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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

FINAL REPORT

Project No.: DP/IND/91/093 - Contract No.: 92/090

ESTABLISHMENT OF AN EXPERIMENTAL DEMONSTRATION UNIT FOR MANUFACTURING SUPER-PURE ALUMINIUM AND CONDENSER FOILS FROM IT

INDIA

FEASIBILITY STUDY

VOLUME I

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Volume II.

Volume III.

Financial analysis of two additional import-oriented variants of the project

LIST OF ABBREVIATIONS

EDU	Experimental demonstration unit (consisting of production of SPA, converting SPA and CPA into foils, treatment of foils by etching and forming)
BALCO	Bharat Aluminium Company, Ltd.
BBU	Bidhanbag unit
PT/MC	Polytechna/Metalconsult - author of Feasibility study
NCAER	National Council of Applied Economic Research
SPA	Super purity aluminium aluminium content min. 99.99 % and above
HPA	High purity aluminium aluminium content min. 99.95 % and above
CPA	Commercial purity aluminium aluminium content about 99.5 %
FTP	Foil treatment plant
WTP	Water treatment plant
WWTP	Waste water treatment plant
LV	low voltage
HV	high voltage
D.C.	direct current
DB	distribution board
AC	air conditioning
t	metric ton
tpy	metric tons per year
hrs	hours
p.a.	purity analysis
M	meter
mm	milimeter
m	micron
MWH	megawatthours
Rs (00)	1,000 Rupees

1. EXECUTIVE SUMMARY (RESUME)

1.1 Project background and history (Chapter 2)

The Bharat Aluminium Company Limited (BALCO), a Government of India enterprise intends to expand the product range and to establish the production of Super pure aluminium (SPA) and condenser foils from it.

A Feasibility Report to set up a Demonstration Unit for the production of 500 tpy SPA metal was prepared with the assistance of UNDP vide project No. DP/IND/84/007 by VAMI (Russia). This project has not been implemented. Another UNIDO Contract No. 92/090 has been signed between UNIDO and Polytechna Co., Ltd. for the provision of services relating to the Establishment of an "Experimental Demonstration Unit (EDU)", for Manufacturing Super-pure Aluminium and Condenser Foils from It".

A market survey was conducted by BALCO to assess the potential demand for SPA metal and condenser foil in India. While there was no demand for SPA metal as ingots, condenser producers need etched foils and formed high voltage foil in the amounts exceeding the projected capacity.

The proposed EDU will consist of a new plant for production of SPA (according to VAMI project) and of a new plant for treatment of plain foil by etching and forming. Production of plain foil from slabs will be provided on the existing equipment, which will be revamped.

1.2 Market analysis and marketing strategy (Chapter 3)

"Market Survey and Study of Super Purity Aluminium" which has been at the disposal to the team preparing the feasibility study, represents a good survey of the SPA market both in India and elsewhere in the world.

Findings of the "Survey" were complemented and modified by the team of experts during their visit in India.

Actual (past) demand was indicated in tons of slabs of several purity grades SPA/year (see the following table):

Past and projected demand of SPA slabs (tpy)

Year	Demand		
1985	141.81		
1986	164.60		
1987	223.67		observed
1988	265.89		
1989	284.04		
	Sc.1	Sc.2	
1990	318.65	318.65	
1991	353.30	353.30	
1992	387.94	387.94	
1993	424.53	424.53	projected
1994	457.22	457.22	
1995	491.84	491.84	
2000	665.82	623.46	
2005	838.18	785.80	

Projected demand of SPA 99.99 % min. slabs for the year 1995 was 491.84 tons. This amount represented about 245 tpy of anode foils.

Future demand is fully based on a linear projection of the increasing production of capacitors (30 % yearly in 1975 - 1987), covering almost the entire SPA demand in India. It may be a subject of discussion, whether such an increase rate would keep a constant pattern during a period of 30 years without any tendency to some saturation level. Nevertheless, it is obvious that any of its future estimates stands higher than the production capacity of EDU analyzed in this project.

After several modifications in accordance with discussions held with the main consumers of foil in India, the following production programme and prices have been adopted for the feasibility study.

- SPA plain anode foil	- 10 tpy	350 Rs/kg
- CPA cathode foil	- 60 tpy	990 Rs/kg
- LV anode foil (etched only)	- 100 tpy	2,170 Rs/kg
- HV anode foil (etched only)	- 10 tpy	2,170 Rs/kg
- HV anode foil (etched and formed)	- 40 tpy	3,340 Rs/kg

The expected sales revenues could be estimated at 435.2 mil Rs/year.

Market capacity is higher (both present and future) and the whole projected capacity of EDU will be utilized in India.

1.3 Materials and other production factors (Chapter 4)

The basic raw material for production of condenser foil is a commercial - grade aluminium metal (CPA) in the amounts of 505 tpy. This is converted in 3 stages.

1. stage - purification of SPA (anode foil) and melting of CPA or production of low content alloys (cathode foil) and casting of slabs

2. stage - converting of slabs to plain foil

3. stage - treatment of plain foil by etching and forming

Besides the CPA, other industrial products are used as for instance chemicals for etching and forming and chemicals for treatment of water and for disposal of used water.

As for utilities, the following are needed in the course of plain foil treatment by etching and forming:

- electric power	10,530 MWh
- raw water	96,000 M^3
- compressed air	294,000 M^3

1.4 Location and site (Chapter 5)

BALCO operates two units located on sites at:

- Korba, Madhya Pradesh State
- Bidhanbag , West Bengal State

Korba is a large integrated aluminium complex established at the end of 1970's as a "green field" project with sufficiently provided infrastructure and based on principles of zonal planning.
Nature of main production buildings is mainly steel structure provided with cranes. Supplementary buildings are mainly precast concrete structures.

Bidhanbag is a medium size metallurgical plant set up at the end of 1930's and gradually extended until 1960's.
Main production buildings are precast concrete structures.

1.4.1 Selection of location for EDU

The possibility of using existing equipment both in Korba and in Bidhanbag was respected during the selection of technology location.

1. stage - In accordance with VAMI project the purification of CPA is proposed in Korba, where three new cells will be installed in smelter. The slabs can be cast on the existing equipment where a new ladle with a stand will be used. Moreover, the installation of ALPUR BATCH equipment is recommended in present report.

2. stage - Converting of slabs can be made on existing equipment partly in Korba (strip rolling - thickness 0.6 mm), and partly in Bidhanbag (foil rolling). Foil rolling mill in Bidhanbag must be modernized.

3. stage - The treatment of plain foil will take place in the new FTP plant (foil treatment plant).

Proposed FTP can be located in either of the plants in Korba or in Bidhanbag. As a part of the study, selection of site in each plant has been carried out and connection to existing services has been made.

In principal, technical proposal for technology and for construction is identical for both locations. Investment cost for technology and for construction in each site is almost the same. More important is operational cost or other factors.

Operational costs differ for the following reasons:
- electrical power is more expensive in Bidhanbag than in Korba,
- transportation of Al semiproducts is necessary in both ways if FTP is located in Korba.

On the basis of economic evaluation the preferable location of FTP is in Korba. Savings on operational cost are not substantial and therefore in the process of evaluation also other factors may be of a significance, e.g. overall development of the company, social aspects (employment) and others.

1.4.2 Impact of FTP on the environment

For treatment of condenser foil chemicals are needed in quantities as follows:

- for etching and forming operations		136.5 tpy
- for water treatment plant		106.5 tpy
	In total	243.0 tpy

Most of the dissolved salts and used water will be drained from the process into waste water treatment plant, which forms part of the technological process.

Liquid waste contains salts (mainly NaCl) in the quantity of 3,000 - 4,000 mg/l and before being discharged it must be diluted twice with other liquid waste inside of plant.

Solid waste contains Al $(OH)_3$ with dissolved salts and will be carried to deposit site in a form of mud.

Fly away waste is negligible, only vapours are exhausted from basins during etching and forming operations.

1.5 Engineering and technology (Chapter 6)

EDU is proposed for the nominal capacity of 220 tpy, out of which 150 t is treated anode foil, 60 t is treated cathode foil and 10 t is plain foil.

The following production programme was determined on the basis of discussions with consumers of condenser foil in India:

- low voltage anode foil	100 tpy
- high voltage anode foil	50 tpy
- cathode foil	60 tpy
- bipolar anode foil	10 tpy

The first two items are treated by etching and some of them by forming according to wishes of customers. The cathode foils are treated only by etching, the bipolar anode foils are delivered as plain foils (without treatment).

Maximum capacity of treated anode foil is limited by capacity of production of SPA and by the possibility of remelting scrap. According to VAMI project the yield of SPA is 67 % which means that the satisfactory quality of SPA 99.98 % minimum is reached in the amount of 370 t of the total production of SPA. The maximum capacity of treated anode foil is 183 tpy. In case of imported SPA slabs, the maximum capacity of anode foil is 210 tpy and 90 tpy of cathode foil. The capacity can be increased to 300 tpy by increasing time fund of the equipment from 6,000 hrs to 8,000 hrs and by increasing number of workmen from 87 to 100.

The recommended technological process is as follows:

1. stage:

According to VAMI project, purification of commercial aluminium produced in Korba is based on application of a three-layer method of electrolytic refining. Three purifying cells with amperage of 70 kA will be installed in Korba smelter. The slabs will be cast directly from a special tapping ladle using the existing caster in the cast-house in Korba plant.
For degassing the melted metal ALPUR BATCH equipment is recommended. As the cathode foils are made of CPA or of alloys the respective slabs are to be produced by usual methods in Korba.

2. stage:

Converting slabs into foils will be carried out on the existing equipment partly in Korba (strip rolling) and partly in Bidhanbag (foil rolling). Whereas the existing equipment in Korba is fully suitable for this operation, the foil rolling mill installed in BBU will have to be modernized.

Since the required dimensions of foils are as for
- cathode foil min. 30 microns of thickness and 500 mm of width
- anode foil min. 70 microns of thickness and 500 mm of width
only modernization of so-called rough rolling mill is considered as sufficient. The respective modernization of the mill and its accessories will be provided by the Lauener Co. (former Von Roll) of Switzerland who produced the existing mills.

3. stage:

The whole foil treatment process proceeds from the storage of plain foil through annealing, brushing, etching, forming, checking and packaging.
The foil treatment is based on electrochemical process consisting of two operations: etching and forming. By etching operation the effective surface of condenser foil is increased several times. During so-called forming (i.e. - anodic oxidation) the surface of etched anode foil is covered by thin layer of aluminium oxide. In order to attain clean surface of plain foil with a desirable cubic texture the foil must be annealed and brushed.

The foil finished on the rolling mill in BBU will be annealed and then trimmed and divided to coils of weight of 50 - 80 kgs. Foil will be winded on spools ϕ 70 mm and transported in soft state to the new foil treatment plant (FTP).

Existing equipment in BBU will be used for this operation, however about one third of the whole condenser foil assortment has to be annealed twice to reach the requested quality . For this purpose a small resistance chamber furnace is proposed to be installed in FTP.

Brushing, etching and forming of foil is carried out on one-purpose production lines. These lines will be in continuous operation with unwinding of coils and their winding after treatment operations. For this purpose production lines are equipped with unwinding and winding station. Coils are jointed by squeezing one through another.

- Brushing lines consist of two supporting rollers with three brushing rollers each. Brushing rollers rotate in the counter direction to the foil shift. All the brushes are made of steel and phosphoric bronze wire.

- Etching and forming lines consist of contacting rollers, tanks with chemical solutions, tanks with rinsing water, spraying jets, drying tunnels and length measuring equipment. During processing various types of chemicals as NaCl, Na_2SO_4, H_3PO_4, H_3BO_3 are utilized.

Main new production equipment is proposed in the following numbers:

- resistance chamber furnace for annealing	1
- brushing line	2
- etching line for anode foil	6
- etching line for cathode foil	5
- forming line	2

Other equipment is proposed for the following purposes:

- transport of material	- trolley crane (crab), lifting trucks
- testing of production	- instruments for checking of quality, laboratory accessories
- maintenance	- equipment for small repair works

In order to reach the good quality of foil, cleaned water is used for preparation of solutions and demineralized water is used for rinsing of foil, therefore the water treatment plant is necessary to be built.

Raw water brought into the plant is treated in clarifying reactor and filtrated by means of a sand filter. The treated water is used for bath preparation, in laboratory and for refilling in the cooling circuit. Treated water also becomes a source for production of demineralized water which is necessary for rinsing of foil. Ion exchangers are used in demineralization process - strong acid catex in the first stage and strong basic anex in the second stage.

Besides the water treatment plant a waste water treatment plant is necessary so that treated water could be discharged in a quality corresponding to Indian Standards.

Waste water treatment plant is processing waste waters from both water treatment plant (mud from clarifying reactor and waste water from demineralization process) and from production process (rinsing water and used solutions).

Waste water treatment process comprises:
-treatment by alkaline (treatment of pH)
-precipitating of undesirable elements in a form of mud by using coagulant and poly-flocculant.

Sedimented mud is thickened in dewatering facility to reach the level of 25 - 45 % of dry solids.

Electro-chemical process of etching and forming is using direct current source individually for each etching and forming unit.

Parameters of D.C. sources are different for etching and different for forming operation:

- sources for etching are 2 kA for cathode foil, 2 - 20 V
- sources for etching are 8 kA for anode foil, 2 - 20 V
- sources for forming are 50 - 500 A for HV anode foil, 20 - 800 V

Sources for etching are wired through an impulse switch, which is necessary for reaching high gain quality foil.

Connection to electrical power from existing sources in Korba or in Bidhanbag (depending on the resolution about location) will be made via ground cable into transformer station situated in the new foil treatment plant on the 1st floor.

New production processes are equipped with airconditioning system which provides for cooling to transformer station and to sources of D.C., for ventilation and exhaust.

1.6 Organization of EDU, overhead and other cost (Chapter 7)

EDU will consist of 3 sections:

section 1:
Process of purifying of SPA proposed by VAMI including casting of slabs will be incorporated in the existing smelter.
No other overhead cost will be needed.

section 2:
Process of converting slabs into foil will be incorporated in the existing rolling mill plant in Korba and foil plant in Bidhanbag.
No other overhead cost will be needed

section 3:
The foil treatment plant will be headed by production manager. Direct subordinate staff to production manager is as follows:
- secretary
- deputy manager (technical control)
- chemical engineer (laboratory)
- electric engineer (el. shop)
- supervisor for water-treatment
- supervisors for production.

Supervisors for production are responsible for the production process in 3 shifts assured by 4 working groups (continuous duty).

1.7 Human resources (Chapter 8)

The number of 87 employees is assumed as necessary for foil treatment plant.

Out of this number as minimum as 4 must have a university degree and minimum of 10 must have secondary school education.

Ratio between skilled and unskilled workers is about 1:1. Skilled workers are envisaged in machinery, electrical engineering and chemistry.

In Bidhanbag, two shifts will be needed for production of plain foil on foil rolling mill and for auxiliary operation. Six workers are required for this purpose.

1.8 Project implementation (Chapter 9)

Implementation stages are proposed as follows:

1 Establishment of project team
2 Basic engineering
3 Tendering
4 Evaluation of bids and awarding contracts
5 Detailed engineering
6 Construction
7 Supply and erection of equipment
8 Start up and commissioning
9 Production

Proposed construction of all stages of EDU is 15 months, supply and erection of equipment for the same is 18 months.

Construction period is proposed in duration of 2 years. Beginning of production up to 30% is proposed at the end of 2nd year, 80% at the end of 3rd year and full production of 100% in the 4th year from starting construction.

In accordance with the latest development of opinions and requirements concerning in particular the construction and start-up schedule of the project, the following implementation programme is proposed:

- after modernization of equipment and engineering in Bidhanbag (foil rolling, duration 1 year), production of SPA foils (10 tpy) will start immediately, using imported SPA material,

- after construction of etching/forming facility (duration 1.5 year) production of anode and cathode foil will start, also based on imported SPA,

- after construction of SPA purification facility (2 years duration, VAMI project) the entire production of foils will use domestic SPA as input material (80 % in the first year of such operations and full capacity thereafter).

1.9 Financial appraisal (Chapter 10)

Financial analysis of the project has been prepared for two basic alternatives of the project (foil treatment in Korba or in Bidhanbag) and based on the Computer Model for Feasibility Analysis and Reporting (COMFAR) developed and widely used by UNIDO.

The following taxes and duties have been applied on imported items (according to BALCO indications):

A.	Equipment:		
	1.	Ocean Freight and Insurance	12 % of cost
	2.	Customs Duty	
		(a) FTP facilities	25 % of CIF
		(b) Foil plant equipment	89 % of CIF
	3.	Port Handling	1 % of CIF
	4.	Inland Transport and Insurance	2 % of CIF
	5.	Know-how tax	25 % of fee
B.	Slabs/Foils:		
	1.	Ocean Freight and Insurance	
		(a) Slabs	5 % of cost
		(b) Foils	7.5% of cost
	2.	Customs Duty	20 % of CIF
	3.	Port Handling	1 % of CIF
	4.	Inland Transport and Insurance	2 % of CIF
	5.	Entry Tax	0.5% of cost (after items at 1 to 4)

The following financial parameters have been adopted for financial analysis:

- All prices and costs correspond to 1993 level.

- Prices and costs resulting from VAMI report (1986) have been updated to 1993 level using an average 10 % inflation rate indicated by the Indian counterpart. It means that each financial flow has been multiplied by $1.1^8 = 2.14$.

- For foreign investment cost calculation (import from Switzerland and from the Czech Republic), an exchange rate of 20.0 Rs/1CHF and of 1 Rs/1 CZK has been adopted.

- The complete financial analysis is based on constant prices which makes it possible to compare both technical alternatives of the project. However, according to the wish of the Indian part, a cashflow and net income surveys for 10 % inflation on sales and costs have been added as well as the same without taxation.

Five subjects of investment costs had to be taken into consideration separately, due to different construction schedules:

- SPA purification
- Slab casting
- Strip rolling
- Foil rolling
- Foil treatment

Five products and one by-product had to be modelled separately due to different technology used and thereof resulting structure of their operating costs:
- SPA plain anode foil
- CPA cathode foil
- LV anode foil (etched only)
- HV anode foil (etched only)
- HV anode foil (etched and formed)

and products of 'other use'

The 'other use' products (tab sheets, lead wires and similar) represent a lower quality by-product of the purification process. Since it is not to be included in the project appraisal, its financial impact (costs and sales) has been neutralised in the COMFAR model.

Therefore, both the investments and the annual production costs used in the computer model represent a slightly complicated calculation procedure reflecting among others the time plan of construction and production build-up of particular products.

This is the reason why the investments and production costs are presented in a very aggregate manner in this summary, with reference to a detailed data description in chapter 10. The project alternative with foil treatment in Korba is used in the summary, since the financial parameters of both alternatives are very similar.

Total investment cost:

These investments (partially also during production) are indicated in the following COMFAR structure (Rs 000):

Description of investment	1994	1995
Land, site preparation, development	968.440	0.000
Buildings and civil works	28,327.786	0.000
Auxiliary and service facilities	0.000	0.000
Incorporated fixed assets	25,084.400	0.000
Plant machinery and equipment	105,010.000	464,405.800
Pre-production capital expenditure	80,718.000	0.000
Working capital	0.000	618.968
Total	240,108.620	465,024.768

Initial data are indicated in chapter 6.

Project financing:

In accordance with BALCO requirements only loans are assumed to be used as the external financial sources for the project in the following schedule (Rs 000):

Year	1994	1995
Loan	240,109.0	361,677.3

A long-term loan (10 years amortization, 18% interest rate, constant principal, yearly repayments) has been used in the project with no debt service problems in the financial cashflow.

Total production cost:

These costs are extensively modified during the first years of operations in accordance with the production build-up and due to initial utilization of imported input materials. An already 'stabilized' year (1999 - fifth year of operation) is presented in this summary with reference to details in chapter 10 and COMFAR tables (Rs 000).

Year	1999
Factory costs	68,135.360
Administrative overheads	2,460.585
Indir. costs, sales and distribution	1,408.457
Direct costs, sales and distribution	0.000
Depreciation	64,822.290
Financial costs	75,825.070
Total	212,652.262

Of it 25.103 % variable.

Financial analysis

The financial analysis shows a high degree of profitability for both alternatives of the project giving a good level of project stability under worsening conditions (lower sales, higher costs). The following parameters represent some of the typical financial statements of the project (1,000 Rs):

Net present value on investment:

- 15 % discount rate
- 16 years horizon for NPV computation, income tax excluded according to BALCO requirements

NPV = 1,345,709.0

Internal rate of return:

IRR = 55.26 %

Pay-back period:

PBP = 3 years

Simple rate of return:
(5th year of operations as an example)

- on equity

ROE not indicated (no equity used)

- on investment

ROI = 45,208%

Break-even analysis:

The break-even chart (1999, financial cost included in the fixed costs) indicates the break-even point at approximately 40% which is a satisfactory value (with the financial costs excluded the break - even point is slightly over 20%)

Sensitivity analysis:

This analysis has been made in the break-even chart and in the internal rate of return charge.

The former analysis has been in particular aimed at decreasing sales prices and increasing fixed or variable part of total production costs which may become potential risk parameters. Variation of 10 and 30% has been examined with the worst case (-30% sales prices and +30% fixed costs) moving the break-even point to the value of 80%.

The latter analysis shows the highest degree of the IRR sensitivity to sales prices, then to initial fixed investment whereas the sensitivity to the operating costs is almost negligible.

Conclusions:

The financial statements indicate a high profitability and financial viability of the project of condenser foil production, in both of its alternatives, even under conditions of a purely loan - oriented financing.

From purely financial point of view, the alternative assuming the foil treatment facility in Korba is slightly better. Higher transportation costs (re-transport of foils back from Bidhanbag) are more than compensated by lower energy costs in Korba in comparison with Bidhanbag.

However, since the differences between the alternatives are really very small, environmental, social and other aspects may be taken into consideration.

2. PROJECT BACKGROUND AND HISTORY

2.1 History of the project

The Bharat Aluminium Company Limited (BALCO), a Government of India enterprise, owns and operates an Integrated Aluminium complex at Korba (M.P.) with a production capacity of 100,000 tpy of aluminium metal along with matching capacity of semis like rolled and extruded products, Properzi continuous cast and rolled rods, etc. In addition, BALCO also operates a semi fabrication complex which converts 5,000 tpy of primary aluminium metal into semis like rolled and extruded products, conductors and foils etc., at Bidhanbag (West Bengal). Thus, in short, BALCO owns and operates aluminium production and semi fabrication facilities up to and inclusive of the manufacture of aluminium foils.

In order to expand the product range, BALCO intends to diversify into the production of Super Pure Aluminium (SPA) metal which is a high value-added product having potential in the electronics industry, and its entire requirement is being met from import. Accordingly, a Feasibility Report to set up a Demonstration Unit for the production of 500 tpy SPA metal was prepared with the assistance of UNDP vide project No. DP/IND/84/007 by VAMI, (Russia).

In the meantime, a market survey was conducted by BALCO to assess the potential demand for SPA metal, which reflected absence of demand for SPA metal as ingots but substantial demand projected for SPA metal foils in etched and formed condition which is currently being met from imports. In view of this, it was decided to prepare a Feasibility Report for setting up a Demonstration Unit for the manufacture of Super Pure Aluminium and its conversion into condenser foils.

2.2 Description of the project idea

Etched and formed foils are the main inputs in electrolytic condensers.

Electrolytic condensers basically consist of two metal plates electrically insulated by a dielectric medium. Aluminium of high purity is used in the two metal plates - anode and cathode.

Plain aluminium foils of appropriate purity grade are etched and formed before using as anode and cathode foils.

Indian producers of electrolytic condensers import foils of various quality. There are more than 15 major condenser manufacturers in India. The production of aluminium electrolytic condensers in India recorded annual growth of over 30 percent during 1975 to 1987. This trend will probably continue to year 2005.

No Indian capacitor manufacturer is currently having etching facilities and neither there is a plan for having the same. Two of capacitor manufacturers (KELTRON, Cannanore and ELCOT New Era Technologies, Hosur) have some capacity for forming of low voltage anode foil, but substantial quantity of high voltage anode foils are being imported.

BALCO intends to establish experimental demonstration unit (EDU) consisting of new plants for production of super pure aluminium (SPA) and for treatment of plain foils. Production of foils from SPA slabs (anode foil) and from Al alloyed slabs (cathode foil) will be provided on the existing equipment.

The site for new treatment plant will be chosen either in Korba or in Bidhanbag according to economical evaluation and with respect to other factors.

2.3 Initiator of the Project

The initiator of the EDU project is Bharat Aluminium Company Limited (BALCO), the Government of India undertaking. BALCO was founded in the year 1965. The head office is located in New Delhi.

The existing Aluminium Complex at Korba under BALCO consists of: bauxite mine, alumina plant, smelter, fabrication complex.

Besides this, the Company also manages the Jaykaynagar unit (Bidhanbag) located about 250 - 300 km from Calcutta. It consists of foundry, extrusion plant, rolling plant and foil plant.

A market survey was conducted by BALCO and its results are included in two reports:

- Report by NCAER (National Council of Applied Economic Research) titled "Market Survey and Study of Super Pure Aluminium".

- Report by Department of Science and Technology of Government of India titled "Technology Status Report on Electrolytic Capacitors".

Market survey reflected absence of demand for SPA metals as ingots but there is a substantial demand for SPA as metal foils both etched and formed. Therefore, it was decided to prepare a Feasibility Report for setting up a Demonstration Unit for the manufacture of SPA and its conversion into condenser foils.

2.4 Executor for the preparation of Feasibility study

UNIDO Contract No. 92/090 has been signed between the United Nations Industrial Development Organization Vienna, Austria and Polytechna Co., Ltd., Prague/Metalconsult Co., Ltd., Prague, The Czech Republic for the provision of services relating to the Establishment of an "Experimental Demonstration Unit (EDU) for Manufacturing Super-pure Aluminium and Condenser Foils from it"- Feasibility Study. The project DP/IND/84/007 executed by UNIDO is a pre-stage for manufacturing condenser foils.

3. MARKET ANALYSIS AND MARKETING STRATEGY

3.1 Market analysis

"Market Survey and Study of Super Purity Aluminium" (Volume 1, Main Report, (Indian) National Council of Applied Economic Research - NCAER, April 1991) has been at the disposal to the feasibility study team as a principal background for the market demand considerations.

The survey was sponsored by BALCO Ltd. and it represents a good survey of the super purity aluminium market both in India and in the world, taking into consideration its contemporary state and including some scenarios of the future demand development.

The findings of the Survey were subsequently complemented and modified in accordance with the results and findings achieved during the fact-finding mission of the feasibility study team and afterwards. The latest information is included in the "Record Note of Discussions" prepared after the fact-finding mission (September 1992) and in the "Record Notes of Discussions" prepared during the subsequent visit at leading capacitor manufacturers in India (November 24, 1992).

3.2 Data and alternative projection methods

Since it has been found that the Indian industry is not able to produce the super purity aluminium at present, there are basically three strategies for any future development:

- import from SPA producing countries (Italy, Japan, Germany, France, Switzerland, United Kingdom, Poland),
- creating a domestic production capacity for SPA (purification, conversion to foil and subsequent etching and forming operations),
- some combination of the previous two possibilities leading to partial import or partial export of the domestic market deficit or surplus respectively.

From the general point of view, the following data for market analysis are needed:

- potential demand for the SPA in India, present and future, taking into consideration the SPA being usually a semi-product finalized subsequently into some immediately utilizable products (foils, wires etc.),
- potential capacity of domestic manufacturer(s),
- import prices of the SPA or some final products of it (including custom duties and transport taxes),

- domestic production and distribution costs and domestic market prices of the SPA products,

- potential export prices of the SPA products for the possibility of exporting some part of the domestic production.

From this particular project point of view the complexity of the necessary marketing data was reduced because the project is clearly oriented to creating own production facility represented by the Demonstration Unit for manufacturing SPA and condenser foils from it. Therefore, specification of the required production capacity is the aim of this part of the feasibility study.

3.3 Determination of market size for products

Since it has been found that there is no domestic SPA production in the country at present and the entire demand is met through imports, it is obvious that all this demand represents a potential market capacity for the domestic production. However, a quality aspect has to be taken into account (at least during the start-up years of production) affecting negatively this optimistic estimate.

The use of the SPA in India is oriented into four sectors:
- Electrolytic condensers (95 % of the entire demand),
- Aeronautical industry,
- Electronic industry,
- Atomic energy.

Thus, this project dealing with the production of SPA foils for capacitors covers a decisive part of the entire SPA consumption in India.

A survey of the actual projected annual demand of the SPA foils in the NCAER report has been used for determination of the potential market. Whereas the actual (past) demand was indicated in tons of slabs of all purity grades per year and their equivalent in foils, the future projection was represented by SPA demand (tpy) following two alternative scenarios - 80 kg SPA per 100,000 capacitors (Sc.1) and reduced to 75 kg SPA per 100,000 capacitors after 1996 (Sc. 2).

Therefore, the past demand has been converted to be equivalent to the future projection (SPA representing 42.2 % of all purity grades of HPA), which resulted in the following figures:

Past and projected demand of SPA slabs (tpy)

Year	Demand		
1985	141.81		
1986	164.60		
1987	223.67		observed
1988	265.89		
1989	284.04		
	Sc.1	Sc.2	
1990	318.65	318.65	
1991	353.30	353.30	
1992	387.94	387.94	
1993	424.53	424.53	projected
1994	457.22	457.22	
1995	491.84	491.84	
2000	665.82	623.46	
2005	838.18	785.80	

Future demand is fully based on a linear projection of the increasing production of capacitors (30 % yearly in 1975 - 1987), covering almost the entire SPA demand in India. It may be a subject of discussion, whether such an increase rate would keep a constant pattern during a period of 30 years without any tendency to some saturation level. Nevertheless, it is obvious that any of its future estimates stands higher than the production capacity of EDU analyzed in this project.

It should be taken into account that the capacity of the SPA purification, which is the initial operation of the whole foil manufacturing process, is determined by the VAMI project of 1986 and should be (in accordance with the Terms of Reference) respected.

Therefore, it will be the production capacity of EDU that will determine the part of the Indian market which will be covered by this first domestic source still giving a lot of space to imports. This capacity is indicated below, in the "Production Programme and Plant Capacity".

It is the question of the future development in the market and of the experience with SPA production in the demonstration unit how the production/import ratio will change in the future.

****NOTE****

The sales revenues of the lower grade SPA utilized for other purposes than condenser foils are not included in the sales within this project as assumed and agreed with BALCO.

3.4 Sales programme and marketing of products

Sales programme

The sales programme assigned to the project covers 3 types of condenser foils:
- SPA > 99.98 % anode foils, etched and formed
- CPA about 99.7 % cathode foil, etched
- SPA plain foils for bi-polar capacitors

Further, SPA < 99.98 % earmarked for lead wires, tab sheets, etc. is obtained as by-product.

****NOTE****
In contrast with Market Survey this report considers also the utilization of SPA purity grade 99.98% and above for production of anode foil.

Marketing strategy

Since the entire potential market for the items indicated above is represented by Indian condenser manufacturing industry the marketing activity was aimed at this area. The results can be summarized as follows:

- Market capacity is (at least at present) higher than the assumed capacity of the projected demonstration unit.
- The capacitor manufacturers are not interested in utilizing the super purity aluminium in slabs for their own manufacture of foils.
- Whereas there is some capacity for forming of anode foils with some of the capacitor manufacturers (or the foils imported are already treated in this way), there is no etching facility there and no plans for establishing it.
- The market is fully saturated by imports, but the manufacturers of capacitors are willing to utilize domestic foils.
- The only conditions are competitive prices and, in particular, the quality which must be comparable with that of the imported material.

Production programme and sales revenues

Sales revenues per year will depend on the production programme and sales prices applied on the market.

The following figures have been adopted in accordance with the NCAER report and BALCO indications.

- SPA plain anode foil	- 10tpy	350 Rs/kg
- CPA cathode foil	- 60 tpy	990 Rs/kg
- LV anode foil (etched only)	- 100 tpy	2,170 Rs/kg
- HV anode foil (etched only)	- 10 tpy	2,170 Rs/kg
- HV anode foil (etched and formed)	- 40 tpy	3,240 Rs/kg

The expected sales revenues could be estimated at 435.2 mil. Rs/year.

4. MATERIALS AND OTHER PRODUCTION FACTORS

4.1 Characteristics of raw materials and inputs

The raw materials and semi-products can be divided according to 3 stages of production:

1. stage - commercial crude aluminium metal from the electrolysis cell-rooms. This is converted by purification to SPA and cast to slabs.

2. stage - SPA slabs for production of anode foil and CPA slabs for production of cathode foil form semi-product that is converted to plain foil on existing rolling equipment.

3. stage - plain foil is a semi-product used for production of condenser foil by means of etching and forming.

In this chapter the raw materials and semi-products needed in the 3. stage are specified. Other raw materials for purification of metal (1. stage) are stated in VAMI project. The slabs are specified in the flow charts 6.02 and 6.03 - Volume II.

4.1.1 Classification of materials for treatment of foils

Raw materials and inputs required for production of treated aluminium condenser foil:

- plain aluminium anode foil
- plain aluminium cathode foil
- chloride of natrium NaCl
- sulphate of sodium Na_2SO_4
- boric acid H_3BO_3
- phosphoric acid H_3PO_4
- dihydrophosphate of ammonia $NH_4H_2PO_4$
- ammonia hydrate NH_4OH

4.1.2 Requirements for raw materials and inputs

For processing of aluminium condenser foil by etching and forming the foils with the following parameters are to be used:

Anode foil	- purity of aluminium	99.98 % minimum
	- foil thickness	0.07 - 0.1 mm
	- foil thickness - bipolar capacitors	0.04 mm
	- foil width	500 mm
	- weight of coil	50 - 80 kg

Cathode foil	- quality of foil	
	a) purity of aluminium	99.5 % minimum
	b) alloys of AlMn, AlCuMn, AlFeMn, amount of alloyed elements up to 2%	
	- foil thickness	0.02 - 0.05 mm
	- foil width	500 mm
	- weight of coil	50 - 80 kg

Chemicals required for etching and forming process:

NaCl	- technical purity
Na_2SO_4	- technical purity
H_3BO_3	- purity analysis (p.a.)
H_3PO_4	- p.a.
$NH_4H_2PO_4$	- p.a.
NH_4OH	- p.a.

Concentration of chemicals required for water treatment and disposal of waste waters:

Water treatment plant (WTP)	- $FeCl_3.6H_20$ - min. content of $FeCl_3$	60 %
	- $Ca(OH)_2$	84 % min.
	- H_2SO_4	94 % min.
	- NaOH	98 % min.
Waste water treatment plant (WWTP)	- NaOH	
	- $Al_2(SO_4)_3$	

Flow sheets of material and utilities are given in tables No. 4.01, 4.02, 4.03 - Volume II.

4.2 Consumption of raw materials, water and energy

The amount of 210 tons of treated aluminium foil for production of electrolytic condensers is envisaged in the following assortment:
100 tons of LV anode foil for etching only
50 tons of HV anode foil for etching out of which 40 tons for forming
60 tons of cathode foil for etching only

The consumption of raw materials and energies for the stated assortment is calculated as follows:

Consumption of plain foils

TABLE 4.01

	SORT OF MATERIAL	UNIT	AMOUNT
1	Anode Al foil for treatment	t	257
2	Anode Al foil for bipolar cap.	t	10
3	Cathode Al foil	t	75
	Al foil in total	t	342

Amount of chemicals required for etching and forming

TABLE 4.02

ITEM	DESCRIPTION	Requirement in kg/t of foil	Requirement in t in total
1	NaCl	432.8	89.0
2	Na_2SO_4	110.7	23.25
3	H_3PO_4 (for passivation)	30.0	1.8
4	H_3PO_4 (for forming)	100.0	4.0
5	H_3BO_3	364.0	14.56
6	NH_4OH	40.0	1.6
7	$NH_4H_2PO_4$ (for passivation)	45.0	1.8
8	$NH_4H_2PO_4$ (for forming)	20.0	0.8

Chemicals required for water treatment and for disposal of waste waters

TABLE 4.03

ITEM	DESCRIPTION	Concentration	Requirement in t/year
	For production of demi water		
1	$FeCl_3 . 6H_2O$	60 % min.	5.0
2	$Ca(OH)_2$	84 % min.	10.0
3	H_2SO_4	94 % min.	24.0
4	NaOH	98 % min.	17.0
	For WWTP		
5	NaOH		45.0
6	$Al_2(SO_4)_3$		5.5

Consumption of el. power per 1 t of treated foil

TABLE 4.04

Sort of foil	MWH		In total
	Etching	Forming	
Anode LV	25.0	29.0	54.0
Anode HV	25.0	159.0	184.0
Cathode	7.0	-	7.0

Consumption of el. power for the overall assortment for the production of 210 t/year.

TABLE 4.05

Sort of foil	tpy		MWH in total
	etching	forming	
Anode LV	100	-	2,500
Anode HV	50	-	1,250
Anode HV	-	40	6,360
Cathode	60	-	420
	In total		10,530

****

Consumption of compressed air (without oil admixtures) is 1,400 m^3/t of treated foil. Considering treatment of 210 t of foil the overall need of compressed air is 294,000 m^3/year.

Water requirement

TABLE 4.06

ITEM	SORT OF WATER	UNIT	AMOUNT
1	Demineralized water for rinsing of foils	m^3/hr	6.0
2	Clarified and filtrated water for technology, preparation of solution, laboratory	m^3/hr	3.0
3	Re-filling to circulation circuits	m^3/hr	4.0
4	Consumption of water for house purposes in WTP	m^3/hr	3.0
	In total	m^3/hr	16

Annual consumption of raw water is 96,000 m^3.

Annual Requirements for Raw Material and Utilities

TABLE 4.07

ITEM	DESCRIPTION	UNIT	Years from start of operation	
			1.st year	2.nd year
1	Al anode foil	t	205.6	257
2	Al anode foil for bipolar cap.	t	10	10
3	Al cathode foil	t	60	75
4	NaCl	t	71.2	89.0
5	Na_2SO_4	t	18.6	23.25
6	H_3PO_4	t	4.6	5.8
7	H_3BO_3	t	11.6	14.56
8	$NH_4H_2PO_2$	t	2.0	2.6
9	NH_4OH	t	1.3	1.6
10	$FeCl_3 \cdot 6H_2O$	t	4.0	5.0
11	$Ca(OH)_2$	t	8.0	10.0
12	H_2SO_4	t	19.2	24.0
13	NaOH	t	49.6	62.0
14	$Al_2(SO_4)_3$	t	4.4	5.5
15	Power for etching	MWH	3,336	4,170
16	Power for forming	MWH	5,088	6,360
17	Annual consumption of raw water	M^3	76,800	96,000

4.3 Selection of Supply Programme

Selection of the supply programme is determined by consumption of materials in the production process, continuity of operation, schedule of material consumption, availability of storage areas, capacity of transport means etc.

Supply programme is also based on the following presumptions:
- on-going production in the amount of 30 t, i.e. approx. 60 days
- finished products on stock in the amount of 20 t, i.e. approx. 1 month production.

Annual consumption of material and chemicals is presented in the tables No. 4.01 and 4.02, the necessary stock supplies are proposed as follows:.

Stocks of Raw Materials and Utilities:

TABLE 4.08

	t	days
Al foils	85	90
NaCl	15	60
Na_2SO_4	4	60
H_3PO_4	1	60
H_3BO_3	2.5	60
$NH_4H_2PO_4$	0.5	60
NH_4OH	0.25	60
Chemicals for WTP, WWTP	18.0	60

4.4 Spare parts

Spare parts have been allowed for the new foil treatment plant.
These are provided for the following sections:
- drives
- heating devices in basins
- regulators
- contacting of foils
- electrical accessories

Cost for spare parts and regular maintenance per year is approximately 5 % of overall investment cost of the equipment.

4.5 Production cost estimate - materials and utilities

Item	Qy		Unit	Cost item	Unit cost Rs 000	Total cost Rs 000	
	Year from start of operation					Year from start of operation	
	1st	2nd				1st	2nd
	273.6	342.0	t	Al foils			
1	109.2	136.8	t	Chemicals for etching and forming		3,501.6	4,377
2	85.2	106.5	t	Chemicals for WWTP and WTP		1,003.2	1,254
3	8,424	10,530	MWH	El. power for etching and forming	(a) Site Korba 1,000	8,424	10,530
					(b) Site Bidhannbag 1,300	10,951	13,689
4				Packing material	estimate	160	200
				TOTAL	(a)	13,088.8	16,361
					(b)	15,615.8	19,520

****NOTE****
The table contains cost estimates relating to treatment of foils only.

5. LOCATION, SITE AND ENVIRONMENT

5.1 Location

In accordance with the UNIDO contract the following Indian states for the EDU location were to be considered:

- Madhya Pradesh State, the BALCO's plant in Korba region,
- West Bengal State, the BALCO's plant in Bidhanbag, in Jaykaynagar region.

5.1.1 Korba aluminium plant

Plant at Korba was established at the turn of 1970's and 1980's. It is located at the foot of the Plutkapahar range south of the Indian plain. The area is highly industrialized with richest raw material resources of India.

The plant was conceptually conceived as a large industrial complex respecting principles of zonal planning with sufficiently established sources of energy, infrastructure, communications and rail tracks. An integrated township area with population of about 20,000 people was built in the vicinity of the plant. The township has a post office, police station, hospital, several schools, training center and cinema hall. As a governmental incentives policy a decent quality housing schemes off houses were provided for the employees working in the plant.

Main production sheds are steel structures on concrete foundations cladded with asbestos sheets. Auxiliary buildings such as transformer stations, air-conditioning units, pump stations and offices are mainly concrete structures with facades made of concrete panels or plastered brickwork with paint finish.

About 7,000 people is employed in the plant.

All buildings are documented in general layout plans in sections provided with coordinates.

The climate is tropical, monsoon type with three distinct seasons

- winter season from December through February, temperatures descend as low as 4 to 10 deg.C,
- hot dry season from mid March to mid June. Dust storms are frequent at this time,
- hot wet season (monsoon) from mid June to mid October. During the rainy season the temperatures may reach 45-50 deg. C and are usually accompanied with high humidity (95 - 98 %).

The average annual rainfall is approximately 150 - 157 cm, most of which occurs during the monsoon season - about 73 rainy days.

5.1.2 Plant in Bidhanbag

The Jaykaynagar region forms part of Indo-Gangetic alluvial plain in the north-east of India. The area is highly industrialized and rich with raw materials such as iron, coal, bauxite and copper. Number of coal mines, steel plants and other heavy industry enterprises are established there.

Plant at Bidhanbag was set up in 1938 as a medium size self contained metallurgical plant incorporated within a coal mine. Since 1940's the plant was gradually extended until 1960's when it consisted of alumina plant, smelter, casting house, rolling mill, extrusion plant, foil plant and conductor plant. Main production buildings are made of concrete structure with plastered brickwork facades. At present, casting, rolling, extrusion and conductor plants are in operation. The other plants were closed down, buildings left in a poor condition and still deteriorating.

The unit is complemented with simple dwellings for employees and with couple of residential houses.

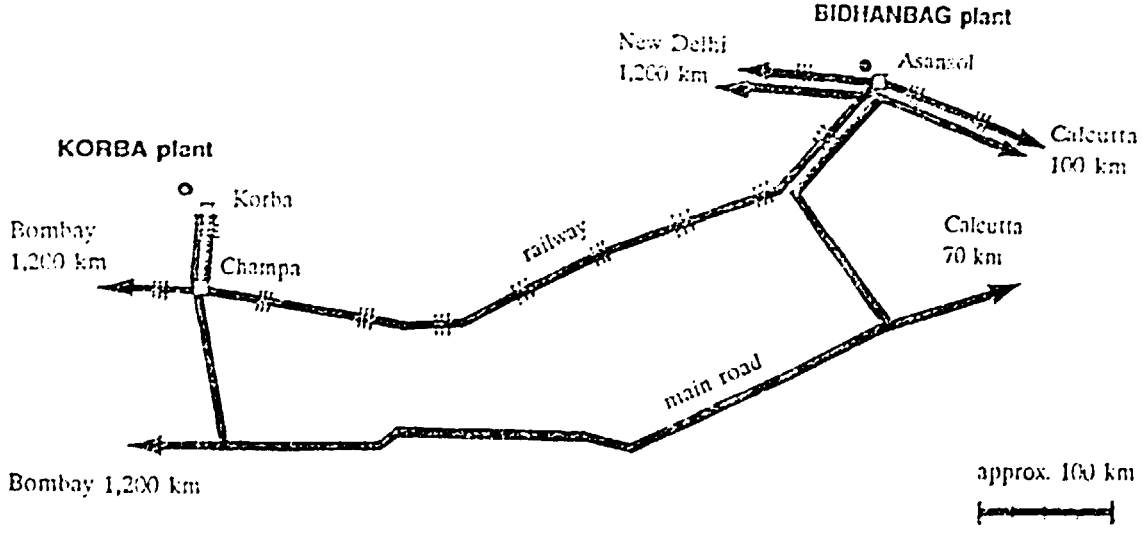
The area is interconnected with rail tracks and roads.

About 1,000 people is employed in the plant.

* * * * *

Existing equipment in Korba and in Bidhanbag will be used for the new production and transport of material is envisaged between both places. It is assumed that most of aluminium will be transported by road as the railway is not used so much for frequent time losses.

Relation of Korba and Bidhanbag is shown on the diagram below.



5.2 Main Factors for Selection of the Foil Treatment Plant (FTP) Location

The location of the FTP was discussed with BALCO representatives, taking the following factors into consideration:

5.2.1 Supply of primary aluminium
5.2.2 Possibility of utilization of the existing facilities
5.2.3 Transportation costs of raw materials and inputs
5.2.4 Possibility of power supply
5.2.5 Availability of skilled labour
5.2.6 Required investment and production costs for construction and operation

5.2.1 Supply of primary aluminium

Production of primary aluminium is situated in Korba and therefore location of SPA production proposed by VAMI project in existing smelter in Korba is respected.

5.2.2 Possibility of utilization of the existing facilities

Existing facilities for slab casting, hot rolling and cold rolling of strips will be utilized in Korba and foil rolling facility will be utilized in Bidhanbag.

5.2.3 Transportation costs of material and inputs

Foil treatment plant (FTP) can be located either in Korba or in Bidhanbag.

Foil stock is produced in Korba and transported to Bidhanbag to be converted into plain foils. In case FTP is situated in Bidhanbag, transport of material will take place only once in the form of strips in direction Korba - Bidhanbag. In case FTP is situated in Korba transport of material will take place in both ways, i.e. in the form of strips in direction Korba - Bidhanbag and in the form of foils in direction Bidhanbag - Korba.

However, transportation of material is unavoidable irrespective of the definite location of FTP.

5.2.4 Possibility of power supply

In both places there is electrical power, compressed air and water available.

Price of electrical power in Korba is 1 Rs per 1 kWH (state in 1992). Operational cost for consumption of electrical power in Bidhanbag will be 1.3 times higher than in Korba. Considering the annual consumption of 10,530 MWH/year this represents sum of 3,159,000 Rs per year.

5.2.5 Availability of skilled labour

Conditions for recruitment of employees of the required skills are convenient in both Korba and Bidhanbag.

5.2.6 Required investment and production cost for construction and operation

Detailed comparison is given in chapter 10.

5.3 Environmental impact assessment

5.3.1 Impact of domestic conditions in India on construction of the new plant

- Climatic conditions (high temperatures, high humidity and rainy seasons) will not affect construction and assembly of technological equipment, which will be adapted to tropical conditions.

- High temperature is negatively affecting operational cost as a result of increased consumption of electric power for ventilation to D.C. power supply and transformers.

- Quality of raw water is not affecting production as the new plant has its own water treatment plant. This is necessary for providing demineralized water of prescribed quality.

Specific electrolytic conductivity at 25 °C	1 S/cm max.
pH	6.5-7
SiO_2 content	1 mg/l max.
Cl^- content	0.2 mg/l max.
Fe content	0.2 mg/l max.

5.3.2 Impact of the new foil treatment plant on the environment

Treatment of foil is an electrochemical process with the need of chemicals (anorganic salts) in quantities as follows:

for production of etched and formed foil	136.5 tpy
for water treatment plant	106.5 tpy
in total	243.0 tpy

Overall amount of water required for production is 9 m^3/hour.

From this amount	- demineralized water requirement is	6 m^3/hr
	- clean industrial water requirement is	3 m^3/hr

Overall consumption of raw water is 96,000 m^3/year even though a partial re-generation is provided. Most of the salts and used water will be drained from the process into waste water treatment plant which forms part of the technological process.
The following quantities of liquid and solid wastes arise in the WWTP:

- liquid waste 52,400 m^3/year

Anorganic salts (mainly NaCl) are diluted in the quantity of 3,000 - 4,000 mg/l.
These wastes can be discharged out of the plant providing they are further diluted twice with other liquid wastes in the plant. In this way the requirement set by Indian Standard is met. In the liquid wastes a content of boron is envisaged in the amount of 26-50 mg/l. This content exceeds Indian Standard by 20 times. Should this content of boron be in compliance with IS the liquid wastes must be drained into neutralization plant where the 20 times dilution is probable or the wastes must be drained into sewage/drainage system with high flow capacity.

- solid waste

Mud from waste water treatment plant mainly containing $Al(OH_3)$ will be carried to deposit site. Mud is not toxic but due to the presence of salted water it is not suitable for further processing.

In the process of etching of foils, losses of Al are within the range up to 38 %. Arised $Al(OH)_3$ is regularly drained from etching basins and deposited as mud after separation from etching solution. About 330 t of mud is created in the process of treating 332 t of plain foils.

Compound of mud is as follows:

$Al(OH)_3$	- 264.0 t
water	- 49.5 t
NaCl	- 13.2 t
Na_2SO_4	- 3.3 t

Mud will be deposited on a non-permeable dumping site. For the future, market possibilities in chemical industry will be explored.

Dust arising from brushing operation is extracted and separated in a dust catcher in the overall amount of approx. 3.6 t/year with the maximum size of particles 0.1 mm. This amount of dust is considered to be small and therefore further processing is not envisaged. Dust will be stored on a dumping site. Permittable limits for effluent discharged in inland surface water in India are presented in the table No 5.01.

- fly away waste

Installed airconditioning equipment mainly provides ventilation to production areas and cooling to electrical equipment. Bearing in mind that the etching and forming process operates with the approximate working temperatures of solutions 80-90 °C, vapours are extracted from each basin or from the complete lines. Extract ducting will be provided by eliminator of drops which ensures that extracted emissions comprise water vapours without harmful chemicals.

6. ENGINEERING AND TECHNOLOGY

6.1 Production programme and plant capacity

6.1.1 Quality requirements on products

Condenser foil will be produced and supplied to Indian consumers after completing Al refinery, modernization of foil rolling mill and after erection of the foil treatment plant.

Production programme and EDU capacity are dependent on the Indian customers demand and on SPA production capacity limits used for production of anode foil.

Indian customers require etched cathode foil 500 mm wide.

Anode foil is either required as etched (for LV condensers) or etched and formed (for HV condensers). Anode foils for HV condensers are formed by customers in 20 % of cases approx., the remaining demand of approx. 80 % is being met by purchase. Required width is also 500 mm.

Small amount of plain anode foil with no electro-chemical surface treatment is also required. These foils are supplied in surface quality after passing rolling operation and they are used for bipolar condensers.

- Chemical composition:

(a) For **anode** foil, SPA is used in purity grade higher than 99.99 %. According to experience of consumers and producers of etched and formed foil aluminium of purity 99.98 % can be used in some kinds of condensers, too.

Minimum content of impurities is important in forming of cubic texture during the rolling and annealing of strips and foils. Maximum content of elements is as follows:
Si - 0.006 % max.,
Fe - 0.005 % max.,
Cu - 0.003 % max.,
Zn - 0.005 % max.,
Ti - 0.002 % max.

(b) For **cathode** foil, CPA is used in purity grade of 99.7 % approx. Beside the electrical capacitance, tensile strength is important and therefore some elements as Mn, Cu, Fe are added to aluminium. One of the used alloys is specified as follows:
Mn = (1.5 - 1.8)%, Fe = (0.6 - 0.8)%, Ti = (0.04 - 0.06)%, remaing part = Al.

- Dimensions and mechanical properties

(a) Anode foil

thickness	70 - 100 micrometer (0.070 - 0.100 mm) (for bipolar condenser 40 micrometer)
tolerance of thickness	± 8 %
weight of coil	50 - 80 kg (exceptionally 100 kg)
tensile strength Rm	80 MPa max.

(b) Cathode foil

thickness	20 - 50 micrometer
tolerance of thickness	± 8 %
weight of coil	50 - 80 kg (exceptionally 100 kg)
tensile strength Rm	90 MPa min.

Both anode and cathode foil are 500 m wide, tolerance -0, +1 mm.

Max. content of Cl on the surface of foils is 0.5 mg/m^2.

6.1.2 Assortment and quantity requirements on production

As described in chapter 3 - following production programme has been agreed with BALCO:

Anode foil - low voltage	100 tpy
Anode foil - high voltage	50 tpy
Anode foil for bipolar condenser	10 tpy
Cathode foil	60 tpy
In total	220 tpy

6.1.3 Plant capacity

The capacity of EDU depends on utilization of the newly proposed purifying cells (according to VAMI project), on utilization of existing equipment in Korba and in Bidhanbag and on capacity of the new foil treatment plant.

(a) Purifying cells (VAMI project)

Production capacity of cells in response to purity grades of SPA:

Item No.1	Al content min. %	Quantity tpy
1	99.995	5.5
2	99.99	243.0
3	99.97	243.0
4	99.95	48.5

For production of anode foil item 1, 2 and half of item 3 can be used, i.e. 5.5+243.0+121.5= 370 t in total. Considering the 1% loss while casting slabs operation, the maximum capacity of purifying cells is 366 t approximately, which amount is adequate to 183 t of finished treated foil (etched and formed). Equivalent ratio of slabs to treated foils is 2:1, minimum purity of anode foil is 99.98%.

Nominal capacity (feasible normal capacity) of treated anode foil 160 tpy
Nominal capacity of production of SPA slabs 320 tpy

Maximum capacity of treated anode foil 183 tpy
Maximum capacity of production of SPA slabs 366 tpy
(maximum capacity is limited by amount of SPA of grade purity 99.98 %).

(b) Existing equipment in Korba and Bidhanbag

- Existing equipment in Korba which will be used for converting slabs into foils has a large capacity compared to the amount of semiproducts produced for condenser foil. Required capacity is only 1.5 % of the total capacity of equipment. This figure applies to equipment for machining of slabs, hot rolling, cold rolling, annealing and slitting. Equipment has sufficient capacity reserve for production of foil stock.

- For production of foils in Bidhanbag, the 4 high non-reversible roughing mill will be used. At present this mill is producing 300 t of semiproducts for further processing on the finishing mill.

After revamping, the roughing mill will be producing 288 t of plain condenser foils in finished size. The mill will be utilized in two shifts for this production programme. Remaining capacity will be available for other production purposes (approx. 1 shift).

Calculation for setting up usage time see in Chapter 6.3.2.

(c) Foil treatment plant

Production equipment is proposed for the nominal capacity of 220 tpy. Maximum capacity is determined by the limited capacity of incoming SPA material which is 250 t. This capacity will be met by increasing usage time on etching and forming units.

6.2 Proposed technology

Setting up production of SPA and foils from it depends on materialization of the following 3 technological stages:

- production of super pure aluminium in a form of slabs,
- conversion of super pure aluminium slabs into plain foils for anode and of pure or alloyed aluminium slabs to plain foils for cathode,
- treatment of plain foils by etching and forming to obtain condenser foils of specific quality.

6.2.1 Super pure aluminium production

Establishment of super pure aluminium production envisaged under the project DP/IND/84/007 is based on application of a three-layer electrolytic refining commercial-grade aluminium metal. The major item of the process equipment is a purifying cell with amperage of 70 kA. There will be three pots installed, two of these being constantly in operation, the third pot will operate at two modes, i.e.
- at the mode of electrolyte preparation and cathode impregnation,
- at refining mode.

The purifying cells will provide 540 t of molten metal per year. Every two days the 3 t vacuum ladle will be prepared with molten metal. The production unit will be situated in Korba Aluminium Smelter in the cell-room No. 75. The supply of molten primary aluminium will be provided directly from existing cell-rooms.

The super pure aluminium will be cast into slabs with the weight up to 3 t per each slab. This weight is determined by parameters of existing rolling mill in aluminium complex in Korba.

Slab casting

In accordance with the results of the VAMI project and in compliance with the Record Note of Discussions in India, the slab casting will be provided directly from the vacuum ladle which is to be used for tapping. The ladle will have a self heating system for pre-heating and have a cover to minimize heat loss from tapped metal. This ladle will be placed on a stand and shall be tilted by means of chain-pulley block to control the pouring rate during casting.

"SNIF" system (ALPUR BATCH) for cleaning of degassing of hot metal before casting can be considered. This system involves spinning of metal for removal of oxides and entrapped gases and will be used also for other production.

Direct casting of slabs from ladle does not allow for remelting scrap. Temperature of metal after refining is 770 °C - 810 °C, which seems insufficient for the scrap to be remelted.

If the scrap is to be recycled the following method of double melting may be considered: Melted SPA metal is cast into pigs. Pigs along with large item of SPA scrap are remelted in the existing oil furnace once in a quarter in batches of 70 - 90 t. The melted metal is then transferred into holding furnace from which slabs are cast.

In respect of the above stated fact that the method of direct casting was preferred, the financial analysis is elaborated solely for this method as for the selected one, however both methods are shown on drawings (Volume II. - Drgs. No. 6.01 and 6.02).

Chips, trims and foil scrap can be remelted separately in electrical induction furnace, cast into pigs and used as charge for production of aluminium conductors.

CPA slabs or alloyed aluminium slabs used for production of cathode foil could be produced in a similar way.

6.2.2 Plain foil production

According to the purpose the condenser foil may be divided as follows:
- foil serving in condenser as anode (so-called anode foil)
- foil serving in condenser as cathode (so-called cathode foil).

Incoming material for anode foil is aluminium of minimum purity 99.99 % (possibly aluminium of range 99.98 - 99.99%) which is being obtained through refinery and by means of casting into slabs (ref. 6.2.1).

Incoming material for cathode foil is aluminium of different purity from 98 % to 99.7 % alloyed with supplementary elements as Mn and Cu. Several alloys with close tolerance in chemical compound are used.

Material for cathode foil will be produced and cast into slabs in Korba in the existing foundry similarly as material for anode foil.

The rolling plant in Korba is equipped with one 4-high reversible hot rolling mill for rolling up to thickness of 4 mm and with one 4-high reversible cold rolling mill for rolling up to thickness of 0.4 mm. The plant is also fully equipped with auxiliary appliances such as furnaces-heating, homogenizing, annealing and with slitting machines. The rolling plant can prepare coils suitable for rolling of finished foil of 500 mm width.

Bidhanbag plant operates two 4-high non reversible mills with parameters suitable for condenser foil rolling. Modernization is recommended in order to provide higher quality of produced foils (tolerance in dimensions).

6.2.3 Treatment of condenser foil

The capacitance of a condenser is proportional to the area of the plates, i.e. of the anode and cathode plate. The effective surface can be increased several times by the etching process.

The capacitance depends also upon the material of the dielectric. The dielectric for aluminium electrolytic capacitors is aluminium oxide "formed" on the anode foil by an anodization process. This aluminium oxide is very thin dielectric with very high insulation resistance.

Treatment of plain foils will be provided in the newly proposed plant. This plant will be located in Korba or in Bidhanbag depending on various conditions and on economy considerations.

Etching and forming of foils is an electrochemical operation carried out continuously on production lines with unwinding of strips and their winding after the course through individual baths. Strips are jointed by squeezing one through another.

Quality of the treated strips is determined by the following:

- chemical purity of incoming foils
- texture of material
- selection of electrical parameters
- selection and preparation of chemical solutions (salts)
- purity and quality of used water.

Quality of treated foil is checked by means of special methods and laboratory equipment:

LV anode etched foil:	-	metering of el. capacity
	-	laboratory testing of forming
HV anode formed foil:	-	metering of el. capacity
	-	laboratory testing of forming voltage
Cathode foil:	-	metering of el. capacity
	-	laboratory testing of stability

Spectroscopy is used for checking of chemical composition (impurities). Small thickness of foil necessitates special apparatuses for metering of mechanical properties.

The foil treatment process proceeds from the storage of plain foil through annealing, brushing, etching, forming, metering, checking and packaging of finished products.

Storage of chemicals, preparation of solutions and mud keeping serve as accessory processes.

Water requirements are met by building up of raw water treatment plant.

Used water flows from basins into waste water treatment plant and after disposal it is to be drained out.

Feeding of equipment is provided by installation of transformer station, distribution stations and by rectifiers of voltage and current for individual production lines including impulse switches.

Ventilation is provided to individual rooms in order to reduce heat gains from equipment as well as to provide extraction of vapours from production lines.

6.2.4 Proposed layout plan arrangement

The production building is proposed as 2 storey with partial basement.

Situated in the basement is part of water treatment plant (WTP), waste water treatment plant (WWTP) and cooling water pumping station. A water tunnel is proposed in the basement to take pipes which are linking storage tanks, WTP and WWTP with production lines and containers for preparation of chemical solutions. Also cable shaft is proposed to start at basement level.

On ground floor plan the main production processes are located, i.e. etching, forming, annealing and brushing. On ground floor the WTP and WWTP are situated in the part of the shed above the basement area. Some of the containers interlink the basement with ground floor and 1st floor, the clarifying reactor reaching up to the top roof level. Changing rooms for 87 employees are proposed on ground floor. Storage of foils and compressed air station are situated adjacent to the forming plant.

Located on the first floor there are rooms for transformers, distribution boards and rectifiers. This electrical equipment is located above the etching plant so that the length of busbars is minimized. Below the electrical rooms there is cable space proposed 2.1 m high.

Preparatory rooms for solutions, storage of chemicals, power sources for forming, laboratory and offices are also situated on the 1st floor. Connection between the sources for forming and transformers is made by cables routed on a sheltered cable tray at roof level. On the rest of the roof space covered by roof structure there is a cooling tower and ventilation equipment installed.

Elevator is proposed interconnecting all three levels through the WTP area.

The proposed layout plan can be modified according to special requirements.

6.3 Description of technology and equipment

The description is given in three sections corresponding to main production steps.

Section	1	Production of SPA and CPA slabs
	1.1	Purifying of aluminium (according to VAMI project)
	1.2	Casting of SPA and CPA slabs
Section	2	Converting slabs into foils using existing equipment
	2.1	Rolling of strips
	2.2	Rolling of foil
Section	3	Treatment of condenser foil
	3.1	Production process (etching and forming)
	3.2	Water treatment
	3.3	Electrical power supply
	3.4	Airconditioning and ventilation

6.3.1 Section 1-Production of SPA and CPA slabs

1.1 Purifying of aluminium

Technology and equipment is described briefly in paragraph 6.2 - Proposed technology. Detailed description is presented in project No. DP/IND/84/007 by VAMI.

1.2 Casting of SPA and CPA slabs (including melting)

Technological process is shown on the flow sheets No. 6.01.1, 6.01.2 and 6.01.3 - Volume II.

Direct casting of slabs from SPA is described in paragraph 6.2 - Proposed technology.

Melting and casting will be provided on existing equipment in Korba:

- Oil fired melting furnace
Capacity 20 t - 7 t/hr

- Electric resistance holding furnace
Capacity 20 t - 10/hr

- Flat ingot casting machine
Max. size of ingot - 2x0.350 M
- 6 - 5 M long

- Flat ingot cutting line

This newly proposed equipment will be ordered as follows:

- Vacuum ladle - producer BALCO
- Stand for ladle - producer BALCO
- ALPUR BATCH - producer PECHINEY, France

6.3.2 Section 2 - Converting slabs into foils using existing equipment

Technological process is shown on the flow sheets Nos. 6.02 and 6.03 - Volume II.

2.1 Rolling of strip

and connected operations will be provided on existing equipment in Korba:

- Ingot milling machine

Capacity 10 t/hr

- Homogenizing furnace

12 - 20 hrs cycle 520 °C - 650 °C

- Slab heating furnace

Capacity 17 t/hr - 600 °C

- Hot rolling mill 4-high 1 800 mm

Rolling speed		0 - 43 M/sec.
Roll body width		1 800 mm
Roll dia		800/760 mm
Slab size	length:	1 300 - 2 700 mm
	width:	800/760 mm
	thickness:	270 - 360 mm
Slab weight		1.4 t, 3.1 t
Output - min. thickness		4 mm

- Cold rolling mill 4-high 1 800 mm

Rolling speed		max. 9.5 M/sec.
Roll body width		1 800 mm
Roll dia		600/570 mm
Input coil	width:	800 - 1 600 mm
	weight:	1.4 t - 8 t
	thickness	4 - 12 mm for Al
Output coil thickness		0.4 - 5 mm

- Slitting line

Input coil	thickness:	0.15 - 2.0 mm
	width:	800 - 1 560 mm
Output coil width		50 - 1 300 mm

- Annealing bell type furnace
10 hrs cycle - 500 °C

2.2 Rolling of foil

will be provided in Bidhanbag on the first of two existing 4 high non reversible rolling mills built by Von Roll Co., Switzerland.

