prevention valve, storage capacity: 15 m^3 (sufficient for about 3 - 3.5 weeks of operation)

1 fuel oil service tank for about 1 day's requirements, approx. 0.5 m^3, complete with overflow prevention

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1) Data apply approximately for equipment from Fourné and K. Fischer, Zimmer requires only about 5 kg saturated steam (mainly 10 atm) per kg of fibre but has higher electricity consumtpion.

1 fuel oil feed pump (storage tank to service tank)
1 feed water tank, service tank with supports
1 steel chimney height approx. 100 ft, 350 mm dia
1 condensator and recirculation equipment
1 water pump (soft water tank to boiler service tank)

Potential suppliers for boiler equipment:

- WANSON (India) Pvt. Ltd., Poona

Probable delivery time will be approx. 6 months.

3.3.4. Nitrogen

Nitrogen is required as blanketing gas for the chips production and melt spinning operation with a maximum O_2 content of 3 ppm. The average consumption is given with 0.14 - 0.18 $Stdm^3$ per kg of product with a maximum consumption for scavenging operation 4 $Stdm^3/h$ over short periods of less than 30 min.

The average daily consumption will amount to about 68 $Stdm^3/day$, the maximum daily consumption being about 100 $Stdm^3/day$, for an fibre output of approx. 23 kg/h.

Supply possibilities exist for ultra high purity (UHP) gases inclnitrogen from Indian Oxygen Ltd., Bombay. Its maximum O_2 content is indicated with 4 ppm, it is usually less,so this gas may suffice in quality. Supply is in cylinders of about 6 $Stdm^3$, thus up to 12 cylinders would be required per day. The price of this UHP nitrogen would be roughly 22 $Rs/Stdm^3$.

Because of cost reasons and easier handling it is advisable to use liquid nitrogen, which is available from

- INDIAN OXYGEN Ltd., Bombay
- BOMBAY OXYGEN Ltd., and in the near future also from
- INDUSTRIAL OXYGEN Ltd., Bombay.

It is fabricated according to Indian Standards ISI 1747-1960 with max. 0.5 % O_2, usually 0.2 % O_2 are achieved.

The equipment required for this supply method comprises a liquid nitrogen tank for approx. 20 to 30 days consumption, with a nitrogen vaporizer and a purification unit, designed for the maximum required throughput during scavenging of the autoclave. This equipment is not available in India and therefore included under auxiliary items of the plant specification.

3.3.5. Air Conditioning

Air conditioning has to be provided for the

- spinning room
- take-up room
- yarn conditioning room
- draw-twisting room
- fibre processing room
- products store
- texturising and warp knitting room
- textile laboratory
- offices and lecture rooms

i.e., the total area of the remodeled existing hall plus the spinning plant has to be air conditioned.

Temperature and humidity conditions, being part of the production know-how, will have to be specified by the suppliers. Cooling capacities can only be specified on the basis of the basic plant engineering.

The demonstration plant requires an

- air conditioning plant, complete with air filter, blower, blower drive, complete cooling unit with compressor, condensor, evaporator, air-moistening equipment, outlet air filter, air ducts etc., as to be specified on the basis of the basic plant and detailed building engineering.

As potential Indian contractor BLUE STAR Ltd., Bombay, is recommended (experience from supplies to about over 10 fibre plants). The main part of the air conditioning equipment may thus be supplied from India while all control and measuring instrumentation should be included into the deliveries offered by the plant supplier and is included in the plant specification.

3.3.6. Miscellaneous Equipment

Miscellaneous equipment comprises various items to be contributed to the project by SASMIRA. These items include:

- Ventilator for ventilation of the polycondensation/polymerisation, part of the building, the utility room, the maintenance workshop and raw material store; with blower to be installed on roof top, capacity approx. 30,000 m^3/h

- Air compressor, capacity approx. 100 $Stdm^3/h$, delivery pressure approx. 6 kg/cm^2, with filter, air chamber

  Potential suppliers:
  -- Kirlosker Pneumatic Co., Poona
  -- Atlas Copco India, Poona

- Air compressor for instrument air, oil free operation, dew point -40°C or below, capacity approx. 100 $Stdm^3/h$ delivery pressure approx. 2 kg/cm^3 with filter, air chamber, air cooler

- Transport and storage equipment comprising:

  2 stationary chips silos approx. 5 m^3 each

  2 silo carriages for transporting the movable chips silos

  6 bobbin carriages for transporting bobbins from take-up unit and storing during conditioning period; welded steel tube design, each to carry 40 - 60 bobbins

  8 transport carriages for draw twisting cops, welded steel tube design, each to accept approx. 100 bobbins

  1 glycol storage vessel, atmospheric pressure, with support, with level indicator, filling and discharging armatures, storage capacity approx. 5,000 l

  1 glycol pump, delivery head approx. 40 m depending on detailed layout, with motor and remote control from glycol measuring tank

  div. shelves for laboratory, spinneret cleaning room, raw materials (auxiliaries) and products store

- Weighing equipment: 3 scales 0 - 5 kg, 0 - 10 kg, 0 - 50 kg

- Fire fighting equipment and fire alarm system, number of fire extinguishers,etc.,to be specified with detailed civil and plant engineering

- Travelling crane, width approx. 6 m, lifting capacity approx. 2,000 kg, lifting height corresponding to polymerisation plant height

- Workshop equipment: about six working benches in addition to existing equipment

- Office equipment, lecture rooms equipment according to SASMIRA standards

3.4. Inputs

Calculations of the probable project inputs must be based on an average production output. According to the experience of the Indian industry and the expectations of SASMIRA, the ratio between fibre and filament production will be about 20:80, i.e., it is expected that staple fibres will be manufactured during about 20 % of operating time (= 60 days) and filament during the rest of the operating time. It is assumed that only polyester staple fibres will be produced, this being true for the entire country of the present time. The total thickness of the tow is 3,600 den.

For filaments, the average thickness is 70 den. The normal operating conditions will be a take-up speed of 900 m/min and a mean drawing ratio of 1:3.2. Normally, 8 filaments are spun simultaneously. The plant is expected to operate on at least 300 days/year, 24 hours per day; it will produce staple fibres of an average of 60 days/year and filaments on 240 days/year. It is further expected that 180 days will be utilised for the production of polyamide filaments, whilst the remaining 60 days will be used for polyester filament production.

From these basic data, one can calculate the following production quantities:

Polyamide yarns:

4,320 production hours (180 days x 24 hours)
10.75 kg/hour filament output

46,440 kg/year total output

Polyester yarns and fibres:

1,440 production hours for yarn (60 days x 24 hours)
10.75 kg/hour filament output

15,480 kg/year PE yarn production

1,440 production hours for fibres
21.6 kg/hour fibre tow output

31,104 kg/year PE fibre production

46,584 kg/year PE total production

The consumption data of all main inputs into production for these mean annual outputs are summarised in Table 14. Details of purchasing conditions, sources of supply and prices of the indvidual basic materials are to be found in the following chapter.

Table 14: Estimated Annual Material Input

Materials	Unit Consumption	Annual Consumption
Raw Material		
Caprolactam	1.1 t/t	51.084 t
Ethylene glycol	0.75 t/t	34.938 t
DMT	1.05 t/t	49.913 t
Auxiliaries		
Acetic acid	0.004 t/t	0.186 t
TiO_2	0.08 t/t	0.744 t
Catalyst	0.002 t/t	0.186 t
Spin finish agent	0.02 t/t	1.860 t
Nitrogen	180 Stm^3/t	16,750 Stm^3
Energy		
Power	12,000 kWh/t +87,500 kWh/a	1,202,800 kWh
Steam	11.5 t/t or 0.92 t/t light fuel oil	85.6 t = 92,240 l light fuel oil
Water		
Tap water	24 m^3/t	2,230 m^3
Cooling water	700 m^3/t	65,100 m^3
Miscellaneous		
Hydrochlorid acid	-	2,200 l
Caustic soda	-	0.880 t
Laboratory chemicals, bobbins etc.	-	lumpsum

3.4.1. Raw Materials

- Polyamide production

The polyamide raw material caprolactam is manufactured with the necessary purity (FP = 69.2°C) by the Gujarat State Fertilizer Co. Ltd. (GSFC), Baroda. Once the teething troubles of this plant have been overcome, supplies to SASMIRA will represent no problem, as the quantities required are relatively small and the Ministry for Petroleum and Chemicals has granted a supply priority.

The caprolactam price in India at present lies between about 36,000 and 40,000 Rs/ton, depending on the supply quantities and conditions. About 50 % of this sum are represented by taxes and duties on the product. For SASMIRA, one may assume the lower price. The manufacturer (GSFC) even hinted that cheaper or even free supplies may be possible; this should however not be taken into account in the project evaluation.

Production experience indicates a specific consumption of about 1,100 kg/ton of fibres; according to the plant supplier, this figure also applies for the planned size of demonstration plant.

- Polyester production

The two raw materials, dimethyl terephthalate (DMT) and ethylene glycol, can be obtained from domestic sources. DMT of the necessary purity (FP = 140.6°C) is manufactured by the Indian Petrochemical Corporation Ltd. (IPCL), Baroda, and glycol is supplied by Nocil Ltd., Kalyan. Preliminary purification of the glycol by distillation may be necessary or not, depending on the desired polymer specification and/or polymerisation conditions. Both methods are used in the Indian synthetic fibres industry. SASMIRA will initially be able to process glycol of the supplied quality; purification can if necessary be carried out by member firms which manufacture polyester, or these could supply distilled glycol. Should it still be found necessary to install a glycol distillation plant at SASMIRA, one should select a plant such as that which is manufactured by J.K. Synthetics, for example. This plant is not included among the essential equipment items.

Supply of the raw material presents no problems; the preferential treatment promised by the Ministry for Petroleum and Chemicals applies for DMT also. Sufficient quantities of glycol are available on the market.

The total price of polyester raw materials is similar to that of nylon. DMT at present costs 19,000 Rs/ton, ethylene glycol 12,000 Rs/ton. With a specific consumption of 0.8 ton glycol and 1.1 ton DMT per ton of polyester fibre, the total raw materials costs are 30,500 Rs/ton of fibres.

The tasks in the training sector therefore necessitate a plant which represent the present level of Indian production engineering. The applied research required by the fibre manufacturers, which is not so much to solve individual production problems but to serve mainly for the further development of products and production methods, necessitates that the planned plant be highly modern and that its first stage already includes plant elements which are not yet known in the Indian industry. Examples of such elements are equipment for colour spinning, high speed spinning, two-component spinning or draw texturising. Inclusion of conventional texturising is necessary. Some of these facilities, namely, colour spinning, high-speed spinning and draw texturising should be available from the beginning in order to interest fibre manufacturers in research.

Two-component spinning should be postponed for the meantime. Two-component spinning calls for two separate melting systems, one of which would have to be closed down when spinning only one component. Then polymer residues could crack in the channels of the unused system and lead to long-term malfunctioning of the plant. It is recommended that separate equipment for two-component spinning alone be purchased at a later date.

3.1.1. Specifications

The specifications for the polymerisation and melt spinning plants are to serve as a basis for tendering, and must describe the scope of delivery for apparatus and equipment. The specifications are to be understood as indications for the necessary plant engineering.

The demonstration plant is to be erected and operated under the following local conditions:

- Location

  Bombay, India (in town location), Worli, Dr. Annie Besant Road
  at the premises of Silk and Art Silk Mills Research Association (SASMIRA)
  near sea shore, approx. 20 m above sea level

3.4.2. Auxiliaries

The main auxiliaries for nylon 6 production are acetic acid or - more rarely - formic acid as stabiliser; the average specific consumption is 4 kg/ton. Both products are available in the necessary quality. Polyester production calls for various transesterification and polycondensation catalysts - usually metal salts. The average specific consumption here is about 2 kg/ton; the average price is 40 Rs/kg. Indian products compete with imported catalysts.

Titanium dioxide is used as a dulling agent for both materials, whereby up to 1.5 % (extra full dull) may be added; 0.8 % is assumed as the average titanium dioxide consumption, as the qualities "full dull" (up to 1 % TiO_2) and "extra full dull" (1 - 1.5 % TiO_2) represent only part of the output, and at least tire cord production runs at the "bright" stage. Imported TiO_2 has generally been used until now. At present Indian material is tested.

Numerous grades of spin finishes are manufactured in India, for example, by Messrs. NOPCO India Ltd., Hico Products India Ltd. or AHURA Chemicals Pvt. Ltd. (all in Bombay). The mean consumption value must be assumed as being 20 kg/ton of fibres; the average price is approx. 20 Rs/kg.

3.4.3. Energy

The total energy requirements of the plant are supplied in the form of steam and electrical energy; the breakdown between the two depends on plant design, and will differ somewhat from supplier to supplier. The input calculations are based on average distribution values stated by Fourné. Zimmer has about 60 % higher power consumption but only 40 % of the steam consumption stated below. Blaschke/K. Fischer plants consume only about 40 % of the stated electricity, but about double as much heating and process steam.

- Electricity

The mean power consumption value is about 12,000 kWh/ton of fibres and filaments. On an annual average, this means a daily process energy consumption of 3,720 kWh. To this must be added some 250 kWh/day for general consumption (lighting, pumps for water storage tanks, etc., ventilators, etc.). This part of demands will probably arise on 350 days/year, and therefore represent 87,500 kWh. The maximum consumption is therefore 6,250 kWh/day with an output of 500 kg/day; the corresponding connected load of 260 kW is far below the planned rating increase. Power will be charged for under Tariff Group GP-1, Industrial Rate (0.21 Rs/kWh); apart from a metered charge of 5 Rs/month, there are no fixed charges. SASMIRA will be exempted from any duties payable on supplied electricity.

- Steam

The steam consumption corresponding to the power consumption is stated at 11.5 kg/kg of fibres. This means a probable annual consumption of 1,070 tons of steam, whose generation will call for 85.6 tons of light fuel oil (cf. Chapter 3.3.3.). With an oil density of 0.928 kg/l, the annual consumption is 92,240 l. The present price of fuel oil is 690 Rs/1,000 l.

3.4.4. Water

- Tap Water

Tap water will be needed in the laboratories and for sanitary purposes; the major portion of consumption will however be for the production of demineralised water, mainly for chips extraction. The consumption of ion-exchange-water is estimated at roughly 20 m^3/ton of fibres; an addition of 20 % allows for the direct consumption of tap water for general purposes. Even during operation of the plant, it will only be possible to approximately estimate this cost component, as water will be drawn from the already installed tank and will not be metered separately. Water costs at present amount to 0.8 Rs/m^3 . A separate cost rate for demineralised water is not necessary, as the regeneration costs of the plant are separately calculated.

