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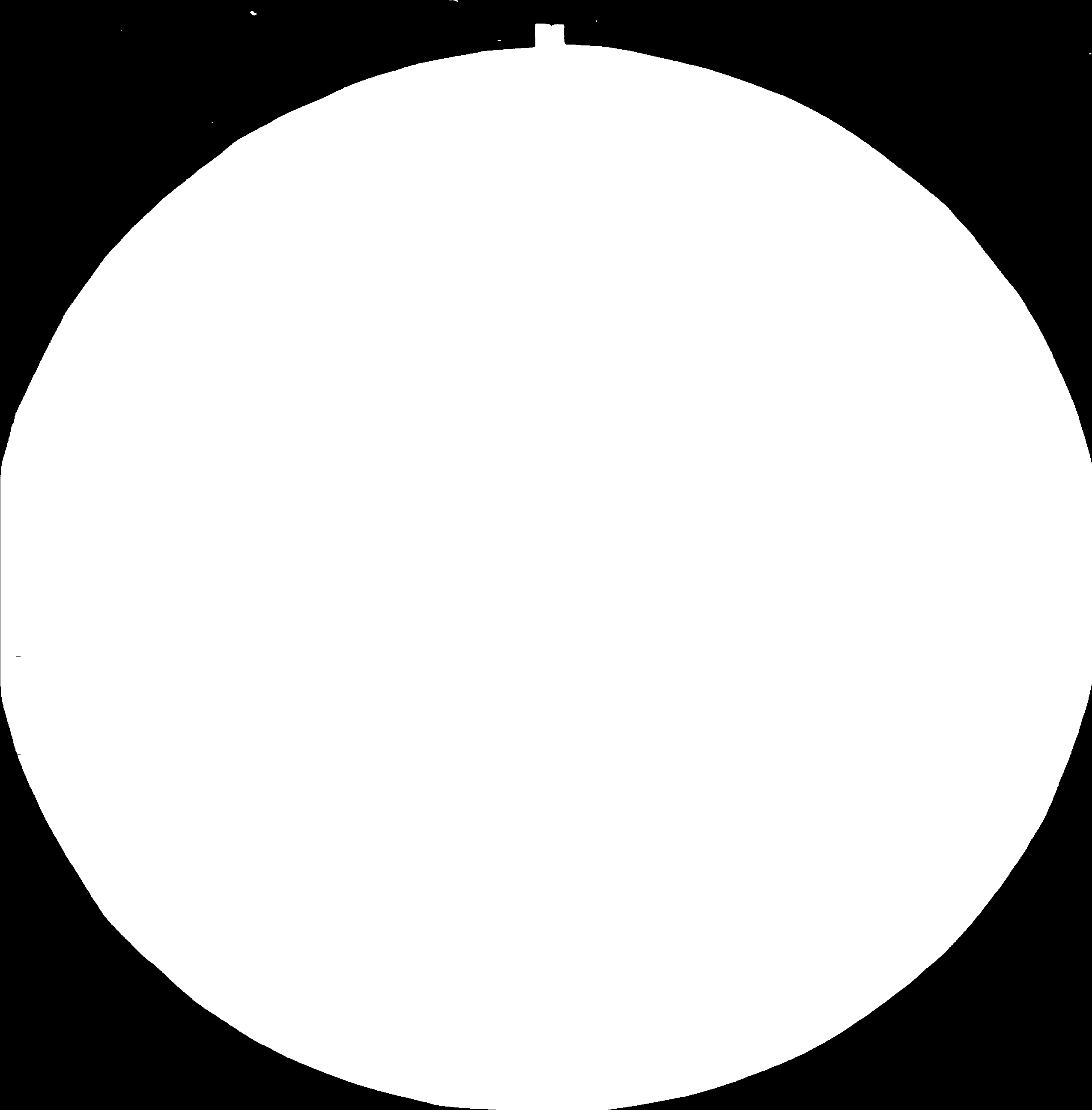

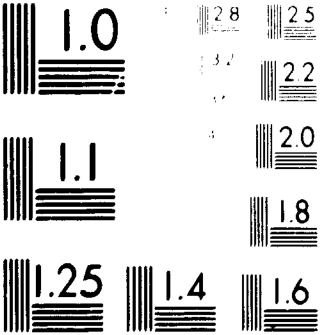

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(1 of 2)

PREPARATORY PROJECT REPORT FOR SETTING-UP AN ALUMINIUM RESEARCH, DEVELOPMENT & DESIGN CENTRE IN INDIA

FINAL REPORT

DP/IND/81/009

G. Toth

ALUTERV–FKI

BUDAPEST / HUNGARY

August, 1983

PREPARATORY PROJECT REPORT
FOR SETTING-UP AN
ALUMINIUM RESEARCH, DEVELOPMENT & DESIGN CENTRE
IN INDIA

Final Report

by

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EXPLANATORY NOTES

R & D	Research and Development
RDDC	Research, Development and Design Centre
Centre	the same as RDDC
m/m	man-month

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1. INTRODUCTION

1. INTRODUCTION

1.1 GENERAL

Aluminium occupies a pride of place in metals today and is the second most widely used metal, next only to steel. The importance of aluminium is reflected in the phenomenal growth in its production and consumption during the past few decades, with an average demand growth rate of about 8 % per annum. The world production of aluminium increased from about 1.5 Mt in 1950 to about 15 Mt in 1980. Assuming a possible average growth rate of about 3 % per annum up to the end of century, the world demand for aluminium may be around 20 Mt by 1990 and about 27 Mt by the turn of the century.

A substantial demand growth has also been recorded in India in the consumption and production of aluminium since the early fifties. The apparent consumption which was of the order of 15,000 t during 1950-51 has risen to about 240,000 t by the year 1981-82. The installed capacity for production of aluminium in India increased during the same period to 371,000 t/yr. The demand growth rate for aluminium in India during the next decade has been projected by the Working Group on Non-Ferrous Metals as 8 to 12 %.*

Five countries namely Guinea, Australia, Brazil, Jamaica and India together control about 72 % of world bauxite reserves of which India's share is about 8 %. With about 2,500 Mt of bauxite reserves in the country and possibility of adequate supply of other raw materials,

* Report of the Working Group on Non-Ferrous Metals (Aluminium and Magnesium), Ministry of Steel and Mines (Department of Mines), June, 1980.

India is a potential supplier of aluminium to the world market. The possibility of India attaining such a position will depend to a great extent upon the economic development of the natural resources with a suitable back-up from the indigenous Research, Development and Design expertise.

The existing aluminium plants in India and the one under construction are based almost entirely on imported technology. Though research and development work is being carried out by the major aluminium producers in the country as well as by the various research and academic institutions in the field of aluminium, a coordinated approach in R & D would be essential for development of new technologies and new products with the aim of attaining self-reliance in alumina and aluminium technology for establishment of future plants without going in for foreign technical collaboration.

Rapid development of aluminium industry demands timely establishment of a self-sustaining, full-fledged and independent Research, Development and Design Centre at the national level. Such a Centre once established, will meet the fast growing needs of technological servicing and support the aluminium industry through the planning, development and operational stages. It will also facilitate adoption of the latest technological innovation and provide the necessary know-how for improvement in process and product development.

1.2 BACKGROUND

Research and Development activities are back-bone of an industry for timely and optimum development, and aluminium industry is no exception. Technological innovations, product and process developments can be achieved through dedicated research and development activities which will help the industry to achieve better efficiency and productivity at reduced costs.

The research efforts in the aluminium industry need to be directed towards improvement of the process technologies and quality of products, optimisation of material and energy consumption through automation and improved process control technique, mechanisation of operations, equipment design, product development for better marketability and development of new pollution control techniques.

The aluminium plants in India are based on technology imported from different sources. Though the basic process for production of alumina, aluminium and semis remains the same, a number of technological improvements have taken place in the advanced aluminium producing countries. Import of the improved technology is not always possible or practicable in existing plants. Moreover, proper assessment is needed to determine the suitability of the new technology under Indian conditions like available raw material quality, present and future product demand, engineering developments, etc.

Indian aluminium industry is now evolving its modernisation programme including capacity expansions. Simultaneously installation of new aluminium plants in green field site is also being followed up in India. It is therefore appropriate to set up a Research, Development and Design Organization to have the full benefits from the capital invested in modernisation as well as installation of new capacity.

The contribution of R & D efforts in various leading aluminium producing countries may serve as a guide to set up the R & D Organization. M/s ALCOA and Reynolds from USA, Pechiney from France, ALUTERV-FKI from Hungary, VAMI from USSR and ALUSUISSE from Switzerland are all credited with pioneering work in the process and product development in the aluminium industry.

All these leading organizations in aluminium field have composite Research and Development Organizations supported by trained scientists and highly advanced range of laboratory equipment. A close interaction amongst research institutes, educational institutes, industry and consumers has enabled numerous important technological advancements in these developed countries.

Over the years, a chain of national laboratories and academic institutions have been set-up in India and scientists have done some research work in the field of aluminium also. However, much benefit has not reached to aluminium industry due to lack of systematic efforts in commercial application of the research findings. Effective interaction between the national laboratories, scientific institutions and aluminium plants is very much necessary for effective technological developments. A gap still exists in India between scientific institutions and industry that needs to be bridged. The setting up of an RDDC, exclusively for aluminium industry, with the facilities for basic and applied research and up-scaling of technology will go a long way in bridging the gap.

The establishment of an Aluminium Research & Development Centre has been under the consideration of the Government of India for quite some time. As early as 1969, a study group set up by the Government of India, submitted a report recommending the establishment of a Research & Development Institute for Aluminium. In 1975 a UNDP/UNIDO sponsored study group evaluated the Research & Development facilities available in some of the leading aluminium producing countries and indentified some of the areas in which development work could be undertaken under specific Indian conditions, as set out in their "Study Report on Establishment of Institutional Support to Aluminium Industry". Subsequently during 1980, a further study on Research and

Development activities in alumina/aluminium, existing R & D set up in Bharat Aluminium Company and requirement of Research and Development in India was carried out by a group of specialists from VAMI Institute of USSR who submitted their findings in the form of reports (i) "Recommendations on Composition and Scope of Work for the Basic Research, Development and Design Complex" and (ii) "Proposed programme of carrying out the experimental and test works in the Pilot Plants available at Korba Complex".

All the reports mentioned above recommended establishment of an Aluminium Research and Development Centre in India. Subsequently, a protocol was signed on 8th June 1981, between the Government of India and UNDP for preparatory assistance for establishment of such an Institute. The first phase of UNDP assistance is for preparation of a Preparatory Project Report for establishment of the RDDC. Based on the recommendations of this Report and its approval by the Government of India, subsequent activities regarding the establishment of the RDDC will be taken up. In accordance with the protocol, the Preparatory Project Report will be prepared by a foreign consultancy organization with the assistance of an Indian consultancy and design organization. Accordingly, ALUTERV-FKI (Hungary) have been appointed as the foreign consultants and MECON as the Indian consultants for the preparation of the Preparatory Project Report for setting up of the Aluminium Research, Development and Design Centre.

Dr.N.N.Tikhonov was appointed by UNIDO as the Chief Technical Adviser for supervising the preparation of the Report and Dr.D.C.Datta was appointed by Govt. of India as the National Project Co-ordinator to coordinate the work of various agencies.

1.3 SCOPE OF SERVICES AND APPROACH

The scope of the Centre and services of ALUTERV-FKI and MECON for the preparation of the Report are indicated in "Terms of Reference of the Detailed Preparatory Report for Aluminium Research Development and Design Centre setting up" (Annexure 1) which were approved by the Steering Group of Department of Mines (Ministry of Steel & Mines) on 1st of October 1982 (Office Memorandum No. 1/38/81-met.v.). The Report inter-alia reviews the status of aluminium industry in India, assessment of future trends of development, existing research, development and design facilities, long and short term objectives, organizational structure, scope of activities and functions, capital and recurring costs, priority of construction and implementation, training programme, etc. The Report has been based on discussions with representatives of leading aluminium producers and concerned Research and Development organizations and institutions in the country. The Report has also taken a note of the recommendations contained in various rep and documents earlier prepared relating to setting u the Research, Development & Design Centre for Aluminium.

ALUTERV-FKI specialists visited the probable sites for location of the RDDC and some of the alumina/aluminium production facilities.

A team of MECON engineers also visited the probable sites for the location of the RDDC and collected data/information on availability of land and infrastructure facilities for the proposed Centre. Discussions were also held with various authorities of the concerned States such as Directorate of Industries and relevant district authorities regarding the site location. MECON team also visited some of the aluminium plants and studied the R & D facilities available with them or being planned.

Both teams (ALUTERV-FKI and MECON) also visited some of the independent research and development organizations carrying out work in the aluminium field, including Regional Research Laboratory-Bhubaneshwar, Regional Research Laboratory Hyderabad, Indian Institute of Sciences-Bangalore, National Metallurgical Laboratory (NML)-Jamshedpur, etc. Detailed discussions were held with concerned officials in each case.

A meeting was held between ALUTERV-FKI, MECON, CTA (UNIDO) and NPC at Delhi on 10th & 11th November 1982 to review the programme and the division of work between ALUTERV-FKI and MECON. The record notes are placed at Annexure 2.

1.4 ACKNOWLEDGEMENT

MECON and ALUTERV-FKI have received valuable co-operation from various agencies in the preparation of the Report. MECON and ALUTERV-FKI thankfully acknowledge the assistance extended by Ministry of Steel & Mines (Department of Mines), Bharat Aluminium Company, National Aluminium Company, Chief Technical Adviser, National Project Co-ordinator, Indian Aluminium Company, Hindustan Aluminium Corporation, Madras Aluminium Company, Regional Research Laboratory-Bhubaneshwar, Regional Research Laboratory-Hyderabad, Indian Institute of Sciences-Bangalore, National Metallurgical Laboratory-Jamshedpur, Defence Metallurgical Research Laboratory-Hyderabad, Governments of Andhra Pradesh, Karnataka, Orissa, Madhya Pradesh and Bihar in connection with the preparation of the Preparatory Project Report.

2. SUMMARY

2. SUMMARY

2.1 GENERAL

Discovery of large bauxite deposits of fairly good quality in the East Coast of India during the early seventies has opened new vistas for the development of Indian Aluminium Industry. The known reserves of bauxite in India are now estimated to be about 2,500 million tonnes. The future development of Indian Aluminium Industry can therefore be planned not only in the context of meeting indigenous demand, but also for the possible export of alumina/aluminium.

The existing installed capacities related to Aluminium Industry in India are as follows:

	Tonnes per year
Alumina	688,000
Primary aluminium metal	371,000
Extruded products	38,060
Rolled products	120,000
Wire rods	118,000
Foils	7,300

A new Aluminium Complex in Orissa with a capacity of 800,000 t/yr alumina and 218,000 t/yr capacity of aluminium is under implementation and is expected to be fully commissioned by 1986/87. Proposals for setting up of an Alumina Plant of 600,000 - 800,000 t/yr capacity in Andhra Pradesh and another plant of 300,000 t/yr in Gujarat have been formulated.

An annual average growth rate of 10-12 % has been projected earlier for the domestic aluminium demand during the present decade. This will mean an estimated demand of 843,000 t/yr of primary metal by 1989-90 (see Table 3.11). Assuming an average growth-rate of about 8 % during the nineties the demand for aluminium by the year 2000 AD is expected to be about 1.8 million tonnes.

2.2 NEED FOR THE CENTRE

The existing alumina/aluminium plants in India are based almost entirely on foreign know-how. Though certain amount of research and development work in this field is being carried out by the industry as well as certain research laboratories, a co-ordinated effort in R & D would be essential to attain self-reliance in the alumina and aluminium technology for the development of the aluminium industry. The research efforts in the aluminium industry need to be directed towards improvement of the process technologies and quality of products, optimization of material and energy consumption through automation and improved process control techniques, mechanisation of operations, equipment design, product development for better marketability and development of new pollution control techniques. Though the basic process for production of alumina, aluminium and semis remained the same, a number of technological improvements have taken place in advanced aluminium producing countries. (Import of the improved technology is not always possible or practicable in existing plants.) Establishment of a self-sustaining, full fledged and independent Research, Development and Design Centre is essential for the development of aluminium industry in India. Such a Centre will meet the fast growing needs of technological servicing and support of the aluminium industry through the planning, development and operational stages. It will also facilitate adoption of the latest technological innovations and necessary know-how for improvement of processes and products. It is in this context that the Government of India has decided to consider setting up a Research, Development and Design Centre for the Aluminium at the national level.

2.3 EXISTING R & D FACILITIES

There are a number of laboratories/educational institutions where certain amount of research work is being carried out in the aluminium field. Besides, all the aluminium producers have their own laboratories with varying degrees of sophistication. These laboratories are basically meant for quality and process control work for the plants, but they also carry out certain amount of research and development work.

2.4 OBJECTIVES OF THE CENTRE

The research and development work to be carried out by the proposed Centre would be mainly in the field of alumina production, aluminium electrolysis, semis and finished production, analytical research, material sciences and application techniques. In the initial stages the activities will be directed towards improvement of the existing technologies and in the later years the efforts will be to develop process know-how for establishment of new alumina/aluminium plants.

The long and short term objectives of the Centre would be:

- improvement of quality and marketability of the products
- increase in efficiency of production technologies and improvement of the economy of the latter

- improvement in economic utilisation of equipment
- reduction in energy and material consumption
- research for new technological processes
- development of technological schemes for new production facilities
- development of basic design and engineering for aluminium industry.

The main long and short term programme for research, development and design work has been indicated in chapter 5 and Annexure 3 of the Report.

2.5 ORGANIZATIONAL STRUCTURE

An organization can perform its functions and attain the objectives if its activities are supported by a well developed organizational structure. The recommended structure is based on five main organizational branches, three of which are meant for fundamental activities namely research, development and design and the other two for general technical and administrative services. These branches are:

- Alumina and aluminium research.
- Semis and finished products research.
- Design and engineering.
- Technical Services.
- Administration.

Each of these branches would be headed by a Dy. Director/General Manager, while the organization itself will be headed by a Director.

The proposed Centre will have a staff of 1009 distributed as:

Highly qualified personnel	-	409
Auxiliary technical personnel	-	401
Administrative personnel	-	199

The total staff, will be built-up in a period of about 6 years. A branch-wise break-up of the staff is shown in Table 2.1.

Table 2.1

STAFF OF THE RESEARCH, DEVELOPMENT AND DESIGN CENTRE

S.No.	Department	Highly qualified	Auxiliary	Administration	Total
1.	Management	11	7	5	23
2.	Alumina and Aluminium	110	147	7	265
3.	Semis and finished products research	92	95	10	197
4.	Design and engineering	122	72	11	205
5.	Technical services	73	79	22	174
6.	Administration	1	1	144	146
Total:		409	401	199	1,009

2.6 LOCATION OF THE CENTRE

The proposed Research Development and Design Centre will be a national institution meant to serve the interests of the aluminium industry as a whole. As such, its location has to be such that it will be reasonably accessible to all the existing plants and those under consideration. Some of the criteria which have to be considered while selecting a suitable site are proximity to bauxite deposits, alumina and aluminium plants, including secondary fabricators and non-ferrous research institutes, good climatic conditions and proximity to a developed city with civic amenities, professional educational institutions, internal and external transport and communication facilities, availability of land and infrastructure facilities.

The location of the Centre may be suitably decided by the Government of India after evaluation of the probable sites.

2.7 EQUIPMENT

The list of the equipment and instruments necessary for the RDDC has been compiled branchwise to ensure that suitable equipment will be available for all the research and development activities required for the aluminium industry. The equipment that is proposed to be imported is shown separately.

In accordance with stage-wise activities planned for individual branches, procurement of equipment has also been planned in three stages. The stage-wise break-down of equipment also identifies the relative importance for research work. It is expected that all the equipment would be provided during the implementation stage itself.

2.8 GENERAL LAYOUT

The Centre will be located in an area of approximately 20 hectares while the built in area of the building is about 15,000 m^2.

The RDDC will be provided with a township to house its personnel. It is envisaged that 100 % of the scientific staff will be provided with accommodation in the township, so that the right talent can be attracted. For the remaining staff about 40 % satisfaction has been considered, as the Centre is expected to be located near an urban area.

The overall satisfaction level has been assumed to be about 70 %.

2.9 INVESTMENT COSTS

The investment for the proposed RDDC has been estimated at about Rs. 488 million, including a foreign exchange component of Rs. 123 million (equivalent to US $ 12.2 million). The broad break up of the investment is:

	In million rupees	
- RDDC proper	316.7	(includes Rs. 152.5 million for equipment)
- Township	77.5	
- Recurring costs during implementation period	93.3	
Grand total:	487.5	say Rs. 488 million

Interest during construction has not been considered as the entire amount is expected to be financed from Government grant and UNDP assistance. The capital costs are based on prices prevailing during the first quarter of 1983 and no provision has been made in the estimates towards escalation.

2.10 IMPLEMENTATION SCHEDULE

It is anticipated that the implementation of the Centre would be completed in a five year period. Construction of all the main and auxiliary buildings and township, procurement and installation of a substantial part of the equipment and instruments, and recruitment and training of personnel would be carried out during this period.

According to the plan of work, majority of the laboratories will start their activities in the first phase of implementation but with a reduced strength and equipment. In the later phases more sophisticated and supplementary activities will be taken up, stage-wise. In the plan of construction, therefore, priority is accorded to those buildings and equipment which would make it possible to start research work in the priority areas, namely alumina and aluminium research branch, semis and finished products research branch and general technical services as well as the pilot plants and workshops.

2.11 ANNUAL EXPENSES

The annual expenses of the RDDC including depreciation charges in a typical year when the Centre would have been fully established have been summarised below:

S.No.	Item	Amount (In million rupees)
1.	Salaries and wages including managerial expenses and other overheads	26.9
2.	Cost of materials and services, repair and maintenance, experts fees, documentation etc.	17.0
3.	Depreciation	24.4
Total annual expenses:		68.3

The prices of materials, services and salaries are based on the rates prevailing during the first quarter of 1983 and no provision has been made for escalation in computation of annual expenses.

2.12 TRAINING

A detailed training programme has been recommended. Initially the technical personnel recruited will be given a 4 to 6 weeks orientation-cum-training course, during which a number of specialists from India and abroad will participate.

It is planned to organise 4 to 6 weeks study tours abroad for heads of departments/laboratories/design branches. The experts who are to actually carry out the R & D work will be deputed on fellowships abroad to acquire practical experience.

2.13 METHOD OF CHARGING

The institute may receive payments from the user industry for testing of raw materials and finished products and know-how for the processes and designs developed and supplied by it. The payment may be in any of the following manner:

i) Lump-sum fee
ii) Cost plus basis
iii) Lump-sum fee plus running royalty.

In order to conduct tests and experiments in the running plants, the Centre may have to make some payments to the industry. The payment may depend upon the loss of productive time and saleable products quality and quantity during the course of the experiment.

The method of charging in either case will have to be worked out on a case to case basis.

3. STATUS OF INDIAN ALUMINIUM INDUSTRY

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3.1 GENERAL

Aluminium has gained greater importance in the field of metals in India in the recent past with its increasing per capita consumption coupled with the discovery of huge reserves of bauxite, the main basic raw material for the production of aluminium.

The aluminium metal was produced for the first time in India in the year 1943 with a total output of 1292 tonnes. After a period of slow growth in the fifties, aluminium industry had a rapid growth to reach the present level of installed capacity of 371,000 t/yr.

The existing aluminium plants have been installed with foreign collaboration as mentioned below:

	Units	Foreign collaborators
i)	Indian Aluminium Company (INDAL) at Hirakud, Alwaye Belgaum, Muri, Belur, Taloja, Kalwa	Alcan Aluminium Ltd., Canada
ii)	Bharat Aluminium Company Limited (BALCO), at Korba The first Government of India Undertaking in the field of aluminium	Alumina Plant - ALUTERV-FKI, Hungary Aluminium Smelter and Fabrication Complex - VAMI, USSR
iii)	Hindustan Aluminium Corporation (HINDALCO),	Kaiser Engineers Overseas Corpn., USA

iv)	Madras Aluminium Company (MALCO), at Mettur Dam.	Montecatini (ALUMETALL), Italy
v)	Aluminium Corporation of India (ALUCOIN) at Jaykaynagar	Swiss Aluminium (ALUSUISSE), Switzerland (for expansion only)

All the facilities set up by these producers have been based on imported technological know-how including basic engineering.

In addition to the above, National Aluminium Company, (NALCO) the second Government of India Undertaking, are setting up a giant aluminium complex in Orissa with technical collaboration with Aluminium Pechiney of France.

3.2 PRODUCTION FACILITIES IN INDIAN ALUMINIUM INDUSTRY

Aluminium industry may be broadly classified into the following major areas:

- Bauxite mining
- Alumina Production
- Aluminium Production
- Aluminium Semis Fabrication
- Finished Products Manufacturing

3.2.1 Bauxite Mining

In the sixties the known bauxite reserves of India were of the order of 215 million tonnes. Further exploration work carried out by the Geological Survey of India between 1960 and 1970 and supplemented by corresponding agencies of some of the State Governments, resulted in raising the bauxite reserves to about 300 Mt. A major break-through was achieved in early 1970s by the discovery of large deposits of bauxite on the East Coast of Orissa and Andhra Pradesh, thus taking the total reserves to about 2,500 million tonnes. Statewise estimated reserves of bauxite in India are indicated in Table 3.1.

The bauxite mining has been expanded from the initial capacity of about 30,000 t/yr bauxite in early 1940, to meet the present level of alumina production capacity of about 700,000 t/yr. The mining operations in India so far adopted are either semi-mechanised or manual. Mechanised mining using large capacity equipment has been envisaged for Gandhamardan Bauxite Project with a capacity of 0.6 million tonne per year for Korba Alumina Plant, BALCO and for Panchpatmali Bauxite Project with a capacity of 2.4 million tonne per year for National Aluminium Company (NALCO) in Koraput district which is under implementation stage. A mechanized mining complex in Andhra Pradesh with a capacity of 2.3/4.0 million tonne per year is in the proposal stage.

3.2.2 Alumina Production

The present installed capacity is 678,000 tonnes/yr of alumina production. The existing alumina plants together with their location and capacity are shown in Table 3.2.

For production of alumina, the conventional Bayer Process is being followed. The Jaykaynagar Alumina Plant which was set up in the early fifties adopted the technology of dry grinding and batch process for digestion and mud filtration. The plants put up later at Renukoot, Belgaum, Mettur and Korba adopted continuous digestion at low or high pressure for extraction of alumina, rotary kilns for calcination and mud causticization for recovery of the caustic. Both floury and sandy type of alumina are being

Table 3.1

ESTIMATED BAUXITE RESERVES IN INDIA

In million tonnes

Sl No	State	Measured	Indicated	Inferred	Total	Grade range percentage Al_2O_3, SiO_2
1.	Andhra Pradesh	26	84	666	776	45-48 < 5
2.	Orissa	83	132	1040	1255	45-48 < 5
3.	Maharashtra	51	32	45	128	43-57 upto 4
4.	Madhya Pradesh	56	13	37	106	45-48 < 5
5.	Bihar	11	17	48	76	46-59 2-7
6.	Gujarat	40	4	2	46	45-51 2-7
7.	Goa	8	9	7	24	-
8.	Karnataka	2	9	13	24	45-50 upto 6
9.	Uttar Pradesh	10	4	2	16	40-60 2-8
10.	Kerala	1	4	3	8	40-50 2-6
11.	Tamilnadu	3	1	2	6	40-45 upto 10
12.	Jammu & Kashmir	-	-	3	3	-
Total		291	309	1868	2468	43-57 2-7

Note: Data from Mineral Exploration Corporation, and from the Report of Working Group on Non-Ferrous Metals, June 1980.

Table 3.2

EXISTING ALUMINA CAPACITY IN INDIA

Sl No	Name of Company	Location	Installed Capacity (t/yr)
1.	Bharat Aluminium Co.Ltd., (BALCO)	Korba (M.P.)	200,000
2.	Indian Aluminium Co.Ltd., (INDAL)	a) Muri (Bihar)	75,000
		b) Belgaum (Karnataka)	160,000
3.	Hindustan Aluminium Corpn. (HINDALCO)	Renukoot	190,000
4.	Madras Aluminium Co. (MALCO)	Mettur	45,000
5.	Aluminium Corpn. of India (ALUCOIN)	Jaykaynagar (West Bengal)	18,000
Total capacity			688,000

Notes: i) ALUCOIN plant is closed since 1973.

ii) National Aluminium Company's (NALCO) Alumina Plant at Damanjodhi in Orissa with capacity of 800,000 t/yr is expected to go into production by 1986.

iii) Data collected from plants.

produced in India which are suitable for aluminium smelters of pre-baked or Soderberg design. Atmospheric digestion and fluidised bad calciner have been adopted for NALCO's Alumina Plant under construction. Projects for recovery of by-products such as vanadium and gallium are either under implementation or under planning in some plants.

3.2.3 Aluminium Production

The total installed capacity for production of primary aluminium metal in India is presently 371,000 t/yr. The actual production and imports of aluminium over the last 30 years are shown in Table 3.3.

The existing aluminium smelters with their location and capacity can be seen in Table 3.4.

Aluminium smelting in India is based on conventional Hall-Heroult technology. Three types of electrolytic cell design namely horizontal stud Soderberg, vertical stud Soderberg and prebaked anode are adopted. The current intensity ranges from 50 to 100 kA. The aluminium smelters constructed at Jaykaynagar and Alupuram in the forties and fifties adopted current intensity less than 50 kA. The electrical power consumption was as high as 20,000 kWh/t of aluminium production. Between 1960 to 1970, aluminium smelters at Hirakud, Renukoot and Belgaum were installed with current intensity around 55 kA, electrical energy consumption of around 18,000 kWh/t of aluminium. The smelter at Mettur which was set up in 1972 was designed for a current intensity of 80 kA. The largest aluminium smelter based on high current intensity of 100 kA was commissioned at Korba in 1975 with a designed power consumption of about 16,000 kWh/t of aluminium. The proposed aluminium smelter of NALCO envisages a current intensity of 175 kA with prebaked system and an estimated energy consumption of 13,000 to 14,000 kWh/t of aluminium.

Table 3.3

AVAILABILITY OF ALUMINIUM IN INDIA
(1950 to 1983)

(tonnes)

Period	Production	Imports	Availability
1950-51	4,045	10,800	14,845
1955-56	7,450	16,100	23,550
1960-61	18,317	25,400	43,717
1965-66	62,058	20,126	75,247
1970-71	168,784	6,386	175,170
1975-76	187,276	5,063	192,339
1980-81	199,020	120,780	319,800
1981-82	206,770	17,200	223,970
1982-83	208,146	Nil	208,146

Note: Data from the Report of Working Group on Non-Ferrous Metals (June 1980) and Ministry of Steel and Mines, Department of Mines.

Table 3.4

EXISTING PRIMARY ALUMINIUM CAPACITY IN INDIA

Sl No	Name of Company	Location	Installed Capacity (t/yr)
1.	Bharat Aluminium Co. Ltd. (BALCO)	Korba, (M.P.)	100,000
2.	Indian Aluminium Co.Ltd. (INDAL)	a) Alwaye (Kerala)	20,000
		b) Hirakud (Orissa)	24,000
		c) Belgaum (Karnataka)	73,000
3.	Hindustan Aluminium Corpn. (HINDALCO)	Renukoot (U.P.)	120,000
4.	Madras Aluminium Co. (MALCO)	Mettur (Tamilnadu)	25,000
5.	Aluminium Corpn. of India (ALUCOIN)	Jaykaynagar (West Bengal)	9,000
Total capacity			371,000

Notes: i) ALUCOIN smelter is closed since 1973.

ii) National Aluminium Company (NALCO)'s Aluminium Plant in Orissa with a capacity of 218,000 t/yr is expected to be commissioned by 1987.

iii) Data from the Report of Working Group on Non-Ferrous Metals, June 1980.

While the earlier aluminium smelters did not envisage any gas cleaning facilities, the plant set up at Korba in mid 1975 provides for gas cleaning with wet scrubbing and electrostatic precipitators. NALCO's proposed smelter envisages dry adsorption system for the gas cleaning.

3.2.4 Aluminium Semis and Finished Products

Aluminium is fabricated into semis like wire rods, rolled products and extrusions, and converted into finished products like cables, utensils, doors, windows, ducting, furniture frame work, vehicle parts, hardware, caps, etc. In highly capital intensive industries like steel and aluminium, production of semis is largely integrated with primary metal producers in India.

Besides the primary producers, there are a number of secondary producers of aluminium contributing to the overall availability of aluminium in semi-fabricated form. JINDAL-Bangalore, EMC-Calcutta, Patel Aluminium-Bombay, Gujarat Extrusion-Baroda are some of the producers of extruded products. Secondary producers for rolled and wire rod products also make substantial contribution. About 19,000 t/yr of extrusion, 8,000 t/yr of rolled products, 31,000 t/yr of wire rods and 4,200 t/yr of foils are contributed by secondary producers.

The existing annual installed capacities in the organized sector for extruded products, rolled products, wire-rods and foils in India are given in Tables 3.5, 3.6, 3.7 and 3.8, respectively.

Extrusion presses installed in India have adopted conventional extrusion technology using oil hydraulic system. Extrusion presses upto 2,000 t were installed in various plants. BALCO has recently commissioned 3,150 t extrusion press at Korba.

Table 3.5

EXISTING ALUMINIUM EXTRUSION CAPACITY IN INDIA

Sl No	Units	Location	Installed Capacity (t/yr)
1.	HINDALCO	Renukoot	5,000
2.	INDAL	Alupuram	3,760
3.	ALUCOIN	Jaykaynagar	1,000
4.	MALCO	Mettur	2,000
5.	BALCO	Korba	7,300
6.	Jindal Aluminium Ltd.	Bangalore	4,200
7.	Karnataka Aluminium	Mysore	3,000
8.	Electrical Manufacturing Co. Ltd.	Calcutta	1,100
9.	Banco Aluminium Ltd.	Vadodara	850
10.	Patel Aluminium	Bombay	1,400
11.	Gujarat Aluminium Extrusions (P) Ltd.	Baroda	1,400
12.	Bihar Extrusions	Gamoria	1,400
13.	Mahabir Aluminium Co. Ltd.	Alwar	2,000
14.	J.B. Advani	Nasik	400
15.	B.S. Castings	Jalgaon	350
16.	Sudeshan Aluminium Industries Ltd.	Nasik	2,400
17.	Abdul Hussain M. Alabaxi Hwari	Maharashtra	500
Total capacity			38,060

Note: Data collected from DGTD.

Table 3.6

EXISTING ALUMINIUM ROLLING CAPACITY IN INDIA

Sl No	Units	Location	Installed Capacity (t/yr)
1.	HINDALCO	Renukoot	20,000
2.	INDAL	Belur, Taloja & Kalwa	29,500
3.	ALUCOIN	Jaykaynagar	2,500
4.	BALCO	Korba	40,000
5.	Aluminium Cables and Conductors Pvt.Ltd.	Calcutta	5,000
6.	Lallubhai Aminchand Pvt.Ltd.		2,500
7.	Others		20,500
Total capacity			120,000

Note: Data collected from the producers and the Report of Working Group on Non-Ferrous Metals, June 1980.

Table 3.7

EXISTING ALUMINIUM WIRE RODS PRODUCTION CAPACITY IN INDIA

Sl No	Units	Location	Installed Capacity (t/yr)
1.	HINDALCO	Renukoot	25,000
2	INDAL	Alwaye (Alupuram)	12,000
3.	BALCO	Korba	35,000
4.	ALUCOIN	Jaykaynagar	3,000
5.	MALCO	Mettur	12,000
6.	Aluminium Cables & Conductors Pvt. Ltd.	Calcutta	10,000
7.	ALIND	Kundra (Kerala)	6,000
8.	Power Cables Pvt.Ltd.	Bombay	6,000
9.	Universal Cables Ltd.	Satna	9,000
Total capacity			118,000

Note: Data collected from the Report of Working Group on Non-Ferrous Metals, (June 1980) and from the producers.

Table 3.8

EXISTING ALUMINIUM FOIL CAPACITY IN INDIA

Sl No	Units	Location	Installed Capacity (t/yr)
1.	Indian Aluminium Co.Ltd. (INDAL)	Kalwa (Maharastra)	2,500
2.	Aluminium Corporation of India Ltd. (ALUCOIN)	Jaykaynagar (W.B.)	600
3.	India Foil Limited (IFL)	Kamarhatti Calcutta (W.B.)	4,200
Total capacity			7,300

Note: Data collected from the producers.

Rolling mills of smaller capacity of upto 20,000 t/yr were installed upto 1972 at Belur, Jaykaynagar and Renukoot. A modern mill was installed at Taloja by Indian Aluminium Company. The latest mills with an annual capacity of 40,000 t have been set up at Korba. These are high capacity mills capable of rolling high strength alloys which can meet the requirements of Aircraft and Defence Industries.

Considerable know-how for extruded and rolled products has been developed in most of the areas of application. However, there is still a technological gap in production of certain products based on sophisticated alloys to meet the requirement of Defence and Aeronautical Industry, which are presently being met through imports. The adoption of improved equipment will add to the refinement of fabrication and finishing techniques to achieve high productivity, lower cost of production and better finish of the products.

3.2.5 New Projects

National Aluminium Company (NALCO) in Orissa is under implementation stage with bauxite mining capacity of 2.4 million tonne per year, alumina plant of 800,000 tonne per year, and aluminium smelter of 218,000 tonne per year alongwith a captive power plant of about 720 MW.

600,000 to 800,00 t/yr alumina plant in the state of Andhra Pradesh is in the proposal stage. TSVETMETPROMEXPORT of USSR has prepared the Feasibility Report for the project.

Gujarat Mineral Development Corporation is considering to set up an alumina plant of 300,000 t/yr capacity in Kutch district of Gujarat, for which ALUTERV-FKI prepared a Feasibility Report in 1979. MECON updated the Report during 1981-1982.

3.3 FUTURE DEMAND ESTIMATIONS

The aluminium industry in India has made rapid strides in the past two decades achieving an average annual growth rate of 8 %. Although India is rich in bauxite estimated to be about 8 % of world resources, the aluminium production is only about 2.5 % of the world production of primary metal. The aluminium industry in India is poised for a break-through and from a position of self-sufficiency, it could emerge as a potential exporter of alumina/aluminium.