Technical Data of Rolling Mills:

Mill No. 1 for Roughing Operation

1. Production Data

Material:	Aluminium
Strip thickness:	Entry 0.8 mm max./0.02 mm min. Exit 0.5mm max./0.012 mm min. - present operating condition - 0.07mm
Strip width:	850 mm max. - present operating condition 655 mm 450 mm min.
Coil DIA:	OD 850 mm max. ID 280 mm (on steel spools)
Coil weight:	1,210 kg (incl. spool) - present operating condition 885 kg
Expandable cores:	To be used for foil stock without spools for 1. pass (dimension to be specified)

2. Mill Data

Mill type:	4-high cold rolling foil roughing mill
Mill builder:	Von Roll, Switzerland
Year of built:	1962 - 1963
Work rolls:	- DIA 185 mm - Barrel length 1020 mm - Roller bearing (new) 2x2 row cylinder roller bearing 130/180 dia. x 50 mm with intermediate ring, 2 row ball bearings (thrust bearing) 100/180 dia. x 34 mm - Lubrication: oil/air mist and oil level

Back up rolls:	- DIA 420 mm - Barrel length 1000 mm - Roller bearing (new) 2x2 roller bearing 220/310 dia.x 225mm 2 row roller bearing (thrust bearing) 120/260 dia.x 86 mm - Lubricatin: oil/air mist and oil level
Mill drive:	0 - 150 - 150 kW
Gear stage:	i = 1,96 (pinion stand)
Roll speed:	0 - 100 - 350 m/min

3. Decoiler Data (optional)

Decoiling speed:	245 m/min max.
Strip tension range:	0.8 - 8 kN
Motor rating:	0 - 32 - 32 kW
Motor revolution:	0 - 800 - 2400 min^{-1}
Gear ratio:	9.60

4. Coiler Data

Coiling speed:	538 m/min max.
Strip tension range:	0.7 - 7 kN
Motor rating:	0 - 52 - 52 kW
Motor revolution:	0 - 800 - 2400 min^{-1}
Gear ratio:	5.48

Mill No. 2 for Finishing Operation

1. Production Data

Material:	Aluminium
Strip thickness:	Entry 0.12mm max./0.02mm min. Exit 0.08 mm max./2 x 0.006 mm min. - present operating condition - 0.009 mm
Strip width:	800 mm max. - present operating condition 655 mm 450 mm min.
Coil DIA:	OD 850 mm max. ID 280 mm (on steel spools)
Coil weight:	1210 kg (incl. spool)

2. Mill Data

Mill type:	4 high cold rolling foil finishing mill
Mill builder:	Von Roll, Switzerland
Year of built:	1962 - 1963

Work rolls:	- DIA 185 mm - Barrel length 1020 mm - Roller bearing (new) 2 x 2 row cylinder roller bearing 130/180 dia. x 50 mm with intermediate ring, 2 row ball bearings (thrust bearing) 100/180 dia. x 34 mm - Lubrication: oil/air mist and oil level
Back up rolls:	- DIA 420 mm - Barrel length 1000 mm - Roller bearing (new) 2x2 roller bearing 220/310 dia.x225 mm 2 row roller bearing (thrust bearing) 120/260 dia.x86 mm - Lubricatin: oil/air mist and oil level
Mill drive:	0 - 150 - 150 kW 0 - 330 - 1000 min^{-1}
Gear stage:	i = 1 : 1 (pinion stand)
Roll speed:	0 - 192 - 580 m/min

3. Decoiler Data

Decoiler I

Decoiling speed:	406 m/min max.
Strip tension range:	0.3 - 3 kN
Motor rating:	0 - 22 - 22 kW
Motor revolution:	0 - 800 - 2400 min^{-1}
Gear ratio:	5,20

Decoiler II (for doubling operation only)

Decoiling speed:	406 m/min max.
Strip tension range:	0.3 - 3 kN
Motor rating:	0 - 22 - 22 kW
Motor revolution:	0 - 800 - 2400 min^{-1}
Gear ratio:	5,20

4. Coiler Data

Coiling speed:	725 m/min max.
Strip tension range:	0.15 - 1.5 kN
Motor rating:	0 - 20 - 20 kW
Motor revolution:	0 - 800 - 2400 min^{-1}
Gear ratio:	2.91

For production of Al condenser foil cold rolled stocks will be brought from Korba aluminium complex. Stocks will be finished to plain foils of these dimensions:
anode foils - thickness 0.070 to 0.100 mm
cathode foils - thickness 0.020 to 0.050 mm

All range of anode and cathode foils can be finished on the mill No. 1 (roughing mill) after modernization. Rolling mill No. 2 (finishing mill) is not needed for the production of condenser foil.

Proposal for modernization is presented on the basis of recommendation by Lauener Co., which company is a specialist for revamping existing mills and installation of control systems.

Purpose of the recommended modernization is:

- rolling thin foil on mill Nr. 1 to reach the size parameters originally projected for the mill
- increase the used rolling speed
- increase quality of foil with respect to the size tolerance, flatness and quality of finish.

Full offer for modernization by Lauener Co. is attached in the Annex 1.

In comparison with the offer by Lauener Co., only modernization of the mill Nr. 1 (roughing mill) is proposed. The mill can provide full production of condenser foil. The mill will be fully modernized by using all adjustments recommended by the offer. In order to keep the cost low an offer by Czech Co. CKD - Cegelec is presented for the new drive system reliance. This offer was also discussed with Lauener Co. Based on a recommendation by Lauener Co. also an adjustment of work rolls and back up rolls is included as an indigenous supply.

Resulting from discussion with BBU specialists, motor on coiler will be changed but motor on rolling mill will stay and this will be provided with control system for mill drives (DCS). New motor will be installed instead of tension break for decoiler. The reason for this modification is the necessity for providing quality rolled finished foil of 0.03 mm thickness. For setting definite decision about the extent of necessary modernization a site inspection by Lauener Co. is required.

Main modernization features for rolling mill Nr. 1:

- roll neck bearing
new work roll chocks
bearing, row ball bearings

- back up roll assembly
modification of back up roll chocks for roller bearing and negative roll bending cylinder (Mae-West), roller bearing, row roller bearings

- roll bending system
hydraulic cylinders in Mae-West blocks, hydraulic cylinders in back up roll chocks, Mae-West blocks, hydraulic valve stand

- AGC roll load cylinder
special high pressure cylinders, servo valves (directly mounted on cylinders)

- new drive system reliance
Drive control consists of the following supplies:
- D.C. motor 32 kW for drive for decoiler
- D.C. transformer with programme module for control of decoiler
- mechanical adjustment for installing motor for decoiler
- D.C. transformer with universal programme module (BASIC) for mill control
- D.C. motor 56 kW for drive for coiler
- D.C. transformer with programme module for control of coiler
- board with superior control system determined for centralizing monitoring and drive control

- roll coolant system
Coolant headers with 48 valves of total flow capacity 900 l/min.
Electrical control for manual operation.
Automatic flatness control.

- coolant oil filtration plant
Filtration system consists of two vertical stack horizontal plate pressure filters.

The following roll specification is recommended:

- Work rolls:	hardness	- roll barrel 100 - 105 Shore D
		- journal 40 - 45 Shore D
	eccentricity	0.005 mm max.
	out of round	0.0025 mm max.
- Back up rolls:	hardness	- roll barrel 70 - 75 Shore D
		- journal 40 - 45 Shore D
	eccentricity	0.005 mm max.
	out of round	0.003 mm max.

Calculation for setting up usage time for rolling mill Nr. 1 (roughing) for production of condenser foil

The calculation is based on the following presumptions:

-Production programme of the mill:

strip thickness	- entry	0.8 mm max.
	- exit	0.5 mm max., 0.012 mm min.
strip width	- 600 mm max.	

- Production programme of condenser foil (representative)

anode foil	- Al 99.99 % 0.070 mm x 500 mm	256 tpy
cathode foil	- Al Mn 0.030 mm x 500 mm	75 tpy
anode foil for bipolar condenser	- Al 99.99 % 0.040 mm x 500 mm	10 tpy

- Width of rolled strip 520 mm, weight of coil 600 kg, input/output ratio - 1.2, time needed for change and recharging of coils - 5 minutes per 1 Nr coil

- Average rolling speed inclusive starting and range - 100 M per minute (maximum speed of mill is 350 M per minute)

- Working fund per annum - 240 working days,

$$\text{usage coefficient} = \frac{\text{time for rolling}}{\text{working fund}} = 0.70$$

- Reduction in passes

anode foil - 0.6 - 0.35 - 0.20 - 0.12 - 0.070 - 0.040 mm
cathode foil - 0.6 - 0.37 - 0.22 - 0.15 - 0.10 - 0.075 - 0.050 - 0.030 mm

Calculation:

thickness mm	output		time requirement hrs	
			rolling	change of coils
mm	kg/hr	tpy	hrs	hrs
anode foil				
0.350	2,835	320	114	44
0.200	1,620	320	200	44
0.120	972	320	329	44
0.070	507	320	564	44
0.040	324	12	37	2
In total			1,244	178

thickness mm	output		time requirement hrs	
			rolling	change of coils
mm	kg/hr	tpy	hrs	hrs
cathode foil				
0.370	2,997	90	30	12
0.220	1,780	90	50	12
0.150	1,215	90	75	12
0.100	810	90	112	12
0.075	607	90	150	12
0.050	405	90	225	12
0.030	243	90	370	12
In total			1,012	84

Summary:

Total rolling time (1,244 + 178 + 1,012 + 84)	2,518 hrs
Working fund of 1 shift per year (70 % utilization)	1,344 hrs
Number of shifts per year	1.87

6.3.3 Section 3 - Treatment of condenser foil

Treatment of foil is an electrochemical process consisting of two operations, i.e. etching and forming. These operations are carried out on one-purpose production lines. Details are given in the paragraph 6.2 - Proposed technology.

Technological processes for production of cathode foil, LV anode foil and HV anode foil are shown on the flow charts No. 6.05, 6.06 and 6.07 - Volume II.

Treatment of foil necessitates supply of water, facilities for water treatment and facilities for disposal of waste water.

Industrial water utilization is shown on diagram No. 6.11. WWTP process is shown on diagram No. 6.12 - Volume II.

Further required are sources of D.C. power for etching and forming. Power supply is desribed on wiring diagrams Nos. 6.13, 6.14 and 6.15 - Volume II.

Technological process also requires ventilation, extracting and cooling.

6.3.3.1 Production process

The production process is divided into the following steps:

1.01 - Storing of raw materials
1.02 - Annealing and brushing
1.03 - Etching
1.04 - Forming
1.05 - Checking and packaging
1.06 - Preparation of solutions
1.07 - Maintenance
1.08 - Control of production

1.01 Storing of Raw Materials

According to stored material the storage area is divided as follows:
- storage of plain and formed foils,
- storage of chemicals for etching plant,
- storage of chemicals for forming plant,
- storage of spare parts.

Plain and formed foils are stored on pallets kept in racks. General purpose lifting trucks or shelve-loaders are envisaged for manipulation with foils.

Chemicals are stored in bags or in glass made vessels. Spare parts to cover needs for the whole Al foil production and for machinery and electrical maintenance are stored in separate storage room.

All stores have electrical installation only, other equipment is not necessary.

At some of the technological departments intermediary storage to serve annealing, brushing and etching of foils are located.

1.02 Annealing and brushing

The anode foil is annealed for the first time after being rolled in the foil plant, however approximately one third of total anode foil production must be annealed for the second time in electrical resistance furnace. The purpose of repeated annealing is to achieve necessary quality in mechanical properties and suitable cubic texture of the foil.

Every treated foil is brushed so that the oxidic layer is removed from the surface of foil as well as the oil spots which remain after annealing.

Foil which has been brushed must be etched within 70 hours time so that a new oxidic layer does not appear on the foil surface.

In the course of brushing an aluminium dust parts of the maximum size of 0.1 mm are generated. These parts are sucked off from the brushing machines.

Annealing will be provided in a electric resistance chamber furnace with output of 255 kW.

Capacity calculation:

- Production of anode foil	257 t
- out of which 1/3 for the second annealing in FTP	85 t
- Weight of charge	0.7 t
- Number of charges	91
- Duration of annealing	24 hours
- Annual utilization	91 days

Brushing unit

Brushing will be provided on two sets of equipment.

This equipment (see - Diagram 6.07 - Volume II) brushes surface of Al-foil (both sides) prior to etching. The foil roll **1** will be put on four rotating support pulleys retarded by a frictional brake. The foil is pulled over two supporting steel rollers **2** cooled by water. On each roller, the foil will be brushed by three brushing rollers **3** rotating on the contrary to the foil shift. All the brushes can be made from steel or from phosphoric bronze. Each brush is powered autonomously. Moreover, all the brushes make a return axial move speeded up with the foil shift. The distance between brushes and supporting rollers (i.e. brushed foil) can be adjusted continuously. The space for brushing is covered and exhausted. The foil shift is powered by three rollers **4**. Two of them are covered by rubber, the third one, pressing roller is made of chromium plated steel. The foil will be wound up in the winding station **5**.

Technical data:

Foil output	0-0.27 m/sec
Foil width	500 mm
Max. outer diameter	350 mm
Roll core	70 mm
Foil gauge	30 - 100 m
Brush outer diameter	150 mm
Brush length effective	550 - 560 mm
Length of pins	30 mm
Diameter of steel pins	0.1 mm
Diameter of phosphoric bronze pins	0.05 mm
Speed of brush rollers	1350 rpm

1.03 Etching

For etching of foils the following equipment will be installed:
- 6 etching units to etch LV and HV anode foil
- 5 etching units to etch cathode foil

One service weight up to 100 kg is proposed.

A steel monorail with crane trolley is proposed for placing coils into the process. The monorail is located above each unit at loading point upright to the unit axis.

Each unit will be provided with the following:
- ventilation duct to take vapours and fumes off the bath
- compressed air intake with no oil admixtures
- demineralized water supply
- clarified water supply
- industrial water for washing of floor and machinery
- etching solution
- electric power installation

- etching solution drainage to waste water treatment plant
- rinsing water piping to waste water treatment plant.

Etching unit for anode foil

The following equipment is designed for etching of anode foil (see - diagram 6.09 - Volume II) .

From an unwinding station **1**, the foil is pulled into the intermediate balance magazine and then over a copper contacting roller **2** (water cooled) into the etching tank. The electrolyte is force-circulated in the etching tank **4**. The foil dip is 2.3 m, the bath temperature 60-95 °C. There is an exhausting system covering the etching tanks installed. A foil cooling unit **3** (water spraying jets) is integrated in this system followed by five rinsing tanks **5**. Demineralized water in the fourth bath is heated to 80-100 °C, pH value kept constant. After rinsing, the foil passes through the drying tunnel **6** with a temperature adjustable up to 250 °C. After passing through the compensation loop, the brake roller, length measuring and marking equipment **7**, the foil is wound up by the winding-up station **8**.

Technical data:

Foil width	500 mm
Foil thickness	70 - 100 m
Unroll core diameter	75 mm
Winding-up core diameter	75 mm
Max. outer diameter	350 mm
Foil output	25 - 150 m/hr
Total size (LxWxH)	8500 x 2900 x 2500 mm
Height (with frame in the upper position)	1300 mm
Power supply unit size (LxWxH)	200 x 1800 x 550 mm
Power input (without power supply)	155 kVA
Power distribution	220/380 V, ~50 Hz
Exhaust	1800 m^3/hr
Consumption of cooling water	3 m^3/hr
Consumption of running water	0,85 m^3/hr
Consumption of demineralized water	0,25 m^3/hr
Pressure showers (totally 3 pairs-circulation of demineralized water)	J = 0.4 Ma Q = 60 l/min for 1 pair

Etching unit for cathode foil

The following is designed for continuous electrochemical etching of cathode foil, width 500 mm, Al-purity 98.0 - 99.7 % (see - diagram No. 6.08 - Volume II.).

From the unwinding station **1**, the foil is pulled through the plant by rollers (the drive of each roller can be disengaged). Two copper contacting rollers **2** are cooled by water and fans. Between the rollers, the foil is cooled in a tank with running water. For more cooling, there are two showers installed. **3**. The etching tank **4** is made of stainless steel, volume 350 l, foil dip 1 m, bath temperature 80 - 90 °C (electrically heated, adjustable ±2 °C, forced circulation

of the electrolyte), bath cooling by copper tube system with running cold water. Four electrodes have a total surface of 6000 cm^2 and are fixed together with rollers to a lifting frame. The tank is electrically insulated against the plant frame and grounded. The evolving gas is exhausted. The first tank **5** is made from aluminum, using running water for rinsing. Brush rollers clean the foil. The second rinsing tank for chemical passivation **8** is made of stainless steel, volume about 200 l, heated electrically to 80 - 85 °C (±3 °C). The rinsing tank **9** is made of aluminum, volume 40 l. Demineralized water is used in both cases, in the rinsing tank and in the shower placed at the output of this section. On the rinsing tank output the foil is blown over by the air stream **10** and then it goes through the drying (or annealing) tunnel **11**. The foil then creates a compensation loop and it is brought to braking rollers **12**, to the foil length measuring and marking unit **13** and to the winding station **14**.

Technical data:

Foil width	500 mm
Foil thickness	30 - 50 m
Foil output	25 - 100 m/hr
Current of contacting rollers	2.5 kA max.
Unroll core diameter	70 mm
Winding-up core diameter	70 mm
Max. outer diameter	350 mm
Plant size (LxWxH)	6300 x 2900 x 1800 mm
Power supply unit size (LxWxH)	2000 x 1800 x 400 mm
Power input (without power supply)	approx. 60 kVA
Power distribution	220/380 V, ~50 Hz

1.04 Forming

Two forming units are installed. Above each unit, a steel monorail with crane trolley is proposed for manipulation with the produced coils and for mending purposes. The rail is situated in longitudinal axis to the units.

Each unit will be provided with the following:
- ducting to take vapours off basins
- compressed air intake with no oil admixtures
- demineralized water supply
- clarified water supply
- cooling water supply
- electric power supply
- drainage for the used solution and rinsing water into the waste water treatment plant
- industrial water for washing of floor and units.

Forming unit

This equipment is designed to form a high voltage anode Al-foil, purity 99,98 %, width 500 mm, up to 650 V in a continual process with the oxide layer stabilization (see - diagram 6.10 - Volume II.).

From an unwinding **1**, the foil goes through the annealing oven **(2)** (the length of annealed foil is 1060 mm, temperature 525 - 600 °C), over three copper or brass contacting rollers **3** (grounded). The voltage drop in the contacting system is measured and displayed on the distribution panel. The foil is cooled by demineralized water. In the boehmite tank **4** made from aluminum (volume 400 l), the foil passes through a bath with temperature 98 °C. The foil dip can be adjusted to 1 or 1.7 or 3 m. The leading rollers are mounted in a lifting frame. This tank can be connected to a DC-low voltage power supply. It is followed by the passivating tank **5** (stainless steel, volume 820 l, temperature 90 °C) the foil dip is 4 m. In the process of forming, the foil emerges once out of the forming bath. NH_4OH is added during operation. A shortcircuiting contact with a discharging resistor is placed at the tank output. The electric current in the forming tank is displayed on a distribution panel. After passing the next rinsing tank **8**, the foil enters the second forming tank **9** (volume 1030 l, temperature 90 °C, foil dip 6 m). The foil emerges twice out of the forming bath. After passing the rinsing tank **10** and depolarizing tank **11** (of the same type as the passivating tank), rinsing tank **12**, the foil enters the third forming tank **13** (of the same design as the 2nd forming tank). After the rinsing tank **14**, the depolarizing tank **15** and rinsing tank **16**, the foil enters a fourth forming tank **17** (similar design as of the 1st forming tank). The dipping length of the foil is 6 m, the bath temperature 90°. While forming, the foil emerges twice out of the forming bath. A rinsing tank **18** with pressure showers (demineralized water by circulation), a blowing unit **19** and a drying unit **20** to follow. The forming plant is complete with the equipment for length measuring and marking of foil **21**.

Technical data

Foil width	500 mm
Foil thickness	80 - 100 m
Unroll core diameter	75 mm
Winding-up core diameter	75 mm
Max. outer diameter	350 mm
Foil output	15 - 70 m/hr
Plant size (LxWxH)	17000 x 3000 x 2700 mm
(incl. gallery for operator)	
Height (with frames in upper position)	3500 mm
Power supply unit size (WxHxD)	2400 x 2000 x 450 mm
Power installed (without power sources of forming)	290 kVA
Power distribution	220/380 V, ~50 Hz
Max. total current load of contacting rollers	1200 A

Capacity calculation - Treatment of condenser foil

- Brushing

Input	- plain anode foil	257 tpy
	average thickness	0.080 mm
	weight of 1 M foil of 500 mm width	108 g
	length of foil of 257 t weight	2,379,629 M

	- plain cathode foil	75 tpy
	average thickness	0.030 mm
	weight of 1 M foil of 500 mm width	40.5 g
	length of foil of 75 t weight	1,851,000 M
	- total length of brushed foil	4,230,629 M
Brushing machine	- speed range	0 - 972 M/hour
	- average speed	400 M/hour
Time requirement for brushing		10,577 hrs
Time fund per one machine		6,000 hrs/year
Required number of machines		2 Nos
Utilization of one machine		5,288 hrs/year

- Etching of anode foil

Input	- plain brushed anode foil	257 tpy
	average thickness	0.080 mm
	length of foil of 257 t weight	2,379,629 M
Etching machine	- speed range	25 - 150 M/hour
for anode foil	- average speed	75,728 hrs
Time requirement for etching		31,728 hrs
Time fund per one machine		6,000 hrs/year
Required number of machines		6 Nos
Utilization of one machine		5,288 hrs/year

- Etching of cathode foil

Input	- plain brushed cathode foil	75 tpy
	average thickness	0.030 mm
	length of foil of 75 t weight	1,851,000 M
Etching machine	- speed range	25 - 100 M/hour
	- average speed	65 M/hour
Time requirement for etching		28,476,923 hrs.
Time fund per one machine		6,000 hrs/year

Required number of machines	5 Nos
Utilization of one machine	5,695 hrs/year

- Forming

Input	- etched anode foil (HV)	40 tpy
	average thickness	0.080 mm
	weight of 1 M foil of 500 mm width	75 g
	(37 % loss after etching)	
	length of foil of 40 t weight	506,329 M
Forming machine	- speed range	15 - 70 M/hour
	- average speed	45 M/hour
Time requirement for forming		11,251,755 hrs
Time fund per one machine		6,000 hrs/year
Required number of machines		2 Nos
Utilization of one machine		5,626 hrs/year

1.05 Checking and Packaging

Packing shop is equipped with work tables and racks. A steel monorail with electrical crab is installed for manipulation with coils. Packed foil will be transported into the storage of plain foil and from there dispatched according to customer's needs.

While manipulating with Al foils stock, plain foils, and treated foils, these must be protected against damage.

(a) foils stock of thickness 0.6 mm transported from Korba to Bidhanbag must be wrapped in undulated paper and tied together with a steel band.

(b) plain foil coils while carried inside of plant, e.g. from foil plant to foil treatment plant must be wrapped as described before.

(c) plain foil coils prior to transporting must be wrapped in thin paper. Ends of coils must be protected against damage by a wooden wool secured by a lid. Coils will be in a polyethylene sacks and stowed in wooden casings (or other suitable casings) and fixed against move.

(d) etched and formed foils must be wrapped in the same way as plain foils when carried from plant to consumers. In each sack a silica gel must be put in to absorb moisture.

1.06 Preparation of etching solutions

The following equipment is envisaged:

- storage containers for chemicals (NaCl, H_3BO_3, Na_2SO_4)
- containers provided with heater and with stirring equipment for preparation of concentrated solutions
- storage tanks to take etching solutions of different concentrations.

Storage tanks for chemicals and etching tanks are made of stainless steel in order to sustain aggressivity of the prepared solutions.

Etching solutions are gravitationally distributed to the unit using insulated piping.

Harmful vapours are exhausted from the area around the storage tanks.

1.07 Maintenance

Machinery and electrical maintenance shop is equipped with basic tools and metering devices.

Large repair work or planned overhaul is envisaged to be done in the central maintenance shop of the factory.

1.08 Control of Production

Control room is equipped with signalling and metering facilities to take data from production lines indicating running of machines, power consumption etc. Control room is connected by computer network to laboratory which is provided with instruments for quality checking of the foils - mechanical and electrical properties.

Control room has connection to storage and intermediate foil storage area, connection to chemical storage and to preparation of etching and forming solutions.

6.3.3.2 Water treatment

Water system for production purposes and its disposal after utilizing in the process may be functionally divided into the following parts:

3.2.01 - Water treatment plant
3.2.02 - Cooling water pumping station
3.2.03 - Internal piping
3.2.04 - Waste water treatment plant

Treated water demand

Demineralized water	6 m^3/hour max. permanently
Clarified and filtered water for technology	3 m^3/hour max. permanently
Refilling to cooling circuit	4 m^3/hour max. permanently

Quality requirements on treated water

Demineralized water:

Specific electrolytical conductivity at 25 °C	1 microS/cm max.
pH	6.5 - 7
SiO_2 content	1 mg/l max.
Cl^- content	0.2 mg/l max.
Fe content	0.2 mg/l max.

Clarified and filtered water:
without special requirements.

Raw water compound

Proposal for water treatment plant is based on the following parameters of incoming raw water:

character of water	river
specific el. conductivity at 25 °C	120 - 160 microS/cm
total soilds	75 - 220 mg/l
suspended solids	30 - 80 mg/l
dissolved solids	45 - 140 mg/l
Chemical Oxygen Demand (COD) - $KMnO_4$	5 - 10 mg/l
pH	7 - 7.5
Fe	0.05 - 0.1 mg/l
Mn	0.05 - 0.1 mg/l
Al	0.15 - 0.1 mg/l
SiO_2	10 - 15 mg/l
salt content	1.46 - 2.58 meq/l
total hardness	1.0 - 1.5 meq/l
p-value (p - Alkalinity)	0 meq/l
m-value (p - Alkalinity)	0.8 - 1.2 meq/l
Ca^{2+}	0.8 - 1.2 meq/l
Mg^{2+}	0.2 - 0.3 meq/l
$Na^+ + K^+$	0.46 - 1.08 meq/l
SO_4^{2-}	0.31 - 0.73 meq/l
Cl^- (Chloride)	0.11 - 0.17meq/l
NO_3^-	0.24 - 0.48 meq/l
CO_2 (free)	6 - 8 mg/l

- 3.2.01 Description of technology of water treatment

With respect to data obtained from the Indian counterpart the following water treatment has been proposed.

Raw water is clarified by using ferric chloride and line decarbonization at the same time in clarifying reactor. This reactor operates on the principle of fully floated sludge bed. Further on, water is filtered in two-layer filter filled with siliceous sand and black coal filtering material of required granulation. Clarified and filtered water is stored in a container to be pumped partly for technology use, partly for refilling in the cooling circuit. For washing of two-layered filters clarified and filtered water and compressed air are used. The rest of clarified and filtered water is pumped into demineralization process which consists of two concentration stages:
- first stage a strong acid Catex of Amberlite IR 120
- second stage a strong basic Anex of Amberlite IRA 478

Demineralized water is stored in vertical steel made rubber lined container from which it is pumped into mix-bed with mixing substance of strong acid Catex of Amberlite IR 120 L and strong basic anex of Amberlite RA 420 MB. This demineralized water is then gathered in horizontal steel made rubber lined container from which it is pumped into technological equipment.

In auxiliary equipment to water treatment plant the required chemicals are prepared and diluted. These are chemicals used in clarifying process - preparation of solution $FeCl_3$ out of crystalline $FeCl_3 . 6H_2O$, and preparation of $Ca(OH)_2$ substation. The regenerated solutions of required concentration for demineralization are prepared by mixing concentrated chemicals of adequate proportions with demineralized water in pipe line. These solutions are H_2SO_4 double concentrated for catexies and NaOH solution for anexies.

Waste waters from individual demineralization stages are drained into waste water treatment plant to be neutralized together with other waste waters coming from technological processes. The sludge from clarifier will be also processed in waste water treatment plant along with sludge which arise here while disposing waste waters from technology. Waters for washing which separate while washing two-layered filters will be discharged into the outside open drainage system in the factory, or after sedimentation they will return back into the process.

Equipment for water treatment plant is controlled semiautomatically with push button controlling individual blocks of technological processes, each machine being controlled by electrically drived fittings.

Consumption of Chemicals

		yearly amount
$Fe Cl_3 . 6H_2O$ crystalline	60 % $FeCl_3$ min.	5 t
$Ca(OH)_2$	84 % $Ca(OH)_2$	10 t
H_2SO_4	94 % min.	24 t
NaOH	98 % min.	17 t

NOTE

The above mentioned consumption of chemicals does not include chemicals needed for neutralization of waste waters, which are generated in the regulation of individual stages of demineralization.

Consumption of Water

Raw water	96,000 m^3/year

List of Machinery and Equipment - Water treatment

Item	Description	Number of pieces	Weight in kg
1	Clarifier	1	8,500
2	Two-layer filter	2	3,258
3	Container for chemical solutions	1	822
4	Container for chemical solutions	2	84
5	Container for chemical solutions	1	1,045
6	Container for chemical solutions	2	1,516
7	Ionex filter for light flow	2	1,580
8	Storage container	1	3,170
9	Mixing filter	2	1,160
10	Container for chemical solutions	1	30
11	Container for diluting solid chemicals	1	2,280
12	Container for chemical solutions	1	672
13	Storage container	1	2,339
14	Pumps of various types	21	3,000
15	Dosing pump	2	320
16	Dosing pump	2	294
17	Dosing pump	2	300
18	Compressor	1	340
19	Storage container	1	3,170
	Piping steel made, stainless steel, rubber coated, polypropylene made		20,000
	Fittings of all kinds		7,000
	Platforms		3,900
	Fillings: Amberlite IR 120 L		
	Amberlite IRA 420 MB		
	Amberlite IR 120		
	Amberlite IRA 478		
	Siliceous sand, grade 1 - 1.6 mm		
	Filtering coal granulation, grade 1.7- 3 mm		

- 3.2.02 Cooling Water Pumping Station

The station provides for water of good quality for indirect cooling to etching and forming drafts and to brushing machines in overall amount of 70 m^3/hour. This water quality which is more than less determined by the quality of additional water (industrial water) from water treatment plant is not affected while cooling the drafts and therefore its recirculation is proposed. Pressure conditions in the equipment are disrupted and the used warmed water flows gravitionally back into the storage tank. Warmed water is pumped to ventilator cooling tower located on the roof level. Pump for Q = 70 m^3/hour has the rated energy Y = 250 $J.kg^{-1}$. Cooled water flows into the cold water storage tank in the basement from where it is distributed into the piping system by means of a pump with the rated energy Y = 600 $J.kg^{-1}$.

The pumping station (machine room and both tanks) is placed in the basement on the area of 12 x 18 m.

Operation of pumping station is automatical by means of water tables in tanks and pressure on delivery pipe of cooling water.

In order to avoid the increased amount of biological build up in the cooling circuit it will be necessary from time to time to dose the solution of biocide into the warmed water in front of the cooling tower. Occasionally, part of the circulating water is also filtrated in the by-pass.

Part of this section is a ventilator cooling tower (micro tower) with the maximum output of 105 m^3 of water per hour for the temperature difference Δt = 15 - 18 °C. At the present there are data available about the temperatures of the dew thermometer in four places in India where the maximum temperature is 29 °C.

During the most hot months the temperature of the cooled water will be higher approximately by 5 °C than dew thermometer, i.e. approx. 34 °C.

- 3.2.03 Internal Piping Connection

Piping connects water treatment plant with etching and forming units, brushing machines, cooling tower and waste water treatment plant.

Main distribution pipes are routed in the collector running down the unit in the basement level, adjacent to the central row of columns. Proposed internal dimensions of the collector are 1.7 m of width by 2.1 m high. Connections from the collector into the piping distributors which stand close to individual drafts (5 pcs. of pipes) are placed in shallow channels in floor upright to direction of the main collector. Steel pipes are envisaged for cooling water, pvc pipes for demineralized and return rinsing water.

- 3.2.04 Waste Water Treatment Plant (WWTP)

The plant provides for disposal of industrial waste waters from production of condenser foils and from WTP.

Amount of Waste Waters

The following waters will flow into the WWTP:	
Rinsing demineralized water	6 m^3/hour
Rinsing clarified water	1.5 m^3/hour
Waste water from demineralization (from regeneration of Ionexes)	0.7 m^3/hour
Waste sludge from clarifier	0.5 m^3/hour
In total	8.7 m^3/hour

Description of Equipment - WWTP

Automated flow water equipment which liquidates waste waters in the way as described is proposed.

Alkaline - acid waste waters arising from production of Al foil will be treated by addition of coagulant /$Al_2(SO_4)_3$/ and by additional treatment of pH in alkaline area where undesirable elements in reactor will precipitate. After dosing polyflocculant the items flocculate with the subsequent sedimentation in the external drainage system, sedimented mud will be thickened in dewatering facility to reach the level of 25 - 45 % of dry solids.

Part of the WWTP is equipment for preparation and dosing of individual disposive chemicals.

Overall process is controlled by microprocessor system which according to user's requirements enables various levels of automation of the technological process from hand operated remote control with automatically filled reactors up to fully automated regime, when action of personnel is limited only to checking of the system and to preparation of disposive chemicals.

The equipment is constructed mainly from noncorrosive materials, e.g. from polypropylene which increases durability and reliability of the equipment.

Operation of the plant is by means of detectors for monitoring of technological process (pH) and by means of detectors for monitoring moving of water levels in individual tanks and reactors.

Hardware is modular. Main processor unit incorporates microprocessor. Number of incoming and outgoing lines may be adjusted and freely changed according to the needs. By means of desk for microprocessors type as IBM - PC each controlling system may be linked into the network and so may enable personnel to watch the production on PC screen.

Each system can be switched to manual operation.

Software is individual and depends fully on the user's needs.

Requirement for chemicals		yearly amount
NaOH solid	98 % NaOH min.	45 t
$Al_2(SO_4)$. 18 H_20)	55.4 % $Al_2(SO_4)_3$ min.	5.5 t
Polyflocculant		175 kg
Loading substance		50 t

Requirements on the Quality of Cleansed Water

Norm for Tolerance Limit for Industrial Effluent Discharge in Inland Surface Water:

Sl.No.	Parameter	Tolerance limit
1	(a) Colour	Colourless
	(b) Odour	Odourless
2	Suspended Solids Mg/l	100
3	Particles Size of Suspended Solids	Shall Pars 850 Micron IS Sieve
4	Dissolved Solids (Inorganic) Mg/l	2100
5	pH	5.5 - 9.0
6	Temperature Deg O°	40 at Pt of discharge
7	Oil/Grease Mg/l	10
8	Total residual Chlorine mg/l	1
9	Ammoniacal Nitrogen (as N) Mg/l	50
10	Total Kjeldahl Nitrogen	100
11	Free Ammonia (as NH_3) Mg/l	5
12	BIO chemical Oxygen demand (5 days at 20 deg. C) Mg/l	30
13	Chemical oxygen demand (5 days at 20 deg. C) Mg/l	250
14	Arsenic (as As) Mg/l	0.2
15	Mercury (As Hg) Mg/l	0.01
16	Lead (as Pb) Mg/l	0.1
17	Cadmium (as Cd) Mg/l	2
18	Hexavalent Chromium (as Cr+6) Mg/l	0.1
19	Total Chromium (as Cr) Mg/l	2
20	Copper (as Cu) Mg/l	3
21	Zinc (as Zn) Mg/l	15
22	Selenium (as Se) Mg/l	0.05
23	Nickel (as Ni) Mg/l	3
24	Boron (as B) Mg/l	2
25	Percent sodium	-
26	Residual Sodium Carbonate Mg/l	-
27	Cyanide (as CN) Mg/l	0.2
28	Chloride (as Cl) Mg/l	1000
29	Fluoride (as F) Mg/l	2
30	Dissolved phosphate (as P) Mg/l	5
31	Sulphate (as So_4) Mg/l	1000
32	Sulphide (as S) Mg/l	2
33	Pesticides	Absent
34	Phenolic Compounds as (C_6H_5OH) Mg/l	1
35	Radio active Materials	
	(a) Alpha emitters Uc/ml	10-7
	(b) Beta emitters UC/ml	10-6

****NOTE****

1. All efforts should be made to remove colour and unpleasant odour as far as possible

2. These norms should be read along with original copy of IS:2490 (Part-II) 1981 for completeness

6.3.3.3 Electrical part

- 3.3.01 Basic technical data

Power distribution:	HV:3 ~ 50 Hz6.6 kV
Power distribution:	LV:3 ~ 50 Hz 440 V/TN-C
Contact protective system:	Protection by connection to neutral

Compensation of cos φ is central in the system of 440 V. Condenser distribution boards RC are arranged into block along with main distribution boards RH at the back of respective transformer. Compensation of cos φ and filtration of higher harmonic current generated by thyristored forming rectifiers is made by means of constant LC filters on HV side and by controlled LC filters in LV compensating distribution board RC4.

Output installed

HV 6.6 kV	sources for forming	3,000 kVA
LV 440 V	motors, rectifiers	4,900 kVA
LV 440 V	lighting, sockets	150 kVA
	In total	8,050 kVA

Load calculated

HV 6.6 kV	sources for forming	2,540 kW
LV 440 V	motors, rectifiers	3,026 kW
LV 440 V	light	50 kW
	In total	5,616 kW

- 3.3.02 Technical description

Power distribution

H.V. Connection

Three parallel HV 3 x 240 mm^2 cables from connecting point are routed into HV distribution board on the 2nd floor level. Cables run partly in existing channels, partly free-laid underground. It is necessary to equip the connecting point with a switch or discontractor.

Cable distribution

Main HV and LV cables are considered plastic made. Fixed cable trays are to be used in an accessible cable space located under electrical equipment. Forming rectifiers will be connected by cables routed on trays at roof level.

Power distribution to etching basins will be done by Al busbars through cable space and ceiling directly to the basins.

6.6 kV distribution and transformer room.

Ref. drawing No. 6.13.

6.6 kV distribution room

Distribution room will be equipped with 7.2 kV distribution boards, rated connectors current to be 1,250 A, short term short-circuit current 1s max. 25 kA, dynamic short-circuit current 60 kA maximum.

Transformer station

Transformer station with transformers T_1 - T_4 is in block arrangement with the main DB's RH1 - RH3, compensation DB's RC1 - RC3 with reserve space for one transformer. Transformers are air cooled 1,250 kVA 6.6 kV/440 V each. Main distribution boards are two sides, each field 800 mm wide, 500 mm deep.

Operational power distribution

Motor DB's will be placed close to individual machinery. DB's with switches and breakers will be located in room for transformers and rectifiers.

Rectifier room

Etching sources 8 kA

Ref. wiring diagram No. 6.15
Sources of D.C. voltage for etching have parameters of +2 - 20 V, +1 - 8 kA. They consist of booster, transformer and rectifier in 6 pulse connection with no control. Minus pole is connected directly to etching machine. Plus pole wiring goes over pulse switch 0 - 8 kA switching at frequency of approx. 20 - 150 impulses per second.

Etching sources 2 kA

Ref. wiring diagram No. 6.14
Etching sources +2 - 20 v, 0,2 - 2 kA are also in arrangement as booster (with constant current rectifier control), transformer and non-controlled rectifier in 6-pulse connection. In the plus pole a pulse 0 - 2 kA switch to switch with approx. 20 - 250 impulse frequency is installed.

Forming sources

Ref. wiring diagram No. 6.13
Three +20 - 800 V, +50 - 500 A sources with current limitation and constant voltage regulation are needed for etching machine. The sources proposed are using three layer winding transformer to serve 2 sources. Transformers T5 - T7 are feeded from the 6.6 kV line. In RT1 - RT3 distribution boards there is switching, protective and signalling el.

equipment installed. Two controlled thyristor rectifiers in the three phase bridge connection are installed in one GV case. In each D.C. ring in each source a smoothing L type air choke is installed.

Filtering and compensating equipment

To compensate power factor of forming sources as well as higher harmonic currents generated by forming and etching sources an uncontrolled LC filters on HV side combined with controlled LC filters to LV RC4 distribution board, are proposed.

Lighting and inside power distribution

Lighting

Lighting will be provided with fluorescent luminaries, protected according to purpose of the room. Lighting level in offices and laboratories will be 750 Lx, in electrical rooms and production areas 500 Lx and in storage areas 150 Lx.

Sockets

In production areas socket boards in system 50 Hz, 440 V, 32 A will be installed including one phase sockets for transferable light fittings included.

Lightning protection

The whole building is protected against lightning by combined grid and bar earthing equipment.

Fire alarm system

Fire alarm detectors are mainly located in electrical rooms and in cable rooms. Individual loops are evaluated in a 24 loop central panel.

Automated controlling system

For operational and failure control of electrical equipment an automated controlling system is proposed consisting of a universally programmed automatic machine, of controlling computer with key-board, printer and screen. In this configuration all main electrical equipment from the key-board can be controlled.

Telephone installation

Telephone lines will be provided to offices, laboratory, electrical maintenance shop and rectifier room.

- 3.3.03 Specification of Electrical Equipment

Pos. 1	HV 6.6 kV connection Plastic HV 10 kV cable 3 x 249 mm^2 - 1,140 m Trench 90 x 50 cm, sand bedding	
Pos. 2	Cabling LV and HV, Automated controlling system	
Pos. 3	Busbars distribution to etching machines	
Pos. 4	DB LV, 12 section, Un = 7.2 kV, In = 1250 A, protection IP 40 11 sections with el. current metering and with HV switch 1 section with el. current and voltage metering, with HV breaker. Overall length - 9,600 mm Delivery dimensions 9,600 x 1,350 x 2,400 mm (lxdxht) Overall weight 7,800 kg	- 1 Nr
Pos. 5	Three phase winded transformer as T_1 - T_4, 1,250 kVA 6.6/0.44 kV, 50 Hz, protection IP 23 Overall dimensions 2,300 x 1,150 x 2,400 mm Overall weight 3,560 kg	- 4 Nr
Pos. 6	DB double-sided, 6 sectional, as RH1-RH3. Voltage 3 ~50 Hz 440 V/TN-C, el. current in busbars 1650 A, protection IP 40 Dimensions 4,200 x 1,000 (500) x 2,250 mm Weight 1,060 kg	- 3 Nr
Pos. 7	Compensating DB one sided, 3 sectional as RC1-RC3. Voltage 3 ~50 Hz 440 V/TN-C, 450 kVA, protection IP 20 Dimensions 2,300 x 500 x 2,250 mm Weight 850 kg	- 3 Nr
Pos. 8	Filtering/compensating DB, 12 sectional, two sided, Voltage 3 ~50 Hz 440 V/TN-C, 1000 kVAr protection IP 20, as RC4 Dimensions 4,800 x 1,000 x 2,250 mm Weight 4,880 kg	- 1 Nr
Pos. 9	Filtering/compensating HV equipment 6.6 kV 600 kVAr as CL Dimension 1,000 x 2,500 x 1,000 mm Weight 1,500 kg	- 1 Nr

Pos.10 Source for etching 8 kA, 20 V D.C. - 6 Nr

1 Nr - simple 3 phase booster NTA 94-2, 123 kW 440/80-800 V,
protection IP23, 123 kW horizontal,
with servomotor incl. regulation on constant D.C. current
and with motor for fan. Boosters as TR1-TR6,
dimensions 1,230 x 1,015 x 1,015 mm,
weight 980 kg.

1 Nr - 3 phase dry rectiforming transformer, 230 kVA, 440/19 V, 50 Hz,
protection IP00, load classification V.
Transformers as T8-T13,
dimensions 1,900x950x1,350 mm,
weight 2,550 kg.

1 Nr - Uncontrolled rectifier in 6 pulse connection of 8 kA, 20 V D.C.
As GU4-GU9,
dimensions 800x1,000x1,700 mm,
weight 350 kg.

1 Nr - Pulsating switch 0-8 kA,
switching frequency 20 - 150 impulses/second.
As GS1-GS6 dimensions 2,400 x 1,000 x 2,200,
weight 1,800 kg.

Pos.11 Source for etching 2 kA, 20 V D.C. - 5 Nr

Each source consists of the following equipment:

1 Nr - Simple 3 phase booster, NTA 84-2, 64 kW, 440/50-830 V,
protection IP 23, foot based, horizontal,
with servomotor incl. regulation on constant D.C. current
and with motor for fan. Boosters as TR7-TR10,
dimensions 1,020 x 875 x 890 mm,
weight 610 kg.

1 Nr - 3 phase dry rectiforming transformer 63 kVA, 440/10 V, 50 Hz
protection IP00, load classification V.
Transformers as T14-T18.
Dimensions 1,450 x 800 x 1,100 mm,
weight 1,350 kg.

1 Nr - Uncontrolled rectifier in 6 pulse connection of 2 kA, 20 V D.C.
As GU 10-GU15, dimensions 530x1,000x1,700 mm,
weight 1,200 kg.

1 Nr - Pulsating switch 0-2 kA, switching frequency 20-250 impulses/second.
As GS7-GS11, dimensions 800x1,000x2,200,
weight 600 kg.

Pos.12 Sources for forming 500 A, 800 V D.C. - 6 Nr

Each source consists of the following equipment:

3 Nr - 3 phase dry, 3 layer winding rectifying transformer
1,000/2x500 kVA, 6.6/2x0.695 kVA, 50 Hz,
protection IP 00, load classification V, transformer as T5-T7

3 Nr - DB, protection IP 40, one-sided, one section, as RT1-RT3.
Voltage 3 ~50 Hz 659 V/IT, 450 A,
dimensions 800x500x2,250 mm,
weight 160 kg

3 Nr - Board with 2 Nr thyristor rectifiers in the 3 phase bridge
6-pulse connection. Each rectifier is provided with voltage regulation
current limitation and over tension protection.
Boards as GU1-GU3, dimensions 800x1,000x1,700 mm,
weight 400 kg

6 Nr Smoothing choke, air reactor 33.5 mH, 500 A, protection IP00.
As L1-L6, dimensions 1,000x800x1,900 mm,
weight 1,250 kg

Pos.13 Operational power distribution
LV DB, 3 ~50 Hz 440 V/TN-C - 4 Nr
Overall number of sections is 22.
Dimensions of each section 800x500x2,250 mm.
Distribution boards to be used for water treatment,
ventilation, regulators, protection and switching boosters.
Protection IP 40, overall weight 5,280 kg.

Pos.14 Lighting

14.1 LV DB, 3 ~50 Hz 440 V/TN-C - 3 Nr
Overall number of section is 5.
Dimensions of each section 800x500x2,250 mm,
protection IP40. Overall weight 1,050 kg.

14.2 Light fittings, cabling, trays, junction boxes, sockets etc.

Pos.15 Lightning rod

Pos.16 Fire alarm system
Central panel 24 loop and fire detectors

Pos.17 Telephone installation

Pos.18 Automated controlling system

18.1 Universal programming system with overall number of 544 entries
and 1240 exits including hardware

18.2 Users software

18.3 DB with programming automatic machine,
protection IP 40, 3 sections of dimensions 800 x 500 x 2,250 mm
Weight 610 kg

6.3.3.4 Airconditioning and ventilation

Airconditioning equipment will be extracting heat gains and detriments and will be supplying additional and ventilation air to individual rooms in the building. Proposed airconditioning units for air supply are equipped with filtration of air with moisturing shower chambers for adiabatic air treatment. Part of the unit is a circulation water pump.

All units will be situated at the roof level above ground floor area protected by roof structure.

Airconditioning equipment for transformer station

Airconditioning equipment will be extracting heat gains arising in electrical distribution rooms. Cooling to individual electrical equipment can be provided by air with incoming internal temperature not exceeding 35 °C. Maximum envisaged increase of temperature of the cooling air is 15 °C. This temperature is determined by extracted heat in the range of 17.6 kW from the large thyristored boards, which are provided with their own cooling fans.

Warmed air from distribution rooms from thyristored boards will be extracted via ducts into the open space. Warmed air from other equipment will be extracted by axial fans situated in perimeter walls.

Air to electrical rooms will be distributed through metal sheet ducts.

Room	Heat gain kW	Amount of cooling air unit m^3/hr	Airconditioning unit Nr	Airconditioning unit Output	Equipment
Sources 8.0 kA	342	79,00	2	39,500	1
Transformers for forming and 6 kV distribution	47,7	11,000	1	11,000	2
Sources 2 kA Transformers 6/0.4 kV	138	32,000	1	32,000	3
Sources for forming	90	20,800	1	20,800	4

Extracting equipment for etching unit for anode foil

Vapours and damaged air from boehmitting and etching bath will be extracted by a hood jointly from each unit (6 hoods in total). Amount of 1,800 m^3/hr of damaged air is to be extracted from each unit. Included in this amount is ventilation air brought into the etching room. Extracting hood will be connected to a gathering off-take duct routed at ceiling level to extract fan situated at roof level. Damaged air will be blown out to open space. One m^3 contains 4.6 mgr of NaCl and 1.1 mgr of Na_2SO_4. Eliminator of water drops for separating water from condensed steam is built into the gathering duct.

Output of the extracting equipment proposed is 10,800 m^3 of air per hour.

Extracting equipment for etching unit for cathode foil

Each etching unit which consists of one etching bath and one passivating bath will be provided with a hood separately for each bath (12 hoods in total). From each hood the released vapours and damaged ventilation air will be extracted in the total amount of 2,000 m^3/hour. Extracting duct from each hood will be linked horizontally above each unit and then linked by a vertical duct to gathering extract duct routed at ceiling level. Damaged air will be blown out to open space through an extract fan located at roof level. Eliminator of drops will be fitted into the extract duct.

Output of the extracting equipment proposed is 10,000 m^3 of air per hour.

Extracting equipment for forming units

In each forming unit each bath (i.e. 1 boehmitting, 1 passivating, 4 forming and 2 depolarizing) is provided with separate hood from which the vapours and brought in/damaged air will be extracted in similar way as described before.

Amount of extracted damaged air is 3,400 m^3/hr per unit. Output of the extracting equipment proposed is 6,800 m^3 of air per hour.

Extracting equipment for brushing units

Amount of extracted air from each brushing machine is 2,500 m^3/hour with content of 170 mgr of aluminium dust per one m^3. Extract from each machine will be brought out in front of the plant into a cloth dust separator made for explosive and combustible dust admixtures. Dust separated in the filter will be delivered by a conveyor into enclosed container and carried for further processing. Cleansed air with the maximum content of aluminium of 3.3 mgr/m^3 will be blown out to open space through an extract fan.

Output of the extracting equipment proposed is 5,000 m^3/hr. Amount of separated dust calculated is 4.2 t/year.

Extracting equipment from annealing furnace

In order to reduce the time for cooling of material after passing the annealing process, the furnace is provided with controlled air cooling system. Extracted air will be brought in a duct into a fan at floor level and blown out to open space.

Output of extracting equipment proposed is 2,800 m^3 of air per hour.

Ventilation equipment for etching room

Amount of 20,800 m^3 of air per hour will be extracted from the etching room. Intake of fresh air for venting will be provided by a proposed airconditioning unit situated together with other equipment at the roof level.

Treated air will be delivered through a duct and blown inside of etching room through grilles.

Output of the equipment proposed is 21,000 m^3 of air per hour.

Ventilation equipment for forming room

Amount of 6,800 m^3 of air per hour will be extracted. To ensure appropriate environment an overpressure ventilation system is proposed. Incoming air will be provided by AC unit in a similar way as described above. Redundant air will be extracted via overpressure valves into open space. Output of the equipment proposed is 10,000 m^3 of air per hour.

Ventilation equipment for annealing and brushing rooms

Amount of 7,800 m^3 of air per hour is to be extracted. Similar ventilation system as preceding is proposed.

Output of the ventilation equipment is 9,000 m^3 of air per hour.

Ventilation equipment for water treatment

Individual rooms will be ventilated by AC unit in the way as precedingly described.

Output of the ventilation equipment proposed is 25,000 m^3 of air per hour.

6.3.3.5 Compressed air station

For technological reasons, compressed air used for blasting foils is required without content of oil. The required amount is approximately 50 Nm^3/hr.

Compressed air of the required quality can not be obtained from existing sources. Therefore, new compressed air station is proposed for air supply to the new technological equipment. Compressed air station will be fitted with 3 Nr. nongrease compressors of Q = 25 Nm^3/hr (output), p = 7 Bar (overpressure). 2 Nr. compressors will be in permanent operation with 1 Nr. compressor used as a stand-by. Necessary space of approx. 6 x 3 M is reserved in storage of foils. Indigenous supply of equipment is envisaged.

6.4 Civil Engineering Works

6.4.1 Super pure aluminium production - project VAMI

According to VAMI project the location of EDU for SPA production is proposed as an extension of cell room No. 75, or No. 78 in the existing smelter in Korba.
Both possibilities were observed on site and confirmed as feasible for further consideration.

6.4.2 Plain foil production - modernization of foil rolling mill

In connection with modernization of foil rolling mill in the existing foil plant in Bidhanbag, remedial work to floor in the plant is proposed along with improvement to ventilation in the electrical distribution room.

(a) Remedial work to floor

At present concrete floor in the foil plant is cracking and pulverizing under the wheels of transporting trolleys.

Recommended remedial work is application of floor filling products by SWEPCO company (South Western Petroleum Corporation, Forth Worth, U.S.A.) such as Epoxy resurfacer or Pourable crack filler.

Other possibility is replacement of existing floor finish with new concrete floor layer either throughout the plant or in the most effected and loaded paths. New flow areas must be properly dilatated and provided with wire netting.

The estimated investment cost for the remedial work to floor in the sum of 686,000,- Rs is included in schedule 6-5 of the report.

(b) Improvement to ventilation

Ventilation in the existing electrical distribution room is not sufficient.

It is recommended that new and more efficient AC unit is installed instead of the existing one with ducting covering the whole area of the distribution room. Additional extract fan is proposed in the perimeter wall.

The estimated investment cost in the sum of 100,000.- Rs is included in schedule 6-5 of the report.

6.4.3 Foil treatment plant

6.4.3.1 Buildings and structures

Conceptually the production building is conceived as a reinforced concrete two storey two bay hall with flat roof with partial basement and overall dimensions 92x25 meters on axis grid of columns 6x12 meters (grid 0 A-C to 15 A-C).

Main production processes on ground floor are arranged in two bays each spanning 12 m with floor to ceiling height 4.5 m. Water treatment plant on ground floor is located within the grid 1 B-C to 9 B-C.

First floor accommodates auxiliary processes such as transformer rooms to etching and forming lines (grid 10 A-C to 15 A-C), rooms for preparation of solutions, part of the water treatment, laboratory, office area and toilets (grid 0 B-C to 10 B-C). Transformer and power distribution rooms are situated on a rised steel structured floor with 2.1 m high cable space below and floor to ceiling height 3.7 m.

Floor to ceiling height in auxiliary rooms proposed is 3.3 m.

Airconditioning equipment located on flat roof within the grid 3 A-B to 10 A-B is covered by a round shaped steel structured roof on steel columns in grid 6x12 m.

Built-up area of the plant is		2,300 m^2
Built-up usage floor area is as follows:		
- Basement plan		500 m^2
- Ground floor plan		2,200 m^2
- First floor plan		1,500 m^2
- Roof level, 1st floor plan		500 m^2
	In total	4,700 m^2

Built-up area space exclusive of foundation is 26,300 m^3.

The proposed structure is reinforced concrete monolithic framework with longitudinal R.C.C. bearing frames and surface T beam R.C.C. in situ ceilings.

Envisaged load bearing floor capacity is 15 kN/m^2 for 1st floor and 25 kN/m^2 for the raised floor in transformer/distribution rooms. Structural height of T beam ceilings proposed above ground level is 900 mm, and 600 mm above 1st floor and basement plan.

Steel floor structure proposed for transformer/distribution rooms consists of trusses with I beams and metal sheets above with overall structural height 900 mm.

Proposed rounded shape roof structure above 1st floor flat roof consists of steel trusses, I beam rafters and corrugated metal sheets as roof covering of overall structural height 700 mm.

R.C.C. foot base water proof insulated foundations on thick gravel bedding are envisaged.

Perimeter walls as well as internal bearing 230 mm thick partition walls are proposed on R.C.C. plinth beam, rendered and painted.

Steel windows are proposed for provision of natural light and ventilation.

The building is documented in floor layout plans in scale 1:200, dwg. No. 5-7 and sections, dwg. No. 8 attached.

Local codes and standards

Design and working drawings for architectural, civil engineering and services sections shall comply with relevant Indian standards in force such as IS: 56, 800, 875, 1983 and 3370 applying to concrete structures, steel structures equipment loads, wind pressure, seismic force etc. Master planning criteria do not apply as both sites are within the existing boundary of a governmental enterprise. Similarly, building permit is nor required. The statutory approval for construction shall be facilitated through BALCO by Department of Mines of the Government of India.

6.4.3.2 Location analysis

Site at Korba

The site is located to the north of the main access road into the factory in the vicinity of the rolling mill. The site is slightly sloping to the north. It is free of mains and structures. The new foil treatment plant is situated by its long axis in parallel with the access road from which it is approached approximately 12 m from a verge of the road in line with the existing weight bridge. In order to make the approach to different parts of the building easier, two link-ways off the main road are proposed. Overall surface area of the new communications proposed is approx. 2,100 m^2.

Possibilities for future extension of the building are in both ways in longitudinal axis and to the north in cross axis direction.

Location of the new foil treatment plant in relation to the existing buildings is apparent from the general layout plan in scale 1:7000, dwg. No. 1 attached.

Detailed location is shown on the site layout plan in scale 1:1000, dwg. No. 3 attached.

With the exception of the electrical connection all necessary energy mains are in close proximity of the site.

All servicing connections will be made from the area across the main road. Under the road the mains will be protected by appropriate casing.

Proposed tapping points to existing services are described as follows:

Power supply	- connection will be made at the existing yard adjacent to the rolling mill. - cables will be routed partly in the existing collector. In front of the new plant they will turn upright into the cable shaft in the new building. 4 Nr HV breakers will be installed in the switch yard. Approximate length of cabling is 245 m.
Industrial water	- connected to existing pipe line, approx. length 70 m.
Drinking water	- ditto, approx. length 70 m
Drainage pipe	- ditto, approx. length 60 m
Compressed air	- ditto, new bridge support, approximate length 70 m.

Soil bearing data have been indicated in range of 1.25 kg/cm^2 at 1.5 m depth below ground level and 2.5 kg/cm^2 at lower depth below ground level. These data prove that conditions for setting foundations are within the usual standard. However these data will have to be confirmed by actual soil investigation on site in compliance with the respective Indian standards in force (as per IS 875) prior starting design work.

Site at Bidhanbag

The site is located in the western part of the factory in the reserve area between the existing foil rolling plant and conductor plant. Access to the site is from the existing road passing by into the foil plant linking the site at the short side from the east. The site is slightly sloping to the west.

Passing through the site there is a cooling water pipe into the foil [illegible] locating this pipe the site will be free. Access for the new foil treatment plant is [illegible] extension of the existing roads passing around. Overall surface area of the new communication proposed is approx. 1,560 m^2.

The proposed distance from the existing foil plant is approx. 15 m with the possibility of future extension for the new plant in southern direction. Possible extension of the foil plant is to the north.

Location of the new plant is apparent from the general layout plan in scale 1:7000, dwg. No.2 attached.

Detailed location is shown on site layout plan in scale 1:1000, dwg. No. 4 attached.

With the exception of drinking water and compressed air the necessary tapping points to services are situated in a fairly distant locations. The area is not provided with a sewage system.

Proposed connections to existing services and provision of new services is described as follows:

Power supply	- cables will be routed in trench from the existing distribution station. Existing 6.6 kV indoor distribution boards will be used for connecting. An independent interconnecting cable will be laid from the existing transformer station at conductor plant to the new transformer station in the foil treatment plant. Approximate length of new cabling is 1,155 m.
Industrial water	- will be tapped from the existing pipe linking the water settling tank and the filtration/storage water tank in the coal mine area. New pumping station will be necessary in connection with industrial water supply. Approximate length of industrial water pipe is 1,000 m.
Drinking water	- connected from the existing lavatories to the north of the foil plant. Approximate length 160 m.
Drainage	- waste water from the new plant will be drained into the Nala river flowing by the water reservoir in the western direction of the plant. Septic tank will be built outside of the new plant for accumulation and cleaning of sewage water from the toilets and lavatories. Pipe for cleansed water from septic tank will be linked to the main drainage pipe. Approximate length of the drainage pipes is 385 m.
Compressed air	- connected to existing pipe passing by the site. Approximate length 10 m.

Soil bearing data have been indicated in the range of 1.0 - 1.2 kg/cm^2 at 3 m depth below ground level. Conditions for setting foundations are less convenient compared to usual standard. However, similar conditions for soil investigation as mentioned before have been applied.

Comparison

Advantages of the site at Korba in comparison with the site at Bidhanbag:
- the site is free of mains,
- the site is well provided with sufficient infrastructure,
- the site has better conditions for setting foundations.

Other aspect:

- operating in Korba as a part of BALCO there is a central design organization which has experience in structural engineering and supervision work. Bearing in mind the obvious requirement by Indian counterpart that civil engineering activities on the project are conducted domestically, the design organization can meet the construction needs on day to day basis without special arrangements.

Disadvantages of the site:

- in connection with routing services some crossings with existing mains are necessary,
- provision of power supply necessitates installation of HT breakers in existing switch yard,
- longitudinal location increases requirements on the servicing communication area separated from the existing access road with frequent traffic.

Advantages of the site at Bidhanbag in comparison with the site at Korba:

- site is in close relation to the existing foil rolling plant which aspect is beneficiary to both plants for various reasons such as operational, maintenance etc.,
- good connection to communications utilizing existing access roads to the foil plant.

Disadvantages of the site:

- weak infrastructure,
- worse conditions for setting foundations,
- relocation of cooling water pipe is necessary in order to free the site.

Conclusion

Construction of the foil treatment plant is feasible in both Korba and Bidhanbag sites. Estimated financial difference in investment cost between the sites is negligible.

6.5 Investment Costs Estimate

6.5.1 Section 1 - Production of SPA slabs in Korba

6.5.2 Section 2 - Modernization of foil rolling mill No. 1 in BBU

6.5.3 Section 3 - Foil treatment plant

6.5.4 Civil engineering works

6.5.5 Project EDU (FTP site at BBU)

6.5.1 Estimate of investment costs

Plant machinery and equipment
Project: EDU, Section 1 - Production of SPA slabs in Korba

N	Q	U	Item description	Unit cost Rs	Rs 000			Producer
					Foreign	Local	Total	
1	1	pcs	Vacuum ladle - 3 t	300,000		300	300	BALCO, India
2	1	pcs	Stand for vacuum ladle	50,000		50	50	BALCO, India
3	1	pcs	ALPUR BATCH	3,000,000	1,500*)		1,500*)	PECHINEY, France
				TOTAL	1,500	350	1,850	

*) By request of BALCO Co. the cost item forms 1/2 of the price of the equipment. The proposed equipment will be also used for existing production.

6.5.2 Estimate of investment costs

Plant machinery and equipment
Project: EDU, Section 2 - Modernization of foil rolling mill No. 1 in BBU

N	Q	U	Item description	Unit cost Rs	Rs 000			Producer
					Foreign	Local	Total	
1	1	Set	Work rolls assembly	3,300,000	1,000[1]	2,300[2]	3,300	Engineering: Lauener, Switzerland Delivery: BALCO, India
2	1	Set	Back up rolls assembly	4,000,000	1,200[1]	2,800[2]	4,000	Engineering: Lauener, Switzerland Delivery: BALCO, India
3	1	Set	Roll bending system	2,540,000	2,540		2,540	Lauener, Switzerland
4	1	Set	AGC Roll Road cylinder	8,460,000	8,460		8,460	Lauener, Switzerland
5	1	Set	New Drive system reliance	7,400,000	8,510		8,510	CKD Cegelec The Czech Republic
6	1	Set	Roll coolant system	4,560,000	4,560		4,560	Lauener, Switzerland
7	1	Set	Coolant oil filtration plant	20,200,000	20,200		20,200	Lauener, Switzerland
				TOTAL	46,470	5,100	51,570	

[1] Engineering
[2] Delivery

6.5.3 Estimate of investment cost

Plant machinery and equipment

Project: EDU, Section 3 - Foil treatment plant

N	Q	U	Item description	Unit cost Rs	Rs 000			Producer
					Foreign	Local	Total	
			PROCESS EQUIPMENT					
1	1	Set	Electric resistance chamber furnace	1,403,000	1,403		1,403	Realistic, Karlovy Vary The Czech Republic
2	2	Set	Brushing unit	4,392,000	8,784		8,784	SOMA Lanškroun The Czech Republic
3	6	Set	Etching unit for anode foil incl. el. sources	20,526,500	123,159		123,159	SOMA Lanškroun The Czech Republic
4	5	Set	Etching unit for cathode foil incl. el. sources	17,232,500	86,162.5		86,162.5	SOMA Lanškroun The Czech Republic
5	2	Set	Forming unit for HV anode foil incl. el. sources	20,191,000	40,382		40,382	SOMA Lanškroun The Czech Republic
6	2	Set	Testing equipment of formability	103,700	207.4		207.4	SOMA Lanškroun The Czech Republic
7	2	Set	Equipment for metering of el. capacity	344,650	689.3		689.3	SOMA Lanškroun The Czech Republic
			AUXILIARY EQUIPMENT					
8	1	Set	Preparation of solution incl. piping			800	800	indigenous
9	1	Set	Transport equipment			1,000	1,000	indigenous

To be continued

(Continuation from p. 90)

6.5.3 Estimate of investment cost

Plant machinery and equipment
Project: EDU, Section 3 - Foil treatment plant

N	Q	U	Item description	Unit cost Rs	Rs 000			Producer
					Foreign	Local	Total	
10	1	Set	Maintenance equipment			1,000	1,000	indigenous
			WATER TREATMENT					
11	1	Set	Water treatment plant		3,100	8,050	11,150	- CKD Dukla, Praha The Czech Republic - indigenous
12	1	Set	Cooling water piping station			1,700	1,700	indigenous
13	1	Set	Internal piping			250	250	indigenous
14	1	Set	Waste water treatment plant		6,800		6,800	OROYA, Praha The Czech Republic
15	1	Set	ELECTROPART		20,396,8	9,175	29,571,8	- CKD Elektrotechnika, Praha - indigenous
16	1	Set	AIRCONDITIONING/ VENTILATION			3,900	3,900	indigenous
17	1	Set	COMPRESSED AIR STATION			700	700	indigenous
			Total		291,084	26,575	317,659	

6.5.4 Estimate of Investment Costs - Civil Engineering Works
Foil Treatment Plant

Works description	Cost per unit, Rs	Costs, Rs	
		Site at Korba	Site at Bidhanbag
A. Site preparation			
Soil investigation, probes		100,000	100,000
Relocation of existing water pipe ϕ 250 mm	500/m		100,000
Site levelling	200/m²	770,000	770,000
Item A in total		870,000	970,000
B. Building and Structures			
Foil treatment plant	3,500/m²*)	17,066,000	17,066,000
10 % allowance on less convenient foundation conditions	350/m²		805,000
Raw water pumping station			700,000
Septic tank			300,000
Motor access way	400/m²	840,000	624,000
Electrical connecting cables	600/m	441,000	693,000
HV Breakers	625,000/1 Nr	2,500,000	
Industrial water pipe connection ϕ 150 mm	400/m	28,000	400,000
Drinking water pipe ϕ 50 mm	200/m	14,000	32,000
Drainage pipe ϕ 300 mm	400/m	26,000	154,000
Compressed air ϕ 50 mm incl. bridge support	600/m	42,000	6,000
Item B in total		20,957,000	20,780,000
C. Preliminaries, engineering, contingency			
Item C in total	20,5 % of A + B	4,474,000	4,459,000
Items A, B and C in total		26,301,000	26,209,000

*NOTE: *) indicative relates to floor area*
Buildings and structures are excluded of electrical installation and ventilation which parts are included in equipment costs.

6.5.5 Total investment costs (fixed assets)

Project: EDU (FTP site at BBU)

Section	Item	Cost category	Rs 000
1	1	VAMI project - Production of SPA	48,514
	2	Production of slabs	1,850
2	3	Modernization of foil rolling mill	51,570
	4	Civil works - remedial work to floor and ventilation	786
3	5	Foil treatment plant Site preparation, levelling	970
	6	Building and structures	20,780
	7	Preliminary and preproduction cost - civil part	4,459
	8	Technology (know-how fee)	15,000
	9	Total equipment and installation cost	317,659
	10	Preliminary and preproduction cost - equipment	41,041
		TOTAL	502,629

Cost level 1993

7. ORGANIZATION OF EDU, OVERHEAD AND OTHER COST

EDU will be divided into three sections.

Section 1 Production of SPA slabs
This will be situated in Korba and will be organized within the aluminium smelter. Provision of manpower, maintenance of buildings and structures etc., will be facilitated within the frame of aluminium smelter.

