OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

20293
(1 of 2)

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

DRAFT 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

METALCONSULT Ltd.
Prague, The Czech Republic

POLYTECHNA Ltd.,
Prague, The Czech Republic

March 1993

CONTENTS

Volume II.

List of abbreviation

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.
PT/MC	Polytechna/Metalconsult - author of Feasibility study
NCAER	National Council of Applied Economic Research
SPA	Super purity aluminium aluminium content min. 99.95 % 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
WWTP	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

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 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 and their equivalent in foils. 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 was fully based on a linear projection according to Market Survey without any tendency to some saturation level.

After several modification 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.

- anode foil (low voltage)	- 100 tpy	- 2,350 Rs/kg
- anode foil (high voltage)	- 50 tpy	- 3,340 Rs/kg
- cathode foil	- 60 tpy	- 990 Rs/kg
- anode plain foil	- 10 tpy	- 350 Rs/kg

The expected sales revenues could be estimated at 465.9 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 501 tpy. This is converted in 3 stages.

1. stage - purification to SPA (anode foil) and melting of CPA and 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

The raw material and utilities are specified for stage 3 (treatment of foil), not for stage 1 and 2.

Besides the CPA, other industrial products are used (chemicals for etching and forming, chemicals for treatment of water and for disposal of used water) and utilities (electric power, raw water, compressed air).

The annual requirements of the treatment of foil for the utilities is as follows:

- chemicals for etching and forming	136.8 t
- chemicals for treatment of water	106.5 t
- 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.

The area is highly industrialized with rich raw material resources.

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

Industrial water and electric power is available in the unit.

The area is highly industrialized and rich with raw material resources.

1.4.1 Selection of location for FTP

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 proposed 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 is 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 anorganic salts 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 in the quantity of 3,000 - 4,000 mg/l and before being discharged they 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 form of mud.

Fly away waste is negligible, only vapours are extracted 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.

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 utilization of SPA is 67 % which means 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 production process consists of 3 technological stages:

- production of SPA and CPA in form of slabs
- conversion of SPA slabs into plain foils for anodes and of CPA slabs into plain foils for cathodes
- treatment of plain foils by etching and forming to obtain condenser foil

Establishment of SPA production according to VAMI project and setting up foil treatment plant according to Feasibility study is necessary for production of condenser foils. In addition, existing facilities must be used and modernization of foil rolling mill must be provided.

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

Water for treatment of foils is required in the following qualities:

- clarified and filtered water
- demineralized water

Treatment of water is provided in the water treatment plant. Disposal of waste water is provided in the waste water treatment plant.

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

Sources for etching are wired through an impulse switch.

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 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 extract.

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

After construction, process of purifying of SPA proposed by VAMI will be incorporated into the existing smelter. The plant is headed by production manager. Direct subordinate staff to production manager is as follows:
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 4 shifts (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 and chemistry.

In Bidhanbag one additional shift will be needed for production of plain foil on foil rolling mill and for auxiliary operation. Four 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 Working of drawings
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.

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.

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

Four products had to be modelled separately due to different technology used and thereof resulting structure of their operating costs:

- Plain foils (SPA)
- Cathode foils (CPA)
- Anode foils (SPA)
- Other use products (lower grade SPA)

Therefore, both the investments and the annual production costs used in the computer model represent a rather 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 costs are allocated into 2 years (the second one representing investments during production) in the following COMFAR structure (1000 Rs):

Year	1994	1995
Land, site preparation, development	968.440	0.000
Buildings and civil works	28,327.780	0.000
Auxiliary and service facilities	0.000	0.000
Incorporated fixed assets	21,334.400	0.000
Plant machinery and equipment	42,947.140	22,1351.000
Pre-production capital expend	59,108.500	0.000
Working capital	0.000	849.217
Total	15,2686.300	22,2200.200

Project financing:

Equity and loans in 50-50 ratio are assumed to be used as the external financial sources for the project. Since the requirements for funds in 1994 and 1995 are very similar, the following schedule for the financing has been adopted (1,000 Rs):

Year	1994	1995
Equity	15,2686.300	0.000
Loan	0.000	14,3228.100

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

Total production cost:

These years 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 operations) is presented in this summary with reference to details in chapter 10 and COMFAR tables (costs in 1,000 Rs).

Year	1999
Factory costs	76,747.000
Administrative overheads	2,655.580
Indir. costs, sales and distrib	1,408.458
Direct costs, sales and distrib	0.000
Depreciation	31,636.010
Financial costs	18,046.740
Total	130,493.800

Of it 45.468 % variable.

Financial analysis

The financial analysis shows a very 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
- 1 year of construction + 15 years of operations

NPV = 669,102.4

Internal rate of return:
IRR = 51.23 %

Pay-back period:
PBP = 3 years

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

- on equity
ROE = 96.099 %

- on investment
ROI = 43.899 %

Break-even analysis:

The break-even chart indicates the break-even point at approximately 17 % which is a very satisfactory value.

Sensitivity analysis:

This analysis has been made in the break-even chart and in the net present value chart.

The former analysis has been in particular aimed at decreasing sales prices and increasing fixed part of total production costs which may become potential risk parameters. Variation of 10, 20 and 40 % has been examined with the worst case (- 40 % sales prices and + 40 % fixed costs) moving the break-even point to the value of 80 %.

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

Conclusions:

The financial statements indicate a high profitability and financial viability of the project of SPA foils production, in both of its alternatives.

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 tpa of aluminium metal along with matching capacity semi 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 tpa of primary aluminium metal into semi 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 tons/y 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 maor 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 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), a 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 Super Aluminium 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, 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 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 production capacity required 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 NCAR 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 10.000 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		
1991	353.30		
1992	387.94		
1993	424.53		projected
1994	457.22		
1995	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.

In should be taken into account that the capacity of the SPA purification being the initial operation of the whole foils 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.

3.4 Sales programme and marketing of products

Sales programme

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

Further, SPA < 99.98 % earmarket 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 - being approximately 430 vs. 340 tpy of SPA slabs equivalent respectively.

- 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 at 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.

Estimate of sales revenues

The NCAER report indicates the following market prices for the year of 1995:

- SPA low voltage anode foil	2,350 Rs/kg
- SPA high voltage anode foil	3,340 Rs/kg
- CPA etched cathode foil	990 Rs/kg
- SPA plain foils	350 Rs/kg

Sales revenues per year will then depend on the production program which is indicated below in the corresponding part of the study.

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

Production programme and plant capacity

As indicated above, the capacity of the demonstration unit is the parameter which has a decisive influence on the quantity of production.

The structure of the production programme has been adapted to the structure of the demand typical for leading capacitor manufacturers.

After several modifications the following production programme and capacity has been adopted for this project:

- anode foil (low voltage)	100 tpy
- anode foil (high voltage)	50 tpy
- cathode foil	60 tpy
- plain SPA foil for bipolar condenser	10 tpy

Referring to the indicated sales prices above, the expected sales revenues per year could be estimated at 464.9 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 casted 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 on 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 scheme 6.02 and 6.03.

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	- 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:

WTP	- $FeCl_3.6H_2O$ - min. content of $FeCl_3$	60 %
	- $Ca(OH)_2$	84 % min.
	- H_2SO_4	94 % min.
	- NaOH	98 % min.
WWTP	- NaOH	
	- $Al_2(SO_4)_3$	

Flow sheets of material and utilities are given on No. 4.01, 4.02, 4.03.