The acid consumption for one regeneration cycle will probably be about 8 - 10 l (HCl 33 %, commercial grade), whilst the NaOH consumption will be between 3 and 4 kg. The upper limit values were assumed as a precaution. Regeneration water consumption account for about 10 % of the soft water, and is included in the total water consumption. For the purposes of quantity calculations, it is assumed that regeneration will be carried out once per day, i.e., 180 times a year, in nylon production and only on every third day, i.e., 40 times per year, in polyester production. This means 220 generation cycles per year, with a total consumption of 2,200 l HCl and 880 kg NaOH.

- Cooling Water

  Sufficient quantities of cooling water can be drawn from the existent well; no treatment will be necessary. The water is to be circulated through a cooling tower. The specific consumption may be assumed as being 700 m^3/ton. A flat rate of 0.2 Rs/m^3 covers all supply costs.

3.4.5. Nitrogen

Nitrogen purities and supply conditions were discussed in Chapter 3.3.4. The mean specific nitrogen consumption for both products was assumed as being 180 Stm^3/ton. Liquefied nitrogen costs including transport and taxes amount to 4 Rs/Stm^3 (gas volume).

3.4.6. Miscellaneous

The miscellaneous inputs include not only the previously-mentioned regeneration chemicals but also all laboratory chemicals and laboratory apparatus replacements, cops and bobbins, office materials, etc. The costs of these items are difficult to assess individually, and are therefore allowed for with a flat rate sum of 50,000 Rs.

3.5. Project Personnel

There will be a total of 68 Indian staff in the project sections

- Technical Education
- Research
- Production, Plant Operation.

To this figure must be added the head of the new Fibres Division which SASMIRA is to set up. Each of the two sections Technical Education and Research will have a staff of 8 persons, including the section head. The main tasks, responsibilities and functions of the senior staff of these sections are described in Chapter 2.1.2.2. (Training Personnel) and 2.2.3.2. (Research Personnel). The following description of personnel requirements is therefore limited mainly to the Production Section and gives only a summary of the necessary Indian staff. Also stated are requirements of expatriate project personnel, their tasks and qualifications, and the scope of additional training of future Indian project staff abroad.

3.5.1. Indian Personnel

The Production Setion will be responsible for operating the pilot plants for all training, research and production tasks.

The Production Section should be headed by a fibre production expert with a degree in chemical engineering. He should have at least 5 years of industrial experience in the production of synthetic fibres. He will be supported by a textiles technologist as deputy sectional head, four junior chemical engineers, a junior textiles technologist, a mechanical engineer, and 44 workers for the pilot plant.

The main tasks of the sectional head will be:

- Assistance in erecting the pilot plant
- Coordination, planning and control of plant operation for training, research and production purposes
- Planning and control of the maintenance and repair of the pilot plant, utilities and buildings
- Budget control in the production sector
- Observation of technical developments in synthetic fibres production, reviewing of literature and passing on of findings to the staff; long-term, also preparation of modernisation and expansion proposals.

Important individual duties are:

- Assistance in preparing training regulations and work programs, insofar as they affect plant and equipment
- Assistance in preparing experimental arrangements and procedural regulations; assessment of the technical effects of experiments which are applied for
- Assistance in preparing cost estimates for sponsored research projects
- Preparation of manufacturing programs for production activities with the plant
- Supervision of performance of research and training work from the plant engineering aspect
- Supervision and control of production activities
- Preparation of quality regulations
- Ascertainment of the quality of products which are to be marketed

- Control of stocks of raw materials, auxiliaries, fuels and lubricants; support to the Administrative Department of the SASMIRA in buying questions
- Quality control of raw materials and auxiliaries
- Observation of cost developments and budget control
- Personnel planning in the plant engineering sector

The deputy sectional head will also have to have an engineering degree and at least three years of experience in industry. His experience should complement that of the sectional head, i.e., one of the two senior staff should have specialised knowledge in the polymerisation and melt spinning sector, whilst the other should be equally well-qualified in the spinning and yarn engineering sector.

The junior chemical engineers are to act as supervisors in the polymerisation and melt spinning plants and the utility plants. The junior textiles technologist will act as supervisor of the textiles sector - draw twisting, texturising, fibre processing. After university education, these staff should have worked in the synthetic fibres industry for a short time at least.

The mechanical engineer will be responsible for the repair, maintenance and servicing of the entire plant and all auxiliary facilities. His main task will be checking the operational safety measures; these will be particularly important at this plant because of the teaching activities.

As desired by SASMIRA and recommended by earlier project reports, a total of 44 workers for plant operation should be provided. The following allocations to plant sections should be observed:

Plant Part	Operating Staff per Shift	Operating Staff Total
Polymerisation /polycondensation	2	8
Chip drying and transportation	2	8
Spinning plant	1	4
Take-up unit	1	4
Draw-twister/texturising unit	2	8
Staple fibre processing line	2	8
Auxiliary and ancillary plant, mechanical work:		
- mechanics	3	3
- electrical fitter	1	1
Total	14	44

In the interest of smooth plant operations, no savings in operating personnel should be attempted, particularly as these will carry out supervisory duties during training activities at the plant, above all, to ensure plant safety. The only possible saving would appear to be in the textiles engineering section of the plant, two persons per shift, i.e., a total of 8 workers, if the staple fibre plant is not operated with bought fibre tow. It would then be possible for two workers per shift to alternately operate the draw twisting and texturising machine or the staple fibre plant.

From the personnel requirements described above, one arrives at the following organisational structure of the Production Section:

Production section head (chemical engineer)	1
Deputy section head (chemical or textile engineer)	1
Plant superintendents (chemical engineers)	4
Plant superintendent (textile engineer)	1
Plant maintenance engineer (mechanical engineer)	1
Plant workers	44

The overall project will therefore have the following establishments in its three sections:

Division head	1
Section heads	3
Deputy section heads	3
Scientific and teaching staff	11
Technical staff	[illegible]
Plant workers	44
Total staffing	72

3.5.2. Fellowships

The senior Indian project staff should be given the opportunity of supplementing the experience they have gathered in the Indian industry with advanced training at foreign production and research facilities.

Fellowships should be granted to the

- Head of Fibres Division (Plant Manager)
- Head of Research Section
- Head of Production Section

The qualifications of these persons are described in Chapters 2.2.3.2. "Research" and 3.5.1 "Project Operation". These chapters also state the future tasks of these persons, and should be used as guideline in determining the details of the fellowships.

We recommend at least 6 months of such additional training, provided that the recruited staff fully meet the minimum requirements stated in the above-mentioned chapters. According to the project time schedule, these fellowships should take place during the 12th - 18th project months.

In the case of the Head of the Production Section, the main accents should be placed on production technology and plant operation. This training should therefore be given by an experienced fibre manufacturer. The same applies for the Head of Fibres Division, who should be given a shorter introduction to plant operation in the form of a practical course, and also the opportunity of familiarising himself with research and teaching in the synthetic fibres sector.

Additional training for the Head of the Research Section should concentrate on the fibres research sector.

Advanced training in the research sector should preferably also be given by an experienced fibre manufacturer. Experience in the chemical industry and particularly also in the synthetic fibres industry however indicates that there may be little chance of obtaining a fellowship in industry. It may possibly be necessary to limit oneself to additional training at a textiles technology department of a university in Europe or the USA.

Preparedness to make fellowship posts available must first be awakened in the synthetic fibres industry. To do this, it will be necessary for the project coordinator (UNIDO) to approach the managements of leading fibre manufacturing companies in his official capacity. Whether these firms will raise charges for providing such training facilities cannot be determined at the moment. Excluding this potential cost component, a fellowship would probably give rise to the following costs:

Travelling expenses	1,800 US $	for flights and travelling in country of fellowship
Daily allowances 180 days à 30 US $	5,400 US $	
Total	7,200 US $	

The total costs of the three fellowships would therefore amount to 21,600 US $. This amount is to be made available from UN/FRG funds. In addition, the Indian project partner would have to pay the domestic salaries of the three staff members.

Independent of the fellowships for the senior staff, three or four of the junior engineers of the future Production Department should be instructed in the operation of the project's pilot plant by its manufacturer, either at the manufacturer's own pilot plant or in the factory of one of its customers. This could give rise to accomodation and travelling costs of 2,850 US $ per person for a 6-week stay in Europe (FRG), i.e., total costs of 11,400 US $ for four junior engineers.

The provision of such training and possibly grants by the plant supplier will be subject to negotiation when discussing the contract.

The maximum amount for the training of SASMIRA staff overseas would therefore be 33,000 US $.

3.5.3. Foreign Experts

Experienced experts will be needed during the initial phase of the project to advise SASMIRA during construction of the plant and, thereafter, support SASMIRA with know-how in the project's research, production and teaching activities. Three posts are foreseen for this purpose, namely, the Chief Project Advisor and two Synthetic Fibre Technologists.

The Chief Project Advisor shall advice SASMIRA on all technical questions and assist in reaching decisions whilst the project is being implemented. Thereafter, he shall support the future Head of the Fibres Division. The following job description states the employment prerequisites, qualifications and main tasks of this advisor:

Post Title:	Chief Technical Advisor
Duration:	One year with possibility of extension
Date required:	January 1976
Duty station:	Bombay, with travels throughout India
Purpose of project:	To asist in the establishment of a demonstration and pilot plant for polyamide and polyester fibres, their treatment and finishing, to advance technical capability in the operation of existing and planned refineries and marketing of their products for the production of synthetic fibres (polyamide and polyester) at SASMIRA.

Duties:

Primary

A) During planning and execution period

- Participation in evaluating offers for pilot plant equipment
- Assistance in elaborating the final plant and building layout including utility installations
- Continuing follow-up of the time schedule for building and plant erection
- Assistance in detailed plant engineering including final selection of utility installations

B) During construction and erection

- Assistance in selecting plant erection contractors
- Participation in the final plant commissioning
- Reporting to UNDP, New Delhi, UNIDO and FRG Government on progress[1]

C) During operation period

- Assistance to the Indian co-project manager in running the fibre division
- Assistance in planning of plant operation including training and applied research
- Advise on supervision of plant operation and co-ordination of all activities of the production, training and research departments
- Co-ordination of the assistance by other expatriate experts
- Planning, execution and control of counterpart training
- Final project evaluation and recommendations on project continuation prior to phasing out of expatriate experts

1) Subject to the final agreement between all parties concerned

Secondary

- Assist in liaison work and co-operation with other institutions in the country on matters related to synthetic fibres

Qualifications:

Essential

Post graduate degree (M.E. or Ph.D.) in chemical engineering, chemistry or related fields.

Desirable

In planning, construction and erection of chemical plants preferably in developing countries

Language: English

Background information: To be completed after finalization of FGU-KRONBERG (PAG-mission) report in consultation with UNDP, FRG and GOI

The tasks which this advisor will have to carry out during the project erection phase necessitate that he begin his duties as early as possible. The period of duty is to be four years. Replacement after two years appears not advisable. Detailed planning of project work including final selection of the project equipment and responsibility for implementation of the planned works should be placed in the hands of one person, in order that construction of the plant harmonises with the ideas of the Chief Technical Advisor on project work in the training and research fields.

This schedules requires the chief advisor to be available for at least four or five years and it may be difficult to negotiate such a long term contract. In this case a solution may be to employ an engineering expert in charge for all plant erection aspects. Nevertheless this possibility also requires to have identified the future Chief Technical Advisor since his personal views and suggestions are required when selecting the plant equipment (plant suppliers) and during the engineering and erection phase he should act as an advisor and assist SASMIRA in important decision-making phases without being present in Bombay for longer periods, In either case, the Chief Technical Advisor will have to be engaged immediately. Finding and selecting such an expert is therefore the first important project preparation task.

Apart from the Chief Project Advisor, two Technical Advisors are to be engaged for the research and production (plant operation) sectors. Both technical advisors should hold engineering degrees. The advisor for the research sector should have experience in fibre chemistry too, most of the research tasks will probably concern problems of production technology.

- Climatic conditions

Tropical climate, heavy monsoon rainfalls during June to November

average annual rainfall 1000 mm
average annual relative humidity [illegible] %

Monthly temperatures (

	average	maximum	minimum
January	24.1	26.1	24.0
February	[illegible].9	27.1	25.0
March	26.9	27.9	26.8
April	29.8	30.2	28.7
May	30.1	31.1	30.[illegible]
June	30.2	32.0	29.1
July	28.2	29.[illegible]	[illegible]
August	27.8	28.0	27.1
September	27.4	28.1	27.0
October	28.1	28.0	27.1
November	27.5	27.5	25.0
December	25.[illegible]	25.9	25.0

- Cooling water conditions

Available supply: 3000 gph = 13.5 m³/h
from tube well, approx. 240 ft = 73 m depth

doubling of supply is possible by drilling a second well; same conditions

Temperature: from well approx. 29 - 30 °C

max. temperature for recycled water approx. 30 - 32 °C (after cooling tower; experience at neighbouring industry)

Hardness: average approx. 100 ppm total hardness
maximum: 186 ppm[1]

Salinity: average 0.013 % total salt content
maximum 0.154 % total salt content[1]

- Tap water

Installed supply capacity: 40,000 gpd (180 m³/day) from municipal supply system; supply irregular for several hours per day, storage tank for 40,000 gal (180 m³) available
Maximum temperature (in storage tank) approx. 32 °C
Hardness: 20 - 26 ppm

1) The maximum figures are observed for short periods after start of pumping following periods of disuse.

The advisor for the production sector should have as broad as possible experience in the synthetic fibres industry in order to be able to cope with the changing tasks at the plant. These two advisors should remain on location for two years, beginning with the date of completion of the plant, i.e., probably after 22 - 24 project months.

The following job descriptions state the qualifications, necessary experience and main tasks of the Technical Advisors.

Advisor to the Head of Production Section

Post Title:	Technical Advisor: Synthetic Fibre Engineer
Duration:	24 man months
Date required:	Latest from 24th project month onwards, i.e., as tentatively scheduled from end 1977/beginning of 1978
Educational background:	Engineering degree (M.E.) in Chemical Technology, Fibre Technology or related fields
Professional experience:	At least 5 years experience in synthetic fibre production, covering polymerisation, melt spinning and drawing of polyamide and polyester fibre material; with expert knowledge in operation and maintenance of polymerisation and spinning equipment
Main functions:	- Assisting the Head of Production Section in all day-to-day questions of running the demonstration plant - Establishing of operation programs for the plant including start up and shut down operations as a basis for plant operation and training performance - Establishing a program for preventive plant maintenance as well as repair instruction - Training of plant personnel in operation and maintenance of the plant and equipment - Assisting the Section Head in elaboration of training program, in designing research operations and specific equipment and in costing of sponsored research tasks - Assisting in planning of production programs, supervision of production activities, control of product quality, planning of inputs requirements and storage - Final evaluation of plant operation during assignment and recommendation for continuation

Advisor to the Head of Research Section

Post Title:	Technical Advisor: Synthetic Fibre Technologist
Duration:	24 man months
Date required:	From 24th project month onwards, i.e., as tentatively scheduled from end 1977/ beginning of 1978
Educational background:	Engineering degree (M.E.) in Fibre Technology, Chemistry or Chemical Engineering
Professional experience:	At least 5 years experience in applied research related to synthetic fibres, possibly also fibre production; with knowledge of polymer chemistry, spinning operations and filament (fibre) to yarn processes
Main functions:	- Assisting the Head of Research Section in all day-to-day questions in applied research work - Assistance in planning and equipping plant laboratories - Establishing of standard research instructions in fibre technology and fibre chemistry - Training of research staff in performing standard and specialised research operations - Assistance to the Section Head in designing research operations and costing of research tasks - Assistance in supervising research operations - Assistance in evaluating and interpreting research results - Assistance in preparation of research reports - Final evaluation of research tasks performed during the assignment and recommendations for continuing work

It is estimated that these advisory services will cost a total of

360,000.-- US $.