3.3.1 Existing Consumption Pattern

The pattern of consumption in India reveals that around 52 % of the aluminium production is utilised in the electrical industry followed by consumer durables (20 %), transport (12 %), canning an packaging (4 %), building and construction (6 %) and miscellaneous (6 %). The consuption pattern in the developed countries like USA, Japan and Germany, however, presents a completely different picture. The electrical industry in these countries accounts for only 12 to 13 % of the aluminium production, while the bulk of the aluminium consumption 50 to 70 % is in the transport, building and construction and consumer durables industries. The disparity in the consumption pattern of aluminium as far as electrical industry is concerned can be attributed to the scarcity of copper, and India's power development and distribution programme. However, in other sectors the smaller share of aluminium consumption is mainly due to cheaper traditional materials already in use like steel, wood, etc. as well as the socio-economic traditions. The actual consumption in India cannot be held representative of true demand pattern mainly because of the limited supply and the rising price of aluminium which act as deterrents for its substitution for other materials. If the constraints mentioned above are remedied and efforts are made to diversify the use of aluminium in some of the areas like transport, building and construction, canning and packaging, the future demand pattern may change substantially.

Use of aluminium for making electrical conductors is now universally well established. The National Metallurgical Laboratory has developed NML-PM_2 aluminium conductor with high electrical conductivity. Winding of motors and generators and the use of aluminium in place of copper in transformer windings is also fairly well established.

In transport sector, aluminium is used extensively for bus and truck bodies, railway coaches and wagons and various parts for the automobile industry. With the increasing energy costs there has been consistent effort in the transport sector to use vehicles with reduced deadweights and increased pay-loads.

Building components like aluminium doors and windows, false ceilings, separation walls, metal shutterings, ladders, etc., are being extensively used. In India, however, usage of aluminium in this sector has been limited mainly due to the price and availability of aluminium.

In the sector of consumer durables aluminium has great potential for replacing stainless steel which is used in the chemical and food industry as well as in the household application. The adaptability of aluminium and its alloys for diverse applications provides a considerable scope to develop new designs in manufacture of pressure cookers, teflon lined aluminium products for kitchenware, hospital and restaurant equipment.

The usage of aluminium as packaging material ranges from chocolate wrapping foils to large size cans. Aluminium foils are extensively used in our day to day life. Thus there is ample scope for the use of aluminium in the packaging and container industry.

Table 3.9 indicates the pattern of consumption for aluminium in India and other developing countries, and developed countries.

Table 3.10 reviews the change in consumption pattern in India from 1950 to 1980. The above facts higlight potential for a large growth of aluminium consumption within the country and diversification of its end uses.

3.3.2 Demand-Supply Projections and Gaps

The Working Group on Non-Ferrous Metals has projected the future demand in India for EC grade aluminium metal to grow at 12 % per year and that of commercial grade metal at 10 % per year for the decade.

Table 3.11 indicates the estimated demand for EC grade metal, commercial grade metal and total requirement from 1984-85 to 1989-90.

For the development of aluminium industry in India, it would be necessary to gear up and streamline all available facilities for designing and setting up of plants with up-to-date technology.

The Report by the Working Group on Non-Ferrous Metals reveals that the demand for aluminium in India would be 551,000 t by 1985-86 and 843,000 t by 1989-90. The estimated production by 1985-86 and 1989-90 with the existing and proposed new facilities would be around 350,000 t and 570,000 t respectively, leaving the gap between demand and domestic supply as 201,000 t and 273,000 t respectively, Table 3.12 gives the projected smelting capacities, demand estimates and gap between demand and domestic supply.

Table 3.9

CONSUMPTION PATTERN FOR ALUMINIUM (1979-80)

	UK %	JAPAN %	USA %	HUNGARY %	INDIA %	Other develop-ing countries %
Electrical	13	12	14	28	52	15
Consumer durable domestic app-liances	11	20	9	13	20	12
Transport	32	19	17	12	12	22
Building & Construction	9	30	27	20	6	23
Packaging & Container	7	5	15	12	4	10
Machinery & Equipment)	28	14	6)	15	2	6
Others)			12)		6	12

Note: Data from Minerals & Metals Review.

Table 3.10

CHANGE IN CONSUMPTION PATTERN IN INDIA

	1950 %	1960 %	1970 %	1980 %
Electrical	20	40	48	52
Household & Commercial	52	24	28	18
Transportation	6	13	8	12
Covering & Packaging	10	11	8	6
Building & Construction	2	1.5	2	6
Miscellaneous	10	10.5	6	6

Note: Data from Minerals & Metals Review.

Table 3.11

DEMAND PROJECTION FOR ALUMINIUM UPTO 1989-90

Year	EC Grade	Commercial Grade	Total
1984-85	291,000	205,000	496,000
1985-86	326,000	225,000	551,000
1986-87	365,000	248,000	613,000
1987-88	409,000	273,000	682,000
1988-89	458,000	300,000	758,000
1989-90	513,000	330,000	843,000

Note: Data from the Report of Working Group on Non-Ferrous Metals, June 1980.

The annual demand growth rate in India is likely to be about 8 % in the period of 1990 to 2000. Completing the Table 3.12 with demand figures calculated on this basis, it can be stated that the gap between the estimated production in 1990 and the demand in 1995 and 2000, respectively further increases upto 670,000 and 1,250,000 tonnes, respectively.

It is obvious that, while on a short term basis the gap between demand and domestic supply could be somewhat bridged by continuing the imports, the widening gap in the later years would indicate a need for establishing additional smelting, alumina production, semis and finished products fabrication capacities during the period 1985-90 and beyond.

Table 3.12

GAP BETWEEN PROJECTED DEMAND AND DOMESTIC SUPPLY

Year	Smelting Capacity	Demand	Estimated Production	Gap between Demand & Domestic Supply
* 1984-85	395,000	496,000	335,000	161,000
1985-86	395,000	551,000	350,000	201,000
1986-87	505,000	613,000	405,000	208,000
1987-88	615,000	682,000	515,000	167,000
1988-89	615,000	758,000	570,000	188,000
1989-90	615,000	843,000	570,000	273,000
**1990-1995		1,240,000		670,000
1995-2000		1,820,000		1,250,000

Notes: * Data from the Report of Working Group on Non-Ferrous Metals, June 1980.

** Assuming the probable annual demand growth-rate of 8 % upto 2000.

4. EXISTING RESEARCH, DEVELOPMENT & DESIGN FACILITIES IN ALUMINIUM FIELD IN INDIA

4. EXISTING RESEARCH, DEVELOPMENT AND DESIGN FACILITIES IN ALUMINIUM FIELD IN INDIA

4.1 LABORATORIES AND UNIVERSITIES IN INDIA ASSOCIATED WITH RESEARCH AND DEVELOPMENT IN THE FIELD OF ALUMINIUM

4.1.1 Research and Educational Institutions

In India there are a number of laboratories/institutes where various activites of interest to aluminium industry in general are carried out. These activities of concerned laboratories are given below:

i) Regional Research Laboratory, Bhubaneshwar.

Mineralogical investigation of bauxite is carried out to ascertain the characteristics of bauxite deposits. Investigations are carried out for reactive and free silica contents, constitution of clay minerals, hydration characteristics of alumina, mineralogy of iron oxides, titania, etc.

These activities are conducted in a well equipped petrographic laboratory with supporting facilities like IR spectrometer, optical spectrometer, X-ray diffraction set up, etc.

Beneficiation experiments have been carried out by selective grinding and washing of some ferrogenous bauxites to reduce the iron and silica content of the same. Ferrogenous bauxite was chlorinated to produce dry $AlCl_3$ which was subsequently electrolysed (in fused Na,K, chloride bath) to produce metallic aluminium. Laboratory scale trials have been conducted with success and at present assembly of equipment for bench scale trials are in progress. The chlorination technique was adopted from the practice being followed at Nuclear Fuel Complex, Hyderabad.

This laboratory has a well equipped hydrometallurgy wing where high pressure digestion studies of other non-ferrous ores have been undertaken. Considerable work has been done in this laboratory regarding utilisation of red mud and also separation of titanium and iron oxide from the same source.

ii) National Metallurgical Laboratory, Jamshedpur.

This is one of the premier research institutes of this country in various fields of metallurgy. This laboratory is well equipped with sophisticated equipment and facilities and has extensive capability for undertaking research work of both industrial and academic interest.

In this laboratory considerable work has been done for digestion studies of bauxite, development of a process for producing vanadium pentoxide from vanadium bearing sludge, production of synthetic cryolite, production of aluminium fluoride from fluorspar, etc.

Major contributions of this laboratory in the field of aluminium are in the development of various aluminium alloys, noteworthy among which are the precipitation hardening aluminium alloy of electrical grade and other aluminium alloys for power transmission, filler wires for aluminium alloy welding, reactive filters for cleaning molten metal and other fundamental studies on various Al-alloys for their metallurgical evaluation.

This laboratory has also a section for carbon technology.

iii) Indian Institute of Sciences, Bangalore.

This is primarily an educational institute but has very well equipped modern laboratories for fundamental and applied research in metallurgy.

The principal activities taken up in this laboratory can be classified as

- Physical and mechanical metallurgical studies of pure Al, Al-alloys, deformation, fatigue, stress-corrosion behaviour, etc.
- Wear studies of aluminium/aluminium alloys for their new applications.
- Development of special alloys of aluminium for air-craft applications by electroslag refining and formulation of Al-Li, Al-Mg, Al-Mg-Li alloys and their evaluation.
- Studies on mechanical processing by hot extrusion on aluminium/aluminium alloys.
- Aluminium fabrication and casting techniques.
- Development of $AlCl_3$ - NaCl - KCl melt electrolysis for the production of aluminium.
- Electrometallurgy of aluminium - basically oriented towards various surface treatments of aluminium.
- Production of super-purity aluminium by triple layer methods also planned for future.

iv) Central Electro Chemical Research Institute, Karaikudi.

This is a self contained modern laboratory for all types of electrochemical studies. In the field of aluminium this laboratory has many noteworthy contributions.

These could be summarized as:

- Surface treatment of aluminium plating, anodising and electro-deposition of aluminium on metals.
- Development of various aluminium alloys for block making, powderless etching, electrical applications like power transmission, anode applications, electrolytic capacitors, cathodic protection, etc.
- Plating of aluminium or aluminium alloy on mild steel by fused salt electrolysis method.
- Galvanising of mild steel.
- Electrothermic production of fused alumina.
- Corrosion studies of aluminium alloy for heat exchangers.
- Production of gallium from spent Bayers liquor of alumina plant.

There are a number of other accomplished laboratories where considerable work has been done and is still being done on development of aluminium alloys, casting and other forming technologies, powder metallurgy, etc. Noteworthy among them are Regional Research Laboratory, Trivandrum, Indian Institute of Technology, Madras and Bombay, National Aeronautical Laboratory, Bangalore and Defence Metallurgical Research Laboratory, Hyderabad. The latter two laboratories are devoted to new alloy development of aluminium for air-crafts and various defence applications.

4.1.2 Primary Aluminium Producers

All the existing aluminium plants are having their own quality control laboratories with varying degrees of sophistication. These laboratories are basically meant for undertaking routine day-to-day control jobs and to some extent limited short term investigations necessary for the plant. A short description of such facilities are given below, company-wise:

i) Bharat Aluminium Company Limited.

The Alumina/Aluminium Complex at Korba has a well equipped quality control laboratory.

A pilot plant for digestion and settling studies of bauxite is already in operation in this plant. It is planned to augment its research and development facilities to include further bench scale/pilot plant scale trial facilities for investigations upto alumina stage.

Typical investigations already carried out by this laboratory are -

i) Red mud causticization: its efficiency relations to lime quality.
ii) Separation studies of P_2O_5, V_2O_5 from alumina plant liquor.
iii) Digestion behaviour of bauxite.
iv) Effect of various impurities in bauxite on digestion.
v) Reasons for appreciable foaming phenomenon in precipitators.

ii) Indian Aluminium Company Limited.

Around 1979 this organisation started their R & D Complex at Belgaum and since then they are equipping the laboratory in a gradual manner for further R & D work.

The present set up here has three defined divisions, namely process development, analytical division and carbon wing.

They have already completed a number of projects in each of the three divisions, primarily for their own process improvements leading to reduction in power consumption in aluminium smelting, fuel consumption in alumina plant and fabrication plants.

Recycling of waste products has been successfully introduced. Sustained efforts are being made to progressively replace all imported items by indigenous products with positive results.

Attempts are being steadily made to diversify the quality of alumina for applications in refractory, abrasive and ceramic industry, standardisation of processing and fabrication of new alloys, designing of equipment components for indigenous replacement.

This organisation has also taken up research and development work on carbon technology for aluminium smelter and at present they are producing carbon blocks for their own use which has been proved to be quite satisfactory.

The long and short term R & D plans of this organisation can be broadly outlined as:

- Crystalline behaviour of V_2O_5 in plant liquor.
- Extraction of high purity V_2O_5.
- Behaviour of organics and other impurities in high pressure digestion of bauxite.
- Mineralogical quality assessment of various bauxites.
- Beneficiation techniques for utilisation of low grade bauxites.
- Bench scale studies to evaluate suitable process parameters with varying bauxite quality.

- Reduction of power consumption, improvement in current efficiency, study of electrolytic characteristics, study and evolving methods for even current distribution, reduction in specific consumption of various inputs, design improvement in technological vehicles, etc.
- Modification in anode types, increase in their current intensity, effects of magnetic fields in aluminium smelters, etc.
- Installation of proto-type cells for evaluation of basic design data of smelter.
- Scope of automation in cell operation.
- Basic studies on ores, alumina, carbon technology, fluoride technology, metal solidification and cleaning.
- Rolling, extrusion, studies of aluminium products including foil.
- Recycling and recovery of waste aluminium products.

M/s INDAL have planned another R & D Centre at their Taloja works for developmental work regarding lubricating and rolling oils required for aluminium industry.

iii) Hindustan Aluminium Corporation.

The R & D group of HINDALCO, Renukoot is active on areas of bauxite mining, alumina production, electro-metallurgy, extraction of by-products, environmental pollution, etc. Some typical R & D assignments taken up completed are -

- Recovery of gallium from spent liquor
- Recovery of vanadium sludge from alumina plant liquor

- Laboratory scale and pilot plant scale studies with aluminium smelter electrolytic baths for -
  - magnetic field distribution;
  - modification of cathode material;
  - development of pneumatically operated feeders for three point feeding of alumina to electrolytic cell to maintain a steady concentration of alumina in the bath; and
  - incorporation of microprocessor control system for cell voltage control.
- Indigenous development of plant spare components
- Dry scrubbing technique to reduce fluoride losses.

Results of the above studies have been implemented in number of operating cells with significant overall performance improvement.

iv) Madras Aluminium Company Limited.

Madras Aluminium Company Limited has its process control laboratory attached to its works at Mettur, which besides catering to day-to-day requirements of production departments, also assists the various departments in developmental work. Some of the areas in which developmental work has been successfully carried out by MALCO are:

- processing of low grade bauxite (with alumina content around 36 - 37 % and high silica content)
- Development of indigenous carbon materials using high ash metallurgical coke.
- Direct starting technique with simultaneous baking.
- Grafting technique for anodes.
- Rotary crust braking machine.

- Project for gallium recovery is under implementation.
- Improvement in rotary calciner to reduce dust emission into atmosphere.
- Continuous strip casting machine for production of aluminium strips.

4.2 DESIGN FACILITIES IN INDIA IN THE FIELD OF ALUMINIUM

The technical know-how relating to design and engineering for the existing aluminium projects in India was earlier provided by the foreign collaborators.

A beginning in the development of consultancy, design and engineering for the aluminium industry in India was made with the National Industrial Development Corporation (NIDC) taking up the detailed engineering for Korba Alumina Plant

Metallurgical & Engineering Consultants (India) Ltd. (MECON) has been closely associated with the development of aluminium Industries in the country since 1971, when BALCO appointed MECON as Prime Indian Consultants to undertake the detailed engineering work of Korba Aluminium Smelter and Fabrication Complex. MECON rendered complete civil, structural, mechanical, electrical and technological services for the setting up of this project. The expertise in these fields has been further developed subsequently by MECON undertaking various studies for development of alumina and aluminium industries in the country.

Engineers India Ltd (EIL) has recently entered in the field of aluminium as consultants to National Aluminium Company (NALCO) for setting up of bauxite mining, alumina and aluminium plants including captive power plant in the state of Orissa which are at present under implementation stage.

Bharat Heavy Electricals Ltd. (BHEL) is capable of undertaking the complete design and engineering of electrical equipment and controls for aluminium industry. In addition to above, there are many organisations in India Viz. Engg. Projects (I) Ltd. (EPI), McNally Bharat Engineering Company, Heavy Engg. Corporation (HEC), Dorr-Oliver, Larsen & Toubro, BHPV etc., who have sufficient experience of designing, manufacturing and erection of plant and equipment for Aluminium Industry.

5. LONG- AND SHORT-TERM OBJECTIVES

5. LONG- AND SHORT-TERM OBJECTIVES OF THE CENTER

5.1 THE MAIN DIRECTIONS OF THE RESEARCH AND DEVELOPMENT WORK

5.1.1 General

Research and development work of the Centre should be directed in all branches to achieve the objectives given hereunder:

- improvement of the quality and marketability of products
- increase of efficiency of production technologies and improvement of the economy of the latter
- improvement of the economic utilization of the equipment
- reduction of energy and material consumptions
- research for new perspective processes
- co-operation in elaboration of technological schemes for new production facilities
- practising high-level basic, theoretical research work ensuring background for the industrial research.

Further on the main directions of research and development work of the Centre are given by branches and departments.

5.1.2 Geological and Mineralogical Investigations

gL1. Petrological and mineralogical investigation on the East Coast and other bauxite deposits.

gL2. Construction of a geological (lithological, structural) map of the bauxite deposits in order to determine the bauxite distribution in the deposit.

gL3. Study of mineralogical and chemical composition and morphological properties of bauxite.

gL4. Investigation of ore dressing and beneficiation problems.

gL5 Determination of blendability of bauxites from the various deposits for optimal use without beneficiation especially for contiguous and closely situated areas.

5.1.3 Research on Alumina Production

AL1. Study of technological properties of the main bauxite deposits and elaboration of technological schemes of their processing.

AL2. Investigation and working out methods and ways to improve the existing technology and equipment in order to reduce consumption of bauxite, caustic soda, steam, fuel and power.

AL3. Working out industrial methods for improvement of alumina quality.

AL4. Investigation and elaboration of technological methods and schemes of the production of gallium, vanadium pentoxide (and of some other by-products) and of aluminate liquors purification from undesirable impurities (organic matters, carbonates and other salts.)

AL5. Development of the process control and automation in the field of alumina production.

AL6. Development of equipment in the field of alumina production, including auxiliary equipment.

AL7. Investigation and elaboration of methods for production of special alumina to be used in different branches of industry (electronic, refractory, radio, motor industry and some other branches).

5.1.4 Research on Aluminium Electrolysis and Carbon Materials Production

BL1. Investigation and improvement of the aluminium electrolysis technology. Selection of the most effective parameters for smelting process in different types of cells.

BL2. Improvement of reduction cells' design. Extension of the service life of the cells. Decreasing of energy losses. Improvement of mechanization of the smelting process.

BL3. Investigation of new aluminium production methods and equipment (e.g. silumin production by aluminothermy).

BL4. Development and improvement of the carbon materials and their production. Study of the influence of raw materials' quality and production technology on the quality of anode and cathode lining and on the main technical and economic characteristics of the smelting process, for cells with both Soederberg and prebake anodes. Standardization of carbon raw materials.

BL5. Investigations and research on materials other than carbon for electrodes.

BL6. Research and improvement in the fluorine regeneration technology (from gases, lining and carbon dust).

BL7. Research and development of automatic systems for controlling the technological process in smelters.

BL8. Fundamental theoretical research of the electrolysis and other metal production processes.

5.1.5 Analytical Research

CL1. Development of analytical methods and elaboration of standardized methods.

Analyses on the materials enumerated below:

- main components and trace impurities of bauxite, red mud and sodium aluminate liquors,
- alumina hydrate, alumina and by-products of the alumina production (soda salt, vanadium salt, etc.),
- electrolyte used for the electrolysis of aluminium, and other auxiliary materials,
- aluminium and its alloys, as well as metals recovered as by-products (Ga, V, etc.),
- coal, carbon-bearing materials and fuel oil, petroleum coke, anode paste, cathode carbon, etc.,
- gas and other samples related to the environmental protection work.

CL2. Carrying out X-ray diffraction studies and adaptation of these methods to bauxite, red mud, alumina and other non-metallic materials for the determination of their mineral composition and structure. Elementar analysis by X-ray fluorescence method.

5.1.6 Research on Semi-Products

DL1. Development and improvement of the processes for purification of molten metal (removing of hydrogen, oxides, other non-metallic inclusions, sodium etc.). Development of on-line techniques (e.g. electro slag filtration, filtration through active agents etc.).

DL2. Development and improvement of D.C. casting technology of ingots and billets. Development of special ingot and billet casting methods (e.g. casting in electromagnetic field, hot top casting etc.). Development and improvement of the equipment.

DL3. Development and improvement of castings' and of powder metallurgical production techniques and equipment.

DL4. Development and improvement of production processes of grain-size refining and of master alloys.

DL5. Improvement of the heat treatment technologies and equipment.

DL6. Development and improvement of the hot and cold rolling technology of strips, sheets and foils; improvement of equipment.

DL7. Development and improvement of extrusion technology and improvement of equipment (direct and indirect, continuous semi-continuous, hot and cold extrusion).

DL8. Development and improvement of cold deformation technologies and equipment (e.g. tube cold rolling, tube and rod drawing etc.).

DL9. Development and improvement of the production technology and equipment for wire rod and wire manufacturing.

DL10. Development and improvement of the technologies and equipment for forgings' production.

DL11. Development of production technology for special products (e.g. lithographic sheets, sheets for deep drawing, semi-products for anodizing etc.), and new products.

DL12. Investigations, research and development of new production techniques (e.g. use of solar furnaces, laser, high energy deformation, production of composite materials, superplastic alloys etc.).

DL13. Research and development of scrap recovery.

DL14. Development and improvement of technological lubricants and lubrication techniques.

DL15. Fundamental and theoretical research in the field of plastic deformation of aluminium alloys.

DL16. Research and development of automatic systems for controlling technological operations in semi-products' fabrication.

DL17. Research and development of computer-controlled production management systems in the area of semis production.

5.1.7 Physical Metallurgy and Material Science

EL1. Improvement of existing mechanical and physical methods for the needs of all technological research departments and development of new ones in order to make them suitable for industrial research purpose.

EL2. Fundamental and theoretical physical research ensuring the scientific background for applied research and development in all technological departments.

EL3. Development of new aluminium alloys according to requirements of the national industry.
Improvement of existing and development of new alloys for different special requirements (e.g. high strength and ultra-high strength alloys for aircraft and other transportation uses, etc.).

EL4. Fundamental and theoretical research in the field of alloy development and heat treatment.

5.1.8 Research on Finished Products Manufacturing

FL1. Development of new uses of aluminium in various fields, elaboration of new finished goods and their manufacturing technology. Determination of features and quality of semis needed for their fabrication according to the function of products.

FL2. Supply of basic data for selection of material for finished goods.

FL3. Development of finished goods' grading methods taking their functions into consideration.

FL4. Rendering assistance for finished goods' manufacturers (testing facilities, consultancy etc.).

FL5. Research and development of surface treatment methods.

FL6. Research and development of corrosion test methods.

FL7. Research, development and improvement of joining methods (welding, soldering, riveting, sticking etc.) related to application of aluminium alloys.

5.1.9 Application Technique

GL1. Acquisition, systematization of the scientific, technical, market etc. information relating to the utilization of aluminium, preparation of forecasts.

GL2. Organizing technical activities relating to the utilization of aluminium (i.e. issue of publications, organization of conferences, exhibitions, demonstrations, instruction courses, or organization of individual training for finished goods' producers). Maintaining relations with social organizations being concerned with the propagation of utilization of aluminium (e.g. Aluminium Association).

GL3. Keeping a close watch on the activity of finished goods' producers using aluminium semis, maintaining relations with the former, making proposals for the development of their products and production technologies. Organization and co-ordination of the assistance of the Centre required for the development work.

5.1.10 Environment Protection

HL1. Development of the equipment and technology for gas, dust, water collecting and cleaning in all branches of the aluminium industry.

HL2. Development of the technology and equipment for recovering, utilisation and, if needed, annihilation of wastes.

HL3. Development of measurement techniques to monitor the efficiency of the environment control.

HL4. Byological studies for the revegetation of red mud ponds.

5.2 THE SHORT-TERM RESEARCH AND DEVELOPMENT PROGRAMME OF THE RDDC

General

After having suggested the main directions of research and development of the Centre, the programme of the first 3 to 5 years (beginning from the third year of implementation) has to be determined.

It needs to be understood that the initial years will be required to set up the facilities, recruit suitable persons for the Centre and get them trained for required jobs. Evidently the progress of work can not be spectacular in the first five years which would form the formative years.

The development of experts' staff can be highly accelerated if they take part in the adaptation of foreign technologies and introduction of new products. It is reasonable if in the first period of activity of the Centre, the technological research units concentrate their main efforts to study the manufacturing parameters, performances and quality levels in the Indian plants and to compare these to the results in foreign plants and to elaborate the condition of optimization of the production and products. It is obvious that inside a professional field the investigations have to be started at the most important operations (e.g. in case of semis' production at handling of molten metal and casting of ingots and billets).

On these considerations certain objectives/directions of research have been selected from the list given under para 5.1 for early start and certain others to follow them. This is indicated in Annexure 3.

5.3 LONG- AND SHORT-TERM OBJECTIVES OF THE DESIGN WORK

5.3.1 Background

In order to progressively attain self-sufficiency in aluminium technology, the structure of this Centre should include a design and engineering devision. The activities of this division would be to develop basic engineering in coordination with research and development divisions which would enable companies having expertise in detailed engineering in the field of aluminium to carry out detailed design, engineering and consultancy activities.

5.3.2 General Long- and Short-Term Objectives

In order to better illustrate the general objectives, the activities of the Design and Engineering Branch may be divided into 3 stages, in accordance with the Annexure 2 of Terms of Reference.

The main long-term objective is that entering the 3rd stage of its operation i.e. after a period of about 10 years, this unit should be able to carry out independently not only basic design and engineering of new plants based on its own research and development results of the Centre, but also provide basic engineering and consultancy in foreign countries.

To attain this long-term objective the necessary knowledge and practice will be acquired in the 1st stage, during a period of about 5 years, by collaborating with foreign contractors providing know-how and basic engineering services for setting-up of new plants and with indigenous sub-contractors carrying out detailed design and engineering as well as erection and commissioning.

The knowledge and experience obtained in the 1st stage will be further developed and applied independently during the 2nd stage, also over a period of about 5 years, when the main task of the branch would be the realisation of new projects foreseen in the mid-term development plans of aluminium industry.

Besides, in each stage of operation an important task will be performed by providing services to existing plants in private and public sector.

5.3.3 Details of the General Objectives

In order to achieve the general objectives the following activities should be accomplished.

1st stage

1. Participation in general design and engineering works for setting up new aluminium plants in collaboration with foreign firms.

1.1 Development of design concepts

1.2 Market analysis

1.3 Cost estimation

1.4 Economic analysis

1.5 Preparation of complete basic technological documentation for new projects

1.6 Elaboration of basic engineering documentation to the companies carrying out detailed engineering work for:

General layout and transport

Equipment and piping

Electricity, instrumentation and automation

Civil and architectural works

Energy supply and other services

1.7 Participation in tender evaluation, guidance and clarification during the detailed design and engineering works, erection and commissioning.

1.8 Assistance in reaching the rated capacity of new facilities. Analysis and feedback of results.

2. Collection and analysis of production, technological, equipment and maintenance data of existing aluminium plants in India.

3. Collection of similar data of foreign plants.

4. Elaboration of proposals and necessary design documentation for increasing the efficiency of technological processes, and equipment in the existing plants (in close cooperation with the research department).

5. Elaboration of new and further development of existing computer programs resulting in more efficient design methods.

6. Classification of data and information under 2. and 3. and storage of the same in the data bank of the Centre.

<u>2nd stage</u>

The main feature of this period is that know-how and design experiences obtained in the first stage of operation will be further developed and independently practised without major foreign assistance.

1. Self-sufficiency in basic design and engineering. The details of this main activity remain the same as under 1.1 to 1.8 with the first stage.

2. Elaboration of further proposals and necessary design documentation for improving the efficiency of existing processes/operations, the performance of various main producing equipment, for modification and/or completion of product-mix, computer control of processes/operations, improved maintenance methods etc.

3. Consultancy based on expertise developed in the 1st stage.

4. Continuous development of the computer technique for design and engineering purposes.

5. Continuous updating and completion of the design data base.

3rd stage

Having about a decade-long experience in providing basic design and engineering to the aluminium industry in India, the unit should be able to undertake similar tasks for foreign customers also.

6. ORGANIZATION AND SCOPE OF ACTIVITY

6. ORGANIZATION AND SCOPE OF ACTIVITY

6.1 GENERAL

An institution can perform its functions and attain the long- and short-term objectives if its activities are supported by a well developed organizatonal structure.

The recommended structure of RDDC, see Table 6.1, is based on five main organizational units called branches. Three of them perform the fundamental activities, viz. research and development as well as basic design and engineering, and two other branches provide the general technical and administrative services. There are also some special departments directly responsible to the director.

To distinguish the various branches and management levels from each other the following system of symbols is used. The highest management levels are marked with capital letters, the other ones are indicated by figures following the relevant capital letters. There are three possible subordinated management levels within the individual branches.

The mark'ng of various units directed by leaders of higher level begins with the following letters

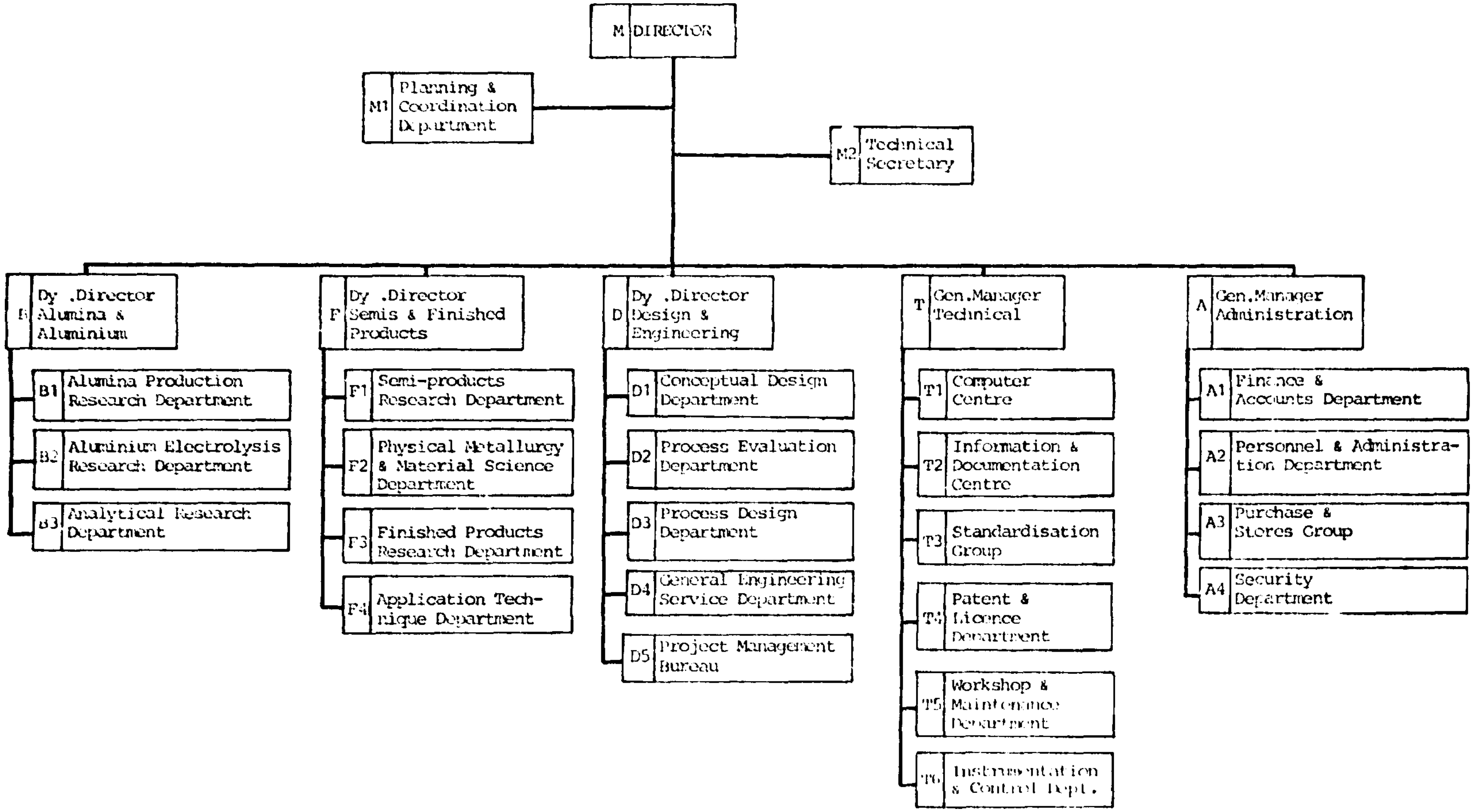
Director	M
Dy. Director Alumina and Aluminium	B
Dy. Director Semis and Finished Products	F
Dy. Director Design and Engineering	D
Gen. Manager Technical	T
Gen. Manager Administration	A

6.2 MANAGEMENT

The management of Centre includes the Director, the special departments directly responsible to him, Dy. Directors and Gen. Managers directing the individual branches.

INDIAN ALUMINIUM RESEARCH, DEVELOPMENT AND DESIGN CENTRE
ORGANIZATIONAL STRUCTURE

Table 6.1



M. DIRECTOR

Task of the Director

The Director is the responsible leader heading the Centre, performing the following duties:

- Determines, together with the Dy. Directors, the strategy of RDDC, the main professional directions of research, development and design works.
- Approves the mid-term and annual operating plans and project documents of the Centre.
- Decides on the rules of management and financial policy of the Centre.
- Ensures the conditions necessary for the fulfilment of social and economic tasks of the Centre.
- Approves in principle the contract terms.
- Determines the internal rules of supervision.
- Determines the sphere of activity of deputy directors and other leaders directly responsible to him.
- Determines the internal accounting and incentive system of the Centre.
- Represents the Centre before the controlling organization, administrative and social organizations or designates the persons authorized to represent the Centre.

M1; Tasks of the Planning and Coordination Department

- Drawing up of the long-term, mid-term and annual operating plans together with the Deputy Directors and General Managers and monitoring of the implementation of the approved plans.

- Compilation of reports on the activities of RDDC for the authorities.
- Conclusion of contracts with external organizations and coordinating the work in the Centre and between the Centre and other institutions/organization, monitoring of the performance. In case of tasks, where common activity of several units is necessary - especially if they belong to different Dy. Directors and Gen. Managers, resp. - initiation of organization of "horizontal teams" and assignment to teamleaders, monitoring of the performance.
- Organization of training of personnel from industry and other institutions.
- In case the implementation of projects or contracts is delayed, it is the task of Planning and Coordination Dept. to draw the attention of the competent Deputy Director(s).

M2; Technical Secretariat

Assists the Director by compiling the written material connected with the matters under consideration and other tasks connected with his activities related with execution of administrative and supervision tasks, so that it is necessary for him to deal only with important questions relating to the totality of the Centre and to continue his research activity corresponding to his professional field.

The B, F and D Deputy Directors as well as the T and A General Managers each in his own professional field, work out, together with the Director, the strategy and the main directions of the activities and exercise independently the operative scientific, technical and/or aministrative control and represent the RDDC at meetings with external organizations and enterprises.

6.3 RESEARCH AND DEVELOPMENT BRANCHES

6.3.1 Organization

On setting up the organizational scheme - see Tables 6.2, 6.3 and 6.5 - the following view-points were considered:

i) The units should be homogeneous from the point of view of objectives and of activity performed. E.g. research and design activities are performed in separate units.

ii) A limited number of Heads of Department are responsible to the Deputy Directors and a limited number of highly qualified researchers to the Heads of Department. The professionally controllable area is similarly restricted. That is why the organizational scheme provides for two Deputy Directors. The departments are divided into laboratories and in limited cases into groups.

iii) Organizational position of non-technological research units (Analytical Research, Physical Metallurgy and Material Science) is determined so as to promote best the efficient research work. It is proven by practice that the activity of material-testing research departments is most productive if they are closely co-operating with the technological research departments.

As the Analytical Research Department frequently gives aid to the Alumina Production Research and Aluminium Electrolysis Research Departments it is responsible to the Alumina & Aluminium Deputy Director. As a great number of tasks are given to the Physical Metallurgy and Material Science Department by the Semi-Products Research and Finished Products Manufacturing Research Departments the former is responsible to the Semis and Finished Products Deputy Director.

Remark: Both departments, of course, corresponding to their technical profile, serve at the same time the entire Research and Development Branch.