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_2OH	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
	In total		136.8

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
	In total		106.5 t/year

Consumption of el. power per 1 t of treated foil

TABLE 4.04

Sort of foil	MWh		
	Etching	Forming	In total
Anode LW	25.0	29.0	54.0
Anode HW	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
	etching	forming	in total
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 solutions, laboratory	m^3/hr	3.0
3	Re-filling to circulation circuits	m^3/hr	4.0
4	Circulating cooling water	m^3/hr	70.0
	Annual consumption of raw water	m^3	96,000
	that is	m^3/hr	16.0

****NOTE****
These requirement are being met by its own water treatment plant.

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_4	t	11.6	14.56
8	$NH_4H_2PO_4$	t	2.0	2.6
9	NH_4OH	t	1.3	1.6
10	$Ca(OH)_2$	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	$Al_2(SO_4)_3$	MWhr	4.4	5.5
15	Power for etching	MWhr	3,336	4,170
16	Power for forming	m^3/hr	5,088	6,360
17	Semi water for rinsing of foil	m^3/hr	4.8	6.0
18	Clarified and filtered water for technology	m^3/hr	2.4	3.0
19	Re-filling to circulation circuit	m^3	3.2	4.0
20	Circulation cooling water	m^3	56.0	70.0
21	Annual consumption of raw water that is	m^3 m^3/hr	76,800 12.8	96,000 16.0

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.

Annual consumption of material and chemicals is presented in the tables No. 4.01 and 4.02

Considering the overall production of treated foils (etched and formed) is relatively small, it is assumed that production of SPA and the foils from it will take place in cycles, i.e. approximately quarterly. Based on this assumption proposal has been made for the necessary stock supplies:

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_4	2.5	60
$NH_4H_2PO_4$	0.5	60
NH_4OH	0.25	60
Chemicals for WTP, WWTP	18.0	60

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.

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
- contracting 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	Qtr		Unit	Cost item	Unit cost Rs	Total cost Rs	
	Year from start of operation					Year from start of operation	
	1st	2nd				1st	2nd
1	273.6	342.0	t	Al foils	*		
2	109.2	136.8	t	Chemicals for etching and forming	3199,5	3,501.6	4,377
3	85.2	106.5	t	Chemicals for WWTP a nd WTP	11,774	1,003.2	1,254
4	8,424	10,530	MWh	El. power for etching and forming	(a) Site Korba 1,000 (b) Site Bidhanbag 1,300	8,424 10,951	10,530 13,680
5	76,800	96,000	m^3	Raw water			
6				compressed air			
7				Packing material		160	200
				TOTAL	(a) (b)	13,088 15,616	16,361 19,520

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

5. LOCATION, SITE AND ENVIRONMENT

5.1 Location

In accordance with the UNIDO contract the following 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 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 at 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, building 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 kWhr (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 MWhr/year this represents 3,159,000 Rs per year.

5.2.5 Availability of skilled labour

Conditions for recruitment of employees of the required skills are similar in Korba and in 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 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. In Czech Republic the content of boron is not being observed. 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 pressence 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. About 330 t of mud is created in the process of treating 332 t of plain foils.

Compound of mud is as follows:

$Al(OH)_3$	- 26.4 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 dusting is 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.

- Dimensions and mechanical properties

(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.

(a) Anode foil

thickness	50 - 110 micrometer (0.050 - 0.110 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 - 30 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
(nominal capacity is derived from market requirement)

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, now operating only in one shift.

After revamping, the roughing mill will be producing 300 t of the present production and 288 t of plain condenser foils in finished size. The mill will be utilized in two shifts after revamping.

(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 of a super purity aluminium production and foils from it depends on materialization of the following 3 technological stages:

- production of super pure aluminium in 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 specification and 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

It 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 for cleaning of degassing of hot metal before casting is proposed. This system involves spinning of metal for removal of oxides and entrapped gases.

Direct casting of slabs from ladle does not allow for remelting scrap.

Temperature of metal after refining is 770 °C - 810 °C. This temperature seems insufficient for the scrap to be remelted.

Therefore, 2nd alternative for production of SPA slabs is proposed by means of double melting.

Melted SPA metal will be cast into pigs. Pigs along with large item of SPA scrap will be remelted in the existing oil furnace once in a quarter in batches of 70 - 90 t. The melted metal will be transferred into holding furnace from which slabs will be cast.

Chips and trims will 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 will 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 Mn, Cu, Si, Fe. 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.

Aluminium complex in Korba produces hot and cold rolled sheets. Rolling is carried out in coil in width up to 1600 mm and strip thickness minimum of 0.5 mm. The complex 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.

Korba is fully equipped with auxiliary appliances such as furnaces-heating, homogenizing, annealing and with slitting machines. The rolling shop can prepare coils suitable for rolling of finished foil of 500 mm width.

In Bidhanbag, the BALCO company produces 300 tpy of Al foils per year for both technical purposes and for packaging. The maximum width of the produced foil is 600 mm of minimum thickness of 9 micrometers under present circumstances. Plant operates two 4 high non reversible mills with parameters suitable for condenser foil rolling. Minimum 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 the 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. Linking forming plant is storage of foils.

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.

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

Melting and casting will be provided on existing equipment as follows:
- oil fired melting furnace
- electric resistance furnace
- electric induction melting furnace
- equipment for semicontinuous casting
- conveyer for casting pigs

Estimated cost for vacumm ladle and stand is 300.000 Rs.

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.

2.1 Rolling of strip

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

- homogenizing furnace
- ingot milling machine
- heating furnace
- 4-high - 1800 mm hot rolling mill
- bell furnace for annealing
- 4-high - 1800 mm cold rolling mill
- slitting line

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 0.8mm max./0.02 mm min. - present condition - 0.07 mm Exit 0.5 mm max./0.012 mm min.
Strip width:	850 mm max. - present 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 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 (optimal)

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. - present condition - 0.09 mm Exit 0.08 mm max./2 x 0.006 mm min.
Strip width:	800 mm max. - present 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 0.110 mm
cathode foils - thickness 0.020 to 0.030 mm

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

(1) Roll Neck Bearing

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

(2) Back up roll assembly

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

(3) X-ray device for measuring of thickness of foil

(4) Drive for Mill and Coiler

1 Control Cabinet including
  - DCS control system for mill/coiler drives
  - Required hard- and software
2 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

(5) Driver for decoiler

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
Mechanicall equipment/engineering for decoiler drive: gear shaft, gear box, couplings etc.

(6) Coolant oil filtration plant (type Womack)

The model HP-20 filtration system consist of two vertical stack horizontal plate pressure filters.-
Filtration capacity: 2,000 l approx.
Tank capacity: 30,000 l approx.

Filtration equipment also serves for rolling mill No. 2.

6.3.2.1 Estimate of investment costs

Equipment - Section 2 - Modernization of foil rolling mill

Rs 000

Item		Foreign	Local	Total
1	Work rolls assembly	1,000	2,300	3,000
2	Back up rolls assembly	1,200	2,800	4,000
3	X-ray device for measuring of thickness	1,000	-	1,000
4	Drive for mill and coiler	4,700	-	4,700
5	Drive for decoiler	9,700	-	9,750
6	Coolant oil filtration plant	20,220	-	20,200
	Total 1-6	37,850	5,100	42,950

6.3.3 Section 3 - Treatment of condenser foil

Treatment of foil is an electrochemical process in two operations of 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.