Section 2 Conversion of slabs into foils.
This will be provided on existing equipment in Korba (rolling of strips) and in Bidhanbag (rolling of foil) within the existing organizational structure of the plants. Therefore, no additional overhead costs are considered.

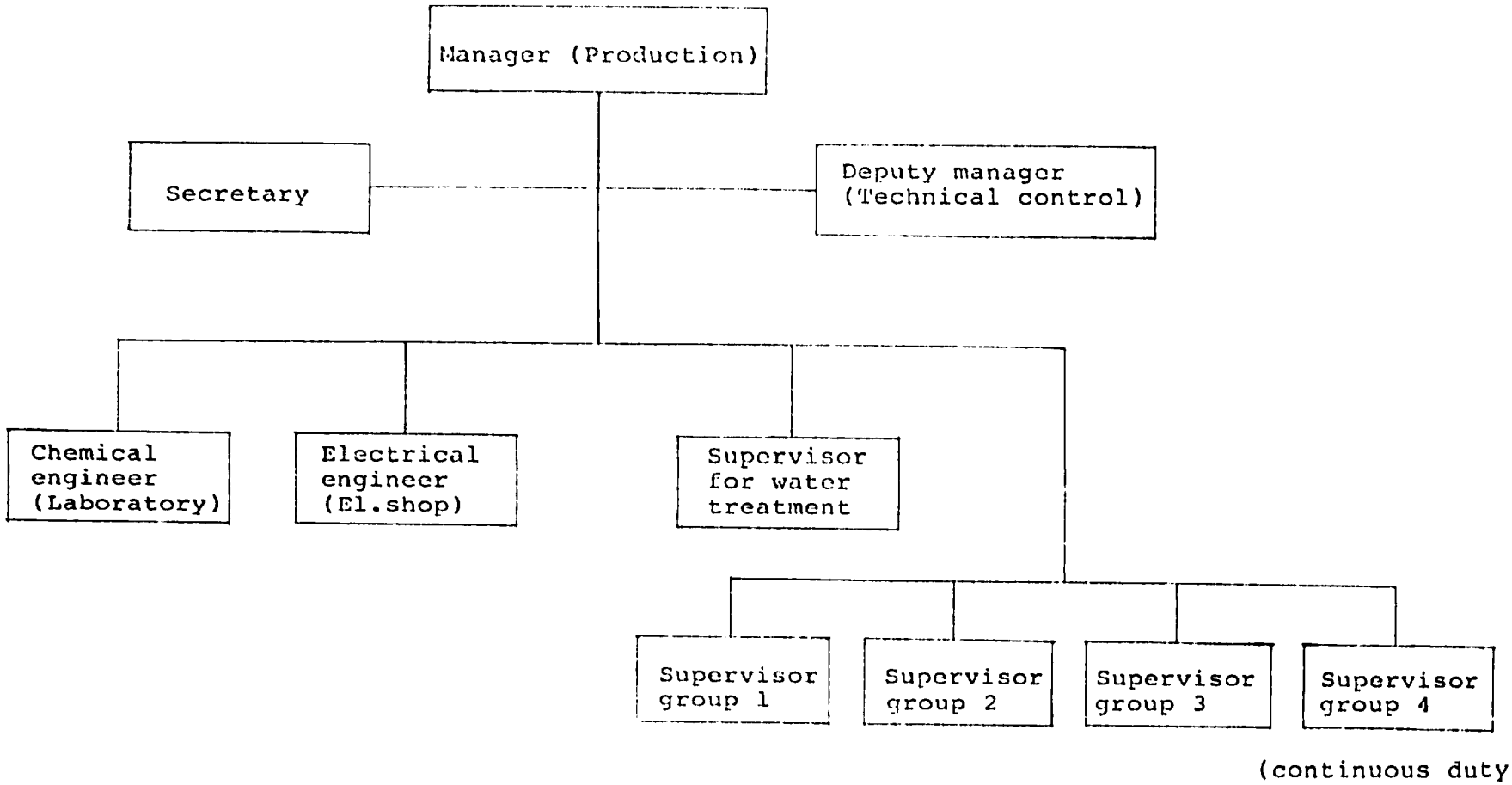
Section 3 Treatment of foil
The following activities are incorporated in the overhead costs of FTP:
- storing of plain foil and chemicals
- storing and packaging of finished products
- checking and testing of finished products
- maintenance of equipment
- water treatment
- disposal of used water

Some services are secured by BALCO company and these are incorporated in their overhead costs:
- building and structure maintenance
- water, electric power, compressed air
- outer transportation
- chemical analysis by spectrography
- manpower provision
- marketing
- purchase
- accountancy

Overhead and other cost are further described in the economic evaluation.

Organization diagram of FTP is shown on the following page.

7.1 ORGANIZATION DIAGRAM OF FOIL TREATMENT PLANT



8. HUMAN RESOURCES

8.1 Qualification of employees

- Production of SPA

Qualification and number of employees is specified in the project No. DP/IND/87/007 by VAMI, Russia.

- Production of plain foil

Number and skills of employees working on existing equipment is identical for the existing production and for the new production, excluding foil rolling mill where six new workers are required.

- Treatment of condenser foils

The new plant will employ skilled and unskilled employees in ratio 1:1. Skilled workers are envisaged in the field of machinery, electrical engineering and chemistry. Out of the overall number of 87 employees as minimum as 4 must have a university degree and minimum of 10 must have secondary school education.

8.2 Working conditions

Production of etched and formed foils is a continuous operation assured by 4 working groups. Other operations are 2 shifted with the exception of storaging and packing, which are one shifted.

Working fund for continuous operation for the capacity of 210 t/year is 6,000 hours, i.e. 250 days/year. The difference of 2,760 hours between the time fund and working fund will be partly used for regular cut offs to change solutions (once every 1 or 2 months) which includes discharging of solutions, cleaning of basins, preparation of new solutions inclusive preventative maintenance. The period for cut offs is approx. 1 month, i.e. 744 hour. Rest of the annual time fund (8,760 - 6,000 -744) of 2,016 hours is a capacity reserve for production increase or for unforeseen breakdown.

8.3 Number of employees and labour cost

Number of employees and labour cost for condenser foil treatment are specified in tables 8.01 and 8.02.

Labour cost for production of both SPA and foils is comprised in the financial analysis in this report.

8.01 Manning table

	Number of employees in total	Category			I.	II.	III.	IV. Continuous duty
		Direct workers	Indirect workers	Staff				
Annealing	1	1	-	-	1	-	-	-
Brushing	6	6	-	-	2	2	2	-
Etching	20	20	-	-	5	5	5	5
Forming	8	8	-	-	2	2	2	2
Maintenance	4	-	4	-	2	1	1	-
Laboratory	9	-	8	1	3	2	2	2
Preparation of solutions	5	-	5	-	2	2	1	-
El. shop	5	-	5	-	2	1	1	1
Storage of raw material	3	-	3	-	3	-	-	
Checking and packaging	4	-	4	-	4	-	-	-
Water treatment	9	-	8	1	3	2	2	2
Transportation	4	-	4	-	2	1	1	-
Management and supervisors	6	-	-	6	3	1	1	1
Secretary	1	-	-	1	1	-	-	-
Reserve	1	1			3			
In total	87	37	41	9	36	20	18	13

8.02 Wages and salaries

Rs 000

CATEGORY	NUMBER	SALARY	SALARY IN TOTAL	ANNUAL SALARIES
Manager	1	8.000	8.000	96.000
Deputy Manager	1	6.000	6.000	72.000
Engineers and supervisors	6	4.000	24.000	288.000
Secretary	1	2.500	2.500	30.000
Skilled workers	37	4.100	151.700	1,820.400
Semiskilled workers	30	3.300	99.000	1,188.000
Unskilled workers	11	2.300	25.300	303.600
In total	87		316.500	3,798.000

... Note: The total value of fringe benefits is included in item Labour cost of Operating Cost Structure tables (Chapter 10)

9. PROJECT IMPLEMENTATION

The following programme and project implementation stages are assumed for the EDU project:

- basic engineering, pre-planning and project strategy, preparing documentation for supplies of technology, searching for suppliers, discussions with suppliers;
- sending invitations to tenderers, explanation of queries;
- evaluation of bids, negotiations, incorporation of changes and awarding contracts
- provision of detailed drawings of technology and civil engineering drawings;
- construction of all stages of EDU in 15 months, supply and erection of equipment for the same in 18 months;
- commencement of production in stages (modernization after 1 year from starting work on the project, FTP after 1 1/2 year, VAMI project after 2 years).
  Details are shown on the implementation schedule, page 99.

During discussions held in India in August 1993 about conclusions made in Draft Final Report, the original scope of services stated by the Terms of Reference was extended in the economical appraisal of 2 additional variants of construction of EDU.

Except of variant 1 which is solicited by the Terms of Reference
i.e. - production of treated condenser foil made of SPA and CPA produced in BALCO Co. which necessitates
- construction of VAMI purification unit, modernization of foil plant and construction of FTP

another 2 variants are financially analysed.

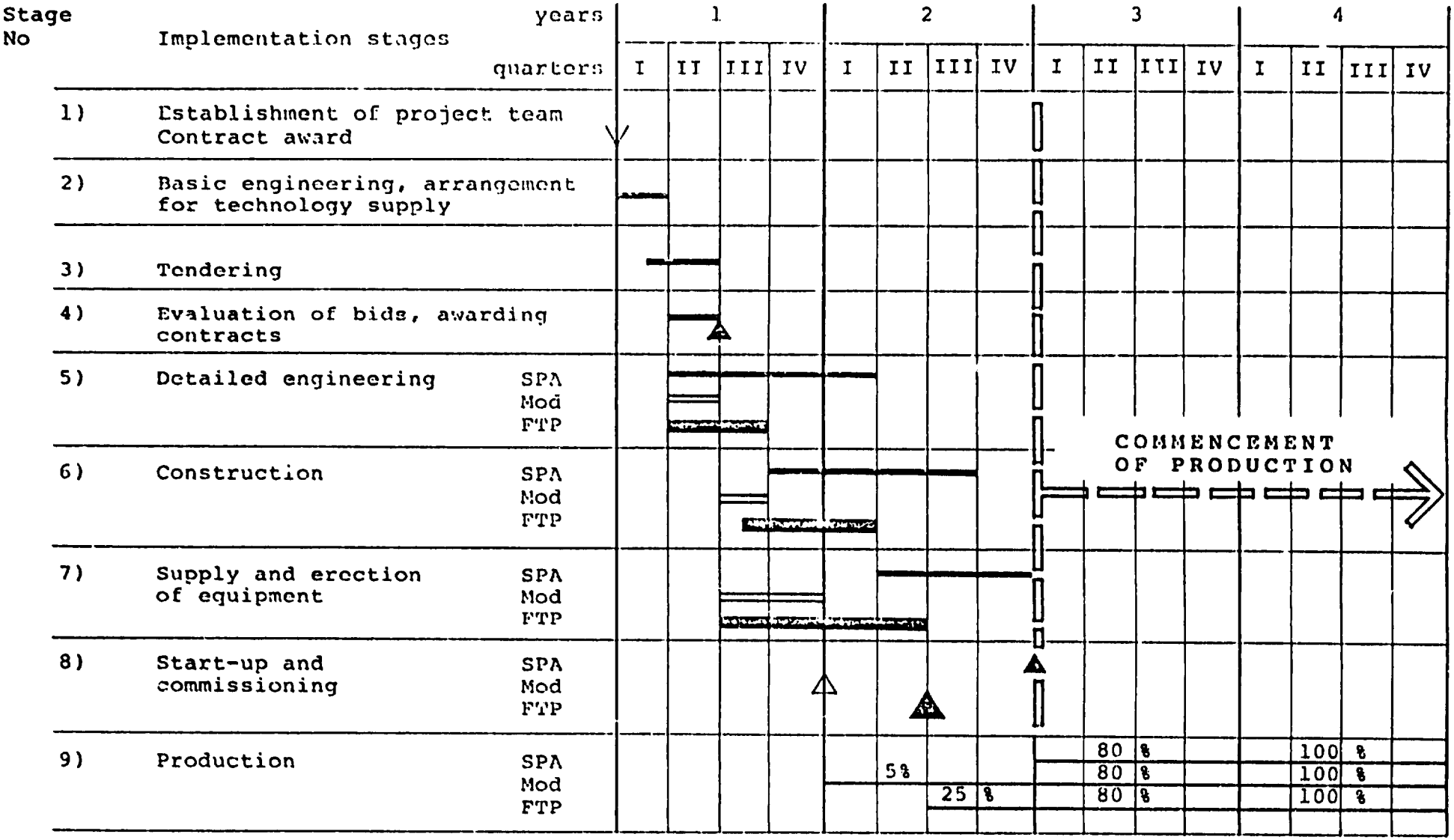
Variant 2
i.e. - production of treated anode foil and plain foil made of SPA imported in slabs and production of treated cathode foil of CPA produced in BALCO which necessitates
  - modernization of foil plant and construction of FTP

Variant 3
i.e. - production of treated condenser foil made of imported SPA and CPA foils which necessitates
  - construction of FTP

All these variants are comprehensively presented in the implementation schedule.

Economic evaluation (financial appraisal) of the new variants 2 and 3 is presented in Volume III. of this Final Report.

EDU Construction Implementation Schedule



Notes: SPA = production of SPA (project by VAMI)
Mod = modernization of foil rolling mill
FTP = foil treatment plant
Production

Implementation budget

Rs 000

Nr.	ITEM	1. year of construction		2. year of construction		In total
		I.-II. Q	III.-IV. Q	I.-II. Q	III.-IV. Q	
1	Feasibility study					*
2	Project management, organization	1,600	2,000	2,400	2,000	8,000
3	Detailed engineering	1,800	6,000	3,000	1,200	12,000
4	Expenditures for training abroad		6,000			6,000
5	Expenditures for training in India			5,000		5,000
6	Pre-production marketing costs	200				200
7	General (commissioning) tests			1,100		1,100
8	Trial operation				3,500	3,500
9	Contingencies				9,700	9,700
	In total	3,600	14,000	11,500	16,400	45,500

Commentary to implementation budget

1 - Feasibility study is financed by UNIDO, therefore the sum of 2,700,000 Rs is not included in pre-production costs.

2 - Project management, organization

Engineering and management team is proposed as 15 members consisting of:

- project manager
- construction manager
- process coordinator
- supervisors civil works - 2 persons
- supervisors technology - 3 persons
- engineering manager
- civil engineer
- mechanical and electrical engineers - 4 persons
- quantity surveyor

Activity of individual members vary from 6 to 24 months. Bearing in mind foreign deliveries it is assumed that 8 members of the team will be Indians and 7 members will be from foreign country.

Cost estimate is 8,000,000 Rs out of which 2,000,000 Rs are expenses for Indian employees and 6,000,000 Rs for foreign experts (fees, travel expenses, accommodation and diets in India).

3 - Detailed engineering

Except of the management team, the detailed engineering work will be carried out by consultancy companies and by suppliers of technology. Expenditures of 12,000,000 Rs are determined as 3 % sum of the overall cost of technology and building works.

4 - Expenditures for training abroad

Training abroad is recommended for 4 employees of the foil plant in duration of 2 weeks and 23 employees in 2 turns for work in the new foil treatment plant.
Training will be accomplished in companies in the Czech Republic, which will provide know-how in the folloving activities:

company	activity
Kovohutě Břidličná	rolling of foil
Tesla Lanškroun	treatment of foil by etching and forming

Time necessary for training for individual activities in FTP.

Activity	Number of employees	Time for training
Management	3	4 weeks
Laboratory	3	4 weeks
Brushing	2	2 weeks
Etching	4	4 weeks
Forming	2	4 weeks
Preparation of solutions	2	2 weeks
Mechanical maintenance	2	2 weeks
Electrical maintenance	2	4 weeks
Water treatment	3	2 weeks

Expenses for training abroad are estimated in the sum of 6,000,000 Rs including travel expenses, accommodation and diets.

5 - Expenditures for training in India

Training in India will be conducted by personnel of subcontractors of know-how during the commissioning period.

- Training for foil rolling will be provided by 2 experts in duration of 4 weeks in BBU

- Training for new operation in FTP will be provided by 3 experts in duration of 3 months during commissioning operation in FTP and by 1 expert in duration of 1 year in the first year of operation.

Expenses for training in India are estimated in the sum of 5,000,000 Rs comprising payment for expert's activity (5,000 USD per month) and accommodation inclusive diets.

6 - Pre-production marketing costs

In the 2nd year of construction it is recommended to undertake a marketing activity which would comprise agreements with buyers about assortment, amount and terms of supplies and verification of quality with buyers.

Estimated cost for marketing is 200,000 Rs.

7 - General (commissioning) tests

Function and guaranteed output of individual equipment will be tested and service manuals will be provided.
Estimated cost is 1,100,000 Rs.

8 - Trial operation

Verification of technological processes will be provided for individual products, as well as provision of technological manuals, quality checking of products in hand with buyers.

Control system for production will be carried out. Estimated cost is 3,500,000 Rs. This sum will cover expenses on salaries, material and energies relating to trial operation.

10. FINANCIAL APPRAISAL

10.1 Financial Analysis

The financial analysis of the project has been carried out using the data estimates specified in previous chapters. All the financial modelling and computation has been entirely based on the Computer Model for Feasibility Analysis and Reporting (COMFAR), developed and widely utilized by UNIDO.

The following financial parameters have been adopted for financial analysis:

- All prices and costs correspond to 1993 level.

- Prices and costs resulting from VAMI report (1986) have been updated to 1993 level using an average 10 % inflation rate indicated by the Indian counterpart. It means that each financial flow has been multiplied by $1.1^5 = 2.14$.

- For foreign investment cost calculations (import from Switzerland and the Czech Republic), exchange rates of 20.0 Rs/1 CHF and of 1 Rs/1 CZK have been adopted.

- The following figures of customs duties, insurance, taxes, fees etc. have been indicated on imported items:

Equipment:		
1.	Ocean Freight and Insurance	12 % of cost
2.	Customs Duty	
	(a) FTP facilities	25 % of CIF
	(b) Foil plant equipment	89 % of CIF
3.	Port Handling	1 % of CIF
4.	Inland Transport and Insurance	2 % of CIF
5.	Know-how tax	25 % of fee
Slabs/Foils:		
1.	Ocean Freight and Insurance	
	(a) Slabs	5 % of cost
	(b) Foils	7.5% of cost
2.	Customs Duty	20 % of CIF
3.	Port Handling	1 % of CIF
4.	Inland Transport and Insurance	2 % of CIF
5.	Entry Tax	0.5% of cost (after items at 1 to 4)

- The complete financial analysis is based on constant prices which makes it possible to compare both technical alternatives of the project. According to the wish of the Indian part, no incorporated income tax has been applied for net income and cashflow calculations.

Two basic alternatives of the project were examined from the financial point of view:

- the alternative supposing the foil treatment (etching and forming) facility would be situated in the Korba plant, where the entire production process starts (with Korba -Bidhanbag -Korba transportation costs taken into account),
- the alternative of finalizing the production in Bidhanbag unit, after the foil rolling operation (Korba - Bidhanbag transportation costs only).

Due to some differences in both investment and production costs in the alternatives in question, the transportation costs do not affect any choice in advance.

Since it was necessary to adapt the input data to the COMFAR data structure, some of the inputs had to be partially joined or pre-summarized as obvious in the COMFAR schedules. Therefore, the initial data structure is indicated here, together with necessary comments.

In accordance with the development of requirements concerning in particular the construction and start-up schedule of the project, the following implementation philosophy has been adopted for the financial analysis:

- after modernization of equipment and engineering in Bidhanbag (foil rolling, duration 1 year), production of SPA foils (10 tpy) will start immediately, using imported SPA material,
- after construction of etching/forming facility (duration 1.5 year) production of anode and cathode foils will start, also based on imported SPA (50% of full capacity),
- after construction of SPA purification facility (2 years duration, VAMI project), the entire production of foils will utilize the domestic SPA as input material (80% in the first year of such operations and full capacity thereafter).

Therefore, a one year construction period (1994) has been adopted in the COMFAR model, making it possible to start at least partial operations (combined with imports of the input material) in accordance with the requirements mentioned above. Of course, from the investor's point of view, a two years construction period is being adopted, with the production start-up already at the beginning or in the middle of the second construction year. Both of these approaches result into the same production build-up schedule.

Since a difference in the production build-up of various products has to be taken into consideration, the following products have been indicated in COMFAR when preparing the input data for the financial analysis:

- SPA plain foils
- CPA cathode foils
- SPA low-voltage anode foils (etched only)
- SPA high-voltage anode foils (etched only)
- SPA high-voltage anode foils (etched and formed)
- products of other use (lower grade SPA)

The 'other use'products (tab sheets, lead wires and similar) represent a lower quality by-product of the purification process. Since it is not to be included in the project appraisal, its financial impact (costs and sales) has been neutralized in the COMFAR model.

All the aggregated data used in the COMFAR model are initially based on this structure and use the following partial estimates (all in the local currency or its equivalent):

Remark:
According to the wish of the Indian part and in addition to this feasibility study, financial analysis of two more alternative approaches to the whole project has been carried out and presented in a separate volume:

- Production of condenser foils using imported SPA slabs and domestic CPA metal (i.e. without SPA purification and slabs casting).

- Production of condenser foils using imported SPA and CPA foils (represented only by foil treatment operations).

10.2 Total Investment Costs

Total investment costs have been estimated in accordance with particular facilities to be constructed or modernized and then divided according to the time schedule of construction mentioned above.

The following table 10.1 gives the full information on investment estimates in terms of the COMFAR input data structure, with the estimates for Korba (K) and Bidhanbag (B) indicated separately in case of the foil treatment (description of investment shortened).

Production facilities with investments

Description of investment	SPA (K) purific.	slabs(K) casting	foil (B) rolling	foil (K/B) treatment
Land				
Site preparation	98.44			K 870.0 B 970.0
Structures (a)	6584.78			
Structures (b)			786.00	K 20,957.0 B 20,780.0
Inc. fixed assets (a)				
Inc. fixed assets (b)	6334.40			18,750.0
Inc. fixed assets (c)				
Machinery and equip.(a)	16,015.76	2,654.0		445,736.0
Machinery and equip.(b)			105,010.0	
Auxiliary facilities				
Pre-production expend.	13,627.52			K 45,481.0 B 45,466.0
Inventory				

Table 10.1 Structure of investment costs (1,000 Rs)

Comments:

Investment costs for SPA purification were (in accordance with the Terms of Reference) adopted from the VAMI project and adjusted to a 10 % average inflation rate as already mentioned above.

No investment costs were indicated for strips rolling equipment (hot and cold rolling) for this project.

For the COMFAR calculation purposes (to approximate sufficiently the realistic time schedule of investments), all the investment costs were allocated into the first year (1994) with the exception of machinery and equipment (a), covering the SPA purification, slabs casting and foil treatment technology which has been allocated into 1995 (see COMFAR schedules, tables Total Initial Investment and Total Current Investment).

10.3 Total Production Costs

Total production costs used in financial analysis consist of operating costs and depreciation and financial costs.

The operating costs estimation has been based on various sources, according to the operation in question: VAMI report, cost statements for slab casting and rolled product in Korba and for foil rolling in Bidhanbag and cost estimates for newly designed foil treatment facilities in either Korba or Bidhanbag.

For the financial analysis purposes, where the project has to be treated as an integrated unit, the operating costs were calculated on a 'value added' base, avoiding a multiple calculating of the initial input material costs (due to a 'buying and selling' effect between subsequent operations).

For the financial modelling purposes, where the production build-up has to be reflected, the operating costs were indicated in Rupees per year for each product and the installed capacity level. A variable capacity utilization during the first years of operations has been simulated directly in COMFAR.

Tables 10.2 through 10.7 show the initial input data of which the yearly operating costs for the COMFAR model were prepared (COMFAR data structure respected).

Remarks:
Due to various structures of the data sources used, some cost items seem to be omitted, but they are usually joined with some others of a similar type in case they could not have been separated in a satisfactory manner. For example, the item 'consumable stores' shares the place with 'spare parts' in the COMFAR model. In view of the fact that the items are summarized, the distortion of the results is not considerable.

A 'direct material flow' concept has been adopted for the financial analysis. It means that the recycling of the waste taking place in the production process has not been reflected from the financial point of view, thus making the material costs higher than in reality. The financial model resigns on some optimistic assumptions in this respect.

Transportation costs from Korba to Bidhanbag and back have been calculated in accordance with Indian regulations indicated in Korba, including the excise, entry tax and insurance as follows:

Transp.cost = net wt/SUR * (unit price + entry tax + insurance)

where:
SUR (space utilization ratio) = 0.75 for the way from Korba
= 0.60 for the way from Bidhanbag

Unit price = 700.0 Rs/t (gross weight)
Excise = 0.25 * cost of product (further as 'cost')
Insurance = 0.002 * (cost + excise)
Entry tax = 0.005 * (cost + unit pr./SUR + excise + insurance)

Cost item 'Marketing, non-labour' has been used to input this information into the model.

Transportation costs Korba - Bidhanbag have been assigned to the production of plain foils, anode foils and cathode foils for both project alternatives examined. Transportation costs Bidhanbag - Korba have been added only in the alternative with foil treatment in Korba and assigned to anode and cathode foils only.

In the initial stage of production based on the imported SPA slabs, the price of the input material is calculated as 2,500 $ per ton (76,250 Rs/t) plus 29.8 % representing the effect of customs duty, ocean freight and insurance, port handling, inland transport and insurance etc., resulting in 98,970 Rs/t. These costs fully substitute the corresponding part of the SPA purification and slab casting costs.

Cost items not indicated in SPA purification column, were included in other items (overheads, utilities) in VAMI project.

Product:	PLAIN FOILS - initial CPA input 12.89 tpy				
Production (tpy)	12.790	12.20	10.840	10.000	
Operation: Operating costs	SPA K purific.	slab K cast.	strip K rolling	foil B rolling	foil K/B treatment
Raw mater.(a)	489.820				-
Raw mater.(b)	66.252	1.830			-
Utilities	227.790	3.294	0.596		-
Energy		3.660	14.092	21.470	- -
Labour direct	20.720	2.562	9.214	120.630	-
Maintenance		0.671	4.444	7.390	-
Spare parts		2.196	3.794	2.110	-
Factory overheads	27.370	0.610	1.897	90.080	-
Administr. labour					-
Admin. non-labour		0.122	2.331	54.540	-
Marketing labour					-
Marketing non-lab			KB BK	19.046 -	- -

Table 10.2 Basic structure of operating costs (1,000 Rs/y)

Product:	CATHODE FOILS - initial CPA input 103.50 tpy				
Production (tpy)		97.70	86.000	75.000	60.0
Operation: Operating costs	SPA K purific.	slab K cast.	strip K rolling	foil B rolling	foil K/B treatment*
Raw mater.(a)	-	3933.0			
Raw mater.(b)	-	14.655			
Utilities	-	26.379	4.730		KB 569.1
Energy	- -	29.310	111.800	161.025	K 1,203.4 B 1,588.6
Labour direct	-	20.517	73.100	904.725	KB 368.5
Maintenance	-	5.374	35.260	55.425	KB 54.9
Spare parts	-	17.586	30.100	15.825	KB 219.4
Factory overheads	-	4.885	15.050	675.600	KB 34.3
Administr. labour	-				KB 55.5
Admin. non-labour	-	0.977	18.490	409.050	
Marketing labour	-				
Marketing non-lab	- -		KB BK	124.012 158.775	

*) foil treatment = etching only !

Table 10.3 Basic structure of operating costs (1,000 Rs/y)

Product:	LV ANODE FOILS - initial CPA input 219.94 tpy				
Production (tpy)	218.270	206.87	184.990	170.670	100.0
Operation: Operating costs	SPA K purific.	slab K cast.	strip K rolling	foil B rolling	foil K/B treatment*
Raw mater.(a)	8,294.260				
Raw mater.(b)	1,130.640	31.030			
Utilities	3,887.390	55.850	10.170		KB 948.6
Energy		62.060	240.490	366.430	K 2,005.7 B 2,647.6
Labour direct	353.600	43.440	157.240	2,058.790	KB 614.1
Maintenance		11.380	75.840	126.120	KB 91.4
Spare parts		37.240	64.750	36.010	KB 365.7
Factory overheads	467.100	10.340	32.370	1,537.400	KB 57.1
Administr. labour					KB 92.6
Admin. non-labour		2.070	39.770	930.830	
Marketing labour					
Marketing non-lab			KB BK	325.020 412.730	

*) foil treatment = etching only !

Table 10.4 Basic structure of operating costs (1,000 Rs/y)

Product:	HV ANODE FOILS - initial CPA input 21.99 tpy				
Production (tpy)	21.830	20.68	18.500	17.070	10.0
Operation: Operating costs	SPA K purific.	slab K cast.	strip K rolling	foil B rolling	foil treatment* K/B
Raw mater.(a)	829.540				
Raw mater.(b)	113.080	3.100			
Utilities	388.790	5.580	1.020		KB 96.9
Energy		6.200	24.050	36.650	K 200.6 B 264.8
Labour direct	35.360	4.340	15.720	205.910	KB 61.4
Maintenance		1.140	7.590	12.610	KB 9.1
Spare parts		3.720	6.470	3.600	KB 36.6
Factory overheads	46.710	1.030	3.240	153.770	KB 5.7
Administr. labour					KB 9.3
Admin. non-labour		0.210	3.980	93.100	
Marketing labour					
Marketing non-lab			KB BK	32.500 41.270	

*) foil treatment = etching only !

Table 10.5 Basic structure of operating costs (1,000 Rs/y)

Product:	HV ANODE FOILS - initial CPA input 87.98 tpy				
Production (tpy)	87.310	82.74	74.000	68.260	40.0
Operation: Operating costs	SPA K purific.	slab K cast.	strip K rolling	foil B rolling	foil treatment K/B
Raw mater.(a)	3,317.780				
Raw mater.(b)	452.260	12.410			
Utilities	1,555.000	22.340	4.070		KB 3,367.4
Energy		24.820	96.200	146.550	K 7,120.3 B 9,399.1
Labour direct	141.440	17.370	62.900	823.420	KB 2,180.0
Maintenance		4.550	30.340	50.440	KB 324.6
Spare parts		14.890	25.900	14.400	KB 1,298.3
Factory overheads	186.240	4.140	12.950	614.880	KB 202.9
Administr. labour					KB 328.6
Admin. non-labour		0.830	15.910	372.290	
Marketing labour					
Marketing non-lab			KB BK	130.010 165.090	

Table 10.6 Basic structure of operating costs (1,000 Rs/y)

Product:	OTHER USE - initial CPA input 158.20 tpy				
Production (tpy)	157.000	149.00	133.000		
Operation: Operating costs	SPA K purific.	slab K cast.	strip K rolling	foil B rolling	foil K/B treatment
Raw mater.(a)	6,011.600			-	-
Raw mater.(b)	813.260	22.350		-	-
Utilities	2,796.170	40.230	7.315	-	-
Energy		44.700	172.900	- -	- -
Labour direct	254.340	31.290	113.050	-	-
Maintenance		8.195	54.330	-	-
Spare parts		26.820	46.550	-	-
Factory overheads	335.980	7.450	23.275	-	-
Administr. labour				-	-
Admin. non-labour		1.490	28.595	-	-
Marketing labour				-	-
Marketing non-lab				- -	- -

Table 10.7 Basic structure of operating costs (1,000 Rs/y)

Depreciations are included into the total production costs directly by COMFAR which calculates them in accordance with depreciation rules indicated together with investment costs.

The following rates were used (BALCO sources):

- Site preparation and development 5.15 %
- Structures and civil engineering 3.34 %
- Technology, machinery and equipment 11.31 %

Financial costs are also generated by COMFAR according to the conditions indicated in the source of finance description (see Project Financing).

Remark:
Only those depreciations and financial costs which are immediately linked with the project are taken into consideration for the financial analysis purposes. No depreciations or interests linked to the entire company's operations and borne partially by other products were included. The reason is a considerably little share of the project-oriented costs in comparison with the production volume being out of the project. Nevertheless, such a potential reduction of these fixed costs is reflected in the sensitivity analysis, giving the break-even charts also for 10 % and 30% increase of these costs, still with a sufficient margin (see COMFAR charts).

10.4 Production Programme and Sales

This part of COMFAR input data reflects the production build-up for all six products separately, in accordance with the time schedule of construction already mentioned.

For the capacitor - oriented products, the following sales prices have been adopted (see chapter 'Market Analysis and Marketing Strategy'):

- plain foils		350 Rs/kg
- cathode foils		990 Rs/kg
- LV anode foils	(etched only)	2,170 Rs/kg
- HV anode foils	(etched only)	2,170 Rs/kg
- HV anode foils	(etched & formed)	3,340 Rs/kg

The 'other use' products are not indicated here anymore because they are of the lower grade of SPA and should be financially neutral towards the project efficiency statements. Therefore, special sales prices were assigned to them just to compensate exactly their production costs. This 'no loss - no profit' approach has been agreed in BALCO.

Also in the case of sales prices, sensitivity was examined to indicate the resistance of the project to potential over-estimation of the prices. A decrease by 10 % and 30 % does not show any critical changes of the break-even point (see COMFAR output charts).

10.5 Working Capital

Only orientation estimates could be collected for working capital requirements module of COMFAR.

Minimum coverage in days was indicated very approximately as follows:

For current assets:	
- accounts receivable	0 days
- inventory & materials	16 days
- energy	0 days
- spare parts	180 days
- work in progress	10 days
- finished products	10 days
- cash in hand	0 days
For current liabilities:	
- accounts payable	30 days

No receivables and cash in hand decrease the liquidity ratio. Nevertheless, the dynamics of the net working capital can affect the cash flow of the project only slightly and during the first three years of the production build-up.

10.6 Project Financing

According to the BALCO specifications, only loan has been adopted as the external source of finance. The following loan conditions have been indicated for the financial analysis:

- long-term loan interest rate 18%,

- 10 years amortization period,

- constant principal type of amortization,

- yearly repayments,

- preferably without any grace period.

According to the first COMFAR simulation (without sources of finance) it was obvious that the loan would have to be used in two disbursements covering financial requirements in the years 1994 and 1995. With the corresponding funds and debt service included into the model, the project proved to be financially viable.

Detailed information on the project financing can be found in COMFAR output schedules 'Source of Finance' an 'Cashflow Tables'.

10.7 Financial Statements

Since the financial analysis has been carried out by means of COMFAR, practically all the financial statements can be found in its output tables or charts.

For each of the two project alternatives the following information and financial statements have been generated in this feasibility study:

Tables:
- Summary sheet (basic + first 3 years of operations)
- Total initial investment
- Total current investment (during production)
- Total production costs
- Net working capital
- Source of finance

- Cashflow tables (constant prices, without income tax as required for feasibility studies in India)

- Net income statement (constant prices, without income tax as required for feasibility studies in India)

- Projected balance sheets

Charts:
- Annual cashflow from operations
- Accumulated cashflow from operations
- Annual flow of funds
- Discounted net cashflow (net present value)
- Sensitivity of internal rate of return
- Fixed cost coverage ratio
- Break-even chart (financial costs included)
- Structure of production costs
- Net cashflow / total sales ratio
- Net profit / total sales ratio
- Total sales and production costs survey

Comments:

The financial statements show a high degree of commercial profitability of both of the project alternatives examined.

In investments (both the initial and current), the alternative with the foil treatment in Bidhanbag is slightly better (see COMFAR tables) which is caused both by lower initial investment costs and by lower working capital requirements affecting current investments. However, the difference is very small.

In production costs, the alternative with the foil treatment in Bidhanbag is slightly inferior to that preferring the final operations back in Korba. Even though the transportation costs are lower, it is the higher energy cost in Bidhanbag to more than equalize this advantage.

In sources of finance, the comparison is very difficult again because the sum of external funds (loans only) is almost the same for both of the alternatives. Whereas the alternative with the foil treatment in Bidhanbag is slightly cheaper in 1994, the loan disbursed in 1995 is slightly higher than that for the Korba-oriented alternative and vice versa.

The **cashflow** tables show again almost identical financial cashflow surplus. The net (operating) cashflow indicates for both alternatives a good pay-back period of 3 years, with the absolute values showing a little better result in the Korba-oriented project alternative. This can be also observed when comparing the cumulated net cashflows or the net present values (calculated at 15% discount rate). Again, the Korba-oriented alternative gives better results but not substantially. The same applies the internal rate of return which is over 50% in both alternatives.

Simple rates of return (return on equity and return on investment) are apparent from the 'Net Income Statement' table. While the return on equity is not indicated (no equity in funds), the return on investment is almost identical for both alternatives and very high (for the fifth year of operations approx. 45%).

Break-even analysis (see break-even charts) indicates the break-even point at approx. 40% with rather high financial costs included in the fixed production costs, again for both project alternatives, which represents a good reserve for the case of worse conditions in sales or production costs. Without financial costs included (or at the end of the debt service period) the break-even point moves to approx. 20%.

Sensitivity analysis made in the break-even chart indicates a rather good degree of the project stability under worsened conditions. For example, a 30 % decrease of sales prices combined with a 30 % increase of the fixed part of production costs would move the break-even point to the value of 80 %.

Sensitivity analysis of the internal rate of return shows the maximum dependence of the IRR on sales prices, then on operating costs and initial investments.

10.8 Conclusions

The financial analysis shows that both alternatives of the project (foil treatment facility in Bidhanbag or in Korba) indicate a very good profitability and that the idea of producing the capacitor foils is viable.

When making appraisal purely from the financial point of view, it can be stated that the alternative with the foil etching and forming in Korba is slightly better.

However, the difference is so small that any other decision supporting aspect (environment protection, social aspects etc.) can be taken into consideration.

ANNEXES

Preliminary offers:

ANNEX 1 - Modernization of two 4-high Von Roll foil rolling mills
Offerer: Lauener Company, Thun
Switzerland

ANNEX 2 - Drive system modernization of two rolling mill No. 1 in BBU
Offerer: ČKD Cegelec, Praha
The Czech Republic

ANNEX 3 - Production and checking equipment for etching and forming of Al condenser foil
Offerer: SOMA Lanškroun, The Czech Republic

MODERNISATION OF TWO 4-HIGH VON ROLL FOIL ROLLING MILLS

Customer: Bharat Aluminium Company Ltd., India

Consultant: HP METALCONSULT Praha
Opletalova 37
110 00 Praha 1
Czechoslovakia

Content:

Thun, 8.2.93/Fa/bs/346.Div

1. INTRODUCTION

The Bharat Aluminium Company Ltd., located in India is operating two 4–high rolling mills built by Von Roll, Switzerland.

Cold rolled stocks with a thickness of 0,6 mm is brought from Indian suppliers. It is then cold rolled in the roughing mill and the finishing mill to a final thickness of 2 x 0,009 mm.

The target now is to modify both mills in such a way that from the incoming material condenser foil can be produced with a thickness of 2 x 0,006 mm.

Metal Consult is working on a feasibility study for an eventual modernisation program. Lauener has been asked through Metal Consult for a proposal containing necessary modifications on the mills to meet the target for producing condenser foil. The actual condition of the mill equipments are not known and therefore only budget prices can be given.

To work out a final proposal more technical information as well as a site inspection would be required. The following cost estimation and recommendations can be used as reference only.

For some equipments we indicate a separate price for the hardware. Those are parts from which we think they can be manufactured locally in India.

2. GENERAL REQUIREMENTS FOR PRODUCING CONDENSER FOIL

- Incoming stock must be wound on accurately machined metal spools.

- Both mills are currently operating with tension brakes instead of electrical motors on the unwind side. If the brake on the roughing mill is diameter compensated it can be further used. For the finishing mill the tension brake is not accurate enough and the use of electrical motors is essential.

- For the roughing mill we recommend a positive/negative roll bending we would recommend for the roughing mill. Due to closed gap operation and the narrow width on the finishing mill a roll bending in this mill would be ineffective.

- *Gauge control modes*
  - Roughing mill: position and pressure control
  - Finishing mill: only pressure control (closed gap operation)

- *Roll specification*

– Work rolls:	Hardness	– roll barrel 100 – 105 Shore D – journal 40 – 45 Shore D
	Eccentricity	0,005 mm max.
	Out of round	0,0025 mm max.
– Back up rolls:	Hardness	– roll barrel 70 – 75 Shore D – journal 40 – 45 Shore D
	Eccentricity	0,005 mm max.
	Out of round	0,003 mm max.

- *Rolling oil filtration*
  During rolling process the rolling oil becomes contaminated with aluminium fines as well as with dirt and other foreign matter it picks up. These contaminants affect the performance of the lubricant. To remove them the roll coolant needs to be continuously filtered.

  Three basic designs of filter are available, i.e. the bag type, the tube and plate type. All operate on the by-pass principle in which oil, pumped from the dirty side of the storage tank, passes through the filter and flows back to the clean side of the tank. The filtration capacity has to be higher than the max. supply to the mill site. The plate type filter is considered to be the most suitable for foil mill operation and is recommended for all replacements and new installations.

Eddy–current gauges

Originally both mills had been supplied with eddy–current gauge systems from Electronic Production Aids. We do not know the actual condition of these systems but would recommend to replace them by the latest models from the same company. These include automatic strip temperature compensation by a dynamic accuracy of +/– 1 % of the nominal thickness.

2.1) Preliminary Technical Datas Mill No. 1 for Roughing Operation

1. Production Datas

Material:	Aluminium, Al. 99.99
Strip thickness:	Entry 0,8 mm max./0,02 mm min. Exit 0,5 mm max./0,012 mm min.
Strip width:	600 mm max. 450 mm min.
Coil DIA:	OD 850 mm max. ID 280 mm (on steel spools)
Coil weight:	1210 kg (incl. spool)
Expandable cores:	To be used for foil stock without spools for 1. pass (dimension to be specified)

2. Mill Datas

Mill type:	4-high cold rolling foil roughing mill
Mill builder:	Von Roll, Switzerland
Year of built:	1962 - 1963
Work rolls:	• DIA 185 mm • Barrel length 1020 mm • Roller bearing (new) 2 x 2 row cylinder roller bearing 130/180 dia. x 50 mm with intermediate ring, 2 row ball bearings (thrust bearing) 100/180 dia. x 34 mm • Lubrication: oil/air mist and oil level

Back up rolls:	• DIA 420 mm • Barrel length 1000 mm • Roller bearing (new) 2 x 2 roller bearing 220/310 dia. x 225 mm 2 row roller bearing (thrust bearing) 120/260 dia. x 86 mm • Lubrication: oil/air mist and oil level
Mill drive:	0 – 150 – 150 kW 0 – 406 – 1220 min^{-1}
Gear stage:	i = 1,96 (pinion stand)
Roll speed:	0 – 100 – 350 m/min

3. Decoiler Datas (optional)

Decoiling speed:	245 m/min max.
Strip tension range:	0,8 – 8 kN
Motor rating:	0 – 32 – 32 kW
Motor revolution:	0 – 800 – 2400 min^{-1}
Gear ratio:	9,60

4. Coiler Datas

Coiling speed:	438 m/min max.
Strip tension range:	0,7 – 7 kN
Motor rating:	0 – 52 – 52 kW
Motor revolution:	0 – 800 – 2400 min^{-1}
Gear ratio:	5,48

2.2) Preliminary Technical Datas Mill No. 2 for Finishing Operation

1. Production Datas

Material:	Aluminium, Al. 99.99
Strip thickness:	Entry 0,12 mm max./0,02 mm min. Exit 0,08 mm max./2 x 0,006 mm min.
Strip width:	600 mm max. 450 mm min.
Coil DIA:	OD 350 mm max. ID 280 mm (on steel spools)
Coil weight:	1210 kg (incl. spool)

2. Mill Datas

Mill type:	4-high cold rolling foil finishing mill
Mill builder:	Von Roll, Switzerland
Year of built:	1962 - 1963
Work rolls:	• DIA 185 mm • Barrel length 1020 mm • Roller bearing (new) 2 x 2 row cylinder roller bearing 130/180 dia. x 50 mm with intermediate ring, 2 row ball bearings (thrust bearing) 100/180 dia. x 34 mm • Lubrication: oil/air mist and oil level
Back up rolls:	• DIA 420 mm • Barrel length 1000 mm • Roller bearing (new) 2 x 2 roller bearing 220/310 dia. x 225 mm 2 row roller bearing (thrust bearing) 120/260 dia. x 86 mm • Lubrication: oil/air mist and oil level

Mill drive:	0 – 150 – 150 kW 0 – 330 – 1000 min^{-1}
Gear stage:	i = 1 : 1 (pinion stand)
Roll speed:	0 – 192 – 580 m/min

3. **Decoiler Datas**

3.1) Decoiler I

Decoiling speed:	406 m/min max.
Strip tension range:	0,3 – 3 kN
Motor rating:	0 – 22 – 22 kW
Motor revolution:	0 – 800 – 2400 min^{-1}
Gear ratio:	5,20

3.2) Decoiler II (for doubling operation only)

Decoiling speed:	406 m/min max.
Strip tension range:	0,3 – 3 kN
Motor rating:	0 – 22 – 22 kW
Motor revolution:	0 – 800 – 2400 min^{-1}
Gear ratio:	5,20

4. **Coiler Datas**

Coiling speed:	725 m/min max.
Strip tension range:	0,15 – 1,5 kN
Motor rating:	0 – 20 – 20 kW
Motor revolution:	0 – 800 – 2400 min^{-1}
Gear ratio:	2,91

3. COST ESTIMATION FOR NECESSARY MODERNISATION

3.1) Budget Prices Mill No. 1 for roughing operation

Roll Neck Bearing

Work roll assembly

- New work roll chocks with new design for roller bearings and roll bending (system Mac-West).
- 2 x 2 row cylinder roller bearing 130/180 dia. x 50 mm with intermediate ring, 2 row ball bearings (thrust bearing) 100/180 dia. x 34 mm.
- Oil mist lubrication system, oil/air mist and oil level.

Budget price for engineering only	***SFr. 50'000.--***
Total budget price for 2 sets incl. total 8 chocks, bearings, lubrication, engineering	***SFr. 165'000.--***

Modifications of the roll necks are necessary but from this price excluded.

Back up roll assembly

- Modification of back up roll chocks for roller bearing and negative roll bending cylinder (Mac-West).
- 2 x 2 roller bearing 220/310 dia. x 225 mm, 2 row roller bearings (thrust bearing) 120/260 dia. x 86 mm.
- Oil mist lubrication system, oil/air mist and oil level.

Budget price for engineering only	***SFr. 60'000.--***
Total budget price for 2 sets incl. bearings, lubrication, engineering	***SFr. 200'000.--***

Modifications of the roll necks and the existing roll chocks are necessary but from this price excluded.

Note:
Existing chock modification to be done locally due to expensive shipping costs as well as long down time by sending them abroad.

Roll Bending System

Positive/negative roll bending system Mae-West

- 8 hydraulic cylinders in Mae-West blocks, mounted on the mill housing.
- 16 hydraulic cylinders in back up roll chocks, 2 sets.
- 4 Mae-West blocks.
- 1 hydraulic valve stand

Total budget price for roll bending hardware for 2 roll sets and engineering. Excl. hydraulic supply, piping, back up roll chock modifications ***SFr. 127'000.--***

Budget price for engineering only ***SFr. 37'000.--***

AGC Roll Load Cylinder

- Special high pressure cylinders of S-L-C design. Cylinder bore bronze plated, special stick slip free and tight sealed.

  - Piston diameter: 180 mm
  - Stroke: 100 mm
  - Operating pressure: 230 bar
  - Available force for roll load: 500 kN/per cyl.
  - Retracting force: 250 kN/per cyl.

- Servo valves type Schneider, directly mounted on cylinders.

Total budget price for AGC package. Excl. hydraulic supply, piping, modifications on existing parts ***SFr. 423'000.--***

New Drive System Reliance

1 Control Cabinet including
- DCS control system for mill/coiler drives
- Required hard- and software

1 Main control panel for mill operator

2 Subcontrol panels

1 DC drive motor for mill type GS 3108 150 kW / 406 - 1220 rpm

1 DC drive motor for coiler type GS 1810 56 kW / 1000 - 2730 rpm

Power requirements: 3 x 500 V, 50 Hz

Total system price without decoiler drive ***SFr. 382'000.--***

Option:
Above modernisation with one additional decoiler drive as follows:

1 DCS control system for one decoiler drive required additional hard- and software

1 DC-drive motor for decoiler GS 1608 32 kW/900 - 2670 rpm

Mechanical equipments/engineering for decoiler drive: gear shaft, gear box, couplings etc.

Total system price including decoiler drive ***SFr. 545'000.--***

Note:
It is not known to LE whether the existing motors can be further used.

Roll coolant system consisting of:

2 GRIP coolant headers complete with a total of 48 valves (35 l/8 bar) spaced on 75 mm pitch. Total flow capacity: 900 l/min.

Refer to coolant distribution sheet for specific coolant flows (see appendix 4.2).

Electrical control for manual operation of spray system.

Total system price for roughing mill ***SFr. 228'000.--***

Note:
With minor changes this system could be adapted to automatic flatness control.

3.2) Budget Prices Mill No. 2 for finishing operation

1) Roll Neck Bearing

Work roll assembly

- New work roll chocks with new design for roller bearings.
- 2 x 2 row cylinder roller bearing 130/180 dia. x 50 mm with intermediate ring, 2 row ball bearings (thrust bearing) 100/180 dia. x 34 mm.
- Oil mist lubrication system, oil/air mist and oil level.

Budget price additional engineering for finishing mill ***SFr. 20'000.--***

Total budget price for 2 sets incl. total 8 chocks, bearings, lubrication, engineering ***SFr. 165'000.--***

Modifications of the roll necks are necessary but from this price excluded.

1.2) Back up roll assembly

- Modification of back up roll chocks for roller bearing and negative roll bending cylinder (Mac-West).
- 2 x 2 roller bearing 220/310 dia. x 225 mm, 2 row roller bearings (thrust bearing) 120/260 dia. x 86 mm.
- Oil mist lubrication system, oil/air mist and oil level.

Budget price additional engineering for finishing mill ***SFr. 25'000.--***

Total budget price for 2 sets incl. bearings, lubrication, engineering. Excl. rolls, modification, of chocks ***SFr. 200'000.--***

Note:
Existing chock modification to be done locally due to expensive shipping costs as well as long down time by sending them abroad.

AGC Roll Load Cylinder

- Special high pressure cylinders of S-L-C design. Cylinder bore bronze plated, special stick slip free and tight sealed.

– Piston diameter:	180 mm
– Stroke:	100 mm
– Operating pressure:	230 bar
– Available force for roll load:	500 kN/per cyl.
– Retracting force:	250 kN/per cyl.

- Servo valves type Schneider, directly mounted on cylinders.

Total budget price for AGC package. Excl. hydraulic supply, piping, modifications on existing parts ***SFr. 423'000.--***

New Drive System Reliance

1 Control Cabinet including
  – DCS control system for mill/coiler drives
  – Required hard- and software

1 Main control panel for mill operator

2 Subcontrol panels

1 DC drive motor for mill type GS 3110 150 kW / 330 - 1000 rpm

1 DC drive motor for coiler type GS 1606 20 kW / 790 - 2400 rpm

Power requirements: 3 x 500 V, 50 Hz

Total system price without decoiler drive ***SFr. 382'000.--***

Option:
Above modernisation with two additional decoiler drives as follows:

1 DCS control system for two decoiler drives required additional hard- and software

2 DC-drive motors for decoilers GS 1310 15 kW/790 - 2670 rpm

Mechanical equipments/engineering for decoiler drives: gear shafts, gear boxes, couplings etc.

Total system price including two decoiler drives ***SFr. 655'000.--***

Note:
It is not known to LE whether the existing motors can be further used.

Roll coolant system consisting of:

2 GRIP coolant headers complete with a total of 48 valves (35 l/8 bar) spaced on 75 mm pitch. Total flow capacity: 900 l/min.

Refer to coolant distribution sheet for specific coolant flows (see appendix 4.2).

Electrical control for manual operation of spray system.

Total system price for finishing mill ***SFr. 228'000.--***

Note:
With minor changes this system could be adapted to automatic flatness control.

3.3) **Budget Prices auxilliary units**

Coolant oil filtration plant type Womack

The model HP–20 filtration system consists of two vertical stack horizontal plate pressure filters.

Filtration capacity:	2'000 l approx.
Tank capacity:	30'000 l approx.

In the price is included a complete filtration plant consisting of filter, pumps, tanks, valves, controls etc.

Total budget price for one filtration plant type Womack ***SFr. 1'010'000.--***

Note:
Both mills can be operated with one filter plant as described above.

Yours sincerely,

LAUENER ENGINEERING LTD.

i.A. D. Fankhauser

B. Frischknecht D. Fankhauser

CEGELEC
ČKD

HP Metalconsult Praha

Opletalova 37
11000 Praha 1
Ing. František Kudr
non-ferrous metallurgy department

931289 CPD Praha 9.9.1993

Ref: Modernization of foil rolling mill, Balco, India

Dear Sir,

Following please find our propcsal for the drive system modernization for the Balco foil rolling mill No 1. This proposal is tc be used in your feasibility study.

I hope you will find our proposal satisfactory and remain

Ing. Jiří Šimonek
manager of metallurgy department
project and sales division

CEGELEC ČKD, a.s., Budějovická 7, 140 00 Praha 4
TELEFON: 02/4121111; FAX: 02/423295, 421471, 421167; IČO 45272735
BANKOVNÍ SPOJENÍ: Komerční banka Praha 8, č. účt. 14308-081/0100

CEGELEC

ČKD

DRIVE SYSTEM MODERNIZATION

PROPOSAL ON THE BASE OF CEGELEC ČKD'S DELIVERY

Foil Rolling Mill No.1 (Roughing Mill) Bharat Aluminium Company Ltd., India

Modernization of drives and their control system is based of delivery following items:

- DC-drive motor 32 kW for decoiler,
- control cabinet including rectifier WNTC 4155 with microprocessor based specialized programme module for the control of decoiler,
- mechanical equipment/engineering for decoiler drive: gear shaft, gear box, couplings etc.,
- control cabinet including rectifier WNTC 4420 with microprocessor based BASIC programmable module for the control of the rolling stand,
- DC-drive motor 56 kW for coiler,
- control cabinet including rectifier WNTC 4155 with microprocessor based specialized programme module for the control of coiler,
- control cabinet including control system on the base of ALSPA 80-35 which will be used for the centralization of the drives control and their monitoring,
- main control panel for mill operator,
- two subcontrol panels,
- required control software.

Cabinets are equipped with required hardware (terminal boards, power sources, sensors and transmitters, fuses etc.). Control system is not supposed to be used for automatic computer thickness or flatness control.

The price estimation of above mentioned items list of CEGELEC ČKD's delivery is 370 000,- SFr FOB Terst. This value is preliminary, valid for 1993 and can be used as reference only.

The price estimation of CEGELEC ČKD's on-site services (including technical assistance, commissioning, performance test and customer staff training) is 55 500,- SFr. The travelling expenses and logging fee are not included. This value is preliminary, valid for 1993 and can be used as reference only.

CEGELEC ČKD, a.s., Budějovická 7, 140 00 Praha 4
TELEFON: 02/4121111; FAX: 02/423295, 421471, 421167; IČO 45272735
BANKOVNÍ SPOJENÍ: Komerční banka Praha 8, č. úč. 14308-081/0100

SOMA spol. s r.o. Konstrukce a výroba jednoúčelových strojů, Smetanova 380, 560 01 Lanškroun

Mr. Petr Bradáč
Director
METALCONSULT, spol. s r.o.
Opletalova 37
110 00 Praha 1

August 31, 1993

Dear Mr. Bradáč !

With relation to the foregoing negotiations and with respect to our last meeting on August 27, 1993 we would like to present you our new offer.

1. Commodity :
   - 1.1. The cathode foil etching equipment, U 3501, with the d.c. source 2000 A, 20 V .....5 pcs
   - 1.2. The anode foil etching equipment, U 3500, with the d.c. source 6000 A, 20 V .....6 pcs
   - 1.3. The forming equipment, U 3511, with three d.c. sources 500 A, 800 V .....2 pcs
   - 1.4. The brushing equipment, UC 536 C .....2 pcs
   - 1.5. The testing equipment for the foil forming ability, KC 2549 A .....2 pcs
   - 1.6. The measuring device for C, tg δ .....2 pcs

2. Price : Total
   - 2.1. After 1.1. 565 000.- USD each (included 94 000.- USD for one source) 2 825 000.- USD
   - 2.2. After 1.2. 673 000.- USD each (included 184 000.- USD for one source) 4 038 000.- USD
   - 2.3. After 1.3. 662 000.- USD each (included 228 000.- USD for 3 sources) 1 324 000.- USD

Turn over, please ....

2.4. After 1.4.
144 000.- USD each 288 000.- USD

2.5. After 1.5.
3 400.- USD each 6 800.- USD

2.6. After 1.6.
11 300.- USD each 22 600.- USD

8 504 400.- USD

The price is to be understood FOB Terst, Italy, with cost of the assembly and putting into operation included.

3. Delivery term : 2 years after the contract has been signed

4. Payment conditions :
   4.1. We would like to ask for the first advance payment of 1/3 ot the total amount after the confirmation of order
   4.2. The other payments will be agreed in the case, the equipment will be ordered

5. Guarantees :
   We pay the guarantee for the proper operation for 12 month since the start of the operation.

6. This offer is valid until December 31, 1993.

With best regards,

SOMA
Ing. L. Verner
Director

SOMA
LANŠKROUN s .r. o.
Konstrukce a výroba jednoúčelových strojů
Smetanova 380, 563 01 Lanškroun

20714 (2 of 2)

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

FINAL REPORT

Project No.: DP/IND/91/093 - Contract No.: 92/090

ESTABLISHMENT OF AN EXPERIMENTAL DEMONSTRATION UNIT FOR MANUFACTURING SUPER-PURE ALUMINIUM AND CONDENSER FOILS FROM IT

INDIA

FEASIBILITY STUDY

VOLUME II

METALCONSULT Ltd.
Prague, The Czech Republic

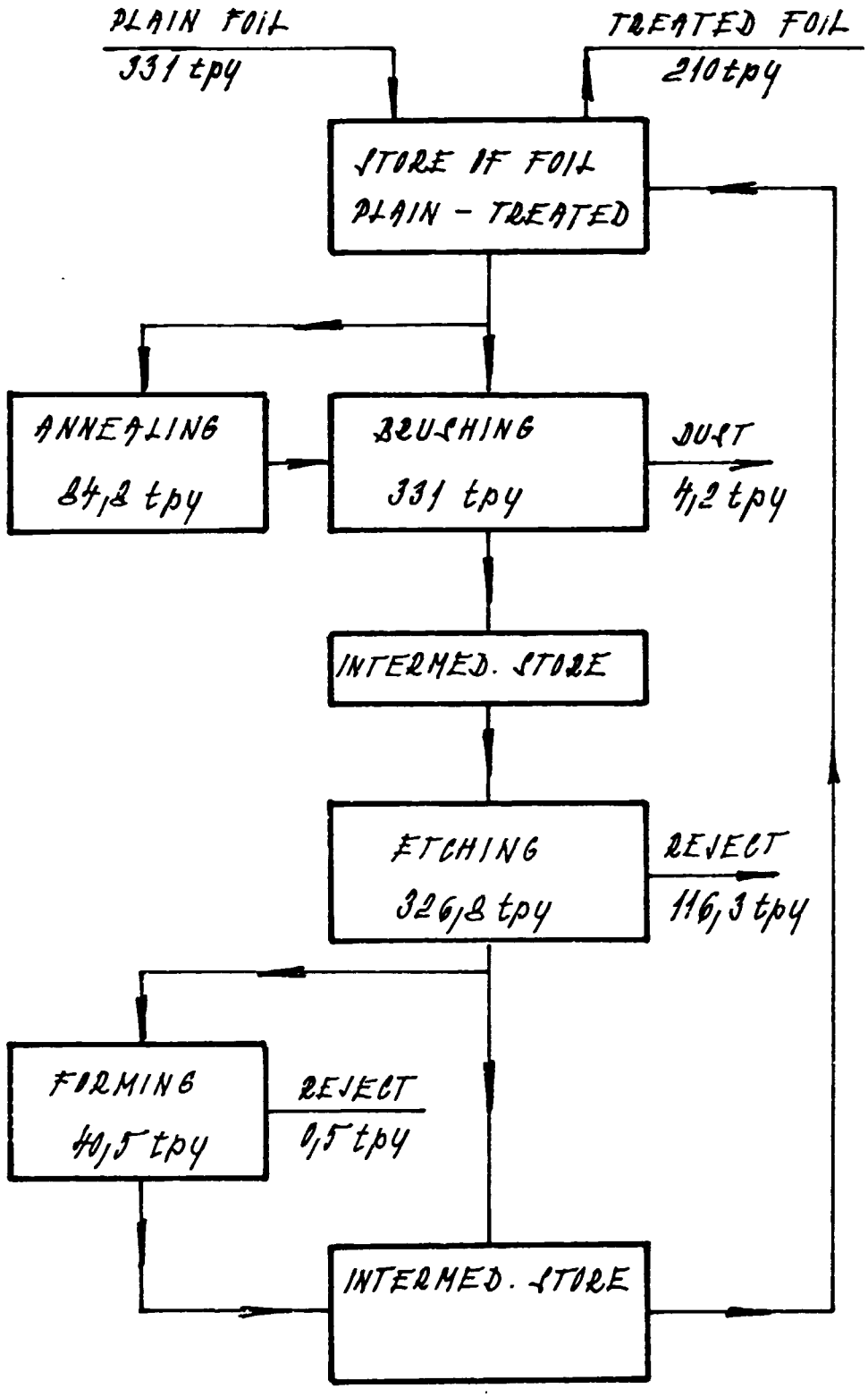
POLYTECHNA Ltd.,
Prague, The Czech Republic

SEPTEMBER 1993

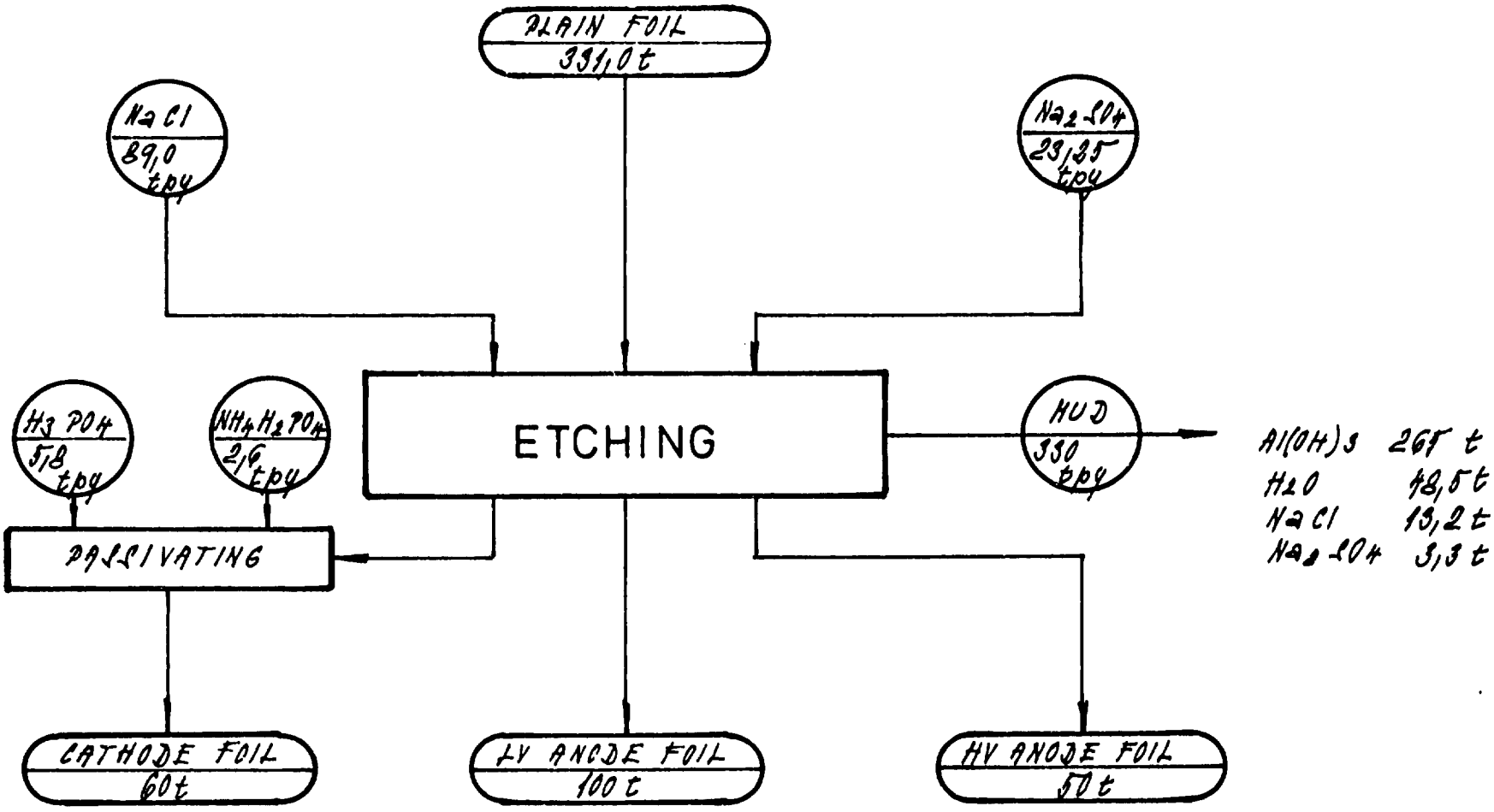
VOLUME II

CONTENTS

1. Flow charts and diagrams

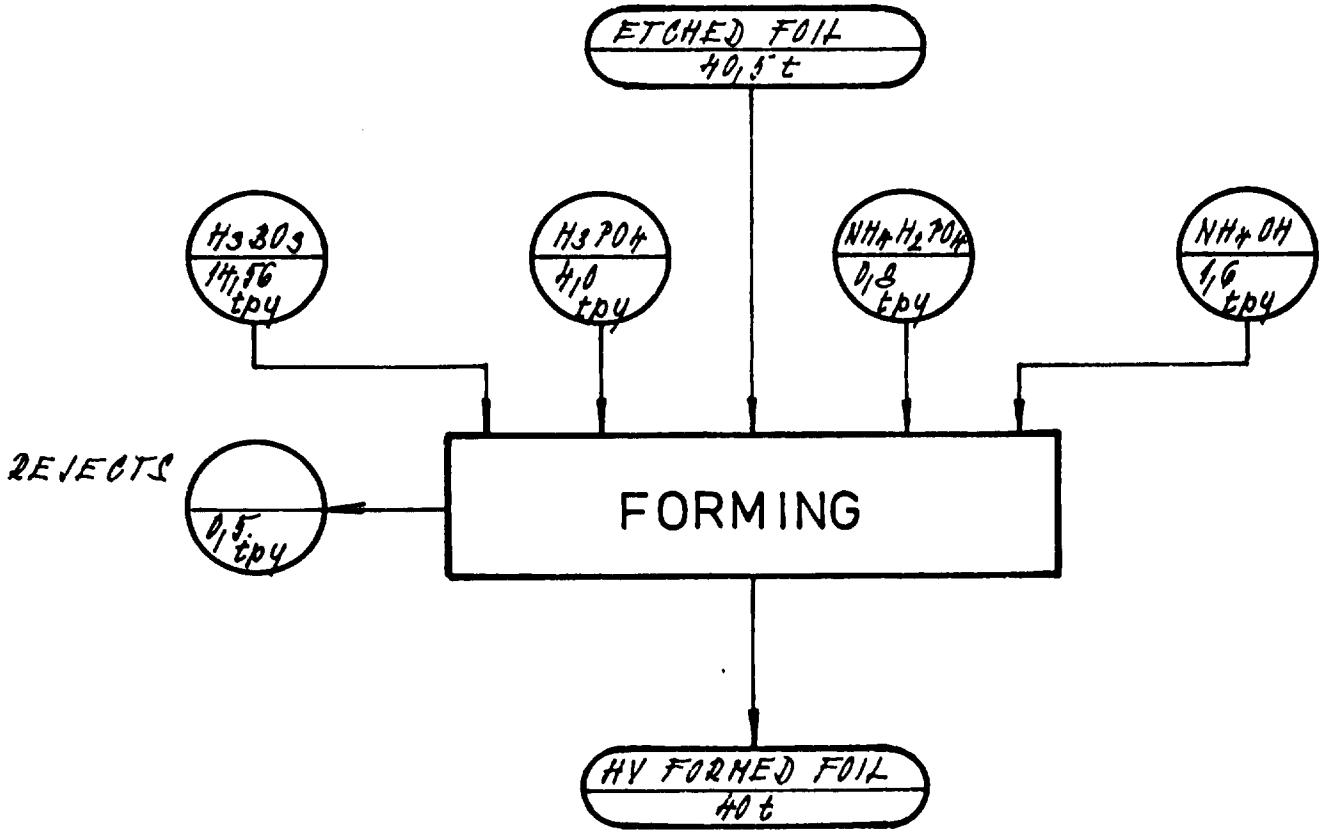


FOIL STORING AND HANDLING

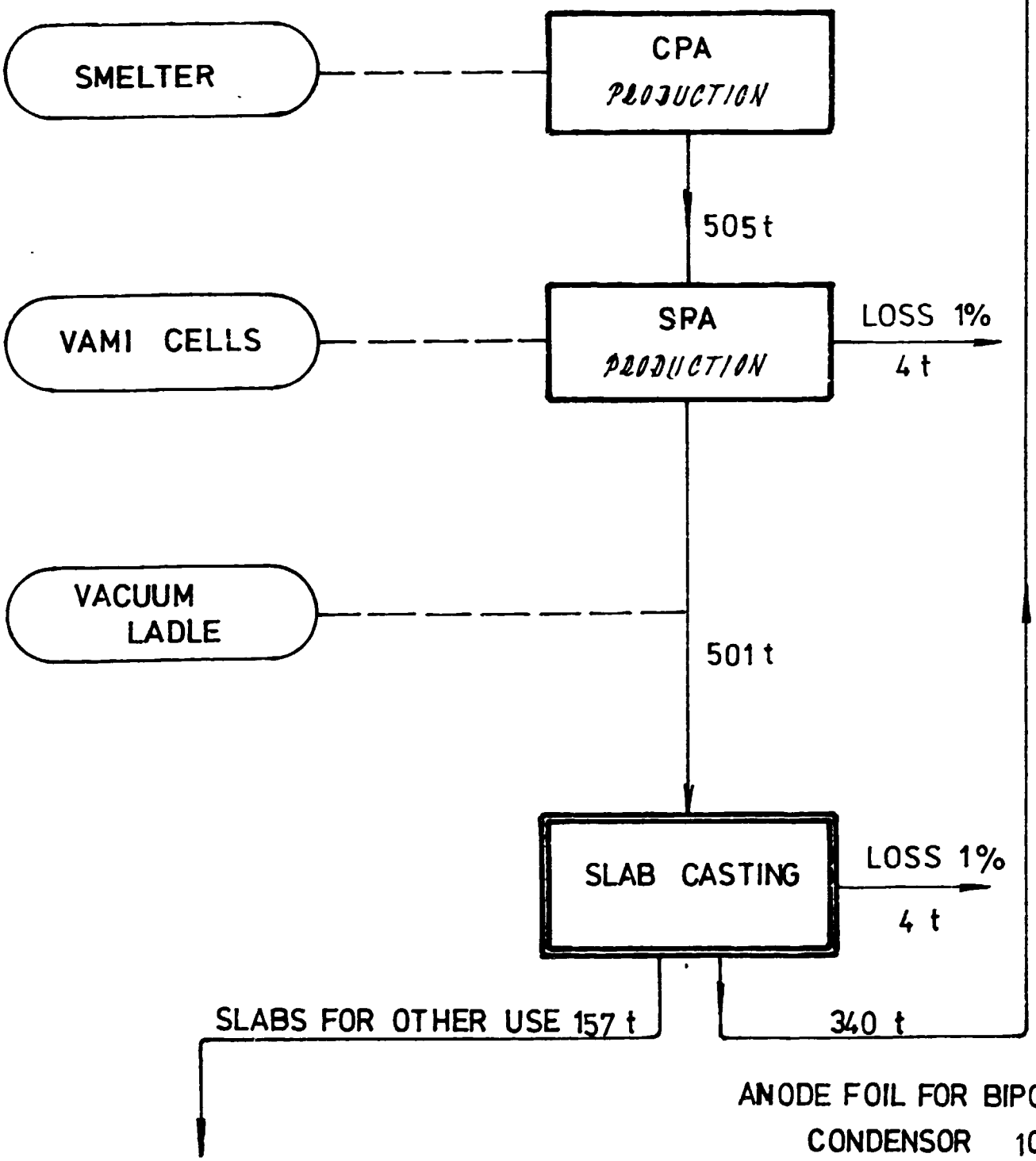


MATERIAL FLOW PER 60 t CATHODE FOIL AND 150 t ANODE FOIL

ETCHING

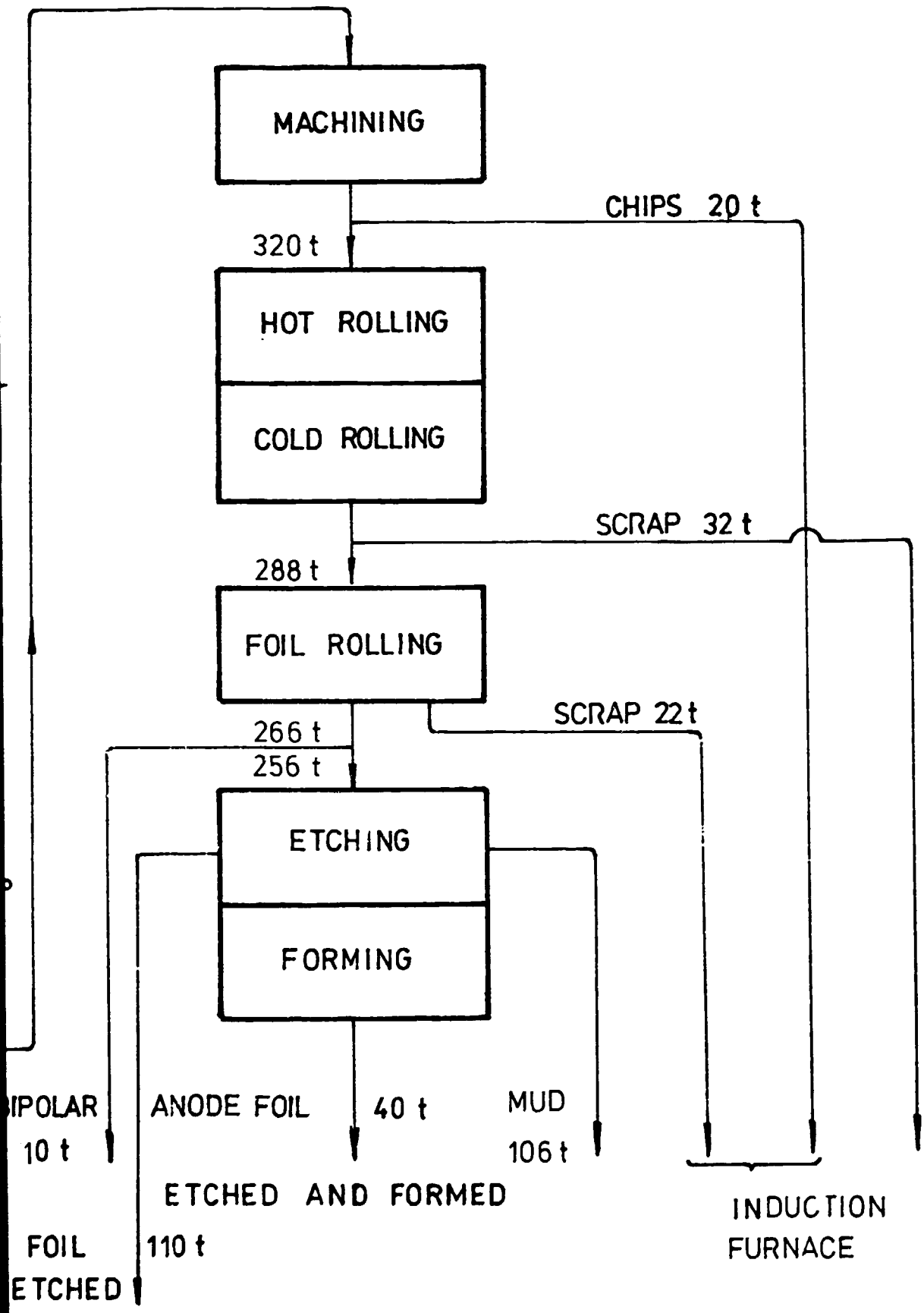


MATERIAL FLOW PER 40 t HIGH VOLTAGE ANODE – FORMING.