This cost figure derives from the following calculation:

Chief Project Advisor

48 man-months à 3,000 US $ each		144,000 US $
Travelling expenses: 4 flights		6,000 US $
travelling in India for familiarisation with fibre industry		2,000 US $
	Total	152,000 US $

Synthetic Fibre Engineer (Production Section)

24 man-months à 3,000 US $ each		72,000 US $
Travelling expenses: 2 flights		3,000 US $
	Total	75,000 US $

Synthetic Fibre Engineer (Research Section)

24 man-months à 3,000 US $ each		72,000 US $
Travelling expenses: 2 flights		3,000 US $
	Total	75,000 US $

Total expected expenses for expatriates	302,000 US $

Most probably the budget figure of 3,000 US $ per man-month will not suffice to employ highly qualified experts having long experience in fibre industry. We therefore suggest to care for a rather high provision for contingencies of approximately 20 %, thus leading to the total advisory costs of 360,000 US $.

Furthermore a provision is made for local transport for expatriates amounting to 100 US $ per man month. This share should be contributed by the Government of India.

3.6. Time Schedule and Work Plan

The project has three main phases:

- the project starting phase,
- the project construction phase, and
- the project operation phase.

The timing of the main individual activities are shown in the bar chart (Fig.9).

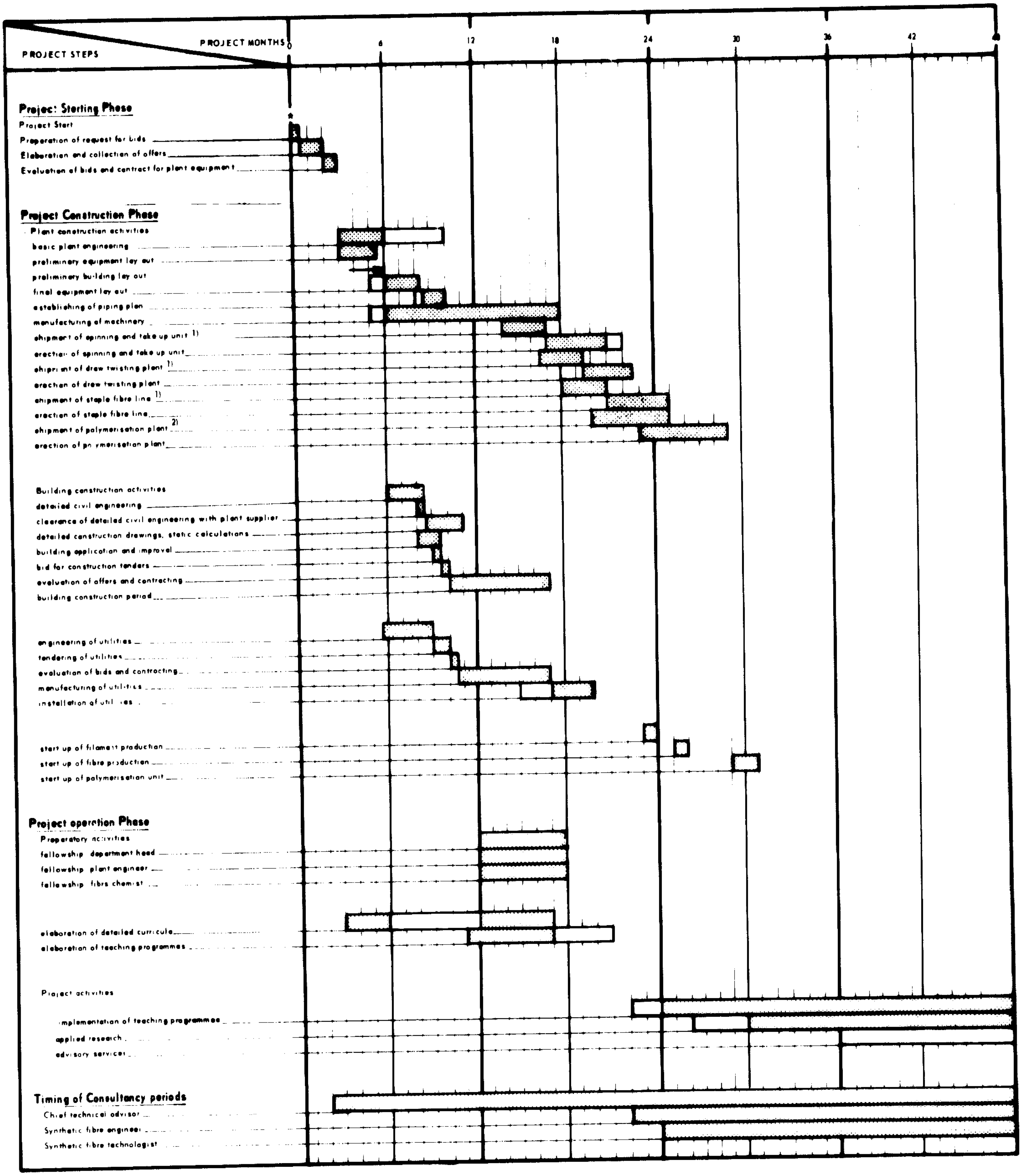
The project starting phase - between the formal commencement of the project and the awarding of contracts for project works - will consist mainly of the tender procedure, contract negotiation and - the most important activity - the engagement of the Chief Project Advisor. The search for a Chief Project Advisor must begin earlier, during the project preparation phase. The aim is to have him on location by two months after commencement of the project at latest, in order that he may participate in the selection of project equipment.

The project construction phase begins with awarding of contracts, and consists mainly of building construction activities and plant installation. The installation and starting-up of individual plant sections should be phased in such a way that first the melt spinning and take-up machines, then the draw twisting plant, than the staple fibre line, and finally the polymerisation plant are installed. The melt spinning plant could thus begin operation with purchased chips whilst the polymerisation plant is being built.

As to planning of the building, plant designing will have to be about two months in advance of construction activities because the draft for the building can first be prepared when the basic engineering works are carried out; this draft is then to be used by SASMIRA in preparing a detailed construction plan. The final drawings of the building will have to be agreed with the plant supplier and approved by the appropriate municipal authority in Bombay.

In view of the present level of underemployment, the architects estimate the minimum construction period to be 6 - 8 months. Seven months were assumed in the time schedule (Fig. 9), so that this will probably be the main bottleneck in the project construction phase. One should therefore look for ways of saving time during the construction preparation phase, and begin work on the detailed construction drawings as early as possible.

Fig. 9: Project Time Schedule



1) Shipment anticipated via Suez plus one month for customs clearance in India and transport to site.

2) Two shipments within two months assumed

It will only be possible to start up the melt spinning plant after 14 project months if the deadlines for construction activities are strictly observed.

Preparation for the project operation phase must begin whilst the plant is being built. The main preparatory activities will include the elaboration of detailed curricula and lecture manuscripts for all planned course. The project leader should begin this activities after ordering the plant, in order to fill out the time until advisory and supervisory duties connected with construction work begins. The project leader should utilise later free time during the construction period to prepare detailed course timetables. The project activities proper begin when the plant is commissioned, which will presumably be possible after 24 project months. Training activities can begin about 2 months earlier, so that basic training has been completed by the time the plant goes on stream. The research activities should begin later, at some time between the 26th and 30th project months.

The fellowships and the training of SASMIRA counterparts should be so timed that no longer period lies between the end of training and the commencement of operations.

If this time schedule is observed, the total project period will be four years, including two years' implementation phase. A further two years will then be available for project work and counterpart training. If the formal project commencement is on 1st January 1976, the project could according to this time schedule be handed over in late 1979.

The relationships between the individual project realisation stages during the construction phase and the several responsibilities are shown in the network plan (Fig. 10) and the legend (Table 15). To simplify, divided responsibilities were allocated to the offices which are mainly responsible, for example, shipment and customs clearing was allocated to the plant supplier, although customs formalities will have to be carried out by SASMIRA, whilst plant installation was allocated to SASMIRA, although the plant supplier will assist and collaborate with SASMIRA in awarding sub-contracts.

The critical path in this network plan, i.e., the determinant sequence of individual activities, passes through Points 0, 1, 4, 7, 8,10 , 11, 13, 14 and 30 - 37. Implementation of the project stages along this critical path can be expected to take 130 weeks.

Fig. 10: Network Plan for the Main Activities During the Project Construction Phase

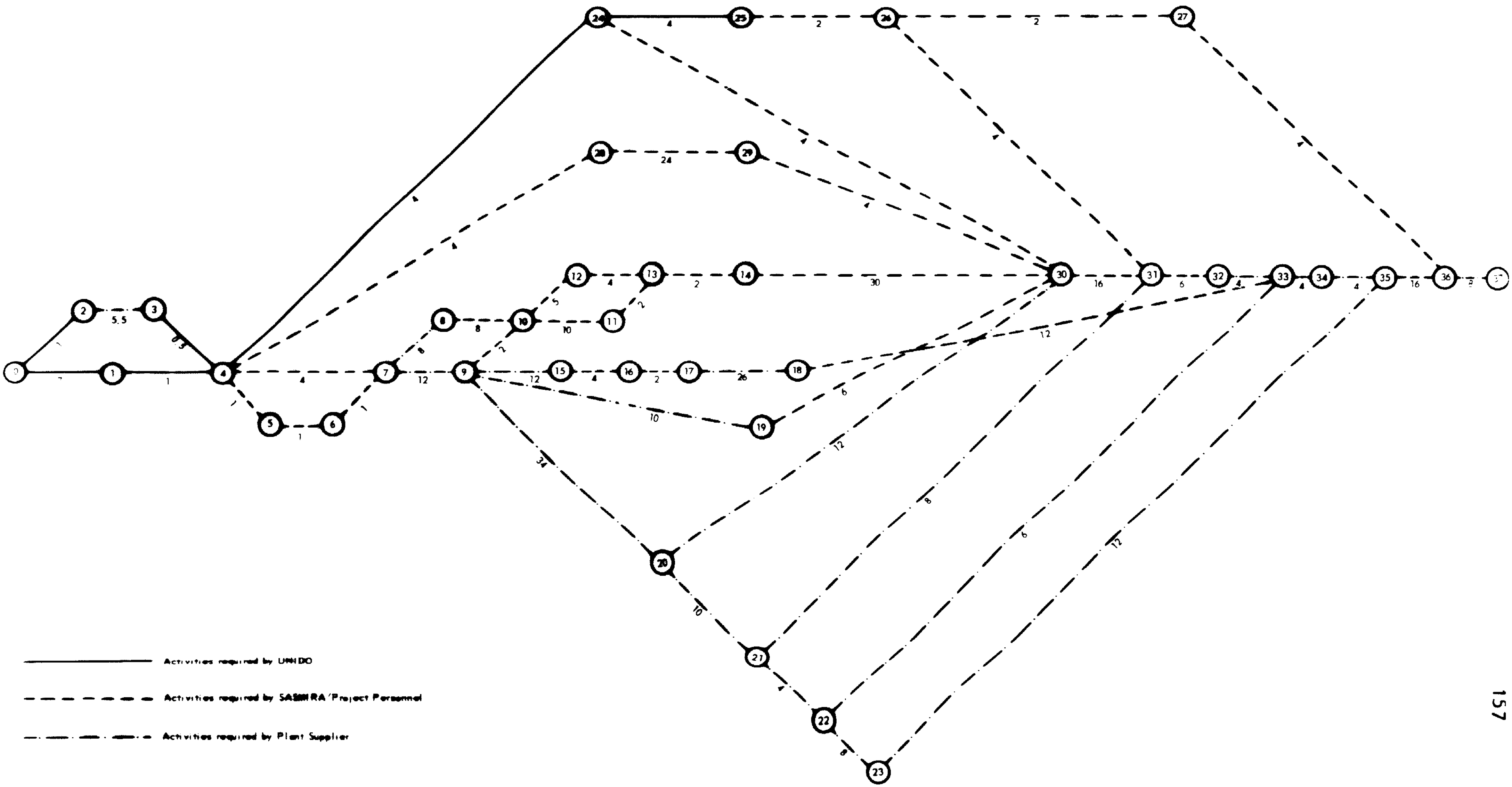


Table 15: Legend of Net Work Plan for the Project Construction Phase

Step Number in Network Plan	Activity	Time (w)
0	Formal start of project	
0 / 1	Identification of the chief technical advisor (to be started already prior to formal project beginning)	7
0 / 2	Preparation of request for bids for plant equipment	1
2 / 3	Elaboration of offers for plant equipment	5.5
3 / 4	Collection of offers for plant equipment	0.5
1 / 4	Contracting of chief technical advisor	1
4 / 7	Evaluation of bids and contract for plant equipment	1
4 / 5	Identification of suitable civil engineering company	1
5 / 6	Selection of civil engineering company	1
6 / 7	Contracting of civil engineering company	1
7 / 8	Preliminary building layout	8
8 /10	Detailed civil engineering	8
10/11	Detailed construction drawings and static calculation	10
10/12	Sanction for construction	5
12/13	Approval procedure for building permit	4
11/13	Tendering of building construction work	2
13/14	Evaluation of bids and contracting	2
14/30	Erection of building	30
7/ 9	Basic plant engineering and preliminary equipment layout	12
9/10	Clearance of detailed civil engineering with plant supplier	2
9/15	Engineering of utilities	12
15/16	Tendering of utilities	4
16/17	Evaluation of bids and contracting for utilities	2
17/18	Manufacturing of utilities	26
18/30	Installation of utilities	12
9/19	Final equipment layout	10
19/30	Designing of piping plan	6

Table 15, continued

Step Number in Network Plan	Activity	Time (w)
9/20	Manufacturing of machinery I (completion of spinning and take-up equipment, start of construction work for draw twister, staple fibre line and polymerisation equipment)	34
20/30	Shipment and custom's clearance: Spinning and take-up	12
20/21	Manufacturing of machinery II: Completion of draw twisting equipment, staple fibre line and polymerisation	10
21/31	Shipment and custom's clearance: Draw twisting equipment	8
21/22	Manufacturing of machinery III: Completion of staple fibre line; polymerisation plant	4
22/23	Manufacturing of machinery IV: Completion of polymerisation plant	8
4/24	Identification of 2 experts	4
24/25	Contracting of 2 experts	4
25/26	Selection of personnel I: Spinning, take up, draw twister, staple fibre line	2
26/27	Selection of personnel II: Polymerisation plant	2
4/28	Identification of counterparts, incl. contracting	4
28/29	Fellowships' training abroad	24
29/30	Fellowships' training at SASMIRA	4
24/30	Familiarising of experts at SASMIRA	4
26/31	Training personnel I	4
27/36	Training personnel II	4
30/31	Erection of spinning plant	16
31/32	Erection of draw twister	6
32/33	Start up of filament production from bought chips	4
22/23	Shipment of staple fibre line	6
23/35	Shipment of polymerisation plant	12
33/34	Erection of staple fibre line	4
34/35	Start up of staple fibre production from bought chips	4
35/36	Erection of polymerisation plant	16
36/37	Start up of polymerisation and switching from bought chips to self producing ones	8

4. Project Financing

Investment costs for the plant and the operation costs will jointly be born by UNIDO, the Government of the FRG and the Government of India. The amounts due, the possible returns of the project operation as well as allocation and utilisation of funds are described in the following.