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.

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.

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 material stored 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 pellets 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 HV foil is annealed in electrical resistance furnace. The purpose of heat treatment is to achieve necessary quality in mechanical properties of the foil as well as achieving suitable cubic texture for annealing.

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 chamber electric resistance furnace with output of 255 kW.

Capacity calculation:	
- Production of anode foil	257 t
- out of which 1/3 for annealing	85 t
- Weight of charge	0.7 t
- Number of charges	91
- Direction of annealing	24 hours - 1 day
- Annual utilization	91 days

Brushing will be provided on two sets of equipment

Capacity calculation		
Brushing of anode foil	- production	257 tpy
	- length	1,542,000 m
Output of one equipment UC 536B		2,400,000 m
Machine time (utilization 85 %)		4,535 hrs
Brushing of cathode foil	- production	75 tpy
	- length	1,350,000 m
Output of one equipment UC 536 B		2,400,000 m
Machine time (utilization 85 %)		3,970 hrs

Brushing unit - UC 536 B

This equipment (see - Diagram 6.07) 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 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 from steel chromium plated. 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 m/min

1.03 Etching

For etching of foils the following equipment is 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.

Capacity calculation	
Etching of anode foil - production	150 t
Output of one etching unit UC 1521 at 6000 hrs/year	27 t
Proposed number of units	6
Production capacity of units in total	162 t
Capacity reserve	12 t

Etching unit for anode foil - UC 1521

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

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** (type KC 2554), the foil is wound up by the winding-up station **8**.

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	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
Pressure air demand (min. pressure 0,4 MPa)	70 m^3/hr
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 - UC 566A

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)

Capacity calculation	
Etching of cathode foil - production	60 t
Output of one etching unit UC 566 at 6000 hrs/year	14 t
Proposed number of units	5
Production capacity of units in total	70 t
Capacity reserve	10 t

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 installed two showers **3**. The etching tank **4** is made from 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 cooper 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 from stainless steel, volume about 200 l, heated electrically to 80 - 85 °C (±3 °C). The rinsing tank **9** is made from 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** (type KC 2554) 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 U 5793 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 - UC 579 B

Capacity calculation

Forming of anode foil - production	40 t
Output of one forming unit UC 579 B at 6000 hrs/year	21 t
Proposed number of units	2
Production capacity of units in total	42 t
Capacity reserve	2 t

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).

From an unwinding **1**, the foil goes through the annealing oven PC 534 (**2**) (the length of annealed foil is 1060 mm, temperature 525 - 6000 °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 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**, type KC 2554.

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

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 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 concentrated solutions preparation
- storage tanks to take etching solutions of different concentrations.

Storage tanks for chemicals and etching tanks are made of stainless steel due to 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 to laboratory provided with instruments for quality checking of the foils - mechanical and electrical qualities.

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 parts as follows:

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 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 Amex 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 amex 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 $FeCl_3 \cdot 6H_2O$, 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 anises.

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	Overall 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	Ionex filter for light flow	2	1,580
9	Storage container	1	3,170
10	Mixing filter	2	1,160
11	Container for chemical solutions	1	30
12	Container for diluting solid chemicals	1	2,280
13	Container for chemical solutions	1	672
14	Storage container	1	2,339
15	Pumps of various types	21	3,000
16	Dosing pump	2	320
17	Dosing pump	2	294
18	Dosing pump	2	300
19	Compressor	1	340
20	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 interrupted 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 hottest months the temperature of the cooled water will be approximately by 5 °C higher 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

These 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 ($C_6H_{50}H$) 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-'I) 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

Power consumption per year:
E = 4,800 hours x 5,616 kW = 26,958 MWhr/year.

- 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 transformers 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 - 1 Nr
Dimension 1,000 x 2,500 x 1,000 mm
Weight 1,500 kg

Pos.10 Sourc. 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 rectifonning 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 V, 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, voltage 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, voltage 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 Lighting 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	11,060	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 m3 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 Estimate of investment cost - FTP

Equipment and installation

Rs 000

Item	Cost strategy	Foreign	Local	Total
	Production process			
1	01 - Storing of foils	-	40	40
2	02 - Annealing and brushing	9,046	-	9,046
3	03 - Etching (without power supply)	92,556	-	92,556
4	04 - Forming (without power supply)	19,549	-	19,549
5	05 - Checking (laboratory), packaging	200	15	215
6	06 - Preparation of solution	-	40	40
7	07 - Maintenance	-	150	150
8	08 - Production control	300	-	300
9	09 - Transport equipment	-	300	300
	Total 1 - 9	121,651	545	122,196
10	Water treatment	9,016	10,000	19,016
11	Electropart (with power supply)	49,947	10,000	59,947
12	Airconditioning and ventilation	-	3,875	3,875
	Total 1 - 12	180,614	24,420	205,034

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 forks in the sum of 750,000.- Rs is included in chapter 10 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 chapter 10 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^3

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.

Load bearing floor capacity envisaged 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 assumed above ground level is 900 mm, and 600 mm above 1st floor and basement plan.

Steel floor structure proposed for transformed/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 is 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 is a cooling water pipe into the foil plant. After relocating this pipe the site will be free. Access for the new foil treatment plant is made by 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 compare to usual standard. However, similar conditions for soil investigation as mentioned before apply.

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.

6.4.4 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 300 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

*NOTE: *) indicative relates to floor area*
Continued/...

Estimate of Investment Cost - Civil Engg. Works, Continued/1

Quantity	Unit	Costs, Rs	
		Site at Korba	Site at Bidhanbag
C. Preliminaries, engineering, contingency			
Preliminary and general conditions for contractor, insurance, contractors compound, management, fee	8 % of A+B	1,746,000	1,740,000
Design, engineering, working drawings	7,5 % of A+B	1,637,000	1,631,000
Contingency sum	5 % of A+B	1,091,000	1,088,000
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
Buildings and structures are excluded of electrical installation and ventilation which parts are included in equipment costs.

6.5 Total investment costs estimate

6.5.1 Foil treatment plant

Rs. 000

Item	Cost category	Korba	Bidhanbag
1.	Site preparation, levelling	870	970
2	Building and structures	20,957	20,780
3	Preliminary and preproduction (20.5 % of item 1+2)	4,474	4,459
	Total 1 - 3	26,301	26,209
4	Technology (know-how tax)	15,000	15,000
5	Total equipment and installation cost	205,035	205,035
6	Preliminary and preproduction cost (20 % of item 5)	41,007	41,007
7	Modernization of foil rolling mill	42,950	42,950
8	Civil works - foil rolling mill	786	786
	Total 1 - 8	331,079	330,987

6.5.2 Experimental Demonstration Unit

Rs 000

Item	Cost category	
1	*SPA production (project VAMI)SECTION 1	48,514
2	Modernization of foil rolling millSECTION 2	42,950
3	Civil works	786
	Foil treatment plant in BidhanbagSECTION 3	
4	Site preparation, levelling	970
5	Building and structures	20,780
6	Preliminary and preproduction cost -civil part (20.5 % from item 4+5)	4,459
	Civil part - FTP - Total 4 - 6	26,209
7	Technology (know-how tax)	15,000
8	Total equipment and installation cost	205,035
9	Preliminary and preparation cost including contingencies (20 % from item 8)	41,007
	Total 1 - 9	379,501

*) (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. Manpower provision, routine and capital repair implementation, building and structures maintenance, outer transportation, water and electric power supply, material storage provision are 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). Out of the overall production of rolled semiproducts in Korba, production of semiproducts for Al foil represents approx. 1 %. Amount of production of plain foil will be 266 t, amount of existing production of foils is 300 t, the ratio will be roughly 1:1.
All activities described in section 1 will be carried out in Korba within the operation of the rolling plant. In Bidhanbag, the above described activities will be carried out within the operation of the foil plant.