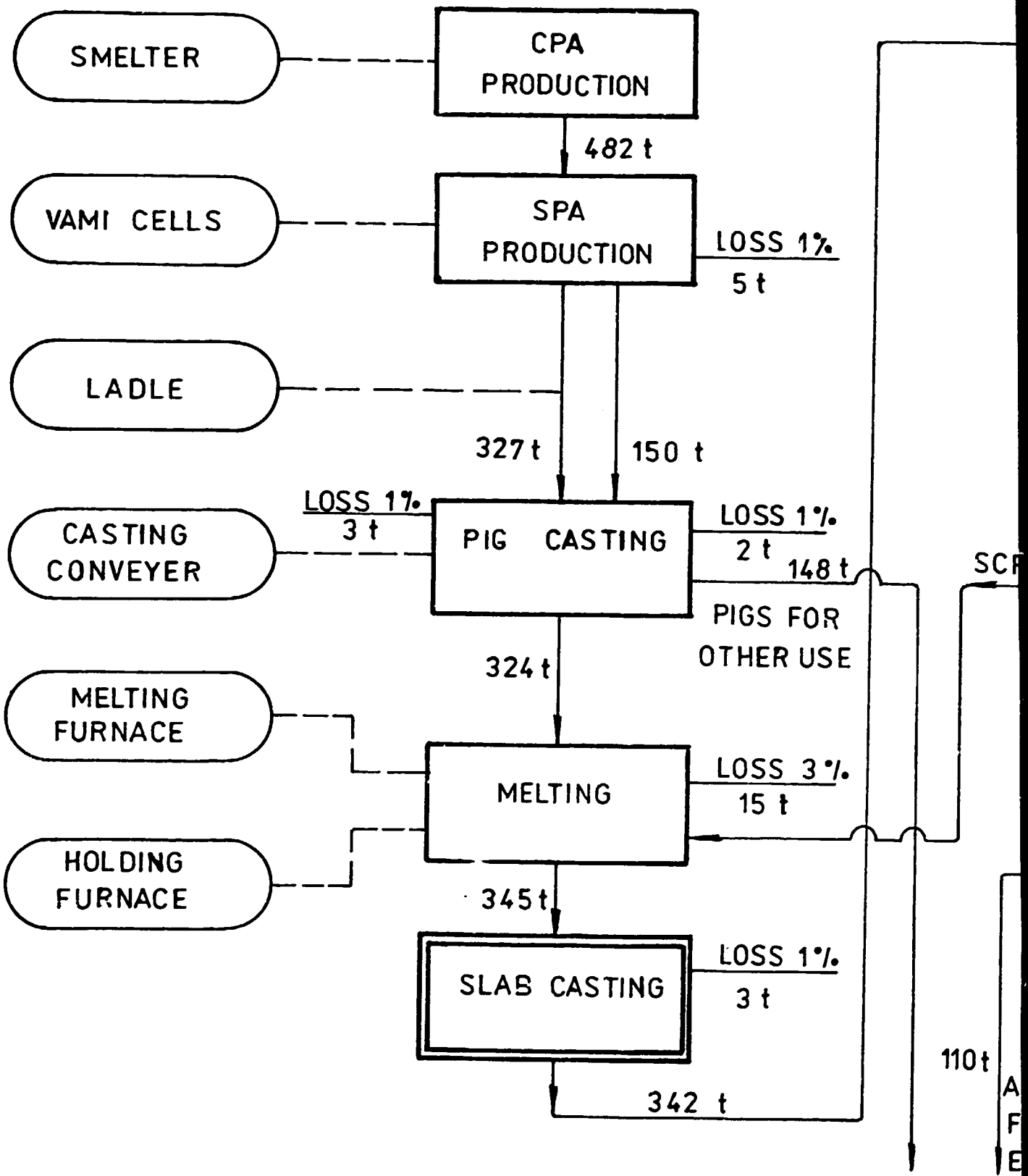
PRODUCTION OF

1. METHOD - DIRECT SLAB CA



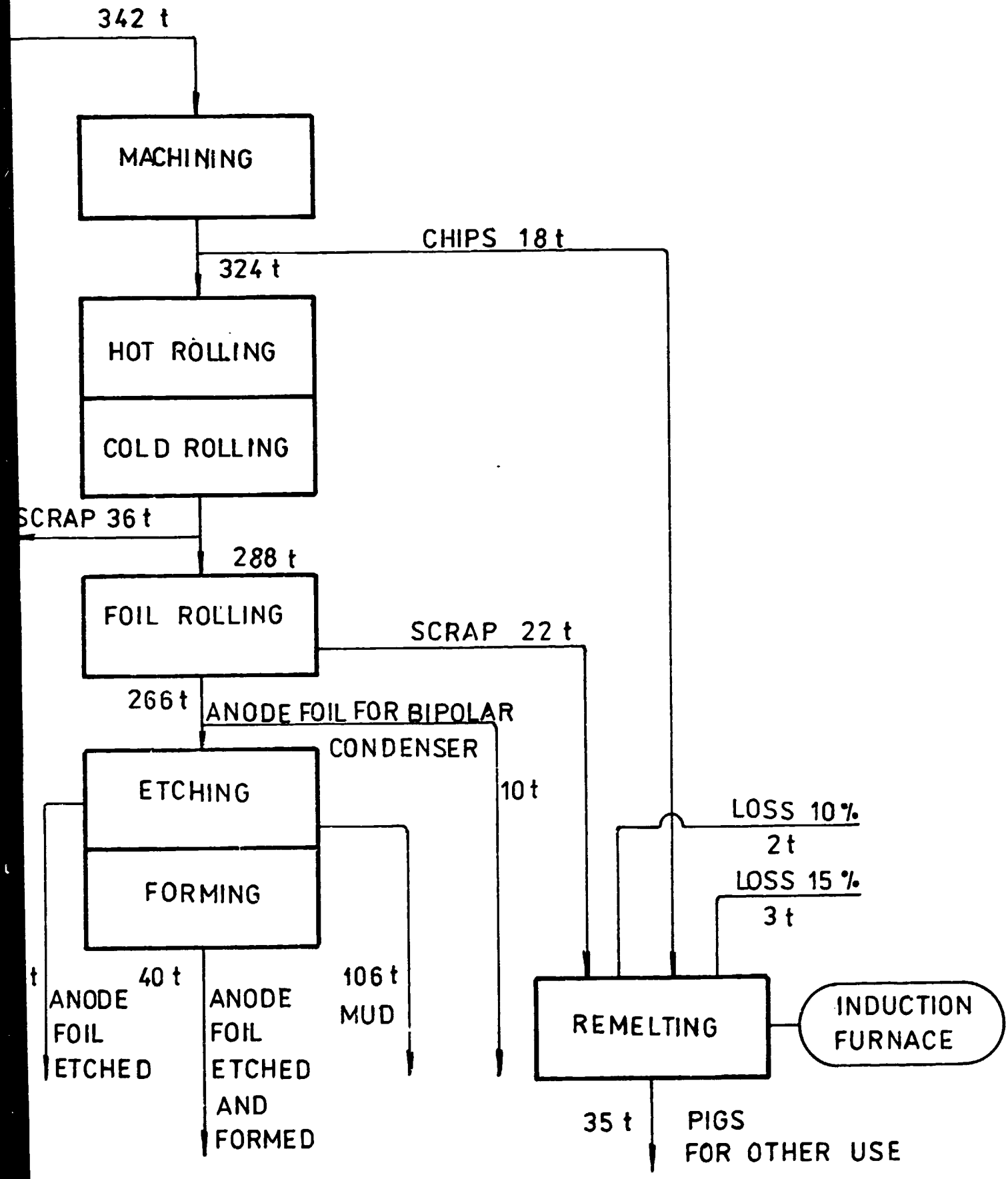
OF ANODE FOIL

CASTING AFTER PURIFICATION.



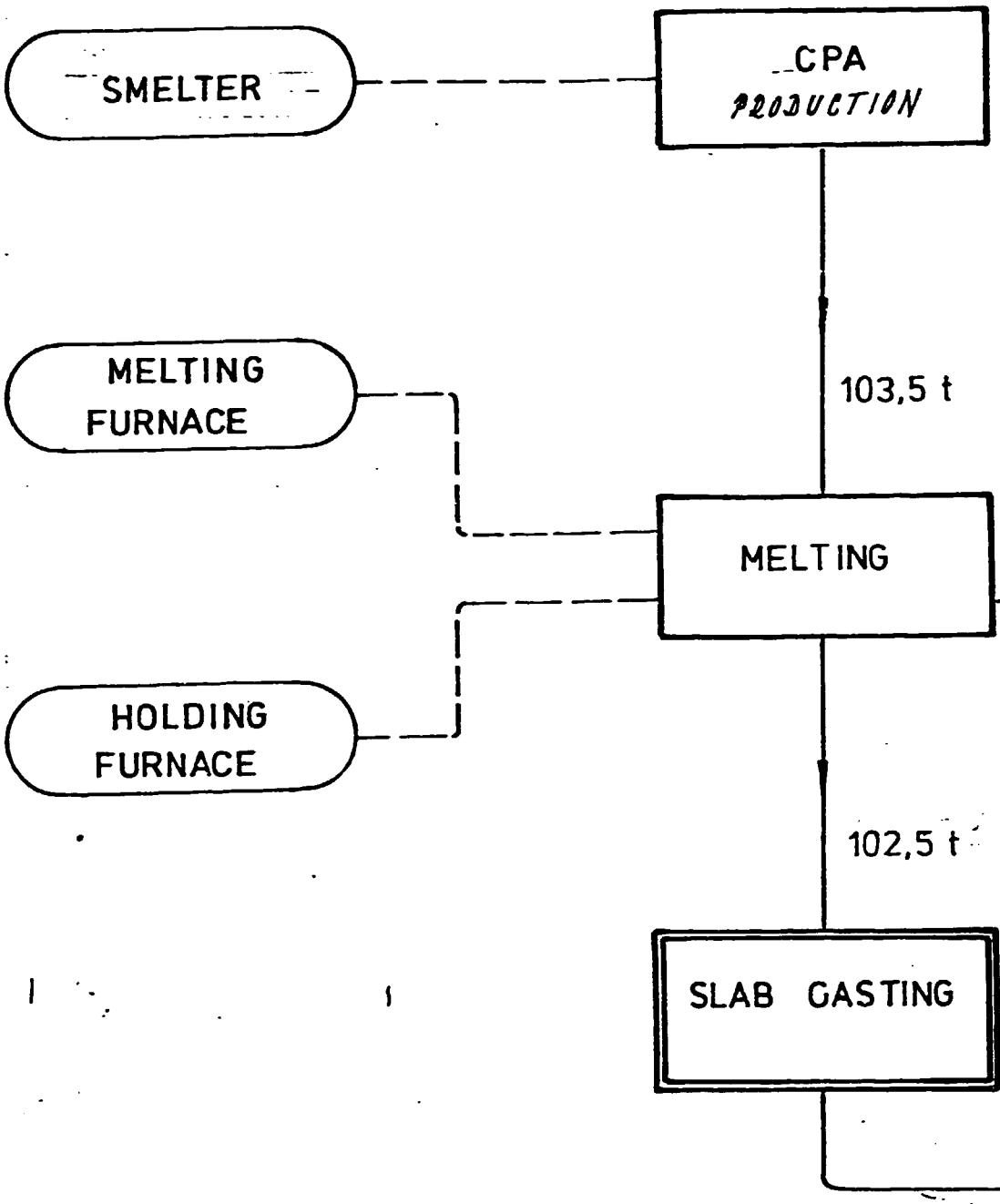
PRODUCTION OF ANO

2. METHOD - SLAB CASTING AFT



NODE FOIL

FTER REMELTING OF PIGS AND SCRAP.



PRODUCTION

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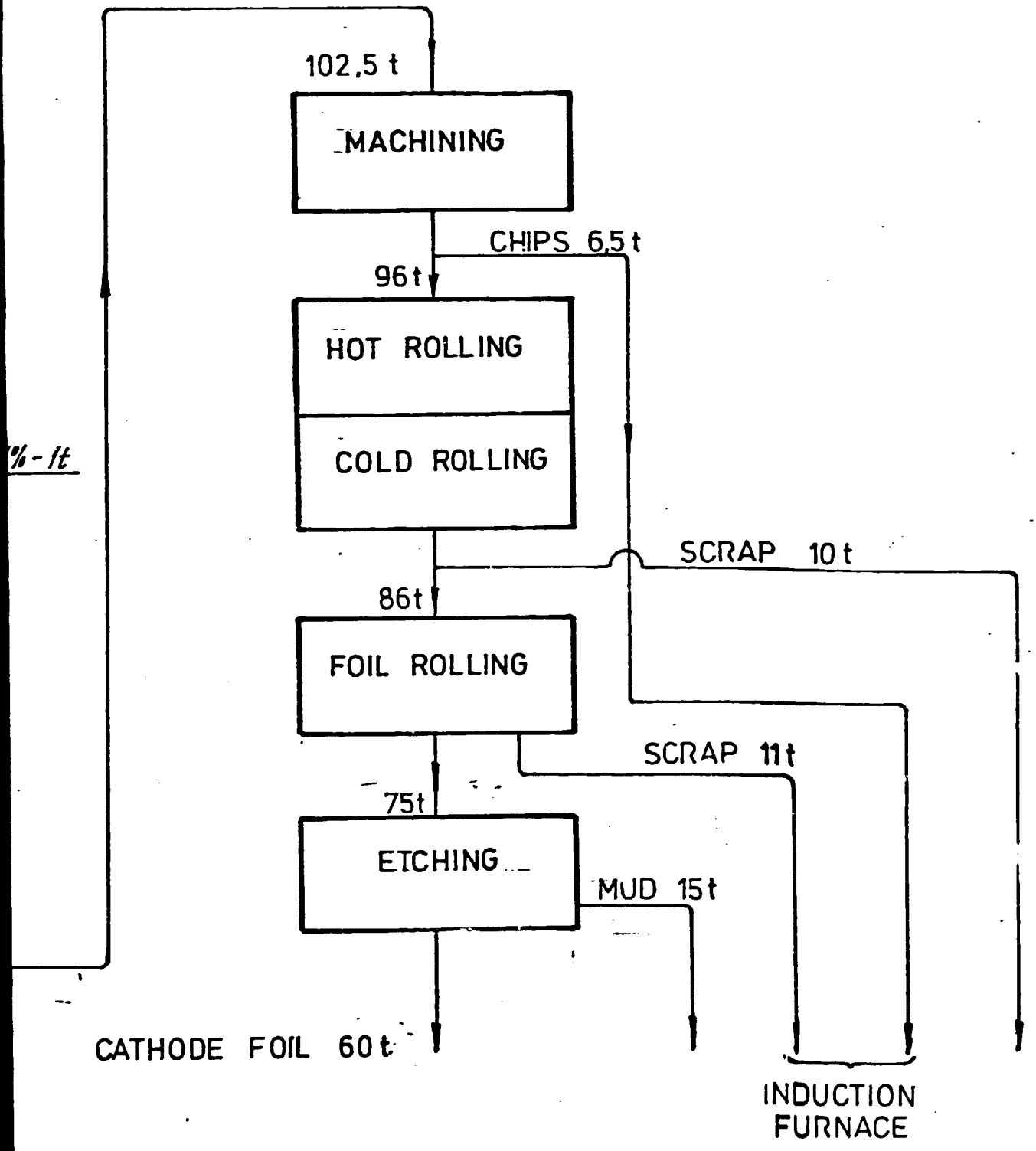
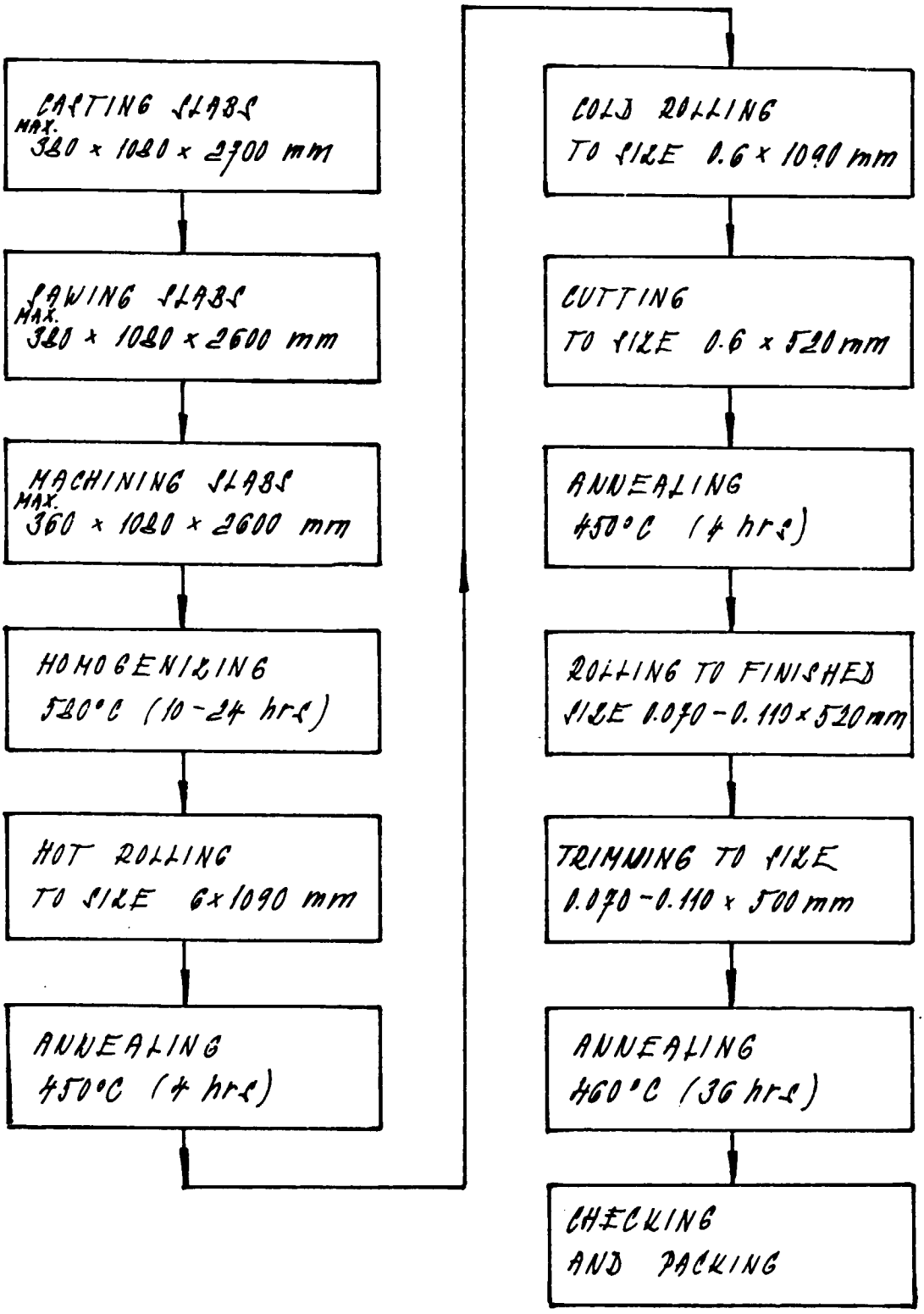


ON OF CATHODE FOIL

SLAB CASTING.

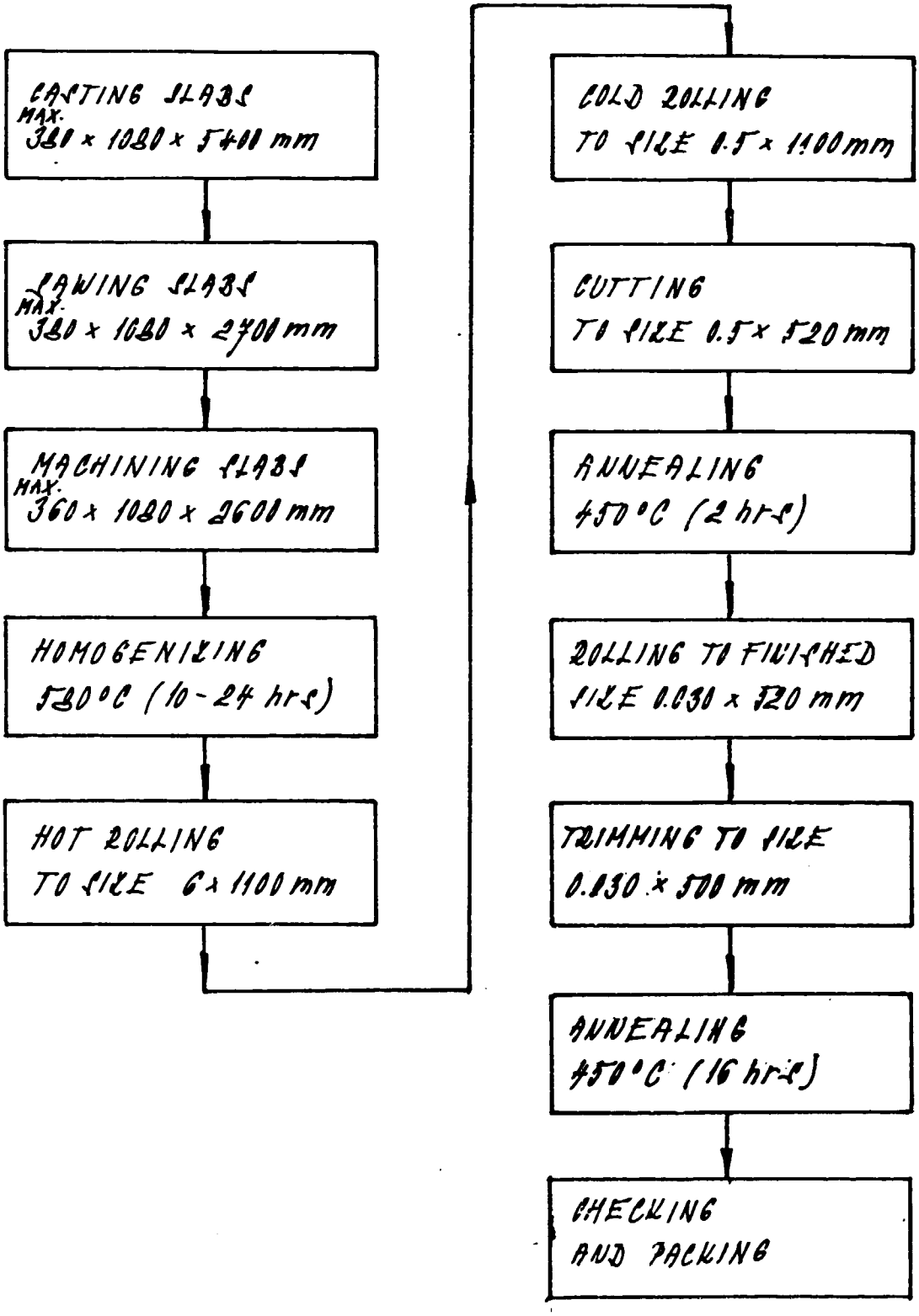
TECHNOLOGY DIAGRAM OF ROLLING OF ANODE FOIL

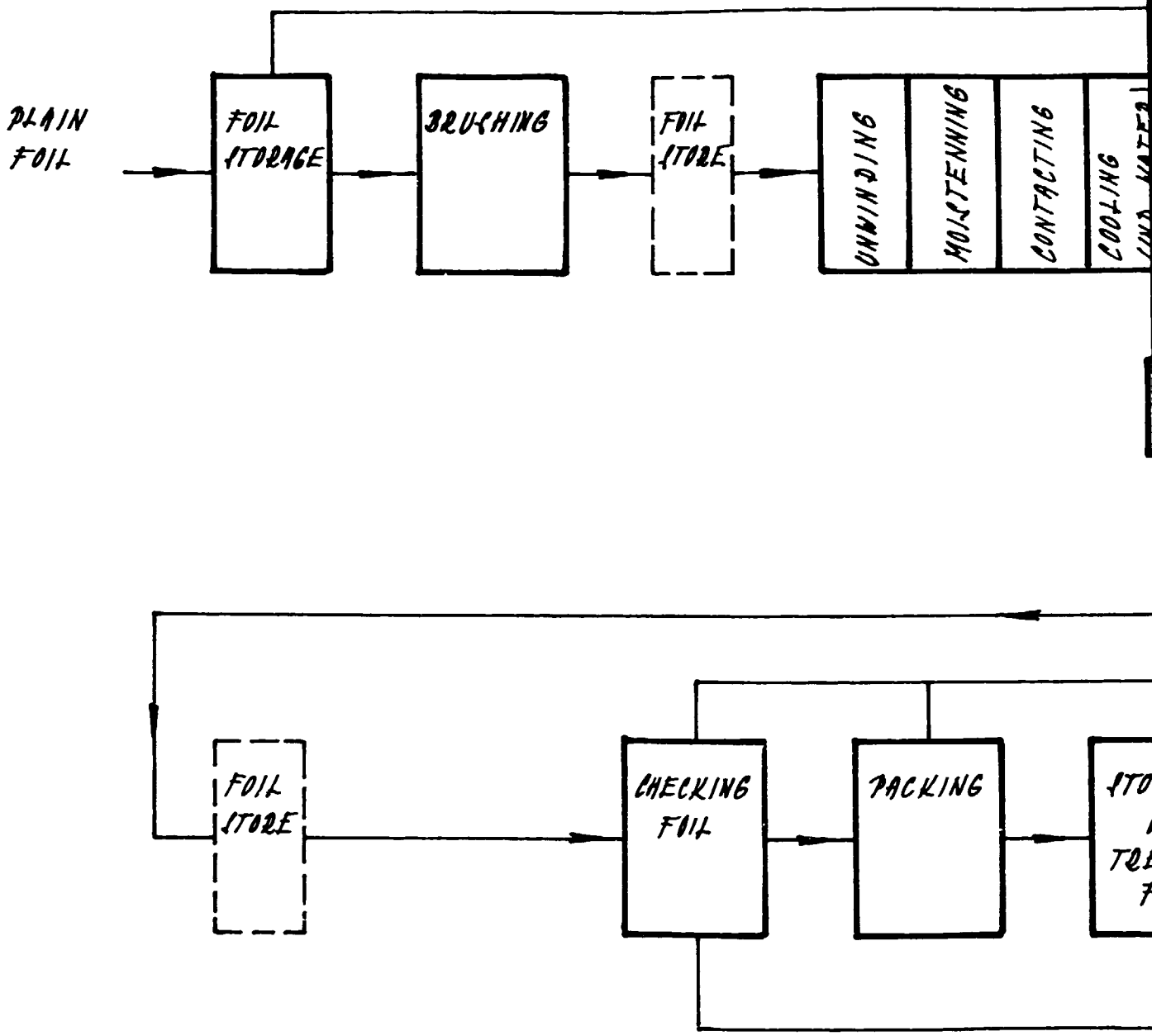
MATERIAL - Al 99.99% DIMENSION OF FOIL 0.070 - 0.110 x 500 mm
WEIGHT OF COIL - 5-20 kg STATE - SOFT R_m - 80 MPa max.

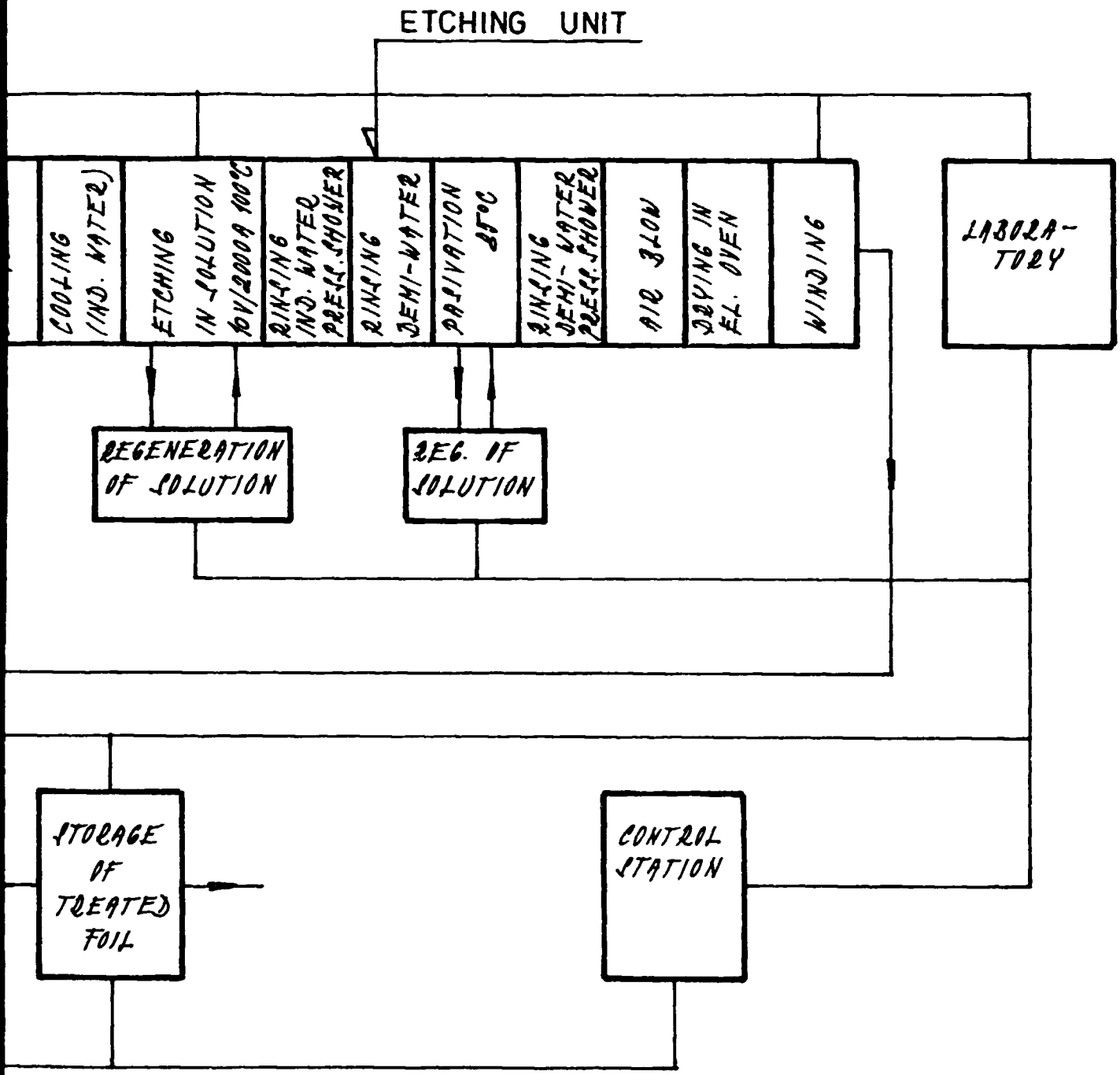


TECHNOLOGY DIAGRAM
OF ROLLING OF CATHODE FOIL

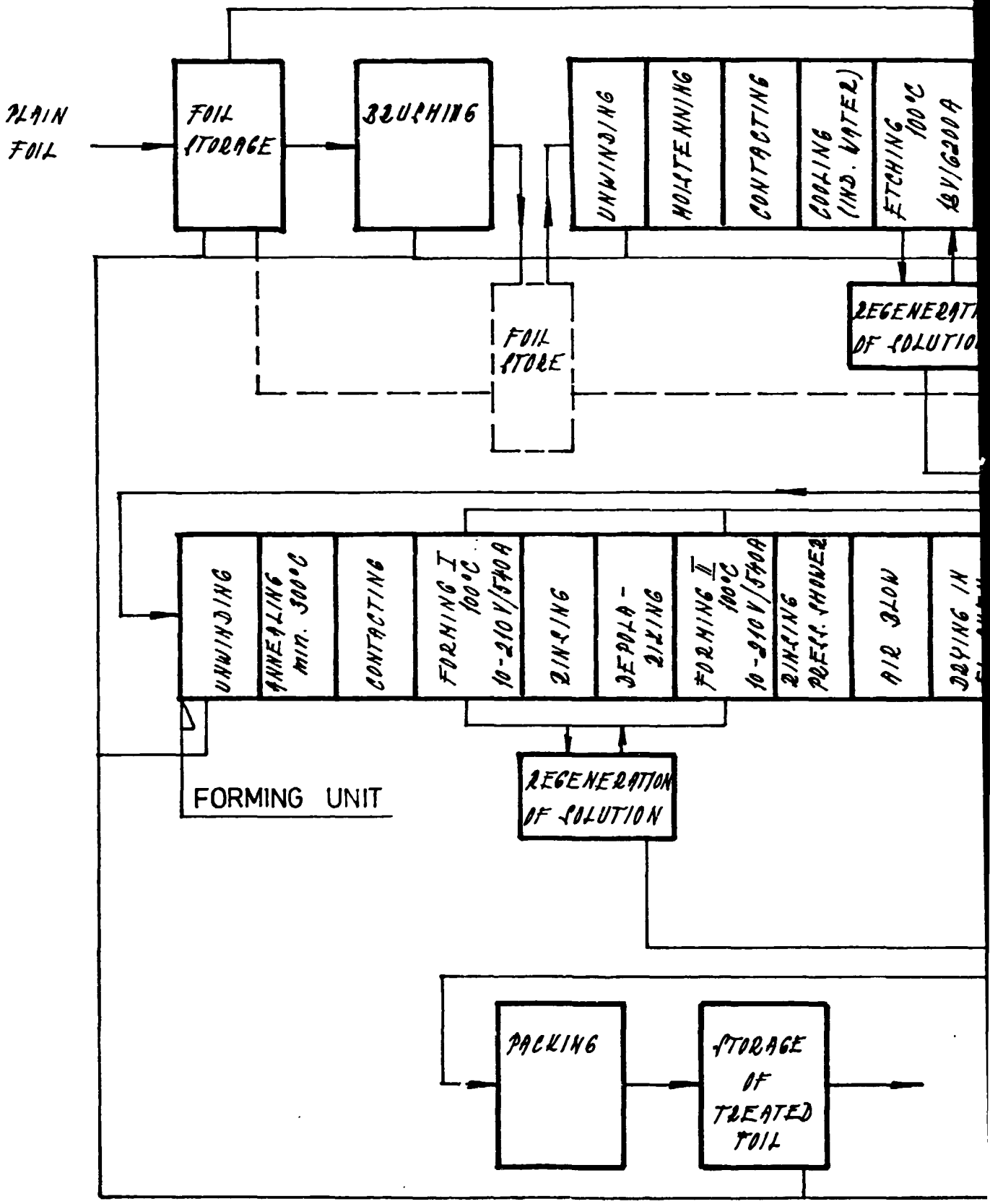
MATERIAL - Al 99.7 %, AlMn, AlCuMn FOIL DIM. - 0.030 x 500 mm
WEIGHT OF COIL - 17-20 kg STATE - SOFT R_m - 90 MPa min.

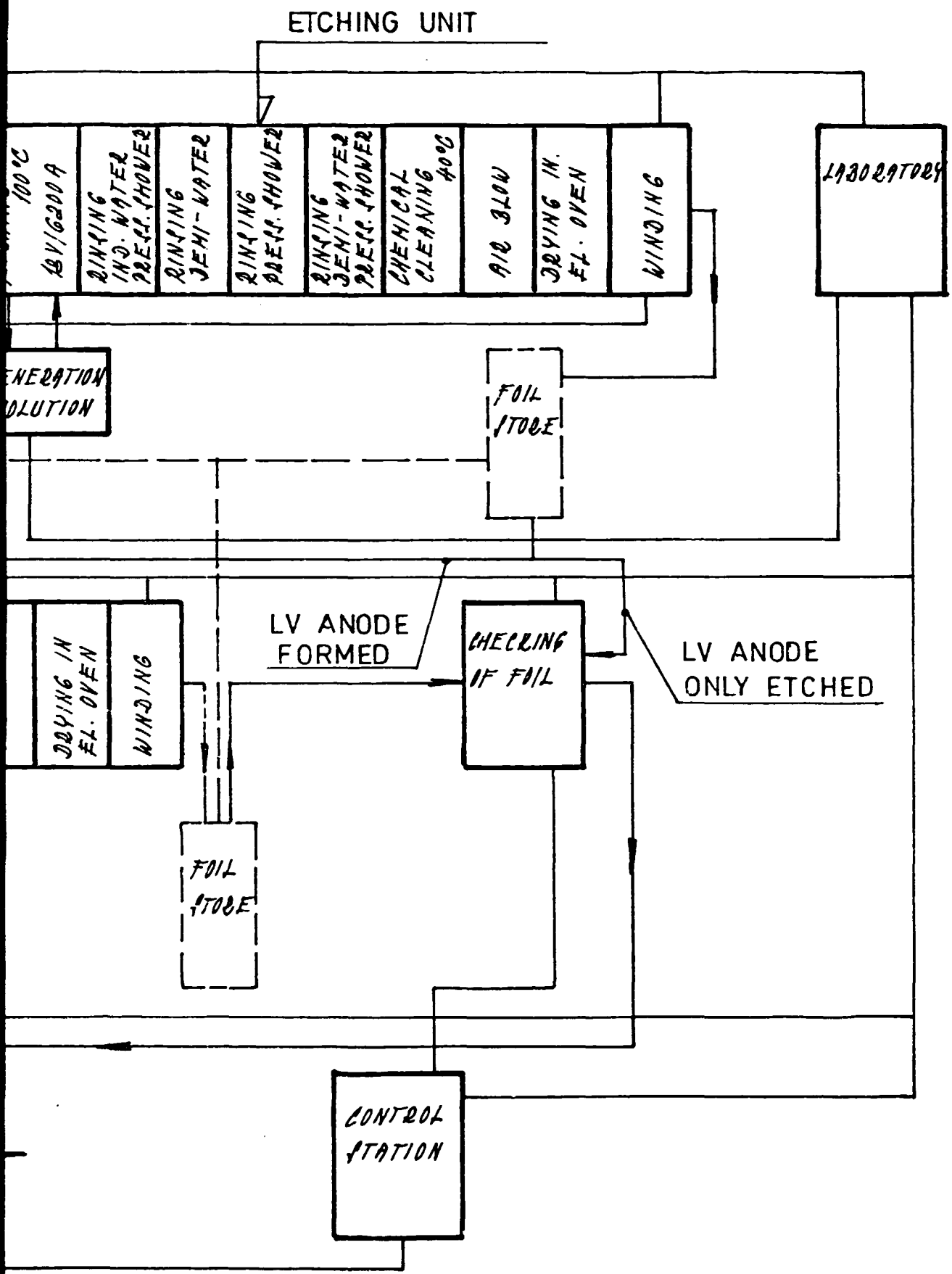



PLAIN FOIL
FOIL STORAGE
BRUSHING
FOIL STORE
UNWINDING
MOISTENING
CONTACTING
COOLING
FOIL STORE
CHECKING FOIL
PACKING

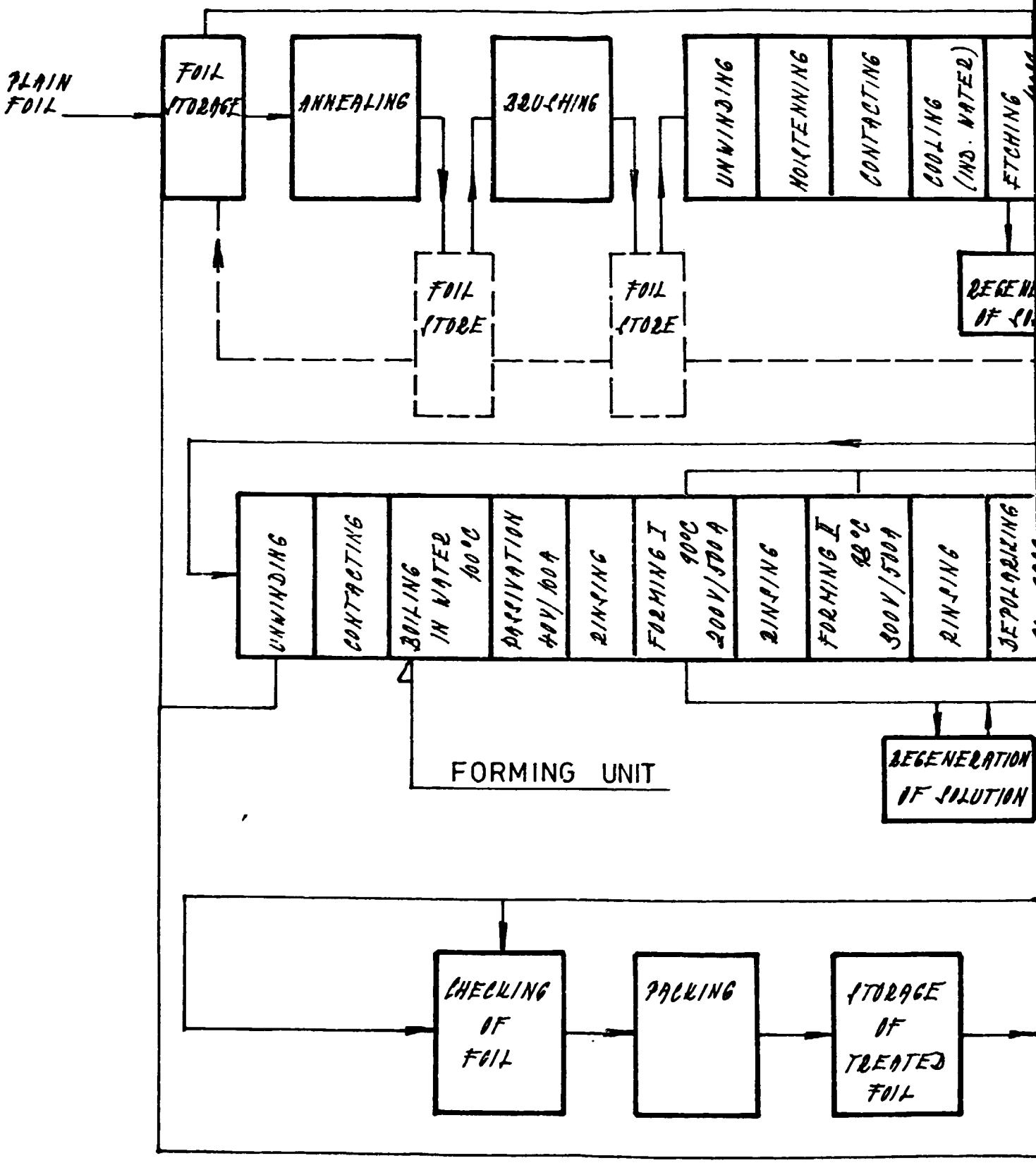


FLOW CHART OF CATHODE FOIL PRODUCTION

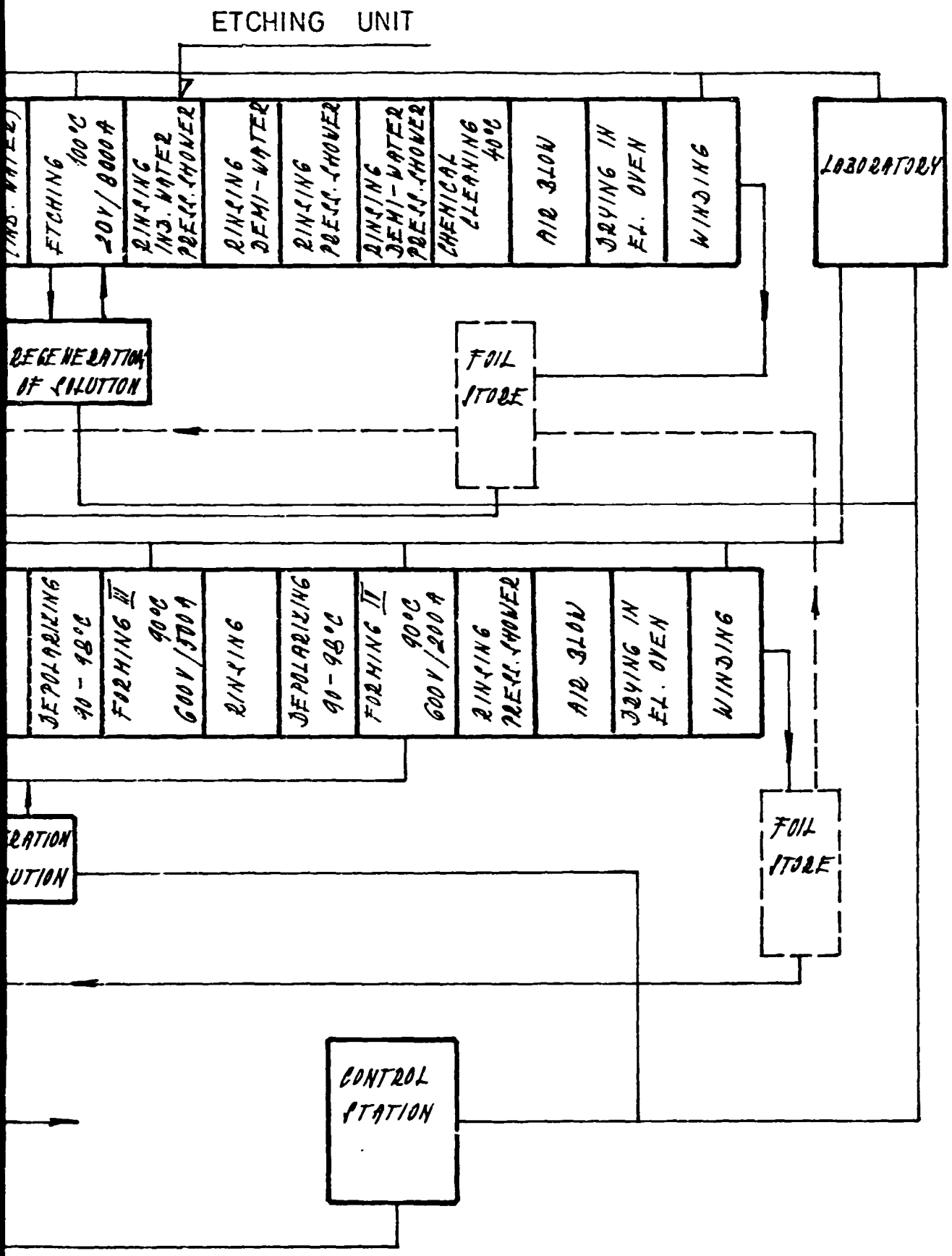

PLAIN FOIL
FOIL STORAGE
BRUSHING
UNWINDING
ROLLTENNING
CONTACTING
COOLING (IND. WATER)
ETCHING 100°C
FOIL STORE
UNWINDING
ANNEALING min. 300°C
CONTACTING
FORMING I 100°C 10-210 V/5A0A
ZINCING
DEPOLA-RIZING
FORMING II 100°C 10-210 V/5A0A
ZINCING PERF. SHOWER
AIR BLOW
DRYING IN
FORMING UNIT
REGENERATION OF SOLUTION
PACKING
STORAGE OF TREATED FOIL



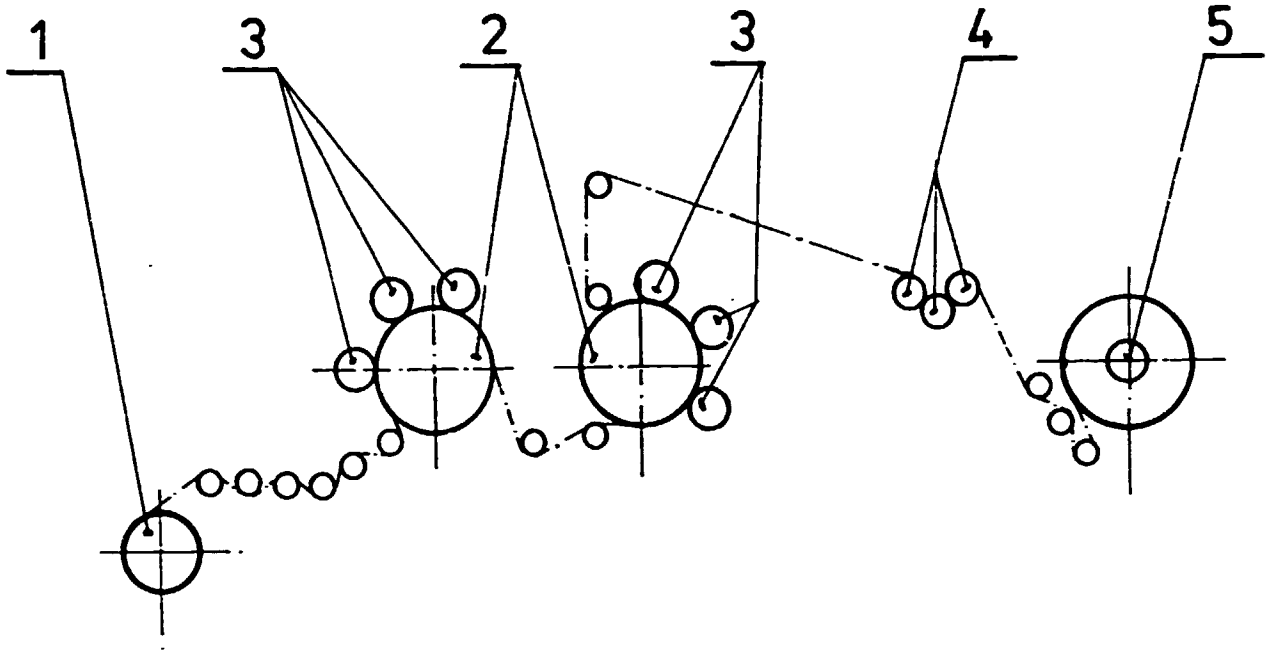
FLOW CHART OF LV ANODE FOIL PRODUCTION


PLAIN FOIL
FOIL STORAGE
ANNEALING
ETCHING
UNWINDING
HOLTENNING
CONTACTING
COOLING (IND. WATER)
FOIL STORE
FOIL STORE
UNWINDING
CONTACTING
BOILING IN WATER 100°C
PASSIVATION 40V/100A
RINSING
FORMING I 90°C 200V/500A
RINSING
FORMING II 98°C 300V/500A
RINSING
DEPOLARIZING
REGENERATION OF SOLUTION
FORMING UNIT
CHECKING OF FOIL
PACKING
STORAGE OF TREATED FOIL

FL

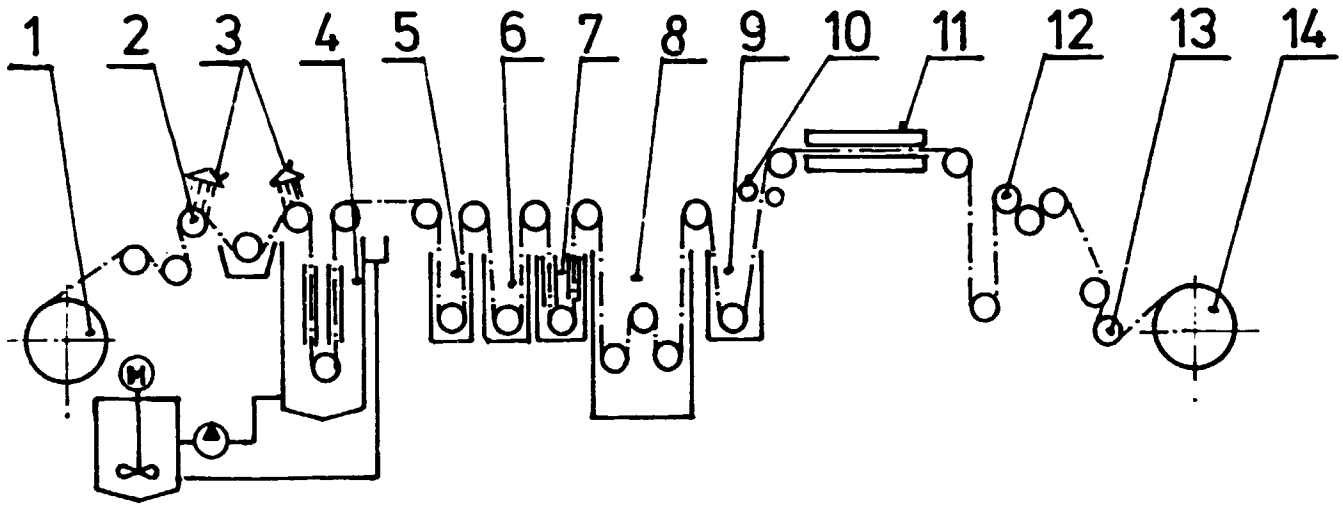


FLOW CHART OF HV ANODE FOIL PRODUCTION



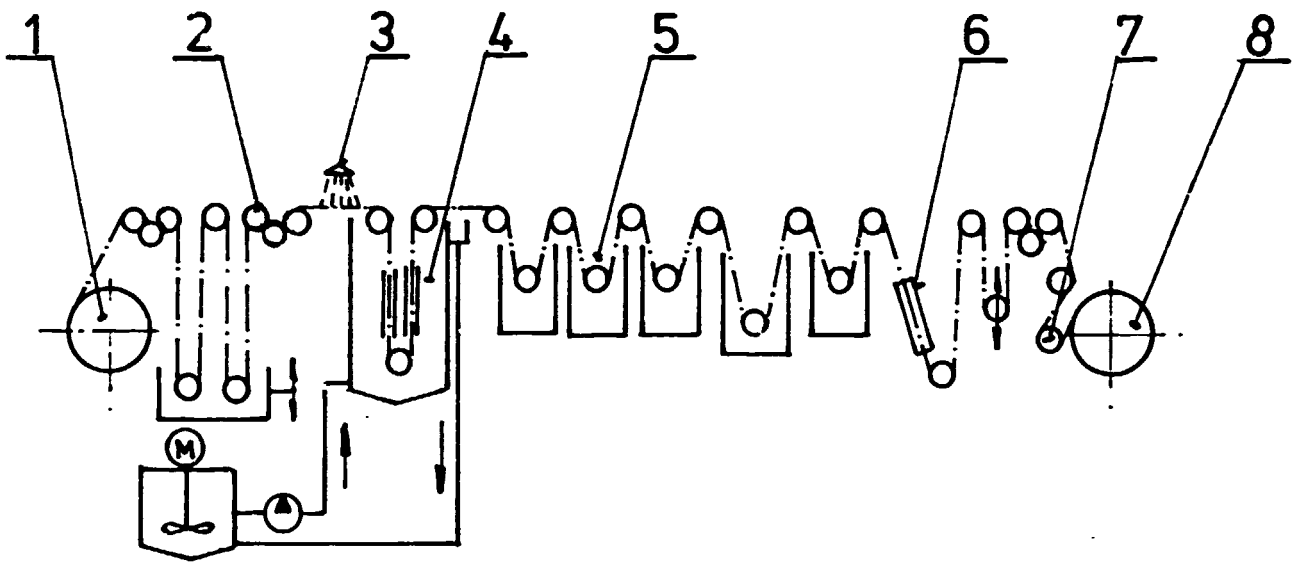
1. FOIL ROLL
2. SUPPORTING ROLLERS
3. BRUSH ROLLERS
4. LIVE ROLLERS
5. WINDING-UP STATION

BRUSHING UNIT



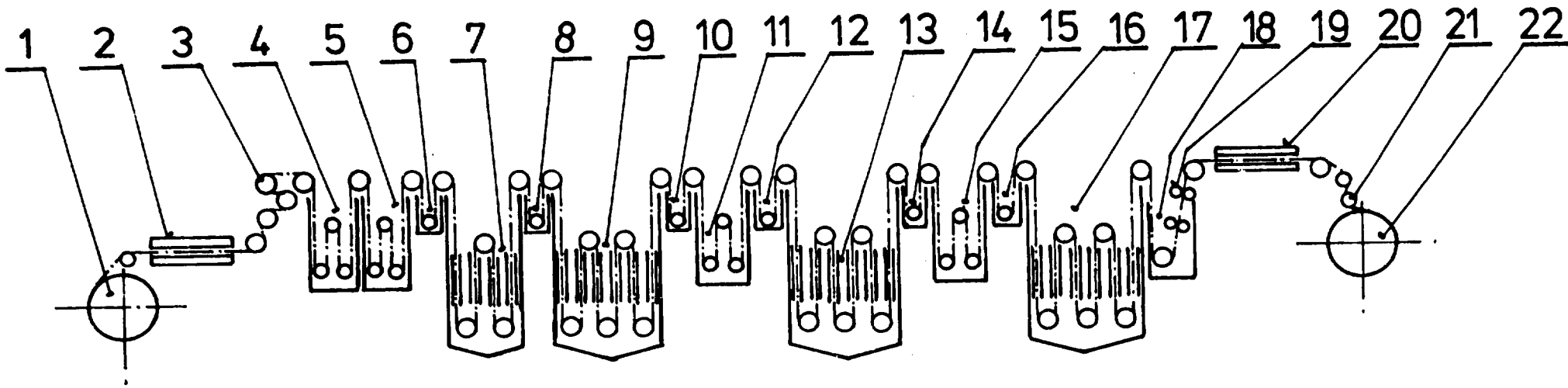
1. UNROLL STATION
2. CONTACTING ROLLERS
3. SHOWER COOLING
4. ETCHING TANK
5. RINSING TANK – RUNNINGWATER – POWER SHOWERS
6. RINSING TANK – DEMIWATER
7. CATHODIC CLEANING
8. CHEMICAL PASSIVATION
9. RINSING TANK – DEMIWATER
10. AIR STREAM
11. DRYING /or ANNEALING / TUNEL
12. BRAKING ROLLERS
13. LENGHT MEASURING
14. WINDING STATION

ETCHING UNIT FOR CATHODE FOIL



1. UNROLL STATION
2. CONTACTING ROLLER
3. WATER SPRAYING JETS
4. ETCHING TANK
5. RINSING TANK
6. DRYING TUNEL
7. LENGHT MEASURING
8. WINDING-UP STATION