Table 6.2

INDIAN ALUMINIUM RESEARCH, DEVELOPMENT AND DESIGN CENTRE

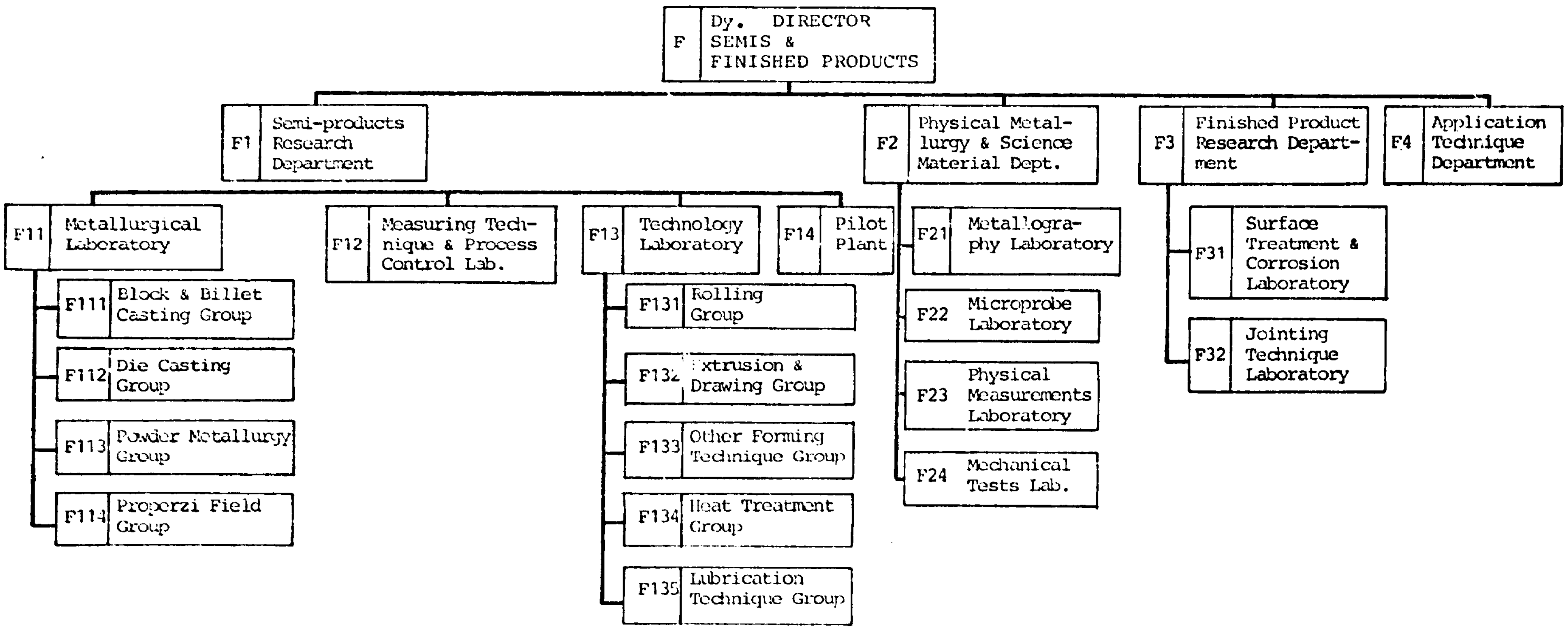
B. ALUMINA AND ALUMINIUM RESEARCH AND DEVELOPMENT BRANCH

- **B** Dy. DIRECTOR Alumina & Aluminium
  - **B1** Alumina Production Research Department
    - **B11** Raw-Material Laboratory
    - **B12** Alumina & By-products Technology Laboratory
    - **B13** Equipment Development Laboratory
    - **B14** Process Control Development Laboratory
    - **B15** Pilot Plant
  - **B2** Aluminium Electrolysis Research Department
    - **B21** Technology & Equipment Development Laboratory
    - **B22** Carbon Laboratory
    - **B23** Gas Purification & Environmental Control Laboratory
    - **B24** Aluminothermy Laboratory
    - **B25** Process Control Development Laboratory
    - **B26** Field Groups
  - **B3** Analytical Research Department
    - **B31** Chemical Analysis Laboratory
    - **B32** Physico-chemical Analysis Laboratory

Table 6.3

INDIAN ALUMINIUM RESEARCH, DEVELOPMENT AND DESIGN CENTRE

F. SEMIS AND FINISHED PRODUCTS RESEARCH AND DEVELOPMENT BRANCH



Testing methods used only by a single technological area (e.g. mineralogical classification, physical and physico-chemical tests for alumina technology, physico-chemical tests and special carbon tests for aluminium electrolysis etc) are ranked into the relevant Research Department.

iv) A similar situation exists for the laboratories dealing with measurement technique and control. They are grouped into the frame of technological research departments specialized for the given technological area. In order to maintain high technical level in general, a central T6 Instrumentation and Control Department is envisaged wihin the organization of the Technical Gen. Manager. All equipment needed for the above task (such as micro-processor development systems, logic analyzers, calibration instruments, etc.) is centralized in this department as it would be uneconomic to establish them in each technological area.

v) Units providing positive conditions for the work of every research department and several design branches have been centralized under the guidance of the Technical Gen. Manager.

6.3.2 Scope of Activity and Functions

B. ALUMINA AND ALUMINIUM RESEARCH AND DEVELOPMENT BRANCH

B1 ALUMINA PRODUCTION RESEARCH DEPARTMENT

The activity of this department comprises all research problems from the evaluation of bauxites for alumina production up to the utilization of alumina and its by-products. The work of the units within the Department is interdependent, the organization is based on close co-operation of individual laboratories and groups.

B11 Raw-Material Laboratory

Collection of representative bauxite samples for tests. Textural and morphologic investigation of samples of bauxite and other ores.

Thermogravimetric (derivatographic) tests of bauxites. Determination of mineralogical composition of bauxites and red muds on the basis of thermogravimetric, X-ray diffraction and chemical analytical investigations in close co-operation with the Analytical Research Department.

Preparation (crushing, grinding) of bauxite samples for the technological and analytical tests. Determination of their Hardgrove-number and Bond-index. Investigation of beneficiation problems of bauxite (improvement of quality of the ore, recovery of valuable components, etc.).

B12 Alumina and By-Products Technology Laboratory

Establishment of standard testing methods for laboratory modelling of alumina production process steps depending on bauxite grade (digestion, pre- or post-desilication, red mud settling, etc.). Technological qualifying tests of representative samples originating from various bauxite deposits. Determination of optimum process parameters and technological indices to be expected on the basis of test results.

The laboratory carries out research work on the development of alumina production technology, investigation of technological problems of the operating alumina plants, fitting the technology to the quality of ore with bauxite reserves foreseen for processing, elaboration of new technological solutions and adaptation of foreign processes.

The laboratory becomes specialized in the investigation of the physical and physico-chemical properties (specific gravity, bulk density, granulometry, angle of repose, specific surface area, porosity, etc.) of bauxite, red mud, alumina, alumina hydrate, special alumina, etc. Tests and measurements for other Departments may also be carried out from time to time.

Elaboration of the production technology of non-metallurgical special aluminas possessing special physical properties (adsorbents, catalyst carriers, fillers, abrasives, products, used in the ceramic and refractory industry), adaptation of foreign technologies, grading of special aluminas.

Research work related to utilization of red mud. Research work related to recovery and utilization of titanium, vanadium and gallium.

B13 Equipment Development Laboratory

Development of alumina plant equipment, elaboration of new mechanical engineering solutions and trial of the same. Design of equipment for special laboratory and pilot plant tests.

B14 Process Control Development Laboratory

Elaboration of new methods for the automatic supervision and control of the alumina production process in close co-operation with the Instrumentation and Control Department.

B15 Pilot Plant

When deciding on the setting up of an alumina pilot plant, the existing pilot unit of KORBA Alumina Plant could not be left out of consideration. This pilot plant, set up a few years ago, is capable of modelling all the operation units of the Bayer-cycle depending on the bauxite grade. Several successful test programs were carried out processing bauxites from various deposits. However, the possibility of modelling the whole Bayer-cycle - enabling the RDDC to study inter alia the problems of producing alumina hydrates of various grades, the purification of plant liquor, the recovery of by-products - is of great importance and necessary, too.

It is assumed that this Pilot Plant will be brought under the direct control of the RDDC with support facilities from BALCO. Hence, only such of the equipment as are additionally required for modelling of the complete Bayer-cycle has been included under this project.

The task of the field staff of RDDC is to compile the test programs to be carried out, to organise and supervise the same and to evaluate the test results. All these activities should be performed in close co-operation with the Alumina Production Design Section of the Centre.

B2 ALUMINIUM ELECTROLYSIS RESEARCH DEPARTMENT

Development and improvement of techno-economic indices of the technology and equipment of the current practice in aluminium electrolysis.

B21 Technology and Equipment Development Laboratory

Elaboration of electrolytic cell-types and technologies of high current efficiency and low specific electric power consumption. Drawing up the tasks for the establishment of new cell structures and process control systems. Drawing up the tasks for modernization, intensification, and reconstruction of existing plants. Investigation and research work aiming the reduction of power consumption.

Development of cell structures for both prebake and Soederberg anodes. Elaboration of methods for mechanization and development of the same in the reduction plant. Preparation of designs of prototypes, supervision of realization. Trial and testing of specimens manufactured in the workshop of RDDC or of other firms.

Basic research-level laboratory investigation of factors affecting the electrolytic process (equilibria, chemical reactions, electrode processes, dissolution, current yield, etc.).

B22 Carbon Laboratory

Performance of special metallurgical qualifying procedures on carbon testing, elaboration and development of the same (coke, anode paste, technological testing of binding materials, e.g. determination of softening point, activity, etc.) as well as development and improvement of carbon materials' production technology.

B23 Gas Purification and Environmental Control Laboratory

This laboratory will conduct the investigation and research work related with environmental control in all areas of the aluminium industry and carries out special investigation belonging to the former. Testing of detrimental materials, realization of efficient collection of the same (primarily anode gases). Elaboration and development of proper gas purification technologies and equipment. Processing or annihilation of detrimental wastes.

B24 Aluminothermy Laboratory

Investigation and research work related to industrial scale aluminium production by direct reduction of alumina or ores, or other non-conventional methods eliminating the Hall-Heroult process.

B25 Process Control Development Laboratory

Instrumental monitoring of the technological process of the reduction plant (testing of magnetic fields, measurement of basic data, etc.), preparation of process control of the procedures - elaboration of algorythms - realization of the same by the association of the T6 Instrumentation and Control Department. Adaptation of the systems to the local conditions. Testing of control systems and special instruments elaborated.

B26 Field Groups

There are 2 groups; one is located next to a smelter operated with Soederberg anodes the other to a smelter operated with prebake anodes. Their task will be testing of the operating technology, processing of results and testing of new technologies and equipment under industrial conditions.

B3 ANALYTICAL RESEARCH DEPARTMENT

The Analytical Research Department meets all the chemical analytical and non-metallic X-ray testing requirements of the total research area of the RDDC. It deals with carrying out test series on external orders, respectively solving special analytical tasks in the entire processing area of the aluminium industry (bauxite mining, alumina production, aluminium metallurgy, semis production, etc.), carrying out decisive analyses in disputed cases.

Its further tasks are: development and standardization of analytical methods all over the aluminium industry, co-operation relative to the institution of the same and training of analysts for the overall industrial area.

Scope of activity of the units of this Department can be given in brief as follows.

B31 Chemical Analysis Laboratory

Preparation, testing and checking of standard materials required for the analysis. Solving of special analytical tasks. Development of wet chemical analysis methods.

Testing of contaminating components of bauxite, alumina and sodium aluminate solutions by means of spectrophotometric methods. Analysis of sodium aluminate solutions by the thermometric method. Qualitative and quantitative determination of the organic material content in the alumina plant's circuit by the gas chromatographic method, analysis of industrial gases. Analysis of fluoride, sulphide etc. content by the electroanalytical methods.

Determination of main components and trace contaminants of bauxite and red mud samples and trace contaminants of sodium aluminate solutions by the atomic absorption spectrophotometric method.

Analysis of high-purity metals (aluminium, gallium, special alloys, etc.).

Determination of ultimate composition of anode carbon, cathode carbon, carbon-base mixtures, lubrication oils, etc.

B32 Physico-Chemical Analysis Laboratory

Analysis of alumina and metal samples by the emission spectrophotometric method.

Quick and accurate determination of composition of bauxite and red mud samples by the X-ray fluorescence spectrometry.

Qualitative and quantitative phase analysis and structural analysis of solid crystalline materials, - primarily in bauxite, red mud and other by-products of alumina plants. Investigation of phase transformation taking place at high temperatures in the area of aluminium metallurgy, structural deformation, transition into molten state, by means of the high-temperature diffractometry. Determination of the molar ratio of the electrolyte-bath in the electrolysis of aluminium.

F. SEMIS AND FINISHED PRODUCTS RESEARCH AND DEVELOPMENT BRANCH

F1 SEMI-PRODUCTS RESEARCH DEPARTMENT

Determination of quality requirements relating to semi-products, elaboration of technology and development of equipment required for the economic production of the same. All this takes place in close co-operation with other research units (primarily F2 Physical Metallurgy and Material Science, F3 Finished Products Manufacturing Research and T6 Instrumentation and Control Department).

Considering that with semis production expensive pilot plant equipment is also necessary for achieving industrially applicable research results, in order to reduce running expenses, the research plant is able to manufacture products in small series, partly aiming to check the elaborated technologies, partly to be sold on the market.

<u>F11 Metallurgical Laboratory</u>

F111 Block and billet casting group

Investigation of factors affecting the quality of metal (e.g. impurities) of the texture and geometry of billets by means of laboratory and pilot plant equipment (melting-casting furnaces, casting machines, etc.) and determination of optimum production parameters. Development of casting tools and foundry equipment. Manufacturing of blocks and billets for experiments performed in industrial plants.

Supplying the technological laboratory with blocks and billets for the research work and manufacture of product.

F112 Die casting group

Development of technologies, tools and equipment in the area of sand casting, gravity die casting, high-pressure casting and pressure die casting.

Metal handling of mould casting alloys, development of auxiliary materials.

Manufacture of products for sale.

F113 Powder metallurgy group

Investigation of factors affecting the quality of metal powders and development of the production of aluminium powders of various composition. Investigation of factors affecting the properties of powder metallurgical products and development of the metal-working technology of powders.

Manufacturing products for sale.

F114 Field properzi group

The group will be posted in the premises of a large state-owned plant, however, as to its organization it will belong to RDDC. It co-operates with the Metallurgical Laboratory and Physical Metallurgy Research Department functioning in RDDC, it relies on their laboratory results, uses its testing equipment and employs the industrial equipment for developing of Properzi-technology and equipment.

F12 Measuring Technique and Process Control Laboratory

In close co-operation with the T61 Instrument and Measurement Technique Laboratory and the technological research (F11 metallurgical and F13 technological) laboratories, elaboration of measuring technique systems required for the semi-product research, development of sensors for the automation; trials on laboratory scale, based on the results of which T6 Instrumentation and Control Department may produce units for industrial application.

In co-operation with T63 Control Technique Laboratory and technological research laboratories, setting-up of data processing systems connected with the semi-product research, formulation of algorythms for the industrial automation of production processes or procedures and designing of microprocessor systems; trials on laboratory scale, based on the results of which T63 may produce units for industrial application.

F13 Technology Laboratory

F131 Rolling, F132 Extrusion and Drawing, F133 Other Forming Techniques, F134 Heat treatment, F135 Lubrication Technique groups.

Corresponding to their professional areas the groups' tasks are: development of the existing laboratory- and pilot plant-level technologies and development or improvement of equipment.

In close co-operation with F2 Physical Metallurgy and Material Science Department and F11 Metallurgical Laboratory, investigation and optimization of factors affecting the properties of products, research and development of new products and their production technologies to the level of commercial operation.

In close co-operation with F12, T61 and T63 elaboration of industrial automation, as well as industrial and research measurement-technical systems.

F14 Pilot Plant

The functions of the pilot plant are described according to their technological profile by other semi-product research laboratories.

The pilot plant will also produce semis for the market in small series.

F2 PHYSICAL METALLURGY AND MATERIAL SCIENCE DEPARTMENT

The Department completes the task of physical metallurgy connected with semi-products and finished products manufacturing research (e.g. alloy development) and physical testing coming up with any research unit of the RDDC.

F21 Metallography Laboratory

Carrying out microscopic investigations: investigation of grain boundaries in metallic materials, of phases of metals in the cast, homogenized and heat-treated state.

Microscopic testing of bauxites and alumina.

Performing of transmission and scanning electron microscopic tests, completed with the qualitative and quantitative elementary analysis. Investigation of microstructure of precipitation hardening and recrystallization processes, studying of dislocation structures and phase transformations in metals. Analyzing of phases of the order of magnitude of 0.1 μm. Extension of the conventional metallographic investigations over several ten thousands of magnification ranges.

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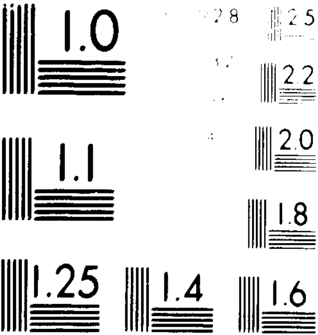

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Taking of phase distribution photographs. Testing of surface areas (surface of fracture, corrosion damaged product, oxide layer, etc.).

Morphologic and quantitative testing of distribution of elements in bauxites and alumina.

Carrying-out of photographic work for the metallographic and other material science laboratories.

F22 Micro-probe Laboratory

Qualitative and high-sensitivity quantitative analysis of phases. Testing of dissolved and precipitated alloying elements and their quantitative distribution. Studying of surface phenomena and of those close to the surface: determination of oxide layers, corrosion products, bond conditions.

F23 Physical Measurements Laboratory

Testing of precipitation and dissolution processes in aluminium alloys by the measurement of resistance and thermo-voltage. Characterization of metal purity, determination of the dissolved proportion of alloying elements. Determination of the kinetics of homogenization, plastic deformation, annealing and tempering processes.

Determination of the texture of aluminium alloy semi-products, plotting of the distribution function. Phase identification, determination of concentrations of phases in metal. Measurement of the lattice constant in order to follow up the precipitation and deformation processes. Determination of subgrain size and micro stress by line-profile analysis. Investigation of the onset of precipitation processes (GP-zones and measure of distance of the transition phases) by means of little-angle X-ray scattering.

Thermal analysis of metals. Plotting of equilibrium and non-equilibrium constitutional diagrams of aluminium alloys. Semi-quantitative investigation of phase transformation (precipitation-dissolution) processes taking place in the alloys. Determination of coefficients of thermal expansion of materials. Studying of phase transformation processes of non-metallic materials.

Determination of hydrogen content of liquid and solid Al-alloys.

F24 Mechanical Tests Laboratory

Deficiency testing by means of non-destructive ultrasonic and macro-X-ray method on cast specimens, semi-products, welding seams.

Fault locating in the course of loadability tests by means of acoustic emission equipment, then detailed testing of fault by means of ultrasonic and macro-X-ray method, respectively (and destructive testing of faults by means of instruments of other laboratories of the Department, primarily with electronoptical methods, if necessary).

Testing of semi-products, joints, structures and structural parts made by various destructive methods.

Carrying out static (tensile, pressure, bending, torsion) and dynamic (small-cycle fatigue) mechanical tests.

Testing of wide-scale assortment of materials arising in the course of alloy- and semi-product research (high-strength alloys, light-gauge strips, foils, light-gauge wire, etc.).

F3 FINISHED PRODUCTS RESEARCH DEPARTMENT

The Department deals with the development of processes which are connected with the utilization of aluminium semi-products such as surface treatment, jointing technique, as well as the research of properties of serviceableness of aluminium semi-products (corrosion, static and dynamic load-ability tests, etc.) and the determination of semi-products best suitable for various application. The Department functions in close co-operation with the F1 Semi-products Research and F2 Physical Metallurgy and Material Science and provides main background for the F4 Application Technique Department.

F31 Surface Treatment and Corrosion

Elaboration of surface treatment systems and making pilot plant trials on the same.

Carrying out corrosion tests on coated and untreated semi-products and finished products by means of available equipment established for this purpose.

Research of factors affecting the corrosion behaviour of products. Surface treatment in small series of semis and finished products for the market.

F32 Jointing Technique

Development of various welding technologies (TIG, MIG, resistance-, pressure welding, etc.) cutting processes and other jointing methods (e.g. riveting, bonding), as well as preparatory processes, auxiliary materials and equipment. Research, elaboration and trial of new processes.

Investigation of factors affecting joints and their quality.

Making joints in little series, primarily special ones by order.

F4 APPLICATION TECHNIQUE DEPARTMENT

As being a non-research unit, its task - based on the experience of RDDC and Indian aluminium industry and market requirements - is to promote the economic and up-to-date utilization of aluminium by advisory and organizational activities with the finished products manufacturers.

This will be a small department comprising consultants possessing wide industrial experience and partly persons for organizational work. The entire RDDC provides background for the successful work: i.e. experts for courses and drawing up corresponding technical papers, equipment for training and testing and producing facilities for the development of new products.

6.4 D. DESIGN AND ENGINEERING BRANCH

6.4.1 Organization

On developing the organizational structure of this branch our former and actual experiences on this field have mairly been utilized. More variants had been considered as a result of which the system shown in Table 6.4 was judged to be the most suitable for meeting the function as well as the long-and short-term objectives of the branch outlined in para 5.2, and for taking a reasonable number of staff at the same time.

The head of the branch is the Dep. Director Design and Engineering.

As it can be seen also in the table the structure of the organization follows the main steps of the process design and engineering activity. In consequence the departments directly governed by the Dep. Director are as follows:

D1 Conceptual Design
D2 Process Evaluation
D3 Process Design (including design of some new and non-standard equipment)
D4 General Engine ring Services
D5 Project Management

The departments comprise more sections/groups. E.g. the D1 and D3 Departments dealing with conceptual design and process design, respectively, consist of four sections each, according to the four main professional fields, as scope of activity of the branch, namely

Alumina Production
Aluminium Electrolysis
Semis Production
Finished Products Manufacturing.

Table 6.4

INDIAN ALUMINIUM RESEARCH, DEVELOPMENT AND DESIGN CENTRE

D. DESIGN AND ENGINEERING BRANCH

- D — Dy. DIRECTOR DESIGN & ENGINEERING
  - D1 — Conceptual Design Department
    - D11 — Alumina Production
    - D12 — Aluminium Electrolysis
    - D13 — Semis Production
    - D14 — Finished Products Manufacturing
  - D2 — Process Evaluation Department
    - D21 — Market Analysis
    - D22 — Economic Evaluation
    - D23 — Cost Estimation
  - D3 — Process Design Department
    - D31 — Alumina Production
    - D32 — Aluminium Electrolysis
    - D33 — Semis Production
    - D34 — Finished Products Manufacturing
  - D4 — General Engineering Services Department
    - D41 — Layout & Transport
    - D42 — Equipment & Piping
    - D43 — Electrotechnics Instr. & Automation
    - D44 — Civil & Architectural Works
    - D45 — Services
  - D5 — Project Management Bureau
    - D51 — Project Managers
    - D52 — Project Engineers
    - D53 — Computer Technique Application

Further specialisation within these sections is not necessary because, on a conceptual design level, the thorough knowledge of a professional field is the basic requirement for a process engineer. Specialization according to smaller process or manufacturing units is justified only in the stage of detailed engineering and erection of a project.

The sections of Department D3 include not only the staff engaged in the process design, but engineers and draftsmen dealing with the design of special new and non-standard equipment pertaining to the relevant field.

D2: Process Evaluation Department consists of three sub-units completing each other's activity in the field of Process Evaluation. These are:

Market Analysis
Cost Estimation
Economic Evaluation.

D4: General Engineering Services Department includes four major sections and one group whose activity covers the whole process engineering area and serves all the four professional fields from the alumina production up to the finished products manufacturing.

In the case a major project is to be carried out, the work of the previous four departments is coordinated by the D5 Project Management Bureau. The Groups of Project Managers and Project Engineers help to perform this task.

The Computer Technique Application Group, however, serving and helping the whole Design and Engineering Branch, can not act as an independent unit because of the few number of staff, therefore it seemed to be an expedient solution to subordinate it to the Project Management Bureau.

Three of these departments, namely D1, D2 and D5, have roughly the same sections/groups of 3 to 9 people. On the contrary the D3 and especially the D4 department, when fully developed, will consist of sections of higher number of staff, e.g. as an extreme, some 36 people for the Machines, Equipment and Piping Section. In the interest of better and more efficient direction of the various activites it would be necessary to form smaller groups performing similar tasks within these bigger sections.

6.4.2 Scope of Activity and Function of the Branch

Scope of activity includes the quasi-whole aluminium industry from the alumina production through the aluminium electrolysis up to the manufacturing of different semis and finished goods.

Function of the Design and Engineering Branch is to provide technological know-how and basic engineering documents both for the establishment of new green field production facilities pertaining to the above outlined scope and the modernization as well as expansion of the existing ones on the same field.

6.4.3 Main Task of the Various Departments

D1 CONCEPTUAL DESIGN DEPARTMENT

Active co-operation in the proposal, selection as well as preliminary, intermediate and final evaluation of different research and development subjects.

Provision for the implementation and utilization of the R & D results in the course of basic design and engineering activity.

Compilation of laboratory and pilot plant test programs.

Determination of scale-up conditions.

Selection and development of the process technology to be designed.

Participation in the techno-economic evaluation and optimization of processes and operations.

Taking a continuous survey on the production data, process parameters, equipment characteristics, product qualities, specific consumptions, etc. of the existing production facilities.

Analysis of this information and elaboration of proposals, studies for the improvement of process efficiency, product quality, reduction of energy consumption, etc. in close co-operation with the relevant R & D departments.

There are 4 sections within this department all having the above listed tasks but performing them on different professional fields. The scope of these sections are as follows:

D11 Alumina Production Section

Manufacturing of metal-grade and special aluminas
Recovery of valuable by-products: V, Ga, Ti
Utilization of wastes: red mud, etc.
Environmental protection.

D12 Aluminium Electrolysis Section

Aluminium metallurgy
Carbon technology
Gas cleaning
By-product and scrap utilization

D13 Semis Production Section

- Refining and casting technologies
- Rolling technologies
- Extrusion, drawing and other forming techniques
- Scrap recovery and waste utilization

D14 Finished Products Manufacturing Section

- Surface treatment technology
- Manufacturing of all kinds of finished goods

D2 PROCESS EVALUATION DEPARTMENT

Working out of economic investigations and estimations of technological processes for new alumina plants, smelters and fabrication facilities.

Carrying out economic evaluation of research works, as well as of proposals for improvement of process/equipment efficiency.

D21 Market Analysis Section

Continuous survey of world market situation of basic and auxiliary materials as well as energy and products of aluminium industry.

Reports and forecasts on the short and long-term market trends.

D22 Cost Estimation Section

Registration of domestic and world market prices for raw and auxiliary materials, energy and products of aluminium industry.

Obtaining quotations for machines and equipment. Preparation of cost estimations regarding the capital outlay for technical proposals, studies, project reports, etc.

D23 Economic Analysis Section

On the basis of technological data supply, market information and cost estimation figures, evaluation of new, improved or adapted technologies, various technical proposals' viability. Economic evaluations for research and development works. Sensitivity analysis. Optimum calculations.

D3 PROCESS DESIGN DEPARTMENT

The main task of this department is to provide details of the selected technology in the following fields and sections.

D31 Alumina Production

D32 Aluminium Electrolysis

D33 Semis Production

D34 Finished Products Manufacturing

Preparation of complete technological documentation for certain sections of the General Engineering Department and for the purpose of detailed design and engineering, including material and heat balances, technological descriptions, engineering flowhsheets, etc.

Specification of non-standard equipment.

Participation in tender evaluations.

Assistance in detailed design, participation in commissioning, analysis and feedback of plant results.

D4 GENERAL ENGINEERING SERVICES DEPARTMENT

On the basis of data supplied by D3 Department this unit provides the documentation of the equipment, for general engineering works and services which can facilitate the implementation and functioning of the selected process/ equipment finally resulting in efficiency, product quality and quantity meeting the requirements.

Expert activity in the relevant professional field.

D41 Transport and Layout Section

Assitance in:

Site selection studies

Plant site optimization

Preparation of general plot plans

Study of different transport methods and facilities.

D42 Equipment and Piping Section

This section is responsible for assistance in selection and layout of all technological and non-technological machines and equipment, except the non-standard ones; for the technological and auxiliary piping design. Similarly it is responsible for the appropriate data supply for the other engineering sections.

Participation in the evaluation of tenders.

Participation in the detailed engineering, erection and commissioning.

D43 Electrotechnic, Instrumentation and Automation Section

Assitance in selection and layout of electric equipment.

Documentation of instrumentation and automation of processes/equipment.

D44 Civil and Architectural Section

Preparation of basic documentation of civil and architectural works to be done, including building service engineering and sewerage.

D45 Services Section

This section provides the elaboration of necessary basic documentation for energy supply and other utility systems including

technological steam
coal, fuel oil, gas supply
compressed air
vacuum and air-conditioning
water supply, water treatment

D5 PROJECT MANAGEMENT BUREAU

The main task of this section is to guide and co-ordinate the work of all other sections during the lifetime of a certain project. This unit keeps direct contact with the client's representatives and the companies carrying out detailed engineering.

These activities are practiced with the help of following groups:

D51 Project Managers

D52 Project Engineers

D53 Computer Technique Application Group

Though this group organizationally belongs to the Project Management Bureau essentially it serves the whole design and engineering branch. Its main task is to elaborate and develop computer programs helping and facilitating the design work of the various professional fields.

6.5 GENERAL TECHNICAL SERVICES BRANCH

6.5.1 Organization

This branch provides for the general technical support of RDDC as a whole, with special regard to branches performing the base activity. The branch is headed by the Gen. Manager Technical. He determines and directs the activities of six departments. The detailed structure of this organizational unit is shown in Table 6.5.

6.5.2 Main Task of Various Departments, Sections and Groups

T1 COMPUTER CENTRE

The information system of the RDDC is based on the Computer Centre. It makes possible assembling, storing and processing of data relating to different activities and the availability of this data for different persons. It is connected to the terminals and computers located in various units and enables the mutual transfer of data or functions. In this way the central and other computers are built into an integrated network. Thus the central computer has to deal with the solving of those tasks only, which surpass the capacity of the smaller computers. It is possible, that only certain authorized persons get access to certain parts of data or programmes.

The central computer has to be suitable to keep contact with international data-bases and other organs, resp.

Systematic use of the computer is judged to be important in the following areas:

a) Development and research
   - data-bank
   - calculation of properties of materials

Table 6.5

INDIAN ALUMINIUM RESEARCH, DEVELOPMENT AND DESIGN CENTRE

T. GENERAL TECHNICAL SERVICES BRANCH

- T GENERAL MANAGER TECHNICAL
  - T1 Computer Centre
  - T2 Information & Documentation Centre
    - T21 Technical Information
    - T22 Technical Library
    - T23 Interpreter Group
    - T24 Reprography & Printing
  - T3 Standardisation Group
  - T4 Patent & Licence Department
  - T5 Workshop & Maintenance Department
    - T51 Design Group
    - T52 Workshop
  - T6 Instrumentation & Control Department
    - T61 Instrument & Measuring Technique Laboratory
    - T62 Radioactive Isotope Laboratory
    - T63 Control Technique Laboratory

- planning of tests, evaluation of measured data
- modelling and simulation of reactions, technological processes

b) Design work

- simulation of operational units, plants (design of process)
- dimensioning of equipment, piping, fittings
- design of control systems
- preparation of drawings, documentations
- preparation of bills of materials
- preparation of cost estimations
- carrying out of economic calculations

c) Project management

- registration of contracts
- time and network programmes

d) Administration

- registration of personnel
- financial status
- check list and control of inventories
- pay-roll accounting

e) Documentation

- check list of stock of the library
- joining to international data-bases in the interests of technical literature and searching of patents
- registration of microfilms containing results of measurements, research reports, drawings, etc.

T2 INFORMATION AND DOCUMENTATION CENTRE

T21 Technical Information Service

Compiling the articles and reviews appearing in the technical literature and makes their abstracts. Groups the elaborated material by themes and issues them in periodical publications. Provides for the distribution of literature. Performs literary research directed to well-defined themes (e.g. research of patents).

T22 Technical Library

Analyses the technical literature of the world and procures the corresponding articles or books. Keeps a list on new accessions of the library and publishes it from time to time. Lends the required material from the holdings for studying it on the spot or for a longer time. Registers the holdings and the issued literature.

T23 Interpreter Group

In case of request prepares translations from foreign languages and makes them available to the persons concerned. Provides interpretation service. Cooperates with the Technical Information Service in preparing quick translations.

T24 Reprography and Printing

Reproduction of individual documentation in the desired number of copies and forms.

T3 STANDARDIZATION GROUP

Elaboration of standard-proposals for the entire aluminium industry, the utilization of aluminium included. Keeping close watch on the trend of development, making proposals for modernization of the standard specifications.

Organizes jury sessions on the individual standard propositions. Producing the proposals to authorized organizations.

T4 PATENT AND LICENCE DEPARTMENT

Main tasks of this department:

i) Collaboration in the preliminary evaluation of inventions elaborated by the RDDC.

ii) Preparation of application for a patent (in close cooperation with the inventor(s).

iii) Registration of inventions for patent with the competent authority, and representation of RDDC's interest during the licensing process.

iv) Elaboration of suggestions and suitable explanations in the case of disputes.

v) Collaboration concerning patent-usurpation, licence and inventor's fees trials.

vi) Registration of patents abroad.

vii) Purchase of inventions and patents.

viii) Marketing of inventions, patents and know-how.

ix) Development of licence and patent policy for RDDC based on directives of the supervisory authority.

x) Administration of trade mark and innovations.

T5 WORKSHOP AND MAINTENANCE DEPARTMENT

T51 Design Group

Carrying out construction work related with the development of research equipment in close co-operation with the corresponding technological research units, and scheduling for maintenance.

T52 Workshop

Preparation of specimens required for the research work. Maintenance of equipment, building, etc.

Making special research laboratory tools and tackles. Making facilities for industrial trials - smaller devices, equipment - and small modifications of the latter.

Remark: In lack of larger metal cutting machines the workshop is not capable of manufacturing equipment prototypes. Should such tasks be performed, external firms would have to be commissioned.

T6 INSTRUMENTATION AND CONTROL DEPARTMENT

Provides measurement-technique, isotopic and automation services for the entire RDDC: establishes measurement-technique, data collecting-evaluating and automation systems, developing the same by close co-operation with the corresponding technological research units. It puts its instruments and equipment at the disposal of other department.

T61 Instrument and Measuring Technique Laboratory

Development, planning and implementation of new laboratory, pilot plant and industrial measuring systems for the research work in the RDDC, and of elements (special sensors, signal devices, transformers, instruments) required for setting up measuring and control systems.

Application of new, micro-electrotechnical and other techniques in the development of instruments.

Maintenance of the instruments of RDDC. In case of special instruments (e.g. electron optical instruments) co-operation with professional servicing firms.

Providing standard means for the calibration of instruments, carrying out calibration of the same.

T62 Radioactive Isotope Laboratory

Investigation by tracer technique methods of transport phenomena (flow and mixing) in laboratory and primarily under industrial conditions (e.g. measuring of holding time in large tanks, flow velocity, useful volume, short-circuits, mixing, homogenization, etc.).

Development of special isotopic devices (radiation gauge, evaluating instruments, etc.) for the continuous contact-free measurement, as well as, for the determination of physical and chemical parameters of solid and liquid materials and mixtures and for the control of processes.

Laboratory reaction-kinetic investigation of chemical processes by tracer technique methods.

T63 Control Technique Laboratory

Design and installation of measuring devices comprising microprocessor elements (mainly for technological parameters directly not measurable but calculable from several directly measured data), and design and assembly of special power circuit modules not available in the market, and digital control systems.

Manufacture of microprocessor-operated devices for important operational units, from elements available in the market or made by T6. Testing and documenting of these devices. Development of microprocessor equipment capable of searching for the optimum working parameters. Application of PLC-s.

Development of micro-software aimed to solve various tasks. Programming of PLC-s. Establishing simulation models for the technological phases and complete sytems. Elaboration of microcomputer-aided operation systems.

Development and realization of systems ensuring full automation or automation of several technological processes, equipment and plants by means available in the market or developed and assembled by T6.

6.6 ADMINISTRATION BRANCH

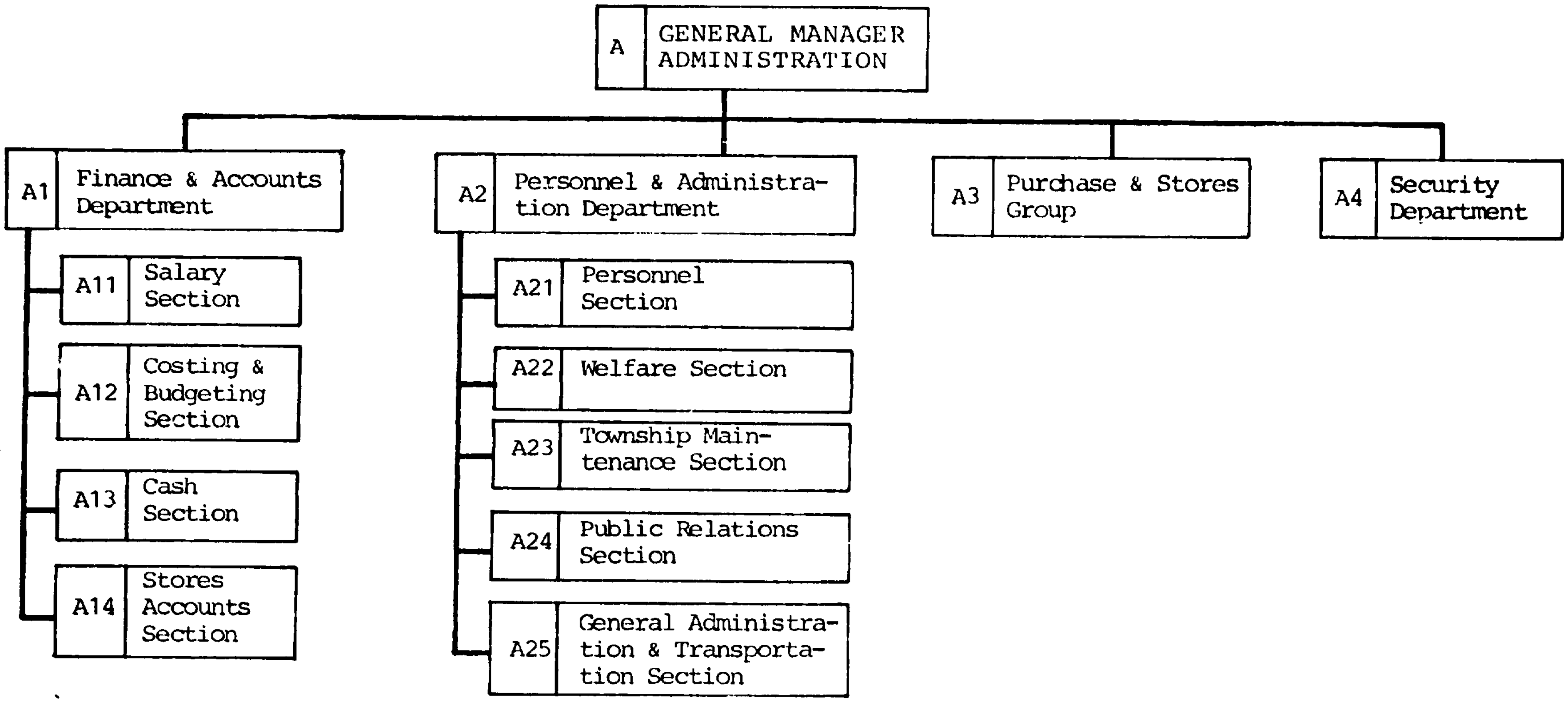
6.6.1 Organization

The administration works of the institution are performed by this branch. The Gen. Manager Administration directs the activity of various departments and groups. The recommended organizational structure of the branch can be seen in Table 6.6.