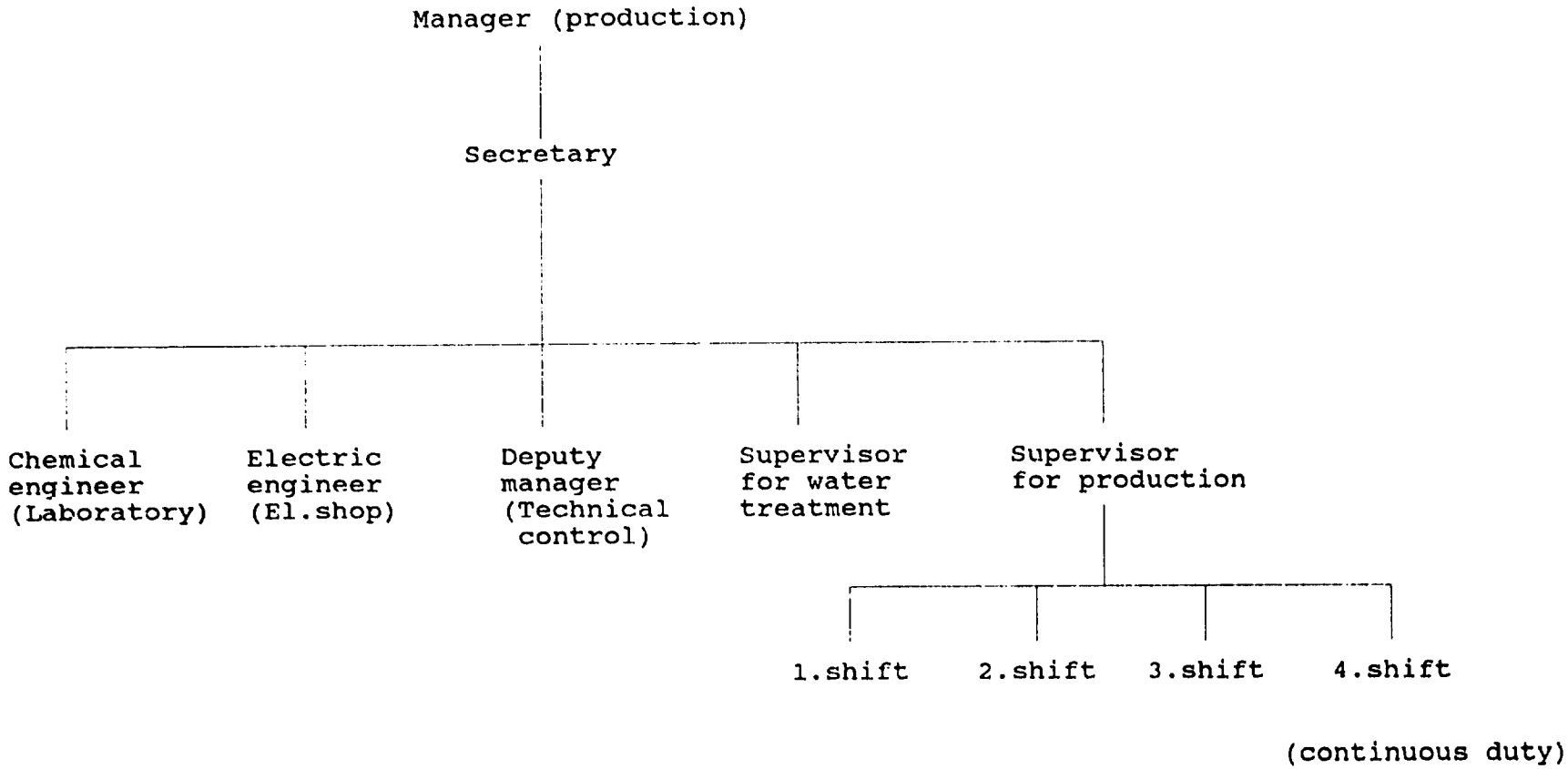
Section 3 Treatment of foil
Operation of the foil treatment plant will be subordinate to the management of rolling plant in Korba in case FTP is situated there. In case FTP is situated in Bidhanbag, both FTP and foil plant will be subordinate to one manager only.

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.

- 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 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 etching and forming is a continuous operation (7 working days in a week). Other operations are 2-3 shifted with the exception of storaging and packing, which are one shifted.

Working fund for uninterrupted 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 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 labor 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 Direct workers	Indirect workers	Staff	I.	II.	III.	IV. Continuous duty
Annealing	1	1	-	-	1	-	-	-
Brushing	5	5	-	-	2	2	1	-
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	-	1	1	1	
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	3	3			3			
In total	87	37	41	9	36	20	18	13

8.02 Wages and salaries

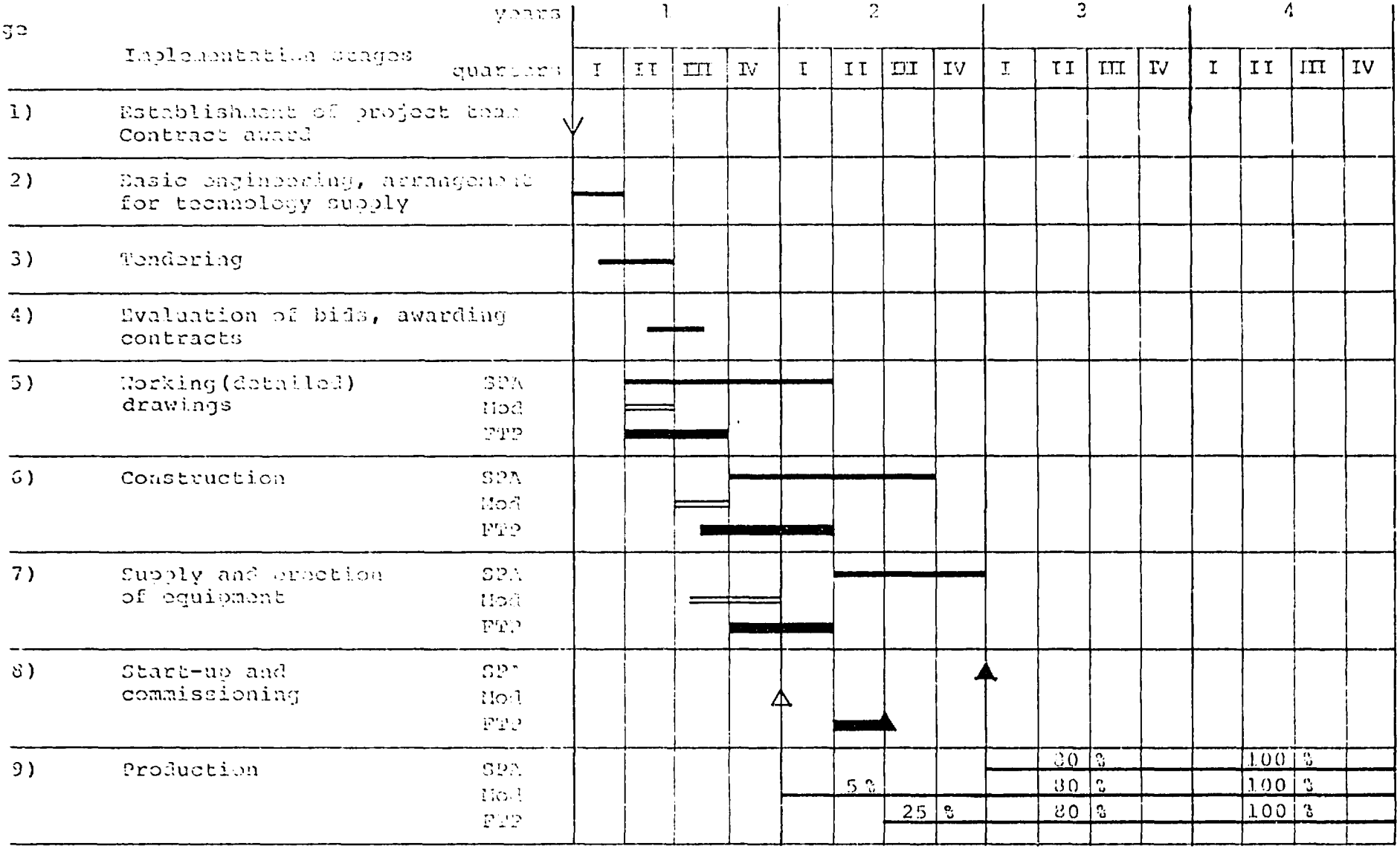
CATEGORY	NUMBER	SALARY	SALARY IN TOTAL	ANNUAL SALARIES
Manager	1	8.000	8.000	96.000
Deputy Manager	1	6.000	6.000	72.000
Engineers and supervisors	6	4.000	24.000	288.000
Secretary	1	2.500	2.500	30.000
Skilled workers	37	4.100	151.700	1,220.600
Semiskilled workers	30	3.300	99.000	1,188.000
Unskilled workers	11	2.300	25.300	303.600
In total	87		316.500	3.798.000