4.1. Expenditures and Revenues

4.1.1. Investment Costs

The project investments can be allocated to three categories, namely:

- Investment costs for plant equipment and erection
- Investment costs for utilities and accessories
- Investment costs for land and buildings

The largest and most important investments are those for the plant. Three bids for the supply and erection of the pilot plant were received in 1973 and 1974.

Since this time, the costs of equipment have increased considerably, and the Indian fibre industry's know-how has grown to a point where more modern and comprehensive equipment must be recommended, i.e., additional equipment for high-speed spinning, draw texturising, conventional texturising and colour spinning should be installed.

Table 16 gives an updated summary of the cost situation for the recommended equipment. The cost data given in the table are based on non-binding figures quoted by plant suppliers, and consist in each case of the equipment previously bid for, supplemented by cost estimates for additional equipment.

Electricity

440 V, 3-phase, 50 Hz
existing connected load: 400 kVA
planned extension for pilot plant: 400 kVA

- Plant concept

The plant is to be of the general-purpose type; batchwise polymerisation of nylon 6, nylon 66 and polyester must be possible.

It must be possible to spin all three materials to textile and technical filaments and staple fibre tow. The take-up unit has to cover both speed ranges: high-speed spinning - draw winding - as well as the conventional spinning speed range.

Draw twisters are to be provided for both textile and technical yarns. Their capacity is to match the maximum output of the spinning plant.

Texturising equipment is to be provided for textile filaments The equipment is to facilitate both conventional texturising of draw-twisted yarns and also draw texturising of high-speed spun yarns.

A complete two-stage drawing line is to be planned for the further processing of staple fibre tow.

The capacity of the polymerisation plant is to be harmonised with the maximum output of the spinning plant, so that the production of staple fibre or tire cord will be possible even over longer periods, The capacity guide value is 500 kg/day.

The average annual operation will be polyamide production during two periods of three months each and polyester production during two periods of two months each.

Table [illegible]: Investment Costs for Plant Equipment and Erection

	[illegible]-Equipment			[illegible]/[illegible]-Equipment			Z[illegible]-Equipment		
	PRC-[illegible] Expenditures		Indian Exp	PRC-[illegible] Expenditures		Indian Exp	PRC-[illegible] Expenditures		Indian Exp
	DM	US $	Rs	DM	US $	Rs	DM	US $	Rs
		([illegible])							
Machinery Costs									
- Polymerisation polycondensation equipment	[illegible]350,[illegible]	[illegible]07,[illegible]	-	[illegible],8[illegible]5,000	7[illegible],000	-	[illegible],7[illegible],[illegible] 10)	[illegible]	-
- Spinning and take-up unit									
-- conventional unit: [illegible] m/min	52[illegible],[illegible]	[illegible]	-	[illegible]2[illegible],000	183,000	-	[illegible]	[illegible]	-
-- additional costs for high speed spinning equipment, up to 3,5[illegible] m/min	29o,000	[illegible]26,000	-	32[illegible],000	[illegible]39,000	-	350,000 1) [illegible] 2)	[illegible] [illegible]	- -
- Draw twisting equipment	[illegible]5[illegible],[illegible] 1) [illegible]05,000 2)	37o,[illegible] [illegible]7,000	-	[illegible],400,000	[illegible],000	-	400,000 34,000 11)	[illegible] 15,000	
- Texturising equipment	[illegible]0,000	[illegible]3,000	-	600,000	261,000	-	[illegible]	[illegible]	-
- Staple fibre line	75o,000 3)	326,[illegible]	-	735,000 7)	32o,000	-	[illegible]	[illegible]	-
- Auxiliary equipment	[illegible],000 4)	70,[illegible]	-	325,000	141,000	-	[illegible] 7)	[illegible]	-
- Spare parts	500,000	217,000	-	300,000	130,000	-	630,000 4)	274,000	-
- Laboratory equipment			-			-			
-- textile laboratory -- chemical laborvtory	300,000	130,000	-	300,000	130,000		300,000	130,000	-
- Engineering fees (basic engineering)	inclusive	inclusive	-	inclusive	inclusive	-	781,000	340,[illegible]	-
- Measuring and control equipment for air conditioning plant	60,000	26,000	-	60,000	26,000	-	60,000	26,000	-
Subtotal equipment fob	6,045,000	2,628,000	-	6,275,000	2,727,000	-	8,502,000	3,696,000	-
Insurance, freight, handling and clearing costs (estimated: 1o % of equipment)	600,000	261,000	-	627,000	273,000	-	212,000 12)	92,000	-
Total equipment costs cif Bombay	6,645,000	2,889,000	-	6,902,000	3,000,000	-	8,714,000	3,788,000	-
Transport to site, lumpsum	-	-	5,000	-	-	5,000	-	-	5,000
Erection costs:									
- Detailed engineering fees	-	-	900,000 5)	275,000 8)	12o,000	1,240,000 5)	-	-	[illegible],000,000 12)
- Erection supervision + start up	400,000	174,000	-	150,000 9)	65,000	-	900,000	392,000	-
- Erection labor and materials	-	-	3,462,000 6)	-	-	4,160,000 6)	-	-	3,300,000 12)
Subtotal erection and start up expenses	400,000	174,000	4,367,000	425,000	185,000	5,405,000	900,000	392,000	5,305,000
Contingencies 1o % of total	7o5,000	306,000	437,000	733,000	318,000	540,000	960,000	417,000	53o,000
Total investment costs for plant equipment	7,75o,000	3,369,000	4,804,000	8,060,000	3,5o3,000	5,945,000	1o,574,000	4,597,000	5,835,000

1) Draw twister for textile yarns
2) Draw twister for industrial yarns
3) Includes accessories for meltspinning unit plus nitrogen storage and purification
4) Estimated at 1o % of equipment (excl.laboratory, control instruments, auxiliary equipment); sufficient for 2 years operation
5) Estimated figure for detailed engineering of polymerisation plant only (approx.2o % of equipment). Engineering for melt spinning and downstream equipment included in equipment costs.
6) According to manufacturers experience: approx. 2o % of equipment costs (cif) excl. laboratory equipment and spare parts
7) Auxiliary equipment and accessories for melt spinning, take up, draw twisting, fibre line plus nitrogen storage and purification and dyestuff preparation
8) Supervision of erection of polymerisation plant (manufacturer's estimate)
9) Estimated supervision expenses for melt spinning and downstream units
1o) Two separate polymerisation lines (engineering fees separate)
11) Operating material for draw twister and take up
12) Plant manufacturers estimate

The bid sums of the three firms differ considerably, between

- approx. 6.6 million DM cif Bombay resp. 7.75 million DM incl. erection and contingencies (Fourné)
- approx. 6.9 million DM cif Bombay resp. 8.06 million DM incl. erection and contingencies (Blaschke)
- approx. 8.7 million DM cif Bombay resp. 10.574 million DM incl. erection and contingencies (Zimmer)

The equipment offered by Zimmer approximates industrial equipment best. Messrs. Zimmer, which does not normally offer or build such pilot plants, thinks that the SASMIRA plant will provide good facilities for training the operating personnel of plants which it or its cooperation partners build in future in South-East Asia. This harmonises with the idea of internationalisation which SASMIRA advocates. The relatively high price of the Zimmer plant results from the fact that Zimmer as a pure engineering company has equipment manufactured to its own design and invoices its own engineering services separately; on the other hand, because of Zimmer's more comprehensive know-how, the plant offered is of higher quality.

The plants offered by Messrs. Fourné and Blaschke on the other hand are designed for experimental operation and therefore somewhat more versatile. This is of interest in view of SASMIRA's planned research activities.

In view of the project target "training", one should first attempt to obtain the most production-orientated plant concept possible for the SASMIRA, as is guaranteed in the plant offered by Zimmer. On the other hand, the plant is not to mainly manufacture an industrial, marketable product within close specification tolerances but

- is to produce experimental quantities of yarns, filaments or staple fibres within given specification limits,
- reproduce and further new developments in polyester and nylon processing, and
- investigate their transfer to the production scale.

From these viewpoints, a versatile plant conception such as offered by Fourné is more recommendable. The final decision should be postponed until after new bids have been obtained.

For calculating the estimated total project costs the updated figures of the Messrs. Fourné will be used in the following.

Table 17: Investment Costs for Utilities and Accessories from Indian Sources

Item	Estimated Investment Costs	
	Indian Rs	US $ (rounded figures)
Air conditioning and cooling plant		
- Equipment	2,200,000[1]	282,000
- Erection and installation	500,000	64,100
Water supply facilities	6,000[2]	800
Ion exchange unit	55,000	7,000
Energy supply and internal distribution	100,000	18,000
Steam boiler and accessories	200,000	25,600
Ventilation equipment	60,000	7,700
Compressors	100,000	12,800
Transport and storage equipment	100,000[3]	12,800
Weighing equipment	12,000	1,500
Fire fighting	50,000[3]	6,400
Travelling crane	80,000	10,300
Workshop equipment	6,000[3]	800
Laboratory furnishings	20,000	2,600
Office equipment and furnishings	20,000[3]	2,600
Contingencies approx. 10 %	351,000	45,000
Total	3,900,000	500,000

1) Estimated budget price for equipment including cooling tower and refrigeration equipment and engineering, excl. duty. Excise duty may be exempted, otherwise 50 % = 1,000,000 Rs will have to be paid.
2) For additional well pumping equipment only, storage facilities included in building costs.
3) Budget figures.

Table 18: Investment Costs for Land and Buildings

	Estimated Investment Costs	
	Indian Rs	US $ (rounded figures) Equivalent
Land and existing building		
Area for new building and surrounding 670 m² à 450 Rs	301,500	38,700
Project area in existing building 936 m² à 450 Rs	421,200	54,000
Value of existing building 936 m² à 300 Rs	280,800	36,000
Total project contribution in kind	1,003,500	128,700
Building costs (reconstruction and new building):		
Excavator's work	4,700	600
Concretor's work	265,000	34,000
Masonry work	51,500	6,600
Steel work	233,400	30,000
Carpentry work	20,500	2,600
Plaster and painting work	84,600	10,800
Flooring work	94,100	12,100
Plumbing, sanitation and electric lighting points	100,000	12,800
Ventilation, air conditioning ducts,insul.	300,000	38,500
Industrial elevator	150,000	19,200
Engineering fees, miscellaneous charges	65,000	8,300
Total expected construction costs	1,368,800	175,500
Contingencies 10 %	136,900	17,500
Building costs	1,505,700	193,000
Total buildings and land	2,509,200	321,700

The probable costs of the ancillary plants and utilities are summarised in Table 17. Including a contingency allowance of 10 %, they amount to about 3.9 million Rs or 500,000 US $. At the present level of information, only budget quotations of relatively low accuracy are applied for this part of the investments, as the final engineering of the plant has not yet been worked out. This concerns mainly the plant sections air-conditioner, ventilation, and to a lesser extent, also steam generator, compressors and energy plant.

The construction costs calculated from the specification (cf. Chapter 3.2.3.) are summarised in Table 18. In determining these costs, it was assumed that provision of land and the existent buildings is to be included in the project investments. The valuation of this component was based on the present land prices in the suburb of Worli, Bombay: approx. 450 Rs/m^2. The land area assumed was that of the hall section which is to be converted and the area available for the new building, i.e.,the base area of the new building (approx. 190 m^2) and its immediate surroundings (approx. 380 m^2). The value of the existent building was assumed as being 50 % of the present value of a new building, approx. 600 Rs/m^2.

The resultant construction costs amount to about 2.5 million Rs, of which approx. 1 million Rs will have to be provided in the form of equipment and materials.

Current costs for foreign experts and the costs of the fellowships for three Indian project staff also have investment character; they will probably amount to a total of 402,600 US $.

The total of the several investment cost items will be

5,210,000 US $

if the project equipment is supplied by Messrs. Fourné. If the equipment is supplied by Messrs. E. Blaschke, the total investments will amount to

5,490,000 US $.

The highest project investment will result if a decision is made in favour of the Zimmer plant, namely

6,570,000 US $.

4.1.2. Operation Costs

The operation costs are made up of the four components:

- Raw material and utility costs
- Labour costs
- Maintenance and repair costs
- Insurance costs

The raw materials account for by far the greater part of the operating costs, some 3.188 million Rs per year; the annual utility costs amount for 532,000 Rs (cf. Table 19). These cost rates are based on the probably average annual inputs stated in Table 14. One must remember that every change in average operating conditions such as could for example be necessitated by experimental operations will lead to considerable cost fluctuations because of the extremely high raw materials prices. For example, increasing the mean spinning speed from 900 to 1,200 metres per minute would lead to a cost increase of about 1.2 million Rs/year.

Increases in raw material prices are not to be expected during the term of the project, as any cost increases will probably be balanced out by the expected reductions in the tax on caprolactam. Past experiences have shown that utility costs however increase by about 10 - 15 % every three years. This is accounted for by increasing the applied utility costs rate after the third project year, i.e., during the second year of operation of the plant, by 79,800 Rs to 611,800 Rs/year.

The annual labour costs will probably amount to about 740,000 Rs. About 36 % of this sum will be accounted for by the 44 workers of the pilot plant (cf. Table 20).