Table 6.6

INDIAN ALUMINIUM RESEARCH, DEVELOPMENT AND DESIGN CENTRE

A. ADMINISTRATION BRANCH



6.6.2 Main Task of Various Departments, Sections and Groups

A1 FINANCE AND ACCOUNTS DEPARTMENT

A11 Salary Section

Prepares the pay bills of the employees. Registers the sums paid to the employees and keeps up-to-date records of wages paid in individual units and in the Centre as a whole.

A12 Costing and Budgeting Section

Elaborates the budget for each year. Determines the annual allocation in the budget for individual units, (utilizable material costs, wages etc.) and the expected return. Plans the financing sources necessary to the smooth operation of the Centre and takes the necessary measures.

In the course of the year monitors the expenditure trends and elaborates reports, and analysis for the Centre and the individual units. Initiates, if necessary, corrective measures.

A13 Cash Section

Runs the current account of the Centre. Honours the financial commitments of the Centre and makes arrangements for the same. Prepares reports on the fulfilment of financial obligations of the Centre. Is responsible, together with the Costing and Budgeting Section, for maintaining the financial balance of the Centre.

A14 Stores Account Section

Keeps up-to-date list of stock of materials of the Centre item-wise. Registers the receipt and issue of stores material. Registers the unit prices item-wise and prepares analysis and lists for material costs of the Centre.

A2 PERSONNEL AND ADMINISTRATION DEPARTMENT

A21 Personnel Section

Keeps up-to-date list of the staff of the Centre. Handles the recruitment of the employees for the Centre. Selects the most appropriate workers for the tasks of the Centre, procures the necessary information on them, and tests their aptitude.

Elaborates the qualification records of the employees from the viewpoints of professional aptitude.

Prepares and registers the instruction and retraining plan of the employees of the Centre, organizes their registration. Monitors the scientific and publishing activity of the employees, acquisition of scientific degrees, study-tours, etc. Prepares reports for the management of the Centre in connection with the staff.

A22 Welfare Section

Handles the welfare of the employees, provides for the quick and effective solution of the problems.

A23 Township Maintenance Section

Periodically inspects buildings and installations and performs the necessary maintenance and repair works. Keeps an inspection system for making quick repairs and prevention of bigger damages.

A24 Public Relations Section

Prepares or has prepared advertising and publicity material, information leaflets, and circulars. Provides for appropriate distribution of the above materials. By utilizing advertisments, fairs, scientific conferences makes known the activity and results of the Centre to the potential clients.

A25 General Administration and Transportation Section

Provides for the handling and routing of the mail arriving to the Centre and organizes the mouvement of letters inside the Centre.

Operates the communication and telecommunication sets (telex, telephone) of the Centre and is responsible for their appropriate maintenance. Supervises the internal and external communications of the Centre. On behalf of the management of the Centre exercises supervision and prepares proposals for solving given operational problems.

Handles and maintains the transport vehicles (passanger cars, trucks). On the basis of instructions arranges the necessary transportations.

A3 PURCHASE AND STORE GROUP

On the basis of orders of the Centre's units procures the necessary materials, chemicals, stationary, etc. Prepares registers on the stock of materials in the store classified by type, quality and storing place. Registers the delivery of the materials to units of the Centre and to persons and takes back the unused material. Is responsible for keeping on level the stock of essential materials.

A4 SECURITY DEPARTMENT

Its task is appropriate protection of property of the Centre. In this interest it organizes a service staff and in case of necessity takes measures in the interest of increased security. Checks persons entering and leaving the Centre and the traffic of material. In case of natural disaster, fire, mass accident, etc. takes the necessary measures.

7. LOCATION OF THE CENTRE

7. LOCATION OF CENTRE

7.1 GENERAL

The Aluminium Research, Development and Design Centre is to be a national institution to serve the interests of the aluminium industry as a whole and as such, its location will have to be such that it will reasonably be accessible to all the existing and potential sites for development of the industry, taking into account also the major concentration to the secondary fabricators. The following factors should be considered while selecting a suitable site for the Centre:

i) Proximity to non-ferrous research institutes.
ii) Proximity to major bauxite deposits.
iii) Proximity to Alumina Plants.
iv) Proximity to Aluminium Plants and secondary fabricators.
v) Availability of research and testing facilities.
vi) Good climatic conditions.
vii) Proximity to the city.
viii) Availability of internal transport facilities.
ix) Availability of external transport (rail+air) facilities.
x) Availability of civic amenities.
xi) Availability of University & professional educational facilities.
xii) Availability of telecommunication facilities.
xiii) Adequate land upto about 100 acres for the Centre and its township.
xiv) Availability of adequate power and water.

7.2 LOCATION OF THE CENTRE

The location of the Centre may be suitably decided by the Govt. of India after evaluation of possible sites in the light of the criteria indicated above.

8. EQUIPMENT LIST

8. EQUIPMENT LIST OF THE CENTRE

GENERAL REMARKS

The list of instruments and equipment necessary to the operation of RDDC was compiled - and broken down according to departments - with the aim to ensure, that suitable and up-to-date equipment be at disposal for all research and design tasks arising in the field of aluminium industry. The most important technical data are marked on the list and brief indications are given on the function of individual instruments and equipment resp. In case of imported equipment the manufacturing firm and the type are given, in order to characterize the level of quality. It has to be remarked, however, that owing to the quick development that can be experienced in the field of instruments, appearance of newer, more up-to-date types has to be reckoned with. After decision on establishment of the RDDC, revision of the equipment list and selection of the most modern types are recommended before placing of orders.

In accordance with the requirements of activities starting stagewise in the individual research branches, purchase of recommended equipment has been broken down into three stages, with foreign and Indian supply listed separately. Furniture and fittings of different laboratories and bureaus were taken into account as estimated amounts in the costs of investment.

The stagewise breakdown of the equipment also identifies the relative importance for research work. It is expected that all the equipment will be provided during the implementation period itself. However, in case of any resources constrain the equipment listed under stage three can be deferred to a later date. In such a case, research work in these areas may still continue making use of similar or analogous facilities available with the industry/other centres.

The detailed equipment list can be seen in Annexure 4.

9. STAFF OF THE CENTRE

9. STAFF OF THE CENTRE

9.1 GENERAL

When setting up such an establishment as the RDDC, beside the modern building complex and sophisticated equipment, the availability of an operating and service staff in adequate number and suitable composition is of primary importance.

In most fields of activity, however, there ar no output norms which could help the exact determination of workforce requirement. Thus on elaborating the total of the staff for this Centre experience of ALUTERV-FKI and other similar institutes had to be overwhelmingly taken into consideration.

The total of the staff and its distribution accoring to highly qualified, auxiliary and administration categories, summarized in Table 9.1, reflect the sound ratios usual with such type of institutes. The staff development schedule projected to a 6-year period is shown in Table 9.2.

Some other details on the staff performing the basic activity of RDDC, i.e. research, development and basic design, are explained in the following paragraphs.

9.2 STAFF OF THE RESEARCH AND DEVELOPMENT BRANCHES

In determining the number of people on the staff of RDDC - especially the number of highly qualified experts - ALUTERV-FKI's and international experiences were used in order to specify the kind of specialization of experts required for solving the tasks of R & D and the number of highly qualified experts that have to be engaged in each of these special fields of activity.

From the point of view of future activity and success of RDDC the professional, managerial and human qualitites of its staff are of prime importance. The Government has to make every effort to ensure that only talented researchers, possessing scientific experience and having scientific degrees, are entrusted with leading positions of RDDC (Director, Deputy Directors, General Managers, Heads of Departments and, possibly, Heads of Laboratories). It would be very desirable, if at least some of them would possess professional experience in aluminium industry. These experts can be recruited from research institutes of related areas, leading universities, industrial enterprises, and from among Indian experts working abroad in the field of aluminium industry. One of the conditions of recruiting high professional level leading cadres is to pay them adequately. It is not necessary that all the highly qualified staff of the institute be recruited from experienced research people, the majority of it will be formed by young engineers, physicists etc. coming from the industry and universities, whose development as researchers is the task of heads of department, making use of the recommended forms of training.

Selection has to be performed continuously, as regularly not every expert thought to be fit for research becomes a good researcher.

The expected build-up, final number and composition of the staff are summarized in Tables 9.1 to 9.4.

The "Highly qualified staff" includes specialists with degrees, doctorates, postgraduate degrees in science and engineering; the "Auxiliary staff" includes technicians, lab. assistants, draftsmen, skilled and unskilled workers; "Administrative" personnel includes those workers who are working inside Research and Design Departments (secretaries, typists, etc.).

9.3 STAFF OF THE DESIGN AND ENGINEERING BRANCH

9.3.1 Background

The total number of staff in this branch amounts to 205 people. This personnel will be capable to serve the existing aluminium plants in both the public and private sector, moreover to carry out, simultaneously the basic design and engineering, in respect of 2 major new projects in each field of aluminium industry, excluding the bauxite mining.

9.3.2 Composition of the staff

The distribution of the staff as regards qualification, as well as the development scheme of the staff during a 6-year period is shown in Tables 9.1 and 9.6.

The major part, about 60 % of the staff, should be of high qualification, holding a degree of some excellent technical university. The reason of this relatively high ratio of highly qualified staff is that less auxiliary work is needed for the basic design activity than for the detailed design or erection of a project.

The auxiliary staff category is represented here by technicians and draftsmen of usually accepted educational level.

9.3.3 Recruitment of the staff

The key problem in this respect is to recruit at least the hard-core of the highly qualified staff from engineers having already some experience in the field of aluminium industry and/or in the field of design and engineering. There are a number of engineers enjoying a high professional reputation with various plants and institutes in India and abroad, who must be taken into consideration when developing the core of the staff. In order to obtain properly qualified people from these sources favourable financial and working conditions must be ensured. As for the working and living conditions, the possible site and the proposed facilities of the Centre should be rather attractive for the qulified workforce. There are key positions in this branch such as Dy. Director, Heads of Department, Heads of Section, Project Managers, to which posts the best educated and experienced engineers available have to be appointed. The capability of these people decisively influences the performance of the branch. Creativity, wide intellectual horizon, ability for decision-making, assumption of responsibility, familiarity with both technical and economic problems in general and with these of the aluminium industry in particular, and talent in management, are the main requirements.

A considerable part of the staff will come from the technical universities. The special professional and post-graduation training of these freshly graduated young people is a task requiring considerable attention and patience which has to be carried out according to a well-concieved long-term educational plan elaborated separately for each person. At the same time, also the heads of section and the experienced senior-engineers must help these young fellow-workers to become specialists as soon as possible.

Table 9.1

STAFF OF THE INDIAN ALUMINIUM RESEARCH, DEVELOPMENT AND DESIGN CENTRE

Symbol	Denomination	Highly Qualified Staff	Auxiliary Staff	Administration	Total
M,M1,M2	Management	11	7	5	23
B	Dy. Director's staff	1	1	1	3
B1	Alumina Production Research Department	47	74	2	123
B2	Aluminium Electrolysis Research Department	38	48	2	88
B3	Analytical Research Department	24	24	2	50
B total		110	147	7	264
F	Dy. Director's staff	1	1	1	3
F1	Semi-products Research Department	42	61	3	106
F2	Physical Metallurgy & Material Science Dept.	24	21	2	47
F3	Finished Products Research Department	12	12	2	26
F4	Application Technique Department	13	-	2	15
F total		92	95	10	197
D	Dy. Director's staff	1	1	1	3
D1	Conceptual Design Department	17	8	1	26
D2	Process Evaluation Department	8	12	1	21
D3	Process Design Department	29	18	2	49
D4	General Engineering Services Department	54	30	4	88
D5	Project Management Bureau	13	3	2	18
D total		122	72	11	205
T	Gen.Manager's staff	1	1	1	3
T1	Computer Centre	10	5	1	16
T2	Information & Documentation Centre	15	16	15	46
T3	Standardization Group	6	-	1	7
T4	Patent & Licence Department	9	-	1	10
T5	Workshop & Maintenance Department	7	37	1	45
T6	Instrumentation & Control Department	25	20	2	47
T total		73	79	22	174
A	Gen.Manager's staff	1	1	1	3
A1	Finance & Accounts Department	-	-	25	25
A2	Personnel & Administration Department	-	-	78	78
A3	Purchase & Stores Group	-	-	15	15
A4	Security Department	-	-	25	25
A total		1	1	144	146
GRAND TOTAL		409	401	199	1009

Table 9.2

STAFF DEVELOPMENT SCHEDULE OF THE CENTRE

Symbol	Denomination	Years of implementation*					
		1	2	3	4	5	6
M	Management	6	14	19	23	23	23
B	Alumina and Aluminium Research	5	60	118	169	217	264
F	Semis and Finished Product Research	5	67	93	134	165	197
D	Design and Engineering	-	60	100	140	180	205
T	General Technical Services	5	62	96	124	147	174
A	Administration	19	54	82	107	132	146
Number of Staff by the End of Years		40	317	508	697	864	1009
Annual Increase of the Staff		40	277	191	189	167	145

Note: *beginning from the date of Government's decision regarding the setting up of Aluminium Research, Development and Design Centre.

Table 9.3

STAFF DEVELOPMENT SCHEDULE OF THE ALUMINA AND ALUMINIUM RESEARCH BRANCH

Symbol	Denomination	Symbol of Laboratory	Years of implementation					
			1st	2nd	3rd	4th	5th	6th
B	Dy. Director's staff	-	2	2	3	3	3	3
B1	Alumina Manufacturing Research Department	-	1	2	3	3	3	3
		B11	-	7	9	11	13	15
		B12	-	10	15	20	25	30
		B13	-	-	5	10	18	25
		B14	-	-	-	5	7	10
		B15	-	-	25	30	35	40
B2	Aluminium Electrolysis Research Department	-	1	2	3	3	3	3
		B21	-	10	12	15	18	20
		B22	-	5	8	10	12	15
		B23	-	-	-	5	8	10
		B24	-	-	-	-	5	10
		B25	-	5	7	8	9	10
		B26	-	-	-	10	14	20
B3	Analitical Research Department	-	1	2	3	4	4	4
		B31	-	10	15	20	25	28
		B32	-	5	10	12	15	18
Number of Staff by the End of Years			5	60	118	169	217	264
Annual Increase of the Staff			5	55	58	51	48	47

Table 9.4

STAFF DEVELOPMENT SCHEDULE OF THE SEMIS AND FINISHED PRODUCTS RESEARCH BRANCH

Symbol	Denomination	Symbol of Labora-tory	Years of implementation						Implementation year of groups	
			1st	2nd	3rd	4th	5th	6th		
F	Dy. Director's staff	-	2	2	2	3	3	3		
F1	Semi-Products Research Department	-	1	2	3	3	4	4	F111	2nd
		F11	-	5	8	14	17	23	F112	4th
		F12	-	4	6	8	8	8	F113	4th
		F13	-	10	14	19	24	30	F114	4th
		F14	-	10	15	25	33	41	F131	2nd
									F132	2nd
									F133	6th
									F134	2nd
									F135	4th
F2	Physical Metallurgy and Material Science Department	-	1	2	2	3	3	3		
		F21	-	6	8	10	12	14		
		F22	-	-	-	3	4	6		
		F23	-	4	7	10	12	15		
		F24	-	3	5	7	9	9		
F3	Finished Product Research Department	-	1	2	2	2	3	3		
		F31	-	5	6	8	10	11		
		F32	-	5	6	8	10	12		
F4	Application Technique Department	-	-	7	9	11	13	15		
Number of Staff by the End of Years			5	67	93	134	165	197		
Annual Increase of the Staff			5	62	26	41	31	32		

Table 9.5

STAFF DEVELOPMENT SCHEDULE OF THE GENERAL TECHNICAL SERVICES BRANCH

Symbol	Denomination	Symbol of Laboratory/Division	Years of implementation					
			1st	2nd	3rd	4th	5th	6th
T	General Manager's staff	-	2	2	3	3	3	3
T1	Computer Centre	-	-	2	5	7	10	16
T2	Information and Documentation Centre	-	1	15	25	30	35	46
T3	Standardisation Group	-	-	-	2	4	5	7
T4	Patent and Licence Department	-	-	3	5	7	9	10
T5	Workshop and Maintenance Department	-	1	2	2	2	2	2
		T51	-	6	8	10	11	12
		T52	-	15	20	25	30	31
T6	Instrumentation and Control Department	-	1	2	2	3	3	3
		T61	-	5	10	13	15	17
		T62	-	-	-	4	6	7
		T63	-	10	14	16	18	20
Number of Staff by the End of Years			5	62	96	124	147	174
Annual Increase of the Staff			5	57	34	28	23	27

Table 9.6

STAFF DEVELOPMENT SCHEDULE OF THE
DESIGN AND ENGINEERING BRANCH

Symbol	Denomination	Years of implementation					
		1st	2nd	3rd	4th	5th	6th
D	Dy. Director's staff	-	1	2	2	2	3
D1	Conceptual Design Department	-	8	13	19	24	26
D2	Process Evaluation Department	-	6	10	15	19	21
D3	Process Design Department	-	15	25	34	44	49
D4	General Engineering Services Department	-	24	40	57	75	88
D5	Project Management Bureau	-	6	10	13	16	18
Total Number of Staff by the End of Years		-	60	100	140	180	205
Annual Increase of the Staff		-	60	40	40	40	25

10. GENERAL LAYOUT AND ARCHITECTURAL CONSTRUCTION

10. GENERAL LAYOUT AND ARCHITECTURAL CONSTRUCTION

10.1 GENERAL LAYOUT

The proposed general layout of the Aluminium Research Development and Design Centre is shown in the drawing No. A-1.

As for the site it was taken into consideration that the RDDC will be located in a typical urban environment suitably provided with public utilities (water, electric energy, sewerage) and road connection. An area was taken into account which is bordered by both a main and a side road joining to the main road. All the auxiliary and service buildings which make the smooth operation of the RDDC possible, are also located in the area.

The various buildings may be ranged in four groups:

- The Entrance building of single storey containing the information and reception, the vestibule, the big conference room with a capacity of 500 persons, the computer centre, the kitchen and the dining-room.
- Administration (office)-buildings and laboratories. The five buildings are shaped and structured in a similar architectural manner but have various number of stories (two to five). All these buildings have a longitudinal central corridor and are separated from one another by stairhalls.
- Single-storied technical buildings supplied with electric travelling cranes. The pilot plants, workshops and stores will be accommodated in these buildings.
- Other auxiliary and service-buildings of single storey as follows:

  three gate-houses
  oil pump house
  water tower

water treatment pump house
transformer substation
waste storage
gas cylinder storage
garage.

The four groups of the buildings are sited in four zones separated from one another by green-belts with trees, bushes and flowers of various height in order to form a comprehensive whole high enough and to provide protection against noise and dust originated in the pilot plants, etc. These protection strips ensure the calm environment which is necessary by all means to the intellectual work of research, development and design. For the relaxation and refreshment of both the intellectuals and the physical workers a recreation park is also provided.

It is considered that the use of the area of about 17.4 hectares - apparently too large - is very important in order to meet the requirement mentioned above.

Thus the RDDC-complex appears as a whole bedded in a big green park with good connection to the urban environment.

The traffic is divided in two parts: passenger and personal car traffic and heavy traffic respectively. Two gates and gate-houses are close to the main road, one of them for the entry, another one for the exit of the passenger and car traffic. For the heavy traffic a third gate and gate-house is located close to the side road which serves for the transportation of the various auxiliary materials and other goods directed inwards and outwards.

An area separated by fence is provided for the water treatment plant including the water reservoir, the water tower, the pump house and the cooling towers.

After skimming, separation and settling of the various chemical (acid, alkali, foam, oil) and physical (sand) contaminations, waste water will be conducted by gravity through the inner sewerage into a waste water reservoir sited in a separate place. From here waste water will be conducted into the public sewerage-network or for lack of this it must be removed by tankers sucking out waste water from the reservoir.

The inner road-network consists partly of one-way and partly of two-way roads depending on traffic requirement. Consequently, the width of the roads is 3.0 m and 6.0 m respectively, the width of the inner footpaths is 1.0 to 1.5 m. The covering of the roads and footpaths will be made of concrete bituminous carpet.

Between the service buildings and the water treatment plant an open-air storage area with concrete pavement is provided.

The main data of the area of the Centre are as follows:

Area covered by buildings	14,450 m^2	8.3 %
Roads	9,400 m^2	5.4 %
Open concrete pavements	9,600 m^2	5.5 %
Footpaths	4,500 m^2	2.6 %
Water treatment plant	10,200 m^2	5.9 %
Sewage farm	2,700 m^2	1.5 %
Park area	123,150 m^2	70.8 %
Total:	174,000 m^2	100.0 %

10.2 THE MAIN TECHNICAL DATA OF THE BUILDINGS AND STRUCTURES

10.2.1 Entrance and Conference Building "E"

This building houses the reception and information sections. The big conference room with a sitting capacity of 500 participants is placed here together with the auxiliary and service premises (projector room, audio-studio, stores, machine room for ventilation, cloakroom, etc.) The conference room is surrounded by the entrance hall, the sitting room, and the lobby which are separated from the computer centre by an internal yard. A smaller kitchen and dining room are also provided in this building. Lavatories are at both ends of the building.

The structure of this single-storied building has columns arranged in a 6 by 6 m network. These columns support the steel truss-girders bearing the continuous steel purlins which support the roofing made of corrugated steel plates. The truss-girders reach beyond the pillars forming cantilevers and an over-hanging roof, respectively. Consequently a suitable protection is assured against sunshine for the external totally glazed walls. On the lower level of the truss-girders a suspended ceiling will be constructed in order to form a space where air-ducts and electric cables can be laid without any problem.

The structure of the conference room differs from that described above because a higher inner clearance is required. Therefore the side walls of the conference room will be constructed from reinforced concrete cast-in-situ which support the steel truss-girders of 18 m span.

The main technical data of the building are as follows:

built-in plinth area	2,160 m^2
built-in volume	15,200 m^3
number of storey	1
terrace level	-0.45 m
floor level	$\pm$0.00 m
level of eave	+6.30 and +9.00 m

10.2.2. Buildings "D", "B", "F", "T" and "A"

These are two-, three-, four- and five-storied buildings with longitudinal central corridors and three-column frame-structure of reinforced concrete cast-in-situ. The floors will be constructed from continuous R.C. slabs cast-in-situ. The external walls and the internal partition walls will be made of bricks. Between the buildings there are stairhalls. The length of the houses and the place of the stairhalls make it possible that in case of fire the stairhalls are accessible within a distance of 30 m maximum, even from the farthest room.

The stairhall contains the staircase, the lift shaft and on each storey lavatories (separate for gents and ladies), water coolers, a tea-room and a chamber for cleaning implements. In all cases the stairhall is one storey higher than the neighbouring building because this topmost storey will accomodate the machine-room for the lift and the air-conditioning, respectively.

On both sides of the longitudinal central corridors there are built-in channels in which the various service lines (water, fecal sewage, air) and electric cables will be installed. Consequently for the installation and maintenance there will be easy access. The space not-occupied by lines and the one above the doors can be used as storage lockers.

Vertical and horizontal reinforced concrete lamellae are constructed along with the elevations on the front and back of the buildings as protection against sunshine.

The natural ventilation of the rooms and premises can be ensured by the windows. In all premises occupied by serving personnel, ceiling fans will provide the ventilation. Exhaust ventilation is provided only in such premises where steam or gas harmful for health, can originate (for example in the acid-hoods). Air-conditioning is provided only for special laboratory-rooms. Window air-conditioner units will be installed in the chambers of directors and senior management personnel.

10.2.3 Building "D". Design and Engineering Branch

In this block, in addition to the offices of "D and E" brancn, the ground-floor accomodates the following departments:

T4 Patent and Licence Department (9 rooms)

B1 Alumina Production Research Department (5 research-rooms)

B2 Aluminium Electrolysis Research Department (4 research-rooms and 2 laboratories)

The main technical data of the building:

built-in plinth area	850 m^2
useful floor area	1,800 m^2
built in volume	9,770 m^3
number of stories	3
floor levels	$\pm$0.00; +3.60 and +7.20 m
level of eave	+11,50 m

10.2.4 Building "B". Alumina and Aluminium Research Branch

The laboratories and the research-rooms of this branch are accommodated in this building.

The main technical data:

built-in plinth area	850 m^2
useful floor area	2,400 m^2
built-in volume	12,830 m^3
number of stories	4
floor levels	$\pm$0.00; +3.60; +7.20 and +10.80 m
level of eave	+15,10 m

10.2.5 Building "F". Semis and Finished Products Research Branch

The laboratories and the research-rooms of this branch are accommodated here.

The main technical data:

built-in plinth area	850 m^2
useful floor area	3,000 m^2
built-in volume	15,900 m^3
number of stories	5
floor levels	$\pm$0.00; +3.60; +7.20; +10.80 and +14.40 m
level of eave	+18.70 m

10.2.6 Building "T". General Technical Services Branch and Management

The ground-floor accommodates the reprography and printing sections, the library and the reading room. On the first floor there are the offices of the Management, on the second and third floors there are other offices and the rooms for instrument repairs.

The main technical data:

built-in plinth area	850 m^2
useful floor area	2,400 m^2
built-in volume	12,830 m^3
number of stories	4
floor levels	$\pm$0.00; +3.60; +7.20 and + 10.80 m
level of eave	+15.10 m

10.2.7 Building "A". Administration Branch and Changing-Room

A section of the ground-floor includes the change-and-bath for 270 men and 30 women, respectively for workers doing dirty physical work or possibility of contamination in the laboratory. In another section of the ground-floor and on the first floor are accommodated the administration offices.

The main technical data of the building:

built-in plinth area	850 m^2
useful floor area	1,350 m^2
built-in volume	6,710 m^3
number of stories	2
floor levels	+0.00 and +3.60 m
level of eave	+7.90 m

Stairhalls:

The main technical data:

built-in plinth area	740 m^2
built-in volume	13,570 m^3

10.2.8 Technical Building "P"

This single-storied, steel-structured building provided with hand-operated electric tavelling cranes contains various plant-units as follows:

- pilot-plants
- maintenance-workshops
- welding- section
- surface treatment section
- store
- lavatories
- electric switchgear-room

While planning the building it was taken into consideration that the corridors serve not only for communication between the halls but also for some other functions as follows:

- various service pipe lines (water supply, sewage, compressed air, etc.) can be installed under the floor
- electric cables and air-ducts can be installed in the space above the false ceiling.

The structure of the building: steel columns arranged at 6 m support steel truss-girders of 12 m span. The cantilevers of the columns support the continuous-welded steel girders. The roofing will be made of heat-insulated corrugated steel sheets. The walls are of brick construction.

The main technical data of this building-complex:

built-in area	5,320 m^2
built-in volume	45,700 m^3
number of stories	1
floor level	$\pm$0,00 m
terrace level	-0.30 m
level of eave	+7.50 m
level of top of crane rails	+6.00 m
capacity of the cranes	5/1 tonnes

10.2.9 Other Buildings

Several small auxiliary and service buildings constructed with brick walls and reinforced concrete roof cast-in-situ are provided for the Centre. Their built-in plinth areas are as follows:

gate-houses, 3 Nos. totally	240 m^2
water supply house	220 m^2
transformer sub-station	360 m^2
waste storage	180 m^2
gas cylinder storage	180 m^2
garage	510 m^2
oil pump-house	40 m^2
corridors between the buildings "E", "F" and "P"	250 m^2

10.3 LIGHTING AND POWER SUPPLY

The electric power system of establishment is as follows:

		Lighting	Power supply	Building Engineering	Total
Installed load	MW	0.58	3.95	0.45	4.98
Simultaneous peak load	MW	0.48	1.19	0.31	1.98
Simultaneous average load	MW	0.38	0.95	0.25	1.58

A building of 30 x 12 m area has been envisaged to receive, transform and distribute the above-mentioned loads.

The high voltage switchgear located in the sub-station is connected to the national grid. The voltage level of the high voltage switchgear may be 11 or 33 kV depending upon the supply voltage. The supply will be provided by two incoming feeders.

The 0.4 kV energy will be provided by 3 Nos, 1,000 kVA transformers, two of which are operating and one acts as a standby unit. The transformers, on their 0.4 kV sides are linked to the single collector busbar metal clad switchgear. The switchgear ensures the energy distribution for the consumers. The power factor correcting condensers and the batteries and rechargers needed for the operation of the circuit breakers, are similarly located in the switchgear-room.

The same battery station supplies power for the emergency lightings in the buildings.

Metal clad single collector busbar distribution boards with double feeding and radial outgoing system are envisaged, one each for buildings marked with "A", "B", "E", "F", "D" and "T" and two each for pilot plants and workshops. One sub-distribution board is located in each floor of the above mentioned bureau and laboratory type buildings in order to develop the suitable power circuits for each floor.

Fluorescent lamp fittings are envisaged in bureaus, laboratories and staircases as well, with an illumination intensity of 150 to 250 lux at working places and 80 lux at corridors and auxiliary (sanitary etc.) rooms.

Mercury vapour lamp fittings with a designed illumination intensity of 120 to 180 lux are taken into consideration for the workshops.

Fluorescent and normal electric lamp fittings with a designed illumination intensity of 100 to 200 lux would be installed in the auxiliary buildings. For the yard and perimeters lighting 8 m high poles with mercury vapour lamp fitting with an average illumination intensity of 12 lux for yard lighting and 4 lux for fence lighting have been considered.

Cables upto 4 mm^2 dia are provided of copper, and aluminium cores are suggested for cables with dia above 4 mm^2.

An earthing system is provided for the electrical system. Neutral earthing complete with protecting network will be used on the 0.4 kV main and the power supply cable network, and neutral earting is envisaged for the lighting network and for the three-phase consumers requiring more than 5 kW.

10.4 EXPANSION POSSIBILITIES

While locating the various buildings the possibility of expansion was taken into consideration. The building "P" can be extended in both directions.

The office- and laboratory buildings of longitudinal central corridors can be extended vertically by adding a new floor to the building if at the implementation stage, the supporting structures would be designed in compliance with this requirement. The stairhalls built on the ends make also possible a horizontal extension by constructing of new wings to the original building.

A part of the area of the Centre is provided as a reserve for expansion in the future. In consequence of this a further expansion can be projected inside the fenced area without requiring new area.

10.5 TOWNSHIP

Township covering an area of about 20 hectares will be built for housing the employees. The housing facilities for about 750 employees will be provided. The township will be provided with essential facilities like shopping centre, health centre, school, maintenance office, store etc. It will be well laid with a network of roads. The recreation facilities will be provided in the form of community centre, parks, playgrounds etc.

Following types of houses have been considered for the township.

	Type	Tentative Plinth Area
1.	Director's Bungalow	2100 sft.
2.	G.M.'s/Dy. Director's Bungalow	1750 sft.
3.	D Type Houses	1500 sft.
4.	C Type Houses	900 sft.
5.	B Type Houses	600 stf.
6.	A Type Houses	385 stf.

Design Features

Simple open type foundations have been considered for the purpose of estimating the cost in absence of soil investigation data. Concrete and Reinforced concrete construction will generally be cast-in-situ type. Plain concrete for levelling course, filling under foundations, apron, floors etc. will be of grades M5 to M10. Reinforced Conc. for foundations and structures will be of grade M-15 and M-20 depending on the type of loading. The buildings will be of bricks masonary. Design of masonary wall shall conform to Indian Standard Specifications.

10.6 LIST OF DRAWINGS

The relevant drawings listed hereafter can be seen in Annexure 5.

Sl.No	Drawing No.	Denomination
1.	A-1	General layout
2.	A-2	Axonometric view
3.	A-3	Ground flour ($\pm$0.00) block "D" and "B"
4.	A-4	Ground floor ($\pm$0.00) block "F" and "E"
5.	A-5	Ground floor ($\pm$0.00) block "T" and "A"
6.	A-6	First storey (level of +3.60) block "D" and "B"
7.	A-7	First storey (level of +3.60) block "F"
8.	A-8	First storey (level of +3.60) block "T" and "A"
9.	A-9	Second storey (level of +7.20) block "D" and "B"

Sl.No	Drawing No.	Denomination
10.	A-10	Second storey (level of +7.20) block "F"
11.	A-11	Second storey (level of +7.20) block "T"
12.	A-12	Third storey (level of +10.80) block "B"
13.	A-13	Third storey (level of +10.80) block "F"
14.	A-14	Third storey (level of +10.80) block "T"
15.	A-15	Fourth storey (level of +14.40) block "B"
16.	A-16	Fourth storey (level of +14.40) block "F"
17.	A-17	Ground floor. Halls block "P"
18.	A-18	Sections I.
19.	A-19	Sections II.
20.	A-20	Elevations I. Views from the main street
21.	A-21	Elevations II. Views from the halls
22.	A-22	Elevations III. Views from the side road
23.	A-23	Elevations IV. Views from water treatment plant.

11. INVESTMENT COSTS

11. INVESTMENT COSTS

11.1 GENERAL

The investment for the proposed Research Development and Design Centre has been estimated at about Rs 488 million, including a foreign exchange component of about Rs 123 million (equivalent to US$ 12.2 million). The broad break-up of the investment is given below:

		In million rupees
i)	RDDC proper	316.7
ii)	Township	77.5
iii)	Running expenses during implementation	93.3
	Total	487.5
	Say	Rs 488 million

Including a foreign exchange component of Rs 123 million.

The above estimates are based on the prices prevailing in the first quater of 1983 and do not include any provision for future escalation.

Interest during construction has not been considered, as the entire amount is expected to be financed from Government and UNDP assistance.

The cost of RDDC proper includes costs towards the laboratory complex including supporting facilities, namely the various laboratories; pilot plants and workshop; services such as electrical power, water supply, ventilation and sewerage facilities.

The break-up of investment under major heads such as equipment; spares; building structures; civil engineering works; erection; contingencies; freight, insurance and taxes; engineering, supervision and site works; land and land development; preliminary expenses including training and deputation of foreign experts, township, recurring expenses during implementation has been indicated in Table 11.1.

Table 11.1

INVESTMENT COSTS

(In million rupees)

Sl.No.	Item	Imported	Indigenous	Total
1.	Equipment	77.4	75.1	152.5
2.	Spares	3.9	3.8	7.7
3.	Building structures	-	5.0	5.0
4.	Civil engineering works	-	59.4	59.4
5.	Erection	-	11.4	11.4
6.	Contingencies	4.1	7.7	11.8
7.	Freight, insurance and taxes	8.5	7.0	15.5
8.	Engineering, supervision and site works	5.0	19.0	24.0
9.	Land and land development	-	2.7	2.7
10.	Preliminary expenses including training and deputation of foreign experts	24.2	2.5	26.7
	Total (RDDC proper)	123.1	193.6	316.7
11.	Township	-	77.5	77.5
12.	Recurring expenses during implementation	-	93.3	93.3
	Grand total	123.1	364.4	487.5
	Say		Rs 488 million	
	Including foreign exchange		Rs 123 million	
			equivalent to US$ 12.2 million	

11.2 EQUIPMENT

Considerable amount of sophisticated equipment for the RDDC which is currently not being manufactured in the country will have to be imported. The costs of such equipment are equally based on the budgetary information available from various suppliers. The costs of other equipment, to be procured from indigenous sources are based on the budgetary prices or cost of similar equipment purchased by existing institutions in India. The estimates are based on the prices prevailing in first quarter of 1983. The unitwise equipment costs have been given in Table 11.2.

11.3 SPARES

Certain amount of spares are to be procured along with the equipment for the initial period of operation. The cost of these spares is indicated separately. The provision for spares has been made at the rate of 5 % of the equipment costs.

11.4 BUILDING STRUCTURES

The structural buildings include the workshop, pilot plant units and the garage. The cost of building structures includes the cost of supply, fabrication and painting.

11.5 CIVIL ENGINEERING WORKS

The cost of civil engineering works includes cost of the buildings, equipment foundations, roads, rain water and faecal sewerage network, sewage treatment plant etc. The estimates are based on the preliminary layout and designs of different units and the rates prevailing in the area.

Table 11.2

UNITWISE EQUIPMENT COSTS

(In million rupees)

Sl.No.	Units	Costs Imported	Indigenous	Total
1.	Alumina Manufacturing Research Department	6.7	2.5	9.2
2.	Alumina Pilot Plant	-	3.7	3.7
3.	Aluminium Electrolysis Research Department	4.4	1.9	6.3
4.	Analytical Research Department	7.7	1.2	8.9
5.	Semi-products Research Department	17.4	31.7	49.1
6.	Physical Metallurgy and Material Science Department	20.2	0.1	20.3
7.	Finished Products Research Department	3.0	2.6	5.6
8.	Computer Centre	11.0	-	11.0
9.	Instrumentation and Control Department	3.0	1.8	4.8
10.	Reprography and Printing Department	4.0	0.2	4.2
11.	Workshop	-	3.9	3.9
12.	Other Facilities Including Electrics, Pump House Cranes, Vehicles etc.	-	25.5	25.5
Total Equipment		77.4	75.1	152.5

11.6 ERECTION

The cost towards erection includes the erection of equipment for laboratories, pilot plants, workshop, etc.; and building structures.