9. PROJECT IMPLEMENTATION

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

- basic engineering, pre-planning and project strategy, preparing of documentation for supplies of technology, searching for suppliers, discussions with suppliers
- sending of invitations to tenderers, explanation of queries
- evaluation of bids, negotiations, incorporation of changes and contracts awarding
- provision of detailed working 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 works on the project, FTP after 1 1/2 year, VAMI project after 2 years).
  Details are shown in the schedule on the following page.

EDJ Construction Implementation Schedule



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

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.

Basically, two 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 cannot be considered as decisive in advance.

- 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 cannot be considered as decisive 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 latest development of opinions and requirements concerning in particular the construction and start-up schedule of the project (see Record Note of Discussion with the Indian delegation, Prague, March 20, 1993), 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 convert to domestic SPA input material (80% in the first year of such operations and full capacity thereafter).

Therefore, a 1 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.

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:

- plain foils
- cathode foils
- anode foils
- products of other use (lower grade SPA)

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):

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			15,000.0
Inc. fixed assets (c)				
Machinery and equip.(a)	16,015.76	300.0		205,035.0
Machinery and equip.(b)			42,947.14	
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, representing after 8 years a coefficient of 2.14.

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

From the COMFAR time planning point of view, 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 projected foil treatment facilities in either Korba or Bidhanbag.

For the financial analysis purposes, where the project must 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 prepared in Rupees per year for each product and the full, installed capacity level. A variable capacity utilization during the first years of operations has been simulated directly in COMFAR.

Tables 10.2 through 10.5 show the initial input data of which the yearly operating costs for the COMFAR model were prepared (COMFAR data structure respected).

Remarks:
Due to a various structures of the data sources utilized, some cost items seem to be omitted, but they are usually joined with some others of a similar type in case they could not be 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 assumption 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:

Transportation cost = net wt/SUR x (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 x cost of product (further as 'cost')
Insurance	= 0.002 x (cost + excise)
Entry tax	= 0.005 x (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 (82,500 Rs/t) plus 25 % customs duty, resulting in 103,125 Rs/t. These costs substitute fully the corresponding part of the SPA purification and slab casting costs.

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	21.470	-
Energy		3.660	14.092	118.930	- -
Labour direct	20.720	2.652	9.214	7.390	-
Maintenance		0.671	4.444	2.110	-
Spare parts		2.196	3.794	90.080	-
Factory overheads	27.370	0.610	1.897		-
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/t)

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 1,992.0
Energy	- -	29.310	111.800	161.025	K 4,212.0 B 5,560.0
Labour direct	-	20.517	73.100	891.975	KB 1,290.0
Maintenance	-	5.374	35.260	55.425	KB 192.0
Spare parts	-	17.586	30.100	15.825	KB 768.0
Factory overheads	-	4.885	15.050	675.600	KB 120.0
Administr. labour	-				KB 195.0
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/t)

Product:	ANODE FOILS - initial CPA input 329.91 tpy				
Production (tpy)	327.410	310.30	277.480	256.000	150.0
Operation: Operating costs	SPA K purific.	slab K cast.	strip K rolling	foil B rolling	foil K/B treatment
Raw mater.(a)	12,536.580				
Raw mater.(b)	1,695.984	46.545			
Utilities	5,831.172	83.781	15.261		KB 4,980.0
Energy		93.090	360.724	549.632	K 10,530.0 B 13,900.0
Labour direct	530.404	65.163	235.858	3,044.608	KB 3,224.0
Maintenance		17.067	113.767	189.184	KB 480.0
Spare parts		55.854	97.118	54.016	KB 1,920.0
Factory overheads	700.657	15.515	48.559	2,306.048	KB 300.0
Administr. labour					KB 486.0
Admin. non-labour		3.103	59.658	1,396.224	
Marketing labour					
Marketing non-lab			KB BK	487.532 619.093	

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

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	54.530	-	-
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 10.5 Basic structure of operating costs (1,000 Rs/t)

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 specified in project financing description (see Project Financing).

Remark:
Only those depreciation 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 born 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 %, 20 % and 40% 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 four products separately, in accordance with the time schedule of construction already mentioned.

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

- anode foils (for mix of low and high voltage 100 and 50 tpy)
  2,680 Rs/kg
- cathode foils 990 Rs/kg
- plain foils 350 Rs/kg

The 'other use' (tab sheets, lead wires and similar) products of the lower grade SPA should be financially neutral towards the project efficiency statements. Therefore, special sales prices were assigned to them 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 %, 20 % and 40 % does not show any dramatic changes of the break-even point (see COMFAR output charts).

10.5 Working Capital

Just orientation data could be collected for working capital requirements module of COMFAR.

Minimum days of coverage were indicated very approximately as follows:

- 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
- accounts payable	30 days

No receivables and cash in hand make the liquidity ratio rather lower. Nevertheless, the dynamics of the net working capital can influence the cash flow of the project only during the first three years of the production build-up and not very substantially.