One may expect that only the Head of the Fibres Division and the sectional heads will have to be paid a full year's salary already during the first project year. Together, they will receive 163,200 Rs, or 22 % of labour costs. During the second year, as the number of staff increases, personnel expenditure may possibly increase to 50 % of the expected overall wage costs. The full annual wage sum shown in Table 20 will first have to be paid during the third project year.

Table 19: Estimated Annual Raw Material and Utility Costs

Mate.	Annual Consumption	Unit Price	Annual Costs Rs/year
Raw Materials			
Caprolactam	51.084 t	36,000 Rs/t	1,839,024
Ethylene glycol	34.938 t	12,000 Rs/t	419,256
DMT	49.913 t	19,000 Rs/t	929,351
Subtotal Raw Material Costs			3,187,631
Auxiliaries			
Acetic acid	0.186 t	7,000 Rs/t	1,302
TiO_2	0.744 t	11,000 Rs/t	8,184
Catalyst	0.186 t	40,000 Rs/t	7,440
Spin finish agent	1.860 t	30,000 Rs/t	55,800
Nitrogen	16,750 Stm^3	4 Rs/Stm^3	67,000
Energy			
Power	1,203,800 kWh	0.21 Rs/kWh + 60 Rs meter charge	252,860
Steam	85.6 t = 92,240 l light fuel oil	690 Rs/1000 l	63,646
Water			
Tap water	2,230 m^3	0.8 Rs/m^3	1,784
Cooling water	65,100 m^3	0.2 Rs/m^3	13,020
Miscellaneous			
Hydrochloric acid	2,200 l	3 Rs/l	6,600
Caustic soda	0.880 t	5,000 Rs/t	4,400
Laboratory chemicals, bobbins, etc.	lumpsum	-	50,000
Subtotal Auxiliaries and Utilities			532,036
Total Materials and Utilities			3,719,667

Table 20: Annual Wages and Salaries of the Fibre Division's Staff

Dept. Code	Position	Monthly Salary Rs	Number of Staff	Annual Personnel Costs Rs
1	Pilot Plant Manager	4,000	1	48,000
2	Section Head Technical Education	3,600	1	43,200
3	Section Head Research	3,000	1	36,000
4	Section Head Production	3,000	1	36,000
2	Lecturer Fibre Chemistry	1,500	1	18,000
2	Ass.Prof.Polymer Chemistry	1,500	1	18,000
2	Lecturers Chemical Engineering	1,500	2	36,000
2	Assistant Lecturers	1,000	3	36,000
3	Scientist	2,000	1	24,000
3	Senior Scientific Officer	1,500	2	36,000
3	Technicians, Laboratory	1,000	4	48,000
4	Textiles Technologist	1,500	1	18,000
4	Junior Chemical Engineer	1,000	4	48,000
4	Junior Textiles Technologist	1,000	1	12,000
4	Mechanical Engineer	1,500	1	18,000
4	Workers	500	44	264,000
	Total		69	739,200

Department Codes:

1 Management Fibres Divison

2 Technical Education Section

3 Research Section

4 Production Section

The expected wage increases are 10 % for the lower wage groups (assumed as including wages of up to 1,500 Rs/month) and 5 % for the higher wage and salary groups. The labour costs for the higher wage groups, totalling 187,200 Rs/year, would therefore increase as follows:

during the second project year, by	9,360 Rs to 196,560 Rs
during the third project year, by	9,840 Rs to 206,400 Rs
during the fourth project year, by	10,300 Rs to 216,700 Rs and
during the fifth project year, by	10,840 Rs to 227,540 Rs

The wages of the lower groups, totalling 552,000 Rs during the third project year, will increase as follows:

during the fourth project year, by	55,200 Rs to 607,200 Rs and
during the fifth project year, by	60,700 Rs to 667,900 Rs.

These cost increases are allowed for in the project expenditure plan (cf. Table 24).

The empirical maintenance and repair cost rates in India are 2 % for buildings and about 3 % for machinery. This leads to annual building maintenance costs of 23,500 Rs and plant maintenance costs (incl. utilities) or 1,023,000 Rs, if one allows for a slightly higher rate (4 %) because of the greater corrosion near the sea.

The empirical rate for the insurance premiums for plant and equipment is 0.3 % of the investment sum for plant and utilities. The corresponding annual costs amount to 93,000 Rs.

The items add up to the following total annual operating costs:

- Raw material costs	3,187,630 Rs
- Utility costs	535,040 Rs
- Labour costs	739,200 Rs
- Maintenance and repair costs	1,046,500 Rs
- Insurance premiums	93,000 Rs
Total annual operating costs	5,601,370 Rs

The project expenditure plan (Table 24) gives information concerning the effects of the discussed changes in costs over the course of time on the annual operating costs; it also shows the probable timing of project investment.

4.1.3. Probable Revenues from Pilot Plant Operation

There are two possibilities of the project contributing towards financing the current costs, namely:

- by the sale of part of the plant's products and
- by the sale of research services in the form of sponsored research.

The plant is expected to achieve a mean annual output of 93 tons of fibre material, but only part of this will be of marketable grades. The reasons for this are production wastes because of training activities, special, unsaleable products produced for research, and the consumption for processing experiments carried out by SASMIRA itself. A conservative estimate of the level of possible revenues is based on a saleable production quantity of 10 % of the desired annual production during the first year of operation, 30 % during the second, and 50 % during the third year of operation. These quantities should be marketed at the presently-valid fibre prices of 170 Rs/kg nylon and 130 Rs/kg polyester fibres.

Sponsored research should be carried out on a non-profit-making basis. The sponsors will be invoiced all expenditure and calculatory costs connected with the tasks carried out. An important expenditure item will be material costs - these can either be invoiced or balanced out by the sponsor providing materials - and labour costs, which should be invoiced as they arise. The calculatory costs include for example depreciation on the plant sections used in research.

On the basis of the activities which can be estimated, one can calculate the following annual revenues from the sale of products and research services:

2 - 4 million Rs (1 - 2 million Rs) during the first year of operation
6 - 8 million Rs (4 - 6 million Rs) during the second year of operation, and
9 -11 million Rs (7 - 9 million Rs) during the third year of operation.

These figures do not include excise duties, which are imposed at differing rates for the differing yarn qualities, and which are charged in additi n to the excise duties on raw materials. If one allows for average levies of 50 Rs/kg of product sold, revenues are reduced to the figures shown in parentheses.

- Scope of engineering

Mainly but not exclusively the plant supplier shall provide the following engineering services, within the terms of plant engineering, supply and erection

a) Basic engineering of plant and equipment incl. detailed specification of energy and utility requirements, as far as possible adjusted to local conditions prevailing at SASMIRA's premises

b) Preliminary building layout, incl statements of statical loads, informations on safety requirements particularly under the aspects of training

c) Inspection and approval of detailed building plans and static calculations established by SASMIRA

d) Detailed plant layout and equipment layout

e) Detailed plant engineering, incl. detailed planning for substations, piping layout, drawings of steel staging for equipment support, instructions for erection of equipment, machinery piping and insulation, specifications and as far as required drawings of erection material such as steel structures, clamping devices, pipe bridges, piping, fittings, insulations etc.

f) Alternatively an Indian contractor firm should be recommended for the detailed engineering work, and supervision of detailed engineering to be made in India should be provided by engineers of the plant supplier

g) Provision of a complete process documentation, comprising primarily input specifications, consumption figures, detailed schedules for batchwise plant operation for polyamide and polyester production, instructions for start up and shut down of the plant, maintenance and overhauling instructions, safety instructions, etc.

3.1.1.1. Polymerisation Plant

The project requires a dual purpose plant for the production of either polyester-, nylon 6- or nylon 66-chips with a rated capacity of approx. 500 kg/day (24 hours) each of polyester or polyamide chips.

The steps of polycondensation/polymerisation, polyamide chips extraction and chips drying will have to be done discontinuously in adequate batches to meet the rated output.

4.2. Allocation of Funds

This comprehensive project is proposed to be jointly financed by UNIDO/UNDP, the Federal Republic of Germany and the Indian Government and the following breakdown is considered desirable:

- UNDP and FRG should finance all foreign equipment and bear the costs of foreign advisors as well as counterpart training abroad

- The Indian Government should bear the costs of the site and building, installation of utilities, the expenses for Indian staff, the raw material and utility costs, as well as maintenance and other plant operating costs

A breakdown of the various project cost items is given in Tables 21 to 23.

Table 21: Allocation of Project Funds: INVESTMENT COSTS

	Indian Contribution Rs	UN and German Contribution US $	Total US $
1. Land and existing building	1,003,500	-	128,700
2. Building and construction costs	1,505,700	-	193,000
3. Plant equipment and erection	4,804,000	3,369,000	3,985,000
4. Utilities and accessories	3,900,000	-	500,000
Total	11,213,200	3,369,000	4,806,700

Table 22: Allocation of Project Funds: INVESTMENT RELATED PERSONNEL COSTS

	Indian Contribution Rs	UN and German Contribution US $	Total US $
1. Fellowships	- [1]	33,000	33,000
2. Expatriates	74,900	360,000	369,600
Total	74,900	393,000	402,600

1) Wages during fellowship assignments are included in the operation costs

Table 23: Allocation of Funds: OPERATION COSTS

	Indian Contribution Rs	UN and German Contribution US $	Total US $
1. Raw materials	3,187,600	-	408,670
2. Utilities	532,000	-	68,200
3. Personnel	739,200	-	94,770
4. Repair and maintenance	1,046,500	-	134,200
5. Insurances	93,000	-	11,930
Total	5,598,300	-	717,870

1 US $ = 7.80 Rs   1 US $ = 2.30 DM   1 DM = 3.30 Rs

4.2.1. UNDP and German Government

The project costs to be contributed by UN-organisations and the German Government are estimated at a total of

3,762,000 US $ or

8,653,000 DM respectively.

Out of this amount 3,369,000 US $ (7,750,000 DM) are project investments for equipment, the remainder of 393,000 US $ (904,000 DM) being investment related personnel costs.

So far UNDP and the Government of the FRG have agreed to contribute a total of 6.69 million DM:

UNDP contribution: 735,000 US $ =	1,690,000 DM	(25.3 %)
FRG contribution:	5,000,000 DM	(74.7 %)
Total funds pledged so far:	6,690,000 DM	(100 %)

This funds so far provided cover about 77 % if the minimum project costs valid at present for equipment bought from F. Fourné KG:

Total project costs	8,653,000 DM =	3,762,000 US $
Funds provided so far	6,690,000 DM =	2,908,000 US $
Balance	1,963,000 DM =	854,000 US $

Since so far no understanding has been reached to distribute costs exceeding original figures pledged by UNDP (735,000 US $ = 1,690,000 DM) and the Government of the FRG (5,000,000 DM) it is plausibly assumed that the contribution rate existing now will also be valid for the costs exceeding the original amount pledged. Therefore 25.3 % would be covered by UNDP and 74.7 % by the Government of FRG:

- Additional UNDP funds	497,000 DM =	216,000 US $
- Additional FRG funds	1,466,000 DM =	638,000 US $
Total additional funds	1,963,000 DM =	854,000 US $

A subdivision of the project (equipment, fellowships and experts) into separate parts implemented separately by the two parties (UNDP/UNIDO and FRG) cannot be recommended. Technically only a separation into a polymerisation project and a melt spinning project would be possible. Both projects, however, would have to be implemented and operated jointly together since particularly research work calls for an integrated approach in polymerisation, spinning and further processing of the products and requires a thorough knowledge of the reaction steps involved in each processing stage. They are therefore interlinked in such a way that physical separation into discreet parts would be impossible. Apart from this both plant units will have to be purchased from the same manufacturer. Another possibility would be the provision of laboratory equipment by one organisation (UNIDO/UNDP) and the supply of the remaining equipment by the other organisation (FRG), but this way no separate projects would be created. In any case, neither of these separations meet the financial breakdown given above.

4.2.2 Government of India

The Indian Government will have to contribute a total of 11,288,000 Rs to the project's investment costs. Additionally an annual amount of 5,596,400 Rs is required to cover the operation costs of the project, this contribution starting from the 3rd project year onwards as indicated in the utilisation of inputs described later on.

The Government of India, Joint Secretary, Ministry of Finance, Department of Economic Affairs, confirmed that this part of the project costs will be met as usual for all UNDP contracts so far.

The Indian Government places great value in simple and clear institutional processing of the project, as the investment costs for the project can for technical reasons not be divided in the same ratio as the contributions of the UNDP and the Government of the FRG. Even if a sensible allocation of the investment costs were possible, the Indian Government would still prefer to see the project in the hands of a single institution. This does not however preclude the conclusion of two bilateral agreements on project financing between the UNDP and the Government of India and the Government of Germany and Government of India if necessary.

4.3. Annual Utilization of Funds

The relatively high share of the investment costs within the total project expenses requires the major part of the funds to be made available during the first and second project year, i.e. as tentatively scheduled during 1976 and 1977. During the following years from the third project year onwards the project operation costs determine the regular annual financial requirements which amount to 5.61 million Rs (719,000 US $) in the third project year which is the first year of scheduled project operation. This costs will increase to 5.76 million Rs in the fourth project year and to about 5.83 million Rs in the fifth project year due to the expected increases in wages, salaries and utility costs. The total annual expenses as well as the breakdown into the sources of financing is given in Table 24.