11.7 CONTINGENCIES

A provision of 5 % of the cost of equipment, spares building structures, civil engineering works and erection has been made towards contingencies to account for the unforeseen aspects of the estimates.

11.8 FREIGHT, INSURANCE AND TAXES

Provision towards oceanfreight and marine insurance for imported equipment has been made on the basis of prevailing rates. No customs duty has been considered, as all scientific and technical instruments, apparatus, equipment including spare parts imported for research institutions attract relief from customs duty. Provision has been made in the estimates towards port handling, inland freight and insurance during transit. Provision has been made in the estimates for sales tax at 4 % on indigenous equipment and spares.

11.9 ENGINEERING, SUPERVISION AND SITE WORKS

Provision has been made in the estimates towards engineering supervision and site works.

Engineering includes the payments to foreign and Indian consultants, towards services like preparation of reports, tender specifications, detailed engineering etc. Supervision of construction, erection and commissioning would cover the project supervision; supervision of erection of structures and equipment; commissioning and site coordination. The cost also includes the provision for enabling works such as temporary buildings, power supply and preparatory work at site.

11.10 LAND AND LAND DEVELOPMENT

The cost of land and land development has been estimated keeping in view the average earth work required, at the prevailing rates in the possible sites.

11.11 PRELIMINARY EXPENSES INCLUDING TRAINING AND DEPUTATION OF FOREIGN EXPERTS

Provision has been made in the cost estimates towards preliminary expenses such as registration; soil investigation; training of Indian personnel in India and abroad and cost of deputation of foreign experts to India. As foreign experts deputed to India are paid under UNIDO assistance, provision for tax on payments to experts (to be made by UNIDO) has not been made in the estimates.

11.12 TOWNSHIP

The estimated manpower of the RDDC is about 1000. It is envisaged that 100 % of the scientific staff would be provided accommodation in the township, so that the right talent can be attracted. For the remaining staff about 40 % satisfaction has been assumed. The overall satisfaction level works out to about 70 %.

11.13 RECURRING EXPENSES DURING IMPLEMENTATION

Recurring expenses include the payments to be made to the staff and other operating expenses viz. materials and services, repair and maintenance etc. during implementation period of 5 years. This amount works out approximately Rs 93.3 million. Yearly recurring expenses would be as follows:

(in million rupees)

Sl. No.	Item	Total	1st year	2nd year	3rd year	4th year	5th year
1.	Salaries and wages, including managerial expenses and other overheads	64.7	1.1	8.5	13.5	18.6	23.0
2.	Other expenses including materials and services, repair and maintenance and documentation	28.6	-	2.0	6.5	9.0	11.1
Total:		93.3	1.1	10.5	20.0	27.6	34.1

11.14 INFRASTRUCTURE FACILITIES

The cost towards infrastructure facilities such as external power supply, water wupply, etc. has not been included in the capital costs. It is assumed that these facilities would be made available by the respective State Government where RDDC will be located.

11.15 MODE OF FINANCING

It is expected that the entire expenses for the establishment of the Research, Development and Design Centre would be met from UN assistance as well as from grant/aid by Government of India. The exact proportion of the funds from the two sources has to be discussed and decided by UNIDO and Government of India at appropriate stage.

11.16 YEARLY FUND REQUIREMENT DURING IMPLEMENTATION PERIOD

The implementation period has been assumed as five years as per the implementation schedule shown in Table 11.1. The yearly requirement of funds including recurring expenses during implementation period has been accordingly worked out, taking into account the implementation schedule and the priority of the purchase of equipment. The yearly fund requirement would be as follows:

1st year	Rs	31.5 million
2nd year	Rs	94.4 million
3rd year	Rs	136.6 million
4th year	Rs	141.3 million
5th year	Rs	83.7 million
Total:	Rs	487.5 million

12. IMPLEMENTATION

12. IMPLEMENTATION

12.1 IMPLEMENTATION SCHEDULE

The most essential activities necessary to establish the Aluminium Research, Development & Design Centre are summarized in an Implementation Schedule shown in Table 12.1.

As this plan of work indicates, the actual implementation of the Centre, i.e. construction of all main and auxiliary buildings as well as that of a township, the procurement and installation of a major part of necessary instruments and equipment, would be carried out in a 5-year period. Only development of the staff is envisaged in the 6th year.

Priorities of setting-up various departments/sections/laboratories of the Centre in order to start the operation as soon as possible, and the relevant construction priorities are explained in the following paragraphs.

12.2 IMPLEMENTATION PRIORITIES OF R & D BRANCHES

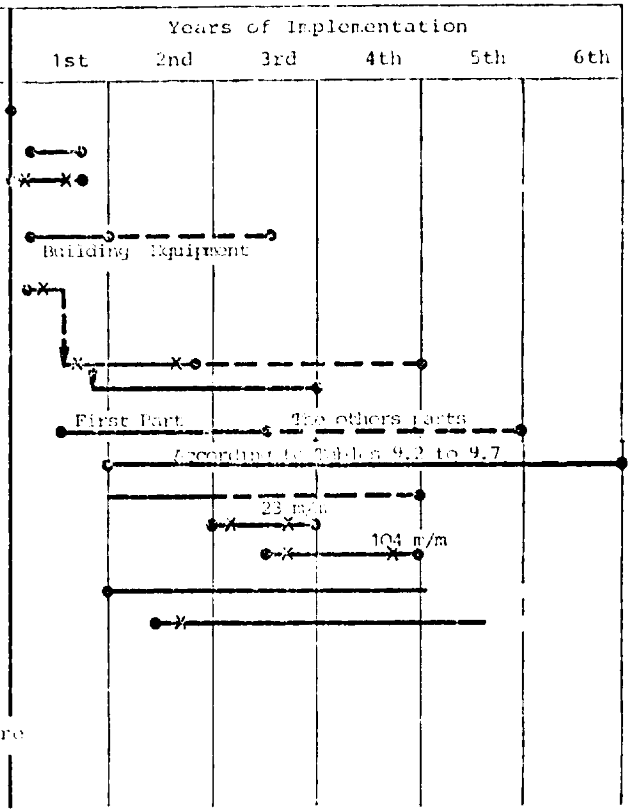
According to our proposal the majority of laboratories presented in the organizational structure will start their activity in the first phase of establishing but with a reduced staff and requirement. In each research area mastery of basic technological research methods and of the related material testing and analytical methods as well as training of researchers has to be regarded as main task in the first period.

In the later phases of the implementation more sophisticated and supplementary activities will be taken up stagewise. This was the reason to suggest procurement of equipment for the first, second and third phase of the implementation.

Table 12.1

IMPLEMENTATION SCHEDULE OF THE
INDIAN ALUMINIUM RESEARCH, DEVELOPMENT & DESIGN CENTRE

Sl.No	ACTIVITIES
1.	Appointment of the National Director and a Core of the Staff
2.	Acquisition of Land for the Centre
3.	Budgetary Action and Financial Appropriation to Prove Total Counter Parts Funds for the Project
4.	Arrangement of Temporary Premises for the Staff (with minimum equipment and instruments for research works)
5.	Appointment of National Foreign, Consultancy Firms for Final Designing of the Centre (including township)
6.	Final Design of the Centre with all Equipment
7.	Construction of Building for the Centre
8.	Construction of Township
9.	Development of the Centre Technical Personnel in India
10.	International Experts Team Service
11.	Training of Technical Staff Abroad - Study Tours - Fellowships
12.	Procurement and Installation of Indigenous Equipment
13.	Procurement and Installation of Imported Equipment



Notes: 1. ● The Government activities.
2. X UNIDO activities.
3. The date of the Government Decision about the Centre setting-up is considered as the first day of the first year of preparatory stage activities.

Research departments and laboratories will attain their total planned number of staff by the end of the establishment period, according to the schedule of development of staff.

The number of laboratories, suggested to be started in later phases of implementation on account of the above viewpoints, is relatively small.

The following laboratories would start their acitivity in the second phase:

B14 Process Control Development Laboratory
B23 Gas Purification and Environmental Control Laboratory
B24 Aluminothermy Laboratory
B26 Field Group
F112 Die Casting Group
F114 Properzi Field Group
F135 Lubrication Technique Group
F22 Microprobe Laboratory
F62 Radioactive Isotope Laboratory

The following would start in the third phase:

F113 PM Group
F133 Other Forming Tecnique Group

In scheduling the civil works priority for building "B" and "F" is suggested, as this would make it possible that the instruments and equipment procured can be placed at their permanent location.

12.3 IMPLEMENTATION PRIORITIES OF OTHER BRANCHES

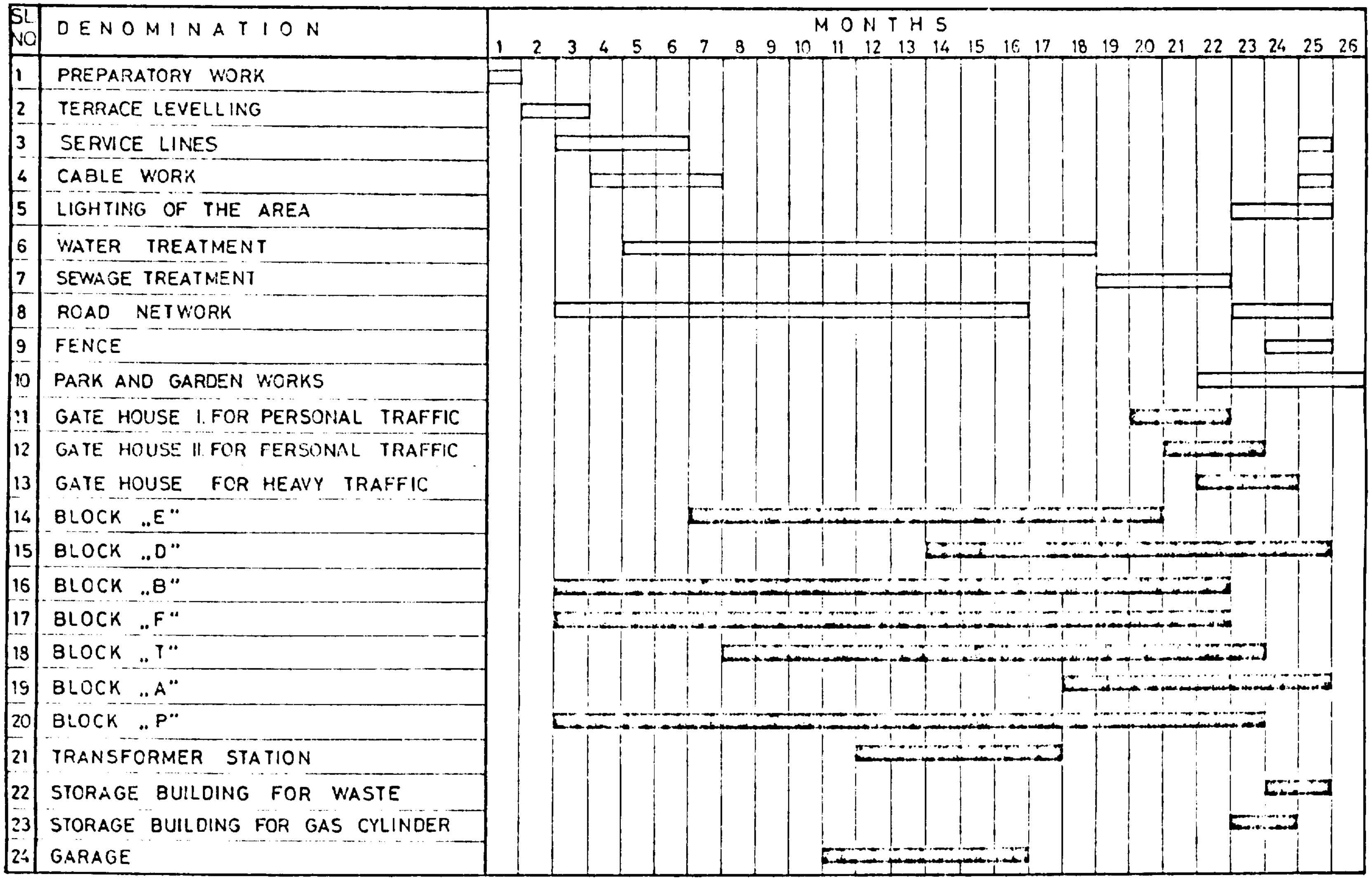
As it can be seen in Table 9.2, the activity of other branches (Design and Engineering, General Technical Services and Administration) would start in the second year of implementation. The operation begins simultaneously in each department and section but with a reduced number of staff which will be gradually increased upto the last year of implementation when it reaches the planned total. Thus, there are no priorities which have some influence on the construction works. In any case, the civil and architectural works must be scheduled to ensure suitable accommodation for the planned number of staff in each year of implementation.

12.4 IMPLEMENTATION PRIORITIES OF CONSTRUCTION

The duration of the construction of the buildings is estimated at 26 months. Taking into account the duration, the chronological order of construction of each building is given in Table 12.2.

First of all the execution of the buildings "B", "F" and "T" (which include laboratories) and the building "P" (which includes pilot plants, workshops and stores) are to be started considering skilled work of various kinds, installation of laboratory equipment, adjusting of machinery, etc.) which are to be done in these buildings.

Table 12.2



SL NO
DENOMINATION
MONTHS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
1 PREPARATORY WORK
2 TERRACE LEVELLING
3 SERVICE LINES
4 CABLE WORK
5 LIGHTING OF THE AREA
6 WATER TREATMENT
7 SEWAGE TREATMENT
8 ROAD NETWORK
9 FENCE
10 PARK AND GARDEN WORKS
11 GATE HOUSE I. FOR PERSONAL TRAFFIC
12 GATE HOUSE II. FOR PERSONAL TRAFFIC
13 GATE HOUSE FOR HEAVY TRAFFIC
14 BLOCK „E"
15 BLOCK „D"
16 BLOCK „B"
17 BLOCK „F"
18 BLOCK „T"
19 BLOCK „A"
20 BLOCK „P"
21 TRANSFORMER STATION
22 STORAGE BUILDING FOR WASTE
23 STORAGE BUILDING FOR GAS CYLINDER
24 GARAGE

13. ANNUAL EXPENSES

13. ANNUAL EXPENSES

13.1 GENERAL

The annual expenses of the RDDC including depreciation charges for a typical year when the Centre would have been fully established i.e. at the end of 5 years have been summarized below:

		In million rupees
i)	Annual expenses	43.9
ii)	Depreciation	24.4
	Total	68.3

The details of annual expenses under various heads such as salaries and wages, experts' fee, materials and services, repair and maintenance have been given in Table 13.1.

The above annual expenses are based on the prices prevailing during first quater 1983, and do not include any future escalation.

13.2 SALARIES AND WAGES INCLUDING MANAGERIAL EXPENSES AND OTHER OVERHEADS

Salaries and wages have been calculated based on the category-wise manpower requirement for the Centre and the payscales and fringe benefits currently prevailing in research establishments in India.

Overheads include salaries of managerial personnel, administrative overheads, expenditure towards social benefits, township maintenance etc.

Table 13.1

ANNUAL EXPENSES

(In million rupees)

Sl.No.	Item	Amount
1.	Salaries and wages including managerial expenses and other overheads	26.9
2.	Expert's fee	4.0
3.	Materials and services	10.2
4.	Repair and maintenance	2.6
5.	Documentation, patents, standards etc.	0.2
	Annual running expenses	43.9
6.	Depreciation	24.4
	Total annual expenses	68.3

13.3 EXPERT'S FEE

The cost towards expert's fee includes the costs to be incurred for hiring the services of experts in different fields to guide the advanced research activities. This also includes the payments may be made to avail of the specialized services of different institutions/organizations in the country and abroad.

13.4 MATERIALS AND SERVICES

The cost towards materials and services include the cost of operating supplies and services such as chemicals, material for sample preparation, consumables, electric power, gas, water, etc.

13.5 REPAIR AND MAINTENANCE

The repair and maintenance costs include the costs to be incurred annually for efficient operation of equipment and services facilities and maintenance of buildings, and other civil engineering works.

13.6 DOCUMENTATION, PATENTS, STANDARDS, ETC.

Provision has been made for the costs to be incurred by RDDC for obtaining various technical books and literature; expenses towards reprography; patents, standards, etc.

13.7 DEPRECIATION

Provision for depreciation has been made on straight line basis at the rate of 5 % of the total investment. It has been assumed that the work in laboratories would generally be carried out in single shift while the pilot plants would be operating on three shift basis.

13.8 INTEREST

As the financing of investment as well as annual expenses of RDDC have been proposed from the grants/aides, no interest would be paid on the fixed capitals as well as working capital requirements for the Centre.

14. TRAINING OF THE STAFF

14. TRAINING OF THE STAFF

14.1 RESEARCH AND DEVELOPMENT BRANCHES

For professional training and retraining of leading researchers and designers the following recommendations may be followed:

14.1.1 Professional courses on the aluminium research to be held in India

A course lasting for 4 to 6 weeks should be held in a suitable place at a time when at least 50 % of the staff of Research and Development Branches has already been recruited. During the course a number of noted foreign and indigenous experts would deliver lectures on the theoretical and practical problems of the aluminium industry and on research methods adopted in the area of aluminium industry according to a preset programme. The foreign lecturers shall be selected from experts/consultants invited to India for implementation of RDDC or invited especially for the courses.

Corresponding to the individual technical areas, training is to be carried out suitably in the following sections:

- bauxite geology, alumina production
- aluminium electrolysis
- alloys, semis and finished products.

The program of all three sections, however, should also comprise lectures on material testing and analytical testing methods adopted in the respective areas, as well as measuring and control techniques.

On drawing up the programme for the course the experience gained on the occasion of the UNIDO Group Training held on alumina production for experts of developing countries in ALUTERV-FKI in Budapest in 1979 can be made use of.

It will be necessary to organize the visits to concerned plants for the participants of the courses.

The site of training will be designated later, after beginning of the implementation stage of RDDC. The location which can be considered are as follows:

- National Metallurgical Laboratory, Jamshedpur
- Indian Institute of Science, Bangalore
- Regional Research Laboratories
- Premises of the new RDDC.

Considering that this kind of training is less expensive, a large number of researchers, engineers and technicians can be trained.

It is advisable to arrange several similar training courses also later on.

14.1.2 Study-tours abroad

It is recommended to organize study-tours abroad for heads of the RDDC, as well as for heads of research and design departments in order to pay visits to similar institutes in different countries. By these study-tours it is aimed to gather information about the organization of work and to get knowledge on the subjects dealt with in the institutes.
A one to one-and-a-half month duration of study-tours is recommended.

14.1.3 Training of experts in foreign and indigenous Institutes

The primary aim of this type of training is that the experts acquire, during fellowships abroad, proper experience for the job to be performed using sophisticated material testing instruments (e.g. X-ray units, electron beam equipment, sophisticated analytical instruments) or other equipment. This kind of training may be carried out at the following locations:

- the supplier of instrument
- the research institute or university using such instruments in India
- research institutes abroad (e.g. ALUTERV-FKI, VAMI, etc.).

The most expedient way of training seems to be the following: the researcher would have the training arranged by the suppliers in India first and after having been trained in handling the instrument, he would go abroad to institutes where the testing method in question is being used in research work in the aluminium industry. Recommended period of training would be 2 to 3 months.

The aim of training researchers working in technological areas is to make them familiar with research technique (both theoretical and practical) and in relation to material science and material testing/analytical methods necessarily needed for following high-level technological research. These researchers have to participate in indigenous training in plants and institutions dealing with material testing and material science before taking part in fellowships abroad.

14.1.4 Invitation of foreign experts/consultants

In order to start the activity of RDDC it is recommended in the initial stage to invite foreign experts/consultants who are engaged in research work and possess considerable experience in this area, for a period of 3 to 12 months for each person.

14.2 DESIGN AND ENGINEERING BRANCH

In order to help the staff to obtain the necessary knowledge and experience indispensable for efficient design work, organization of group trainings in various forms is recommended.

14.2.1 Professional course in India

The third year of implementation seems to be the most suitable period to start the training. It is foreseen that by this time about 40-50 % of the technical staff would have already been engaged.

As a first step of training, organization of a professional course lasting some 3-4 weeks would be desirable. The elaboration of a well-considered, comprehensive program for this course is indispensable, including lectures on the general status of aluminium industry both in India and in the main aluminium producing countries, main trends of development, techno-economic problems etc. Beside the subjects of general interest special lectures should be held on the alumina production, aluminium electrolysis, semis and finished products manufacturing, and on the basic design and engineering problems in the same fields. In order to ensure that this course be really successful and profitable, the management should invite experienced, well-informed lecturers enjoying high professional reputation in the relevant field. Invitation of a few foreign lecturers, too, is recommended.

It would be useful if the date of this course could be co-ordinated with the similar program of the Research and Development Branches. The lectures on the subjects of general interest could be attended jointly. Thus number of lecturers might be reduced besides the members of different branches would have the chance to develop/consolidate professional and personal contact with each other resulting in more efficient co-operation of branches.

As this form of training is not particularly expensive, it may be recommended to be held for the overwhelming part of technical staff available at that time. Even the repetition of this type of training is definitely suggested at a later date when the formation of the staff is already completed.

14.2.2 Field training in India

After having finished the professional course a chance should be given to a major group of senior and junior engineers, economists and senior technicians, to participate in field training. The period of this field training would be 4 to 8 weeks depending on the professional area and position. This field training can be performed in various aluminium industry establishments e.g. alumina plants, smelters and manufacturing facilities as well as design and engineering companies. First of all plants and companies of public sector can be taken into account for training, but it would be useful and desirable if also some important representative(s) of the private sector, willing to share their experiences with the staff of RDDC in the interest of common goals, will take part.

14.2.3 Training abroad

The aim of this form of training is to broaden the horizon of the participants by visiting similar institutes, plants and other facilities of aluminium industry and studying their activity in leading aluminium producing countries.

In the course of these study tours/fellowships the would-be leaders and specialists of the Design and Engineering Branch will have the opportunity to study, compare and evaluate the results of other organizations, their methods of management and planning, the organizaton of work, applied incentives etc. and to have discussions with several experienced specialists working in similar field.

The proposed period of the training is 4 to 6 weeks depending on the professional area and position. Visit to establishments in several countries is recommended for each person.

14.2.4 Foreign experts' assistance

In the first phase of implementation, when the various forms of training are already accomplished, it is advisable to engage a few foreign experts/consultants of high professional reputation in the field of process design of alumina plants, smelters, semis and finished products manufacturing facilities, general engineering, and in handling the economic problems.

They assist the leadership of the branch to start and to continue the basic design and engineering activity according to the objectives outlined in Chapter 5 and to overcome the initial difficulties. The suggested period of this foreign technical assistance is 3 to 6 months per person.

The details of recommended training forms is summarized in Tables 14.1 and 14.2.

14.3 COSTS OF TRAINING

14.3.1 Costs in Foreign Currency

The expenses for suggested study tours and fellowships abroad, those for engagement of foreign experts/consultants to help starting the professional activity of RDDC, and the costs to be incurred when inviting foreign lecturers for the proposed professional courses, should be met from convertible foreign currency source.

The summary of these costs is indicated in Table 14.3.

14.3.2 Domestic Costs of Training

The expenses ncurred in domestic currency when performing the recommended training program of technical staff in India, depends among others on the location of training (site of various research laboratories, alumina and aluminium producing and processing plants and shops, etc.) and the number of people intended to be sent to individual training centres. Considering that all these details are not yet known, an estimated lump-sum of 0.3 million Rupees has been taken into account as domestic costs of training.

Table 14.1

TRAINING OF STAFF IN INDIA. FOREIGN EXPERTS/CONSULTANTS IN INDIA

S.No	Denomination	Professional course			Invited foreign experts/consultants			Training in Indian** plants and institutions, persons
		Foreign lecturers	Indian lecturers	Participants of the course	Number of persons	Assumed interim *	Total duration, m/m	
1.	M: Director	-	-	-	1	2nd-5th	40	-
2.	B1: Alumina Production Research Department	2	2	11	2	3rd-4th	24	4
3.	B2: Al Electrolysis Research Department	2	2	14	2	2nd-3rd	24	4
4.	B3: Analytical Research Department	1	2	8	1	2nd	12	3
5.	F1: Semi-products Research Department	3	2	20	4	3rd-4th	33	7
6.	F2: Phys. Met. and Mat. Science Department	3	3	10	3	3rd-4th	18	5
7.	F3: Finished Products Research Department	2	2	6	1	4th	6	2
8.	F4: Application Technique Department	-	-	6	-	-	-	-
9.	T6: Instrumentation and Control Department	3	2	13	1	3rd-4th	12	3
10.	Long & Short-Term Planning	-	-	-	1	2nd	6	-
11.	Consultants (research)	-	-	-	5	2nd-3rd	12	-
12.	Alumina Production and Design	1	2	8	1	3rd	6	6
13.	Aluminium Electrolysis and Design	1	2	8	1	3rd	6	6
14.	Semis and Finished Products Manufacturing and Design	1	3	14	1	3rd	6	8
15.	General Engineering	1	4	30	1	3rd	6	20
16.	Process evaluation	1	2	8	1	3rd	3	4
Total		21	28	156	28		214	72

Notes: * Years of implementation
** Training preceding the fellowship abroad

Table 14.2

TRAINING OF THE STAFF ABROAD

HOST COUNTRIES (ASSUMED): USSR, HUNGARY, FRANCE, CANADA, JAPAN, etc.

Nos.	Denomination	Number of People	Assumed Year of Implementation	Duration man-month
1	A. STUDY TOURS			
1.1	Director	1	3rd	1
1.2	Deputy Directors	3	3rd	3
1.3	General Manager Technical	1	3rd	1
1.4	Heads of Department	12	3rd	18
	Total A	17		23
2	B. FELLOWSHIPS			
	Engineers (Research) of the following specialities			
2.1	Raw Materials Investigation	1	3rd	3
2.2	Alumina Technology	2	3rd	6
2.3	Equipment for Alumina Production	2	3rd	6
2.4	Aluminium Electrolysis Technology and Equipment	2	3rd	6
2.5	Carbon Materials Technology	1	3rd	3
2.6	Gas and Liquors Cleaning Technology	1	4th	3
2.7	Technological Lubrication	1	3rd-4th	3
2.8	Refining and Casting Technology	1	3rd-4th	3
2.9	Extrusion Technology	2	3rd	6
2.10	Rolling Technology	2	3rd	6
2.11	Powder Technology	1	3rd-4th	2
2.12	Surface Treatment Technology and Corrosion	1	3rd-4th	2
2.13	Jointing Technique	1	3rd-4th	2
2.14	Metallography, Physical Measurements, Mechanical Tests	5	3rd-4th	12

Table 14.2 (cont.)

Nos.	Denomination	Number of People	Assumed Year of Implementation	Duration man-month
2.15	Analytical and Physico-chemical Investigation	3	3rd	8
2.16	Instrumentation and Control	3	3rd-4th	6
	Design Engineers and Economists			
2.17	Alumina Plant Design	3	3rd	4.5
2.18	Smelter Design	2	3rd	3
2.19	Fabrication Facilities Design	4	3rd	6
2.20	General Engineering	5	3rd	7.5
2.21	Economic Evaluation and Estimation, Computer Technique and Project Management	4	3rd	6
	Total B	47		104
	Total A + B	64		127

Table 14.3

COSTS OF TRAINING IN FOREIGN CURRENCY

(in US $)

Sl.No.	Denomination	Number of Persons	Total m/m	US $ per m/m	Years of Implementation 2nd	3rd	4th	5th	Total
1.	Study Tours	17	23	3,000	-	15,000	54,000	-	69,000
2.	Fellowships	47	104	2,000	-	-	82,000	126,000	208,000
3.	Foreign Experts'Assistance	27	214	-	32,200	525,960	708,420	762,420	2,029,000
4.	Other Costs: Foreign Lecturers' Fee, Travalling Costs, etc.	-	-	-	7,800	24,200	32,000	30,000	94,000
GRAND TOTAL					40,000	565,160	876,420	918,420	2,400,000

15. METHOD OF CHARGING

15. METHOD OF CHARGING

15.1 METHODS OF CHARGING FOR THE SERVICES RENDERED TO THE CLIENTS

The institute may receive payments from the user industry for testing of raw materials and finished products and know-how for the process and designs developed by the institute. The payments may be in the following manner:

i) Lump-sum fee
ii) Cost plus basis
iii) Lump-sum fee plus running royalty.

Lump-sum fee: In this type of payment the institute and the user industry agree for a particular sum to be paid by the industry for the services being rendered by the institute. Again, the sum may be paid by way of advance, progress payment and final payment. The fee depends upon the nature of job, cost to be incurred and the benefits accruing to the industry.

Cost plus basis: In this form of payment the two parties agree for a particular percentage which is to be paid to the institute over and above the actual cost, may be incurred by the institute during the course of rendering services.

Lump-sum fee plus running royalty: This type of payment is normally made in case of an accepted process or patents developed by the institute. In this, the payments are in two parts, firstly as a lump-sum amount and secondly a running royalty for a period of 5 to 10 yrs. The running royalty is normally around 1 % of the net sales realization for the final product. During the royalty period institute is bound to keep informed the industry for the future developments in the process.

15.2 PAYMENTS TO BE MADE BY THE INSTITUTE TO OTHER ORGANIZATIONS

In order to conduct some tests and experiments in the running plants, the institute may have to make some payments to the industry. The payments may depend upon the loss of productive time and saleable products quality and quantity during the course of experiment.

12909
(2 of 2)

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

PREPARATORY PROJECT REPORT
FOR SETTING-UP AN
ALUMINIUM RESEARCH, DEVELOPMENT & DESIGN CENTRE
IN INDIA

FINAL REPORT

ANNEXURES 1, 2, 3, 4

ALUTERV–FKI

BUDAPEST / HUNGARY

August, 1983

PREPARATORY PROJECT REPORT
FOR SETTING-UP AN
ALUMINIUM RESEARCH, DEVELOPMENT & DESIGN CENTRE
IN INDIA

Final Report

by

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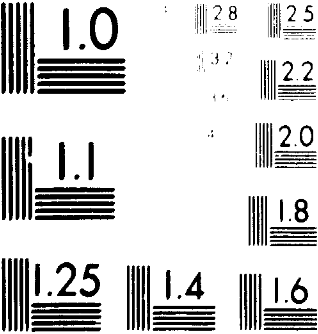

MICROCOPY RESOLUTION TEST CHART

CONTENTS

ANNEXURE 1

TERMS OF REFERENCE

Annexure 1

TERMS OF REFERENCE
OF THE DETAILED PREPARATORY REPORT
FOR ALUMINIUM RESEARCH DEVELOPMENT
AND DESIGN CENTRE SETTING UP

1. Aluminium Research Development and Design Centre is being set up by Indian Government for carrying out of economics, research, development and design works to meet the full requirements of Indian National Aluminium Industries for both Public and Private Sector.

2. The Centre after having been developed in full scale should be able to carry out the RDDC works as mentioned below:
   The main directions of R & D works (Annexure I)
   The design work field (Annexure II)

3. Besides the main research and design departments and divisions all relevant auxiliary maintenance and administrative divisions should be provisioned to ensure that the centre is capable to work at a high level.

4. Location will be determined by the Government not later by end of January 1983 after relevant proposals consideration.
   Proposals must be submitted to Government by CTA in the middle of January 1983 and it should meet the enclosed requirements (Annexure III).

5. The contents of the Detailed Preparatory Project Report should meet the plan according to Annexure IV.

6. While working out the Report it must be taken into account that the whole annual revenue Government expenditure for the R & D works should not be over 1.5 % (approx) of annual sales value in Aluminium Industry (as a rule).

7. Detailed Preparatory Project Report (Feasibility Report) should be carried out in time period according to the General Scheme (vorking plan) Annexure V).

Chief Technical Adviser (UNIDO)
(DR NN TIKHONOV)

National Project Coordinator
(DR BC DATTA)

ANNEXURE - I
to ARD & DC Terms of
Reference

THE MAIN DIRECTIONS OF THE RESEARCH AND DEVELOPMENT WORKS

No.	Title of R & D works	Anticipated commencement of the work
1.	Economics investigations	
1.1	Elaboration of the general long/short term plans of national aluminium industry development.	1985
1.2	Working out of the economic investigations and estimations for new mining enterprises, alumina plants, smelters, fabrication shops designs.	1987
1.3	Carrying out economic evaluation of research works and suggestions for technology and equipment improvement.	1988
2.	Geological and Mineralogical Investigations	
2.1	Petrological and Mineralogical investigation of the East Coast and other bauxite deposits.	1984
2.2	Construction of a geological map (lithological, structural) of the bauxite deposite for determining the bauxite distribution in the deposit.	1986

No.	Title of R & D works	Anticipated commencement of the work
2.3	Study of Mineralogical and Chemical composition of bauxite	1984
2.4	Fundamental research on geology of the bauxite deposits.	1987
2.5	Determination of blendability of bauxite from the various deposits for optimal use without benefication especially for contiguous and closeby areas.	1986
3.	<u>Research & Development in the field of Alumina Production</u>	
3.1	Study of technological properties of the main bauxite deposits and elaboration of technological schemes of their processing.	1984
3.2	Investigation and elaboration of technological methods and schemes of the production of Gallium, Vanadium pentoxide (and some other by-products) and the methods of aluminate liquors purification from undesirable impurities (organic matters, carbon, sulphur and other salts).	1985

No.	Title of R & D works	Anticipated commencement of the work
3.3	Investigation and elaboration of methods for production of special aluminas to be used in different branches of national industry (electronic, refractory, radio, automobile and some other spheres).	1986
3.4	Working out of industrial methods of alumina quality improving (in particular sandy type alumina methods production).	1986
3.5	Investigation and working out of methods and ways to improve the existing technology and equipment for bauxite, caustic soda, steam, fuel and power saving of Alumina Plants.	1985
3.6	Developments of new types of heat exchanger and other hydrochemical equipments used in Alumina Production.	1988
3.7	Development in the field of calcination in order to save energy and new types of furnace equipment.	1987
3.8	Development of auxiliary equipment e.g. pumps, valves etc.	1989

No.	Title of R & D works	Anticipated commencement of the work
4.	<u>Research & Development in the field of Electrolysis of Aluminium and Carbon Materials Production</u>	
4.1	Investigation and improvement of the aluminium electrolysis technology. Selection of the most effective parameters for Smelter process at different types of cells.	1985
4.2	Improvement of cells structure. Working out and commercialisation of the measures to extend the cell service life (under construction works, anode sintering and putting the cell into operation). Improving of the Smelter process mechanisation.	1986
4.3	Development and improvement of the carbon material production. Study of the influence of pitch, cokes quality and technology of both anode and cathode carbon paste production on the quality of carbon paste production on the quality of carbon materials and on the main technical and economic characteristics of the smelter process.	1985

No.	Title of R & D works	Anticipated commencement of the work
5.	<u>Research and development in the field of Aluminium casting and Fabrication</u>	
5.1	Development of the technology of new aluminium alloys production according to up-to-date requirements of the national industry. Development of the methods for new alloys casting process. Working out new improved methods of casting technology.	1986
5.2	Development and improvement of the process for removing hydrogen, non-metal inclusions and sodium from Aluminium.	1986
5.3	Development and improvement of the equipment for production of aluminium alloys casting pigs and ingots.	1988
5.4	Development of the latest aluminium refining techniques (electroslag, filteration through corundum, bubbling with nitrogen etc.).	1988
5.5	Development of the latest methods of casting high quality ingots (electromagnetic casting etc.).	1987
5.6	Development of special high strength alloys, for example alloys of Al-Zn-Mg-Cu-Cr & system.	1986

No.	Title of R & D works	Anticipated commencement of the work
5.7	Development of the process for production of modifying alloys of the system Al-Ti, Al-Ti-B in the form of pigs and wire rod.	1986
5.8	Improvement of the heat treatment technology for ingots from aluminium and its alloys to improve their mechanical properties and to increase the capacity of the equipment and their utilisation factor as well.	1986
5.9	Investigation and development of the hot and cold rolling technology of sheets bars, strips etc.	1986
5.10	Investigation and development of the technology for extrusions production to meet different consumer's requirements (hot extrusion-both direct and indirect, tapper heating extrusion, extrusion with lubricant container liners, cold extrusion, continuous and semi-continuous extrusion, composite materials extrusion etc.).	1987
5.11	Study and development of the cold rolling and drawing technology of the tubes from Aluminium and its alloys.	1986
5.12	Development and improvement of the equipment and process for wire rod production.	1986

No.	Title of R & D works	Anticipated commencement of the work
5.13	Development of the process for production of wire rod from special alloys for communication cables, railway transport etc.	1987
5.14	Development of the rolling technology for new production, including foil, lithographic plates and new alloys.	1988
5.15	Development of the new heat treatment techniques for increasing the electric conductivity and mechanical properties of aluminium for electrical application.	1987
5.16	Improvement of the hot rolling technology of aluminium and aluminium alloys.	1987
5.17	Increasing the quality of the extrusions and the main equipment productivity as well.	1986
5.18	Investigations of surface treatment for protection against corrosion and marketability improvement.	1987
5.19	Development of the process for use and regeneration of all types of the process lubricant.	1986

No.	Title of R & D works	Anticipated commencement of the work
5.20	Fundamental and theoretical research and investigations in the field of new alloys, new technology, new testing methods development, and in the field of the physics and metals as well.	1988
6.	Works in the field of technological process automatization	
6.1	Working out of the main technological process automatic control system.	1987
7.	Environment protection	
7.1	Development of the equipment and technology for gas cleaning, dust collecting and water cleaning under all branches of aluminium industry.	1988
7.2	Development of measures for efficiency of environmental control to be improved further.	1988
7.3	Investigation of the methods for waste products utilization.	1989

No.	Title of R & D works	Anticipated commencement of the work
8.	Analytical control service development of relevant analytical methods	
8.1	Chemical, physico-chemical and physical investigation of the materials as follows: - Bauxite of all mineralogical types - Alumina and by-products of alumina production - Aluminium and its alloys - Carbon materials (Petroleum coke, pitch, anode paste, bottom paste, prebake anodes, bottom blocks) - All intermediate materials of alumina, aluminium and carbon materials production - All materials due to environmental control.	1984-85
8.2	Preparation of standard specimen.	1985
8.3	Development and improvement of all methods for overall investigation of above mentioned materials.	