10.6 Project Financing

As the external sources of finance, the following were specified by the Indian part:

- equity (government)
- long-term loan (government)
- short-term loan (bank)

No subsidies or grants are being supposed. Conditions for financing the project are the following:

- 50 % equity and 50 % loan
- long-term loan interest rate 18 %, 10 years amortization
- short-term loan interest rate 21 %
- constant principle repayments

After the first COMFAR simulation it was obvious that the financial requirements in the years 1994 and 1995 are practically equal. Therefore the following schedule for the financing was adopted:

- year 1994 fully financed by equity
- year 1995 fully financed by a long-term loan

Even though the debt - equity ratio is not exactly 50-50 in this case (the equity prevailing approximately in a ratio of 15/14), the financial cash flow shows a good surplus to make the

project viable under worse financing conditions. Even dividing the financial sources 50-50 for each of the years 1994 and 1995 (which is not optimal from the financial costs point of view) should not generate a deficit in the financial cashflow.

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, income tax and current prices at 10 % inflation rate, with or without income tax for comparison as required for feasibility studies in India)

- Net income statement (constant prices, income tax and current prices at 10 % inflation rate, with or without income tax for comparison as required for feasibility studies in India)

- Projected balance sheets

Charts:
- Annual cashflow from operations
- Accumulated cashflow from operations
- Annual flow of funds
- Debt service ratio (net cashflow/debt service)
- Debt equity ratio
- Discounted cashflow, investment (net present value) + sensitivities
- Sensitivity of internal rate of return
- Break-even chart (financial costs included) + sensitivities
- 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 higher transportation costs in case of returning the foils back to Korba for the final operations. However, the difference is practically negligible.

In production costs, the alternative with the foil treatment in Bidhanbag is rather 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 is almost the same for both of the alternatives. Whereas the alternative with the foil treatment in Bidhanbag is slightly cheaper in equity required, the loan disbursed in 1995 is 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. It can be also observed when comparing the cumulated net cash flows or the net present values (the discount rate has been obtained as an average of the equity opportunity costs - 12 %, source UNIDO New Delhi and the interest rate on the government loan 18 %). Again, the Korba-oriented alternative gives better results but not substantially. The same applies the internal rate of return being over 50 % in both alternatives.

Simple rates of return (return on equity and return on investment) are apparent from the 'Net Income Statement' table. For both alternatives are the rates almost identical and very high (for the fifth year of operations approx. 95 % and 43 % respectively).

Break-even analysis (see break-even charts) indicates the break-even point at approx. 17 %, again for both project alternatives, which represents a good reserve for the case of worse conditions in sales or production costs.

Sensitivity analysis made in the break-even chart indicates a rather good degree of the project stability under worsened conditions. For example, a 40 % decrease of sales prices combined with a 40 % increase of the fixed part of production costs would move the break-even point to the value of 80 %.

Sensitivity analysis made in the discounted cashflow (net present value) chart shows the maximum dependence of the net cashflow on sales prices, then on operating costs, whereas its sensitivity to changes in initial investments is practically negligible.

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.

20293
(2 of 2)

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

DRAFT 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

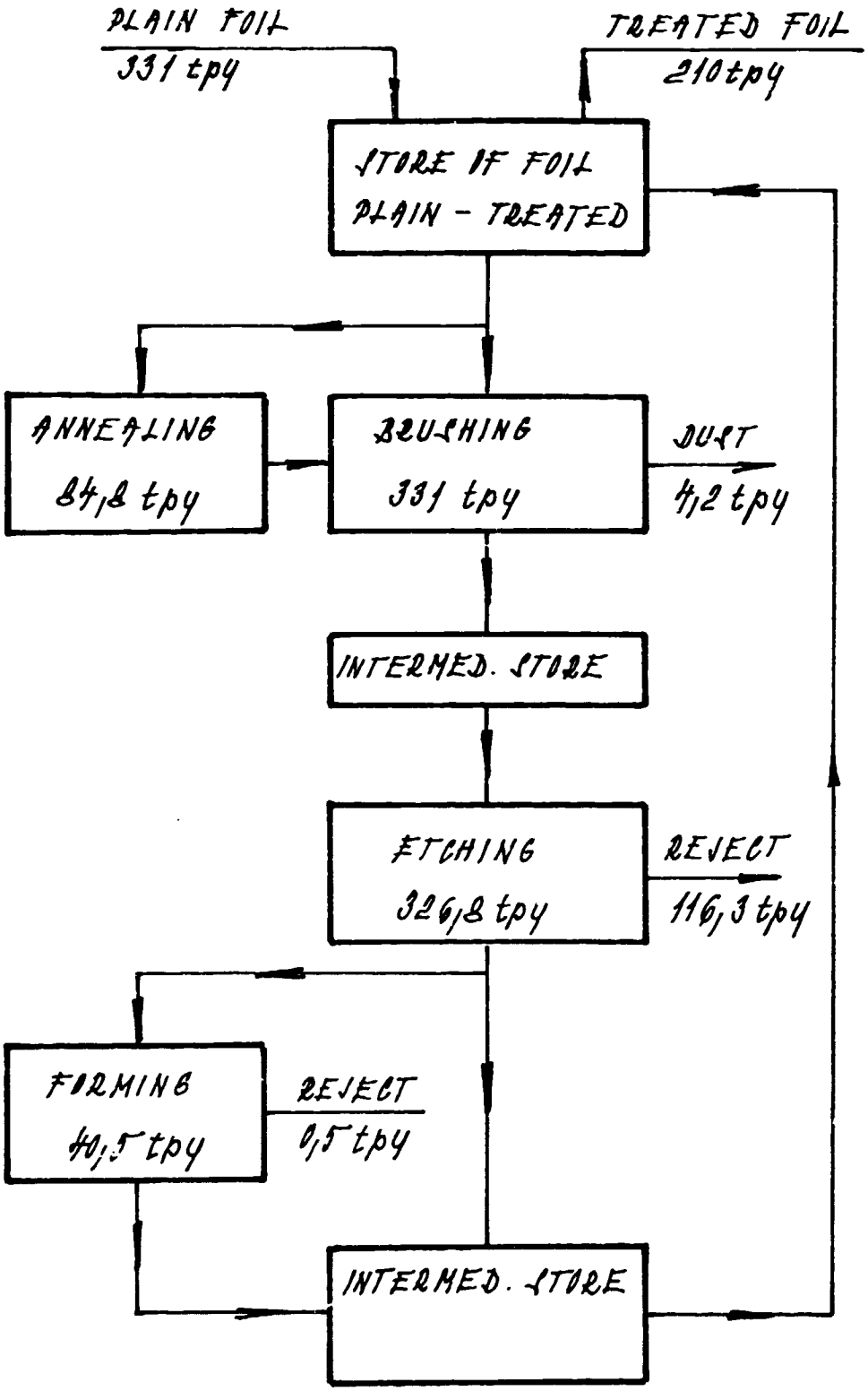
POLYTECHNA Ltd.,
Prague, The Czech Republic