ETCHING UNIT FOR ANODE FOIL



1. UNROLL STATION
2. ANEALING OVEN
3. CONTACTING ROLLERS
4. BOEHMITE TANK
5. PASSIVATING TANK
6. RINSING TANK
7. FORMING TANK I.
8. RINSING TANK
9. FORMING TANK II.
10. RINSING TANK
11. DEPOLARIZING TANK
12. RINSING TANK
13. FORMING TANK III.
14. RINSING TANK
15. DEPOLARIZING TANK
16. RINSING TANK
17. FORMING TANK IV.
18. RINSING TANK
19. BLOWING UNIT
20. DRYING UNIT
21. LENGHT MEASURING AND MARKING
22. WINDING-UP STATION

FORMING UNIT

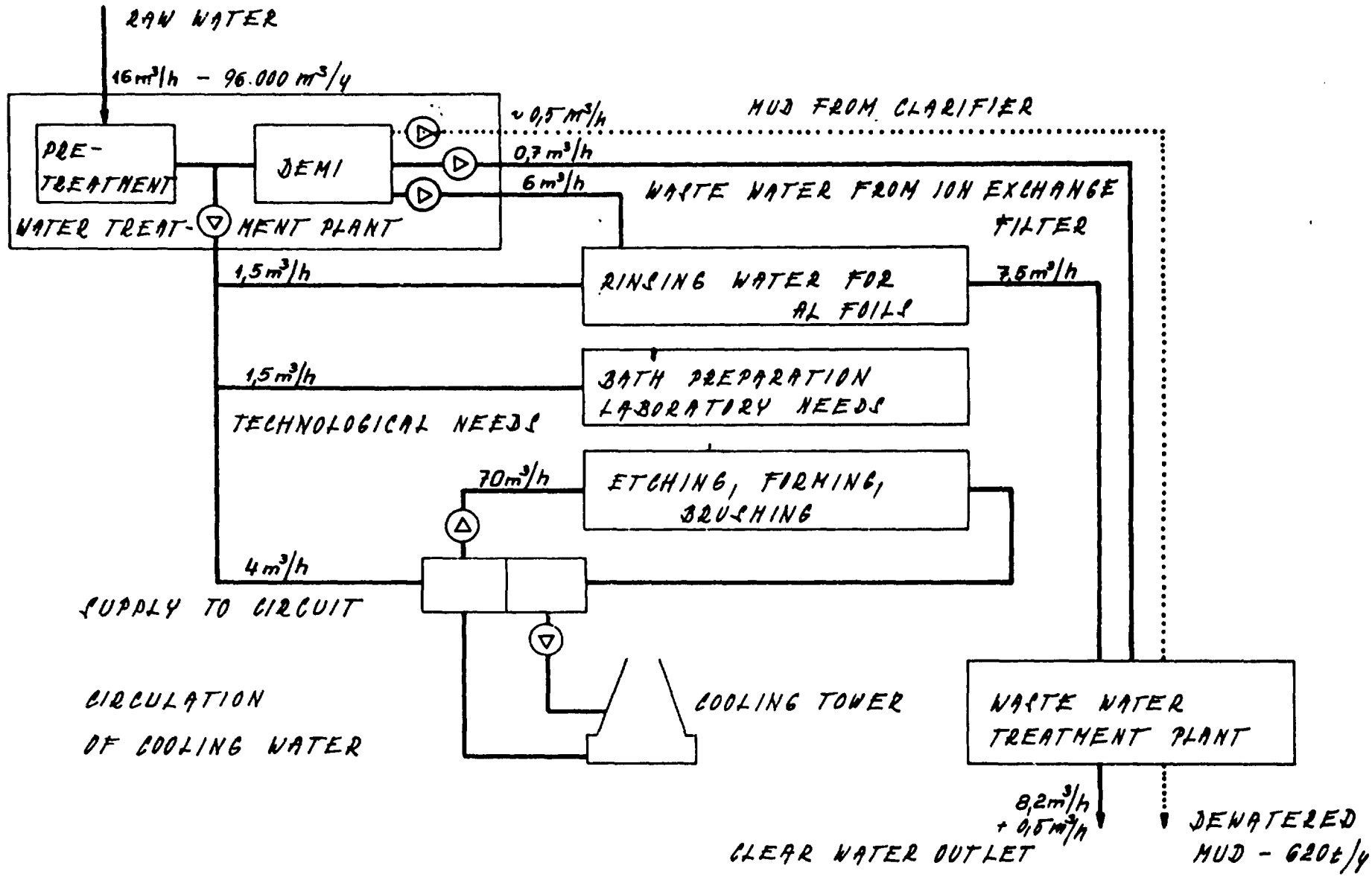


DIAGRAM OF INDUSTRIAL WATER UTILIZATION

NOTE: EXPLANATION TO FIG. 1-10
IS SHOWN ON FOLLOWING PAGE

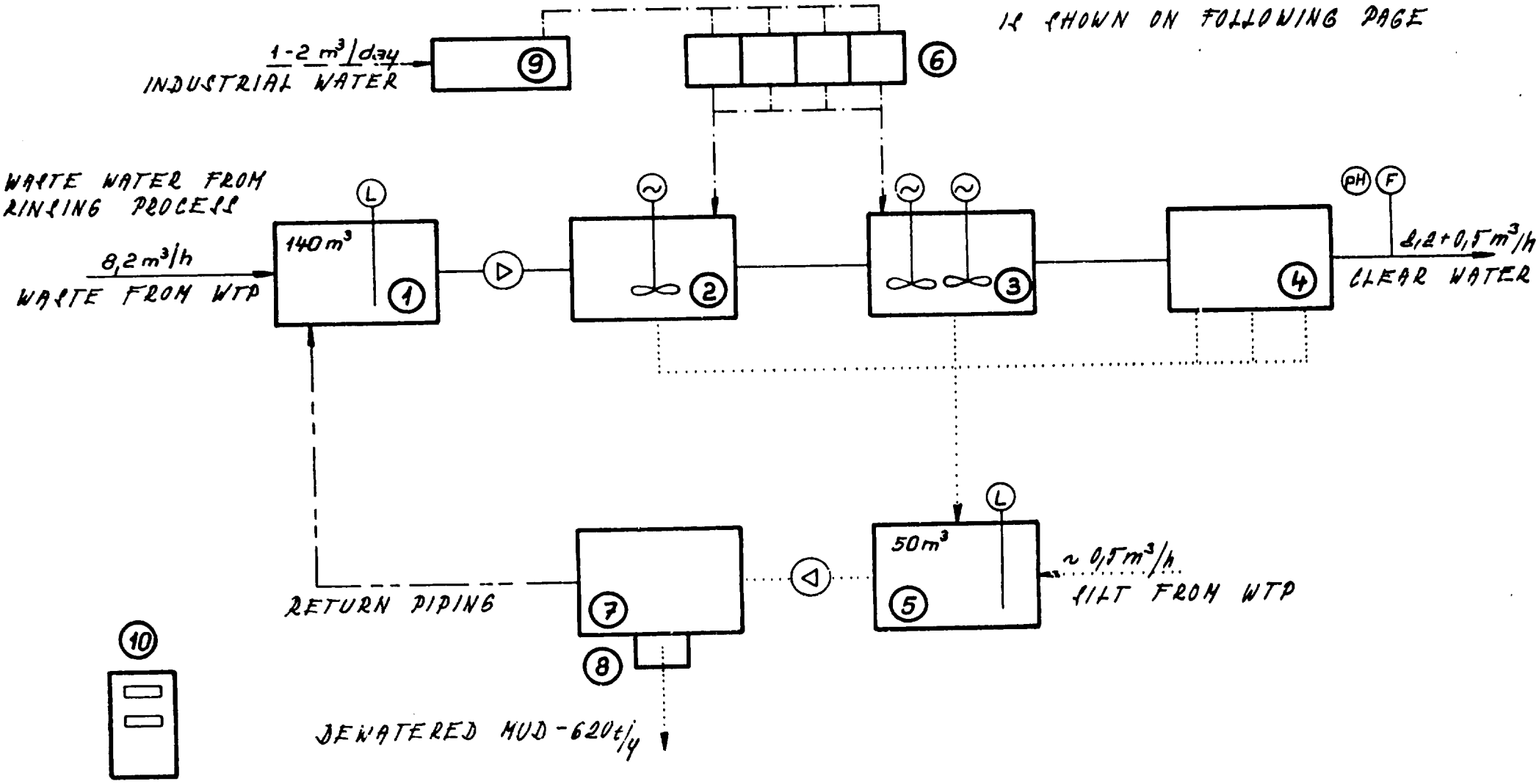
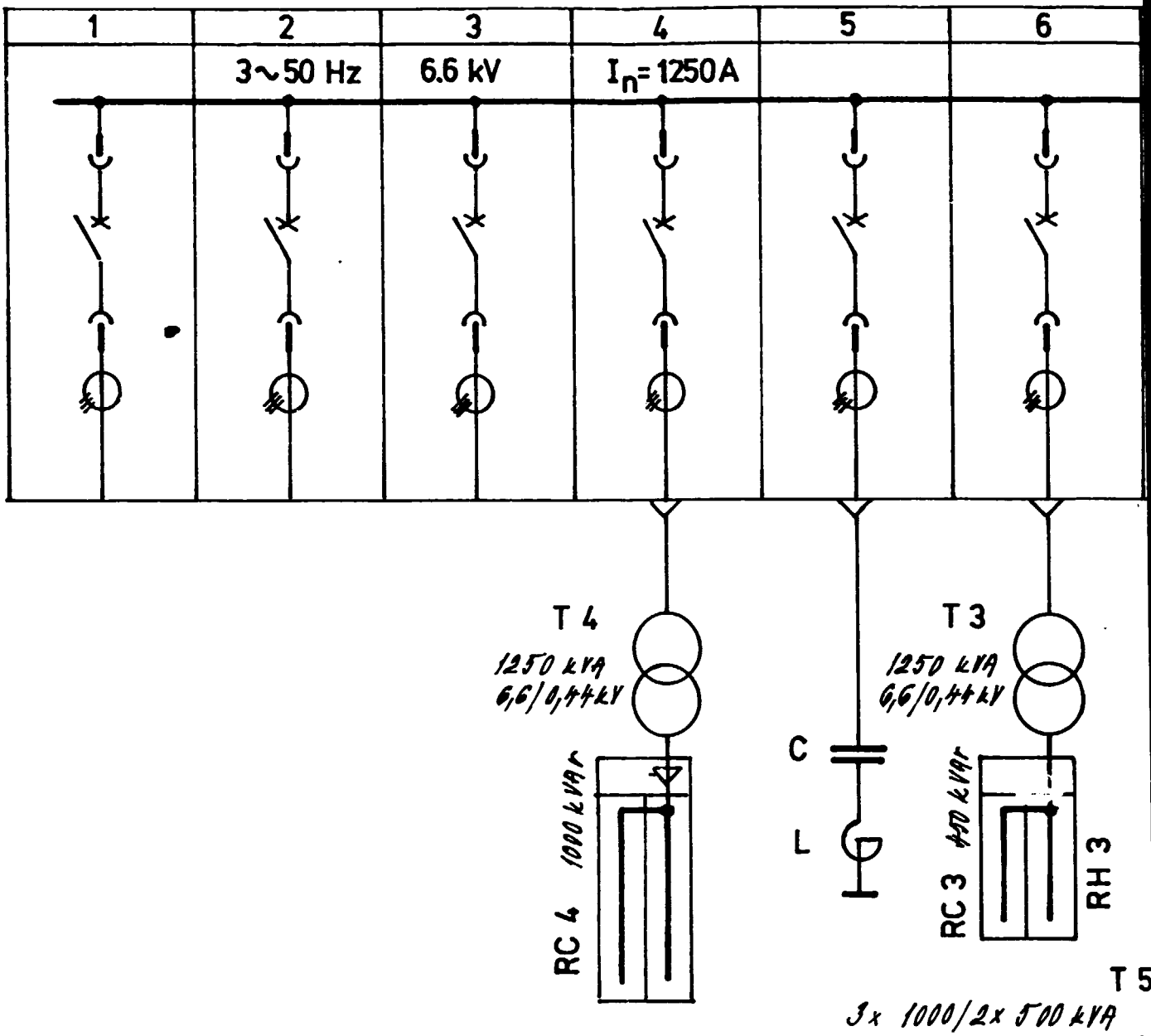
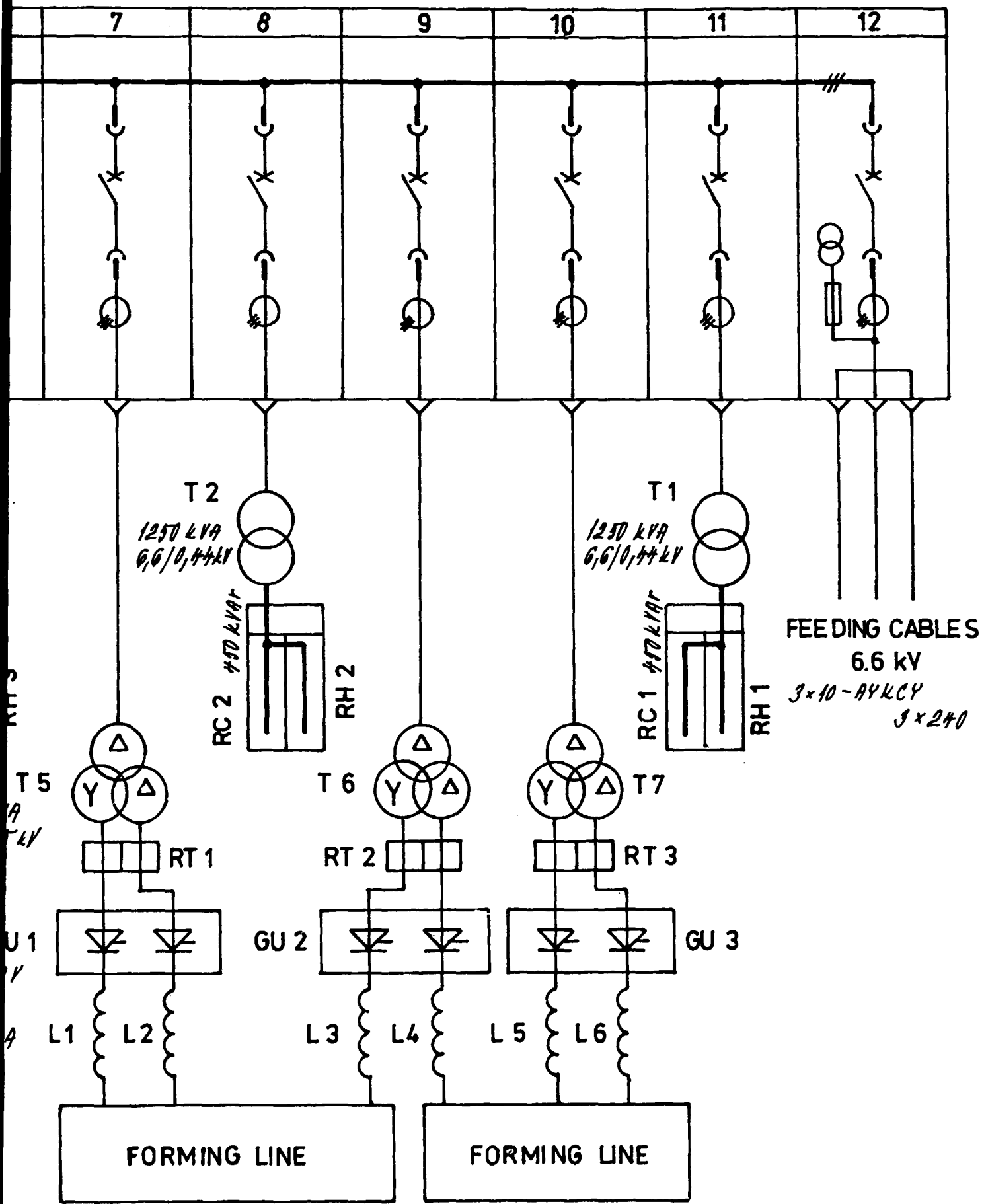


DIAGRAM OF WASTE WATER TREATMENT PLANT /WWTP/

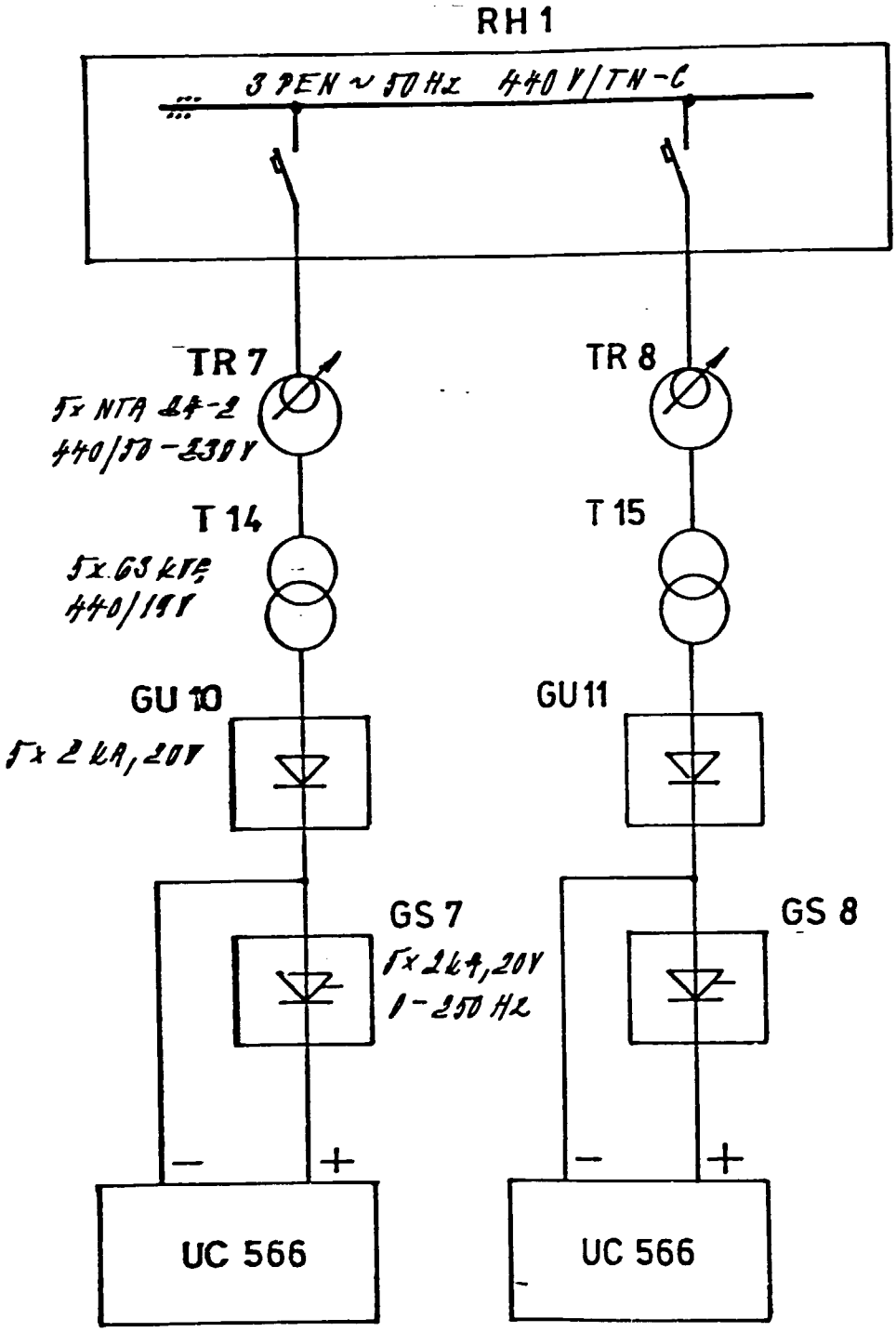


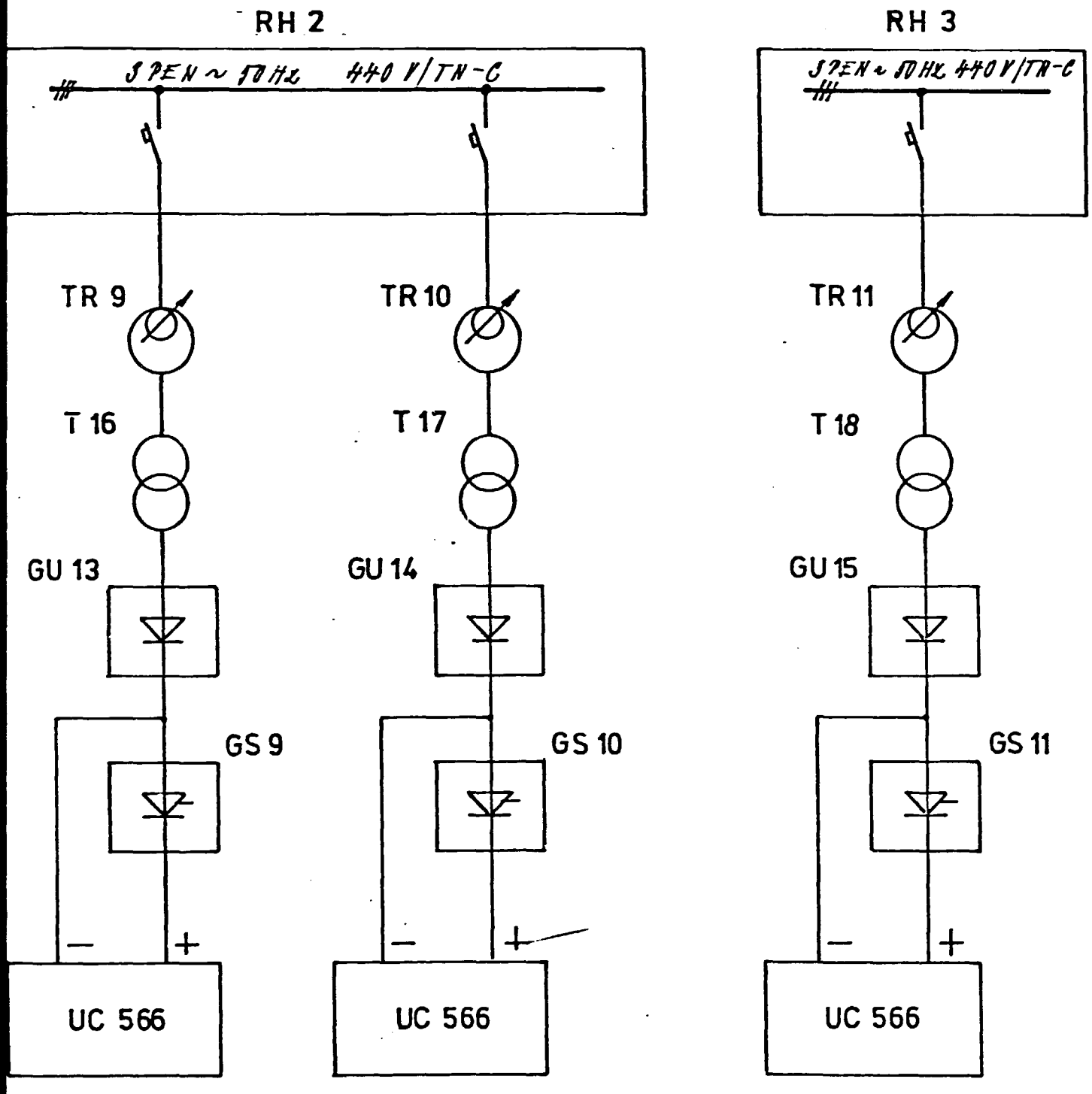
SUBSTATION 6.6 kV; POWE



WER SOURCES FOR FORMING, COMPENSATION cos φ

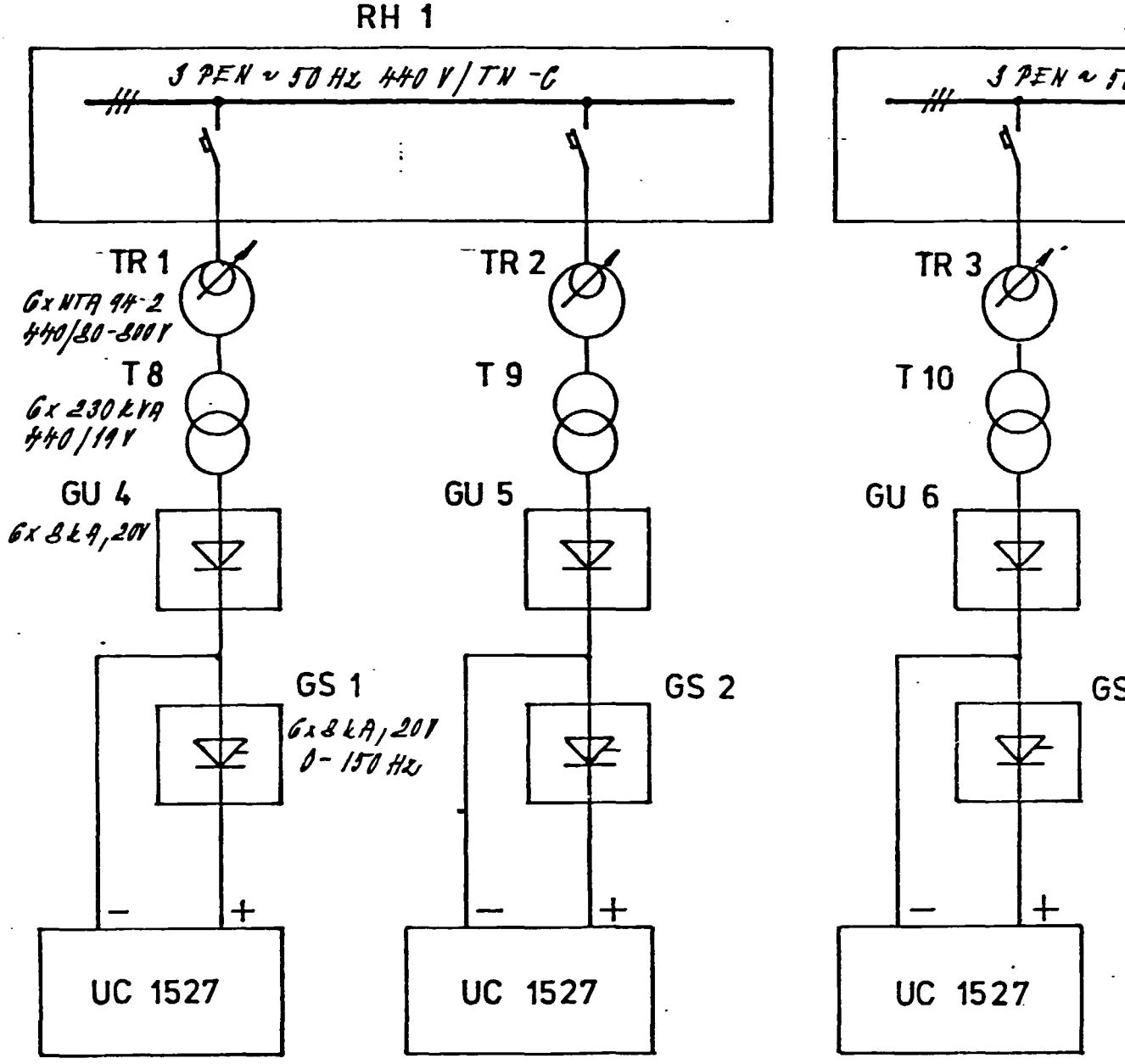
WIRING DIAGRAM

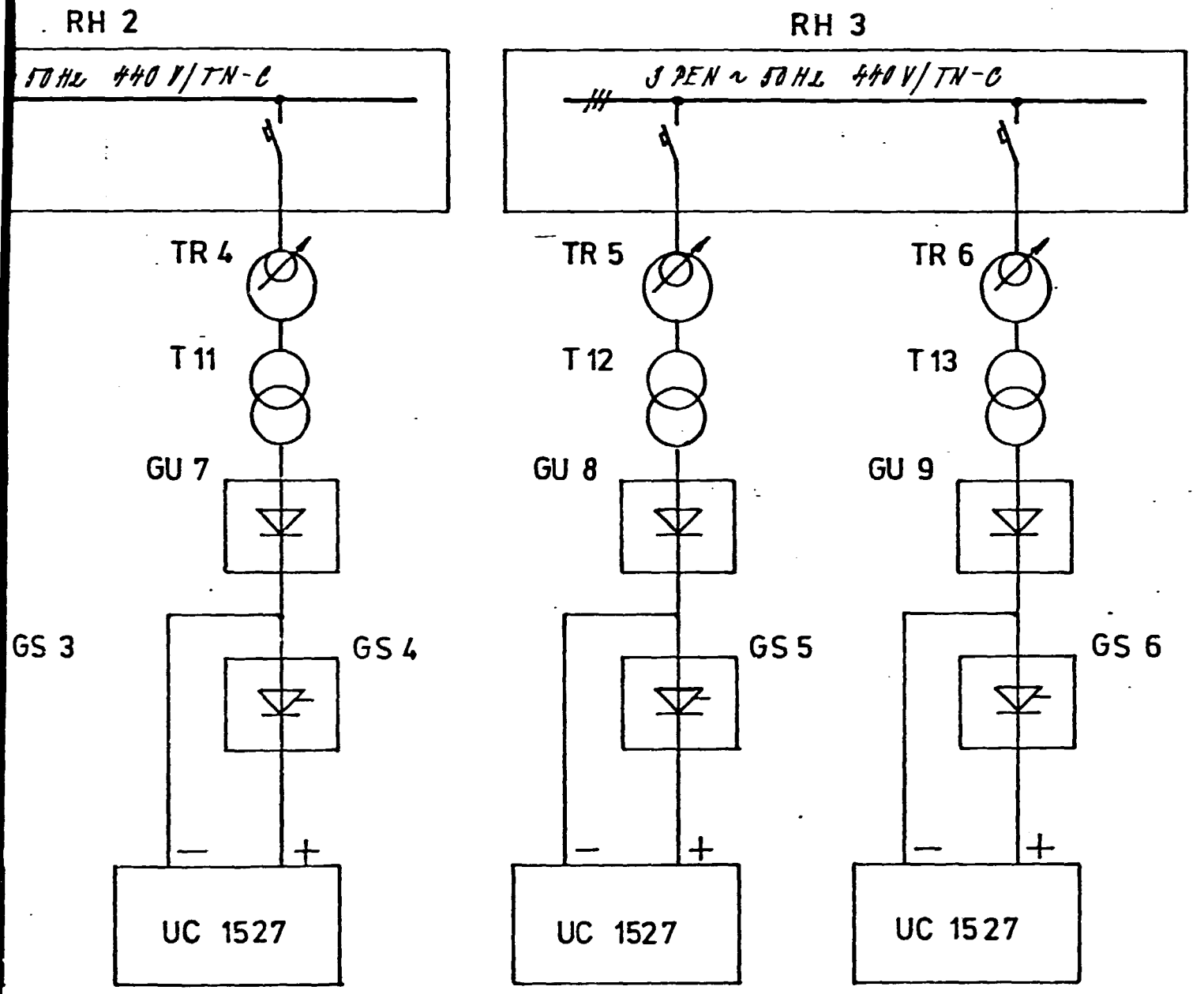

RH 1
3 PEN ~ 50 Hz 440 V/TN-C
TR 7
5x NTA 24-2
440/50-230 V
TR 8
T 14
5x.63 kVA
440/19 V
T 15
GU 10
5x 2 kA, 20 V
GU 11
GS 7
5x 2kA, 20 V
1-250 Hz
GS 8
UC 566
UC 566



D.C. POWER SOURCES FOR ETCHING, 2 kA, 20 V

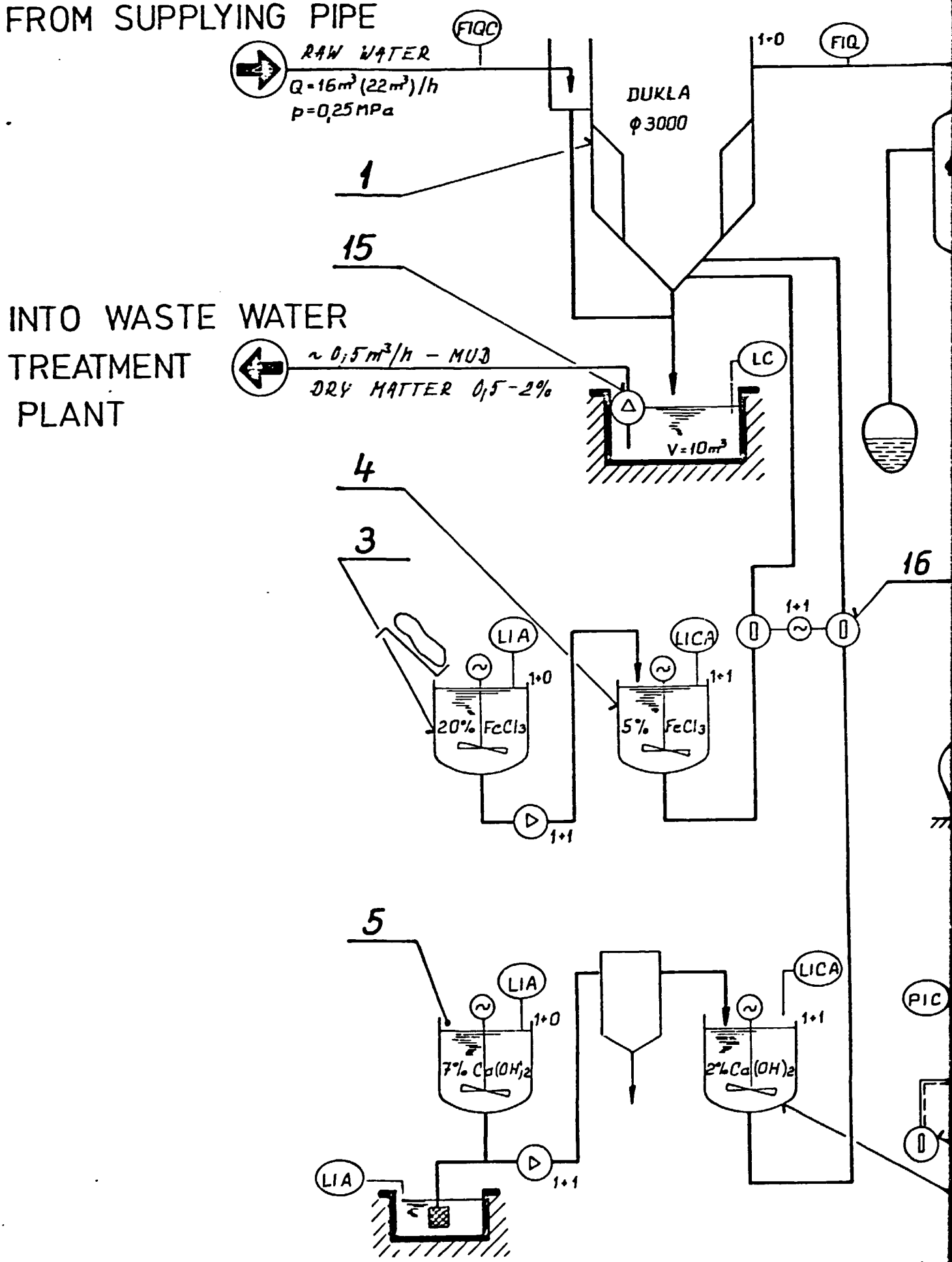
WIRING DIAGRAM

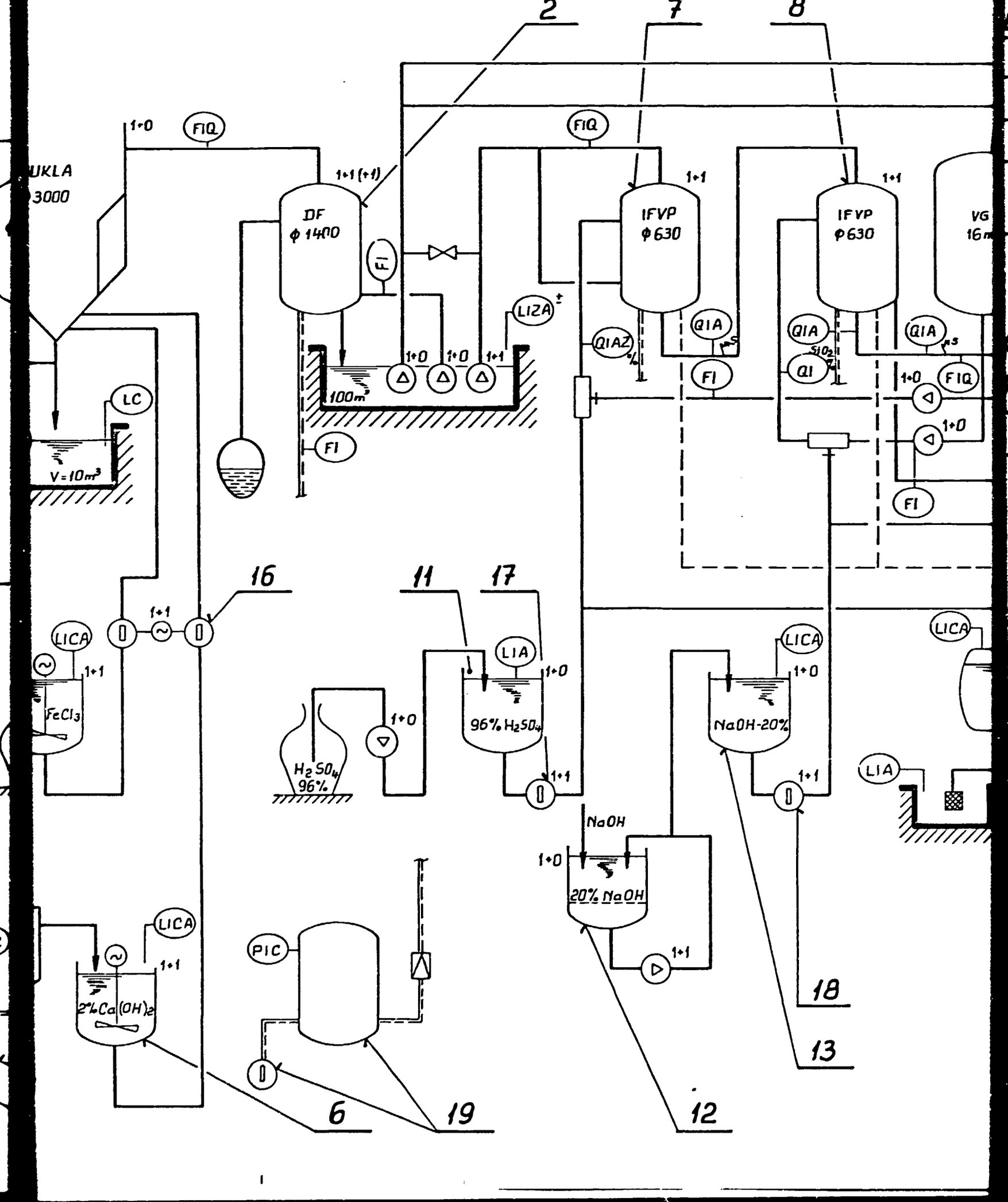

RH 1
3 PEN ~ 50 Hz 440 V / TN - C
TR 1
6x NTA 94-2
440/80-800 V
T 8
6x 230 kVA
440/19 V
GU 4
6x 8 kA, 20 V
GS 1
6x 8 kA/20 V
0 - 150 Hz
UC 1527
TR 2
T 9
GU 5
GS 2
UC 1527
TR 3
T 10
GU 6
UC 1527

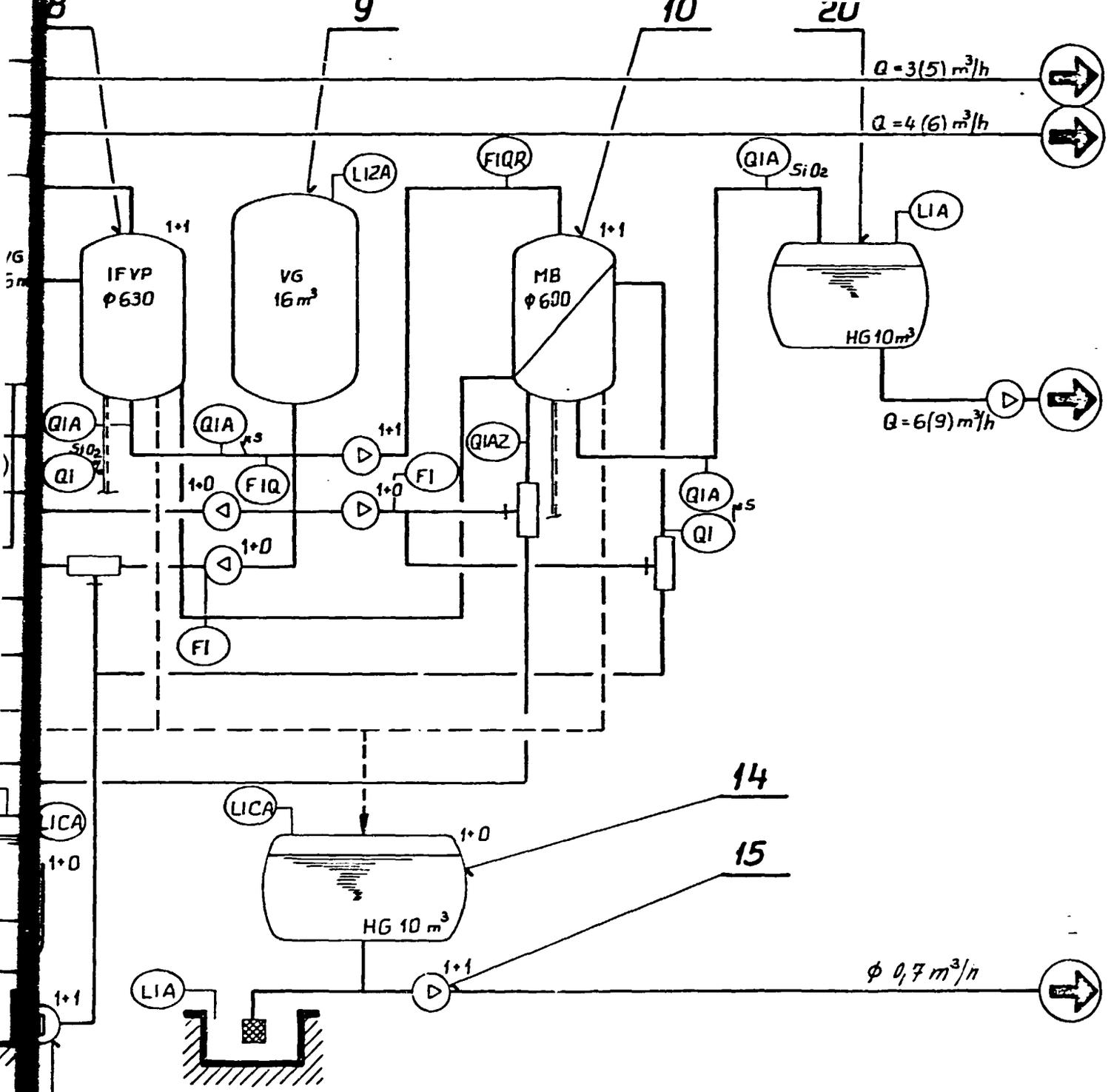


D.C. POWER SOURCES FOR ETCHING 8 kA, 20 V

WIRING DIAGRAM

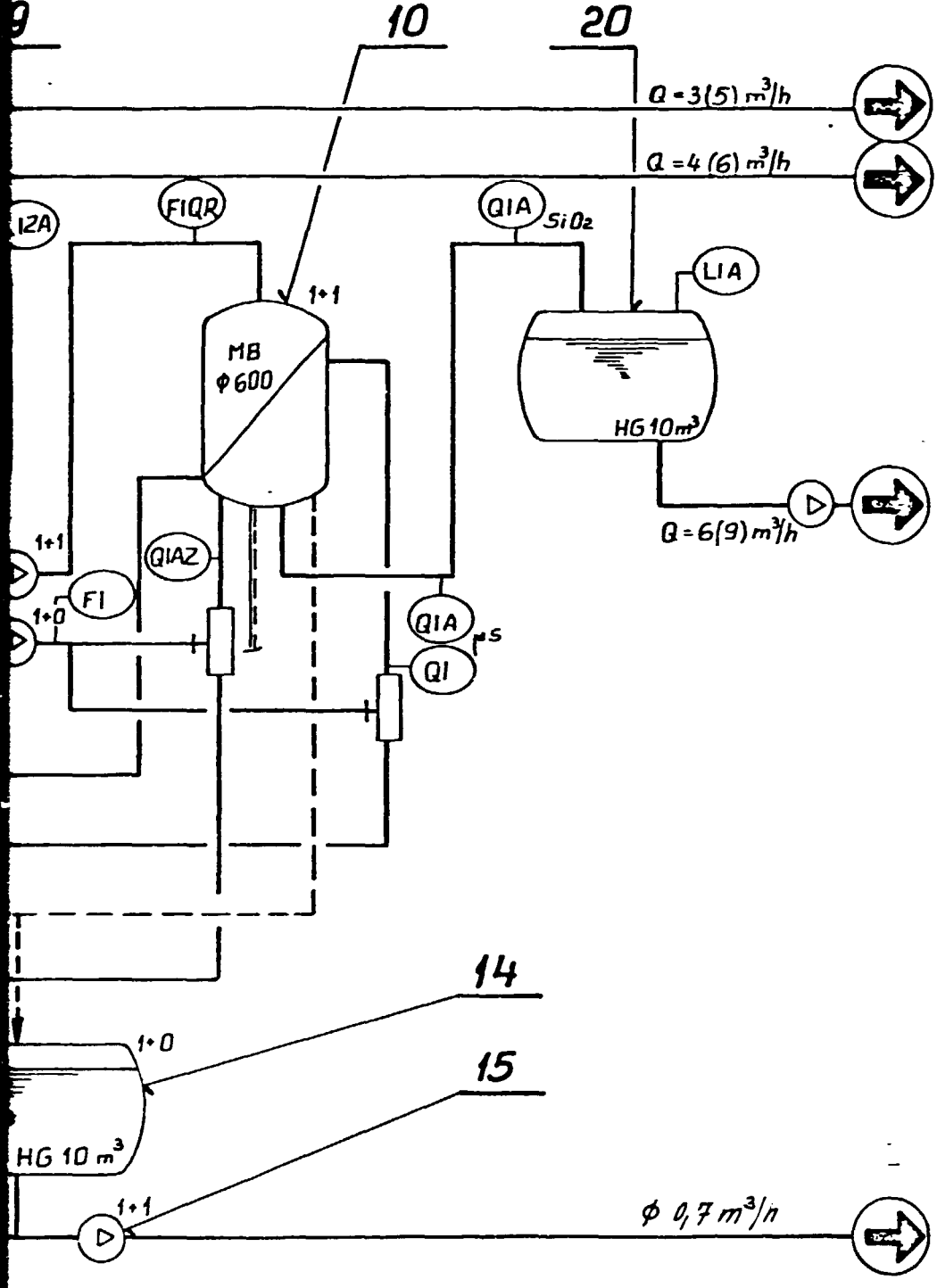

FROM SUPPLYING PIPE
RAW WATER
Q=16m³(22m³)/h
p=0,25MPa
FIQC
1+0
FIQ
DUKLA
φ3000
1
15
INTO WASTE WATER
TREATMENT
PLANT
~0,5m³/h – MUD
DRY MATTER 0,5-2%
LC
V=10m³
4
3
16
LIA
LICA
1+0
1+1
20% FeCl3
5% FeCl3
1+1
5
LIA
LICA
PIC
1+0
1+1
7% Ca(OH)2
2% Ca(OH)2
1+1
LIA


2
7
8
UKLA
3000
1÷0
FIQ
1÷1 (÷1)
DF
ϕ 1400
FI
LIZA
±
100m³
1÷0
1÷0
1÷1
LC
V=10m³
FI
FIQ
1÷1
IFVP
ϕ 630
QIAZ
%
QIA
FI
1÷1
IFVP
ϕ 630
QIA
QI
SiO₂
%
QIA
1÷0
FIQ
1÷0
FI
VG
16m
16
11
17
LICA
1÷1
FeCl₃
1÷1
LIA
1÷0
96% H₂SO₄
1÷1
1÷0
H₂SO₄
96%
LICA
1÷0
NaOH-20%
1÷1
LICA
LIA
NaOH
1÷0
20% NaOH
1÷1
LICA
1÷1
2%Ca(OH)₂
PIC
18
13
12
6
19



NOTE: EXPLANATION TO FIGURES 1-10 IS MADE
TECHNICAL REPORT SECTION WATER TRE

WATER TREATMENT D



NOTE: EXPLANATION TO FIGURES 1-10 IS MADE IN TECHNICAL REPORT SECTION WATER TREATMENT.

WATER TREATMENT DIAGRAM

List of Metering and Regulation Circuits

Flow Metering

FIQC	Once	- inlet of raw water into reactor, signal to dosing pumps control
FIQ	Twice	- inlet of clarified water intofilters - DF
FI	Once	- flow of purifying air
FIQ	Twice	- inlet of clarified water into cation filter
FIQ	Twice	- outlet of water on anion filter
FIQR	Twice	- inlet of water into MB filters
FI	Three times	- water for diluting and washing
FI	Once	- flow of washing water

Water Level Metering

LC	Once	- float - level in sludge storage tank below reactor
LIZA	Once	- float - level in filtration water tank
LIZA	Once	- bubbling - level in container of demineralized water
LIA	Once	- float - level in container of demineralized water
LIA	Once	- float - level in diluting tank of $FeCl_3$
LICA	Twice	- float - level in $FeCl_3$
LIA	Once	- float - level in $Ca(OH)_2$ mixer
LICA	Twice	- float - level in $Ca(OH)_2$ mixer
LIA	Once	- float - H_2SO_4 design container
LICA	Once	- float - NaOH dosing container
LIA	Once	- float - storage tank for aggressive wastes
LICA	Once	- float - container of aggressive wastes
LIA	Once	- float - $Ca(OH)_2$ waste tank

Pressure Metering

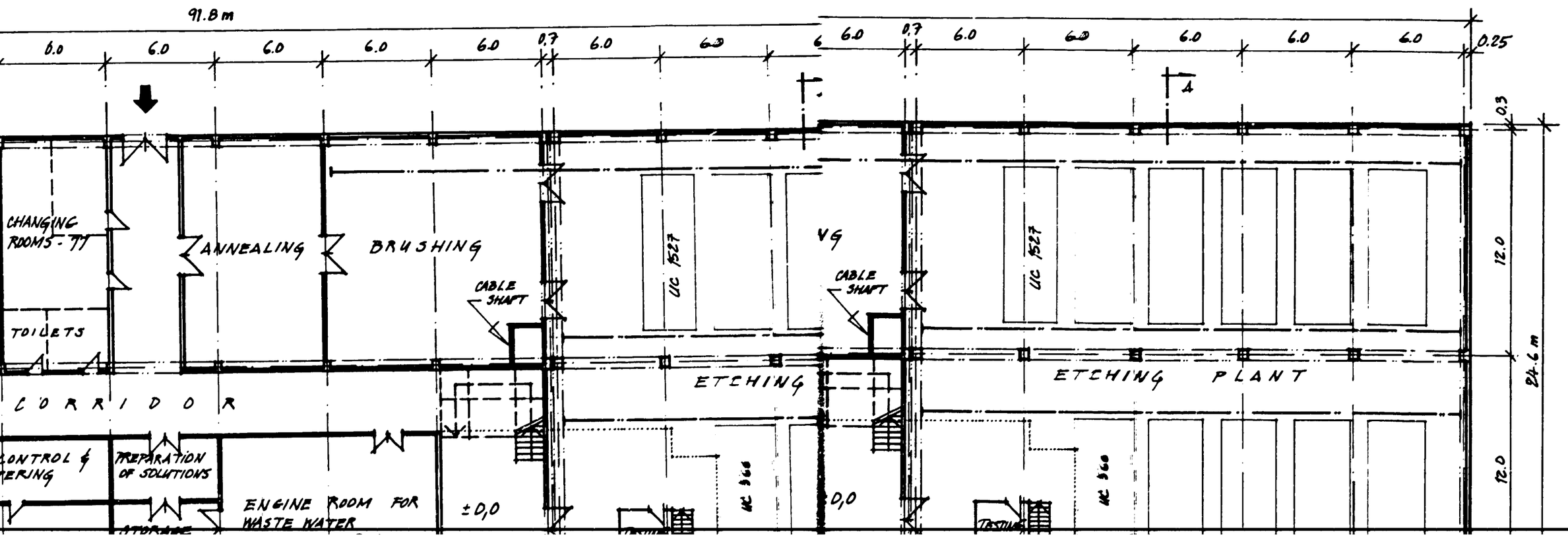
PIC	Once	- metering to air pressure in air chamber and to compressor switching mechanism

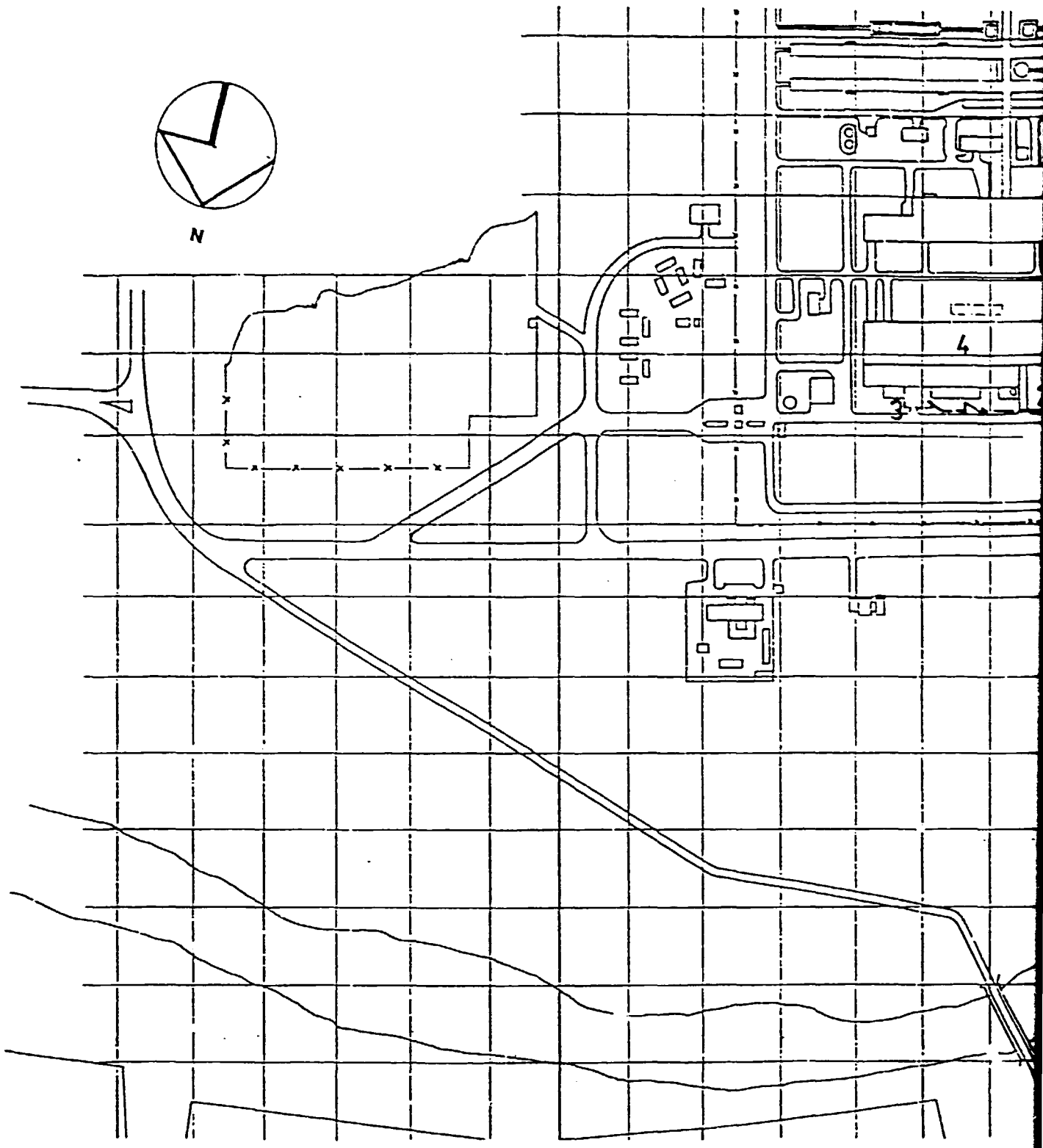
All process will be controlled by sequences.

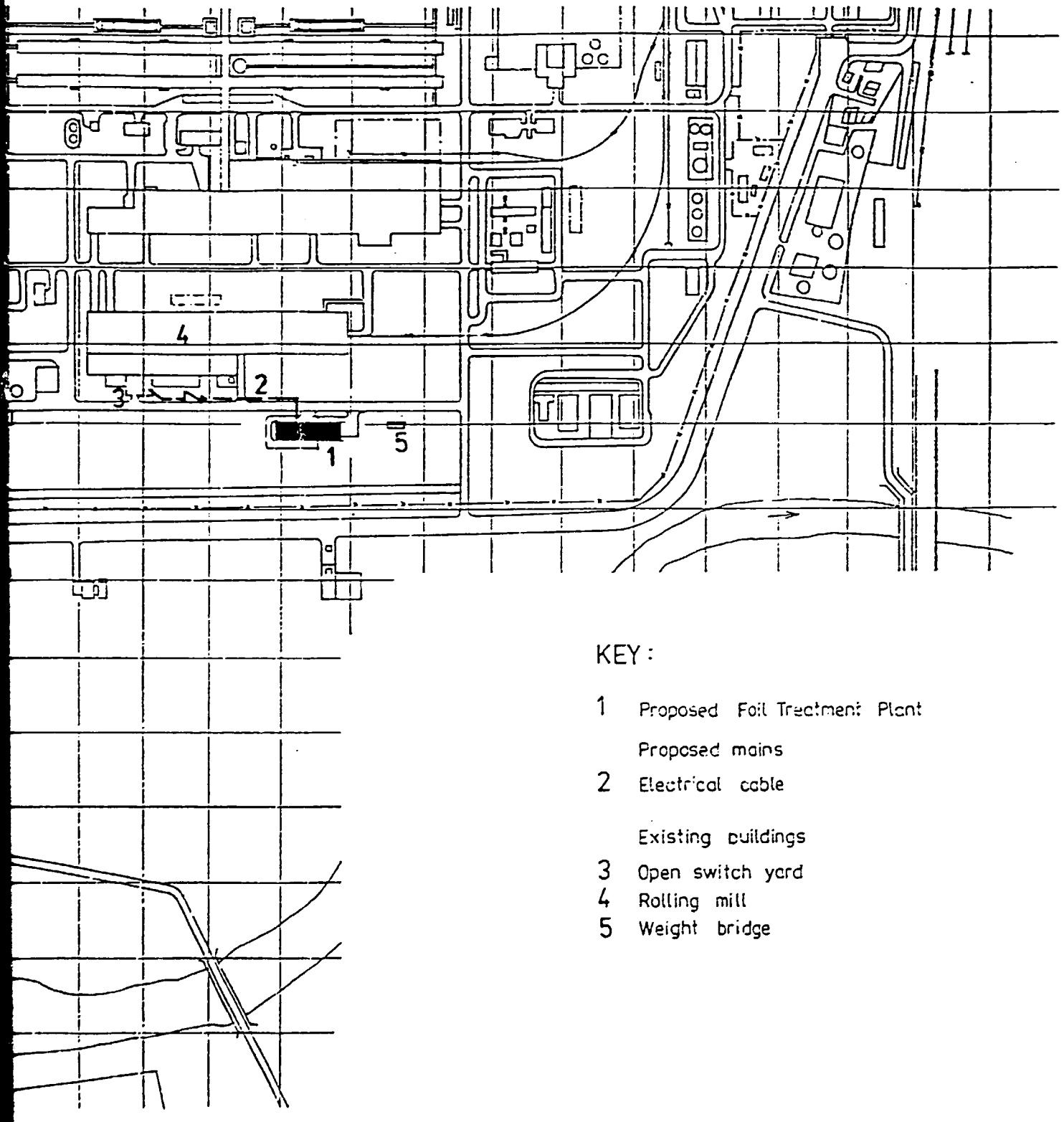
2. Drawings

Dr. No.