ANNEXURE - II
to ARD & DC Terms of Reference

THE DESIGN WORK FIELD

No.	Description	Anticipated commencement of the work
1.	Participation in design works for new aluminium industry enterprises setting up in collaborations with some foreign firms.	1986
1.1	Preparation of some necessary data and specifications of the technological process to be designed by foreign firms.	
1.2	Preparation of the drawing of some special non-standard equipment for newly developed process and equipment.	
1.3	Participation in supervision at the stage of erection and putting new facilities into operation.	
1.4	Assistance in reaching the design performance level for new facilities.	
1.5	Elaboration of necessary design documentation for improving of technological process and equipment at the existing plants according to research department suggestions (in collaboration with some other design firms).	

No.	Description	Anticipated commencement of the work
1.6	Elaboration and preparation of the background and specifications for sub-contracting design organizations concerning: Interplant transport Heat and gas supply Power supply Water supply Civil and sanitary engineering General layout of plants Automation of production process.	
2.	General designing of all new national aluminium industry enterprises.	1990
2.1	Elaboration of the technological and apparatus flowsheets according to research department suggestions background.	
2.2	Preparation of the drawing of some special non-standard equipment for newly developed process and equipment.	
2.3	Supervision at the stage of erection and participation in putting new facilities into operation.	
2.4	Assistance in reaching the design performance level of new facilities.	

No.	Description	Anticipated commencement of the work
2.5	Elaboration of necessary design documentation for improving of technological process and equipment at the existing plants according to research department suggestions (in collaboration with some other design firms).	
2.6	Elaboration and preparation of the background and specifications for sub-contracting design organisations concerning: Interplant transport Heat and gas supply Power supply Water supply Civil and sanitary engineer[illegible] General layout of plants Automation of production p[illegible]ss and etc.	
2.7	General guidance of all sub-contracting design firms.	
3.	Carrying out orders of some foreign customers for designing aluminium industry plants.	1995

ANNEXURE - III

to ARD & DC Terms of Reference

THE REQUIREMENTS FOR THE LOCATION OF THE INDIAN NATIONAL ALUMINIUM R & D CENTRE

Only excellent R & D Centre will be able to do something in the field of progress and developing of Indian Aluminium Industry.

So, it is worth setting up either an excellent centre or no centre at all.

The first requirement is the excellent staff. It is the question of paramount importance: All the other questions are significance of the second rate.

Therefore the main requirements for the location of the future centre appeared to be as follows:

1. The centre must be located in or near some important cultural & Scientific city with highly developed infrastructure and rather well climatic conditions. By other words the place of the Centre location must be attractive themselves for skilled scientists and engineers with high professional reputation.

2. Besides, the location should have easy transport connection with Government establishment, some Research & Design Organisation (assumed sub-contrators). Possibility to get the main enterprises of Aluminium Industry must be taken into account as well.

3. It is desirable to have some existent or future Alumina Plant in immediate nearness from the Centre (because the most suitable location of Alumina pilot installation is some alumina plant at).

4. It would be better to have possibility to arrange the staff residence place in a proper way to ensure good contacts between staff people in free time.

5. It is desirable to have in the same city some high educational establishment of corresponding scope.

ANNEXURE - IV
to ARD & DC Terms of Reference

PLAN OF DETAILED PREPARATORY PROJECT REPORT

No.	Contents of the work
1.	Introduction (including review of the existing documents and reports relating to setting up of the RDDC).
2.	Review of the state of Indian Aluminium Industry, assessment of the future trends of development of the industry.
3.	Long and short terms objectives of the RDDC. Draft tentative plans of RDDC works to be worked out by the Centre.
4.	Review of the existing research development and design facilities in aluminium field in the country (both in the public and private sectors).
5.	Scope and function of the Centre (including pilot plant installations). Composition and organisational structure. The main task of each section and division.
6.	Requirements for the location of the centre. Recommendation of a suitable site for the Centre location.
7.	Draft layout of the building.
8.	Equipment for all department and division (research design, pilot plants) installations - indigenous and imported separately.

No.	Contents of the work
9.	Staff of the centre (on the whole and of its each division).
10.	General layout plant of the Centre (with a township for the working personnel).
11.	Investment - Buildings, equipment, relevant infrastructure, township etc. - domestic and foreign currency separately. Financial plan for a period of five years.
12.	Priority of construction and implementation of works, setting up of operation, sections and divisions of the Centre (1st, 2nd and 3rd stages).
13.	Annual recurring cost of the Centre (According to priority - 1st, 2nd and 3rd stages).
14.	Training programmes (priority must be taken into consideration) Participation of International staff in training programmes - cost - domestic and foreign currency separately.
15.	Tentative detailed plan of construction and implementation. Works according to priority (per each year of the period).
16.	Recommend suitable method of charging for the services rendered to the clients.

ANNEXURE - V

to ARD & DC Terms
of Reference

THE GENERAL SCHEME (WORKING PLAN) FOR ELABORATING OF THE DETAILED PREPARATORY PROJECT REPORT AND PROJECT DOCUMENT

ACTIVITY	AUG 1982	SEPT 1982	OCT 1982	NOV 1982	DEC 1982	JAN 1983	FEB 1983	MAR 1983	APR 1983	MAY 1983	JUNE 1983	JULY 1983	AUG 1983
Elaborating of the Terms of Reference for Preparatory Project Report	—	—											
Work of Hungarian Team's members on Project area		—	—	—						—	—		
Carrying out of Progress Report			—	—	—	—							
Elaboration of suggestions for the Centre location to be submitted to the Government			—	—	—								
Preparation of Draft Final Report							—	—	—				
Work on the Project area by two UNIDO consultants									—	—			
Study tour of CTA, NPC and MECON team to Budapest (Hungary)								—					
Discussions of the Draft Final Report										—			
Submission of the Final Report to the Government											—		
Elaborating the Project document for full scale ARD&DC setting up and submission them to the Government							—	—	—	—	—	—	

ANNEXURE 2

RECORD NOTES OF DISCUSSIONS

Annexure 2

RECORD NOTES OF DISCUSSIONS BETWEEN ALUTERV-FKI, MECON, CTA (UNIDO) & NPC HELD AT DELHI ON 10TH & 11TH NOVEMBER '82 REGARDING SETTING UP OF ALUMINIUM RESEARCH, DEVELOPMENT & DESIGN CENTRE IN INDIA

P R E S E N T

Ministry of Steel & Mines

Mr. C.P.S. Nair, Adviser (S & T)

UNIDO

Dr. Nicolai N. Tikhonov, CTA

BALCO

Mr. I.M.Aga, CMD

Mr. C.Sharma, TS

Dr. B.C. Datta, NPC

ALUTERV-FKI

Mr. G.Toth - team leader of ALUTERV-FKI

Mrs. V.Sapsal

Mrs. M.Kacso

Dr. J.Zoldi

Mr. J.Lang

MECON

Dr. S.R.Pramanik, Director

Shri D.S.Sethi, Project Manager

Shri M.K.Mallik, Dy. Project Manager

Shri SN Chatterji, AEM

The progress of work with regard to the setting up of the Aluminium Research, Development and Design centre in India was discussed specially with regard to various places in India. It was noted that the foreign consultants M/s ALUTERV-FKI and the Indian Consultants, M/s MECON have started the work for the preparation of Project Report. Regarding the location of the Centre the recommendations from MECON will be furnished to the Government by 15th January, 1983 based on detailed study to be carried out of the following locations:

1. Bhubaneshwar
2. Vishakapatnam
3. Ranchi
4. Hyderabad
5. Bangalore &
6. Raipur.

Any further locations to be considered and to be included in the study will be indicated to the Indian consultants within the next two weeks.

Detailed discussions were held regarding the exchange of assignments between MECON and ALUTERV-FKI, further discussions to be held for the project and the schedule of furnishing the reports/notes to be prepared by MECON to ALUTERV-FKI. The detailed schedule in this respect was issued and is enclosed at Annexure 1,2, & 3.

CTA NPC ALUTERV-FKI MECON

ANNEXURE - 1

PREPARATORY PROJECT REPORT FOR ALUMINIUM
RESEARCH DEVELOPMENT AND DESIGN CENTRE

TIME SCHEDULE FOR EXCHANGE OF ASSIGNMENTS AND DATA/
INFORMATION BETWEEN MECON AND ALUTERV-FKI

Sl.No.	Assignments/Data	Action	Date
1.	Data required by ALUTERV-FKI as per questionnaire handed over to MECON	MECON	31.12.82
2.	Existing documents and Reports related to setting up of the Centre to MECON	MPC	20.11.82
3.	Record notes/details of discussions held by CTA and ALUTERV-FKI with different agencies in India during their visit in October/ November 82 to MECON	NPC/ ALUTERV-FKI	15-12.82
4.	Draft/block layout of the building for the Centre and different divisions to MECON	ALUTERV-FKI	15.2.83
5.	Equipment list with broad parameters for the Centre to MECON	ALUTERV-FKI	31.1.83
6.	Manpower technological requirement of the Centre for each division category-wise to MECON	ALUTERV-FKI	31.1.83

Sl.No.	Assignments/Data	Action	Date
7.	Requirement of services - water, power, compressed air, steam, air conditioning and other auxiliary facilities, etc. in various divisions/units to MECON	ALUTERV-FKI	31.1.83
8.	Suggested inter-relationship between various divisions to MECON	ALUTERV-FKI	15.1.83
9.	Volume of work for concrete, refractory, structurals, piping etc. for various divisions/units including auxiliary services to MECON	ALUTERV-FKI	15.1.83
10.	Volume of work for piping Requirement of special consumables on annual basis to MECON	ALUTERV-FKI	31.183
11.	Method of charging for the services as adopted in Research Institutions in Hungary and other countries to MECON	ALUTERV-FKI	25.2.83
12.	Other relevant data/information considered necessary for preparation of the report will be exchanged between MECON & ALUTERV-FKI	ALUTERV-FKI	

ANNEXURE - 2

DETAILED TIME SCHEDULE FOR DISCUSSIONS IN HUNGARY AND INDIA

Sl.No.	Activity	Place	Period
1.	Discussions between ALUTERV-FKI, MECON, NPC, and CTA for working out a time schedule and other technical aspects of the project at Delhi	INDIA	10.11.82 to 11.11.82
2.	Discussions between ALUTERV-FKI and MECON to finalise the various technical aspects of the preparatory project report including basic concept, general layout/ shop layout, selection of equipment (Indigeneous and Imported separately) auxiliary facilities, services requirements and consumables at various stages, implementation schedule etc.	HUNGARY	15.3.83 to 7.4.83
3.	Discussions between ALUTERV-FKI, MECON, CTA and NPC to finalise cost estimates (capital and operating) method of charging, financial analysis, etc.	HUNGARY	1.4.83 to 15.4.83

ANNEXURE - 3

DRAFT PLAN OF DETAILED PREPARATORY REPORT
(with the work distribution between Foreign and Indian Consultant Firms)

Sl.No.	Contents of the Work	Foreign	Indian	Date
1.	Introduction (including review of the existing documents and reports relating to setting up of the ARD&D Centre).	A	E	31.1.83
2.	Review of the state of Indian Aluminium Industry, assessment of the future trends of development of the Industry.	A	E	31.1.83
3.	Long and short terms objectives of the ARD&D Centre. Draft tentative plans of ARD&D Centre Works to be worked out by the Centre.	E	A	31.1.83
4.	Review of the existing research development and design facilities in aluminium field in the country (both in the public and private sectors).	A	E	31.1.83
5.	Scope and functions of the Centre (including pilot plant installations). Composition and organisational structure. The main task of each section and division.	E	A	

Sl.No.	Contents of the Work	Foreign	Indian	Date
6.	Requirements for the location of the centre. Recommendation of a suitable site for the Centre location.	A	E	31.1.83
7.	Draft layout of the building.	E	A	
8.	Equipment for all department and division (research, design, pilot plants) installations indigenous and imported separately.	E	A	
9.	Staff of the centre (on the whole and of its each division).	E	A	
10.	General layout plant of the Centre (with a township for the working personnel).	A	E	15.3.83
11.	Investment - Buildings, equipment, relevant infrastructure, township etc. - domestic and foreign currancy separately. Financial plan for a period of five years.	A	E	15.3.83
12.	Priority of construction and implementation of works, setting up of operation, sections and divisions of the Centre (1st, 2nd and 3rd stage).	E	A	

Sl.No.	Contents of the Work	Foreign	Indian	Date
13.	Annual recurring cost of the Centre (According to priority 1st, 2nd and 3rd stages.	A	E	15.4.83
14.	Training programmes (priority must be taken into consideration) Participation of International staff in training programme - cost - domestic and foreign currency separately.	E	A	
15.	Tentative detailed plan of construction and implementation. Works according to priority (per each year of the period).	A	E	15.4.83
16.	Recommend suitable method of charging for the services rendered to the clients.	A	E	1.4.83

Note: E - Execution
A - Assistance

ANNEXURE 3

THE SHORT-TERM RESEARCH AND DEVELOPMENT PROGRAMME OF THE RDDC

Annexure 3

THE SHORT-TERM RESEARCH AND DEVELOPMENT PROGRAMME OF THE RDDC

Research on Alumina Production

AS1. Petrological, mineralogical, chemical and morphological investigation of representative samples from different bauxite deposits.

AS2. Study of technological properties of the bauxites (grinding, digestion, red mud settling etc.) using representative bauxite samples from different deposits.

AS3. Determination of blendability of bauxite from the various deposits for optimal use without beneficiation.

AS4. Investigation of some technological problems of the existing alumina plants (causticization of red mud, foaming problems, red mud settling, recovery of vanadium salt etc.).

Research on Aluminium Electrolysis

BS1. Investigation and improvement of the aluminium electrolysis technology. Selection of the most effective parameters for smelter process in different types of cells.

BS2. Development and improvement of the carbon materials. Study of the influence of raw materials' quality and production technology on the quality of metal.

BS3. Research and development of automatic system for controlling technological process in smelters.

Analytical Research

CS1. Development of analytical methods and carrying out of all analyses necessary for technological developments.

Research on Semi-Products

DS1. Development and improvement of the processes for purification of molten metal (removal of hydrogen, oxides, other non-metallic inclusions, sodium, etc.).

DS2. Development and improvement of D.C. casting technology of ingots and billets.

DS3. Improvement of the heat treatment technologies.

DS4. Development and improvement of the hot and cold rolling technology.

DS5. Development and improvement of extrusion technology.

DS6. Development and improvement of the production technology for wire rod manufacturing.

DS7. Development of production technology for special (e.g. lithographic) sheets, sheets for deep drawing, semis for anodizing etc.).

DS8. Research and development of scrap recovery.

DS9. Research and development of automatic system for controlling technological operations in semi-products' fabrication.

Physical Metallurgy and Material Science

ES1. Improvement of existing mechanical and physical methods as required by the technological research departments.

ES2. Development of new aluminium alloys according to the requirements of the industry.

Finished Products Manufacturing Research

FS1. Determination of features and quality of semis needed for fabrication of finished products according to their functions. Development of uses of aluminium in various fields.

FS2. Furnishing of basic data for the selection of materials for finished goods.

FS3. Assistance at finished goods' manufacturers (testing facilities consultancy etc.).

FS4. Research and development of surface treatment methods.

FS5. Research and development of corrosion test methods.

FS6. Research and development of jointing methods.

Application Technique

GS1. Acquisition and systematization of the information relating to the utilization of aluminium.

GS2. Keeping a close watch on the activity of finished goods' producers using aluminium semis, making proposals for the development of their products and production technologies. Organization and co-ordination of the assistance of the Centre required for the development work.

Environment Protection

HS1. Development of the technology for gas, dust, water collection and cleaning in all branches of the aluminium industry.

HS2. Development of measuring of the efficiency of the environment control.

ANNEXURE 4

EQUIPMENT LIST OF THE CENTRE

PRELIMINARY EQUIPMENT LIST

Annexure 4

B1 Alumina Manufacturing Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Cut-off saw	1	LOGITECH LTD of Scotland Type: Cs-10		Cutting of ore samples for microscopic investigation
2.	Equipment for polishing mineral grains	1	BUEHLER LTD, USA Type: Techn.-met No. 48-1572 Polimet No. 47-1850 Low speed No. 44-1502 Automet No. 60-1900		Preparation of ore samples for microscopic investigations
3.	Polarising microscope	1	Opton Feintechnic GmbH GFR	M:1000x Inc.: photographic accessory	Petrographic investigations of bauxites and other minerals
4.	Roll crusher	1	Karl Marz Maschinen Fabr., GFR Type: Flex Roller mill	Feed size: max. 10 to 20 mm, output size: 0.2 to 0.3 mm, roller dia: 200 mm roller length: 160 mm, both rollers equipped with r.p.m. controller separately	Intermediate crushing of bauxite samples

PRELIMINARY EQUIPMENT LIST

Annexure 4

B1 Alumina Manufacturing Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
5.	Laboratory sample cutter with mixer	1	Retsch GmbH, GFR Type: PKZ + DR 40	Volume of collector: 30 lit., sample ratio: 1/10 to 1/200	Blending of bauxite samples and average sample preparation
6.	Air jet mill	1	ALPINE AG, GFR Type: AFG-200	Capacity: 2.5 to 200 kg/h, size of output material: 2 µm, inner air classifier and dust precipitator, air consumption: 100 to 200 m^3/h	Grinding of extremely hard materials (hard bauxites, corundum, special aluminas)
7.	Colloid mill	1	ALPINE AG, GFR Type: Contraplex Labormuhle 63-C	Capacity: 0.5 to 2.5 kg/h, min.grindable mass: 20 g size of output material: 5 to 65 µm, max feed size: 1.5 mm, controllable r.p.m. 0 to 34000	Preparation of bauxite and other solid material samples (excluding red mud)
8.	Laboratory autoclave	2	Triedrich Ude GmbH, GFR Type: PM-25	Useful volume: 5 lit., max.temp.: 350 °C, max.pressure: 25 MPascal	Bauxite digesting tests by high temperature hydrothermic process
9.	Laboratory autoclave	1	Dorr Instrument Co., USA Model 4552	Useful volume: 7.5 lit., max.temp.: 350 °C, built in sampling facilities	Bauxite digesting tests by high temperature hydrothermic process

A4-2

PRELIMINARY EQUIPMENT LIST

Annexure 4

B1 Alumina Manufacturing Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
10.	Laboratory equipment for digesting tests	2	Szondy I.Sz., Hungary Type: 3023.K.3.00	Oil bath with controllable electric heating, 6 bomb digesters of 200 cm^3 capacity each, temperature control upto 260 C	Bauxite digesting tests
11.	Equipment for predesilicating and causticizing tests	1	ALUTERV-FKI Hungary	Water or silicon oil bath with programmable heating, 6 pressure vessels of 1 lit capacity each	Predesilicating, red mud causticization, atmospheric bauxite digesting tests
12.	Laboratory centrifuge	3	BVG, Hungary Type: LU-418 HV	6 vessels of 1 lit capacity each, index No: 2000 g, heating upto 80 ^oC	Separation of red mud and other slurries
13.	Small size evaporator	1	Anhydro A/S Denmark Type: Compact Fallstorm - Eindampfer	Capacity: 25 to 40 kg/h, water evaporation, falling film type	Evaporation of sodium aluminate solutions
14.	Air jet sieve	1	ALPINE AG, GFR Type: A-200 LS	Normal and micro set of sieves	Investigation of grain size distribution of various powdered samples

PRELIMINARY EQUIPMENT LIST

Annexure 4

B1 Alumina Manufacturing Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
15.	Wet screen set	1	Fritsh GmbH, GFR Type: Analysette +3 injection ring	Normal sieve set 20 µm to 25 mm, micro sieve set 5 to 100 µm, normal sieve dia: 200 mm, micro sieve dia: 75 or 110 mm	Investigation of grain-size distribution of slurries and suspensions. Separation of various sizes of grains from slurries
16.	Derivatograph with gastitrimeter	1	MOM, Hungary Type: Q-1500D	Heating range of furnace: upto 1500 °C, heating speed: 5 to 20 °C/min., automatic heating programme, gastitrimeter accessory	Thermogravimetric investigations
17.	Analytical balance	1	Sartorius GmbH, GFR Type: 2004 MP-6	Electronic balance with automatic taring, accuracy: ± 0.05 mg	
18.	Angle of repose instrument	1	ALUTERV-FKI, Hungary		Tests of alumina flow properties
19.	γ-ray absorption model settler	1	ALUTERV-FKI, Hungary Special	Computer controlled equipment for evaluation of settling properties	Settling tests of red mud and other slurries

Annexure 4

PRELIMINARY EQUIPMENT LIST

B1 Alumina Manufacturing Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
20.	Reoviscosimeter	1	Seibold Messgerate Fabric, Austria Type: Rheomet-115	Automatic measurements controlled by micro-computer, in built thermostat with a measuring range from -40 to +100 °C	Determination of viscosity of red mud slurry and different liquids
21.	Oscirhometer	1	ALUTERV-FKI, Hungary Type: OK-105/1	Speical	Conductivity measurements
22.	Thermometric titrator	2	ALUTERV-FKI, Hungary Type: Thermatic	Quick analyzer equipment, operating with end point signal method, connected to automatic burette, desk calculator, printer and recorder	Quick analysis of sodium aluminate solutions
23.	Vibrating cup mill	1	FRITSCH GmbH, GFR Type: Pulverisette 9	Volumes of grinding ponts: 50, 100, 250 mlit, material of grinding pots: wear resistant steel, agate, tungsten carbide, ground particles size: 20 µm	Grinding of extremely hard materials samples

PRELIMINARY EQUIPMENT LIST Annexure 4

B1 Alumina Manufacturing Research Department

FIRST STAGE LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Jaw crusher	1	Capacity: max. 200 to 300 kg/h, feed size 125x100 mm, output size: 10 to 30 mm	Precrushing of bauxite samples
2.	Vibrating screen	1	Screen area: approx. 0.5 m^2, min. screen hole: 20 μm	Classifying of different crushed samples
3.	Laboratory ball mill for Bond index determination	1	Grinding vessels volume: 1 to 20 lit, grinding vessels material: porcelain and steel	Dry and wet grinding, determination of Bond index
4.	Air classifier	1	Capacity: 150 to 200 kg/hr, classifying range, 30 to 200 μm	Ore beneficiation by selective grinding and classification. Classification of dusts with particles below 200 μm
5.	Universal mill	1	Sample mass: 2 to 20 g, volume of grinding pot: 250 mlit, material of grinding pot: stainless steel	Preparation of red mud samples
6.	Vibrating screen	1	Screen diam. 200 mm Set of sieves: 45 μm to 5 mm	Checking of sample preparation for Bond index tests and particle size distribution tests
7.	Universal sample splitter	1	Applicable for sample masses from 50 g to 25 kg	Average sample preparation

PRELIMINARY EQUIPMENT LIST

Annexure 4

B1 Alumina Manufacturing Research Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
8.	Drying oven	3	Heating range upto 200 °C Size: approx. 0.6x0.6x1.5 m	Drying of bauxite and red mud samples
9.	Drying oven	1	Heating range upto 300 °C	General purposes
10.	Ignition furnace	1	Heating range 1300 to 1400 °C	General purposes
11.	Laboratory press filter	3	Filter area: 100 cm^2	Filterability tests
12.	pH-meter	1		
13.	Combinating thermostat	3	Temperature 0 to 100 °C	
14.	Water distiller	2	Capacity: 25 to 30 lit/h each	
15.	Physical balances	1 3 3 3	Capacity: 100 kg Capacity: 5 kg Capacity: 3 kg (accuracy ± 0.01 g) Capacity: 500 g (accuracy ± 0.001 g)	
16.	Laboratory press filter	1	Filter area: 155 cm^2, volume: 5.5 lit, suitable for both pressure and vacuum filtration	Quick filtration of various products of flotation
17.	Electric heating plates	5	Double hot plates	
18.	Laboratory stirrers	10 10	Mechanical stirrer Magnetic stirrer	
19.	Ultrasonic bath	1		Cleaning of sieves and ultrasonic dispersion of samples

PRELIMINARY EQUIPMENT LIST

Annexure 4

B1 Alumina Manufacturing Research Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Universal impact mill	1	ALPINE AG, GFR Type: 160-UPZ	Capacity: 30 to 150 kg/h, min.grindable mass: 100 g, size of output material: 5 to 1500 µm, rotor dia: 160 mm, r.p.m.: 0 to 14300, power: 5.5 kW, changeable screen and grinding accessories, automatic dust precipitator	Selective grinding and classifying tests
2.	Air classifier	1	ALPINE AG, GFR Type: Turboplex Windsichter ATP-80	Capacity: 10 to 15 kg/h, classifying range: 1 to 30 µm	Ore beneficiation by selective grinding and classification. Classification of dusts with very fine particles
3.	Wet magnetic separator	1	BOX MAG RAPID, GB Type: LHW Laboratory magnetic separator	Field strength: 2.4 Tesla, charging mass: 200 g, input grain-size: 3 µm to 3 mm	Wet separation of para and diamagnetic materials having fine grain-size distribution
4.	Disc magnetic separator	1	BOX MAG RAPID, GB Type: LOG-14, DM Separator	Capacity: 20 to 50 kg/h, continuous operation	Separation of para- and diamagnetic materials having a grain-size distribution from 60 µm to 10 mm

PRELIMINARY EQUIPMENT LIST

Annexure 4

B1 Alumina Manufacturing Research Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
5.	Air table	1	SEPOR INC, USA Type: AC 34" ix29" H No. 40010		Dry fluidised separation by specific gravity
6.	Specific surface area analyser	1	Micromeritics Instrument Corp., USA Type: Digisorb-2500	Measuring range: above 0.001 m^2/g, automatic measurement and evaluation in connection with computer	Determination of specific surfaces. Plotting of adsorption and desorption isotherms
7.	Pore sizer	1	Micromeritics Instruments Corp., USA Type: Autopore-9200	Measuring range: 3.1 to 600000 μm, fully automatic, connected to the computer	Determination of pore volume, pore distribution, porosity, etc. (special aluminas, red mud etc.)
8.	Laboratory precipitator	1	ALUTERV-FKI, Hungary Special	Water bath with automatic temperature programme controller, 12 closed steel vessels of 1 lit capacity each, speed controlled stirrer from 50 to 600 r.p.m.	Alumina hydrate precipitating tests

PRELIMINARY EQUIPMENT LIST Annexure 4

B1 Alumina Manufacturing Research Department

SECOND STAGE LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
9.	Instrument for grain-size distrubiton analysis	1	Pacific Scientific HIAC Instrument Division, USA Type: Hiac Pa-720	Biggest cross section measurement on the basis of light absorption, automatic data processing, test results printed in table and plotted, measuring range: 1 to 900 μm	Determination of grain-size distribution of alumina hydrate, alumina, special aluminas
10.	Helium pycnometer	1	Micromeritics Instrument Corp., USA Type: Autopycnometer 1320	Accuracy: $\pm$ 0.02 cm^3	Density measurement

PRELIMINARY EQUIPMENT LIST

Annexure 4

B1 Alumina Manufacturing Research Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Laboratory hydrocyclone	1	Cyclones dia: 20 to 200 mm, including feed pump and feed tank with a volume of 100 lit	Wet separation of ores (e.g. separation of clay minerals from bauxites)
2.	Laboratory drum filter	1	Filter area: 0.25 m^2, including scraper and roller cake removal, sprinkling, accessories	Filterability tests of red mud, alumina hydrate and other materials
3.	Laboratory pan filter	1	Filter area: 0.25 m^2	Filterability tests
4.	Combining thermostat	3	Temperature: 0-100 ^{o}C	General use

Annexure 4

PRELIMINARY EQUIPMENT LIST FOR
COMPLETION OF KORBA ALUMINA PILOT PLANT
ENABLING IT TO MODEL THE QUASI-WHOLE BAYER-CYCLE

SECOND STAGE LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data
1.	Red mud filter	1	Vacuum drum filter, A = 5–7 m^2
2.	Filtrate tank	1	V = 15 m^3, covered, flat bottom
3.	Filtrate pump	1	Q = 8–10 m^3/h
4.	Red mud slurrying tank	1	V = 15 m^3, flat bottom, mech. agitation
5.	Red mud slurry pump	1	Q = 8–10 m^3/h
6.	Aluminate liquor filter	1	Press filter e.g. type: Funda; A = 1–2 m^2
7.	Aluminate liquor cooling tank	1	V = 25 m^3, flat bottom, side agitation, with cooling possibility
8.	Cold aluminate liquor	1	Q = 8–10 m^3/h
9.	Precipitators	10	V = 25 m^3, flat bottom, covered, mech. agitation
10.	Precipitated slurry pump	2	Q = 8–10 m^3/h
11.	Floor waste liquor tank	2	V = 6.3 m^3
12.	Floor waste liquor pump	2	Q = 8–10 m^3/h
13.	Fine seed slurry tank	1	V = 15 m^3, covered, mech. agitation
14.	Fine seed slurry pump	1	Q = 8–10 m^3/h
15.	Coarse seed slurry tank	1	V = 15 m^3, covered, mech. agitation
16.	Coarse seed slurry pump	1	Q = 8–10 m^3/h
17.	Hydroseparator feed tank	1	V = 25 m^3

Annexure 4

PRELIMINARY EQUIPMENT LIST FOR
COMPLETION OF KORBA ALUMINA PILOT PLANT
ENABLING IT TO MODEL THE QUASI-SHOLE BAYER-CYCLE

SECOND STAGE LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data
18.	Hydroseparator feed pump	1	$Q = 8-10\ m^3/h$
19.	Primary thickener	1	$A = 0.5-1\ m^2$, cone 60^o
20.	Primary thickener underflow tank	1	$V = 6.3\ m^3$
21.	Primary thickener underflow pump	1	$Q = 8-10\ m^3/h$
22.	Secondary thickener	1	$A = 2-3\ m^2$, cone 60^o
23.	Secondary thickener underflow tank	1	$V = 6.3\ m^3$
24.	Secondary thickener underflow pump	1	$Q = 8-10\ m^3/h$
25.	Secondary thickener overflow tank	1	$V = 15\ m^3$
26.	Secondary thickener overflow pump	1	$Q = 8-10\ m^3/h$
27.	Product hydrate filter	1	Vacuum pan filter; $A = 1-2\ m^2$
28.	Filtrate tank	1	$V = 6.3\ m^3$
29.	Filtrate pump	1	$Q = 8-10\ m^3/h$
30.	Product hydrate slurrying tank	1	$V = 6.3\ m^3$
31.	Product hydrate slurrying pump	1	$Q = 8-10\ m^3/h$
32.	Wash water tank	1	$V = 6.3\ m^3$
33.	Wash water pump	1	$V = 8-10\ m^3/h$
34.	Fine seed hydrate filter	1	Press filter, Type Funda; $A = 1-1.5\ m^2$

Annexure 4

PRELIMINARY EQUIPMENT LIST FOR
COMPLETION OF KORBA ALUMINA PILOT PLANT
ENABLING IT TO MODEL THE QUASI-SHOLE BAYER-CYCLE

SECOND STAGE — LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data
35.	Filtrate pump	1	$Q = 8\text{-}10\ m^3/h$
36.	Seed slurry pump	1	$Q = 8\text{-}1P\ m^3/h$
37.	Evaporator set	1	Por evaporation under both vacuum and pressure conditions. Capacity: about 5 t evaporated water/h
38.	Strong liquor tank	2	$V = 15\ m^3$, with cooling and heating possibility
39.	Strong liquor pump	2	$Q = 8\text{-}10\ m^3/h$
40.	Vacuum pump	1	$Q = 500\ m^3/h$
41.	Clear condensate tank	1	$V = 3\ m^3$, $p = 4\text{-}5$ bar
42.	Clear condensate pump	1	$Q = 8\text{-}10\ m^3/h$
43.	Alk. condensate tank	1	$V = 6.3\ m^3$
44.	Cooling water tank	1	$V = 6.3\ m^3$
45.	Cooling water pump	1	$V = 8\text{-}10\ m^3/h$
46.	Salt filter	1	Vacuum drum filter; $A = 0.5\text{-}1\ m^2$
47.	Filtrate tank	1	$V = 6.3\ m^3$
48.	Filtrate pump	1	$Q = 8\text{-}10\ m^3/h$

Annexure 4

PRELIMINARY EQUIPMENT LIST

B1 Alumina Manufacturing Research Department

THIRD STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Separator (Dyna-Wirpol)	1	SALA, Sweden Type: Dyna-Wirpol	Dia: from 100 to 250 mm	Separation of heary suspensions by means of specific gravity
2.	Laboratory disc mill	1	FRIMA, GFR Type: MC-90 Combimuhle	Disc dia: 90 mm, disc types: corundum, gear, holed, min.grain-size: 5 µm, including feed pump	Disaggregation of materials by gear discs. Fine grinding of hard materials by corundum discs
3.	Model filter	1	ALUTERV-FKI, Hungary Special	Filter area: 100 cm^2	Model filter for filterability tests
4.	Laboratory air precipitator	2	ALUTERV-FKI, Hungary Special	Programming temperature control, air agitated tank, volume: 20 lit	Alumina hydrate precipitating tests
5.	Zeta potential analyser	1	Micromeritics Instrument Corp., USA Modul 1202	Combined zeta potential and conductivity analyser	Investigation of interfacial effects of solutions and solid particles
6.	Laboratory flotating equipment	1	Denver, USA Model D-12	Feeding mass: 250 to 2000 g, volume of pots: 1 to 8 lit	Flotation of ores with particle sizes of 5 to 500 µm

PRELIMINARY EQUIPMENT LIST

Annexure 4

A1 Alumina Manufacturing Research Department

THIRD STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
7.	Laboratory flotating equipment	1	Wemco-Fragergran Type: WemcoLab Fag 1+1	Cell Volume: 4 lit	Flotation of various materials with particle sizes of less than 5 μm
8.	Pneumatic micro flotating tank	1	ALUTERV-FKI, Hungary Special	Cell Volume: 150 cm^2	Investigation of small amounts of fine grain samples
9.	Phertometer	1	Carl Mahr Essligen, GFR	Accuracy: 0.2 to 0.9 μm	Testing of special aluminas produced for grinding and plishing
10.	Humidity meter	1	General		
11.	Compaction meter	1	Paul Weber, GFR Type: PWA 40E	Measuring range upto 500 kg/cm^2	Testing of special aluminas produced for ceramics
12.	Whiteness tester	1	Dr.Lange GmbH, Switzerland Type: LF-90	Measuring range: 400 to 700 μm	Testing of special aluminas

PRELIMINARY EQUIPMENT LIST — Annexure 4

B1 Alumina Manufacturing Research Department

THIRD STAGE — LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Magnetic drum separator	1	Field strength: 0.2 Tesla, drum dia: 200 mm, drum length: 200 mm	Regeneration of suspensions
2.	Wiefley type concentrating table	1	Table size: 1270x610 mm, capacity: 25 to 75 kg/h, glass fibre table plate with varying ribs in length	Separation of fine and coarse grain ores by specific gravity
3.	Decanter centrifuge	1	Capacity: 50 to 150 l/h, rotor dia: 150 mm, r.p.m. 6000	Dewatering of very fine grains slurries
4.	Spray dryer for laboratories	1		Drying of alumina hydrates and special aluminas
5.	Gas flow meter	1	Measuring cap.: 20 to 250 m^3/h air	Investigation of dinamic sorption of special aluminas
6.	Ignition furnace	1	Max. temp.: 1700 °C, size: approx. 0.45x0.3x0.3 m	Production of special aluminas and various investigations
7.	Ignition furnace	1	Max. temp.: 1300 to 1400 °C, inner size: 140x120x310 mm	Special aluminas
8.	Combining thermostat	4	Temperature: 0-250 °C	General use

PRELIMINARY EQUIPMENT LIST

Annexure 4

B2 Aluminium Electrolysis Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Automatic universal data acquisition and analysing system	1	Hewlett-Packard, USA Type: 3054 A/9845 T	Multichannel A/D inputs, attachments, software	Precision measuring system
2.	Real-time signal analyser	1	Intertechnique, France Type: IN-110	64KBytes memory (expandable upto 160KBytes), testing range DC-100 kHz, 256 channels, IEE 488 interface	
3.	Heavy-duty measurement and control system	1	Analog Devices USA Type: MACSYM-2	128KBytes memory, extended BASIC, anal/digit in- and outputs, for industrial duty	
4.	Temperature measuring system	1	GFR Type: Therm 5200	50 measuring spots, inbuilt compensation and linearity control	
5.	Cassette data recorder (analog)	1	TEAC, Japan Type: R-81	7 channels, compact cassette system, portable, 4 speeds, 0 to 5 kHz	
6.	Cassette data recorder	1	TEAC, Japan Type: ZR-30/50	Video cassette, 7 and 14 channels input	
7.	Tape data recorder (anal/digit)	1	GFR Type: EUROMAG-i	Long term, 4 channels data storage in analog and digital system	

PRELIMINARY EQUIPMENT LIST

Annexure 4

B2 Aluminium Electrolysis Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
8.	Multichannel oscilloscope industrial application	1	Hewlett-Packard, USA Type: 1200B	Max.range 50 kHz, digital data storage, min. 2 beams	
9.	Multichannel digitalstorage, mainframe oscilloscope	1	Hewlett-Packard, USA Type: 1800 Series	Split up system (vertical and horizontal deflection, timer etc.)	
10.	Oscilloscope measurement system	1	Hewlett Packard, USA Type: 1980 A/B	Digital storage, extendable measuring capacity, HP-IB compatibility	
11.	Fast recorder (for high frequency signals)	1	Gould Biomation 805, USA	Range: 100 mV to 50 V, DC-1.25 MHz Storage: 8 bitsx 2048 words	
12.	Plotter	2	Hewlett-Packard, USA Type: 7220 C/T 7225 /B	Multicolour pen plotter, universal output, HP-IB compatibility	
13.	Thermoelement with shield	10	GANZ, Hungary Type: THN, THF, TN, THP		
14.	Digital programming power supplier	1	Hewlett-Packard, USA Type: 6024 A	Programming current and voltage setting, cap.: 200 W, HP-IB compatibility	
15.	Programming signal source	1	Hewlett-Packard, USA Type: 8165 A	Range upto 50 MHz	Impulse and function generating