Table 24: **Annual Utilization of Project Funds**

Cost Items		Project Years: First Year	Second Year	Third Year	Fourth Year	Fifth Year
INVESTMENTS						
Land and existing building		1,003,500 Rs	-	-	-	-
		(129,000 US$)	-	-	-	-
Building construction costs		1,505,700 Rs	-	-	-	-
		(193,000 US$)	-	-	-	-
Plant equipment costs		3,875,000 DM	3,875,000 DM	-	-	-
		(1,685,000 US$)	(1,685,000 US$)	-	-	-
Plant erection costs[1]		900,000 Rs	3,904,000 Rs	-	-	-
		(116,000 US $)	(500,000 US$)	-	-	-
Utilities and accessories costs		1,950,000 Rs	1,950,000 Rs	-	-	-
		(250,000 US$)	(250,000 US$)	-	-	-
Fellowship costs		-	33,000 US$	-	-	-
Expatriates		47,000 US$	44,000 US$	136,000 US$	133,000 US$	-
Total project investments	US$	2,420,000 US$	2,572,000 US$	136,000 US$	133,000 US$	-
Thereof Indian contribution	Rs	5,359,200 RS	5,854,000 Rs	-	-	-
	US$	688,000 US $	750,000 US$	-	-	-
Raw material costs		-	530,000 Rs[2]	3,187,600 Rs	3,187,600 Rs	3,187,600 Rs
Utility costs		-	89,000 Rs[2]	532,000 Rs	611,900 Rs	611,900 Rs
Personnel - upper level[3]		187,200 Rs	196,600 Rs	206,400 Rs	216,700 Rs	227,600 Rs
- lower level[4]		-	-	552,000 Rs	607,200 Rs	667,900 Rs
Repair and maintenance		-	-	1,046,500 Rs	1,046,500 Rs	1,046,500 Rs
Insurances		-	-	93,000 Rs	93,000 Rs	93,000 Rs
Total operating costs	Rs	187,200 Rs	815,600 Rs	5,617,500 Rs	5,762,900 Rs	5,835,400 Rs
Total annual expenses	UNDP/ FRG Funds	1,732,000 US$	1,762,000 US$	136,000 US$	133,000 US$	-
	Indian Funds	5,546,400 Rs	6,669,600 Rs	5,617,500 Rs	5,762,900 Rs	5,835,400 Rs

1) incl. detailed engineering costs which are due during first project year
2) approximate figure for two months operation
3) Personnel receiving monthly wages above 1,500 Rs
4) Personnel receiving wages of 1,500 Rs or less

5. Related Project Information

5.1. Organisation Chart of SASMIRA after Project Integration

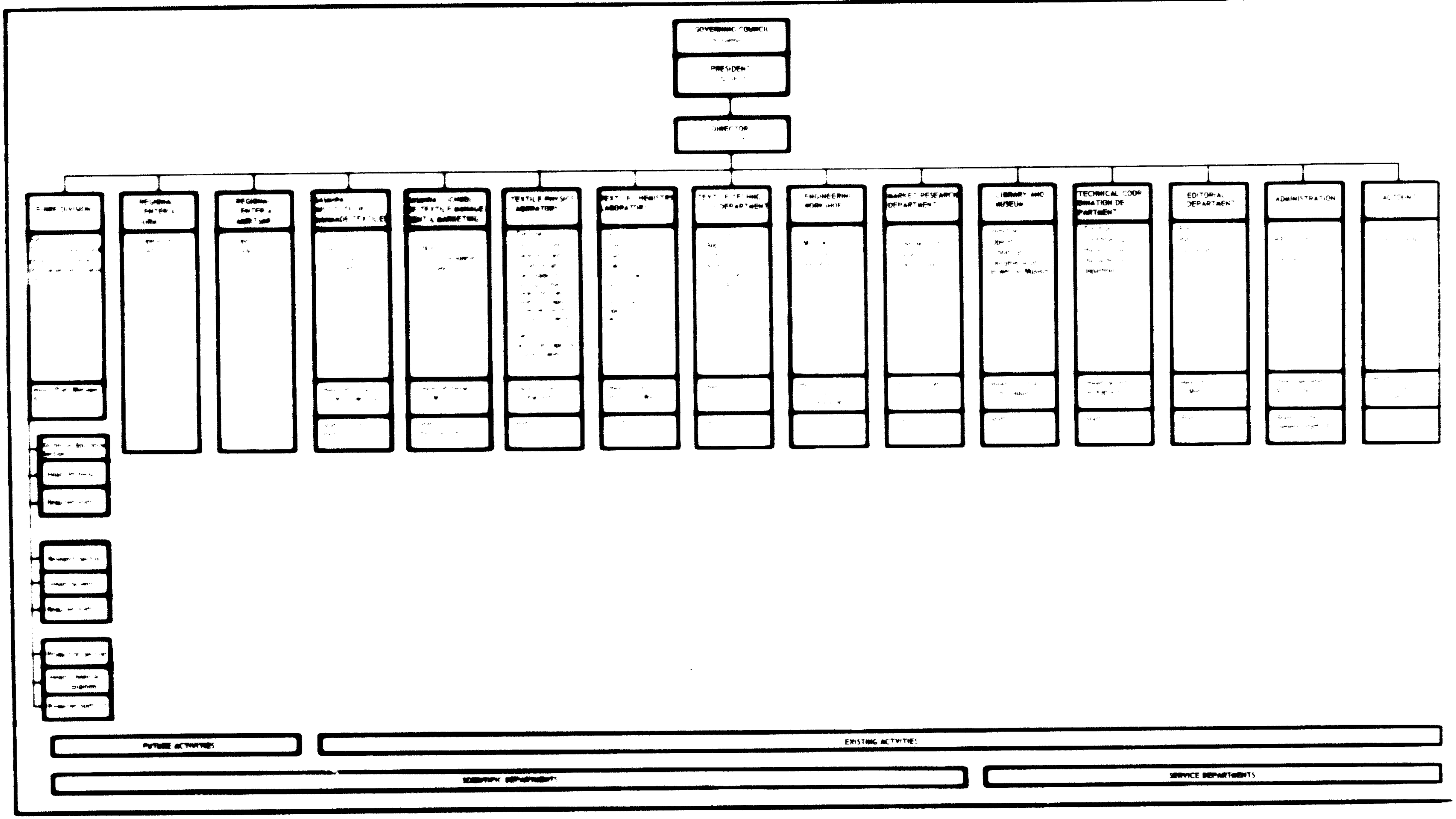
SASMIRA (cf. Fig.11) is governed by a 25 member council. 21 council members are elected representatives of the 139 member companies, while 4 council members are nominated representatives of CSIR (Council for Scientific and Industrial Research). The council is headed by a president (D.N. Shroff) whose deputy is a vice-president (N.M. Patel).

All activities of the association are supervised by its director (J.G. Parikh). He is responsible for 7 scientific and 5 services departments, comprising a total fulltime staff of 122 persons (including 87 general staff persons). In the future he will also be responsible for the Fibres Division and two regional centers at Surat and Amritsar, both traditional textile centers in India.

The Fibres Division will comprise training, research and production of polyamid and polyester filament and staple fibre both for textile and industrial use. These three activities will be attributed to different sections,each headed by a senior employee. Aside from the plant manager being responsible for the fibre division and its three section chiefs (a professor for technical education, a scientist for research and a chemical engineer for production) the division will employ some 65 persons.

The regional center at Surat will become operated late in 1975, the one in Amritsar some time in 1976. Both centers will provide the traditional services of SASMIRA, i.e., testing of fibres, yarns and fabrics, technical advisory services as well as training in various fields.

SASMIRA's Institute of Man-Made Textiles and SASMIRA's School of Textile Management & Marketing are exclusively geared to training. Each department is headed by a professor. Technology, management techniques and marketing are taught by a permanent staff of 15 persons assisted by almost 40 parttime instructors.


GOVERNING COUNCIL
PRESIDENT
DIRECTOR
TEXTILE PHYSICS LABORATORY
ENGINEERING WORKSHOP
MARKET RESEARCH DEPARTMENT
LIBRARY AND MUSEUM
EDITORIAL DEPARTMENT
ADMINISTRATION
FUTURE ACTIVITIES
EXISTING ACTIVITIES
SERVICE DEPARTMENTS

Both the Textile Physics Laboratory and the Textile Chemistry Laboratory are headed by a scientist. With a staff of currently 6 persons the Physics Laboratory is mainly testing textile materials as well as man-made fibre fabrics and is undertaking technical service work for the field of applied research for industry. The major functions of the Chemistry Laboratory are similar.

With a staff of 10 persons the Textile Technology Department headed by a scientist conducts applied research and technical service work for industry in addition to training.

The Engineering Workshop is responsible for maintenance of machinery and equipment as well as, since about two years, for the fabrication of instruments. The group of 7 persons is led by an instrument engineer.

Techno-economic studies and market research is conducted by the Market Research Department. The small team of three experts is headed by an economist.

The service departments comprise of the Library and Museum, the Technical Coordination Department being responsible for the coordination of all activities of the scientific or technical departments, the Editorial Department, publishing SASMIRA's Journal and Bulletin, the Administration Department and the Accounting Department.

The organisation of SASMIRA reflects its main activities. They all seem to be properly attributed. The whole association is smoothly and efficiently operated. However, with the expansion of SASMIRA the span of responsibility will become to large for its director. Therefore, the Plant Manager of the Fibres Division should become a deputy director to share the management tasks with Mr. Parikh. This regulation is already anticipated by SASMIRA's president and director.

5.2. Status and Expected Developments of SASMIRA's Finances

Table 25 summarises the main balance sheet items for the business years 1970/71 - 1973/74. The balance sheet sum remained almost constant over this period; the only greater difference was between 1970/71 and 1971/72, this resulting from the setting up of the "Staff Quarter Fund" and from liabilities to the "Ruby General Insurance Co. Ltd.". If one ignores these two factors, one finds that even the individual liability items underwent no drastic changes.

A few assets items on the other hand altered considerably ("Advances and Deposits" and "Cash and Balances") or showed a definite trend ("Balance of Income and Expenditure Account"). The accumulated losses amounted to some 1.6 million Rs in 1970/71, and increased to 1.9 million Rs by 1973/74; this corresponds to an average annual loss of about 0.1 million Rs during the reference period. It has to be stated however, that the losses shown are exclusively due to taking into account depreciation which is not an item of expenditure. In future balance sheets this item will not be provided.

The costs and revenues of the published profit and loss statements for the same period are summarised in Table 26. Aggregation of the individual items to larger "type of cost" groups, ignoring outside expenditures and revenues, is effected in Table 27.

The following is an attempt to forecast financial developments in SASMIRA under two alternative hypotheses:

- Continuation of previous activities without introduction of new activities
- Continuation of previous activities, additionally, operation of the demonstration plant and the connected activities (basic and advanced training of operators, research, consultancy)

Table 25: **Balance Sheet, 1971/72 - 1973/74 (in ,000 Rs.)**

Funds and Liabilities						**Properties and Assets**					
No.	Item	1970/71	1971/72	1972/73	1973/74	No.	Item	1970/71	1971/72	1972/73	1973/74
1.	**Research Fund**	6,148	6,214	6,203	6,237	7.	**Fixed Asset**	4,155	4,985	3,883	4,025
2.	Technical Institute Fund	182	182	-	-	8.	Closing Stock	19	17	16	14
3.	**Merit Awards, Merit Scholarship and Freeship fund**	4	10	-	-	9.	**Book Depts**	27	19	23	12
4.	**Staff Quarters Fund**	-	293	293	293	10.	**Advances and Deposits**	63	308	348	55
5.	**Liabilities**	66	480	347	273	11.	Cash **and Bank Balances**	541	1,007	822	792
5a)	**Saudry Creditors**	(13)	(38)	(22)	(18)	12.	**Income and Expenditure Account (Balance)**	1,595	1,743	1,751	1,905
5b)	Other **Liabilities**	(53)	(89)	(44)	(47)						
5c)	**Ruby General Insurance Co.Ltd. (Deposit)**	-	(75)	(75)	(75)						
5d)	**Ruby General Insurance Co. Ltd. (Advance against Leave and** Licence **Agreement)**	-	(278)	(206)	(133)						
6.	Total	6,400	7,179	6,843	6,803	13.	Total	6,400	7,179	6,843	6,803

The achievable polymerisates have to meet the quality standards for production of either

- textile fibres,
- textile filaments,
- technical yarns or
- tyre cord

Attainable product specifications:

Polyester chips, textile grade:	intrinsic viscosity:	0.65 - 0.68
	relative viscosity:	1.59 - 1.62
	moisture content prior to drying:	0.01 %
	residual moisture:	0.005 %
Nylon chips, textile grade:	relative viscosity:	2.8
	extract content:	8 %
	residual extract content, monomer:	0.3 % in chips
	residual moisture content:	0.005 %
Nylon chips, tyre cord grade:	relative viscosity:	3.5
	residual extract content, monomer:	0.33 %
	residual moisture content:	0.005 %

For textile grades TiO_2-dosages up to 1.5 % for semidull, full dull and extra full dull; TiO_2 constancy in chips $\pm$ 10 %.

The scope of delivery will comprise complete equipment for polyester chips production plus additional equipment for manufacturing nylon 6 and nylon 66 chips. The melt filter, polymerisation autoclave and chips preparation equipment being used both for nylon and polyester.

Table [illegible] : Income and Expenditure Account, 1970/71 - 1973/74 (in ,000 Rs.)

	Expenditure						Income				
No.	Item	1970/71	1971/72	1972/73	1973/74	No.	Item	1970/71	1971/72	1972/73	1973/74
1.	Salaries	569	491	431	469	27.	Subscription	77	76	78	81
2.	Contribution to Provident Fund	37	39	39	40	28.	Amount received from C.S.I.R. against Recurring Grant	48[illegible]	[illegible]	311	300
3.	Contribution to Staff Gratuity Fund	15	20	25	50	29.	Grant in Aid from S.N.D.T. Women's University	-	8	16	[illegible]
4.	Staff Health Insurance Scheme Expenses	9	10	13	14	30.	Testing Fees	[illegible]	[illegible]	[illegible]	46
5.	Rates and Taxes	10	15	16	16	31.	Income from Techno-Economic Surveys	58	[illegible]	87	50
6.	Insurance	8	-	-	-	32.	Technical Survey Charges	46	[illegible]	25	16
7.	Auditor's Honorarium	1	1	1	-	33.	Income from Sale of Instruments	-	-	21	62
8.	Electricity Charges	12	12	15	11	34.	Income from Training Courses	27	[illegible]	60	100
9.	Printing and Stationary	31	32	24	41	35.	Income on Deposits	[illegible]	26	28	29
10.	Postage and Telegrams	8	-	8	8	36.	Miscellaneous Income	14		12	[illegible]
11.	Telephone Charges	11	12	10	16	37.	Excess Balance of Income over Expenditure of "Resham Bhavan Property Account" transferred	4	[illegible]	207	194
12.	Transportation	58	62	31	87	38.	Excess Balance of Income over Expenditure of "Technical Institute Account"	-	10	-	-
13.	Advertisement	2	-	1	-	39.	Excess of Expenditure over Income carried down	116	[illegible]	31	156
14.	Subscription	20	-	10	10						
15.	Laboratory Expenses	20	18	17	13						
16.	Pilot Plant Expenses	28	17	-	12						
17.	Miscellaneous Expenses	19	18	20	27						
18.	Repairs and Maintenance	44	37	46	57						
19.	Garden Expenses	1	1	1	2						
20.	Museum Expenses	1	-	1	-						
21.	Depreciation	160	159	133	126						
22.	Contribution towards SASMIRA's Institute of Man-made Textiles	-	-	41	21						
23.	Contribution to Labour Welfare Board	-	-	-	-						
24.	Expenses for Training Courses	-	-	13	16						
25.	Excess of Expenditure over Income Technical Institute	-	7	-	-						
26.	Total	1,064	468	939	1,049	40.	Total	1,064	468	939	1,049

Table 27: Shares of Main Income and Expenditure Items in Total Income and Expenditure, 1970/71 - 1973/74

No.	Main Expenditure Item	Position in Table 2	1970/71 %	1971/72 %	1972/73 %	1973/74 %
1.	Salaries and Related Items	1. to 4.	59	58	60	57
2.	Rates, Taxes, Insurance etc.	5. to 7.	2	2	2	2
3.	Electricity, Printing etc.	8. to 14.	13	14	12	18
4.	Depreciation	21.	15	16	15	12
5.	Others	15. to 20., 24.	11	10	11	11
6.	Total	-	100	100	100	100

No.	Main Income Items	Position in Table 2	1970/71 %	1971/72 %	1972/73 %	1973/74 %
7.	Subscription	27.	9	11	11	11
8.	Incomes from C.S.R.I. and S.N.D.T.	28. to 29.	58	52	47	44
9.	Fees, Sales etc.	30. to 33.	27	31	28	25
10.	Income from Training Courses	34.	3	2	8	14
11.	Others	35. to 36.	3	4	6	6
12.	Total		100	100	100	100
13.	"Loss" as percentage of total "operating income"[1]		27	40	26	43

1) Calculated excess of expenditures over incomes, excluding "non-operating" items (positions 22. to 25. and 37. and 38. of Table 26)

As it is scarcely possible to forecast price developments, all values given are based on 1973/74 prices (last available data). The data for the assumption upon which the forecasts are based were determined in conference with the competent officers of SASMIRA. All outside revenues (profit and loss statements items 37 and 38; cf. Table 26) and expenditure (profit and loss statement items 22 - 25; cf. Table 26) were ignored; the forecast therefore concerns only those revenue and expenditure categories contained in Table 27.