- **D.1** Korba, General layout plan in scale 1:7000
- **D.2** Bidhanbag, General layout plan in scale 1:7000
- **D.3** Korba, Site layout plan in scale 1:1000
- **D.4** Bidhanbag, Site layout plan in scale 1:1000
- **D.5** Foil treatment plan, Basement plan in scale 1:200
- **D.6** Foil treatment plan, Ground floor plan in scale 1:200
- **D.7** Foil treatment plan, First floor plan in scale 1:200
- **D.8** Foil treatment plan, Section A-A, B-B in scale 1:100







KEY :

1 Proposed Foil Treatment Plant

Proposed mains

2 Electrical cable

Existing buildings

3 Open switch yard
4 Rolling mill
5 Weight bridge

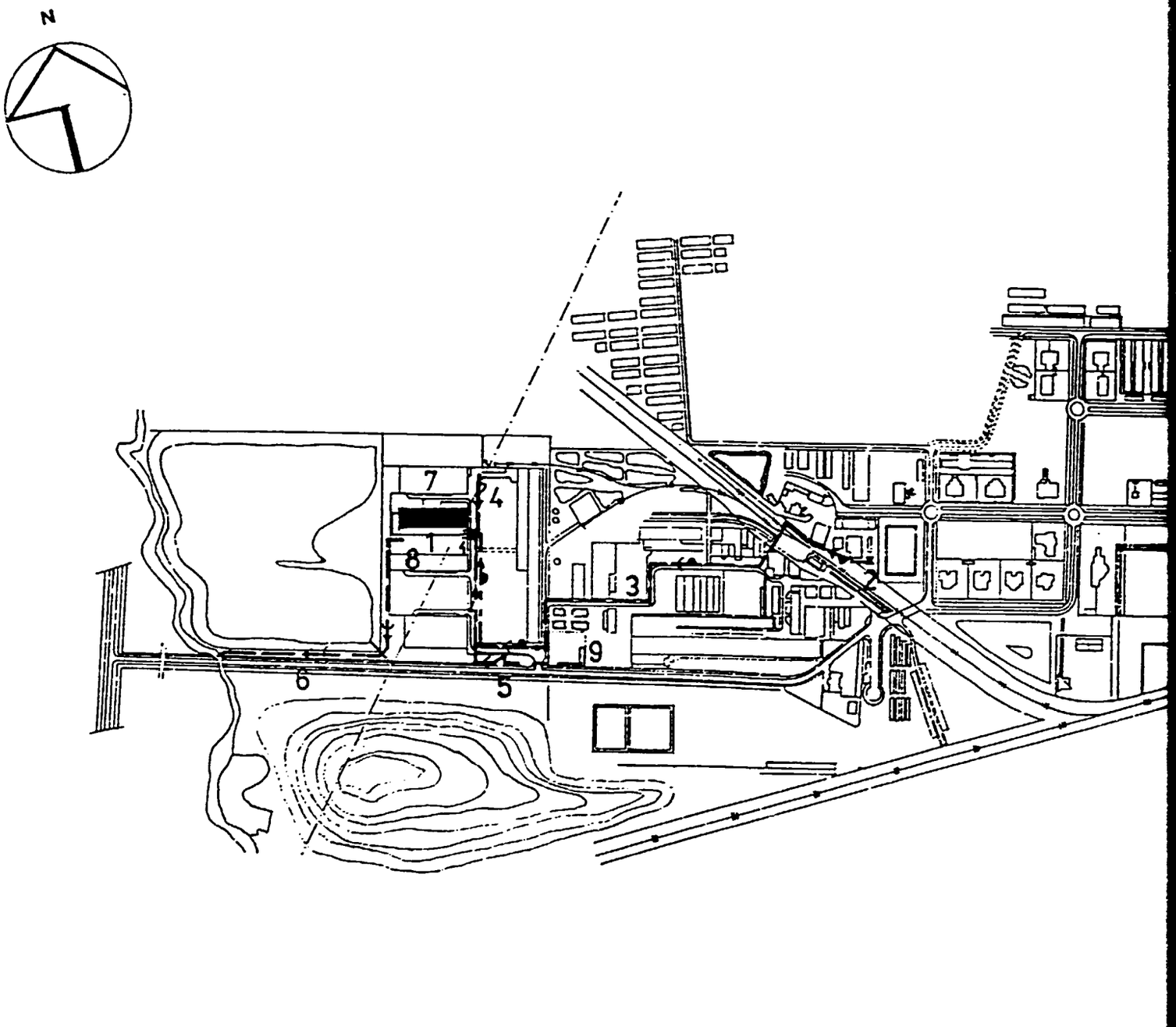
FOIL TREATMENT PLANT

KORBA

General Layout Plan in Scale 1: 7000

BALCO, INDIA

D.1



FOIL

Gene
BALC

KEY:

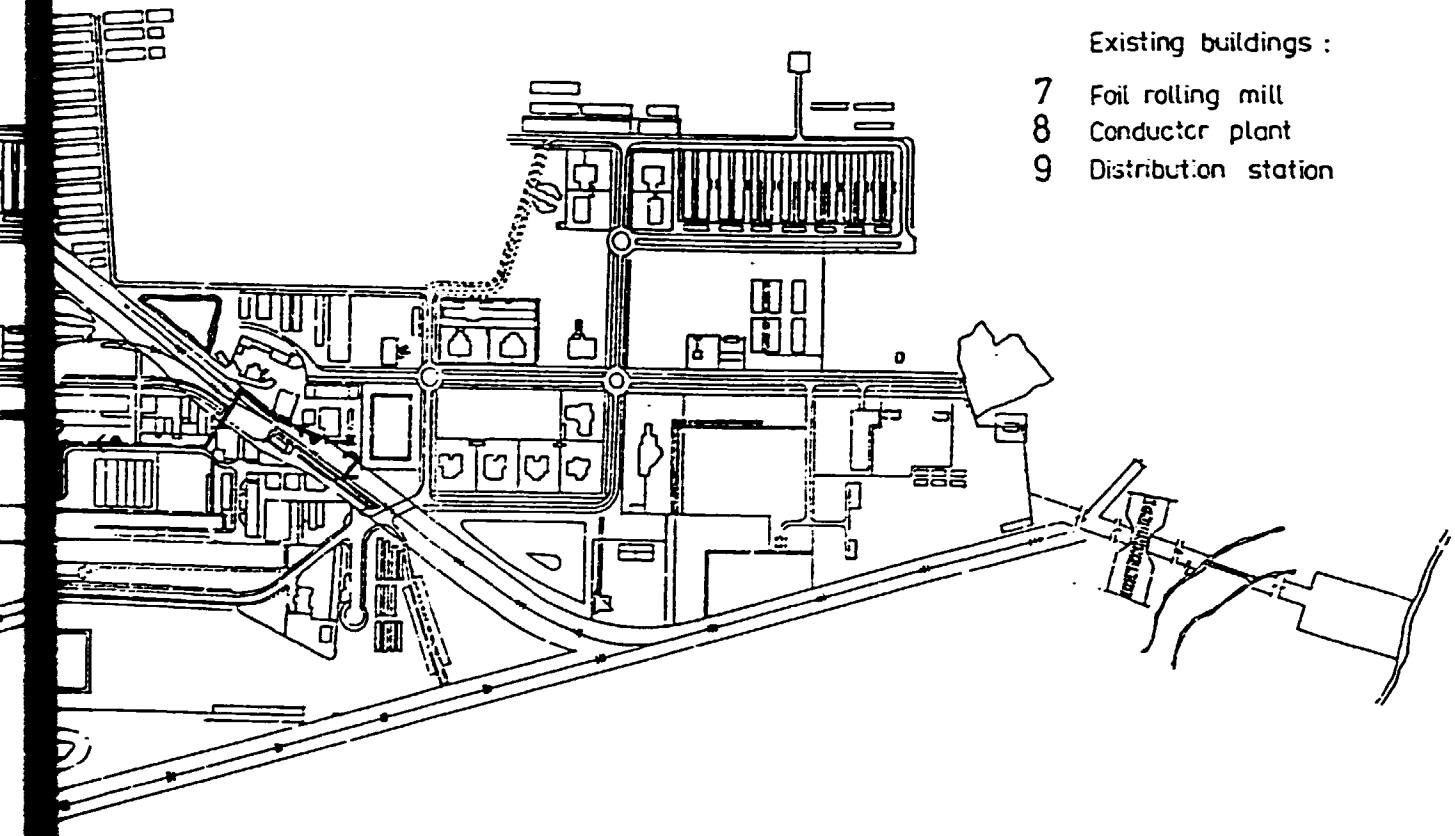
1 Proposed Foil Treatment Plant
2 Proposed Raw Water Pumping Station

Proposed mains:

3 Raw water
4 Drinking water
5 Electrical cable
6 Drainage pipe

Existing buildings :

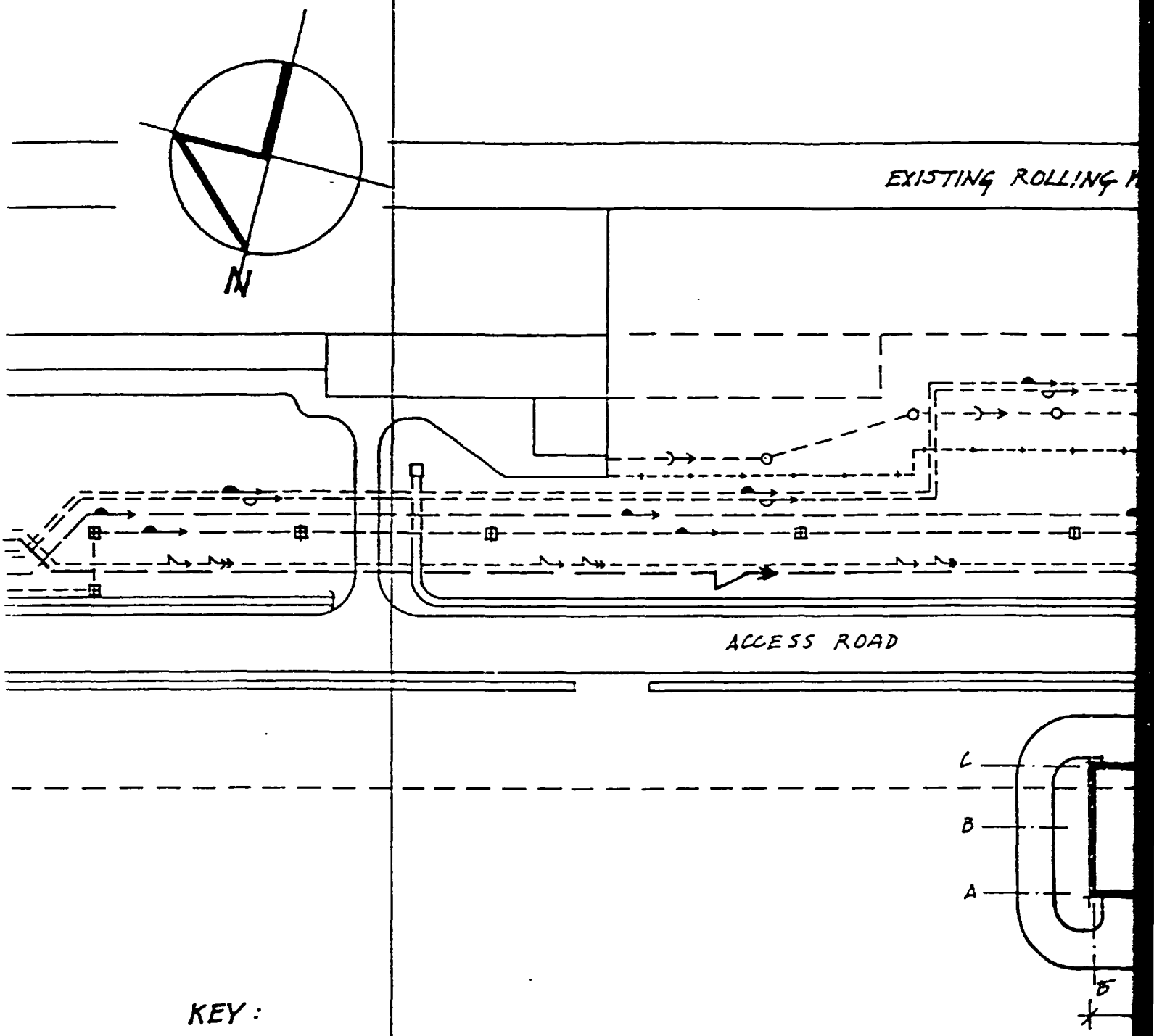
7 Foil rolling mill
8 Conductor plant
9 Distribution station



FOIL TREATMENT PLANT
BIDHANBAG

General Layout Plan in Scale 1:7000
BALCO, INDIA

D.2



KEY :

CONNECTING SERVICES MAINS PROPOSED

ELECTRICAL HV

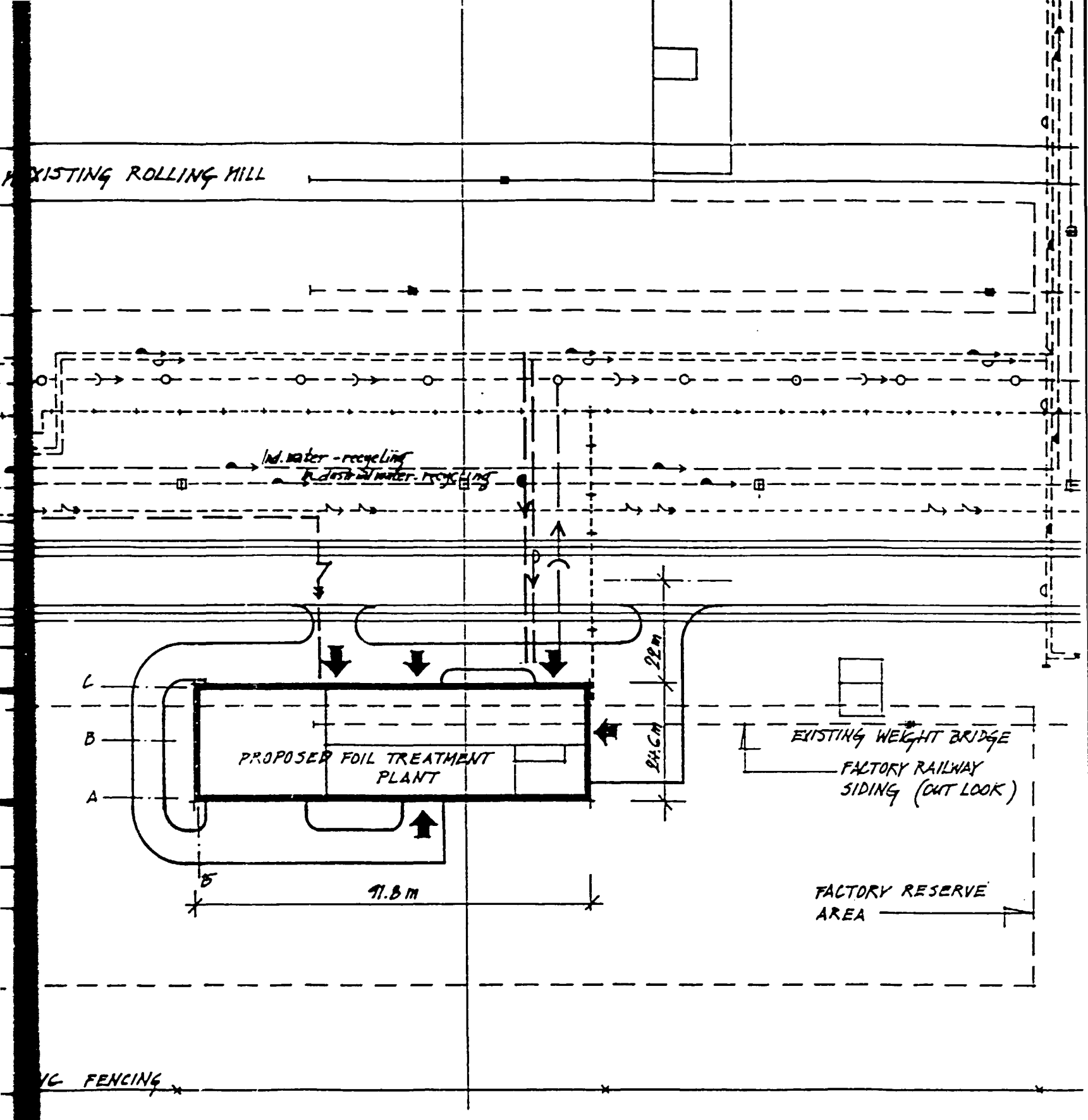
INDUSTRIAL WATER

EXISTING FENCING

DRINKING WATER

SEWAGE

COMPRESSED AIR /BRIDGE/



FOIL TREATMENT PLANT
KORBA

SITE LAYOUT PLAN in SCALE 1:1000

BALCO, INDIA

D.3

N

EXNG. LAVATORIES

EXISTING FOIL ROLLING PL

FOIL ROLLING PLANT

RELOCATED COOLING WATER PIPE /PROPOSAL/

15m

24.6 m

A

B

C

PROPOSED FOIL TREATMENT PLANT

PROPOSED SEPTIC TANK

91.8 m

91.8 m

ROAD ACCESS

EXISTING FENCING

EXISTING EXTRUSION PLANT

EXISTING SWITCH YARD & DISTRIBUTION RM

KEY:

CONNECTING SERVICES MAINS PROPOSED

- ELECTRICAL HV
- ELECTRICAL LV
- INDUSTRIAL WATER
- DRINKING WATER
- SEWAGE
- COMPRESSED AIR /BRIDGE/

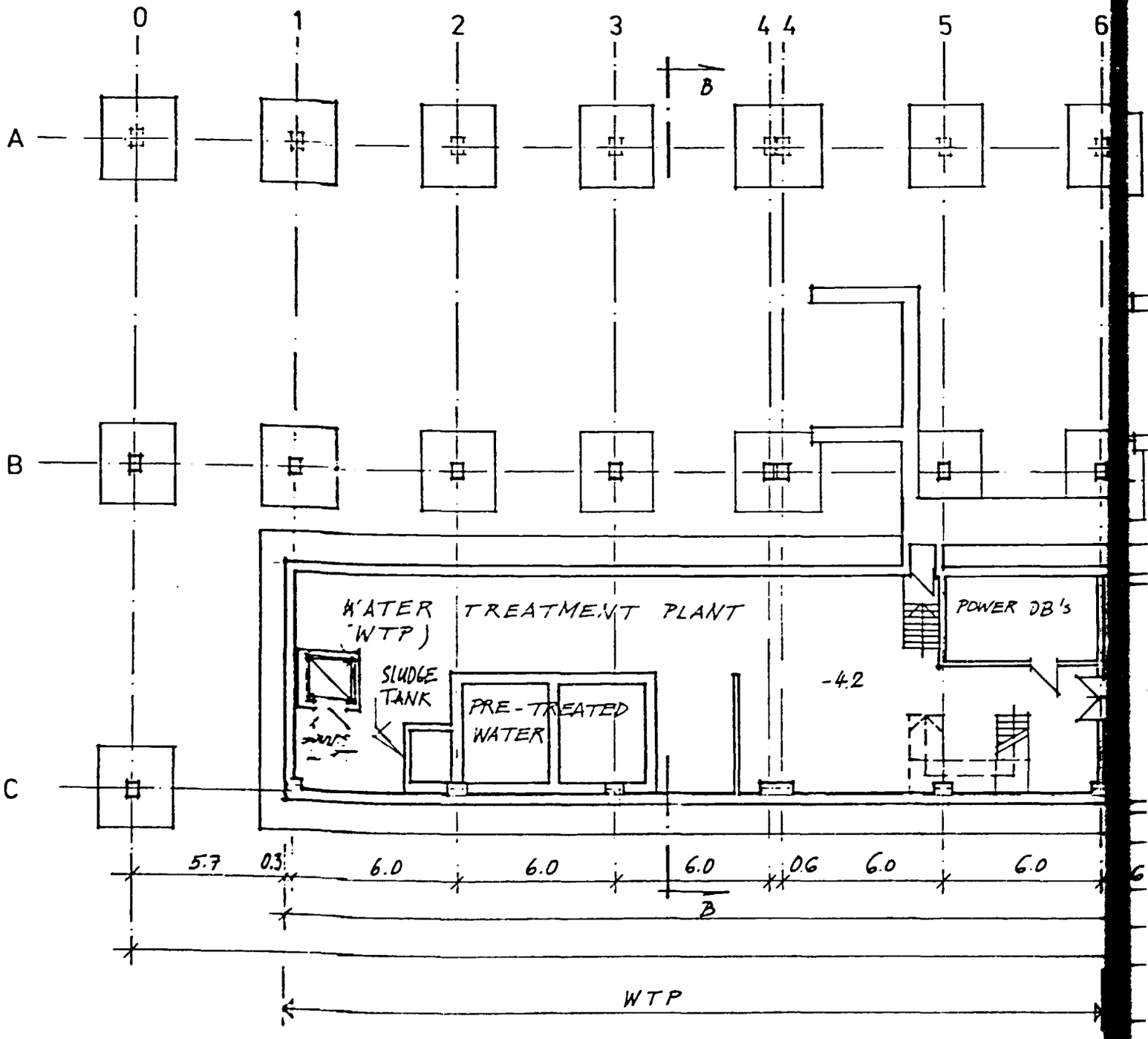
FOIL TREATMENT PLANT
BIDHANBAG

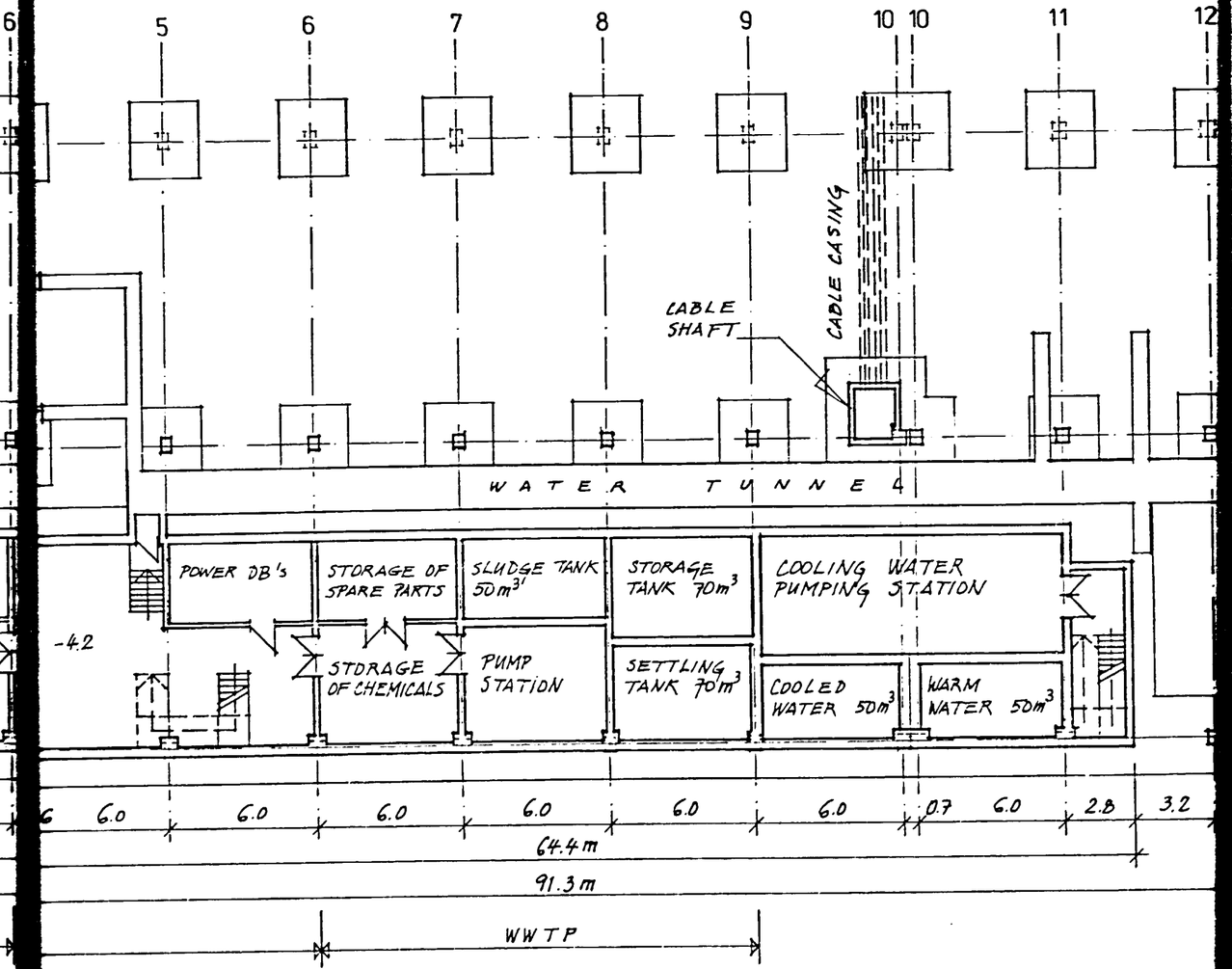
SITE LAYOUT PLAN in SCALE 1:1000

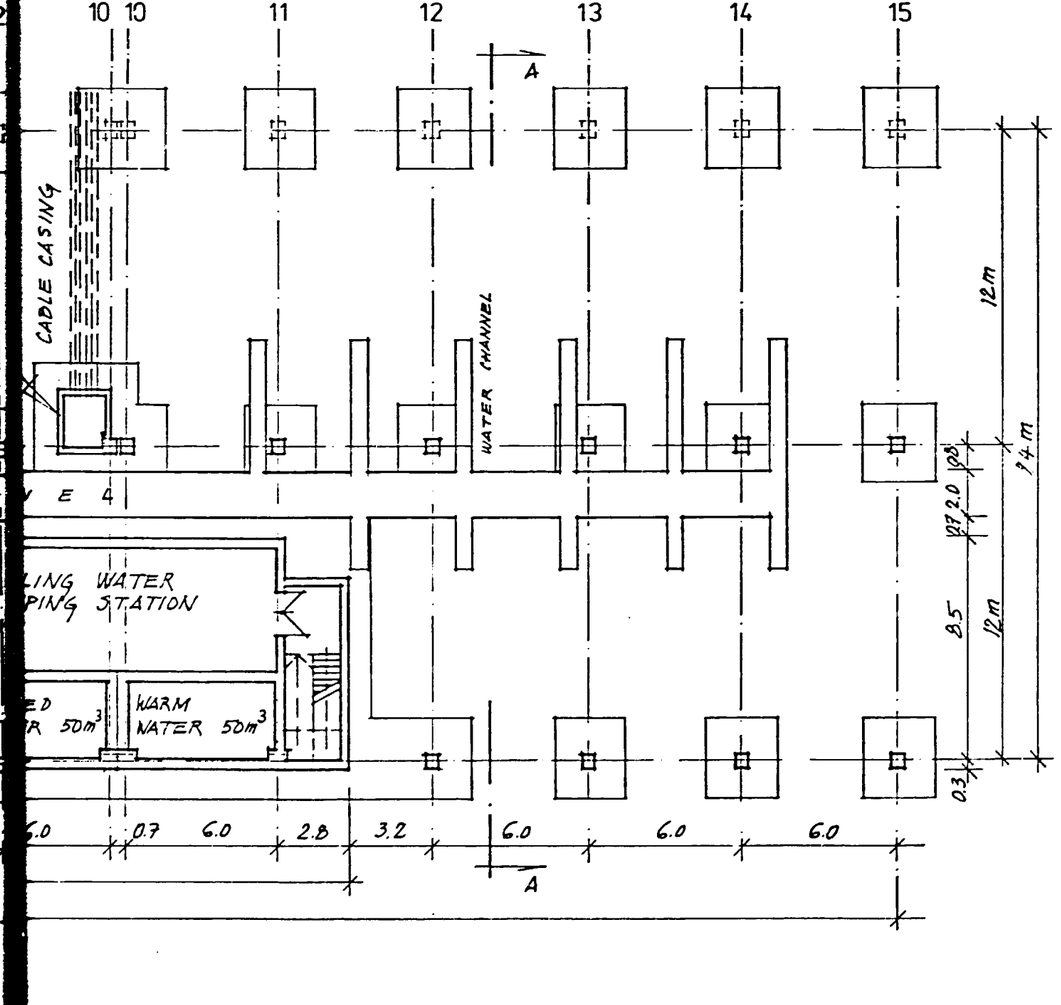
BALCO, INDIA

D.4

BASEMENT PLAN





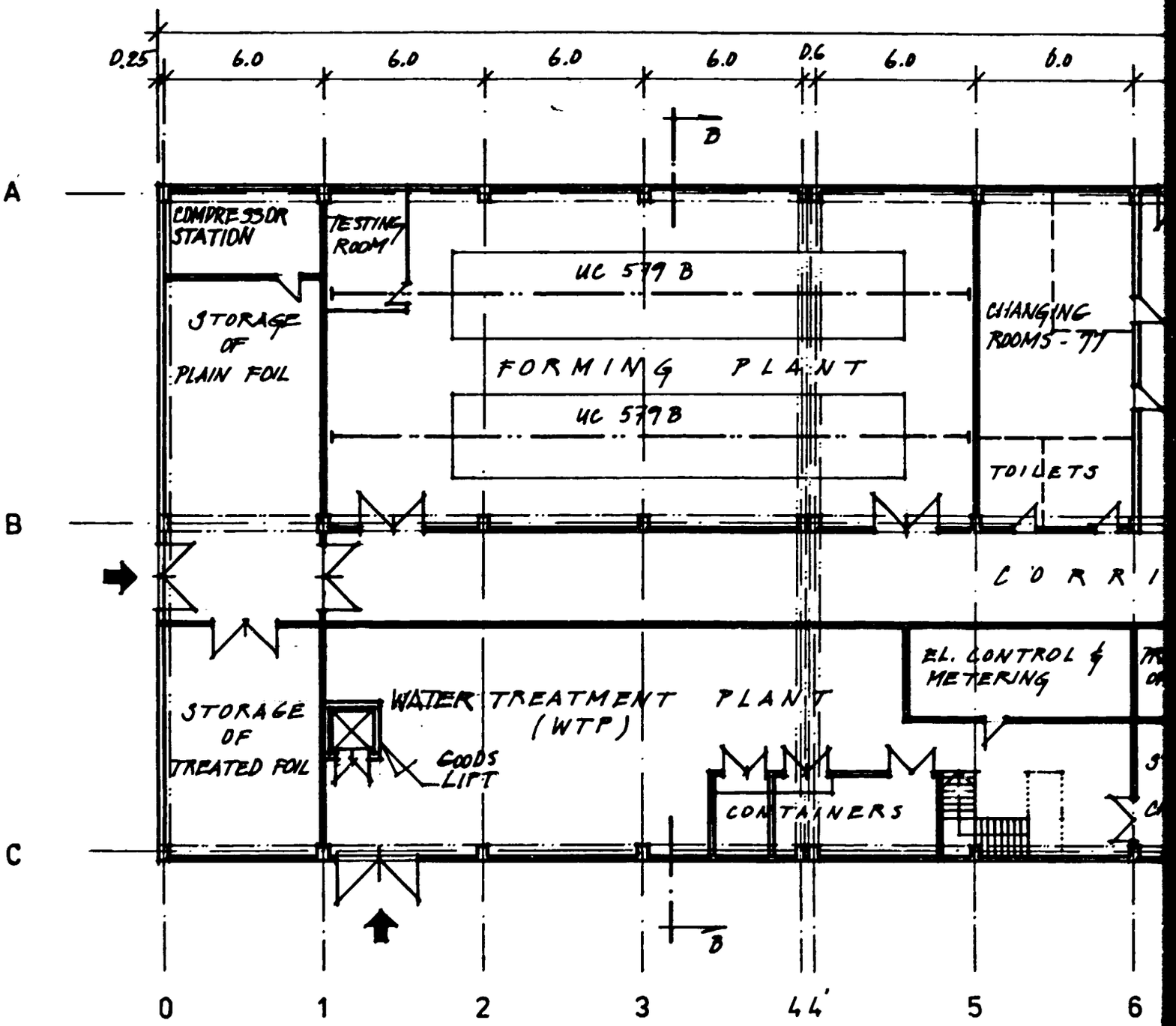


FOIL TREATMENT PLANT

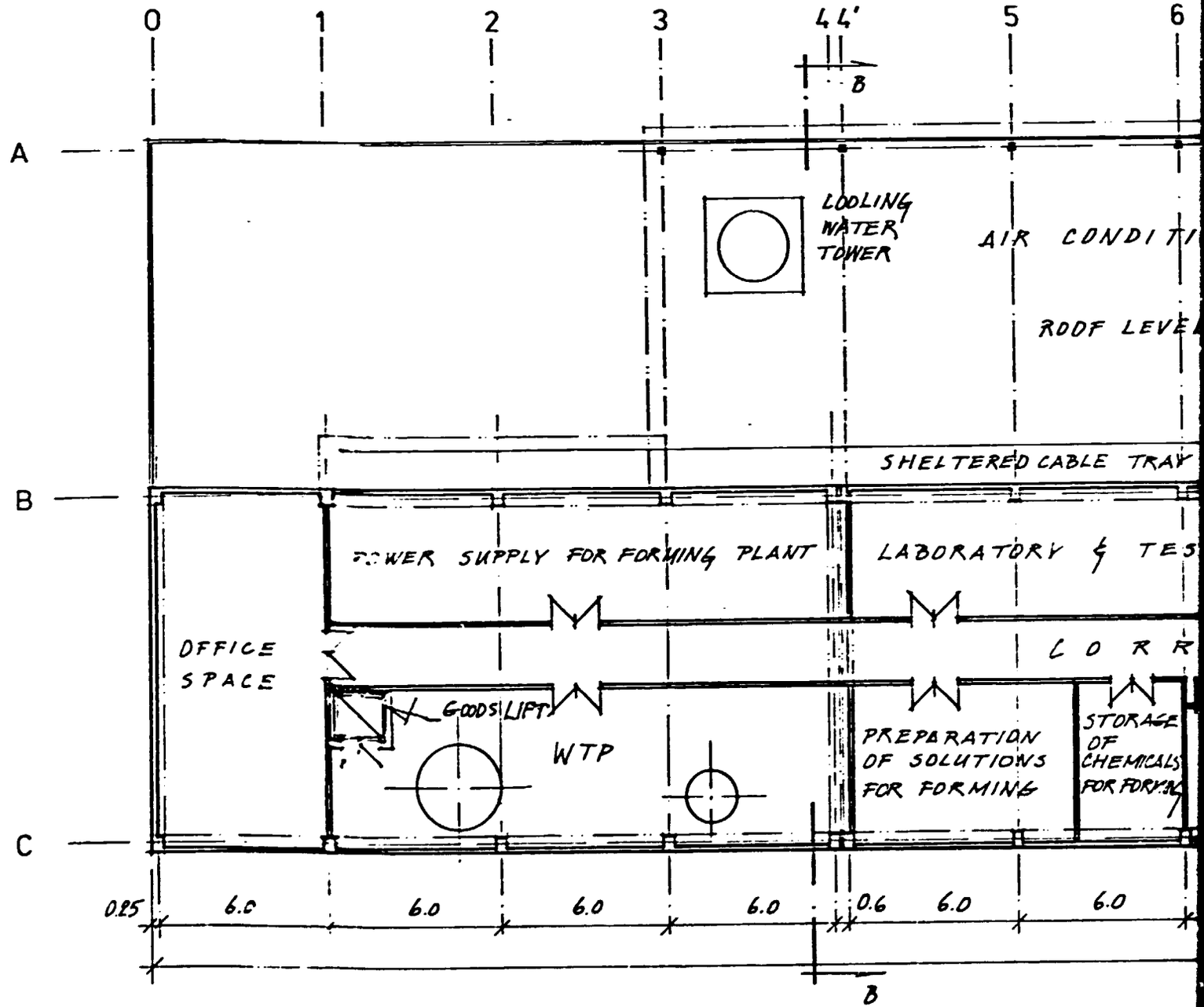
GENERAL ARRANGEMENT
Basement Plan in Scale 1:200
BALCO, INDIA

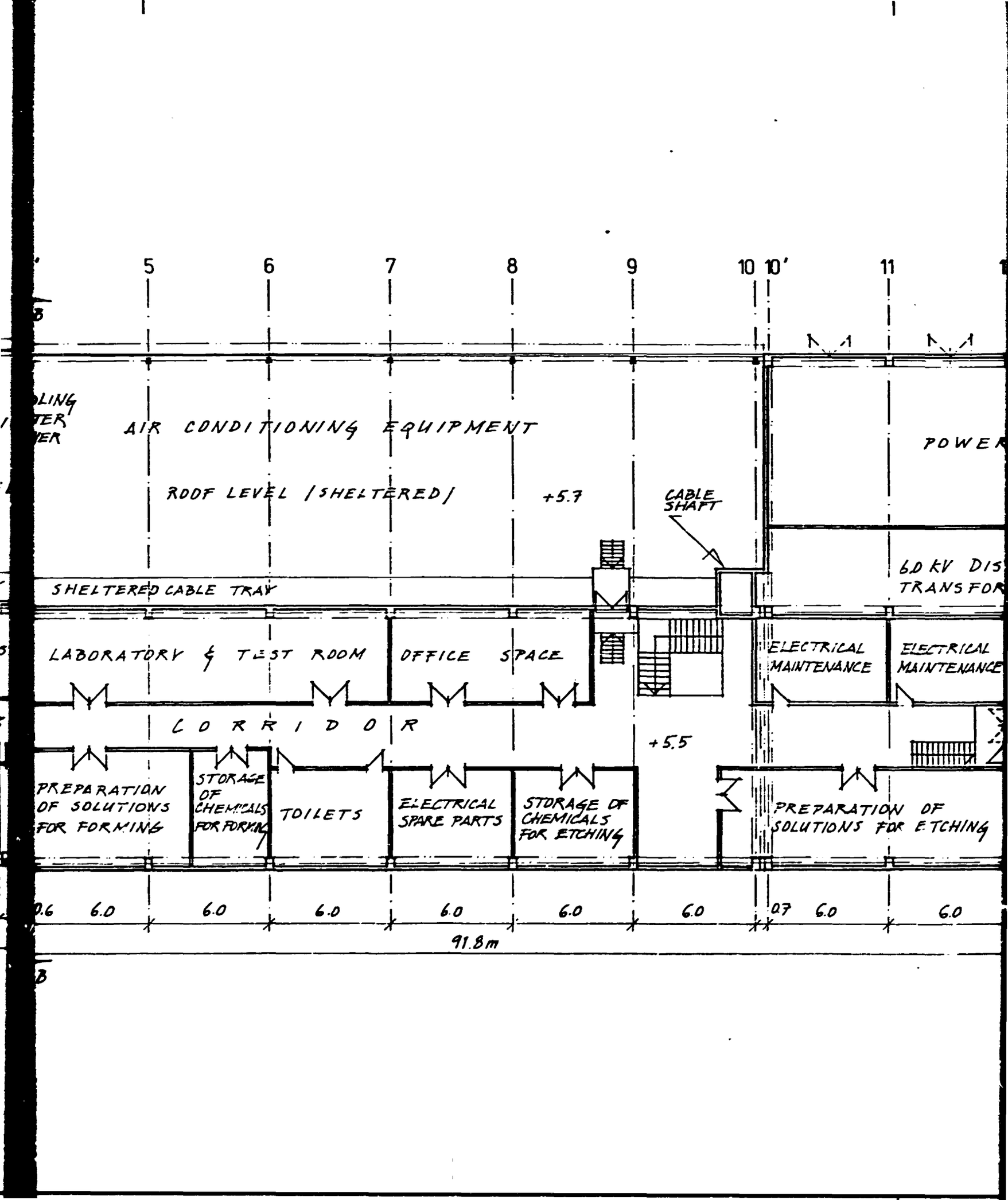
D.5

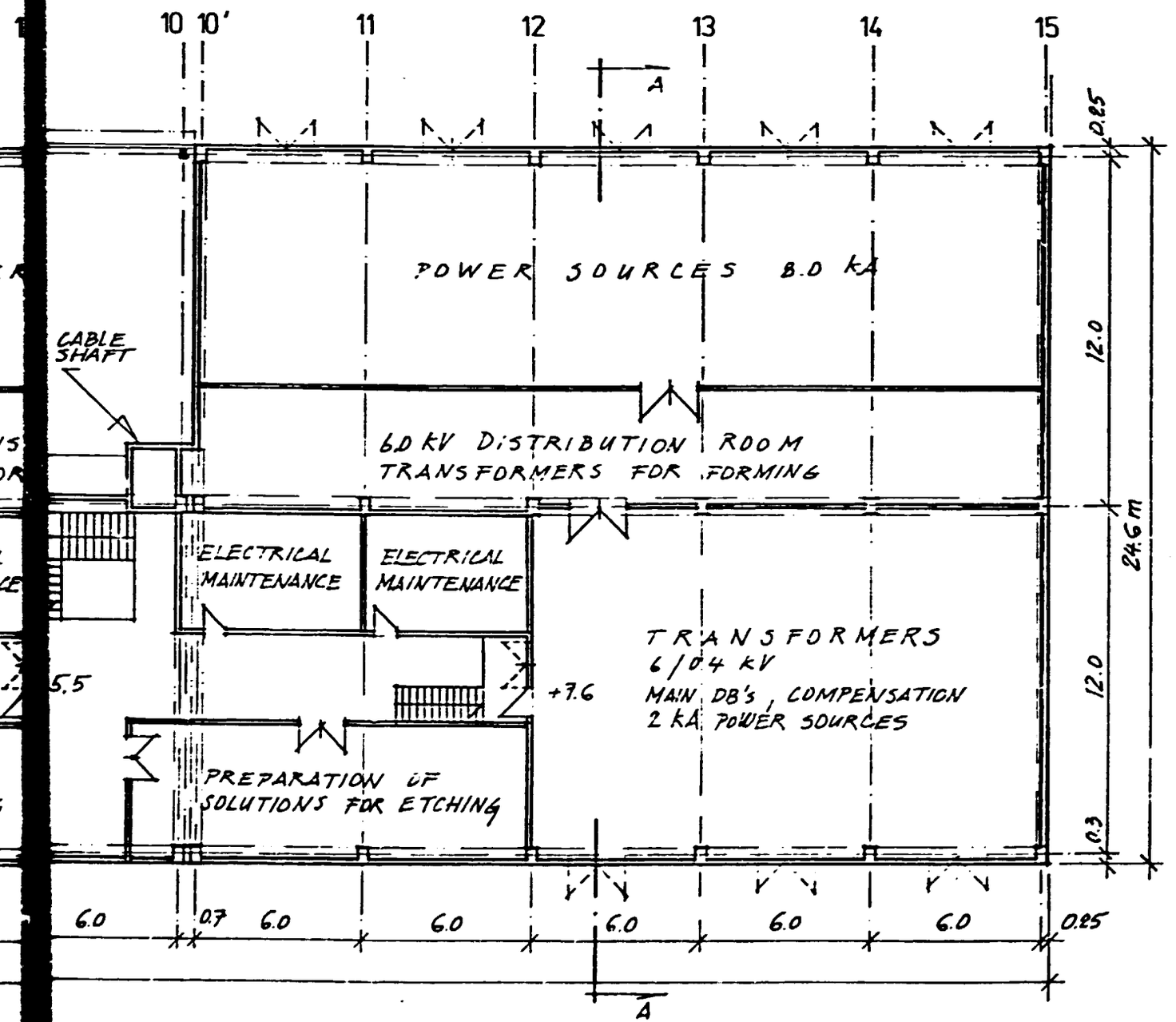
GROUND FLOOR PLAN



FIRST FLOOR PLAN




5
6
7
8
9
10
10'
11
AIR CONDITIONING EQUIPMENT
ROOF LEVEL /SHELTERED/
+5.7
CABLE SHAFT
POWER
SHELTERED CABLE TRAY
LABORATORY & TEST ROOM
OFFICE SPACE
ELECTRICAL MAINTENANCE
ELECTRICAL MAINTENANCE
CORRIDOR
+5.5
PREPARATION OF SOLUTIONS FOR FORMING
STORAGE OF CHEMICALS FOR FORMING
TOILETS
ELECTRICAL SPARE PARTS
STORAGE OF CHEMICALS FOR ETCHING
PREPARATION OF SOLUTIONS FOR ETCHING
6.0
6.0
6.0
6.0
6.0
6.0
6.0
6.0
91.8m



FOIL TREATMENT PLANT

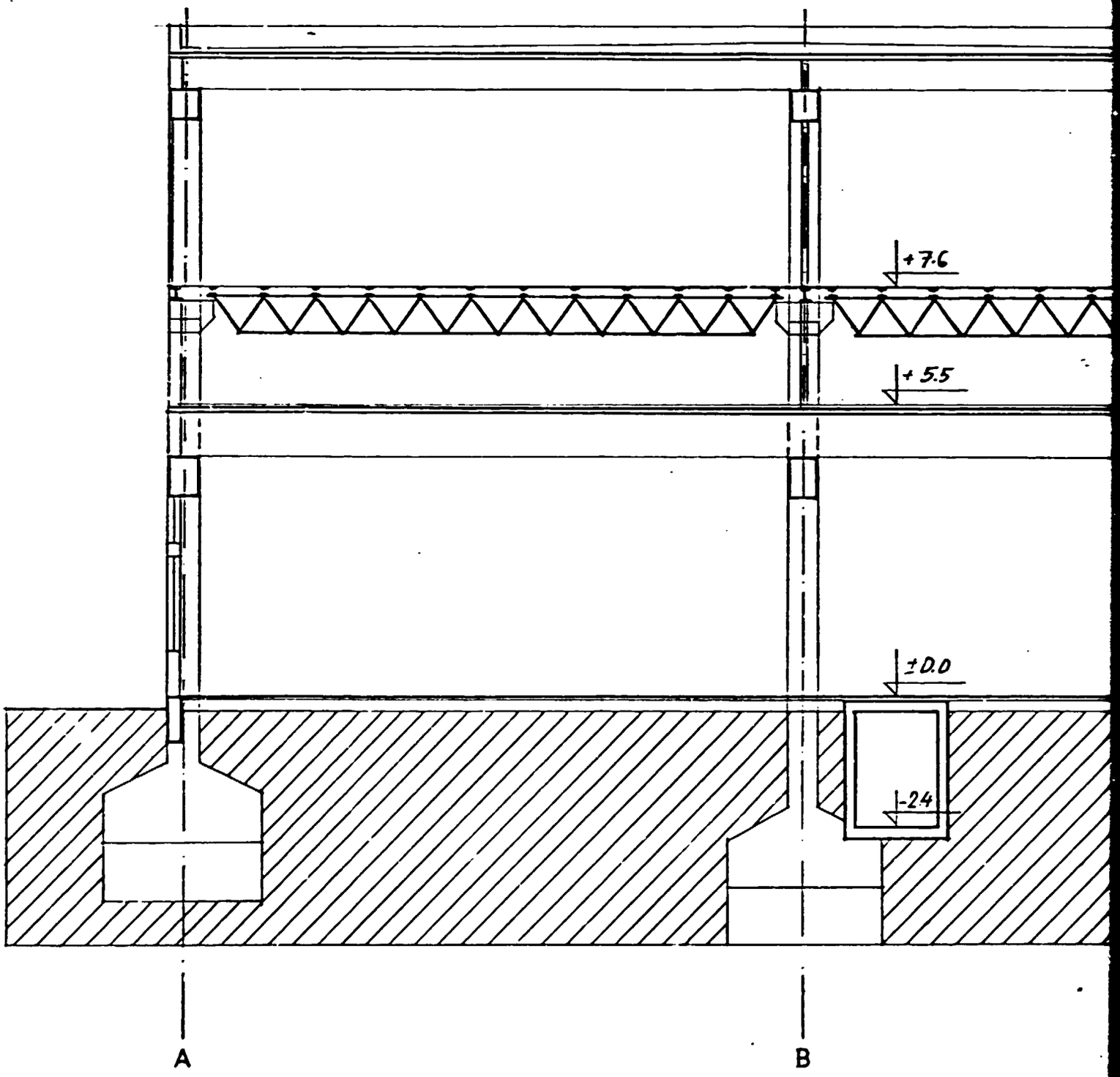
GENERAL ARRANGEMENT

First Floor Plan in Scale 1:200

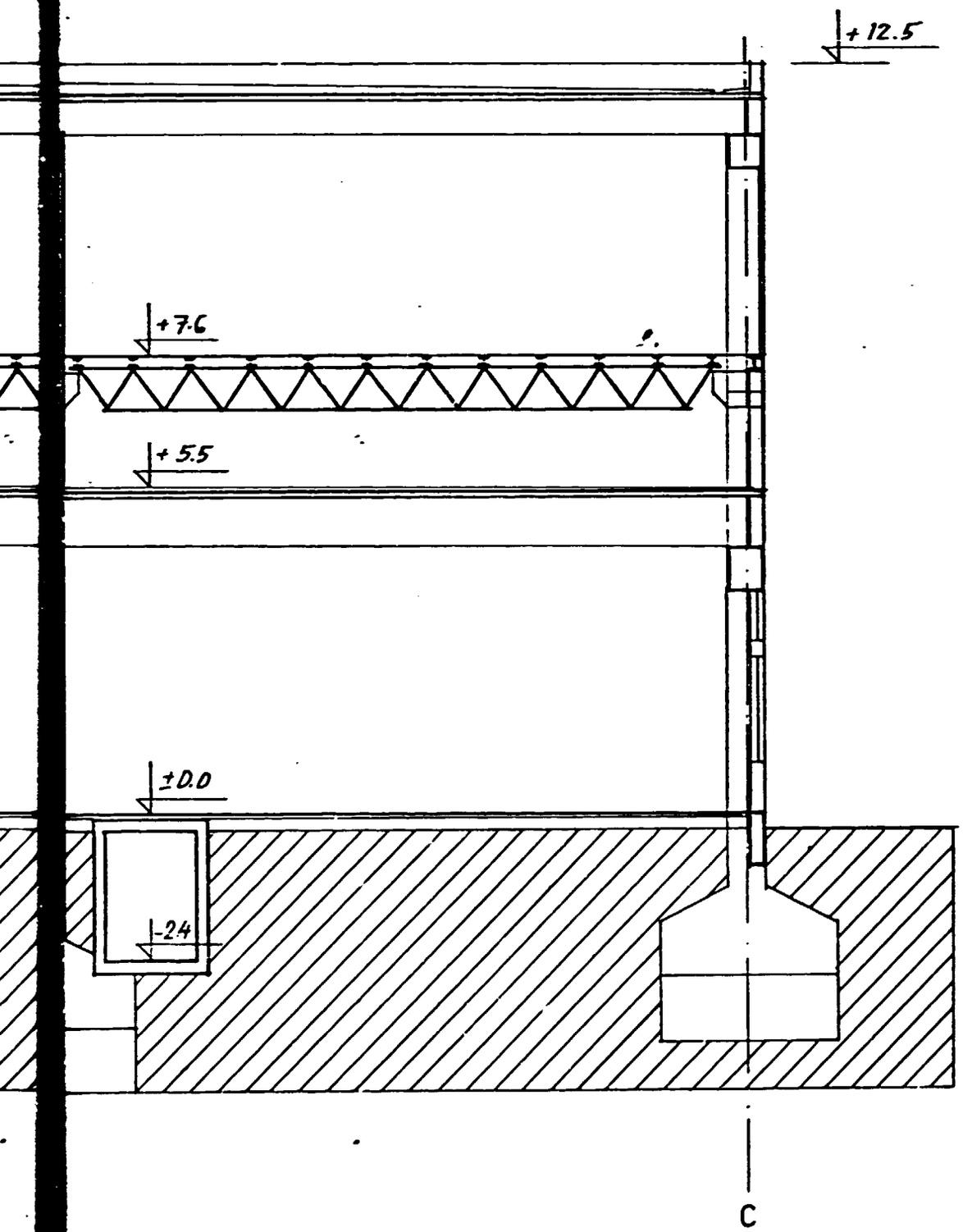
BALCO, INDIA

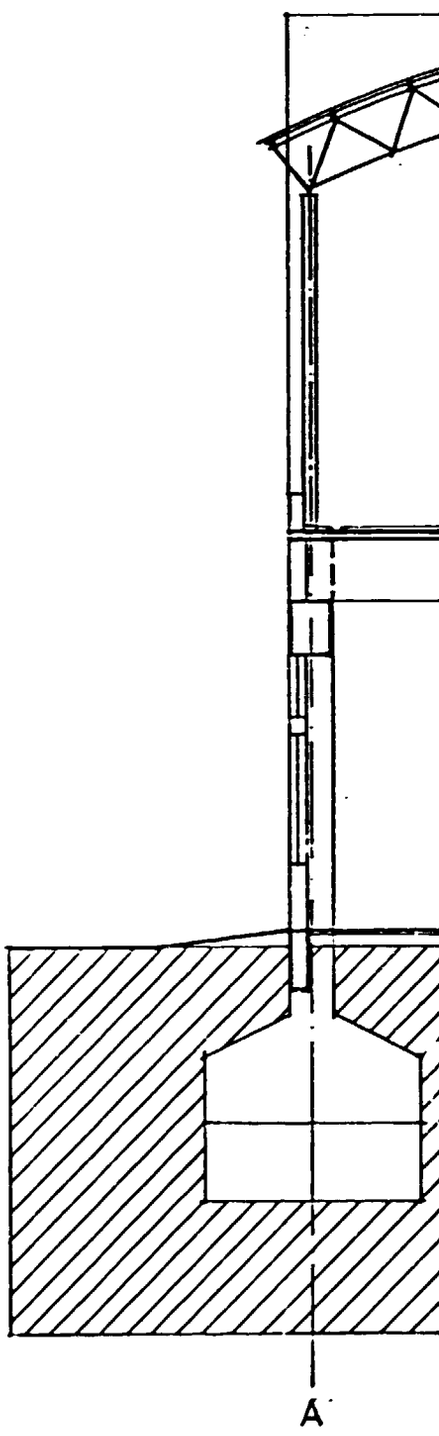
D.7

SECTION A - A

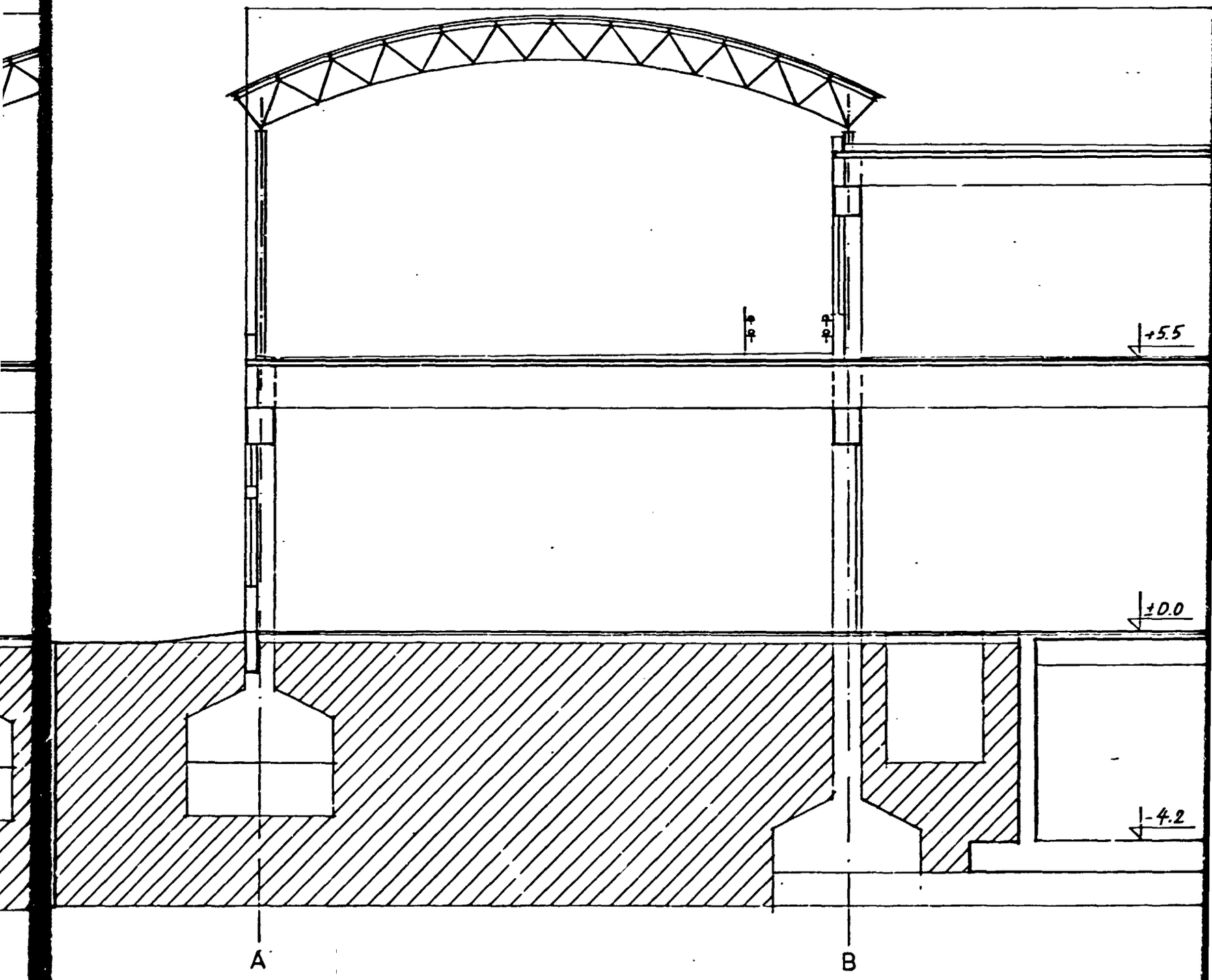


SECTIO



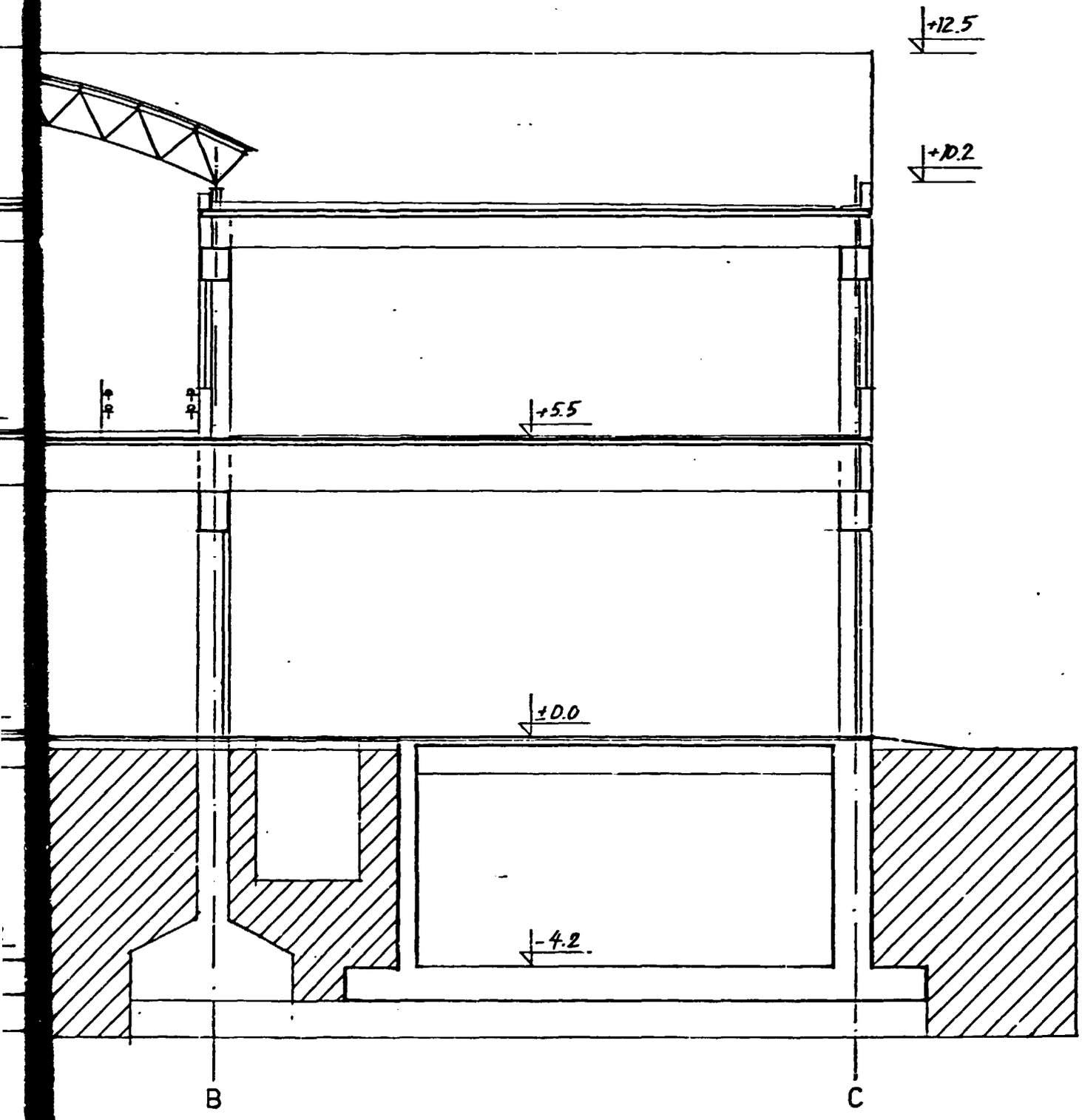


SECTION B - B



FOIL

GENERAL A
Section A-A
BALCO, IND



FOIL TREATMENT PLANT

GENERAL ARRANGEMENT
Section A-A, B-B in Scale 1: 100
BALCO, INDIA

D.8

3. COMFAR tables - KORBA

BALCO - SPA foils for capacitors BALBK1
13.9.1993 (loan only, no income tax)
Foil treatment in Korba, no SPA recycl.

1 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: 1,000 Rs

Total initial investment during construction phase

fixed assets:	240108.90	0.000 % foreign
current assets:	0.00	0.000 % foreign
total assets:	240109.90	0.000 % foreign

Source of funds during construction phase

equity & grants:	0.00	0.000 % foreign
foreign loans :	0.00	
local loans :	240109.00	
total funds :	240109.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	40231.93	61551.31	72004.91
depreciation :	14924.21	64822.29	64822.29
interest :	75770.57	108321.50	97489.37
production costs	130926.70	234695.10	234316.60
thereof foreign	0.00 %	0.00 %	0.00 %
total sales :	219350.00	357740.20	446040.00
gross income :	88423.27	123045.00	211723.50
net income :	88423.27	123045.00	211723.50
cash balance :	0.06	127376.00	216225.00
net cashflow :	-285906.70	295876.10	373893.00

Net Present Value at: 15.00 % = 1345709.00
Internal Rate of Return: 55.26 %
Return on equity1: not found
Return on equity2: not found

Index of Schedules produced by COMFAR

Total Initial Investment in 1,000 Rs

Year	1994
Fixed investment costs	
Land, site preparation, development	968.440
Buildings and civil works	26327.780
Auxiliary and service facilities	0.000
Incorporated fixed assets	25084.400
Plant machinery and equipment	105010.000
Total fixed investment costs	159390.600
Pre-production capital expenditures.	80718.300
Net working capital	0.000
Total initial investment costs	240108.900
Of it foreign, in %	0.000

Total Current Investment in 1,000 Rs

Year	1995	1996	1997
Fixed investment costs			
Land, site preparation, development	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000
Incorporated fixed assets	0.000	0.000	0.000
Plant, machinery and equipment	464405.800	0.000	0.000
Total fixed investment costs	464405.800	0.000	0.000
Preproduction capitals expenditures.	0.000	0.000	0.000
Working capital	618.968	312.726	142.166
Total current investment costs	465024.700	312.726	142.166
Of it foreign, %	0.000	0.000	0.000

Total Production Costs in 1,000 Rs

Year	1995	1996	1997	1998	1999
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	8677.110	18425.880	22876.000	22876.000	22876.000
Other raw materials	946.670	2146.000	2660.867	2660.867	2660.867
Utilities	5702.339	11272.540	14016.710	14016.710	14016.710
Energy	7140.567	10164.670	12092.400	12092.400	12092.400
Labour, direct	8294.998	8693.678	8693.678	8693.678	8693.678
Repair, maintenance	751.762	904.282	971.299	971.299	971.299
Spares	1815.247	2113.597	2271.951	2271.951	2271.951
Factory overheads	3576.309	4287.474	4552.957	4552.957	4552.957
Factory costs	36905.000	58003.210	68135.860	68135.860	68135.860
Administrative overheads	2311.825	2412.527	2460.585	2460.585	2460.585
Indir. costs, sales and distribution	1015.107	1130.575	1408.457	1408.457	1408.457
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	14924.210	64822.290	64822.290	64822.290	64822.290
Financial costs	75770.570	108321.500	97469.370	86657.220	75825.070
Total production costs	130926.700	234695.100	234316.600	223484.400	212652.300
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	0.000	0.000	0.000	0.000	0.000
Of it variable,%	16.897	18.797	22.782	23.887	25.133
Total labour	8756.697	9160.957	9179.678	9179.678	9179.678

Total Production Costs in 1,000 Rs

Year	2000	2001	2002	2003	2004
% of nom. capacity (single product)	0.000	0.000	0.000	0.000	0.000
Raw material 1	22876.000	22876.000	22876.000	22876.000	22876.000
Other raw materials	2660.867	2660.867	2660.867	2660.867	2660.867
Utilities	14016.710	14016.710	14016.710	14016.710	14016.710
Energy	12092.400	12092.400	12092.400	12092.400	12092.400
Labour, direct	8693.678	8693.678	8693.678	8693.678	8693.678
Repair, maintenance	971.299	971.299	971.299	971.299	971.299
Spares	2271.951	2271.951	2271.951	2271.951	2271.951
Factory overheads	4552.957	4552.957	4552.957	4552.957	4552.957
Factory costs	68135.860	68135.860	68135.860	68135.860	68135.860
Administrative overheads	2460.585	2460.585	2460.585	2460.585	2460.585
Indir. costs, sales and distribution	1408.457	1408.457	1408.457	1408.457	1408.457
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	64822.290	64822.290	64822.290	64822.290	50844.350
Financial costs	64992.910	54160.760	43328.610	32496.460	21664.300
Total production costs	201820.100	190988.000	180155.800	169323.600	144513.600
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	0.000	0.000	0.000	0.000	0.000
Of it variable,%	26.451	27.951	29.632	31.527	36.940
Total labour	9179.678	9179.678	9179.678	9179.678	9179.678

Total Production Costs in 1,000 Rs

Year	2005- 8	2009
% of nom. capacity (single product).	0.000	0.000
Raw material 1	22676.000	22676.000
Other raw materials	2660.867	2660.867
Utilities	14016.710	14016.710
Energy	12092.400	12092.400
Labour, direct	8693.678	8693.678
Repair, maintenance	971.299	971.299
Spares	2271.951	2271.951
Factory overheads	4552.957	4552.957
Factory costs	68135.860	68135.860
Administrative overheads	2460.585	2460.585
Indir. costs, sales and distribution	1408.457	1408.457
Direct costs, sales and distribution	0.000	0.000
Depreciation	946.221	946.221
Financial costs	0.000	0.000
Total production costs	72951.139	72951.139
Costs per unit (single product)	0.000	0.000
Of it foreign, %	0.000	0.000
Of it variable,%	73.176	73.176
Total labour	9179.678	9179.678

Net Working Capital in 1,000 Rs

Year	mdc	coto	1995	1996	1997	1998-2009
Coverage						
Current assets &						
Accounts receivable	0	---	0.000	0.000	0.000	0.000
Inventory and materials	16	22.5	672.266	1419.219	1762.198	1762.198
Energy	0	---	0.000	0.000	0.000	0.000
Spares	180	2.0	907.624	1056.799	1135.976	1135.976
Work in progress	10	36.0	1025.139	1611.339	1892.663	1892.663
Finished products	10	36.0	1089.356	1678.354	1961.012	1961.012
Cash in hand	0	---	0.000	0.000	0.000	0.000
Total current assets			3694.385	5765.711	6751.848	6751.848
Current liabilities and						
Accounts payable	30	12.0	3075.417	4834.017	5677.988	5677.988
Net working capital			618.968	931.694	1073.860	1073.860
Increase in working capital			618.968	312.726	142.166	0.000
Net working capital, local			618.968	931.694	1073.860	1073.860
Net working capital, foreign			0.000	0.000	0.000	0.000

Note: mdc = minimum days of coverage ; coto = coefficient of turnover .