PRELIMINARY EQUIPMENT LIST

Annexure 4

B2 Aluminium Electrolysis Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quan-tity	Likely source and type	Technical data	Function
16.	Specific resistance meter	1	Carbontest, Hungary	Measuring range: 1 to 100 µOhm meter	Specific resistance measurement of the carbon materials of anodes and cathodes
17.	Electrolyte temperature meter	1	Ajka system, Hungary	Measuring upto 900-1000 °C	
18.	Data acquisition system	1	Solartron, GB	Microprocessor controled system, 16-31-48 channels, extendable to 64 channels	
19.	Heat flux meter	1	BME-ALUTERV-FKI, Hungary		Measuring of the surface heat current of the cells
20.	Thermal conductivity meter	1	Sumitomo, Japan		
21.	Memory oscilloscope	1	Hewlett-Packard, USA Type: 1980 A/B 1981 A plot ROM	Incl.: plotter	Measuring of high speed electro-chemical transients
22.	Impulse generator	1	Hewlett-Packard, USA Type: 3312 A	Output Voltage: 0 to 5 V, output impedance: 50 Ohm, 0.01 Hz - 10 kHz	

PRELIMINARY EQUIPMENT LIST

Annexure 4

B2 Aluminium Electrolysis Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
23.	Impedance meter	1	Hewlett-Packard, USA	Controllable measuring frequency: 5 Hz - 13 MHz Standard HP-IB	Main phases measurements, amplitude
24.	Potentiostat	2	TACUSSEL 5/25 A	Current: (1) O $\pm$ 5A (2) O $\pm$ 25A Ref. voltage (1) O $\pm$ 5V (2) O $\pm$ 10V	
25.	Viscometer	1	Norwegian Techn. Institute	Temperature upto 1200 ^{o}C	
26.	Computer	1	Hewlett-Packard, USA Type: 9845 T/S		
27.	Density measuring equipment	1	ALUTERV-FKI, Hungary	Radioactive isotopic measurement upto 1000 ^{o}C temperature	Measuring of molten cryolite and alumina density
28.	Vibrating mill	1	Retsch VM 1, GFR	Feed grain-size max. 6 mm, useful volume 12 cm^3	
29.	Sample drilling machine	1	Alumina, Switzerland Type: 80-71 HL		Preparation of anode samples for laboratory tests

PRELIMINARY EQUIPMENT LIST

Annexure 4

B2 Aluminium Electrolysis Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
30.	Density measuring device	1	Beckmann piknometer, GFR Type: 93o	Volume of sample pot: approx. 50 cm^3, accuracy: 0.1 cm^3	Density measurement of coke, pitch and burnt material samples
31.	Powder (grain) resistance meter	1	Alusuisse, Switzerland Type: 83-71HL	Complex instrument	Testing of samples
32.	Anode reactivity (Scalliet)	1	Heraeus, GFR Type: ROJ/R 10/60 ALUTERV-FKI, Hungary		Behaviour of samples against CO_2
33.	Viscosity measuring device	1	Visco-Tauchaggregat TD, Switzerland or Contraves, Austria Type: MS-RT-B/D		Measurement of viscosity of binding materials
34.	Binding material blower	1	ALUTERV-FKI, Hungary Special	Closed vessel with inlet and outlet nozzles connected to a closed cooling system. Volume: approx. 50 lit, capacity: approx. 20 kg/8 h of material at a temperature of max. 350 °C	

PRELIMINARY EQUIPMENT LIST Annexure 4

B2 Aluminium Electrolysis Research Department

FIRST STAGE LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
35.	Heat treating equipment	1	ALUTERV-FKI, Hungary Special	Inner volume: approx. 10 lit, electric heating: approx. 3 kW, inner height: approx. 500 mm	Heat treating with additives
36.	Ramming tester	1	ALUTERV-FKI, Hungary Special		Compacting tests of paste materials (after having heated upto 200 °C in a drying oven) by means of predetermined number and weight of beats
37.	Sample polisher	1	ALUTERV-FKI, Hungary Special	Horizontal polishing disc with a dia of 300 mm, r.p.m. of disc: 120, changeable polishing heads, rinsing possibility with various liquids	
38.	Rappaport equipment	1	ALUTERV-FKI, Hungary Special	Inner volume: 300x500x300 mm, heating range upto 1100 °C Inner silite heating. Equipped with temperature controller and exhauster	Measurement of the expansion of cathode carbons during elecrolysis

PRELIMINARY EQUIPMENT LIST Annexure 4

B2 Aluminium Electrolysis Research Department

FIRST STAGE LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
39.	Anode consumption determining equipment	1	ALCAN system, Canada		Determination of weight loss of anodes during electrolysis in the molten cryolite-alumina electrolyte
40.	Evolved gas analyser	1	Hartmann-Braun GRF		
41.	Ultrasonic resonance meter	1	GFR		
42.	Single channel recorder	3	Philips, Holland		
43.	Multichannel recorder (4-6 channels)	1	Philips, Holland	Synchronized plotter, HP-IB compatibility	
44.	Low frequency signal source	1	Philips, Holland	Range: 0.01 Hz to 10 Hz	Generating of multiple curves of functions
45.	R-L-C sets and standards	15	Philips, Holland		For calibrations general purposes
46.	X-Y recorder	1	Philips, Holland		
47.	Vertical hydraulic press	1	ALUTERV-FKI, Hungary	Manually operated, load: 10 t, lifting height: approx. 100 mm, capacity: 10 pcs/h	Hot paste samples preparation with about 200 kg/cm^2 pressure

PRELIMINARY EQUIPMENT LIST

Annexure 4

B2 Aluminium Electrolysis Research Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Temperature measuring instrument	5	With wide range temperature measuring device, adequate for laboratory and industrial measurements	
2.	Resistance thermometer	10		
3.	Volt-and ampermeter (anal/digit)	15	Wide measuring range	Laboratory, industrial and service purposes
4.	Thompson-wheatstone bridge	1		General purposes
5.	Universal measuring bridge	1	HP-IB compatibility	For precision, automatic, complex impedance measurements
6.	Simple power supplier	1	Single and multi output with a range of 25 to 200 W	
7.	Thermostat	2		For calibrations, general purposes
8.	Contact thermometer	1	Measuring range: 0 to 500 °C	Temperature measurement on cell surface
9.	Voltmeter (digital)	1	Max. input: 30 V High internal resistance	
10.	Power supply unit	1	Voltage: 0 to 20 V, current 0 to 45 A	
11.	Electric furnace	5	Temperature: 1200 to 1300 °C, size: 150 mm dia x 400 mm temperature accuracy: ± 1 °C	

PRELIMINARY EQUIPMENT LIST

Annexure 4

B2 Aluminium Electrolysis Research Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
12.	Jaw crusher	1	Feed grain-size max. 65 mm, output grain-size: variable from 1 to 12 mm	
13.	Mortar mill	1	Useful volume: 150 ml	
14.	Sampler	1	Capacity: 50 kg/h in case of a follow speed of 1 m/s, at a material with 1 t/m^3 density	
15.	Coke grinder	1	Capacity: 100 kg/h, feed grain size: 5 mm (coarse grinding of cokes), grinding discs: manganese steel, electric driving	
16.	Coarse screen with vibrating equipment	1	Wooden framed screen, screen surface: approx. 0.3x0.3 m, set of screen plates with screen hole dia: 1; 3.2; 6; 10; 20 mm; capacity: 10 kg/h	
17.	Paste mixer	1	Steel vessel with a volume of approx. 10 lit., inner electric heating, stirrer. Heating upto 180 °C, capacity: 15 kg/h	Heating and mixing of the pastes
18.	Coke oven	1	Useful volume: approx. 50 lit, heating upto 600 °C, capacity: approx. 30 kg/8 hours, gas heated incl., closed distiller and cooler system	Precoking of derivatives of carbons and mineral oils having softening point of about 200 °C
19.	Stanko extensometer with drying oven	1	Chuts with 3 measuring spots, 3 samples producing rammer	

Annexure 4

PRELIMINARY EQUIPMENT LIST

B2 Aluminium Electrolysis Research Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
20.	Lathe (horizontal)	1	Capacity: 2 pcs/h, max. dia: 80 mm, max. length: 300 mm	Forming and cutting of carbon samples
21.	Ignition furnace	1	Inner volume: 180x200x200 mm, heating upto 1100 ^{o}C, equipped with temperature programme controller, inner silite heating	
22.	Ring and ball apparatus for pitch binder	1		
23.	Air permeability meter	1		
24.	Grain-size distributor	1		
25.	Compression strength meter	1		
26.	Hardgrove tester	1	As per ASTM D409	Determination of grind-ability of cokes
27.	Mercury volume meter	1		

PRELIMINARY EQUIPMENT LIST Annexure 4

B2 Aluminium Electrolysis Research Department

SECOND STAGE LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	AGA thermovision Infrared system	1	Sweden Type: AGA Thermovision 782 S/W	Temp. range: 1200 to 1600 °C, different angle lenses, video cassette, colour screen monitor, software	
2.	Device for high temperature range (pyrometer)	2	U-PIR, GFR, 0-2000 °C	Adequate for laboratory and industrial measurements	
3.	Infrared telethermometer	1	AGA Thermopoint 110, Sweden	Measuring range: 500 to 1000 °C	Quick measurements at sites
4.	Contact resistance meter	1	Ajka system, Hungary	Measuring range: 0 to 10000 µOhm	Measuring of transmission resistance of busbar connections
5.	Metal and electrolyte level meter	1	ALUTERV-FKI, Hungary		Measuring of the level of molten metal and electrolyte in the cells
6.	Universal cell control equipment	1	ALUTERV-FKI, Hungary	With anal/digit output	Measuring of cell voltage, cell line current, potential drop, cell resistance, monitoring of effects and anode movement

PRELIMINARY EQUIPMENT LIST

Annexure 4

B2 Aluminium Electrolysis Research Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
7.	Potential separator equipment	1	ALUTERV-FKI, Hungary		Separating the investigated cell voltage from the line potential, monitoring the cell resistance
8.	Equipment for indicating errors of anode bottom	1	ALUTERV-FKI, Hungary		Indicating of unevennes of anode surface
9.	Alumina concentration meter	1	Aluminatest, Hungary	Measuring range: 0 to 10 %	Determining the alumina content of electrolyte
10.	Fluor contents meter	1	Flucheck, Hungary		Determining the fluor gases
11.	Data acquisition system	1	MINIDATA, Hungary	100 channels, high voltage measuring spot change over switch, integrating time: 0.1; 1.0; 10 sec, measuring range: 0 to 10 mV 0 to 100 V	
12.	Infrared thermometer	1	AGA Thermopoint 80, Sweden	Portable instrument with telescope accessory	
13.	Dust analysis system with velometer	1	Strohlein, GFR		

PRELIMINARY EQUIPMENT LIST

Annexure 4

B2 Aluminium Electrolysis Research Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Small car	1	Mini-bus	Transportation of thermovision equipment
2.	Magnetic field-induction meter	1	Measuring range: 0 to 100 mT	Measuring of the components of magnetic field-induction in the electrolysing cell and its surrounding area
3.	Current distribution meter	1	Measuring range: 0 to 10 kA	Inductive measurement of the current in the feed lines of anodes and cathodes
4.	Air flowmeter	1	Measuring range: 0.3 to 40 m/s; digital output	Environment control, for gases
5.	Measuring container	1	Portable measuring container	Experimental measurements at sites

PRELIMINARY EQUIPMENT LIST

Annexure 4

B2 Aluminium Electrolysis Research Department

THIRD STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Small size aluminium reduction cell	1	Cap.: 10 kA	Cell for research purposes with prebaked anode

PRELIMINARY EQUIPMENT LIST

Annexure 4

B3 Analytical Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Sequence fusion apparatus	2	ALUTERV-FKI, Hungary Special	Temperature range: 300 to 1500 °C, heating up time 1 to 30 min.	Automatic digestion of 6 or 7 samples by fusion
2.	Analytical balances	6	Sartorius GmbH, Switzerland Type: 1602 MP6	Max. load: 160 g, sensitivity: 0.05 mg	General scaling
3.	Spectrophotometer	1	Pye Unicam Ltd, GB Type: SP 6-500	Single beam, optical grating system,digital output, automatic sample replacement	Spectrophotometric detecting (demodulation)
4.	Thermometric analyser	1	ALUTERV-FKI, Hungary	Range of reaction heat: 0.2 to 25 kJ/mol, duration of titration: 3 to 5 min.	Aluminate liquor analysis
5.	Atomic absorption spectrophotometer	1	Pye Unicam Ltd, GB Type: SP-9	AAS of flame and furnace	AAS analysis of main components of bauxite, red mud, etc.
6.	C and S analyser (automatic)	1	Leco Co., USA		Elementary analysis
7.	Standard high stability X-ray generator with 2 tubes operated simultaneously	1	Philips PW 1730 generator PW 1735 extension	V = 60 kV V = 65 mA	Stabilized high voltage supply for the instruments of X-ray diffraction laboratory (other suppliers: Siemens, Seifert)

PRELIMINARY EQUIPMENT LIST

Annexure 4

B3 Analytical Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
8.	Computer controlled powder diffractometer system with pot flux analyser	1	Philips PW 1700		Quantitative and qualitative phase analysis of powder mixtures having large amounts of crystals
9.	Closed circuit water cooling system	1	General	Cap.: 24 LPM	Supplying cooled water in closed circuit (4 pcs Zephyr 0002 ZEM 3.3, cap.: 6 LPM each or other solutions like Opton, Ital structures)
10.	Stereo microscope	1	Polaron M 119		For non powder sample preparation
11.	Stereo viewer	1	Polaron M 560		For non powder sample preparation
12.	Automatic sequential X-ray spectrometer with generator	1	Philips PW 1400 with PW 1730		Sophisticated equipment for elementar analysis of bauxite, red mud, etc.
13.	Semi automatic high frequency induction melting machine	1	Philips PV 8910		Samples preparation (melting, casting into moulds) for fluorescence spectrophotometric tests

Annexure 4

PRELIMINARY EQUIPMENT LIST

B3 Analytical Research Department

LIKELY FOREIGN SUPPLY

FIRST STAGE

Item	Designation	Quantity	Likely source and type	Technical data	Function
14.	Hydraulic press	1	Herzog HTP 40		Samples preparation for fluorescence tests
15.	Digital analytical balance	2	METTLER CAHN		Weighing of fluorescence and diffractometric samples and of references
16.	Sample press	1	Philips HTP 40		Preparation of powder samples

Annexure 4

PRELIMINARY EQUIPMENT LIST

B3 Analytical Research Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Drying oven	2	Temperature upto 300 °C volume: cca. 300 lit.	Drying of different samples
2.	Electric ignition furnace	2	Temperature upto 1200 °C	Ignition of different samples
3.	Water distiller	1	Cap.: 30 lit per hour	Distilled water production
4.	Universal instrument lathe	1		Preparation of metal samples
5.	Precision balance	2	Max. load: 1000 g sensitivity: 0.01 g	General scaling
6.	Precision pH meter	2		Potentiometric measurements
7.	Universal instrumental lathe	1		Preparation of non-powder samples
8.	Pedestal drilling machine	1		Preparation of non-powder samples
9.	Small file bench	1		Preparation of non-powder samples
10.	Drying oven	2		Samples preparation for fluorescence tests
11.	Milling machine	2		Preparation of powder samples
12.	Set of sieves	1		Preparation of powder samples

PRELIMINARY EQUIPMENT LIST

Annexure 4

B3 Analytical Research Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Ion analyser	1	Radelkis, Hungary Special		Potentiometric, ion selective electrode terminal measurements
2.	Polarographic analyser	1	EGG Princeton Applied Research Co., USA Model 384-4	Fully automatic	Electro analytical, surface activity (e.g. Zn) measurements
3.	Infrared spectrometer	1	Pye Unicam Ltd, GB TypeL SP 1000	Double beam 3800-625 optics IR 50 infradetector	
4.	Emission spectrometer	1	Philips, Holland Aluminium Programme		Emission spectro-photometric analysis

PRELIMINARY EQUIPMENT LIST

Annexure 4

B3 Analytical Research Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Water distiller	1	Cap.: 1.5 lit per hour	Double distilled water production
2.	Potentiostat	1		Electrolyses, electro gravimetric analysis
3.	Conductivity meter	1		Conductivity measurements

PRELIMINARY EQUIPMENT LIST

Annexure 4

B3 Analytical Research Department

THIRD STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	HP liquid chromatograph	1	Pye Unicam Ltd, GB Type: LC-3		
2.	Polarograph	1	Sargent-Welch Co., USA Model 5001		Investigations of clear materials
3.	Static mercury drop electrode	1	EGG Parr Co., USA Model 303		
4.	Components for gas chromatograph (item 1 third stage likely Indian supply)				

PRELIMINARY EQUIPMENT LIST

Annexure 4

B3 Analytical Research Department

THIRD STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Gas chromatograph	1		
2.	Fume hood (laminar box)	3		

PRELIMINARY EQUIPMENT LIST | Annexure 4

F1 Semi-Products Research Department

FIRST STAGE | LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	H-content tester	1	Feinmechanik Anstalt in Lichtenstein Type: FMA		
2.	Point recorder	1	Philips, Holland Type: PM 8236	12-channel, 0-1200 °C	For Ni-CrNi Pyrometers
3.	Portable digital thermometer	2	Technoterm, GFR Type: DT 9500	Temp.range: 0-1200 °C	
4.	Mobil data acquisition system complete with inputs and power lines (options) and 7 channels cassette data recorder	1	Hewlett-Packard, USA Model 3054 DL/HP 85 TEAC, Japan Type: R-81		For pilot plant and industrial scale measurement
5.	Computer	1	DEP, USA Type: PDP 11/440	1MByte internal memory, back-up memory (floppy-disc), magnetic tape memory, with 2 terminals, TEKTRONIX (USA) tablet, 2 graphic displays, plotters, etc.	Data processing of semis and finished product research, process modelling
6.	Direct-indirect rod, profile and tube extrusion press (preheating furnace, finishing equipment)	1	FIELDING, England Type: FIELDING	Pressing force: 5 MN container dia: 80 mm, thread length: max. 20 m, streching machine: 100 kN, preheating furnace with gas heating upto max. 500 °C	Experiments, product manufacture

PRELIMINARY EQUIPMENT LIST

Annexure 4

F1 Semi-Products Research Department

LIKELY FOREIGN SUPPLY

FIRST STAGE

Item	Designation	Quantity	Likely source and type	Technical data	Function
7.	3-stage wire-drawing machine (Thermo-mechanical treatment possibility)	1	Heinrich, GFR	Max.drawing force: 20 kN, drawing dia range: 0.6-5 mm, direct electric resistance heated furnaces between the stages	Wire drawing, experiments, product manufacture
8.	Plastometer	1	TARNOGROCK GmbH, GFR	Max. pressing force: 0.5 MN	Formability experiments
9.	Fluid heat-treatment furnace	1	Heraens, GFR	Furnace room: 250x250x300 mm, temperature: 700 °C, precision: ± 1 °C	
10.	Programmable hydraulic forming machine	1	MFL Pruf- und MeB-system GmbH, GFR	Max. static load: ± 400 kN max. dynamic load: ± 320 kN	Deformation experiments, static and dynamic test of structures
11.	Torsion testing machine	1	Hungary Type: non-standard equipment	Max. torsional moment: 50 Nm, rotation: 1-200 mm/min, max.temp.: 600 °C	
12.	Universal sheet-formability testing machine	1	Hemmer-Schudwig, GFR Type: Erichsen	Forming force: max. 300 kN, formation speed: 5-200 mm/min	
13.	Immersion pyrometer	2	Hottinger, GFR	Upto 800 °C	

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PRELIMINARY EQUIPMENT LIST

Annexure 4

F1 Semi-Products Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
14.	Recorder	1	Philips, Holland	6-channel, 0.5 mV/250 mm, max. recording speed: 1 m/s	
15.	Hydraulic drawing machine 20 kN	1		Hydraulic main operation, pneumatic end seizure, max. drawing dia:50 mm, max. length: 8 m	Tube and rod drawing, experiments, product manufacture

PRELIMINARY EQUIPMENT LIST

Annexure 4

F1 Semi-Products Research Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Melting-casting furnace	1	2 t, fixed; oil-heating: max. 800 °C	For plant size ingot casting
2.	Melting-casting furnace	1	200 kgs, tilting, electric heating: max. 800 °C	For bench scale ingot casting
3.	D.C. casting machine	1	Working load: 2.5 t, casting velocity: 10 to 400 mm/min, length of ingot: max. 4 m, hydraulic, max. ingot sizes: 400x1000 mm and dia 350 mm	
4.	Induction melting furnace	1	100 kg, with tilting crucible, max. 1200 °C	For manufacture of pre-alloys and special materials
5.	Tilting crucible furnace	1	20 kg, tilting, with electric heating, max. 1200 °C	For manufacture of pure metal base pre-alloys
6.	Crucible furnace	1	5 kg, electric heating, max. 800 °C	For preparation of model alloys
7.	Sawing machine	1	Hydraulic frame sawing machine, 250 mm can be cut	
8.	Balance			
9.	Fork-lift electric truck	1		
10.	Foot-fork electric truck	1		
11.	Digital multimeter	3		AC/DC voltage-current-resistance measuring for general purposes

PRELIMINARY EQUIPMENT LIST Annexure 4

F1 Semi-Products Research Department

FIRST STAGE LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
12.	Multitester	2	3-channel supply unit, AC-DC voltage-current-resistance measuring, frequency measuring, signal generator	
13.	Power supply	1	2-channel, AC 0 to 40 V, 0 to 2 A	
14.	Oscilloscope	1	0-50 MHz, 5 mV/spacing - 10 V/spacing	
15.	Measuring table	1	1000x3000 mm, with etched flat surface	Quality control of semis
16.	Rod tube pointer	1	Roll forging machine, forge-roller dia: 100 mm	Seizure end formation
17.	Air-hammer	1	Pig mass: 40 kg	Deformation experiments
18.	Air-circulated heat-treatment furnace	1	Furnace room: 700x700x2000 mm, resistance heating, temperature 700 ^{o}C, precision: $\pm$ 5 ^{o}C	
19.	Air-circulated heat-treatment furnace	1	Furnace room: 250x250x300 mm, resistance heating, temperature 700 ^{o}C, precision: $\pm$ 2 ^{o}C	
20.	Air-circulated heat-treatment furnace	1	Furnace room: 500x500x800 mm, resistance heating, temperature 600 ^{o}c, precision: $\pm$ 5 ^{o}C	

PRELIMINARY EQUIPMENT LIST

Annexure 4

F1 Semi-Products Research Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
21.	Air-circulated heat-treatment furnace	1	Furnace room: 250x250x300 mm, resistance heating, temperature 600 °C, precision: ± 2 °C	
22.	Air-circulated heat-treatment furnace	1	Furnace room: 500x500x600 mm, resistance heating, temperature 300 °C, precision: ± 2 °C	
23.	Melting-casting furnace	1	100 kg, electric heating upto 900 °C	For alloy manufacturing, high pressure casting machine, die-casting, sand casting

PRELIMINARY EQUIPMENT LIST

Annexure 4

F1 Semi-Product Research Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Diecasting machine	1	Gebrüder Bühler AG, Switzerland Type: H-160-B-D2	Horizontal cold chamber, oil-hydraulic high pressure casting machine, 1.6 MN, local ventilation	
2.	Point recorder	1	Philips, Holland Type-PM 8236	12-channel, 0-1200 °C	To Ni-CrNi pyrometers
3.	Portable digital thermometer	2	Technoterm, GFR Type: DT-9500	Temp. range: 0-1200 °C	
4.	Micro wire drawing machine	1	NIEHOFF, GFR Type: M5	Max. drawing size: 1 mm, final size: -0.1 mm, 21-stage slide drawing machine	
5.	Recorder	1	Philips, Holland	6-channel, 0.5 mV/250 mm, recording speed: 1 m/s	
6.	Hydraulic drawing machine 200 KN	1		Hydraulic main operation, pneumatic end seizure, max.drawing dia:50 mm, max. length: 12 m	Tube, rod and profile drawing, experiments, product manufacture
7.	MILLIPORE Oil-testing equipment	1		Measuring range: +0.5 µm	Size and quantity measuring of solid contaminants in oil

PRELIMINARY EQUIPMENT LIST

Annexure 4

F1 Semi-Products Research Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
8.	Emulsion testing equipment	1		Measuring range: +0.3 µm	Measuring of oil-dispersity in emulsion
9.	SHELL four-ball lubricant testing equipment	1			Measuring of wear-reducing effect of oils and greases

Annexure 4

PRELIMINARY EQUIPMENT LIST

F1 Semi-Products Research Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Foot-fork electric truck	1		
2.	Foundry edge runner	1	For 20 lit sand mixture	For preparation of mould sand mixture
3.	S-blade mixer	1	For 10 lit core-sand mixture	
4.	Foundry edge runner	1	For 5 lit sand mixture	
5.	Explosion type core blower	1	For 5 lit sand mixture, operating with compressed air	
6.	Band saw	1	∅ 600 mm	
7.	Grinding wheel machine	1	Two disks of dia 175x20 mm	
8.	Core knock-out box	1		
9.	Desintegrator	1	Loosening of mould sand	
10.	Sand blasting machine	1	Sand-casting cleaning with compressed air	
11.	Lab. sand washing equipment	1		
12.	Drying oven	1	Temp. max. 300 °C	Sand Laboratory
13.	Laboratory furnace	1	Temp. max. 900 °C	Sand Laboratory
14.	Lab. sieve shaker	1		Sand Laboratory
15.	Gas permeability measuring	1		Sand Laboratory
16.	Strength tester	1		For sand and core

PRELIMINARY EQUIPMENT LIST

Annexure 4

F1 Semi-Products Research Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
17.	Lab. specimen moulding	1		For sand specimen preparation
18.	Lab. rotary drum mixer	1		For mixing of solutions
19.	Lab. balance	1	Precision: 0.1 g	
20.	Digital multimeter	2		AC/DC voltage-current-resistance measuring for general purposes
21.	Multitester	1	3-channel supply unit, AC-DC voltage-current-resistance measuring, frequency measuring, signal generator	
22.	Power supply	1	2-channel, AC 0 to 40 V, 0 to 2A	
23.	Salt-bath quenching furnace	1	Size: 600x600x4000 mm, max. temp.: 600 °C, precision: $\pm$ 1 °C	Experiments and product manufacturing (quenching)
24.	Horizontal quenching and annealing furnace	1	Gas firing, furnace room: 800x800x6500 mm, max. temp.: 650 °C, precision: $\pm$ 5 °C, air circulation, water basin under or beside the furnace room	Experiments and product manufacturing (quenching)
25.	Aging furnace	1	Gas firing, furnace room: 800x800x6500 mm, max. temp.: 250 °C, precision: $\pm$ 5 °C, air circulation	Experiments and product manufacturing (quenching)

PRELIMINARY EQUIPMENT LIST

Annexure 4

F1 Semi-Products Research Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
26.	Excentric forging press	1	Nominal pressing force: 630 kN	Formation experiments
27.	High-speed centrifuge	1	R.P.m. 5000-10000	Separation of emulsions and contaminants
28.	Standardized lubricant testing equipment	1		Measuring of lubricating oils' characteristics: flashpoint, destillation curve, tendency to coking, cold point, viscosity, water cont., density
29.	Melting-casting furnace	2	100 kg, electric heating upto 900 °C	For high pressure casting machine, die-casting, sand casting
30.	Oil fired tilting crucible furnace	2	100 kg, max. 1000 °C	

PRELIMINARY EQUIPMENT LIST — Annexure 4

F1 Semi-Products Research Department

THIRD STAGE — LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Atomising chamber	1	ECKART-WERKE, GFR	For metal powder manufacture, with min. capacity in controlled gas-flow, with suction and filter system	
2.	Vertical PM pressing machine	1	PROFEL BILLAUD France, Type: PROFEL-80	Slow run, oil-hydraulic, 0.8 MN	For squeeze casting, too
3.	Sizing press	1	BILAUD, France Type: PROFEL 6	0.06 MN	
4.	Components for hot-rolling mill (item 2 in third stage likely Indian supply),	1			
5.	Components for cold-rolling mill (item 3 in third stage likely Indian supply)	1			

PRELIMINARY EQUIPMENT LIST

F1 Semi-Product Research Department

Annexure 4

THIRD STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Vibrating screen	1		For metal powder classification; grain-size -0.5 mm, small capacity
2.	Hot-rolling mill with pre-heating furnace	1	Two-high operation, Ø 300x-300 mm, reversal, cooling, lubrication: emulsion	Hot rolling of small size ingots. Max. ingot size: 120x250x400 mm
3.	Cold-rolling mill + filter statiton	1	Speed: 0-200 m/min, two-high operation: Ø 300x300 mm, four-high operation: Ø 120/ Ø 300x300 mm, cooling, lubrication: oil, coilers, with variable stretching force	Cold strip rolling, product manufacture
4.	Shear	1	Lenth of cutting edge: 2000 mm, max. cutting force: 500 kN	Cutting-off
5.	Slitting machine	1	Max. slitting edge: 320 mm, max. slitting thickness: 2 mm	Edging, thin strip manufacture
6.	Sheet annealing furnace	1	Nominal charge: 2.5 t, number of heating zones: 3	Intermediate and final annealing of sheets and strips
7.	Disc-shear	1	Dia to be cut: 80-300 mm, thickness: 0.2-4 mm	Disc manufacture
8.	Tilting electric hearth furnace	1	100 kg, max. 1000 °C	For metal pulverization
9.	Vacuum heating furnace	1	Temp. max.: 550 °C, inner size about 500x500x500 mm	

PRELIMINARY EQUIPMENT LIST

Annexure 4

F2 Physical Metallurgy and Material Science Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quan-tity	Likely source and type	Technical data	Function
1.	Light microscope I.	1	Reichert, Austria Type: R. MeF2	Image-projection M:2000x1, photo-automation with special micro hardness measuring attachment	Traditional metallugraphy Micro hardness measuring
2.	Stereo light microscope	1	Reichert, Austria Type: Stereostar		General Viewer
3.	Scanning electron microscope with image analyser	1	Philips, Holland Type: P.SEM 505 Omnicon	Resolution: 4 to 6 nm, M:10 to 150000x, accelerating voltage: 2 to 30 kV vacuum: 5.10^{-8} torr	Small and large magnifying metallography
4.	ED-analyser and WDX with liquid nitrogen plant (6 l/h)	1	EDAX, USA, Holland Type: EDAX-9100 S60; WDX and nitr. plant: Philips, Holland	4000 channel: 2^{20} capacity/channel, 200 MHz A/D converter, resolution: 150 eV	Phase-analysis identification
5.	Transmission electron microscope with ED, STEM, high temp. stage, EELS	1	Philips, Holland Type: P.EM400	M:50 to 800000x, 20 to 120 kV, resolution 0.14/0.25 nm spot Ø 200 nm	Microstructural investigations; EDX, STEM
6.	Video recorder	1	Philips, Holland		

PRELIMINARY EQUIPMENT LIST

Annexure 4

F2 Physical Metallurgy and Material Science Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
7.	Specimen cutting machine	1	Struers, Denmark Type: Discotom		Rough preparation of specimens
8.	Turning machine	1	Polaron, Great-Britain VS Type: E-4000 D.P.V.		Specimen preparation
9.	Grinding-wheel machine	1	Struers, Denmark Type: Planpol/Predemax		Surface preparation of specimens
10.	Mechanical polisher I.	1	Struers, Denmark Type: DP-V2+PdM	Simultaneous polishing of 6 specimens	Final surface preparation of specimens
11.	Mechanical polisher II.	1	Struers, Denmark Type: DP10+PdM	Simultaneous diamond paste polishing of 6 specimens	Final surface preparation of specimens
12.	Electrolytical polisher I.	1	Struers, Denmark Type: Polectrocol		Metallographic specimens preparation
13.	Electrolytical polisher II.	1	Struers, Denmark Type: Visapol		Metallographic specimens preparation
14.	Electrolytical foil thinning	1	Struers, Denmark Type: Tenupol		Specimen preparation for transmission electron microscope
15.	Supersound cleaner	1	Type: TUC-150 de Lux		Surface cleaning of specimen

PRELIMINARY EQUIPMENT LIST

Annexure 4

F2 Physical Metallurgy and Material Science Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
16.	Specimen embedding	1	Polaron, England, USA		Preparation of difficult to handle specimen
17.	Differential scanning calorimeter	1	Perkin-Elmer, USA TypeL DSC-2C	Temp.range:-75 to 725 °C, sensitivity: 0.01 mcal, heating and cooling velocities: 0.3 to 320 °C/min.	
18.	High temperature differential thermal analyser	1	Perkin-Elmer, USA Type: DTA 1700	Can be used for DTA and DSC, temp.range: 20 to 1500 °C, heating and cooling velocities: 0.5 to 100 °C/min, quantity of sample: max. 100 mm^3, manually-controlled, programmed and cyclic operations	
19.	Thermomechanical analyser	1	Perkin-Elmer, USA Type: TMS-2	Temp.range:-70 to 725 °C sample dimension: dia 7.6x12.7 mm	Operations: Drawing, bending, pressing expansion, dilatometry
20.	Thermal analysis data station	1	Perkin-Elmer, USA	Automatic control, data visualisation, analysis and storage, program language BASIC	

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PRELIMINARY EQUIPMENT LIST

Annexure 4

F2 Physical Metallurgy and Material Science Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
21.	Dilatometer	1	Adamel Lhomargy, France Type, LKO2	Sample dimension: dia 2x12 mm	Study of thermal behaviour of metal and other materials. Characteristics which can be examined: Change in length = f(T) Change in length = f(t) (t, T = consts.) T = f(t) cyclic; Derived curves $\frac{dT}{dt} = f(T)$ (f/t) $\frac{dl}{dt} = f(T)$ (f/t)
22.	Hydrogen determinator	1	Adamel Lhomargy, France Type: ITHAC 12	Precision: 0.001 μg/g, max.sample dimension: dia 10x40 mm, carrying gas: N_2, analysis time 15 min.	Determination of hydrogen content in liquid and solid Al(alloys). Control of fused metal purification processe, investigation of effects caused by change in the technological parameters

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PRELIMINARY EQUIPMENT LIST

Annexure 4

F2 Physical Metallurgy and Material Science Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quan-tity	Likely source and type	Technical data	Function
23.	Automatic polycrystalline diffraction system	1	Philips, Holland Type: PW 1730	Components of the system: 1) X-ray generator: separate or simultaneous operation of two X-ray tubes, stability of generated voltage (20 to 60 kV) and power (10 to 80 mA) is 0.001 % kV and mA resp. in the case of 1 % fluctuation in the power network	Phase identification by comparison with 36000 documented data. Determination of phase concentrations. Measuring of lattice constant in order to follow the segregation processes. Determination of average sub-grain dimension and microvoltage by line profile analysis.
			Type: PW 1710	2) Microprocessor cont. unit	Remarks: By rotating the sample, the system is suitable for examining the diffraction of compact metals.
			DEC, USA Type: PDP-11/440	3) Minicomputer with 2 graphic displays	

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PRELIMINARY EQUIPMENT LIST

Annexure 4

F2 Physical Metallurgy and Material Science Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
24.	Pole figure diffractometer	1	SEIFERT, German Federal Republic	Texture goniometer complete, with generator, microprocessor control unit, automatic data processing. The whole 0^{o} to 90^{o} range of the pole figures are measured by both reflexion (0^{o} to 70^{o}) and transmission (50^{o} to 90^{o}) operation, precision of angle adjustment: 0.05^{o}	The pole figures disclose the anisotropy of the sample, by means of which the anisotropy of physical properties (flow limit, r-value) can be described. They help to develop the optimum technologies.
25.	Universal material testing machine	1	ZWICK, GFR System 1474	Max.load: 100 KN, extreme tension ranges: 0 to 0.01 N 0 to 100 kN, extreme pressure ranges: 0 to 0.1 N 0 to 100 kN, crosshead velocity: 0.05 to 400 mm/min, test temp.range: -70 to +320 ^{o}C	Examinations: tension, compression bending, small cycle fatigue, shortened creeping and stress relaxation, break-mechanical test (NYR, NOD, COD, NAVY), loadability tests.