March 1993

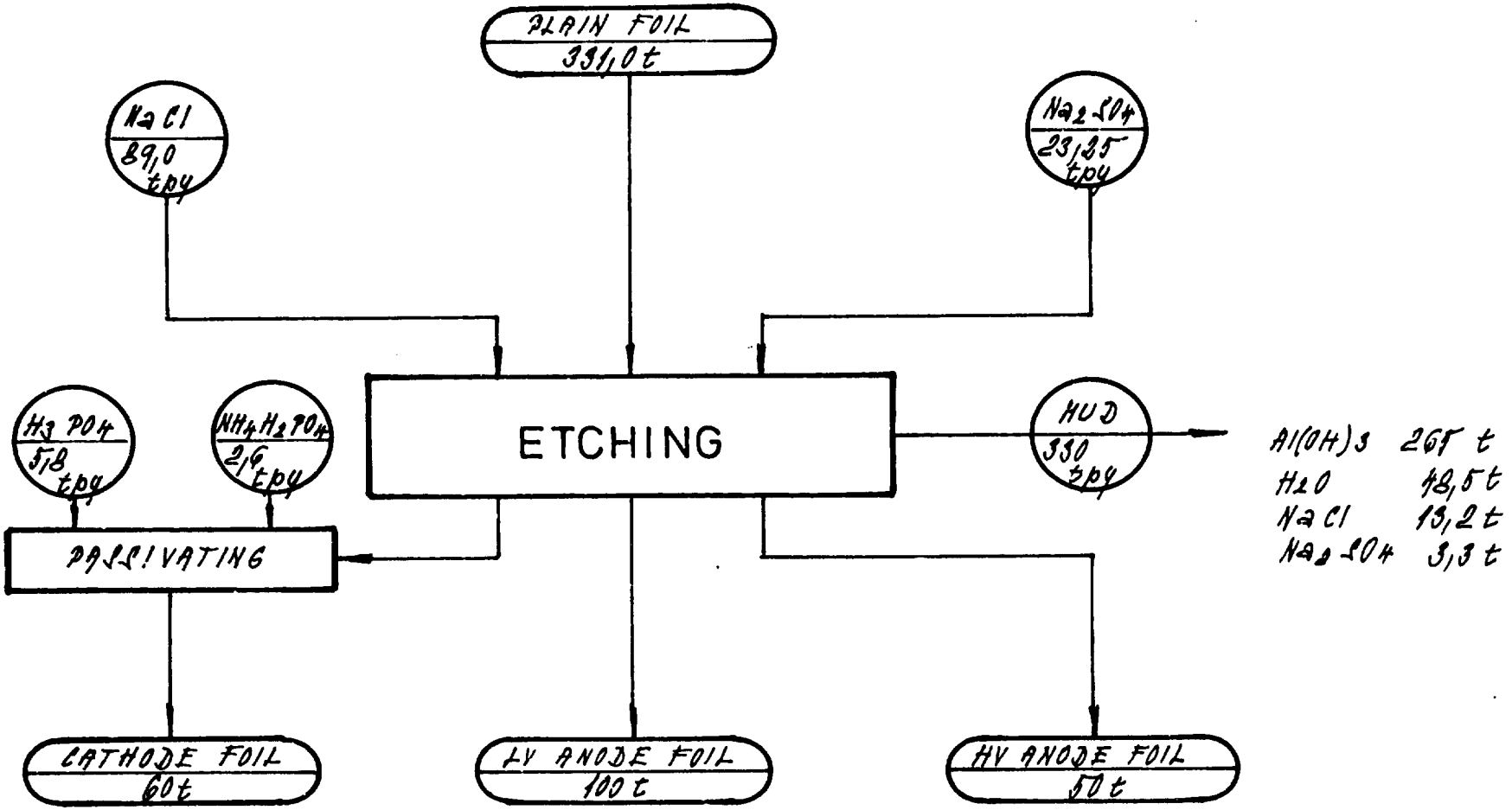
VOLUME II

CONTENTS

1. Flow charts and diagrams

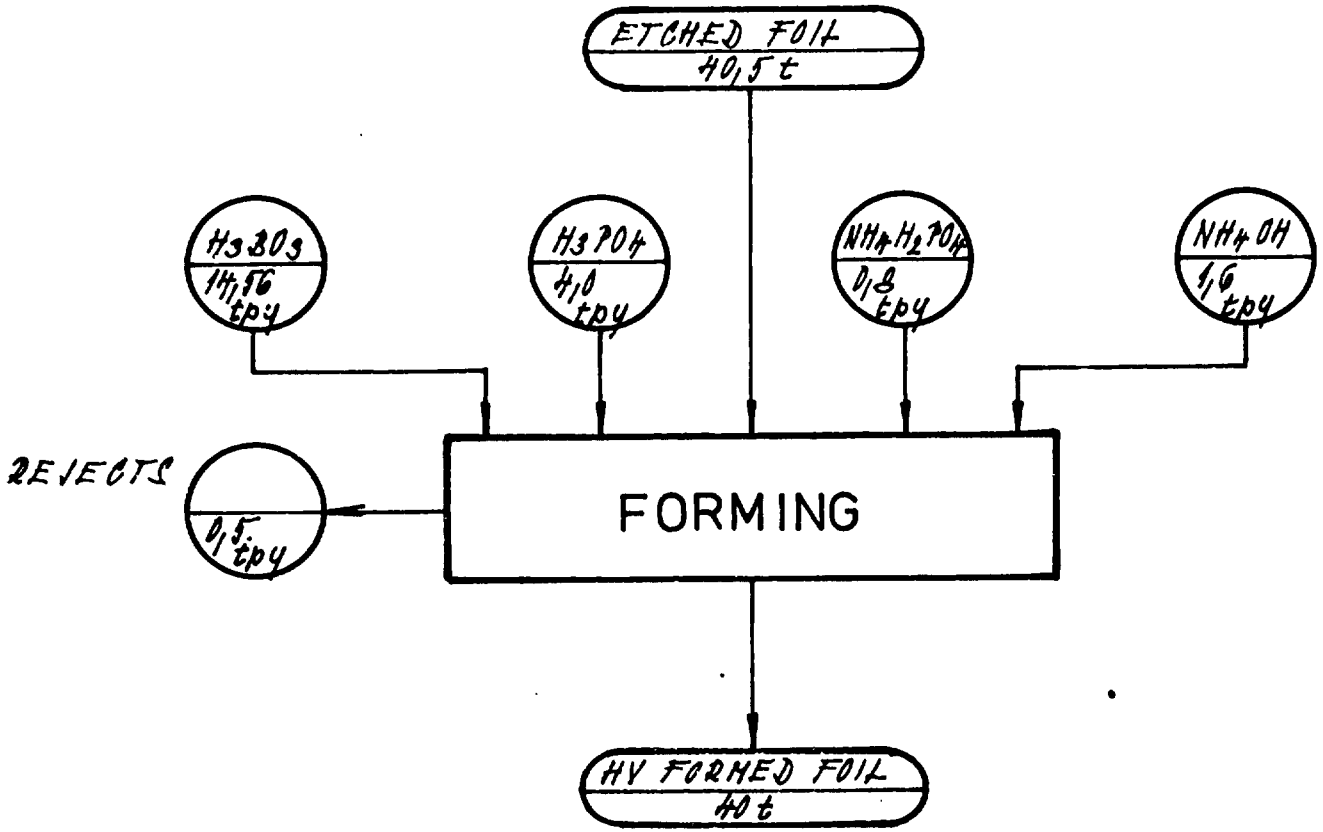


FOIL STORING AND HANDLING

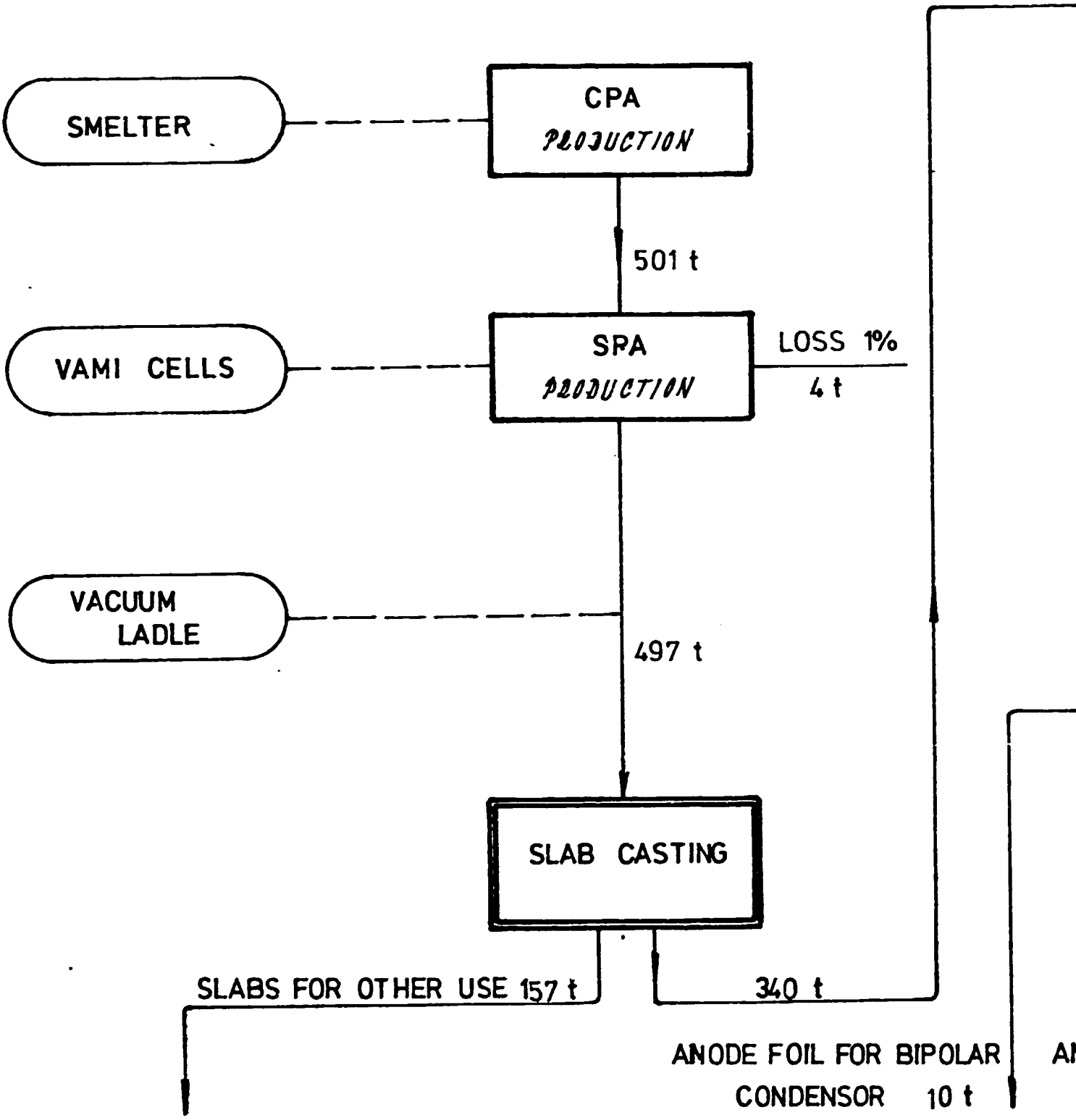