Source of Finance, construction in 1,000 Rs

Year	1994
Equity, ordinary ..	0.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	0.000
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	240109.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	240109.000
Current liabilities	0.000
Bank overdraft	0.000
Total funds	240109.000

Source of Finance, production in 1,000 Rs

Year	1995	1996	1997	1998-2005
Equity, ordinary ..	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000
Loan A, foreign .	0.000	0.000	0.000	0.000
Loan B, foreign..	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000
Loan A, local....	361677.300	-60178.630	-60178.630	-60178.630
Loan B, local....	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000
Total loan	361677.300	-60178.630	-60178.630	-60178.630
Current liabilities	3075.417	1758.600	843.971	0.000
Bank overdraft	0.000	0.000	0.000	0.000
Total funds	364752.700	-58420.020	-59334.659	-60178.630

Cashflow Tables, construction in 1,000 Rs

Year	1994
Total cash inflow . .	240109.000
Financial resources .	240109.000
Sales, net of tax . .	0.000
Total cash outflow . .	240108.900
Total assets	218499.100
Operating costs . . .	0.000
Cost of finance . . .	21609.800
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	0.016
Cumulated cash balance	0.016
Inflow, local	240109.000
Outflow, local	240108.900
Surplus (deficit) .	0.016
Inflow, foreign . . .	0.000
Outflow, foreign . . .	0.000
Surplus (deficit) .	0.000
Net cashflow	-218499.100
Cumulated net cashflow	-218499.100

Cashflow tables, production in 1,000 Rs

Year	1995	1996	1997	1998	1999	2000
Total cash inflow . .	584102.800	359498.800	446884.000	446040.000	446040.000	446040.000
Financial resources .	364752.700	1758.600	843.971	0.000	0.000	0.000
Sales, net of tax . .	219350.000	357740.200	446040.000	446040.000	446040.000	446040.000
Total cash outflow . .	584102.600	232122.800	230659.000	218840.800	208008.600	197176.400
Total assets	466100.100	2071.326	936.137	0.000	0.000	0.000
Operating costs . . .	40231.940	61551.310	72004.910	72004.910	72004.910	72004.910
Cost of finance . . .	75770.570	108321.500	97489.370	86657.220	75825.070	64992.910
Repayment	0.000	60178.630	60178.630	60178.630	60178.630	60178.630
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	0.125	127376.000	216225.000	227199.300	238031.400	248863.600
Cumulated cash balance	0.141	127376.100	343601.100	570800.400	808831.800	1057695.000
Inflow, local	584102.800	359498.800	446884.000	446040.000	446040.000	446040.000
Outflow, local	584102.600	232122.800	230659.000	218840.800	208008.600	197176.400
Surplus (deficit) .	0.125	127376.000	216225.000	227199.300	238031.400	248863.600
Inflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	0.000	0.000	0.000	0.000	0.000	0.000
Net cashflow	-285906.700	295876.100	373893.000	374035.100	374035.100	374035.100
Cumulated net cashflow	-504405.800	-208529.700	165363.300	539398.400	913433.600	1287469.000

Cashflow tables, production in 1,000 Rs

Year	2001	2002	2003	2004	2005	2006
Total cash inflow	446040.000	446040.000	446040.000	446040.000	446040.000	446040.000
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	446040.000	446040.000	446040.000	446040.000	446040.000	446040.000
Total cash outflow	186344.300	175512.100	164680.000	153847.800	143015.700	72004.910
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs	72004.910	72004.910	72004.910	72004.910	72004.910	72004.910
Cost of finance	54160.760	43328.610	32496.460	21664.300	10832.150	0.000
Repayment	60178.630	60178.630	60178.630	60178.630	60178.630	0.000
Corporate tax	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	259695.700	270527.900	281360.100	292192.200	303024.300	374035.100
Cumulated cash balance	1317391.000	1587919.000	1869279.000	2161471.000	2464496.000	2838531.000
Inflow, local	446040.000	446040.000	446040.000	446040.000	446040.000	446040.000
Outflow, local	186344.300	175512.100	164680.000	153847.800	143015.700	72004.910
Surplus (deficit)	259695.700	270527.900	281360.100	292192.200	303024.300	374035.100
Inflow, foreign	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	0.000	0.000	0.000	0.000	0.000	0.000
Net cashflow	374035.100	374035.100	374035.100	374035.100	374035.100	374035.100
Cumulated net cashflow	1661504.000	2035539.000	2409574.000	2783609.000	3157644.000	3531679.000

Cashflow tables, production in 1,000 Rs

Year	2007	2008	2009
Total cash inflow . .	446040.000	446040.000	446040.000
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	446040.000	446040.000	446040.000
Total cash outflow . .	72004.910	72004.910	72004.910
Total assets	0.000	0.000	0.000
Operating costs . . .	72004.910	72004.910	72004.910
Cost of finance . . .	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	374035.100	374035.100	374035.100
Cumulated cash balance	3223398.000	3597433.000	3971468.000
Inflow, local	446040.000	446040.000	446040.000
Outflow, local	72004.910	72004.910	72004.910
Surplus (deficit) .	374035.100	374035.100	374035.100
Inflow, foreign . . .	0.000	0.000	0.000
Outflow, foreign . . .	0.000	0.000	0.000
Surplus (deficit) .	0.000	0.000	0.000
Net cashflow	374035.100	374035.100	374035.100
Cumulated net cashflow	3905714.000	4279749.000	4653784.000

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value .....1303143.00 at 15.00 %
Internal Rate of Return (IRRE1) .. not found

b) Net Worth versus Net cash return:

Net present value .....1239726.00 at 15.00 %
Internal Rate of Return (IRRE2) .. not found

c) Internal Rate of Return on total investment:

Net present value .....1345709.00 at 15.00 %
Internal Rate of Return (IRR) .. 55.26 %

Net Worth = Equity paid plus reserves

Net Income Statement in 1,000 Rs

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	219350.000	357740.200	446040.000	446040.000	446040.000
Less: variable costs, incl. sales tax.	22123.140	42929.440	53383.040	53383.040	53383.040
Variable margin	197226.900	314810.700	392657.000	392657.000	392657.000
As % of total sales	89.914	88.000	88.032	88.032	88.032
Non-variable costs, incl. depreciation	33033.020	83444.170	83444.160	83444.140	83444.140
Operational margin	164193.800	231366.500	309212.800	309212.900	309212.900
As % of total sales	74.855	64.674	69.324	69.324	69.324
Cost of finance	75770.570	108321.500	97489.370	86657.220	75825.070
Gross profit	88423.270	123045.000	211723.500	222555.600	233387.800
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	88423.270	123045.000	211723.500	222555.600	233387.800
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	88423.270	123045.000	211723.500	222555.600	233387.800
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	88423.270	123045.000	211723.500	222555.600	233387.800
Accumulated undistributed profit	88423.270	211468.300	423191.800	645747.400	879135.100
Gross profit, % of total sales	40.311	34.395	47.467	49.896	52.324
Net profit, % of total sales	40.311	34.395	47.467	49.896	52.324
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	24.022	33.834	45.208	45.208	45.208

Net Income Statement in 1,000 Rs

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	446040.000	446040.000	446040.000	446040.000	446040.000
Less: variable costs, incl. sales tax.	53383.040	53383.040	53383.040	53383.040	53383.040
Variable margin	392657.000	392657.000	392657.000	392657.000	392657.000
As % of total sales	88.032	88.032	88.032	88.032	88.032
Non-variable costs, incl. depreciation	83444.140	83444.140	83444.140	83444.140	69466.210
Operational margin	309212.900	309212.900	309212.900	309212.900	323190.800
As % of total sales	69.324	69.324	69.324	69.324	72.458
Cost of finance	64992.910	54160.760	43328.610	32496.460	21664.300
Gross profit	244219.900	255052.100	265884.300	276716.400	301526.500
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	244219.900	255052.100	265884.300	276716.400	301526.500
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	244219.900	255052.100	265884.300	276716.400	301526.500
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	244219.900	255052.100	265884.300	276716.400	301526.500
Accumulated undistributed profit	1123355.000	1378407.000	1644291.000	1921008.000	2222534.000
Gross profit, % of total sales	54.753	57.181	59.610	62.038	67.601
Net profit, % of total sales	54.753	57.181	59.610	62.038	67.601
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	45.208	45.208	45.208	45.208	47.252

Net Income Statement in 1,000 Rs

Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	446040.000	446040.000	446040.000	446040.000	446040.000
Less: variable costs, incl. sales tax.	53383.040	53383.040	53383.040	53383.040	53383.040
Variable margin	392657.000	392657.000	392657.000	392657.000	392657.000
As % of total sales	88.032	88.032	88.032	88.032	88.032
Non-variable costs, incl. depreciation	19568.080	19568.080	19568.080	19568.080	19568.090
Operational margin	373088.900	373088.900	373088.900	373088.900	373088.900
As % of total sales	83.645	83.645	83.645	83.645	83.645
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	373088.900	373088.900	373088.900	373088.900	373088.900
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	373088.900	373088.900	373088.900	373088.900	373088.900
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	373088.900	373088.900	373088.900	373088.900	373088.900
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	373088.900	373088.900	373088.900	373088.900	373088.900
Accumulated undistributed profit	2595623.000	2968712.000	3341801.000	3714890.000	4087979.000
Gross profit, % of total sales	83.645	83.645	83.645	83.645	83.645
Net profit, % of total sales	83.645	83.645	83.645	83.645	83.645
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	54.547	54.547	54.547	54.547	54.547

Projected Balance Sheets, construction in 1,000 Rs

Year	1994
Total assets	240109.000
Fixed assets, net of depreciation	0.000
Construction in progress	240108.900
Current assets	0.000
Cash, bank	0.000
Cash surplus, finance available	0.016
Loss carried forward	0.000
Loss	0.000
Total liabilities	240109.000
Equity capital	0.000
Reserves, retained profit	0.000
Profit	0.000
Long and medium term debt	240109.000
Current liabilities	0.000
Bank overdraft, finance required.	0.000
Total debt	240109.000
Equity, % of liabilities	0.000

Projected Balance Sheets, Production in 1,000 Rs

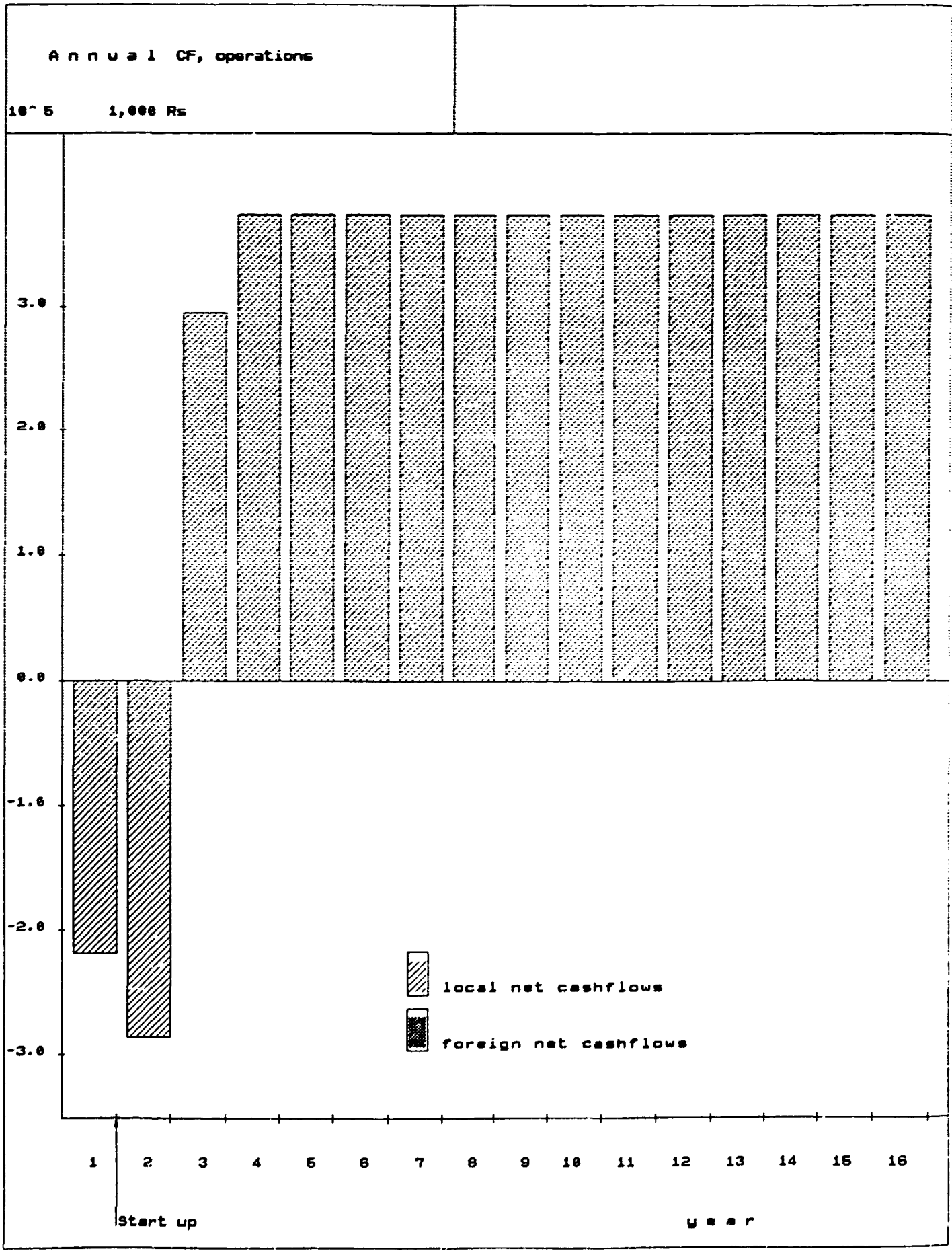
Year	1995	1996	1997	1998	1999
Total assets	693284.900	757909.900	910298.800	1072676.000	1245885.000
Fixed assets, net of depreciation	225184.700	624768.200	559945.900	495123.600	430301.300
Construction in progress	464405.800	0.000	0.000	0.000	0.000
Current assets	3694.385	5765.711	6751.849	6751.849	6751.849
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	0.063	127376.100	343601.000	570800.300	808831.800
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	693284.900	757909.900	910298.800	1072676.000	1245885.000
Equity capital	0.000	0.000	0.000	0.000	0.000
Reserves, retained profit	0.000	88423.270	211468.300	423191.800	645747.400
Profit	88423.270	123045.000	211723.500	222555.600	233387.800
Long and medium term debt	601766.300	541607.600	481429.000	421250.400	361071.800
Current liabilities	3075.417	4834.017	5677.988	5677.988	5677.988
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	604861.700	546441.600	487107.000	426928.400	366749.800
Equity, % of liabilities	0.000	0.000	0.000	0.000	0.000

Projected Balance Sheets, Production in 1,000 Rs

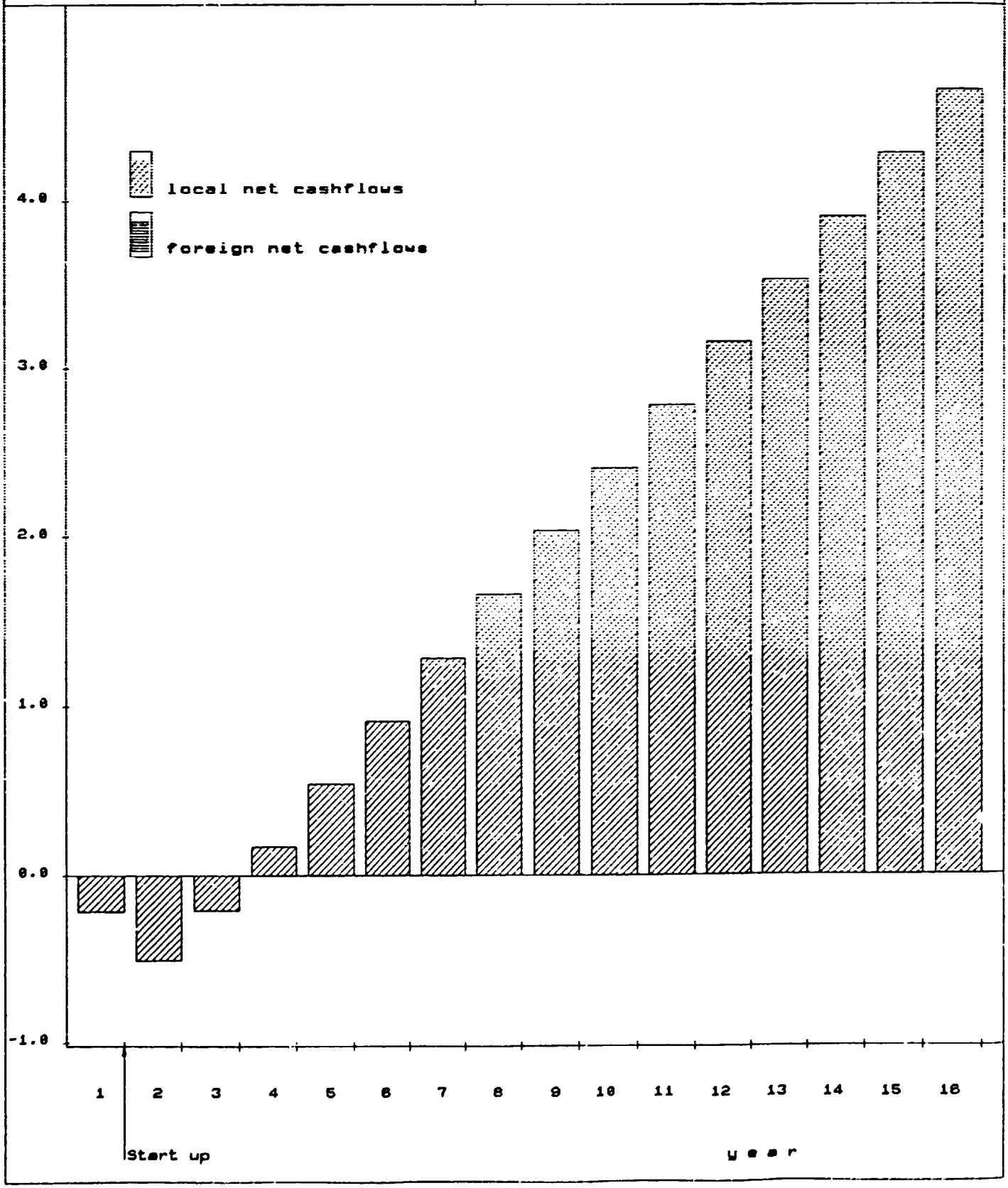
Year	2000	2001	2002	2003	2004
Total assets	1429926.000	1624800.000	1830505.000	2047043.000	2268391.000
Fixed assets, net of depreciation	365479.000	300656.800	235834.500	171012.200	120167.800
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	6751.849	6751.849	6751.849	6751.849	6751.849
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	1057695.000	1317391.000	1587919.000	1869279.000	2161471.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	1429926.000	1624800.000	1830505.000	2047043.000	2268391.000
Equity capital	0.000	0.000	0.000	0.000	0.000
Reserves, retained profit	879135.100	1123355.000	1378407.000	1644291.000	1921008.000
Profit	244219.900	255052.100	265884.300	276716.400	301526.500
Long and medium term debt	300893.100	240714.500	180535.900	120357.300	60178.630
Current liabilities	5677.966	5677.966	5677.966	5677.966	5677.966
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	306571.100	246392.500	186213.900	126035.200	65856.610
Equity, % of liabilities	0.000	0.000	0.000	0.000	0.000

Projected Balance Sheets, Production in 1,000 Rs

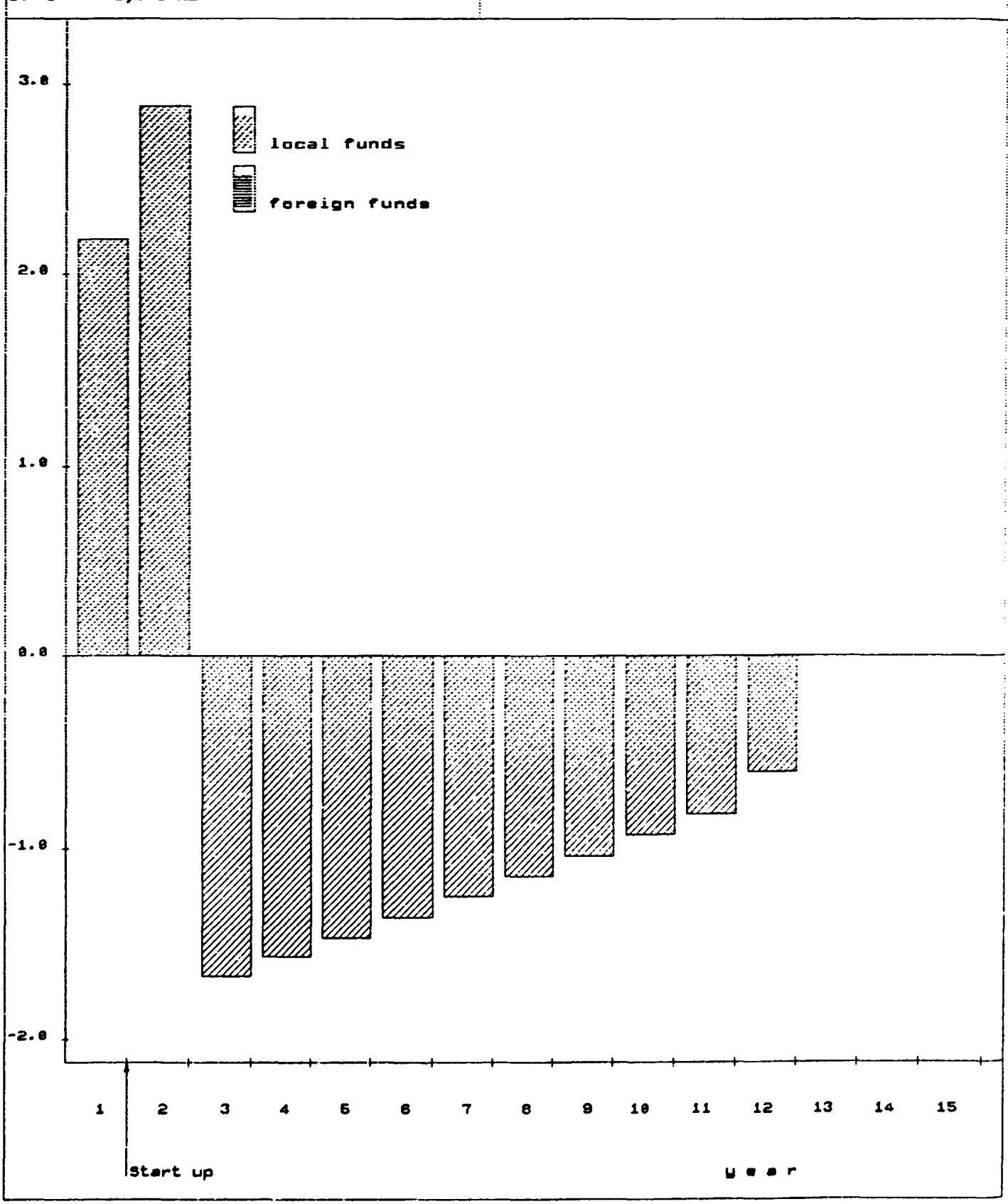
Year	2005	2006	2007	2008	2009
Total assets	2601301.000	2974390.000	3347479.000	3720568.000	4093657.000
Fixed assets, net of depreciation	119221.600	118275.400	117329.200	116382.900	115436.700
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	6751.849	6751.849	6751.849	6751.849	6751.849
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	2475328.000	2849363.000	3223398.000	3597434.000	3971469.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	2601301.000	2974390.000	3347479.000	3720568.000	4093657.000
Equity capital	0.000	0.000	0.000	0.000	0.000
Reserves, retained profit	2222534.000	2595623.000	2968712.000	3341801.000	3714890.000
Profit	373086.900	373086.900	373088.900	373088.900	373088.900
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	5677.988	5677.988	5677.988	5677.988	5677.988
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	5677.988	5677.988	5677.988	5677.988	5677.988
Equity, % of liabilities	0.000	0.000	0.000	0.000	0.000

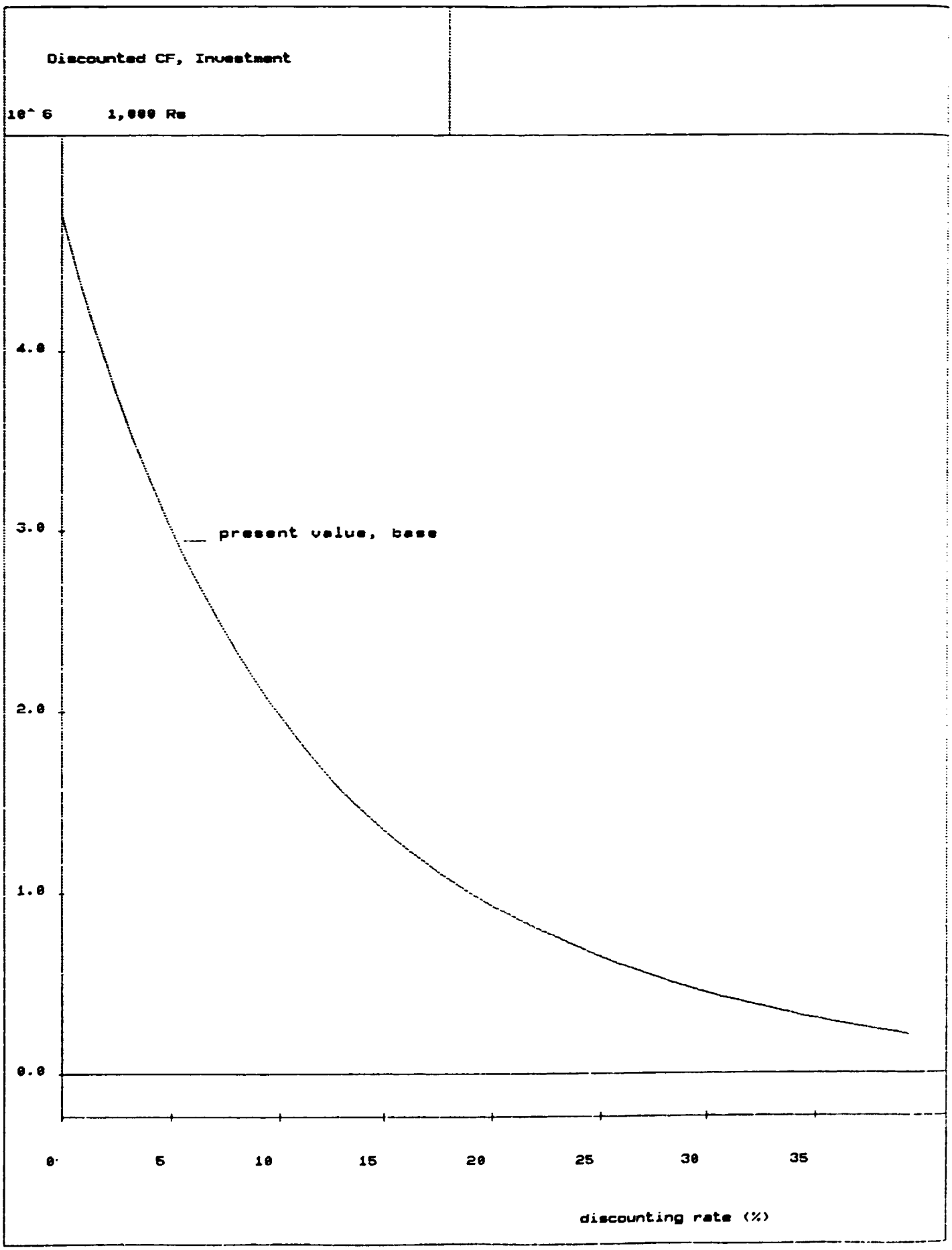

A n n u a l CF, operations
10^ 5
1,000 Rs
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
local net cashflows
foreign net cashflows
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
y e a r

Accumulated CF, operations



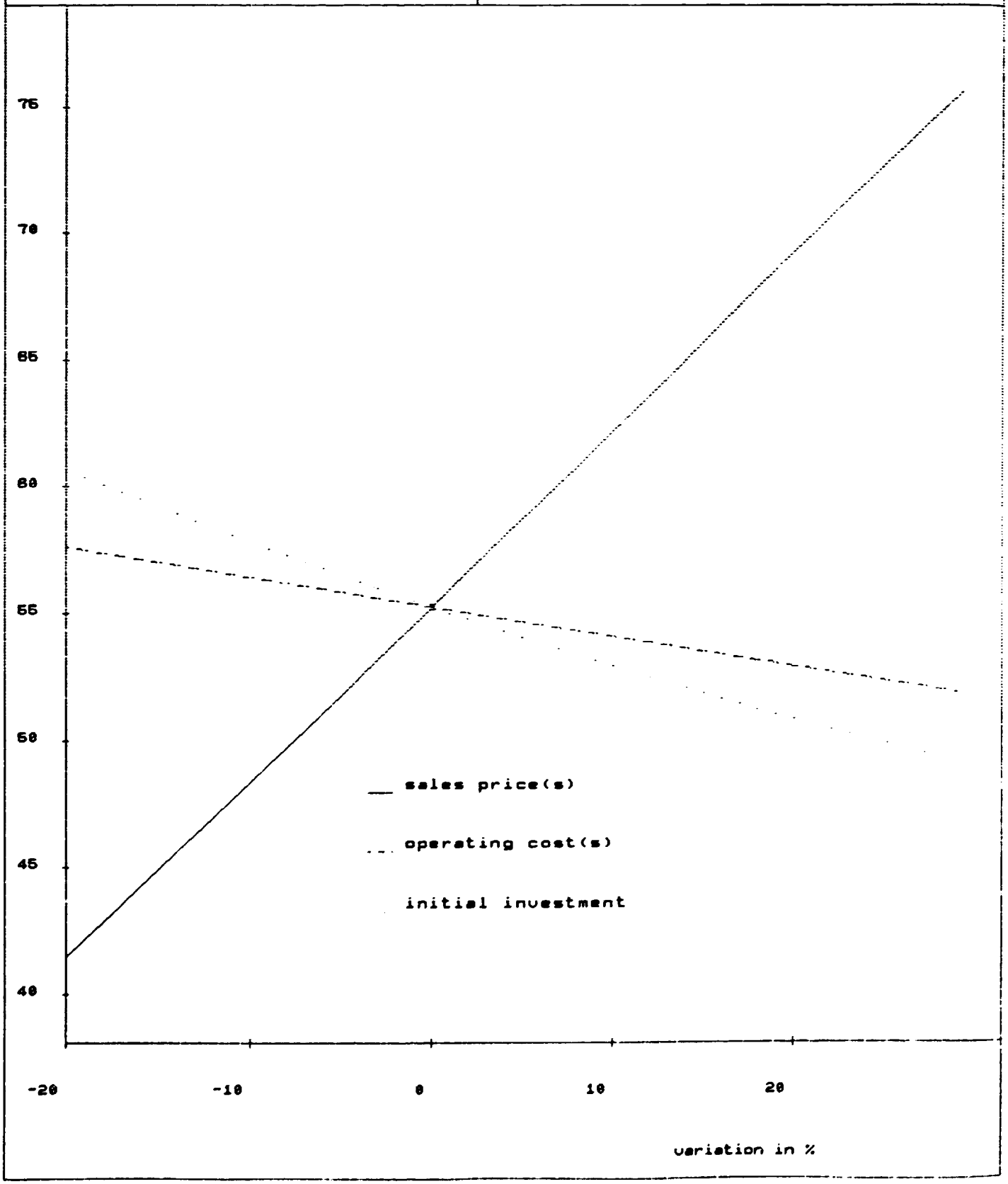
Annual flow of funds (finance)




Discounted CF, Investment
10^ 6
1,000 Rs
4.0
3.0
2.0
1.0
0.0
present value, base
0
5
10
15
20
25
30
35
discounting rate (%)

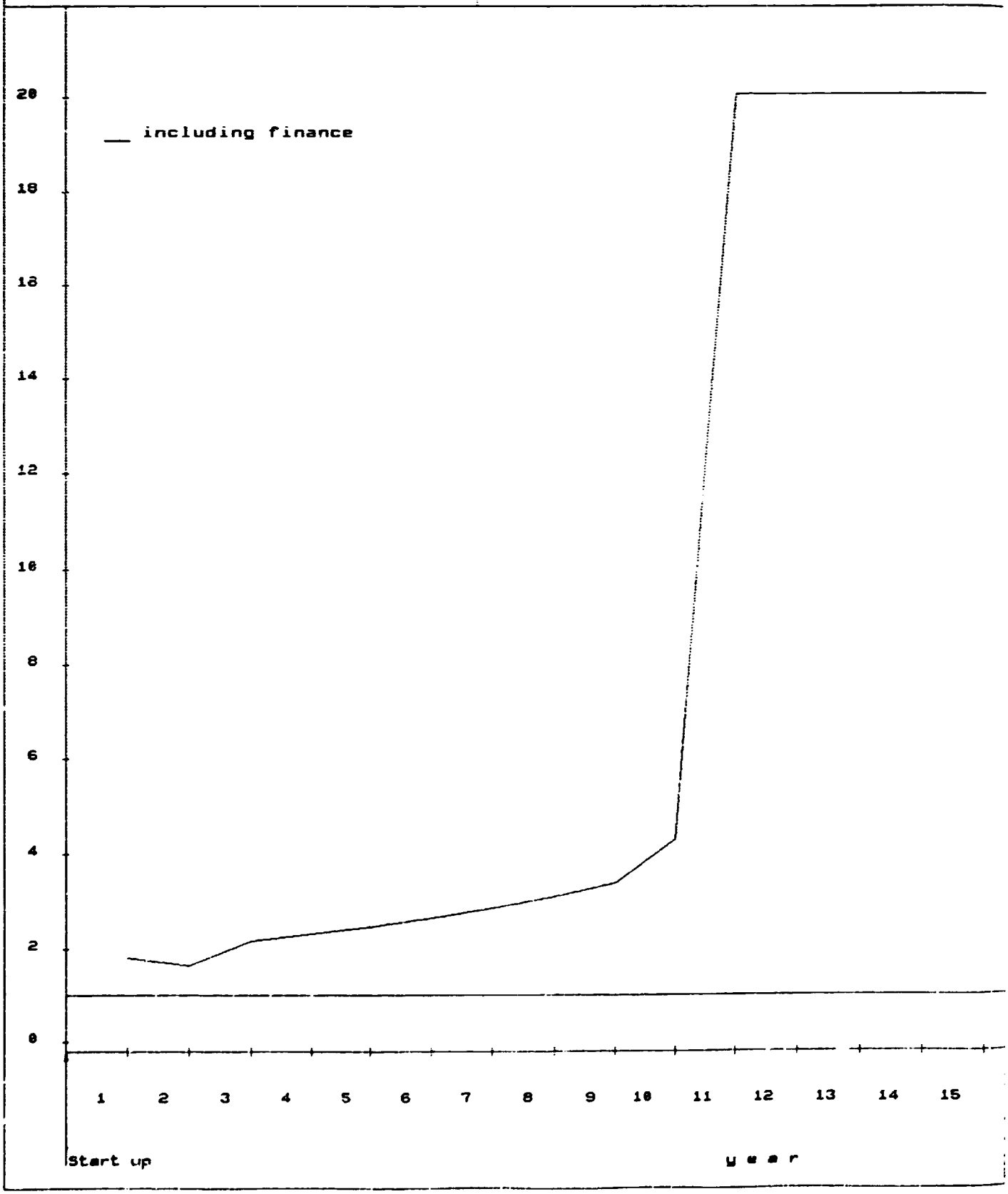
Sensitivity of IRR

internal rate of return



Fixed Costs Coverage Ratio

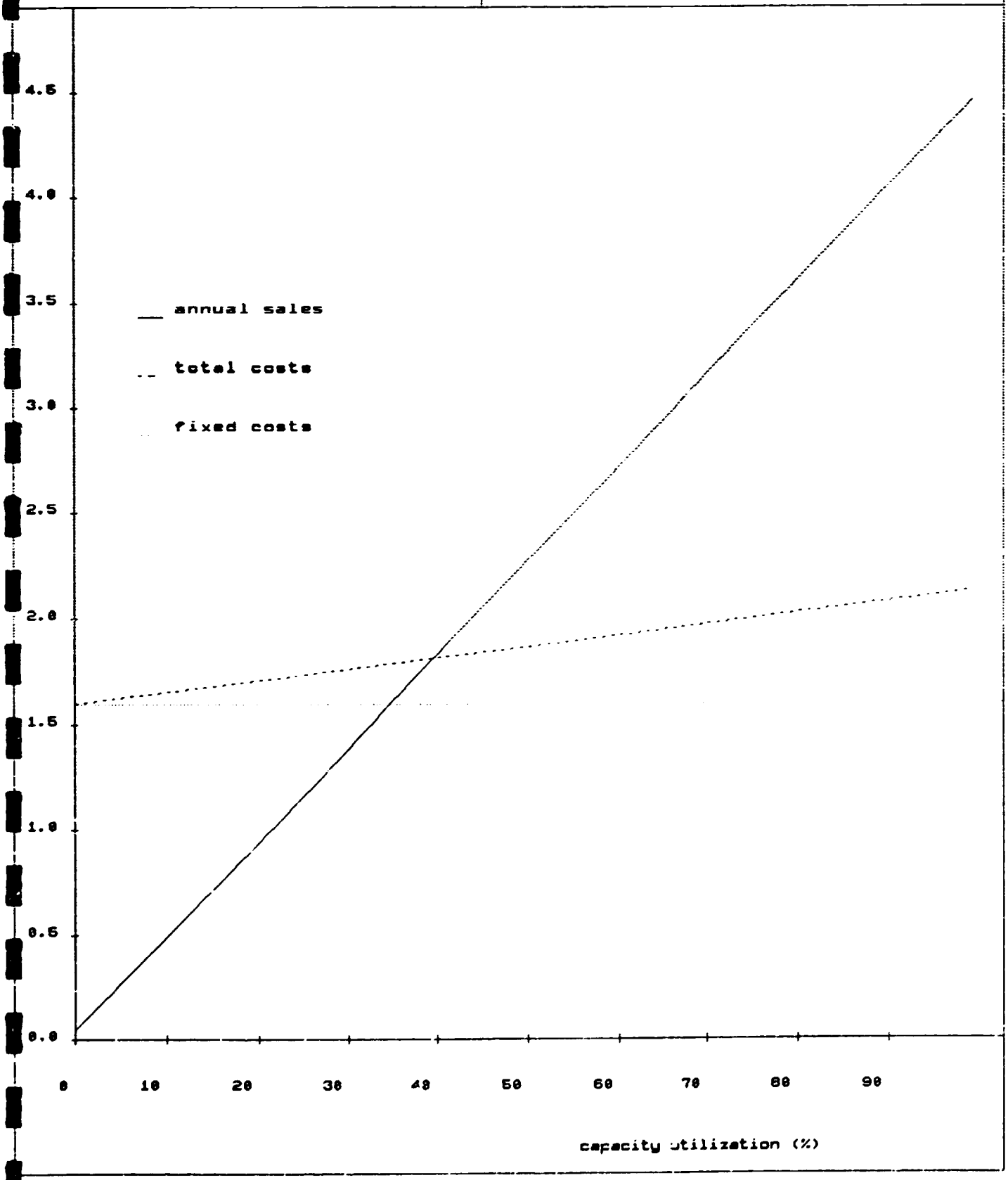
variable margin/fixed cost



Break even chart incl. finance

10^ 5 1,000 Rs

for 5th production year

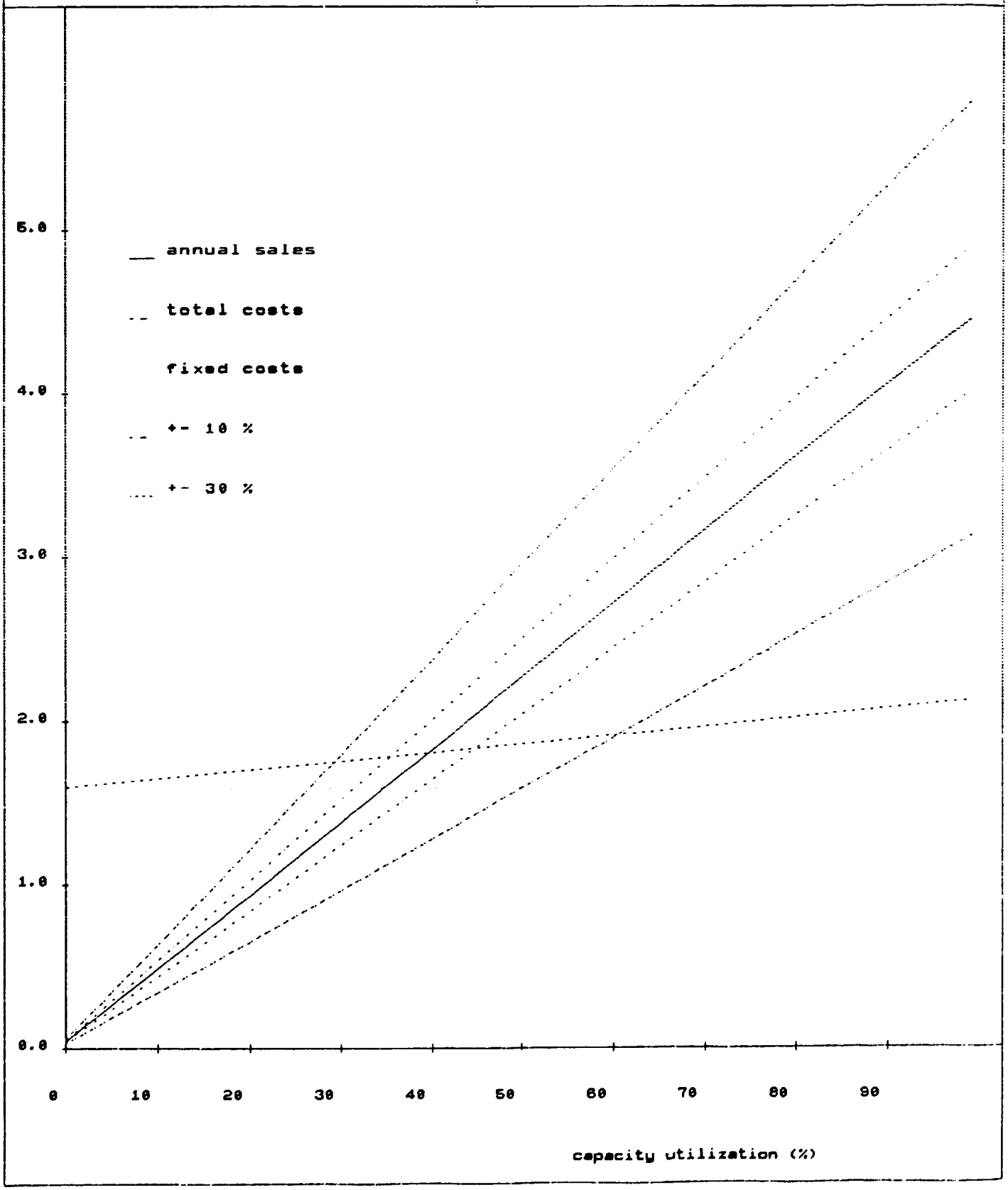


Break even chart incl. finance

variation of sales prices

10^ 6 1,000 Rs

for 6th production year

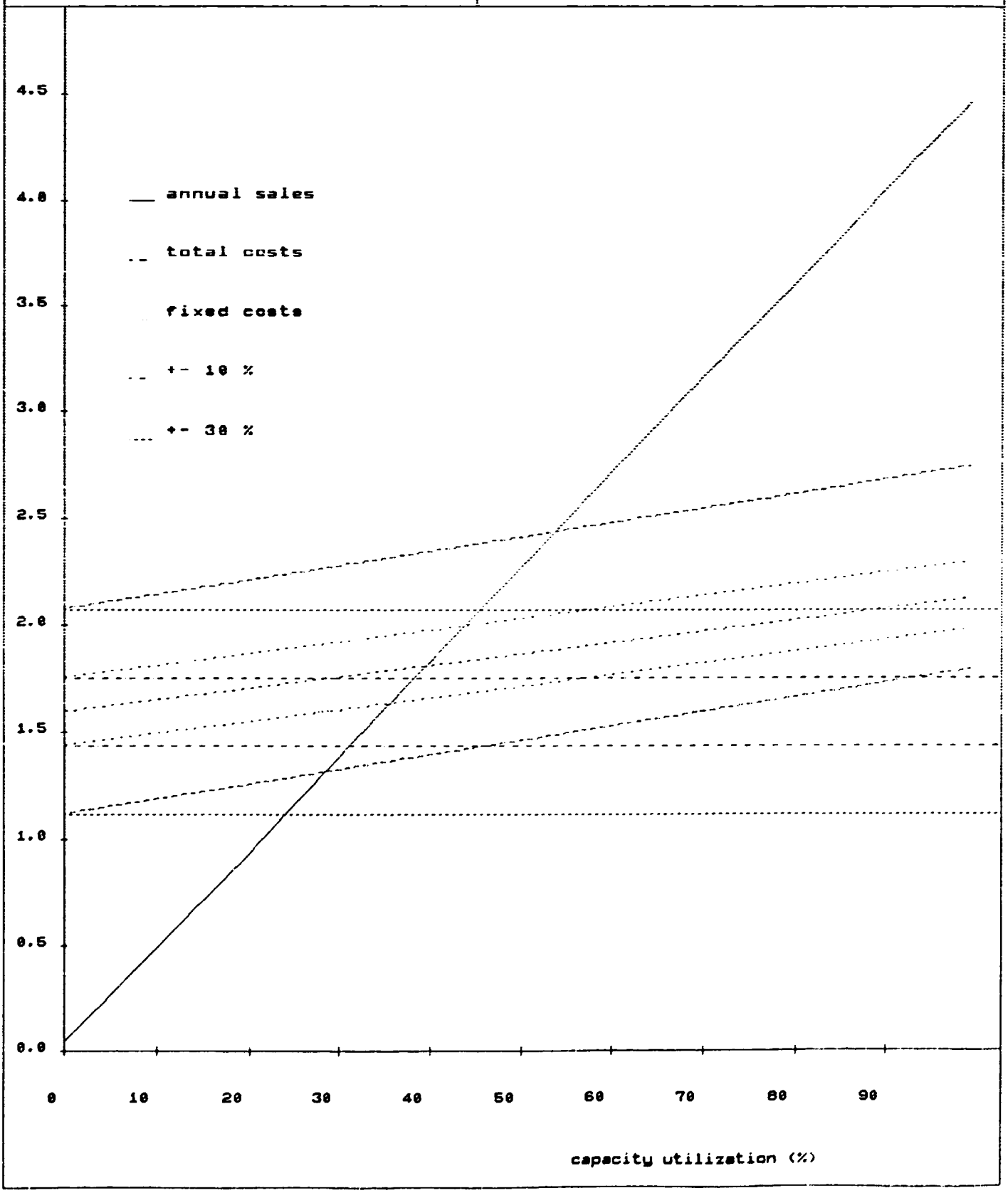


Break even chart incl. finance

variation of fixed costs

10^ 5 1,000 Rs

for 5th production year

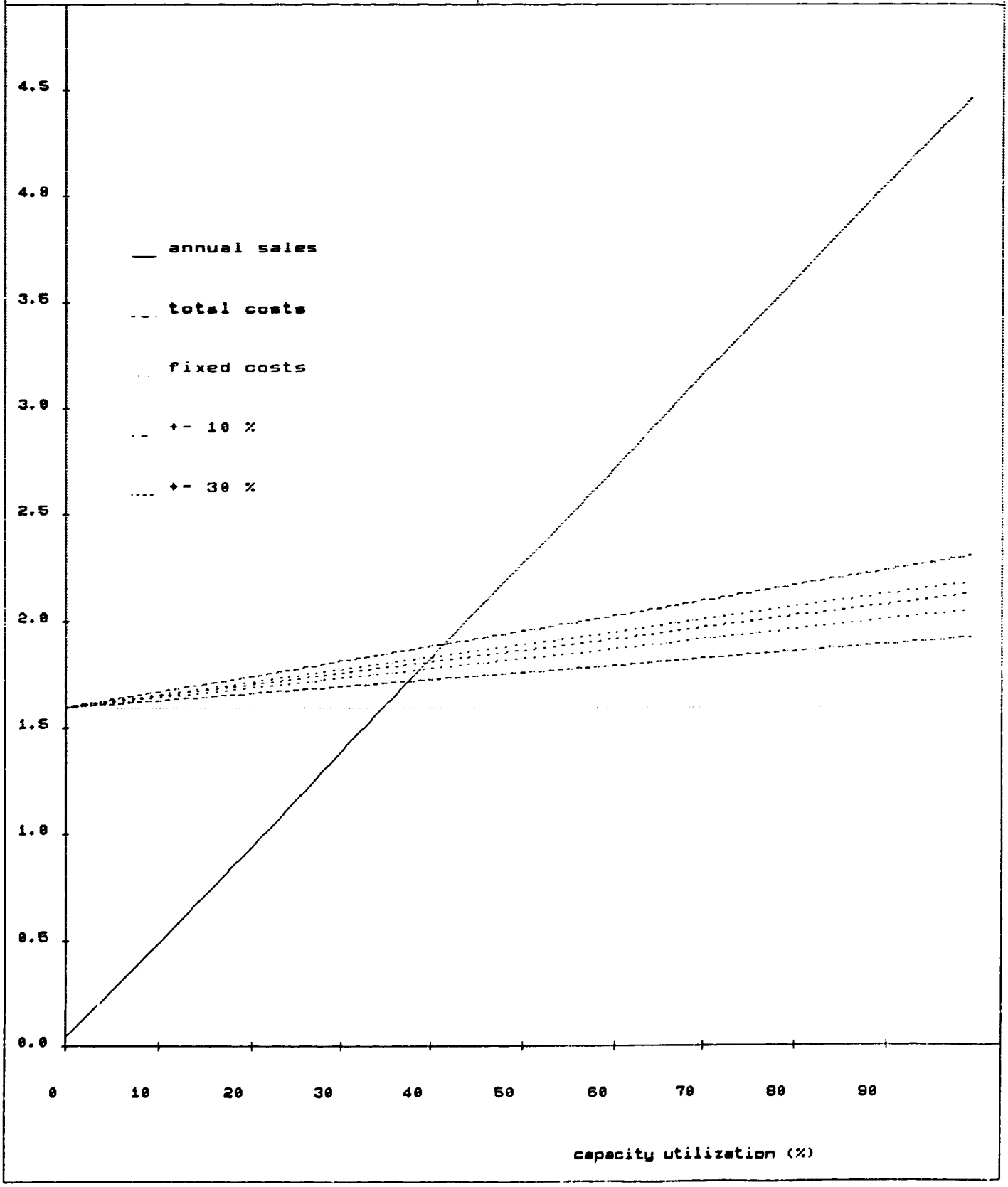


Break even chart incl. finance

variation of variable costs

10^ 5 1,000 Rs

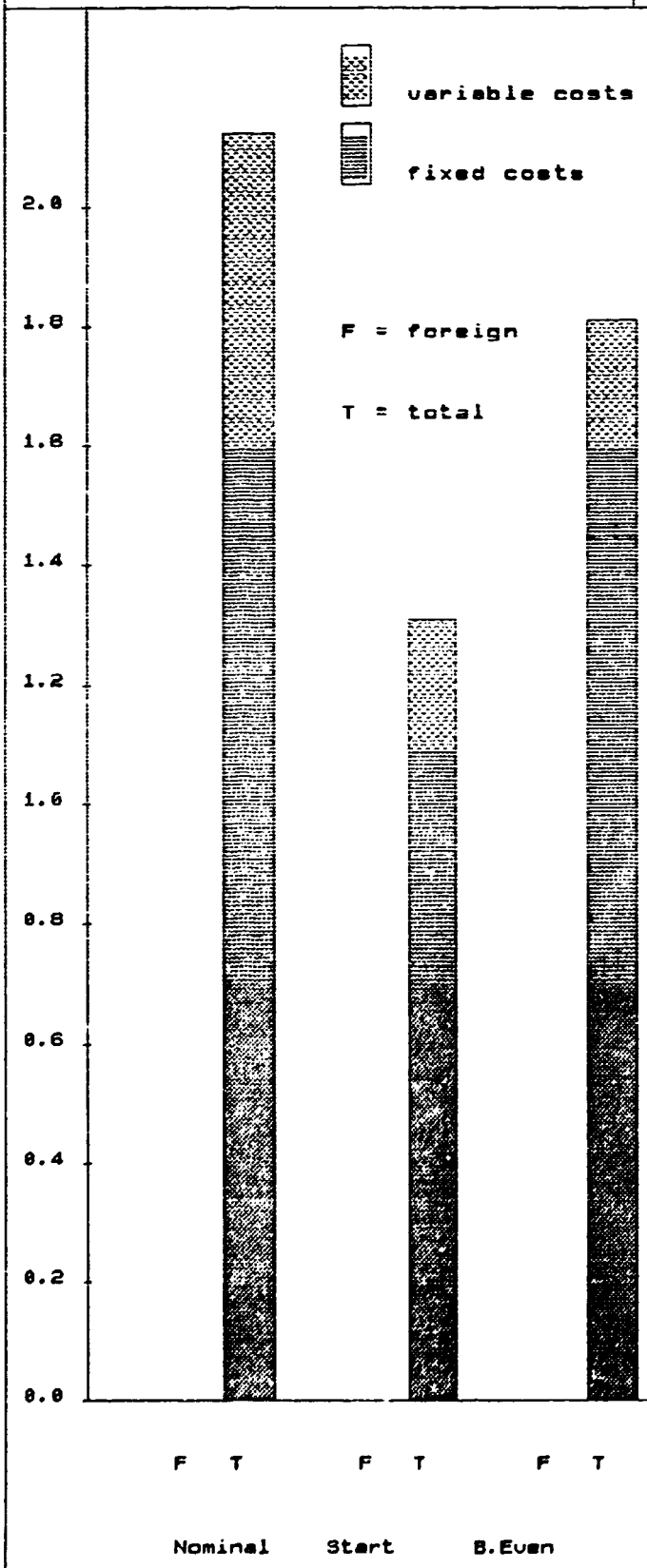
for 5th production year



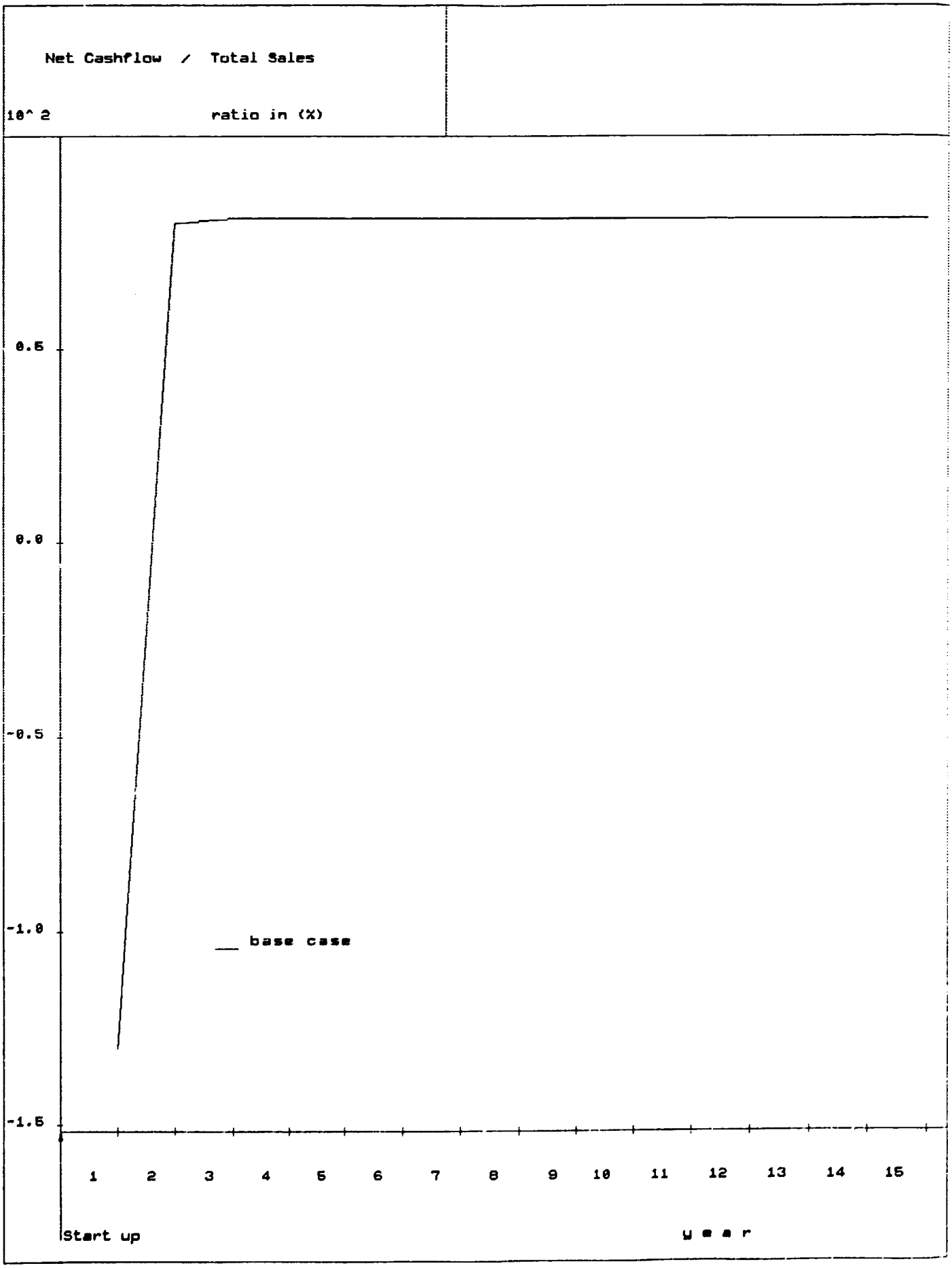
Structure of Production Costs

10^ 5 1,000 Rs

for 5th production year

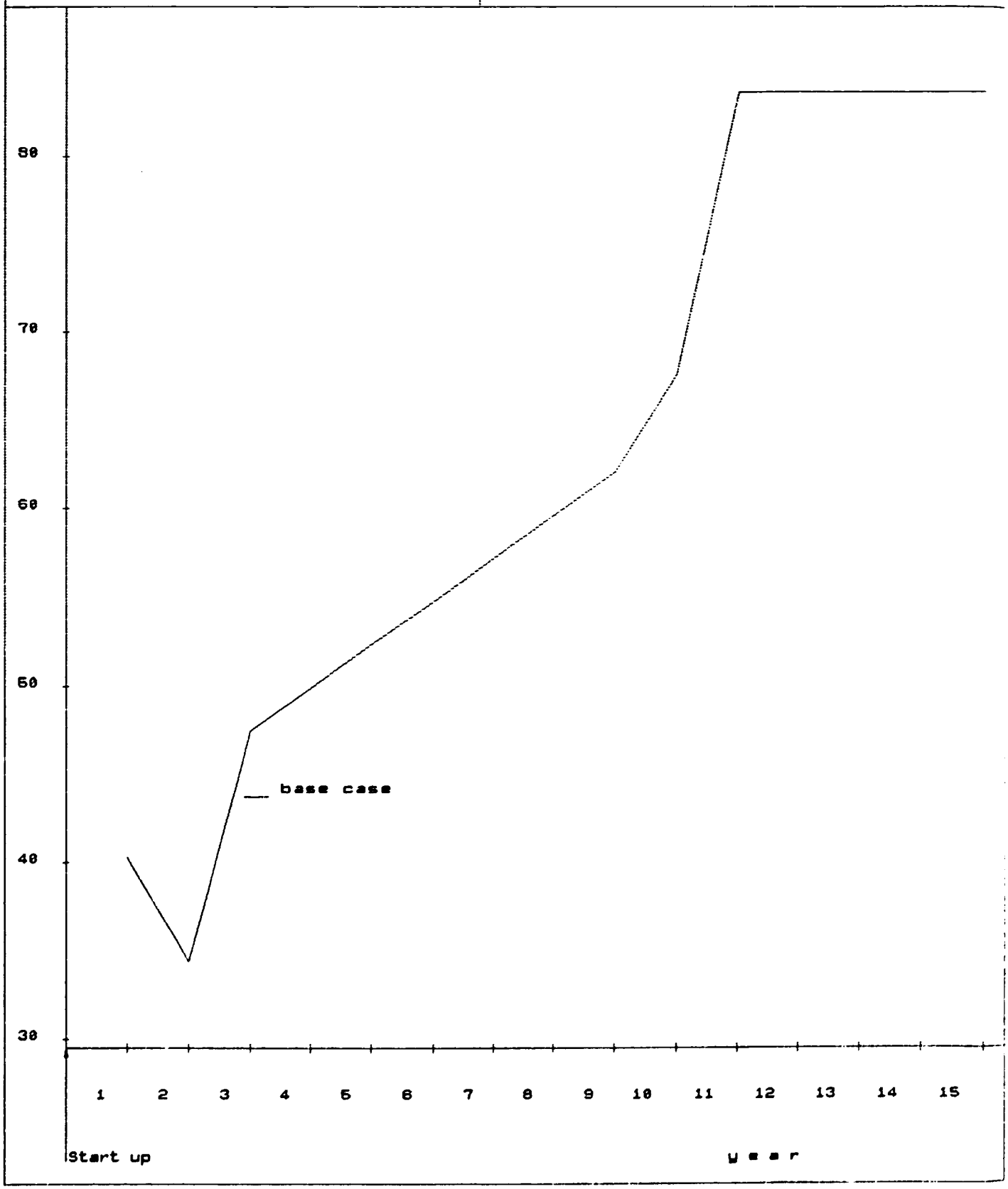


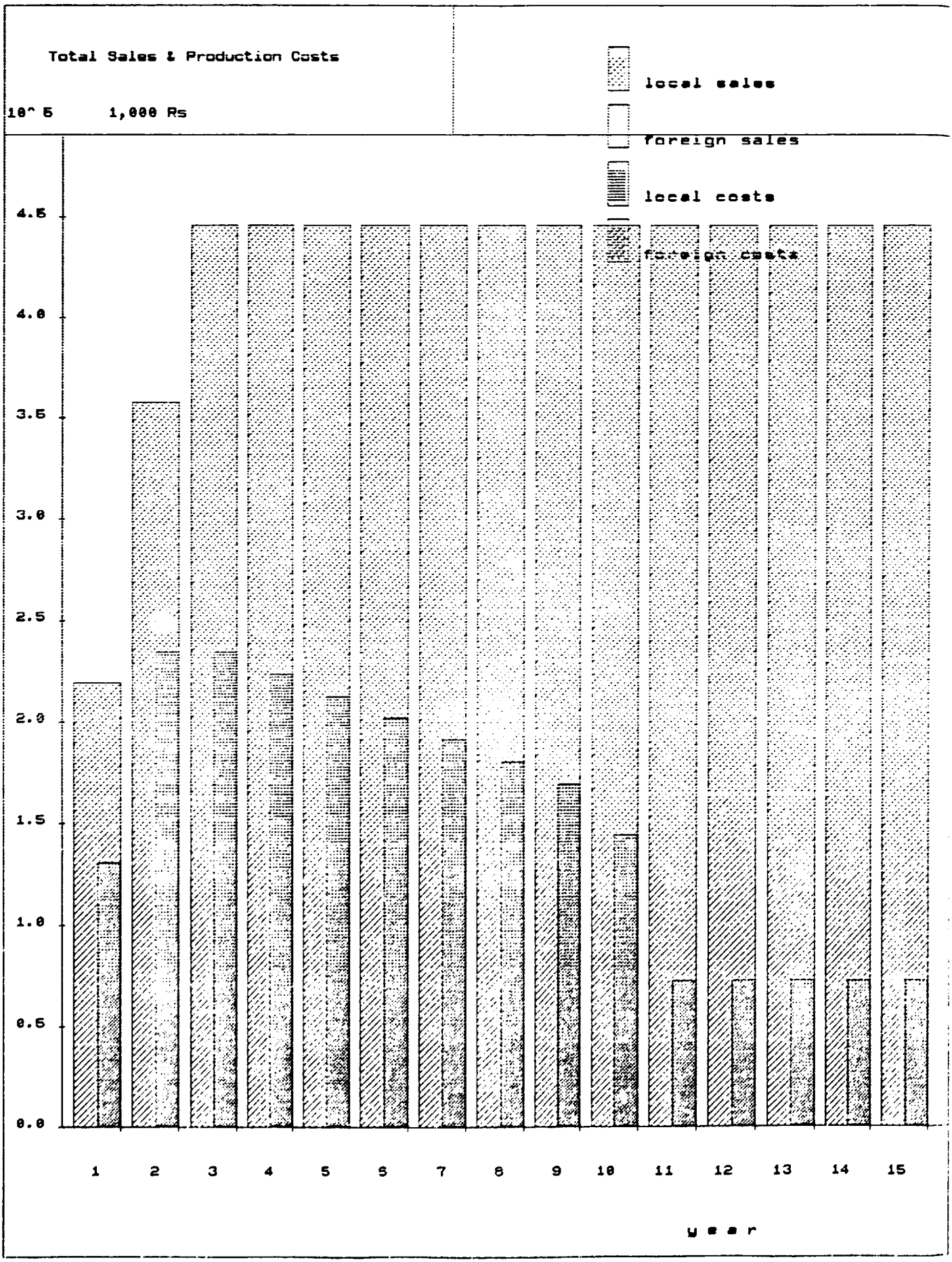
Nominal	Start up	
10.76	6.63	raw material
1.25	0.72	other RM
6.59	4.36	utilities
5.29	5.45	energy
4.39	6.34	labour
0.46	0.57	maintenance
1.07	1.39	spares
3.96	5.27	overheads
30.48	11.40	depreciation
35.66	57.87	interest
100.00	100.00	Total Prod C.


Net Cashflow / Total Sales
10^ 2
ratio in (%)
0.5
0.0
-0.5
-1.0
-1.5
base case
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Start up
year

Net Profit / Total Sales

ratio in (%)




Total Sales & Production Costs
10^ 5
1,000 Rs
local sales
foreign sales
local costs
foreign costs
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
year

4. COMFAR tables - BIDHANBAG

BALCO - SPA foils for capacitors BALBB1
13.9.1993 (loan only, no income tax)
Foil treatment in BBU, no SPA recycl.

1 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: 1,000 Rs

Total initial investment during construction phase

fixed assets:	240007.80	0.000 % foreign
current assets:	0.00	0.000 % foreign
total assets:	240007.80	0.000 % foreign

Source of funds during construction phase

equity & grants:	0.00	0.000 % foreign
foreign loans :	0.00	
local loans :	240007.90	
total funds :	240007.90	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	41865.01	63759.83	74597.05
depreciation :	14923.49	64821.58	64821.58
!nterest :	75906.53	108611.60	97750.47
production costs	132695.00	237193.00	237169.10
thereof foreign	0.00 %	0.00 %	0.00 %
total sales :	219350.00	357740.20	446040.00
gross income :	86654.97	120547.10	208870.90
net income :	86654.97	120547.10	208870.90
cash balance :	0.00	124738.60	213225.50
net cashflow :	-287483.60	293690.10	371315.80

Net Present Value at: 15.00 % = 1331825.00
Internal Rate of Return: 54.84 %
Return on equity1: not found
Return on equity2: not found

Index of Schedules produced by COMFAR

Total Initial Investment in 1,000 Rs

Year	1994
Fixed investment costs	
Land, site preparation, development	1068.440
Buildings and civil works	28150.780
Auxiliary and service facilities .	0.000
Incorporated fixed assets	25084.400
Plant machinery and equipment . . .	105010.000
Total fixed investment costs	159313.600
Pre-production capital expenditures.	80694.210
Net working capital	0.000
Total initial investment costs . . .	240007.800
Of it foreign, in %	0.000

Total Current Investment in 1,000 Rs

Year	1995	1996	1997
Fixed investment costs			
Land, site preparation, development	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000
Incorporated fixed assets	0.000	0.000	0.000
Plant, machinery and equipment	464405.800	0.000	0.000
Total fixed investment costs	464405.800	0.000	0.000
Preproduction capitals expenditures	0.000	0.000	0.000
Working capital	562.801	290.258	127.189
Total current investment costs	464968.600	290.258	127.189
Of it foreign, %	0.000	0.000	0.000

Total Production Costs in 1,000 Rs

Year	1995	1996	1997	1998	1999
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	8677.110	18425.880	22876.000	22876.000	22876.000
Other raw materials	946.670	2146.080	2660.867	2660.867	2660.867
Utilities	5702.339	11272.540	14016.710	14016.710	14016.710
Energy	9162.572	12996.480	15462.410	15462.410	15462.410
Labour, direct	8294.998	8693.678	8693.678	8693.678	8693.678
Repair, maintenance	751.762	904.282	971.299	971.299	971.299
Spares	1815.247	2113.597	2271.951	2271.951	2271.951
Factory overheads	3576.309	4287.474	4552.957	4552.957	4552.957
Factory costs	38927.010	60839.020	71505.880	71505.880	71505.880
Administrative overheads	2311.825	2412.527	2460.585	2460.585	2460.585
Indir. costs, sales and distribution	626.173	505.281	630.590	630.590	630.590
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	14923.490	64821.570	64821.570	64821.570	64821.570
Financial costs	75906.530	108611.600	97750.470	86889.310	76028.140
Total production costs	132695.000	237193.000	237169.100	226307.900	215446.800
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	0.000	0.000	0.000	0.000	0.000
Of it variable,%	17.395	18.746	23.317	24.436	25.668
Total labour	8756.697	9169.957	9179.678	9179.678	9179.678

Total Production Costs in 1,000 Rs

Year	2000	2001	2002	2003	2004
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	22876.000	22876.000	22876.000	22876.000	22876.000
Other raw materials	2660.867	2660.867	2660.867	2660.867	2660.867
Utilities	14016.710	14016.710	14016.710	14016.710	14016.710
Energy	15462.410	15462.410	15462.410	15462.410	15462.410
Labour, direct	8693.678	8693.678	8693.678	8693.678	8693.678
Repair, maintenance	971.299	971.299	971.299	971.299	971.299
Spares	2271.951	2271.951	2271.951	2271.951	2271.951
Factory overheads	4552.957	4552.957	4552.957	4552.957	4552.957
Factory costs	71505.880	71505.880	71505.880	71505.880	71505.880
Administrative overheads	2460.585	2460.585	2460.585	2460.585	2460.585
Indir. costs, sales and distribution	630.590	630.590	630.590	630.590	630.590
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	64821.570	64821.570	64821.570	64821.570	50843.540
Financial costs	65166.980	54305.810	43444.640	32583.480	21722.320
Total production costs	204585.600	193724.400	182863.300	172002.100	147162.900
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	0.000	0.000	0.000	0.000	0.000
Of it variable,%	27.031	28.546	30.242	32.151	37.578
Total labour	9179.678	9179.678	9179.678	9179.678	9179.678

Total Production Costs in 1,000 Rs

Year	2005- 8	2009
% of nom. capacity (single product).	0.000	0.000
Raw material 1	22876.000	22876.000
Other raw materials	2660.867	2660.867
Utilities	14016.710	14016.710
Energy	15462.410	15462.410
Labour, direct	8693.678	8693.678
Repair, maintenance	971.299	971.299
Spares	2271.951	2271.951
Factory overheads	4552.957	4552.957
Factory costs	71505.880	71505.880
Administrative overheads	2460.585	2460.585
Indir. costs, sales and distribution	630.590	630.590
Direct costs, sales and distribution	0.000	0.000
Depreciation	945.497	945.504
Financial costs	0.000	0.000
Total production costs	75542.550	75542.560
Costs per unit (single product)	0.000	0.000
Of it foreign, %	0.000	0.000
Of it variable,%	73.205	73.205
Total labour	9179.678	9179.678

Net Working Capital in 1,000 Rs

Year	mdc	coto	1995	1996	1997	1998-2009
Coverage						
Current assets &						
Accounts receivable	0	---	0.000	0.000	0.000	0.000
Inventory and materials	16	22.5	672.266	1419.219	1762.198	1762.198
Energy	0	---	0.000	0.000	0.000	0.000
Spares	180	2.0	907.624	1056.799	1135.976	1135.976
Work in progress	10	36.0	1081.306	1689.973	1986.274	1986.274
Finished products	10	36.0	1145.523	1756.987	2054.624	2054.624
Cash in hand	0	---	0.000	0.000	0.000	0.000
Total current assets			3806.719	5922.978	6939.072	6939.072
Current liabilities and						
Accounts payable	30	12.0	3243.918	5069.918	5958.823	5958.823
Net working capital			562.801	853.060	980.249	980.249
Increase in working capital			562.801	290.258	127.189	0.000
Net working capital, local			562.801	853.060	980.249	980.249
Net working capital, foreign			0.000	0.000	0.000	0.000

Note: mdc = minimum days of coverage ; coto = coefficient of turnover .