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PRELIMINARY EQUIPMENT LIST — Annexure 4

F2 Physical Metallurgy and Material Science Department

FIRST STAGE — LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
26.	Cyclic fatigue-tester	3	SCHENK MASCHINENFABRIK GmbH, GER Type: Hydropuls-Schwingprüfmaschine	Load range: $\pm$ 60 KN, hydraulic loading unit, max. frequency: 250 Hz	Tension and compression fatigue tests (pulsating load). Static tension-pressure, specimen precracking, loadability and small cycle tests
27.	X-Ray testing device	1	Philips, Holland	Specimen thickness: max. 120 mm, tube voltage: 0 to 150 kV, tube power: 2 to 5 mA angle of ray-cone: 50°	Fault detection, non-destructive test of castings, forged pieces and welded seams
28.	Ultrasonic tester	1	KRAUTKRÄMMER, GFR Type: USIP 11	Frequency range 0.5 to 24 MHz, specimen thickness: 5 to 15 mm (for steel), test methods: one head, double head, SE-operation	Fault detection test (mainly with semi-products). Non-destructive determination of loadability (combined with static mechanical test)

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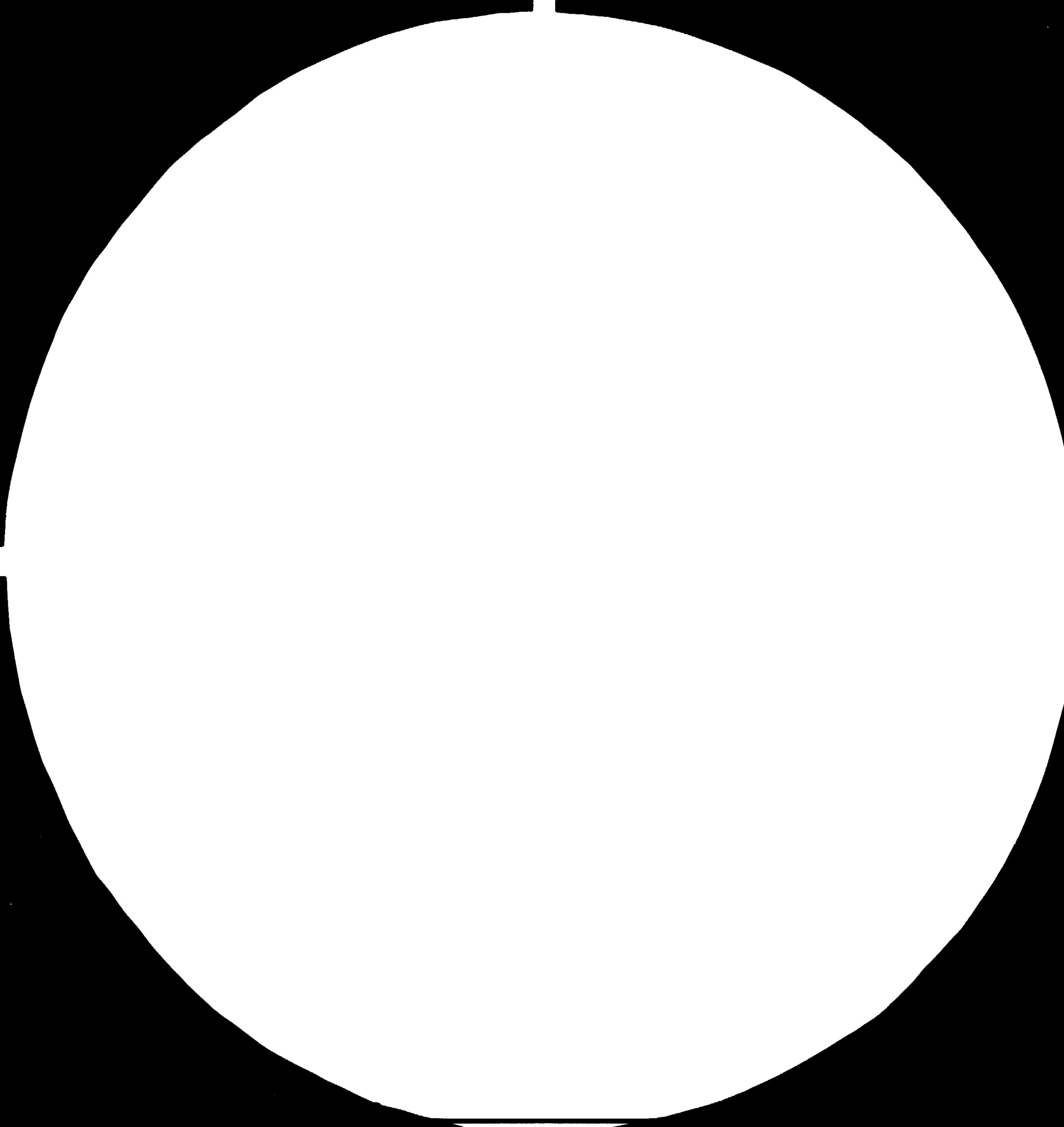

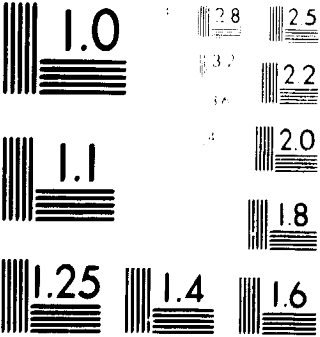

MICROCOPY RESOLUTION TEST CHART

PRELIMINARY EQUIPMENT LIST

Annexure 4

F2 Physical Metallurgy and Material Science Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Photo enlarger (black-white)	1	Automatic focussing, two types of condenser and objective systems	Black-white enlargement of photographs
2.	Developing tank	1	Temp. controlled thermostated automatic development	Development of photofilms and papers
3.	Photopaper drier	1		Drying of photopapers
4.	Hardness tester	1	Test-strength: 9.58 to 1840 N, microscope magnification: 70x precision of impression measuring: 0.0005 mm	Determination of Brinell, Vickers and Rockwell hardness

PRELIMINARY EQUIPMENT LIST

Annexure 4

P2 Physical Metallurgy and Material Science Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Light microscope II.	1	Reichert, Austria Type: 2.MeF2		
2.	Transmission light microscope	1	Reichert, Austria Type: R.Diapo	Basis equipment only Magnification upto 500x	General service microscope
3.	Vacuum evaporating equipment	1	Balzers, Lichtenstein Type: BAE-120	Traditional and electron beam evaporator for carbon and metal, motordriven specimen holder	Preparation of surface printing
4.	Ultramicrotome	1	Reichert, Austria Type: OmU-3	Fully automatic cutting	Preparation of thin cuttings
5.	Ion etching equipment	1	Balzers, Lichtenstein Type: BAE-300	Controlled ion etching, turbulent molecular pump	Etching sample preparation
6.	Photo enlarger (colour)	1	Durst, Italy Type: AC-650 Comp.	Automatic, computerized, colour correction	Blow-up of colour photographs
7.	Photostatic apparatus	1	Rank-Xerox, England Type: Xerox-3107		Copying of texts and figures

PRELIMINARY EQUIPMENT LIST

Annexure 4

F2 Physical Metallurgy and Material Science Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
8.	Electrical resistivity and thermoelectric power measuring system consisting of:	1	Hewlett-Packard, USA		Characterization of metal purity. Study of processes referring to the formation, recrystallization, renewal of pure metals. Examination of alloys' homogenization, dissolution and segregation processes.
	Digital multimeter		Type: HP 3468A	Sensitivity: 1 μV	
	Personal computer		HP 75C		
	Data collector		HP 3421A		
	Interface loop		HP 82160		
	TV-interface		HP 82163		
	Printer/plotter		HP 82162		
	Cassette drive		HP 82161		
	Sample holders		ALUTERV-FKI, Hungary	Temperature range: 78 to 900 ^{o}K	**Remarks:** The proposed system may be replaced by the following assembly: Personal calculator, Type: HP 85; Digital multimeter, HP 3868A; Data collector, HP 3421A; Printer, HP 82162
	Thermostats		MLW, German Democratic Republic Type: U 10	Temperature range: 30 to 250 ^{o}C	
	Furnace		ALUTERV-FKI, Hungary	Temperature range: 20 to 1000 ^{o}C, precision: $\pm$ 2 ^{o}C	

PRELIMINARY EQUIPMENT LIST

Annexure 4

F2 Physical Metallurgy and Material Science Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
9.	High precision Guinier camera	1	Philips, Holland Type: SXDC-700	Film camera with monochromator, examination: 20 ranges, 0° to 90°	Detection of phases in small (0.5 mg) samples
10.	Debye-Scherrer camera	1	Philips, Holland Type: PW 1024	Film camera, dia 114.8 mm, 2 mm on the film equals to $\Theta = 1^{\circ}$	Routinish measuring of lattice constant and phase identification
11.	Integrated small angle system	1	Anton Paar K.G., Austria Type: KIEC	Intensity measuring of counter tube. By up and down driving and inclination of the X-ray tube installed into the chamber body, an intensity gaint of 2 to 4 times higher can be achieved here than in other usual systems. The pace equipment can be electronically programmed (computer program packages), heatable sample holder (20 to 3000 $^{\circ}C$)	The average dimension and distance of a few times 10 A^{o} zones developing when the segregation begins, can be determined. Precondition: the mass number of segregation atoms must be far from that of the base material. That is the reason why the Zn can be well detected in Ai metal whilst the Mg can not. Remark: The necessary X-ray radiation is provided by the simultaneous operating generator, type PW 1730, and installed in the same room

PRELIMINARY EQUIPMENT LIST

Annexure 4

F2 Physical Metallurgy and Material Science Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
12.	Torsion machine	1	SHENK-TREBEL GmbH, GFR Type: RTA 10	Specimen dimensions: cylindric: dia max. 10 mm flat: width max. 20 mm, torque: 300 Nm, specimen length: max. 500 mm, torsion velocity: 15/30 r.p.m.	Cold torsion test of wires and rods. Torsion tests of flat and rectangular samples
13.	Acoustic emission tester	1	FÖRSTER ENG. TRADING GmbH, GFR Type: AE SYSTEM SERIES 3000	Frequency range: 20 KHz to 2 MHz + 4 filter position, count-range: 0 to 1000 0 to 10000 0 to 100000 0 to 1000000	Detection and quantitative characterisation of malleable formchanging processes, crecks and other fault places

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PRELIMINARY EQUIPMENT LIST

Annexure 4

F3 Finished Product Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quan-tity	Likely source and type	Technical data	Function
1.	Electrochemical corrosion testing device	1	TACUSSEL, France Type: CORROSCRIPT	Voltage source: max. ± 10 V, output current: max. ± 0.5A, O-point stability: ± 0.5 mV/d Potential measuring: input impedance 10^{12} Ohm, measuring limits ± 150 to ± 5000 mV, stability 0.5 mV/d, registration: logaritmic 0.1 µA to 0.1A linear 125 nA to 125 mA	Serial corrosion test of alloys and specimens originating from semis research by electro-chemical method (poten-tiostatic, and galvanostatic opera-tions)
2.	Corrosion tester con-sisting of:	1			
	Potentiostat		TACUSSEL, France Type: PRT 20x2XZ	Output voltage: ± 20 V, output current: ± 2 A, reagency time: 2 to 3 µS, O-point stability: ± 50 µV/d,	Corrosion research, development of electro-chemical examination methods
	mV-meter		TACUSSEL, France Type: S8R	Input impedance: 10^{12} Ohm, measuring limits: 6, 125, 500, 1250, 2500, 5000 mV	

PRELIMINARY EQUIPMENT LIST

Annexure 4

F3 Finished Product Research Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
	Recorder		TACUSSEL, France Type: EPL-2 TILOG 101 TU 11G	Paper width: 250 mm, paper velocity: 0.15 to 600 mm/min	
	Cell		TACUSSEL, France Type: CSG, CNC 145/170	Made of teflon, glass, for general purposes	
3.	Constant strain rate testing machine	1	KORROS-DATA, GFR Type: 6-String CS-mach	Strain rate: 10^{-7} to 10^{-3} mm/s, 6 measuring spots	Stress corrosion test (constant strain rete method).
4.	Sealing tester	1	ANOTEST, GFR	Surface conductivity meter	
5.	Thickness measuring	1	PERMASCOPE, GFR	Eddy current principle	
6.	Micro-balance	1	GDR	upto 1 g, sensitivity 10^{-6} g	
7.	Lab. equipment for anodizing	12	NAPSUGAR KTSZ, Hungary	12 pots with accessories, V = 400 lit/pot	
8.	8 beam digital memory oscilloscope	1	FOKGYEM, Hungary Type: TR 4901/A	8 measuring inputs, 1 closksignal input trigger signal input 70 VA	
9.	Analytical ba'ance	1	Hungary		

PRELIMINARY EQUIPMENT LIST

Annexure 4

F3 Finished Product Research Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Lab. balance	1		
2.	Projector	1		
3.	DC power supply	2	0 to 80 V, 200 A	
4.	AC power supply	2	0 to 80 V, 200 A	
5.	A-, and V-meters	10		
6.	TIG welding unit	1	Programmable power supply primary: 380 V, 66 A, 1 phase, 50 Hz, 25 kVA secondary: AC: 60 % ED: 40 V, 500 A, 100 % ED: 36 V, 390 A U_O= 75 V DC: 60 % ED: 36 V, 410 A 100 % ED: 33 V, 320 A U_O= 69 V	Suitable for spot welding and manual arc welding, too.
7.	MIG welding unit	1	Possibilities for spot welding and pulsating arc welding primary: 380 V, 19 A, 3 Phase, 50 Hz, 12.5 kVA secondary: 60 % ED: 34 V, 350 A 100 % ED: 34 V, 270 A	

PRELIMINARY EQUIPMENT LIST

Annexure 4

F3 Finished Product Research Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
8.	Resistance spot welding machine	1	380 V, 3 phases, 50 Hz, I_2 = 42 kA 60 % BI $I_{short\ circuit}$ = 104 kA	Suitable for spot, multiple spot- and roller welding. Programmed resistance
9.	2x6 line recorder	1		
10.	Power supplies	2	2A/24V	
11.	X-Y recorders	2		
12.	Binocular microscope	1	Magnification: 6.3 to 100x	
13.	Slide and writing projector	1		
14.	Salt-spray chamber	1	Temperature: max. 60 °C	Investigation of corrosion behaviour in an agressive medium

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PRELIMINARY EQUIPMENT LIST

Annexure 4

F3 Finished Product Research Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Corrosion fatigue testing machine	1	KORROS-DATA, GFR Type: 6-String pulsator	Max. load: 30 kN, 6 measuring spots	Examination of combined effect of a corrosive medium and the small frequency fatigue
2.	Combined weathering tester	1	GFR Type: XENOTEST 1200	1200 lit	
3.	Bacteriological thermostat	1		Volume 500-700 lit, temperature: max. 60 °C, accuracy: ± 0.1 °C	
4.	Coulomb meter	1		0 to 80 V, 0 to 10 A	
5.	Plotters	3			Plotting of power voltage and temperature
6.	Colour meter	1	Hungary Type: MOMCOLOR	Tri-stimulum colour meter	
7.	Stereo microscope	1	ZEISS, GDR		
8.	Ultrathermostat	1	Hungary	Temp. range: 20 to 80 °C	
9.	Cassette data recorder	1	TEAC, Japan Type: R-81	7 channels portable instrument, transmission 0-5 kHz	Can be connected to HP 3054A/HP 9845 system

PRELIMINARY EQUIPMENT LIST

Annexure 4

F3 Finished Product Research Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Climate equipment	1		Special air conditioner for item 25
2.	Drying oven	2	Temp. 20 to 200 $^{\circ}$C, 300 lit	
3.	Paintspraying device	1	2 m^3	
4.	TIG welding unit	1	Programmable power running down, primary: 380 V, 66 A, 1 phase, 50 Hz, 25 kVA, secondary: AC: 60 % ED: 40 V, 500 A 100 % ED: 36 V, 390 A U_O= 75 V DC: 60 % ED: 36 V, 410 A 100 % ED: 33 V, 320 A U_O= 69 V	Suitable for spot welding and manual arc welding, too
5.	MIG welding unit	1	Possibilities for spot welding and pulsating arc welding primary: 380 V, 19 A, 3 phases, 50 Hz, 12.5 kVA, sedondary: 60 % ED: 34 V, 350 A 100 % ED: 34 V, 270 A	

Annexure 4

PRELIMINARY EQUIPMENT LIST

F3 Finished Product Research Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
6.	High current density MIG welding unit	1	Primary: 380 V, 68 A, 3 phases: 50 Hz, 26 kVA, secondary: 100-800 A, 24-44 V, $U_o = 56$ V	For welding of thick materials
7.	Motion film projector	1		

PRELIMINARY EQUIPMENT LIST

Annexure 4

F3 Finished Product Research Department

THIRD STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Gloss meter	1	GARDNER, USA LANGE, GFR	Surface reflexion meter of 60° geometry	
2.	Abrasion resistance tester	1	ERICHSEN, GFR Type: 317		
3.	Adhesion tester	1	ERICHSEN, GFR Type: 295	Grid cutting device	

PRELIMINARY EQUIPMENT LIST

Annexure 4

F3 Finished Product Research Department

THIRD STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Humid chamber	1	150 lit	
2.	pH-meter	1	Lab. pH-meter with combined glass electrode	

PRELIMINARY EQUIPMENT LIST

Annexure 4

T1 Computer Centre

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Personal computer	12	APPLE, GB Type: APPLE 2	64 KByte internal memory, back-up memory, plotter, display etc, can be connected to the PDP and VOX system	To be placed and used in research and design departments

PRELIMINARY EQUIPMENT LIST

T1 Computer Centre

Annexure 4

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Personal computer	7	APPLE, GB Type: APPLE 2	64 KByte internal memory, back up memory, plotter, display etc. can be connected to the PDP and VOX system	To be placed and used in research and design departments

PRELIMINARY EQUIPMENT LIST

T1 Computer Centre

Annexure 4

THIRD STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Personal computer	5	APPLE, GB Type: APPLE 2	64 KByte internal memory, back-up memory, plotter, display etc, can be connected to the PDP and VOX system	To be placed and used in research and design departments
2.	Computer network	1	DEC, USA Type: VAX	Main storage 16 MByte, with 100 MByte CDC or Winchester discs (4pcs), graphic displays (2pcs), terminals (25pcs)	Terminals shall be placed in research, design, and other departments

PRELIMINARY EQUIPMENT LIST

Annexure 4

T24 Reprography and Printing

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Ball-headed typing machine	2	IBM		
2.	Copyrapid machine	1	IBM Type: COPIER-III Model 20		For single-, and double-faced copying in format A4, with simultaneous reduction of format A3 to A4
3.	Collating machine	1	IBM Type: COPIER-III COLLATOR	20 compartments Format: A4	
4.	Enlarger	1	Agfa-Gevaert Type: ESKOFOT 241-1		For quick preparation of plates and copying from cut film to plate
5.	Developing equipment	1	Agfa-Gevaert Type: ESCOFOT-339		
6.	Reducing-exposure machine	1	Agfa-Gevaert Type: REPROMASTER-2001	Format: A1 to AO	For reduction of tracing paper to cut film

PRELIMINARY EQUIPMENT LIST

Annexure 4

T24 Reprography and Printing

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Retouching and mounting table	1	Enlighted area: min. Format A2	
2.	Printing machine	1		For preparation of prints in formats A3 and B3
3.	Staple press	1		
4.	Cutting-machine	1	Automatic positioning to the pre-set format	
5.	Perforating machine	1	Format: A2	
6.	Blue-printing machine	1	Format: A0. Fully automated	For blue-printing and folding

PRELIMINARY EQUIPMENT LIST

Annexure 4

T24 Reprography and Printing

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Copyrapid machine	1	Type: OCÉ 1900 DF/CFF	Copies in formats A3 and A4, with computer print copying accessory	
2.	Developing equipment	1	Agfa-Gevaert Type: ESCOFOT-339		
3.	Collating machine	1	LINDACO, Sweden		For collecting A3 prints
4.	Microfilm exposure machine	1		Format: A3 and AO with variable reduction	
5.	Microfilm developing equipment	1			
6.	Microfilm finishing equipment	1			
7.	Microfilm projector	2			

PRELIMINARY EQUIPMENT LIST

Annexure 4

T24 Reprography and Printing

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Filmdrying oven	1		For drying of cut films
2.	Retouching and mounting table	1	Enlighted area: min. Format A2	

PRELIMINARY EQUIPMENT LIST

Annexure 4

T24 Reprography and Printing

THIRD STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Copyrapid machine	1	IBM Type: COPIER-III Model 20		For single-, and double-faced copying in format A4, with simultaneous reduction of format A3 to A4
2.	Collating machine	1	IBM Type: COPIER-III COLLATOR	20 compartments Format: A4	
3.	Tilting-frame copying machine	1			Heavy duty machine for contact copying of plates from cut film
4.	Ball-headed, magnetic tape composing-machine	1	IBM Type: Composer-82		
5.	Reader printer	1			For making prints from microfilm

PRELIMINARY EQUIPMENT LIST Annexure 4

T24 Reprography and Printing

THIRD STAGE LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Retouching and mounting table	1	Enlighted area: min Format A2	
2.	Printing machine	1		For preparation of prints in formats A3 and B3
3.	Staple press	1		
4.	Spiral stitching machine	1	Format: A4	

Annexure 4

PRELIMINARY EQUIPMENT LIST

T5 Workshop and Maintenance Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data
1.	Small size lathe	1	Clamping dia: 250 mm, centre distance: 750 mm
2.	Universal lathe	1	Clamping dia: 400 mm, centre distance: 1000 mm
3.	Univer . . milling machine	1	Table size: 320x1250 mm
4.	Universal milling machine	1	Table size: 400x1600 mm
5.	Bench drilling machine	2	Spindle dia: 15 mm
6.	Drill press	1	Spindle dia: 20 mm
7.	Hydraulic framed saw	1	Cutting dia: 250 mm
8.	Disc saw	1	Cutting thickness: 100 mm, stroke: 600 mm
9.	Strap saw (for metals)	1	Dia: 600
10.	Pedestal grinding machine (with double grinding wheel)	1	Size of grinding wheel: 175 mm dia x 20 mm
11.	Universal tool grinding	1	-
12.	Plate shear (electric operation)	2	Cutting thickness: 3.5 mm, cutting width: 1250 mm
13.	Plate bending machine (electric operation)	1	Plate thickness: 3 mm, plate width: 1250 mm
14.	Tube bending machine	1	-
15.	Welding equipment with generator	1	-
16.	Gas welding equipment	1	-
17.	Flame cutting equipment	1	-
18.	Heat treating furnace	1	Size: 500x500x500 mm, temperature up to 1200 °C

Annexure 4

PRELIMINARY EQUIPMENT LIST

T5 Workshop and Maintenance Department

FIRST STAGE | LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data
19.	Hydraulic press	1	Compressive force: 31.5 kN
20.	Bench ball press	1	Compressive force: 100 kN
21.	Pump for hydraulic tests	1	Pressure: 65/225 bar
22.	Air compressor	2	Capacity: 15 m^3/h, pressure. 0.980 MPa, connected to a buffer tank a volume of 100 lit.
23.	Vice benches, supporting grates, cases	50 %	
24.	Hand tools, cutting, chipping and drilling tools	50 %	
25.	Strap saw (for wood)	1	Dia: 600 mm
26.	Combined panel planning machine (for wood)	1	Table width: 400 mm
27.	Disc saw (for wood)	1	Disc dia: 300 mm
28.	Milling machine (for wood)	1	
29.	Welding machine for saw strip welding	1	
30.	Drawing table with drawing machine	4	
31.	Electric truck	1	AC-DC voltage: 600 v, current: 6 A
32.	Portable electrical instrument	2	AC-DC voltage: 600 V, current: 6 A
33.	Earthening tester	1	Measuring range: 0.1 to 100 Ohm, accuracy: $\pm$ 1 %

Annexure 4

PRELIMINARY EQUIPMENT LIST

T5 Workshop and Maintenance Department

FIRST STAGE | LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data
34.	Insulation tester	1	Measuring voltage: 100 to 1000 V, measuring range: 0 to 10000 MOhm
35.	Universal contact protection tester	1	Measuring voltage: 180 to 250 V, measuring current: 1 to 10 A
36.	Digital current meter (pronged type)	1	Voltage: 0.1 to 10000 V, current: 0.1 to 10000 A, resistance: 0.1 to 1000 Ohm
37.	Portable cos φ meter	1	Measuring range: 0.4 to 1 cos φ
38.	Electric truck	1	Capacity: 3.0 t

Annexure 4

PRELIMINARY EQUIPMENT LIST

T5 Workship and Maintenance Department

SECOND STAGE | LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data
1.	Small size lathe	1	Clamping dia: 250 mm, centre distance: 500 mm
2.	Small size lathe	1	Clamping dia: 250 mm, centre distance: 750 mm
3.	Universal lathe	1	Clamping dia: 400 mm, centre distance: 1000 mm
4.	Universal lathe	1	Clamping dia: 400 mm, centre distance: 1500 mm
5.	Shaping machine	1	Stroke: 1000 mm
6.	Bench drilling machine	1	Spindle dia: 15 mm
7.	Drill press	1	Spindle dia: 40 mm
8.	Centre grinding machine	1	Clamping dia: 160 mm, centre distance: 320 mm
9.	Plane grinding machine	1	Table size: 200x500 mm
10.	Hydraulic framed saw	1	Cutting dia: 250 mm
11.	Strap saw (for metals)	1	Dia: 600
12.	Pedestal grinding machine (with double grinding wheel)	1	Size of grinding wheel: 175 mm dia x 20 mm
13.	Universal tool grinding machine	1	-
14.	Plate rolling machine (manual operation)	1	Plate thickness: 2 mm, plate width: 1000 mm
15.	Welding equipment with transformator	1	-
16.	Welding equipment for plastic materials	1	-

Annexure 4

PRELIMINARY EQUIPMENT LIST

T5 Workship and Maintenance Department

SECOND STAGE LIKELY INDIAN SUPPLY

Item	Designation	Quan-tity	Technical data
17.	Vice benches, supporting grates, cases	50 %	
18.	Hand tools, cutting, chipping and drilling tools	50 %	
19.	Drawing table with drawing machine	2	
20.	Electric truck	1	Cap.: 2.0 t

Annexure 4

PRELIMINARY EQUIPMENT LIST

T5 Workship and Maintenance Department

THIRD STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data
1.	Universal lathe	1	Clamping dia: 400 mm, centre distance: 1000 mm
2.	Universal milling machine	1	Table size: 320x1250 mm
3.	Drill press	1	Spindle dia: 20 mm
4.	Hydraulic framed saw	1	Cutting dia: 250 mm
5.	Pedestal grinding machine (with double grinding wheel)	1	Size of grinding wheel: 175 mm dia x 20 mm
6.	Drawing table with drawing machine	2	

PRELIMINARY EQUIPMENT LIST

Annexure 4

T6 Instrumentation and Control Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quan-tity	Likely source and type	Technical data	Function
1.	Digital memory storage oscilloscope	1	Philips Type: PM 3310	0-60 MHz, 400 VDC	For measuring of dynamic characteristics
2.	Strain gauge apparatus	1	Hottinger, GFR Type: KWS 3050	100 μm/m-5000 μm/m	For bench-scale and plant size experiments
3.	Surface roughness meter	1	Bruel-Kjaer Type: 6102	0.1-30 μm ± 2 %	
4.	Stroboscope	2	Hungary Type: OE-721	R.p.m.: 100-9990± 0.1 %	For r.p.m. measurings
5.	Measuring tape recorder	1	Philips Type: MINI-Log 4	DC-500 Hz,DC-5 kHz, carrying frequency: 2.7 and 28 kHz	
6.	Digit-thermometer	2	Technoterm, GFR Type: DT 9500	0-1200 °C	Plant size measuring
7.	Two-colour ratio pyrometer	1	Teejay, England Type: two-colour	300-600 °C	Plant size measuring
8.	Anemometer	1	Thermo-System Type: 1650-1	0-30 m/sec ± 2 %	
9.	Logitester	3	Hungary Type: OF-92	0-5 MHz	For TTL-systems
10.	Digital manometer	1	Keithleg Type: 180	10 μV-1 V, max. sensitivity: 1 nV	

PRELIMINARY EQUIPMENT LIST

Annexure 4

T6 Instrumentation and Control Department

FIRST STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
11.	$X-Y_1-Y_2$ recorder	1	Hewlett-Packard Type: 2FRAM	0.2 mV/cm-20 V/cm, A3 writing surface	
12.	Digit-thermometer	1	Norma Type: D-2500	-20 °C - +1372 °C, precision: ± 0.3 %	
13.	Logic analyzer	1	FOK-GYEM, Hungary Type: TR-4091/A	Frequency range: 0-10 MHz, max. input voltage: ± 20 V	16x16 time release clock-work, logical circuits for positive and negative signals
14.	Logic probe	3	OMSZÖV, Hungary Type: OE-92	Reception of TTL-level signals	Characterization of TTL-system logic state
15.	Logic pulser	3		Generation of single TTL-impulse	Investigation of TTL-systems
16.	ROM emulator	2	LABOR MIM, Hungary Type: OL622	1 kbyte memory	Programming of 1kbyte (12708)ROM
17.	ROM eraser	2		Adjustable erasing time max. 15 min	Erasing of ROM's content

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PRELIMINARY EQUIPMENT LIST

Annexure 4

T6 Instrumentation and Control Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Digital multimeter	3	AC-DC voltage, current, resistance measuring	General
2.	Digital multimeter	1	AC-DC voltage, current, resistance measurint 10 µV - 1000 V, 10 mOhm - 1000 kOhm	For measurings of high level
3.	Multitester	4	3-channel supply unit. AC-DC voltage, current measuring	Resistance, temperature measuring. Signal generator
4.	DC power supply	2	Output voltage: 2x0-40 V, output current: 0-2A	For circuital experiments
5.	Double beam oscilloscope	2	0-50 MHz, 0.005 V/space-10 V/space	For circuital experiments and plant scale measurings
6.	12-point recorder	1	0-1500 °C Pt-PtRh, 0-1200 °C Ni-CrNi	For plant size measurings
7.	Digital multimeter	1	100 mV-1200 V (in 5 zones), max. sensitivity: 100 µV, input impedance: 10 MOhm	
8.	Impulse generator	1	10 Hz-10 MHz	
9.	Digital portable multimeter	4	100 mV-600 V; 10 A - 0.2 A	
10.	Digital frequency meter	1	2 Hz-25 MHz, 50 µs-0.5 sec.	
11.	Megohm-meter	1	0.6 MOhm-500 TOhm	
12.	Capacitance meter	1	0.001 pF-100 µF	

PRELIMINARY EQUIPMENT LIST

Annexure 4

T6 Instrumentation and Control Department

FIRST STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
13.	Induction-meter	1	0.05 µH-1.15 H	
14.	Instrumental lathe	1	Mechanician turning lathe and drilling milling-cutter equipment	For precision mechanician works
15.	Double beam storage oscilloscope	1	Frequency range: 0-25 MHz, max.input voltage: 100 V, max.storage time: 1 h	Examination of single run, randomly occuring signals
16.	Digital multimeter	2	Measuring range: 100 uV-1000 V=, 100 uV_{eff} -500 V_{eff}, 100 nA-1A=, 100 nA_{eff} -2A_{eff}, 0.1-2 MOhm	For measuring of AC/DC voltage and current as well as resistance
17.	Double power supply	3	Output voltage: 2x0-40 V output current: 2x0-2A stability: 0.5 %/8 hours	Supply unit of high reliability for starting of sample panels, circuits and equipment
18.	Function generator	1	Frequency range: 0.01 Hz-10 MHz, signal shapes: rectangular, triangle, sin, signal amplitude: 0.01V-10V	Starting and trail of sample panels and experimental circuits
19.	Logic analyzer	1		Complex trial of TTL, ECL and CMOS-systems

PRELIMINARY EQUIPMENT LIST

Annexure 4

T6 Instrumentation and Control Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
1.	Digital memory storage oscilloscope	1	Philips Type: PM 3310	0-60 MHz, 400 VDC	For measuring of dynamic characteristics
2.	Multiline recorders - 4 pen	2	Linseis, GFR Type: L2001-6	0.5 mV/250 mm, max.writing speed: 1 m/sec	For plant size measurings
3.	Strain gauge apparatus	1	Hottinger, GFR Type: KWS 3050	100 µm/m - 5000 µm/m	For bench-scale and plant size experiments
4.	Strain gauge apparatus	1	Brüel-Kjaer Type: 1516	Measuring frequency: DC-300 kHz, No. of measuring places: 50, sensitivity: 10^{-4}, measuring time: 0.5-4 s	
5.	Digit-thermometer	1	Technoterm, GFR	0-1200 °C	Plant size measurings
6.	Logitester	4	Hungary Type: OC-92	0-5 MHz	For TTL-systems
7.	$X-Y_1-Y_2$ recorder	1	Hewlett-Packard Type: 2FRAM	0.2 mV/cm-20 V/cm, A3 writing surface	
8.	Recording multimeter	1	Goerz Type: Multiscript	50 µA-1 A; 100 mV-500 V	
9.	Digital multimeter	1	Hewlett-Packard Type: 3490A	100 mV-1 kV precision: 0.001 %	

PRELIMINARY EQUIPMENT LIST

Annexure 4

T6 Instrumentation and Control Department

SECOND STAGE

LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
10.	4096 channel analyzer with converter	1	KFKI, Hungary Type: ICA-80 and A/D converter	Multichannel system fitted to the amplitudes of semiconductor	Gamma spectrometric analysis
11.	Cooled semi-conductor detector	1	ATOMKI, Hungary Nucl.Enterprizes, England	Li(Ge) semi-conductor	Gamma spectrometric analysis
12.	Energy-selective scaler	4	GAMMA, Hungary Type: NK-350	Solid state circuits for counting, 1 to 10 V threshold voltage, adjustable window level, adjustable supply voltage	
13.	Scintillation measuring head	4	GAMMA, Hungary Type: ND 131F	Including: NaJ (T1), plastic, phosphor and ZnS detector-crystals	
14.	Radiation dose intensity meter	1	GAMMA, Hungary	In the range of: 0.01 Sv-10 Sv	
15.	Contamination meter	1	TISSZ, USSR		For measuring of surface contamination of α,β,γ radiation
16.	Logic probe	3	OMSZÖV, Hungary Type: PE-92	Reception of TTL-Level signals	Characterization of TTL-systems logic state

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PRELIMINARY EQUIPMENT LIST Annexure 4

T6 Instrumentation and Control Department

SECOND STAGE LIKELY FOREIGN SUPPLY

Item	Designation	Quantity	Likely source and type	Technical data	Function
17.	μP development system	1	TEKTRONIX, USA Type: MODEL 8002	z 80 basis central unit, dual floppydisc, line printer, 2716 PROM program 32kByte memory	Development of operation programme for micro-processor controlled measuring and control equipment
18.	Micro-manometer	2	USSR		
19.	Pneumatic universal test benches with accessories	2	Scandura, Italy		
20.	Electronic test and calibration benches complett with plugged-in modular AC/DC voltage sources, meters, calibrators	1	Scandura, Italy		
21.	Multiline recorders - 6 pen	2	Linseis, GFR Type: L2001-4	0.5 mV/250 mm, max. writing speed: 1 m/sec	For plant size measurings
22.	Flow calibration rig	1	UK		Flow calibration for orifice plates
23.	Portable conbustible gas detectors	2	UK		
24.	Test, calibration and repair benches for control valves	2	UK		

PRELIMINARY EQUIPMENT LIST

Annexure 4

T6 Instrumentation and Control Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
1.	Digital multimeter	3	AC-DC voltage, current, resistance measuring	General
2.	Digital multimeter	1	AC-DC voltage, current, resistance measuring 10 uV - 1000 V, 10 mOhm - 1000 kOhm	For measurings of high level
3.	Multitester	4	3-channel supply unit, AC-DC voltage, current measuring	Resistance, temperature measuring. Signal generator
4.	DC power supply	3	Output voltage: 2x0-40V, output current: 0-2A	For circuital experiments
5.	Double beam oscilloscope	3	0-50 MHz, 0.005 V/space-10 V/space	For circuital experiments and plant scale measurings
6.	12-point recorder	1	0-1500 °C Pt-PtRh, 0-1200 °C Ni-CrNi	For plant size measuring
7.	Impulse generator	1	10 Hz-10 MHz	
8.	Digital portable multimeter	3	100 mV-600 V; 10A - 0.2 A	
9.	Digital frequency meter	1	2 Hz-25 MHz, 50 µs-0.5 sec.	
10.	Lead-shielding	4		For reception of α,β and γ-radiation sources
11.	Stainless steel, or chromclad platter, pliers, pincers	30	Possibility of suitable decontamination, alkali and acid resistive	
12.	Analytical balance	1		

PRELIMINARY EQUIPMENT LIST

Annexure 4

T6 Instrumentation and Control Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
13.	Laboratory balance	1		
14.	Laboratory centrifuge	1	R.p.m.: 300, V = 50 ml	
15.	Lead tresor	1	Min. 2 cm Pb-steel wall-thickness	
16.	Dry chamber	1	Possibility for manipulation with rubber gloves and for proper decontamination	
17.	Double beam storage oscilloscope	2	Frequency range: 0-25 MHz, max.input voltage: 100 V, max.storage time: 1 h	Examination of single run, randomly occuring signals
18.	Digital multimeter	3	Measuring range: 100 μV-1000 V=, 100 uV_{eff} -500 V_{eff} 100 nA-2A=, 100 nA_{eff} $-2A_{eff}$ 0.1 Ohm-2 MOhm	For measuring of AC/DC voltage and current as well as resistance
19.	Double power supply	3	Output voltage: 2x0-40 V, output current: 2x0-2A, stability: 0.5 %/8 hours	Supply unit of high reliability for starting of sample panels, circuits and equipment
20.	Function generator	2	Frequency range: 0.01 Hz-10 MHZ, signal shapes: rectangular, triangle, sin, signal amplitude: 0.01V-10V	Starting and trial of sample panels and experimental circuits

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Annexure 4

PRELIMINARY EQUIPMENT LIST

T6 Instrumentation and Control Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
21.	Digital voltmeter	4		
22.	AVO multimeter	5		
23.	Digital IC tester	5		
24.	Universal bridge	5		
25.	Wheatstone bridge	5		
26.	Electronic counter	3		
27.	Cable fault detector	3		
28.	Auto-transformator	3		
29.	Phase and power factor meter	5		
30.	Soldering station	10		To work on electrical/ electronic circuits
31.	Shunts-various ranges	20		
32.	Illuminated magnifying glass	5		
33.	Drying heat treatment furnaces			
34.	Test, calibration and repair benches for weighing equipment	1		
35.	Ultrasonic cleaner	2		
36.	Vacuum cleaner	2		
37.	Letter stamping tool	1		

PRELIMINARY EQUIPMENT LIST

Annexure 4

T6 Instrumentation and Control Department

SECOND STAGE

LIKELY INDIAN SUPPLY

Item	Designation	Quantity	Technical data	Function
38.	Oscillator	2		
39.	Small range air compressor	1		
40.	Shape imp.generator	1	0.001 Hz-1 MHz, colour, square, triangle, sawshaped	
41.	Logic analyzer	1		Complex trial of TTL, ECL and CMOS-systems

PRELIMINARY EQUIPMENT LIST

Annexure 4

T6 Instrumentation and Control Department

LIKELY FOREIGN SUPPLY

THIRD STAGE

Item	Designation	Quan-tity	Likely source and type	Technical data	Function
1.	μP development system	1	TEKTRONIX, USA Type: MODEL 8002	Z 80 basis central unit, dual floppy disk, line printer, 2716 PROM program 32kbyte memory	Development of operation programmes for microprocessor controlled measuring and control equipment