The forecast of expenditure developments (without the demonstration plant) is based on the following assumptions:

- The direct and indirect wage and salary expenditure will increase by an average 5 % p.a. over the coming years
- Fees, taxes, insurance and examination costs will increase by an average 3 % p.a.
- If the scope of activities remains unchanged, one may expect approximately the same expenditure for electricity, telephone, printing costs, etc. (profit and loss statement items 8 - 14)
- For miscellaneous costs, the same annual growth rate as for total costs is assumed.

One thus arrives at the following cost structure in the business year 1979/80:

Expenditure	1973/74		1979/80	
	'000 Rs	%	'000 Rs	%
Salaries and Related Items	573	57	770	62
Rates, Taxes, Insurance etc.	21	2	25	2
Electricity, Printing etc.	177	18	180	15
Depreciation	126	12	130	10
Others	115	11	140	11
Total	1,012	100	1,245	100

In the case of revenues (without demonstration plant), relatively great increases in income from course fees will lead to considerable alterations in the components of the individual categories.
The assumptions are:

- Slightly increasing revenue from members (+ 2 % p.a.) as the number of members increases.
- Almost unchanged revenues from the CSIR and the SNOT Women's University.
- Increases in revenue from test fees, techno-economic surveys and technical survey charges and sale of instruments by an average of 2 % p.a.
- An increase in revenue from training courses of 12 % p.a.
- Other incomes: as above.

Under these assumptions, the structure of revenue in the business year 1979/80 will be as follows:

Income	1973/74		1979/80	
	'000 Rs	%	'000 Rs	%
Subscription	81	11	90	10
Incomes from CSIR, SNOT	310	44	310	37
Fees, Sales etc.	174	25	195	23
Income from Training Courses	100	14	200	24
Others	42	6	50	6
Total	707	100	845	100

A comparison of the expected costs and revenues (without demonstration plant) shows an increase in returns from 0.3 million Rs (1973/74) to about 0.4 million Rs (1979/80). The relationship between loss and income will increase during the same period from 43 to about 47 %.

The annual costs of the new demonstration plant are summarised in Table 28. (see also Table 23).

Table 28: Annual Costs of Demonstration Plant ('000 Rs)

No.	Cost Items	1976/77	1977/78	1978/79	1979/80	1980/81
1	Raw Materials	-	530	3,188	3,188	3,188
2	Utilities	-	89	532	612	612
3	Personnel	187	197	758	824	895
4	Repair & Maintenance	-	-	1,047	1,047	1,047
5	Insurance	-	-	93	94	93
6	Depreciation[1]	-	-	3,158	3,158	3,158
7	Total	187	816	8,776	8,922	8,993

1) 2 % on building and 10 % on plant

Revenue from operation of the plant will probably be about 7 - 9 million Rs from 1980 onwards; also to be added are the contribution of the CSIR, amounting to 50 % of annual costs[1]. Revenues will therefore be as shown in Table 29.

Table 29: Annual Incomes from Demonstration Plant ('000 Rs)

Income	1976/77	1977/78	1978/79	1979/80	1980/81
Operating Income	-	-	1,500	5,000	8,000
Income from CSIR	95	405	4,500	4,575	4,610
Total	95	405	6,000	9,575	12,610

From 1980 onwards, the total income can therefore be expected to exceed total costs.

1) According to a (provisional) agreement

Consolidation of the forecast values for the present SASMIRA activities and the demonstration plant reveals that a surplus of revenues is to be expected from 1980 onwards, also when taking the overall view (cf. Table 30).

Table 30: Consolidated Incomes and Expenditures ('000 Rs)

Item	1976/77	1977/78	1978/79	1979/80	1980/81
Income	870	1,200	6,820	10,420	13,480
Expenditure	1,310	1,965	10,020	10,240	10,360
Balance	- 440	- 765	-3,200	180	3,120

5.3. Eventual Project Extensions for Textile Engineering

SASMIRA presently operates textile engineering equipment comprising all necessary production steps as staple fibre spinning, weaving, knitting and wet processing. Regarding capacity and scope of different production steps this machinery however will not suffice to process the pilot plant's output. Modernisation and completion of this equipment is desirable to meet the requirements set up with the pilot plant operation.

This refers particularly to the mechanical spinning equipment for processing the staple fibre output; there the following machinery is urgently required:

- Spinning equipment item	approximate price
-- blender with opener	500,000 Rs
-- carding machine	200,000 Rs
-- draw frame	97,000 Rs
-- high speed frame, 36 spindles	130,000 Rs
-- high speed ring frame, 80 spindles	64,000 Rs
Total staple fibre spinning equipment	991,000 Rs (127,000 US $)

In addition the following machinery for knitting and wet processing is required by SASMIRA.

- Knitting equipment item	apprximate price
-- warping machine with suitable creel	130,000 Rs
-- pattern warping machine	35,000 Rs
-- raschel knitting machine (multi-bar)	230,000 Rs
-- tricot warp knitting machine with positive let-off and take-up systems (3 bar)	200,000 Rs
-- warp knitting (tricot) for spun yarns	170,000 Rs
-- V-bed flat knitting machine	8,000 Rs
-- power socks knitting machine - double cylinder with jacquard attachment	80,000 Rs
-- linking machine	10,000 Rs
-- inter-lock circular knitting machine - 24 " diam. (24 ")	20,000 Rs
-- single jersey machine with jacquard attachment - 24 " diam.	70,000 Rs
-- sinker top machine with positive feed - 20" diam.	10,000 Rs
Total knitting equipment	963,000 Rs (ca. 126,000 US$)

- Wet processing equipment item	approximate price
-- pressure muff dyeing for crimped yarn - lab model	130,000 Rs
-- muff expander for crimped yarn	22,000 Rs
-- coning machine with oiling device for crimped yarn - 18 spindles	70,000 Rs
-- high pressure and high temperature jet dyeing machine	530,000 Rs
Total wet processing equipment	752,000 Rs (ca. 97,000 US$)

Most of this equipment would be available from Indian manufacturers. Only for the knitting equipment imported machinery items are preferable. The total estimated costs for this machinery amounts to approximately 2.706 million Rs (approx. 347,000 US $), roughly 963,000 Rs (124,000 US$) are estimated to be required for imported machinery.

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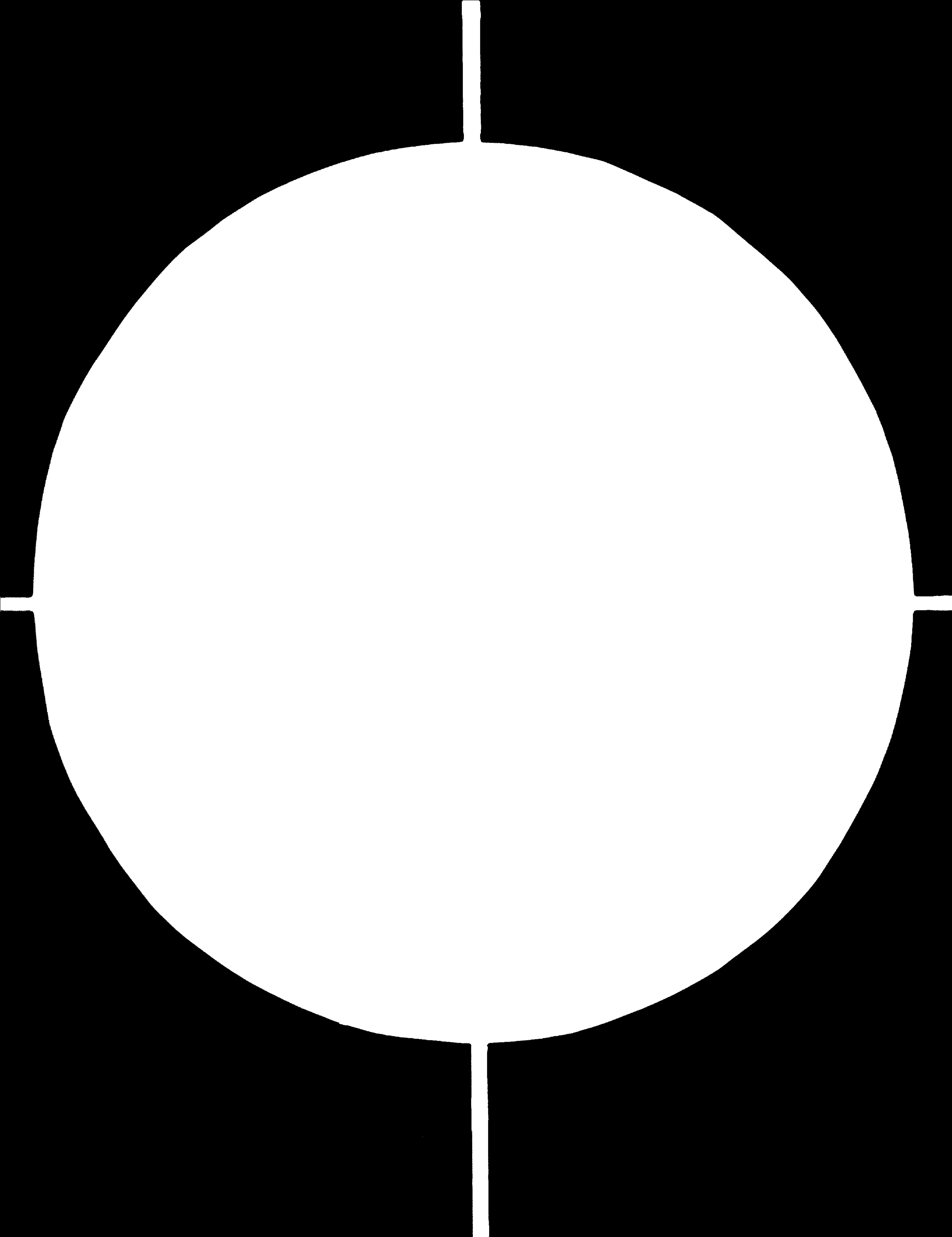

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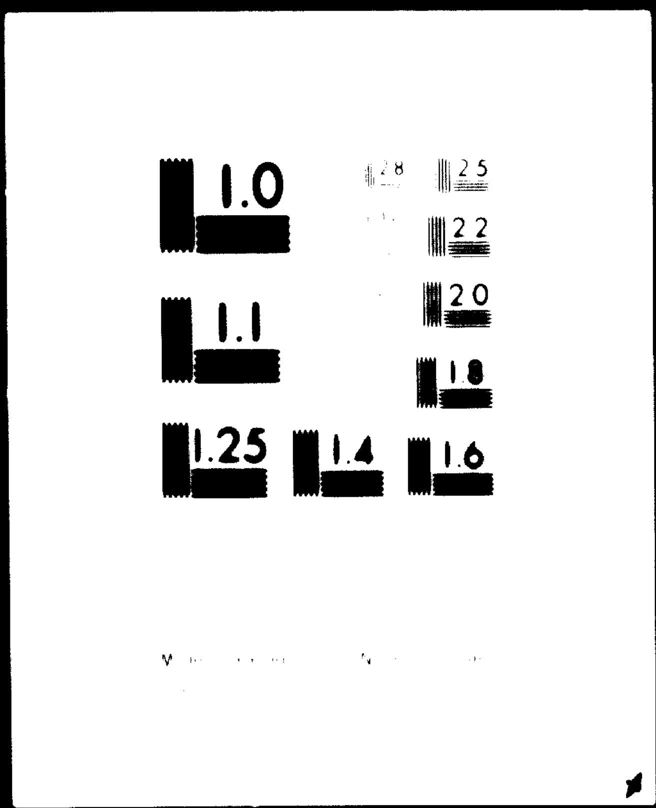

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To provide facilities for experimental work especially in the polymer-to-yarn processes for synthetic fibres and for the development and application of process and product technology in this field.

To provide a focus for the collection and dissemination of technical data on synthetic fibres.

3. Responsibility of the Contractor

Statement of work

Having in mind the background and aims of the project stated above, the contractor shall, under the terms stated below undertake and carry out a PAG mission (preparatory assistance to Government) to define the assistance required from the FRG and UNDP/UNIDO respectively to establish the demonstration plant. In so doing, it should consider, in respect of all tasks listed below the programme as a whole and the role to be played by each project in achieving it. The mission is expected to be in India for two months (four man months); its role will include but not necessarily be limited to the following:

a) to determine and recommend as precisely as possible, the relative inputs required from the Government of FRG and India and the UNDP. These inputs include the costs of imported expertise and equipment as well as fellowships for training abroad. To this end, the UNDP has agreed in principle to provide US$ 735,000 (if necessary, with a possibility of expanding this allocation to US$ 845,250) for experts, equipment and fellowships. The FRG agrees to provide the balance of the funds required for establishing the demonstration plant. The precise amount of these funds, as well as the specific inputs required of each donor and the Government of India will be recommended by the contractor;

b) To assist in preparing specifications for the demonstration plant including polymerisation reactors, spinning unit, filament and staple fibres processing lines, draw twisting equipment and laboratory equipment for testing;

d) To recommend names of suppliers for the above equipment to be tendered for through international competitive bidding;

d) In consultation with the Government authorities, to recommend placements for fellowships;

e) To asist in revising the work plan including time-table and work schedule and duration for the arrival of experts and equipment as well as for fellowships;

f) To discuss and define in detail the proposed technical and advisory services to be provided by SASMIRA to the fibres processors;

g) To assist the Government of India in finalizing detailed requirements for space, layout of the plant and of the buildings, supervision during erection, counterpart services, arrangements for the operation of the plant on the basis of continuous or discontinuous operation.

h) To prepare a report on the above.