Source of Finance, construction in 1,000 Rs

Year	1994
Equity, ordinary ..	0.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	0.000
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	240007.900
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	240007.900
Current liabilities	0.000
Bank overdraft	0.000
Total funds	240007.900

Source of Finance, production in 1,000 Rs

Year	1995	1996	1997	1998-2004	2005
Equity, ordinary ..	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	0.000	0.000	0.000	0.000	0.000
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000
Loan A, local....	363390.100	-60339.800	-60339.800	-60339.800	-60339.750
Loan B, local....	0.000	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000	0.000
Total loan	363390.100	-60339.800	-60339.800	-60339.800	-60339.750
Current liabilities	3243.918	1826.001	868.904	0.000	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000
Total funds	366634.000	-58513.800	-59450.900	-60339.800	-60339.750

Cashflow Tables, construction in 1,000 Rs

Year	1994
Total cash inflow . .	240007.900
Financial resources .	240007.900
Sales, net of tax . .	0.000
Total cash outflow . .	240007.800
Total assets	218407.100
Operating costs . . .	0.000
Cost of finance . . .	21600.710
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	0.063
Cumulated cash balance	0.063
Inflow, local	240007.900
Outflow, local	240007.800
Surplus (deficit) .	0.063
Inflow, foreign . . .	0.000
Outflow, foreign . . .	0.000
Surplus (deficit) .	0.000
Net cashflow	-218407.100
Cumulated net cashflow	-218407.100

Cashflow tables, production in 1,000 Rs

Year	1995	1996	1997	1998	1999	2000
Total cash inflow . .	585984.000	359566.200	446928.900	446040.000	446040.000	446040.000
Financial resources .	366634.000	1826.001	886.904	0.000	0.000	0.000
Sales, net of tax . .	219350.000	357740.200	446040.000	446040.000	446040.000	446040.000
Total cash outflow . .	585984.100	234827.500	233703.400	221826.200	210965.000	200103.800
Total assets	468212.500	2116.260	1016.094	0.000	0.000	0.000
Operating costs . . .	41865.000	63759.840	74597.060	74597.060	74597.060	74597.060
Cost of finance . . .	75906.530	108611.600	97750.470	86889.310	76028.140	65166.980
Repayment	0.000	60339.800	60339.800	60339.800	60339.800	60339.800
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	-0.063	124738.600	213225.500	224213.900	235075.000	245936.200
Cumulated cash balance	0.000	124738.600	337964.100	562178.000	797253.000	1043189.000
Inflow, local	585984.000	359566.200	446928.900	446040.000	446040.000	446040.000
Outflow, local	585984.100	234827.500	233703.400	221826.200	210965.000	200103.800
Surplus (deficit) .	-0.063	124738.600	213225.500	224213.900	235075.000	245936.200
Inflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	0.000	0.000	0.000	0.000	0.000	0.000
Net cashflow	-287483.600	293690.100	371315.800	371443.000	371443.000	371443.000
Cumulated net cashflow	-505890.800	-212200.700	159115.100	530558.100	902001.000	1273444.000

Cashflow tables, production in 1,000 Rs

Year	2001	2002	2003	2004	2005	2006
Total cash inflow . .	446040.000	446040.000	446040.000	446040.000	446040.000	446040.000
Financial resources .	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax . .	446040.000	446040.000	446040.000	446040.000	446040.000	446040.000
Total cash outflow . .	189242.700	178381.500	167520.300	156659.200	145798.000	74597.060
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs . . .	74597.060	74597.060	74597.060	74597.060	74597.060	74597.060
Cost of finance . . .	54305.810	43444.640	32583.480	21722.320	10861.150	0.000
Repayment	60339.800	60339.800	60339.800	60339.800	60339.750	0.000
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	256797.400	267658.500	278519.700	289380.800	300242.100	371443.000
Cumulated cash balance	1299987.000	1567645.000	1846165.000	2135546.000	2435788.000	2807231.000
Inflow, local	446040.000	446040.000	446040.000	446040.000	446040.000	446040.000
Outflow, local	189242.700	178381.500	167520.300	156659.200	145798.000	74597.060
Surplus (deficit) .	256797.400	267658.500	278519.700	289380.800	300242.100	371443.000
Inflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	0.000	0.000	0.000	0.000	0.000	0.000
Net cashflow	371443.000	371443.000	371443.000	371443.000	371443.000	371443.000
Cumulated net cashflow	1644687.000	2016330.000	2387773.000	2759216.000	3130659.000	3502102.000

Cashflow tables, production in 1,000 Rs

Year	2007	2008	2009
Total cash inflow . .	446040.000	446040.000	446040.000
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	446040.000	446040.000	446040.000
Total cash outflow . .	74597.060	74597.060	74597.060
Total assets	0.000	0.000	0.000
Operating costs . . .	74597.060	74597.060	74597.060
Cost of finance . . .	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	371443.000	371443.000	371443.000
Cumulated cash balance	3169535.000	3560978.000	3932421.000
Inflow, local	446040.000	446040.000	446040.000
Outflow, local	74597.060	74597.060	74597.060
Surplus (deficit) .	371443.000	371443.000	371443.000
Inflow, foreign . . .	0.000	0.000	0.000
Outflow, foreign . . .	0.000	0.000	0.000
Surplus (deficit) .	0.000	0.000	0.000
Net cashflow	371443.000	371443.000	371443.000
Cumulated net cashflow	3873545.000	4244988.000	4616431.000

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value .....1288164.00 at 15.00 %

Internal Rate of Return (IRRE1) .. not found

b) Net Worth versus Net cash return:

Net present value .....1225586.00 at 15.00 %

Internal Rate of Return (IRRE2) .. not found

c) Internal Rate of Return on total investment:

Net present value .....1331825.00 at 15.00 %

Internal Rate of Return (IRR) .. 54.84 %

Net Worth = Equity paid plus reserves

Net Income Statement in 1,000 Rs

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	219350.000	357740.200	446040.000	446040.000	446040.000
Less: variable costs, incl. sales tax.	23082.210	44463.960	55301.180	55301.180	55301.180
Variable margin	196267.800	313276.200	390738.800	390738.800	390738.800
As % of total sales	89.477	87.571	87.602	87.602	87.602
Non-variable costs, incl. depreciation	33706.290	84117.450	84117.440	84117.440	84117.440
Operational margin	162561.500	229158.700	306621.400	306621.400	306621.400
As % of total sales	74.111	64.057	68.743	68.743	68.743
Cost of finance	75906.530	108611.600	97750.470	86689.310	76028.140
Gross profit	86654.970	120547.100	208870.900	219732.100	230593.300
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	86654.970	120547.100	208870.900	219732.100	230593.300
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	86654.970	120547.100	208870.900	219732.100	230593.300
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	86654.970	120547.100	208870.900	219732.100	230593.300
Accumulated undistributed profit	86654.970	207202.100	416073.000	635805.100	866398.400
Gross profit, % of total sales	39.505	33.697	46.828	49.263	51.698
Net profit, % of total sales	39.505	33.697	46.828	49.263	51.698
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	23.788	33.519	44.841	44.841	44.841

Net Income Statement in 1,000 Rs

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	446040.000	446040.000	446040.000	446040.000	446040.000
Less: variable costs, incl. sales tax.	55301.180	55301.180	55301.180	55301.180	55301.180
Variable margin	390738.800	390738.800	390738.800	390738.800	390738.800
As % of total sales	87.602	87.602	87.602	87.602	87.602
Non-variable costs, incl. depreciation	84117.440	84117.440	84117.440	84117.440	70139.400
Operational margin	306621.400	306621.400	306621.400	306621.400	320599.400
As % of total sales	68.743	68.743	68.743	68.743	71.877
Cost of finance	65166.980	54305.810	43444.640	32583.480	21722.320
Gross profit	241454.400	252315.600	263176.800	274037.900	298877.100
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	241454.400	252315.600	263176.800	274037.900	298877.100
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	241454.400	252315.600	263176.800	274037.900	298877.100
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	241454.400	252315.600	263176.800	274037.900	298877.100
Accumulated undistributed profit	1107853.000	1360168.000	1623345.000	1897383.000	2196260.000
Gross profit, % of total sales	54.133	56.568	59.003	61.438	67.007
Net profit, % of total sales	54.133	56.568	59.003	61.438	67.007
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	44.841	44.841	44.841	44.841	46.885

Net Income Statement in 1,000 Rs

Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	446040.000	446040.000	446040.000	446040.000	446040.000
Less: variable costs, incl. sales tax.	55301.180	55301.180	55301.180	55301.180	55301.180
Variable margin	390738.800	390738.800	390738.800	390738.800	390738.800
As % of total sales	87.602	87.602	87.602	87.602	87.602
Non-variable costs, incl. depreciation	20241.360	20241.360	20241.360	20241.360	20241.360
Operational margin	370497.500	370497.500	370497.500	370497.500	370497.500
As % of total sales	83.064	83.064	83.064	83.064	83.064
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	370497.500	370497.500	370497.500	370497.500	370497.500
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	370497.500	370497.500	370497.500	370497.500	370497.500
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	370497.500	370497.500	370497.500	370497.500	370497.500
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	370497.500	370497.500	370497.500	370497.500	370497.500
Accumulated undistributed profit	2566758.000	2937255.000	3307753.000	3678250.000	4048748.000
Gross profit, % of total sales	83.064	83.064	83.064	83.064	83.064
Net profit, % of total sales	83.064	83.064	83.064	83.064	83.064
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	54.183	54.183	54.183	54.183	54.183

Projected Balance Sheets, construction in 1,000 Rs

Year	1994
Total assets	240007.900
Fixed assets, net of depreciation	0.000
Construction in progress	240007.800
Current assets	0.000
Cash, bank	0.000
Cash surplus, finance available	0.063
Loss carried forward	0.000
Loss	0.000
Total liabilities	240007.900
Equity capital	0.000
Reserves, retained profit	0.000
Profit	0.000
Long and medium term debt	240007.900
Current liabilities	0.000
Bank overdraft, finance required.	0.000
Total debt	240007.900
Equity, % of liabilities	0.000

Projected Balance Sheets, Production in 1,000 Rs

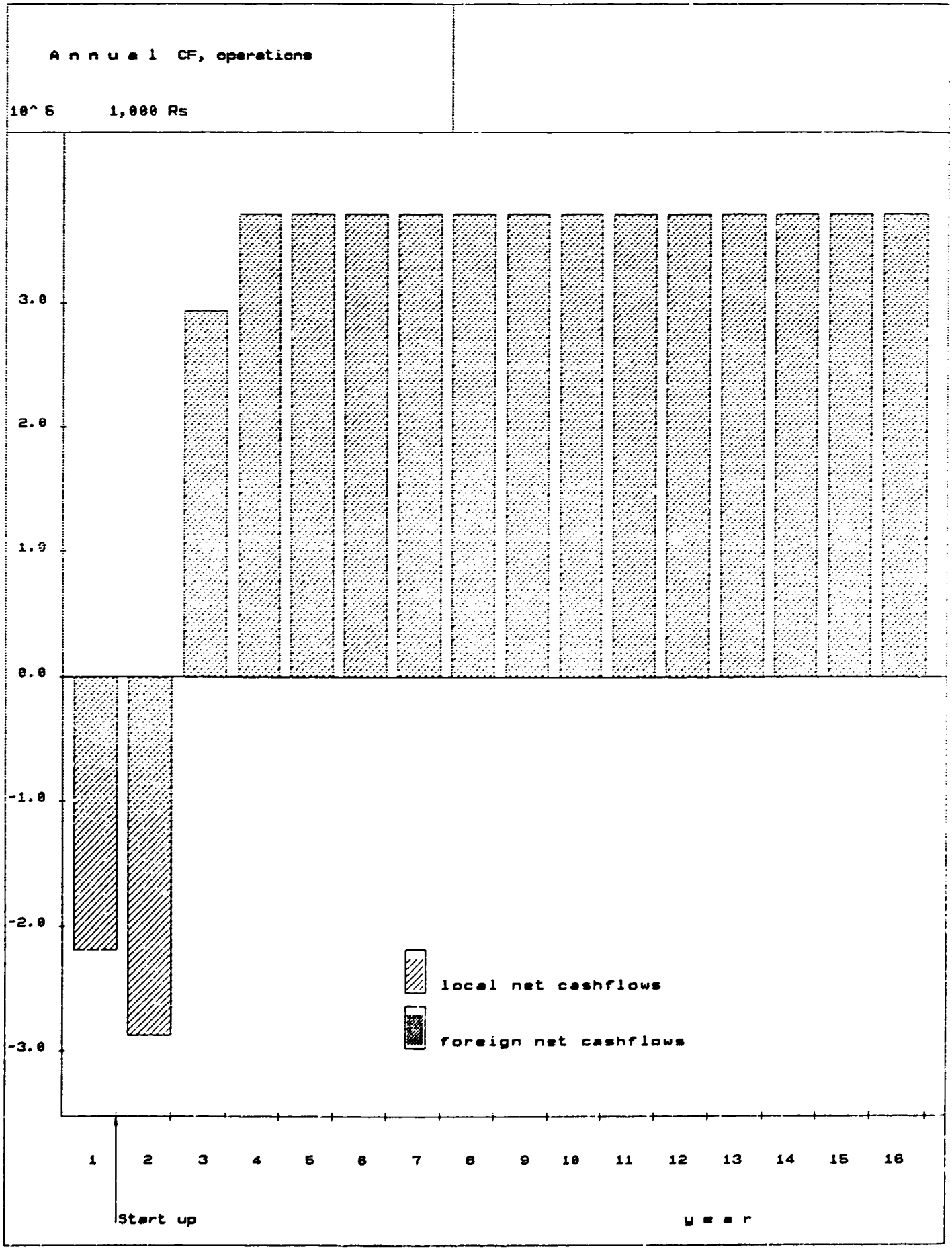
Year	1995	1996	1997	1998	1999
Total assets	693296.900	755330.200	904750.200	1064143.000	1234396.000
Fixed assets, net of depreciation	225084.400	624668.600	559847.100	495025.500	430203.900
Construction in progress	464405.800	0.000	0.000	0.000	0.000
Current assets	3806.719	5922.979	6939.072	6939.072	6939.072
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	0.000	124738.600	337964.100	562178.100	797253.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	693296.900	755330.200	904750.200	1064143.000	1234396.000
Equity capital	0.000	0.000	0.000	0.000	0.000
Reserves, retained profit	0.000	86654.970	207202.100	416073.000	635805.100
Profit	86654.970	120547.100	208870.900	219732.100	230593.300
Long and medium term debt	603398.000	543058.200	482718.400	422378.600	362038.800
Current liabilities	3243.918	5069.918	5958.823	5958.823	5958.823
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	606641.900	548128.100	488677.200	428337.400	367997.600
Equity, % of liabilities	0.000	0.000	0.000	0.000	0.000

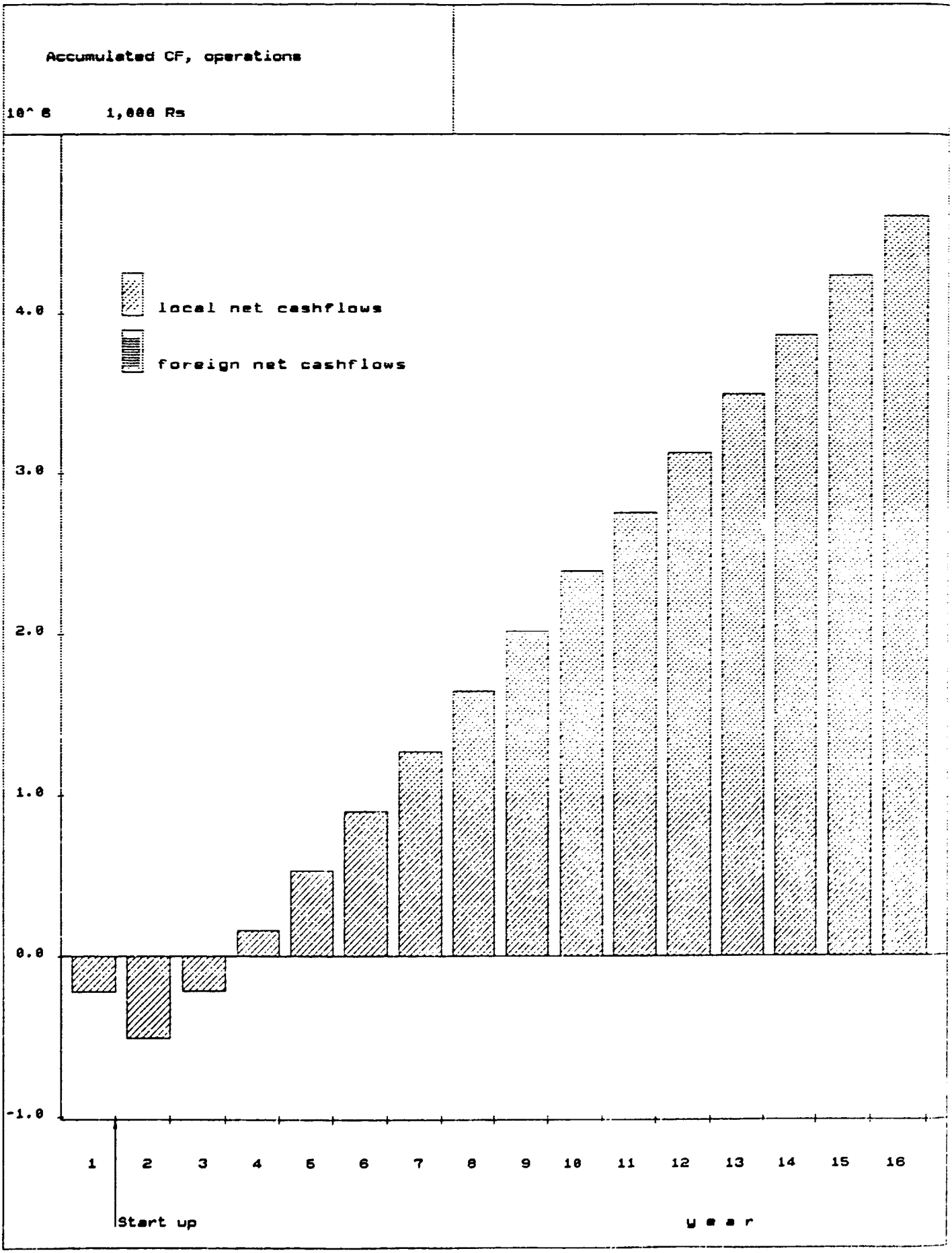
Projected Balance Sheets, Production in 1,000 Rs

Year	2000	2001	2002	2003	2004
Total assets	1415511.000	1607486.000	1810323.000	2024021.000	2262559.000
Fixed assets, net of depreciation	365382.400	300560.800	235739.200	170917.700	120074.100
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	6939.072	6939.072	6939.072	6939.072	6939.072
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	1043169.000	1299987.000	1567645.000	1846165.000	2135545.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	1415511.000	1607486.000	1810323.000	2024021.000	2262559.000
Equity capital	0.000	0.000	0.000	0.000	0.000
Reserves, retained profit	866398.400	1107853.000	1360168.000	1623345.000	1897383.000
Profit	241454.400	252315.600	263176.800	274037.900	298877.100
Long and medium term debt	301698.900	241359.100	181019.300	120679.500	60339.750
Current liabilities	5958.823	5958.823	5958.823	5958.823	5958.823
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	307657.800	247318.000	186978.200	126638.400	66298.570
Equity, % of liabilities	0.000	0.000	0.000	0.000	0.000

Projected Balance Sheets, Production in 1,000 Rs

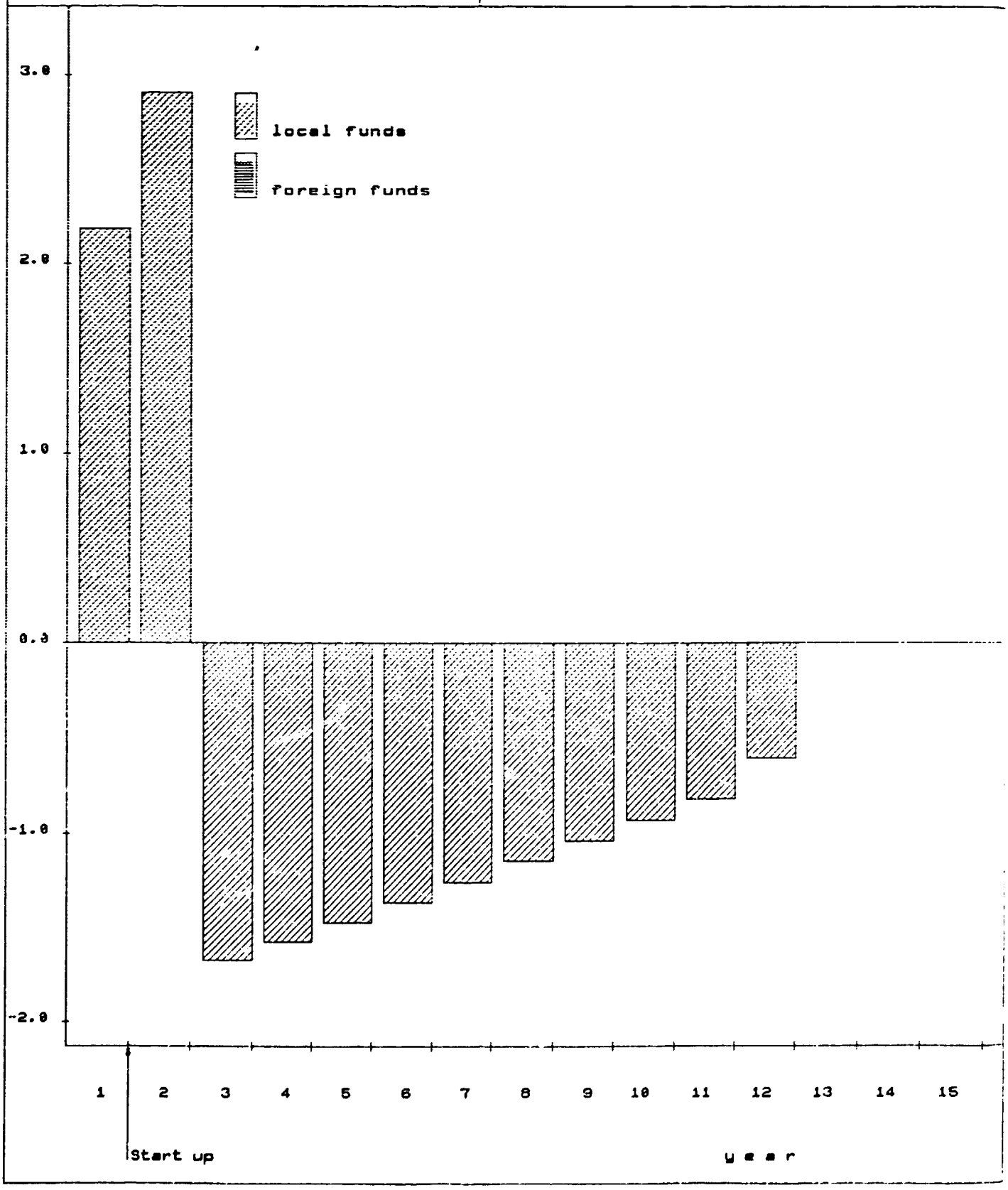
Year	2005	2006	2007	2008	2009
Total assets	2572716.000	2943214.000	3313711.000	3684209.000	4054706.000
Fixed assets, net of depreciation	119128.600	118183.100	117237.600	116292.100	115346.600
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	6939.072	6939.072	6939.072	6939.072	6939.072
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	2446649.000	2818092.000	3189535.000	3560978.000	3932421.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	2572716.000	2943214.000	3313711.000	3684209.000	4054706.000
Equity capital	0.000	0.000	0.000	0.000	0.000
Reserves, retained profit	2196260.000	2566758.000	2937255.000	3307753.000	3678250.000
Profit	370497.500	370497.500	370497.500	370497.500	370497.500
Long and medium term debt	-0.004	-0.004	-0.004	-0.004	-0.004
Current liabilities	5958.823	5958.823	5958.823	5958.823	5958.823
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	5958.819	5958.819	5958.819	5958.819	5958.819
Equity, % of liabilities	0.000	0.000	0.000	0.000	0.000


A n n u a l CF, operations
10^ 5 1,000 Rs
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
local net cashflows
foreign net cashflows
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
y e a r


Accumulated CF, operations
10^ 6 1,000 Rs
local net cashflows
foreign net cashflows
4.0
3.0
2.0
1.0
0.0
-1.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
y e a r

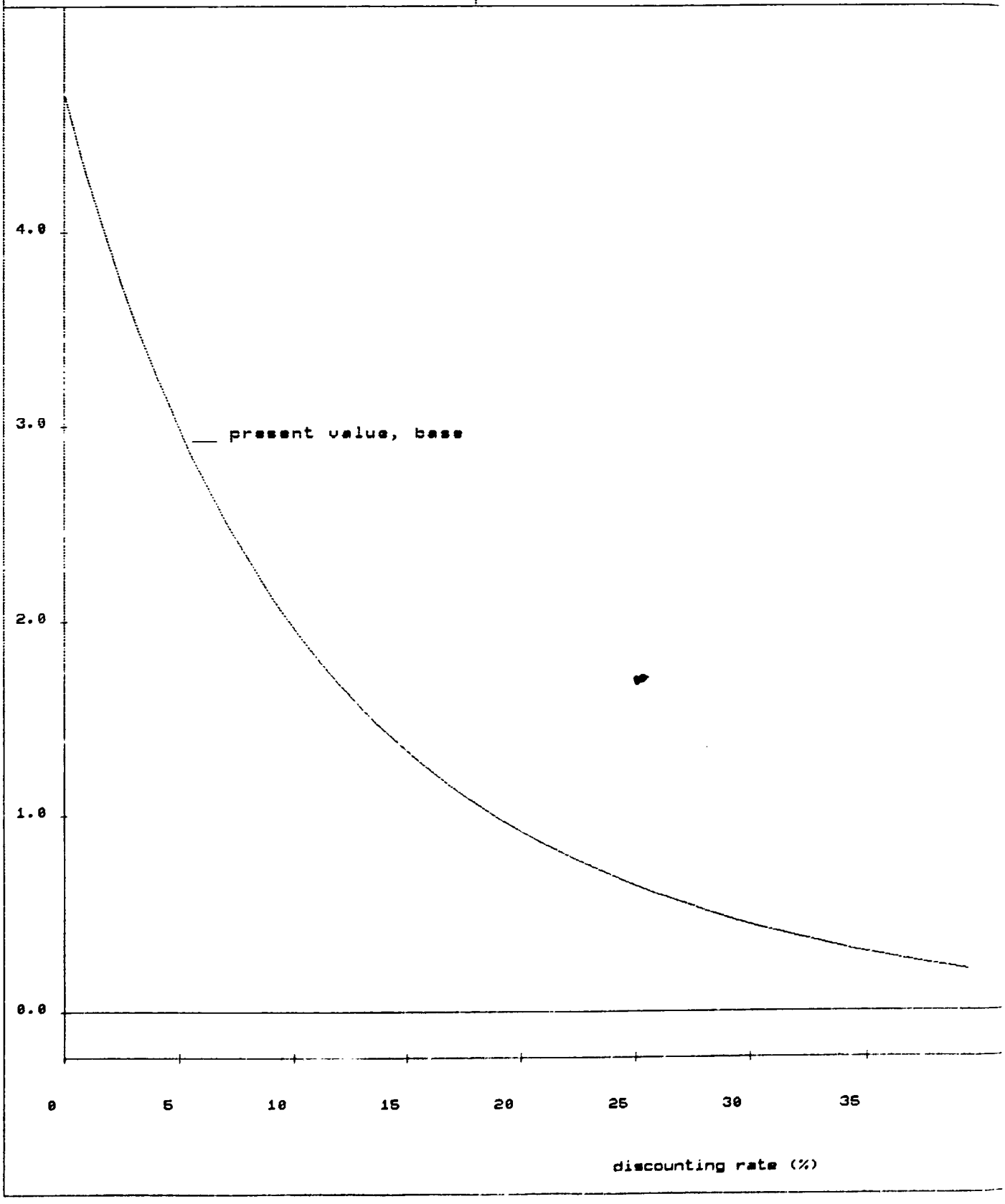
Annual flow of funds (finance)

10^ 5 1,000 Rs



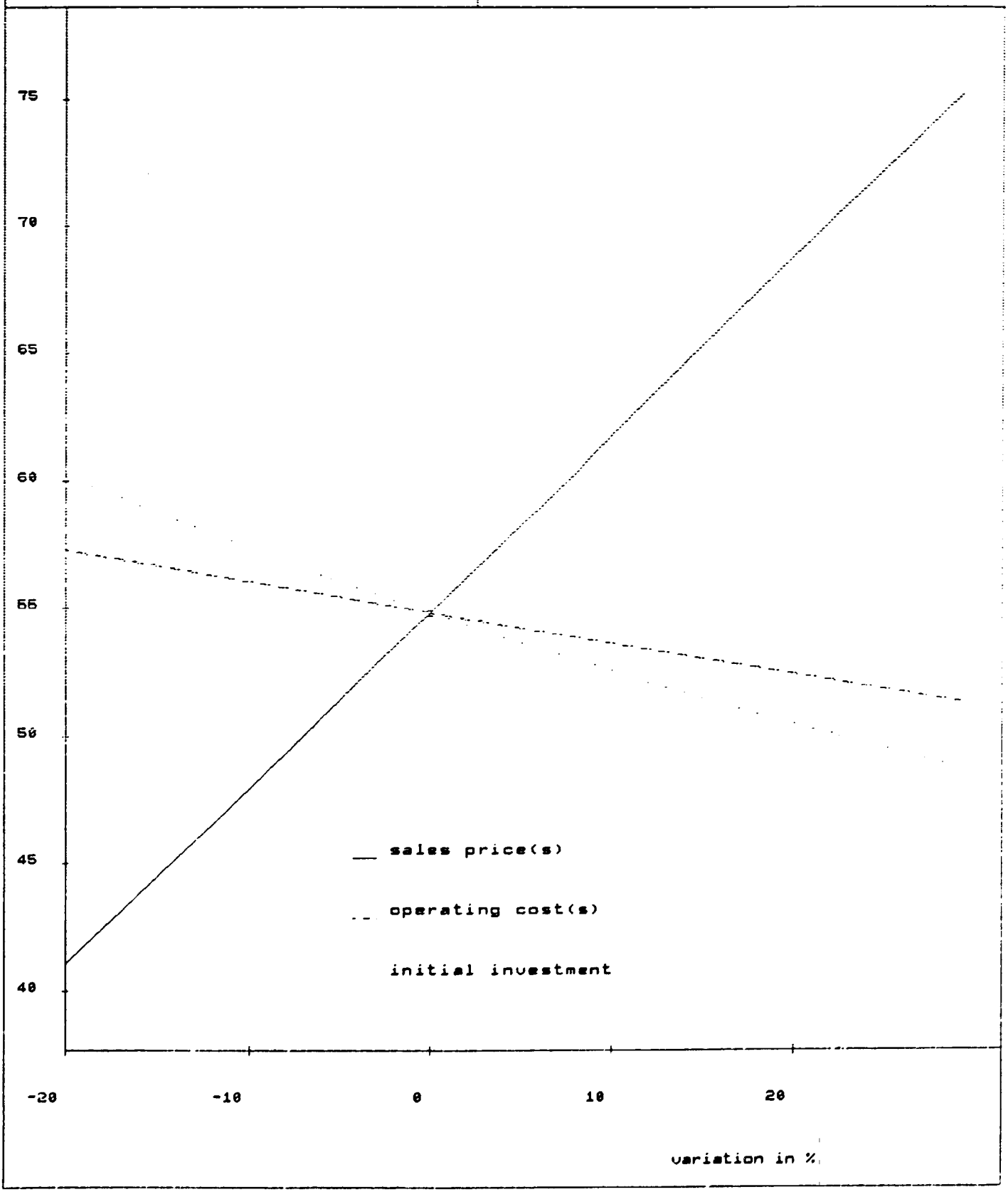
Discounted CF, Investment

10^ 6 1,000 Rs



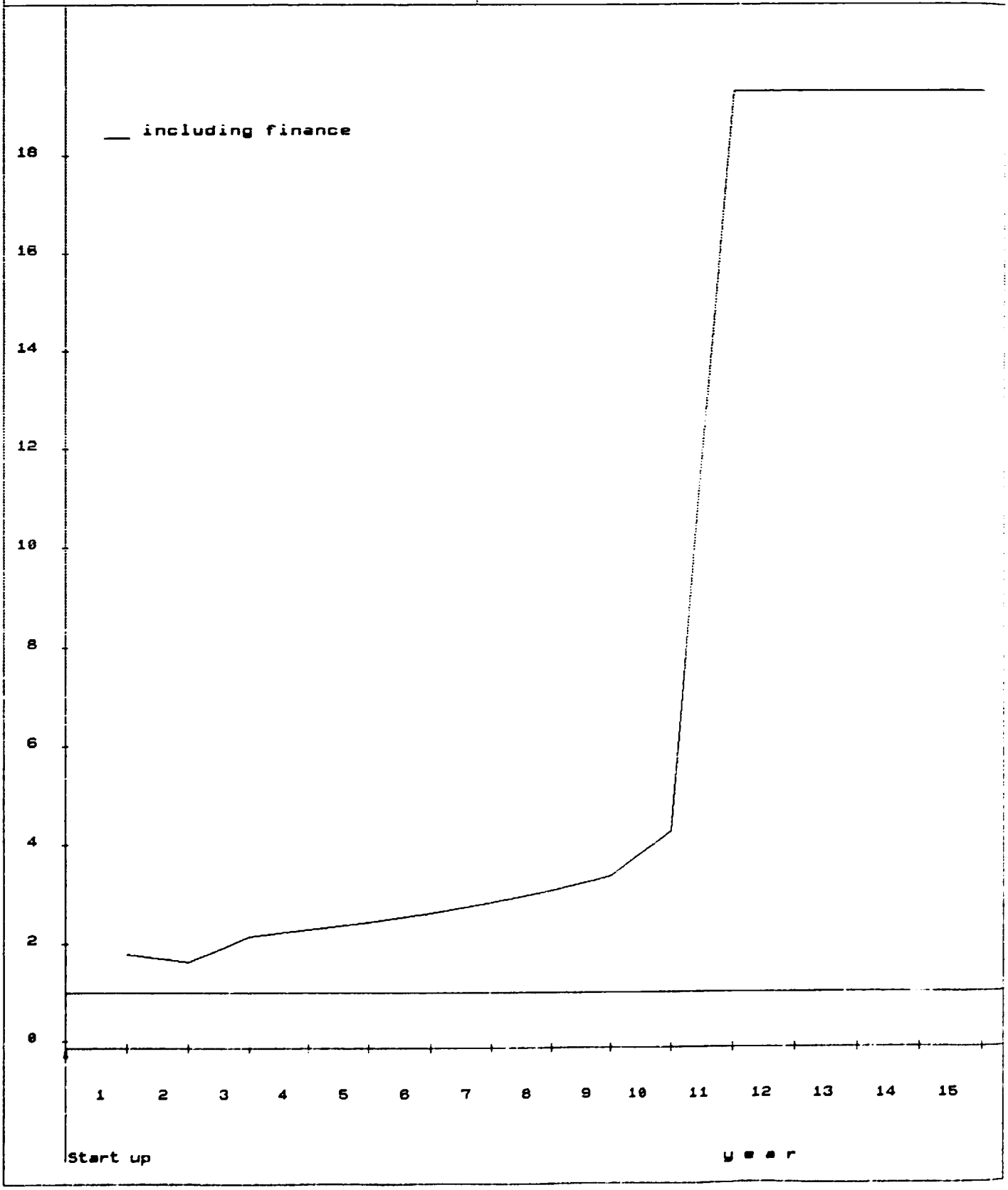
Sensitivity of IRR

internal rate of return



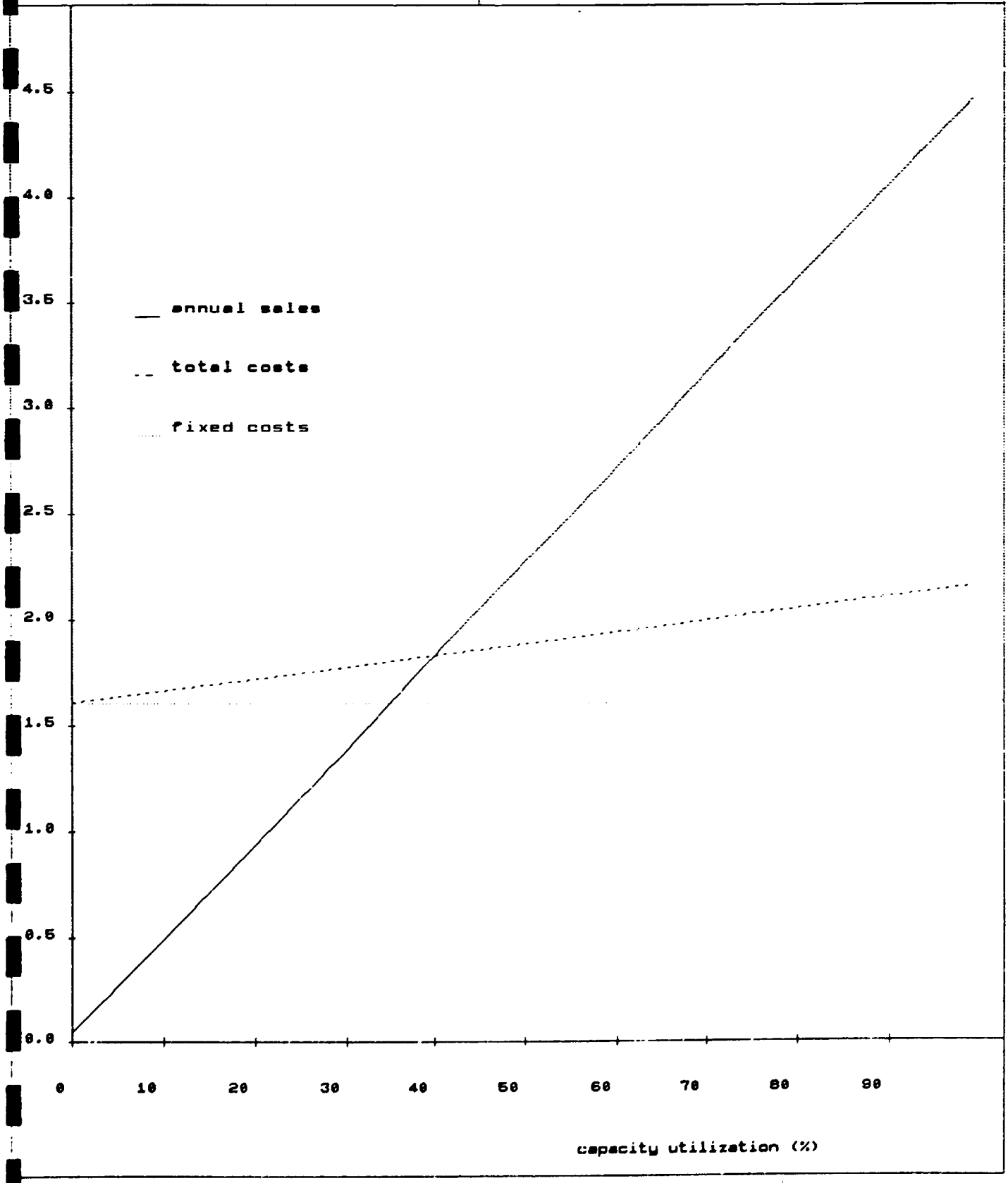
Fixed Costs Coverage Ratio

variable margin/fixed cost



Break even chart incl. finance

for 5th production year

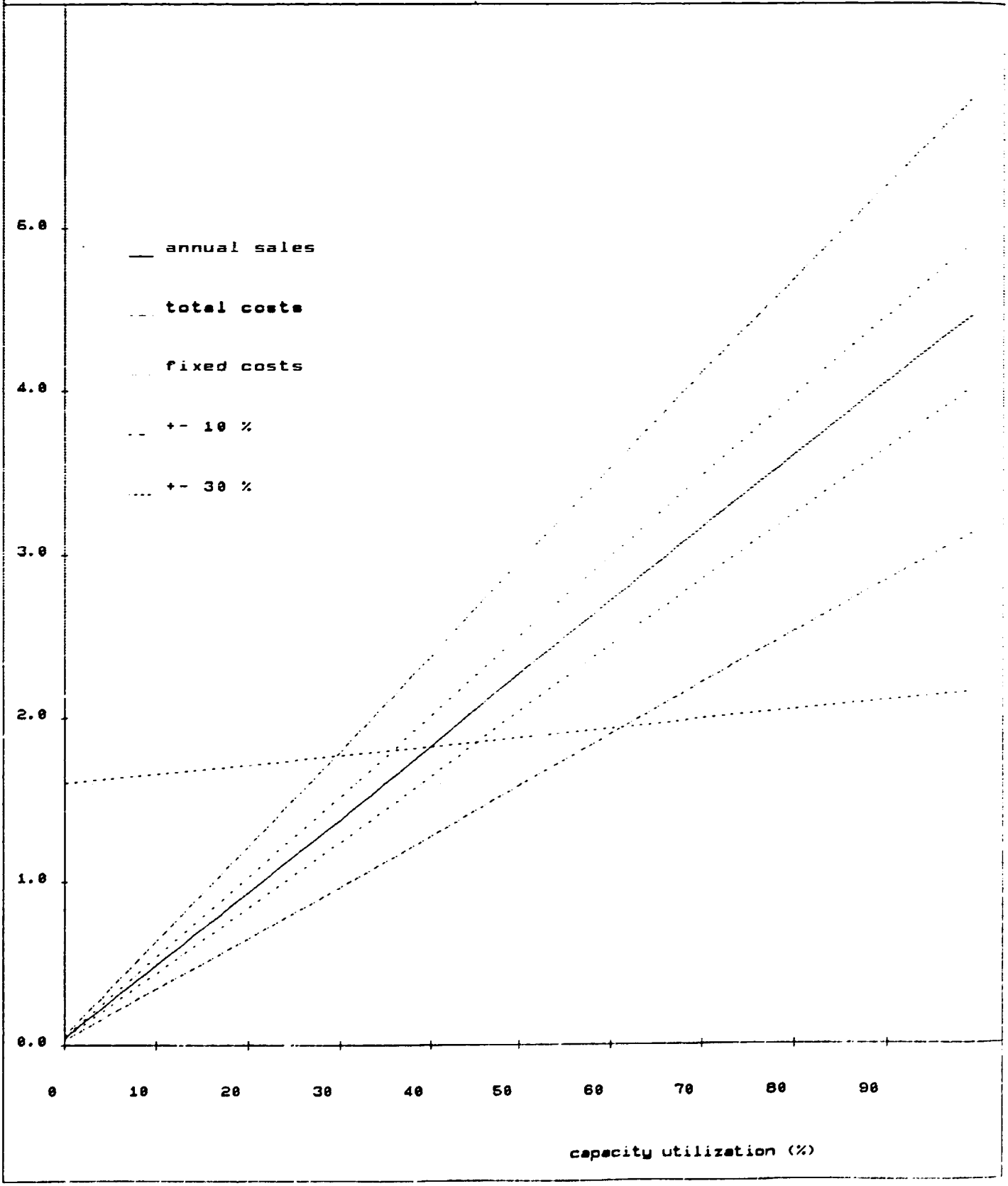


Break even chart incl. finance

variation of sales prices

10^ 5 1,000 Rs

for 5th production year

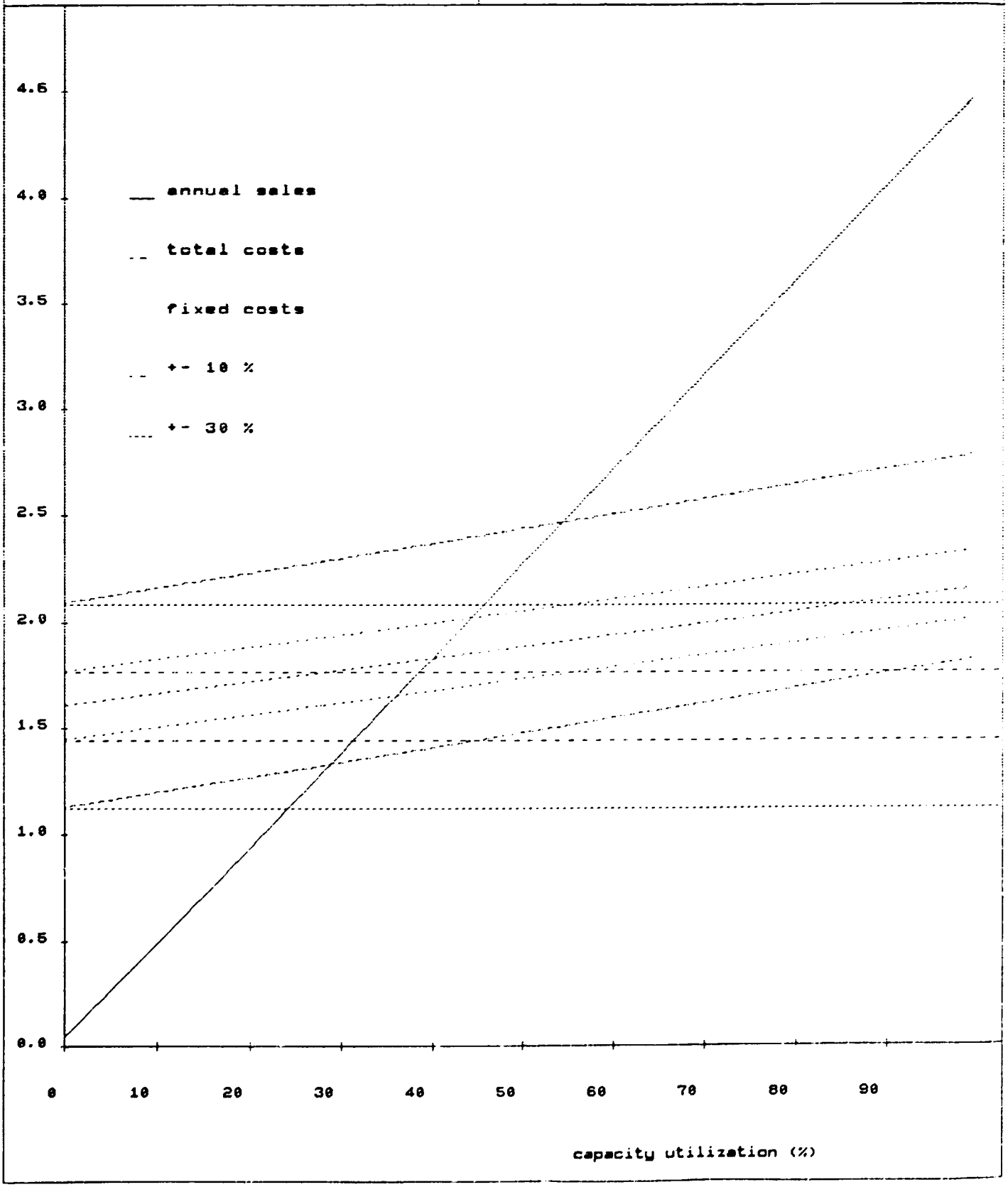


Break even chart incl. finance

variation of fixed costs

10^ 5 1,000 Rs

for 5th production year

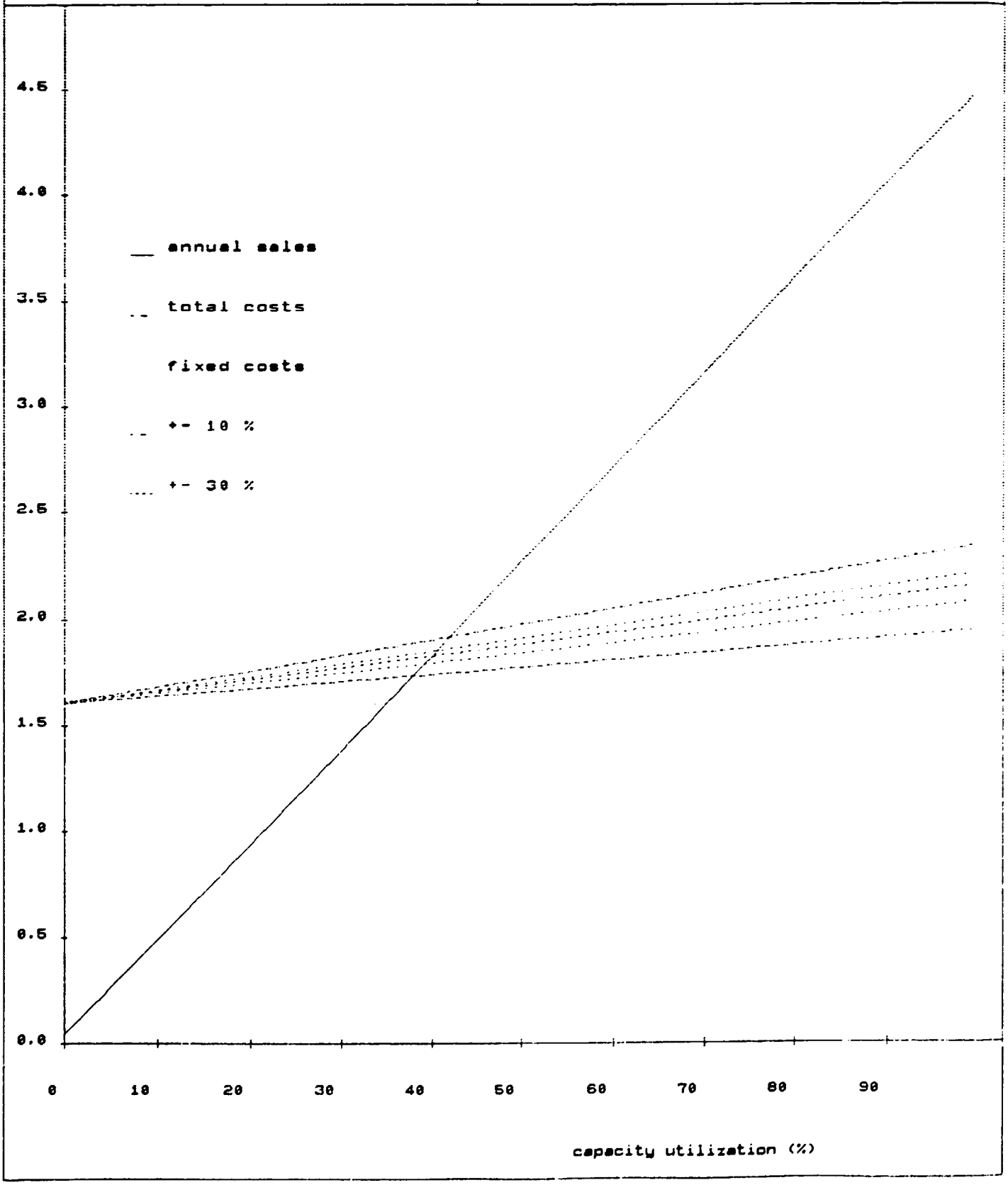


Break even chart incl. finance

10^ 5 1,000 Rs

variation of variable costs

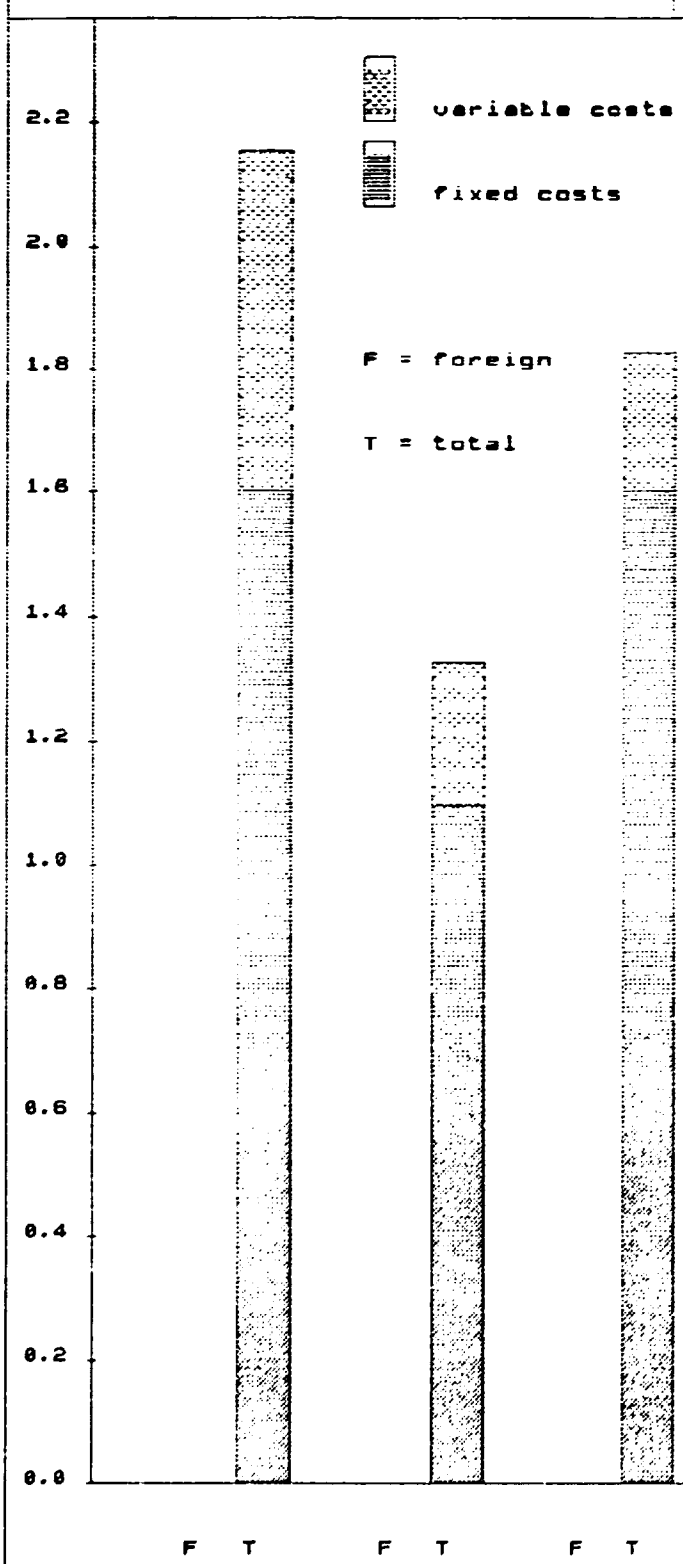
for 5th production year



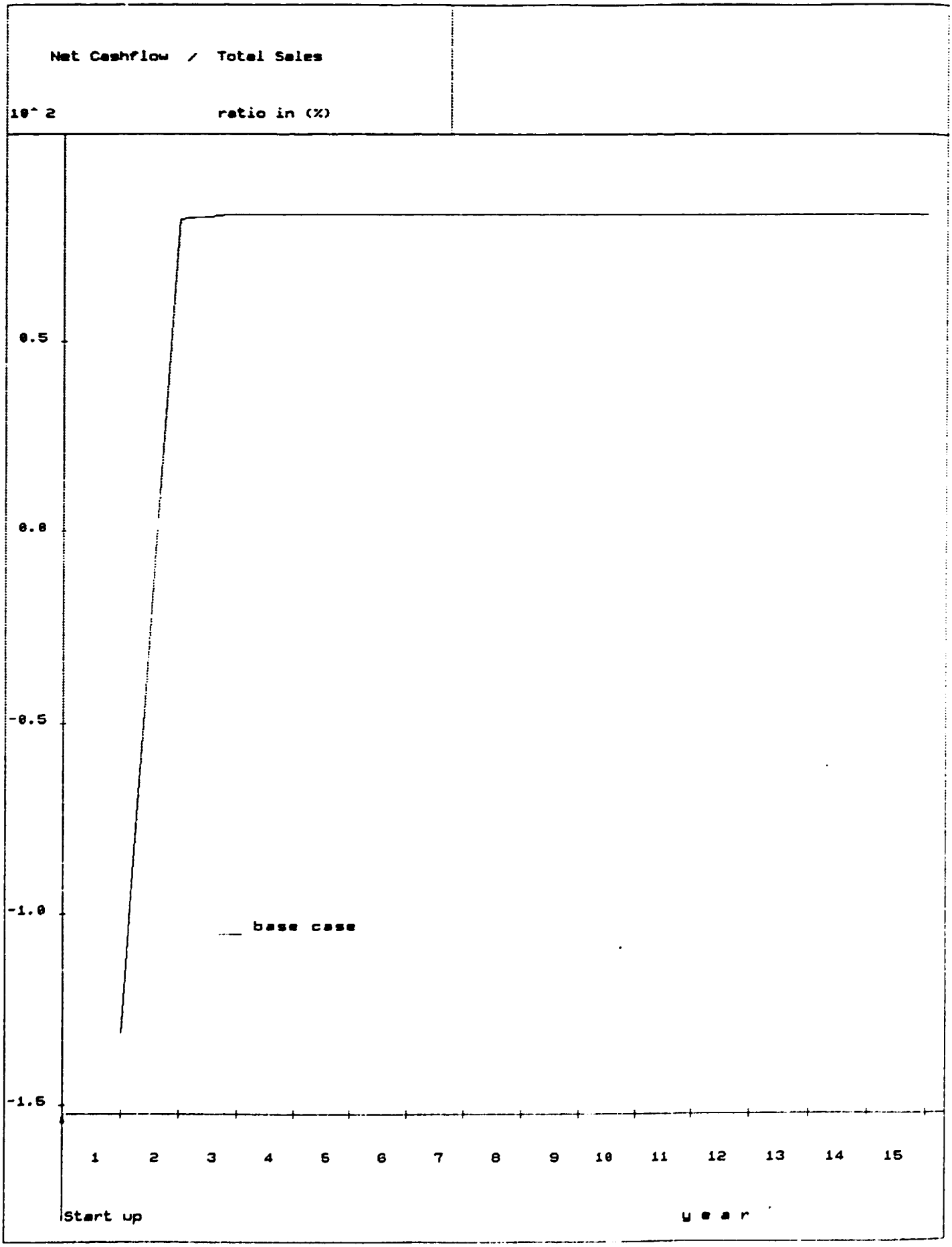
Structure of Production Costs

10^ 6 1,000 Rs

for 6th production year

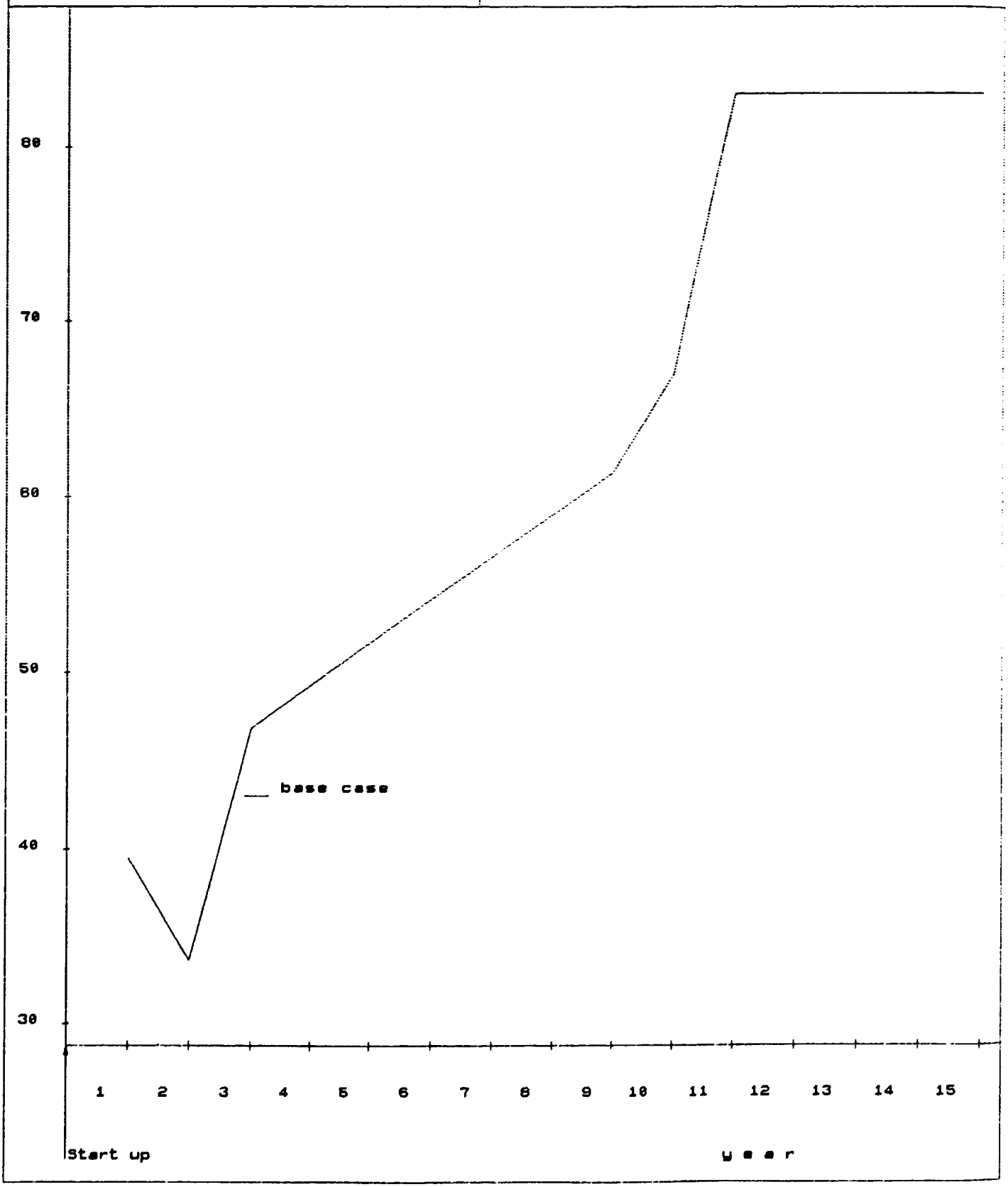


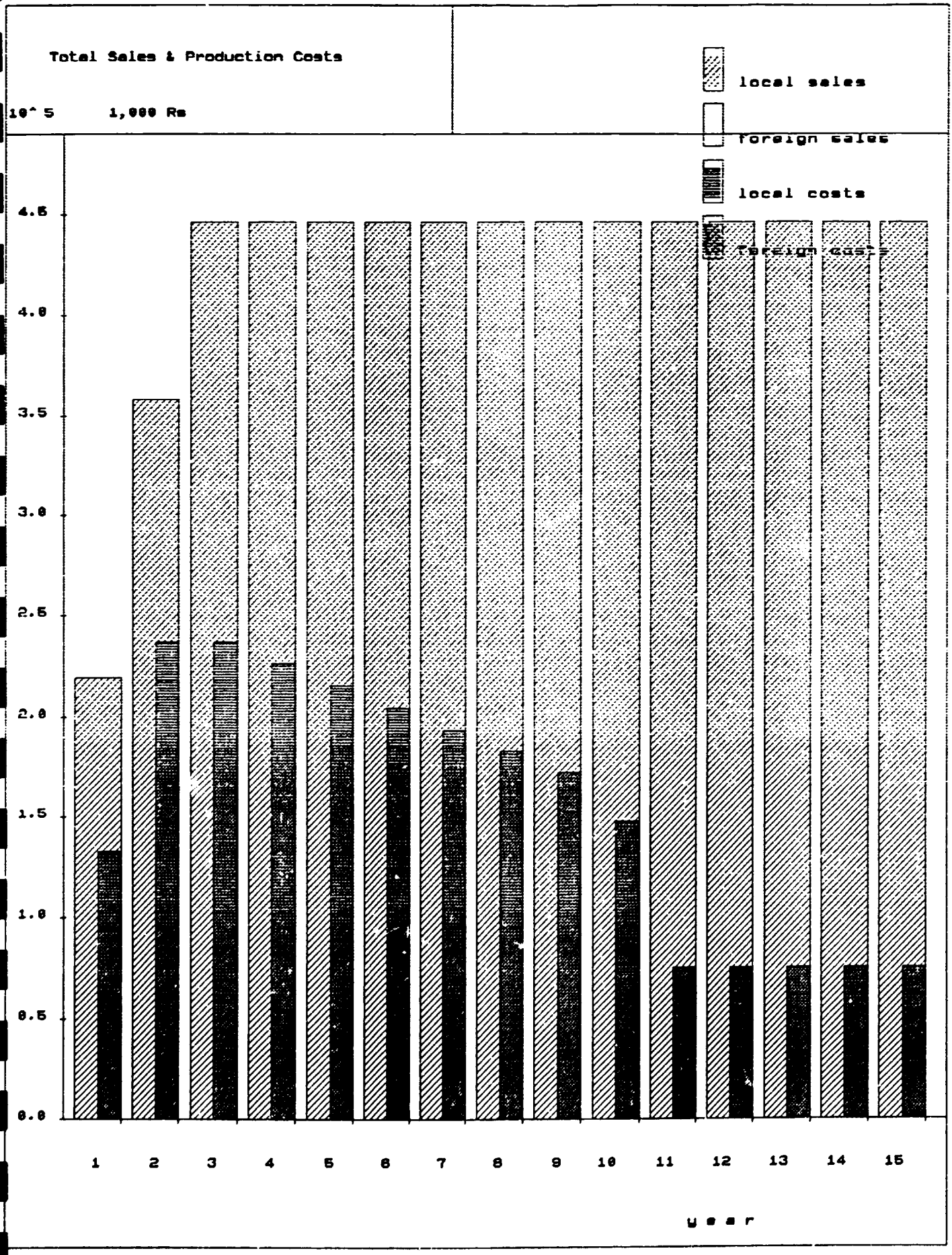
Nominal	Start up	
10.62	6.54	raw material
1.24	0.71	other RM
6.51	4.30	utilities
7.18	6.90	energy
4.04	6.25	labour
0.45	0.57	maintenance
1.05	1.37	spares
3.66	4.91	overheads
30.09	11.25	depreciation
35.29	57.20	interest
100.00	100.00	Total Prod C.


Net Cashflow / Total Sales
10^ 2
ratio in (%)
0.5
0.0
-0.5
-1.0
-1.5
base case
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Start up
year

Net Profit / Total Sales

ratio in (%)




Total Sales & Production Costs
10^ 5 1,000 Rs
local sales
foreign sales
local costs
foreign costs
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
year