It is understood that during the mission, the contractor will have the close co-operation and collaboration of UNDP/UNIDO representative in India and the Government authorities.

4. Consultations with Mr. R. Walker of Dupont Canada

Before going to India the contractor should have a meeting in Montreal, Canada, with Mr.Robert Walker of Dupont Canada and former UNDP consultant to clarify with him all the points he raised in his letter of 1 August 1974 to Mr.J.Berke on the project facilities and costs and project personnel. A copy of the letter is attached.

5. UNIDO Briefing and Debriefing

One day for briefing and three days for debriefing at UNIDO headquarters in Vienna will be required.

6. Reports

Five copies of the draft report and twenty copies of the final report in English will be required.

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In the longer range this equipment should be completed by adding the machinery items mentioned below. They are rated by SASMIRA to be important or desirable for its future work:

Important equipment items	estimated approx.price
- Weaving Preparatory	
-- Automatic creel for warping	60,000 Rs
-- Sizing machine	650,000 Rs
- Weaving	
-- Automatic loom with unifil equipment for weft supply, with latest dobby attachment	150,000 Rs
- Knitting	
-- Power socks knitting machine - double cylinder with jacquard attachment	80,000 Rs
- Textile testing instruments	
-- Abrasion tester	20,000 Rs
-- Lovibond tintometer - for visual comparison of dyed samples	15,000 Rs
Total of important equipment items	975,000 Rs (125,000 US$)

Desirable equipment items	estimated approx. price
- Weaving	
-- Sulzer weaving machine - 4 colours with jacquard	250,000 Rs
- Non-woven fabric manufacturing pilot plant	
-- Sample card	54,000 Rs
-- Rando feeder/[illegible]er	630,000 RS
-- Needle loom	140,000 Rs
-- Spray equipment	210,000 Rs
-- Curing oven	224,000 Rs
-- Saturater	280,000 Rs
-- Tufting machine	
- Knitting	
-- Co-ve-knit machine (west insertion)	300,000 Rs
- Wet processing machines	
-- Beam dyeing machine - laboratory model	200,000 Rs
-- Skein dyeing machine - laboratory model 50 kg capacity	100,000 Rs
-- Drum tumbler dryer - 30 lbs capacity	14,000 Rs
-- Thermo-fixing unit - high temperature steaming for fixing printed goods	52,000 Rs
- Finishing	
-- Shearing and cropping machine for woven and knitted fabrics - 2 cylinder	430,000 Rs
Total desirable equipment items	2,883,000 Rs (370,000 US$)

These machinery and equipment is not necessarily required during the project's termination and should be kept for SASMIRA's long range investment program.

5.4. Eventual Project Extension for Melt spinning and Yarn Engineering

There will be no short term need for extension and additional investments in the fibre production sector, as the proposed design of the plant is such that it will go beyond the present state of the art and know-how in the Indian synthetic fibres industry.

Later however, supplementation of the polymerisation equipment by a continuous nylon polymerisation plant (VK tube) may become desirable. The necessity for thus must be confirmed by plant operation during the early years of the project.

The melt spinning plant could be supplemented by a separate plant to allow bicomponent spinning. This further investment should however also be postponed until a later year. The relatively high expenditure for a complete spinning station for this purpose only justifies a thorough evaluation.

Additional investments in this plant sector are not necessary during the term of the project.

6. Appendix I: Sources of Information

This report is based on discussions in India, Canada, Austria and the FRG and the secondary material listed in the Chapter 6.2.

6.1. Discussion Partners

Important discussion partners of the PAG-mission were the following ladies and gentlemen. Besides that the mission had the opportunity to talk to several members of the board of directors and the executive board of Indian and foreign companies in the textile industry field, as raw material producers, fibre producers, processors, engineering firms and machinery suppliers.

India

Mr. P.K. Dave, Secretary, Ministry of Petroleum and Chemicals

Mr. J.R. Hiremath, Joint Secretary, Ministry of Finance, Department of Economic Affairs

Mr. K.H. Krishnamurthi, Joint Secretary, Ministry of Science & Technology

Mr. O.P. Kohli, Ministry of Finance, Department of Economic Affairs

Mr. P.C. Dhio, Ministry of Finance, Department of Economic Affairs

Mr. N.N. Krishnamurthi, Chief Advisor, Ministry of Petroleum and Chemicals

Mr. K.N. Johri, Head (International Scientific Colaboration), CSIR

Mr. B. Singh, CSIR

Mr. M. Malhotra, CSIR

Mr. R. Polgar, Resident Representative, UNDP

Mr. H. Kaufman, Deputy Resident Representative, UNDP

Mr. G. Patterson, Assistant Resident Representative, UNDP

Mr. A.J. Scordialos, Assistant Resident Representative, UNDP

Mr. D.H. Fröhlich, Advisor to E.I.L., UNIDO

Mr. V.K. Hemrajani, UNDP-Office
Mr. H. Burr, Economic Counsellor of the Embassy of the FRG
Mrs. H. Schöttle, Consul General of the FRG

Mr. H. Dane, German Consulate General

Mr. D.N. Shroff, President, SASMIRA

Mr. N.M. Patel, Vice President, SASMIRA

Mr. J.G. Parikh, Director, SASMIRA

Mrs. A. Kaplash, Scientist, SASMIRA

Mrs. M.D. Bhavsar, Scientist, SASMIRA

Mr. M.R. Paranjape, Scientist, SASMIRA

Mr. M.V. Lobo, Secretary, SASMIRA

Mr. P.U. Mehta, Administrative Officer, SASMIRA

Mr. K.M. Mehta, Managing Director, Ambika Silk Mills Ltd., Bombay

Mr. M.V. Karve, Works Manager, Ambika Silk Mills Ltd., Bombay

Mr. H.S. Anand, Managing Director, Anand Synthetics Pvt.Ltd., Delhi

Mr. A.M. Anand, Sales Manager, Anand Synthetics Pvt.Ltd., Delhi

Mr. R.M. Modi, Manager Laboratory & Control, Baroda Rayon Corp.Ltd., Surat

Mr. K. Inamdar, Blue Star Ltd., Bombay

Mr. D.J. Gaitonde, President, Century Enka Ltd., Poona

Mr. K. Dev, Vice President, Century Enka Ltd., Poona

Mr. K.S. Rao, Manager, DCM Silk Mills, Delhi

Mr. P.K.Kaul, Processing Superintendent, DCM Silk Mills,Delhi

Mr. M.C. Gorg, Weaving Superintendent, DCM Silk Mills, Delhi

Mr. O.M. Narain, Sales Department DCM Silk Mills, Delhi

Mr. V.K. Ramesh, Finance Department, DCM Silk Mills, Delhi

Mr. A.S. Sule, Factory Chief Executive, Garware Nylons Ltd., Poona

Mr. M.L. Kotnis, Garware Nylons Ltd., Poona

Mr. J. Lawale, Garware Nylons Ltd., Poona

Mr. M.S. Kulkarni, Garware Nylons Ltd., Poona

Mr. M.D. Rajpal, Managing Director, Gujarat State Fertilizer Corp.(GSFC),Baroda

Mr. B.Bandyopadhyay, General Manager (Fibres), GSFC, Baroda

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Mr. K.D. Patel, Senior Superintendent Caprolactam Plant, GSFC, Baroda

Mr. D.Parmar, Manager Research Laboratory, GSFC, Baroda

Mr. B.H. Bachkaniwala, Sales Director, Himson Mills Ltd., Surat

Mr. S.H. Bachkaniwala, Technical Director, Himson Mills Ltd., Surat

Mr. N.H. Panchal, Deputy Project Manager, Indian Organic Chemicals Ltd., Fibre Division, Madras

Mr. A.J.A. Tauro, Finance Director, Indian Petrochemicals Corporation Ltd. (IPCL), Baroda

Mr. R.R. Singanporia, India Oxygen Ltd. Bombay

Mr. R. Sethuraman, Production Manager, IPCL, Baroda

Mr. K.N. Venkatasubramanian, Marketing Manager, IPCL, Baroda

Mr. V. Garud, Ion Exchange (India) Ltd., Bombay

Mr. C. Sivaraman, Technical Coordination Manager, J.K. Synthetics Ltd., Kota

Mr. H.V. Mehta, Partner, Jyoti Silk Mills, Bombay

Mr. C.N. Shah, Partner, Kumkum Silk Mills, Bombay

Mr. K.K. Modi, President & Director, Modi Enterprises, Modinagar

Mr. M.K. Modi, Director & Chief Executive, Modipon Ltd., Modinagar

Mr. V.K. Singhal, Administration Manager, Modipon Ltd., Modinagar

Mr. J.K. Modi, Director, Modi Spinning and Weaving Mills Ltd., Modinagar

Mr. S.R. Goel, General Technical Assistant, Modi Spinning and Weaving Mills Ltd., Modinagar

Mr. Vasudev, Plant Manager, Nanikrom Sobhraj Mills Ltd., Ahmedabad

Mr. Sagol, Weaving Superintendent, Nanikrom Sobhraj Mills Ltd., Ahmedabad

Mr. V.R. Chinai, Chief Executive, National Art Silk Mills Pvt. Ltd., Bombay

Mr. S.O. Taraporewala, Works Manager, National Rayon Corporation (NRC), Kalyan

Mr. A.C. Shah, Project Manager Nylon, NRC, Kalyan

Mr. R.M. Deshmukh, NRC, Kalyan

Mr. V. Sagar, Executive Director, Nirlon Synthetic Fibres and Chemicals Ltd., Goregaon

Mr. M. Haribal, Administration Manager, Orkay Mills, Bombay

Mr. L. Mathur, Development Manager, Orkay Mills, Bombay

Mr. I.D. Swarup, Technologist, Orkay Mills, Bombay

Mr. S. Dalal, Optimum Corporation, Bombay

Mr. S. Jhaveri, Optimum Corporation, Bombay

Mr.B.B. Mathur, Managing Director, Petrofils Cooperative Ltd., Baroda

Mr.N.N. Bajaj, General Manager, Podas Silks & Synthetics Ltd., Bombay

Mr. I. Solanki, Factory Manager, Sadhana Textile Mills Ltd., Bombay

Mr. V.H. Metha, Director, Saraswati Silk Mills, Bombay

Mr. I.B. Lal, General Manager, Shriram Fibres Ltd., Madras

Mr. J.K. Sharma, Production Manager, Shriram Fibres Ltd., Madras

Mr. A.K. Gaur, Technical Services Manager, Shriram Fibres Ltd., Madras

Mr. K.N. Seetal, Technical Coordinator, Shriram Fibres Ltd., Madras

Mr. K. Hemrajani, Wanson (India) Pvt. Ltd., Bombay

Mr. S. Shah, Wanson (India) Pvt. Ltd., Bombay

Mr. J.B. Irani, Chartered Architect, Bombay

Canada

Mr. R.F. Walker, Du Pont Canada Ltd., Montreal

Mr. E.L. Fletcher, Du Pont Canada Ltd., Montreal

Federal Republic of Germany

Mr. F. Fourné, F. Fourné KG, Impekhoven

Mr. N. Kobel, Zimmer AG, Frankfurt

Mr. G. Fuhrmann, Emil Blaschke & Co GmbH, Endersbach

Mr. R. Thiel, Emil Blasche & Co GmbH, Endersbach

Mr. H. Ehrlich, Karl Fischer, Berlin

6.2. Reference Material

The following listed secondary material is kept in the FGU-KRONBERG documentation and will be available on request.

- FGU-KRONBERG Report: Demonstration Plant for the Production of Synthetic Fibres (Polyamide and Polyester) at the SASMIRA in Bombay/India and the related documentation as listed on p.103-104 in this report
- SASMIRA? Are Man-made Textiles Luxuries?, brochure to SASMIRA Silver Jubilee Year, 1975
- SASMIRA: Statistics Man-made Textiles, August 1974
- SASMIRA: Technical Education Programme in Man-made Textiles, June 1974
- SASMIRA: Technology of Man-made Textiles in India, National Seminar on Technology & Economics of Man-made Textiles in India, New Delhi, April 1975
- SASMIRA: Economics of Man-made Textiles I, National Seminar on Technology & Economics of Man-made Textiles in India, New Delhi, April 1975
- SASMIRA: Economics of Man-made Textiles II, as above
- Man-made Textiles in India, Official Organ of the SASMIRA, Vol.18, No.1, Jan. 1975
- SASMIRA's Bulletin, Vol.13, No.3, March 1975
- SASMIRA: 21st (1970/71), 22nd (1971/72), 23rd (1972/73) and 24th (1973/74) Annual Reports
- J.G. Parikh, Man-made Fibres Cellulosic and Synthetic, SASMIRA publication, March 1974
- Berufsbild für den Lehrberuf Chemiefacharbeiter
- Franz Fourné: Synthetische Fasern, Herstellung und Verarbeitung, Stuttgart 1964

7. Appendix II: Terms of Reference

Terms of Reference, PAG-Mission on the Establishment of a Demonstration Plant for the Production of Synthetic Fibres at the Silk and Art Silk Mills Research Association (SASMIRA), Bombay, India

1. Background

During 1973, negotiations were concluded between the Governments of India and the Federal Republic of Germany, UNDP and UNIDO on the establishment of a Synthetic Fibre Demonstration Plant project within the Silk and Art Silk Mills Research Association (SASMIRA) in Bombay, India. The proposed financing for the project is expected to come from UNDP under the IPF of the country programme and from bi-lateral aid from the Federal Republic of Germany which is to be used essentially for equipment. The projects assisted by each will be developed separately, but will be co-ordinated with one another so that, taken together, they form a single assistance package for the demonstration plant. The aims of the project are stated below:

2. Aims of the Project

Long-range

To encourage and accelerate the production and use of synthetic fibres as textile fibres in order to reduce India's dependance on imported cotton and other raw materials for the textile industry.

To establish technical and advisory service in synthetic fibres to the textile industry and to carry out systematic programmes of experimental work and training, collect technical information, act as a non-partisan consultant and provide an impartial communication system between fibre producers, textile mills, the textile trade and consumers to ensure that all efforts in this field are optimally directed.

Immediate aims

To provide at the premises of SASMIRA a demonstration unit for the development of the production and use of nylon and polyester fibres for textiles as well as the simultaneous production of the staple fibres and filament. The plant will not be used as a production unit on a commercial scale but the fibre produced will be used for end product development.

To provide facilities for the training and upgrading skills of personnel in synthetic fibre technology.