MATERIAL FLOW PER 60 t CATHODE FOIL AND 150 t ANODE FOIL

ETCHING

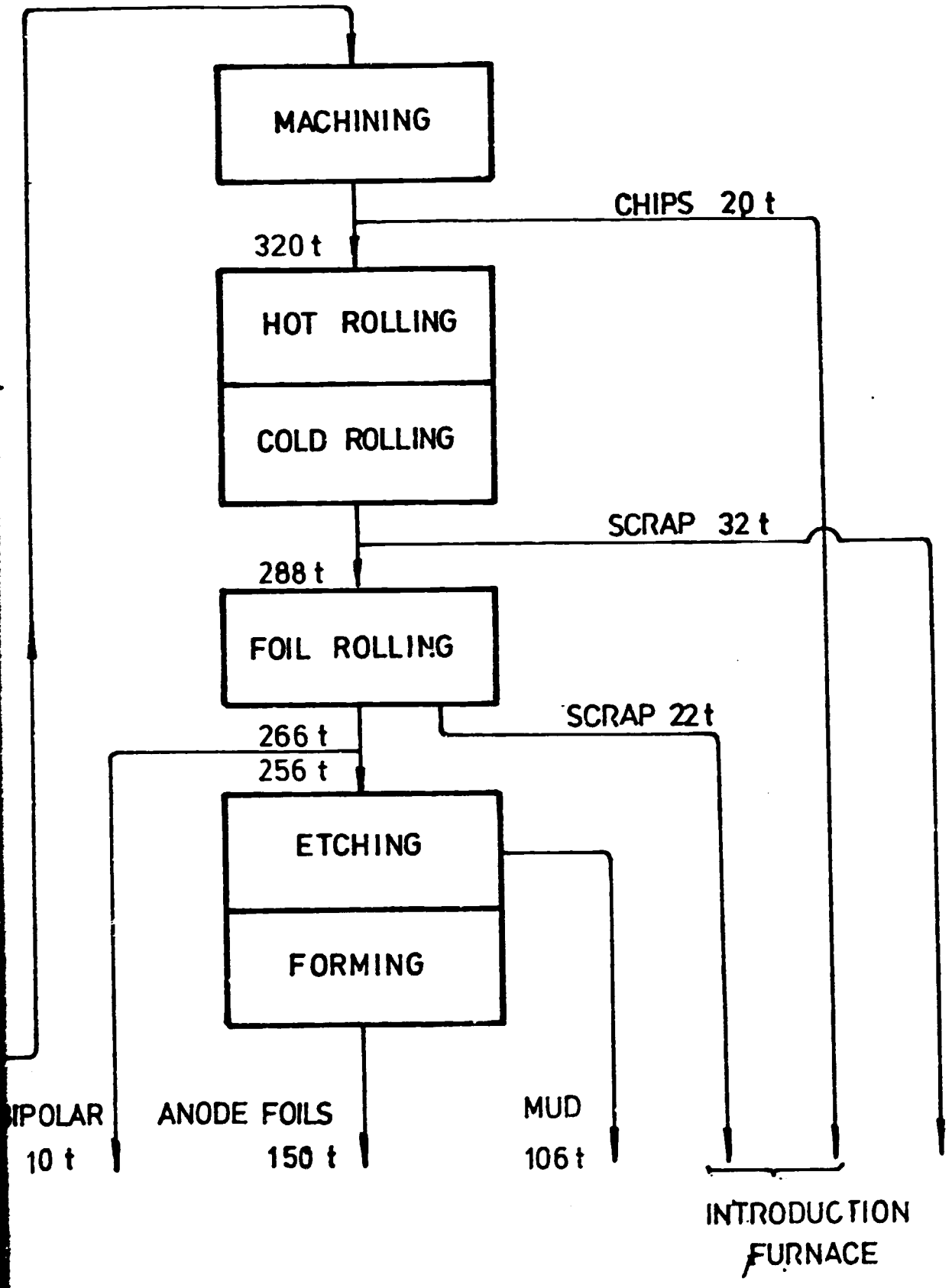


MATERIAL FLOW PER 40 t HIGH VOLTAGE ANODE – FORMING.



SECTION 1 | PRODUCTION OF ANOD

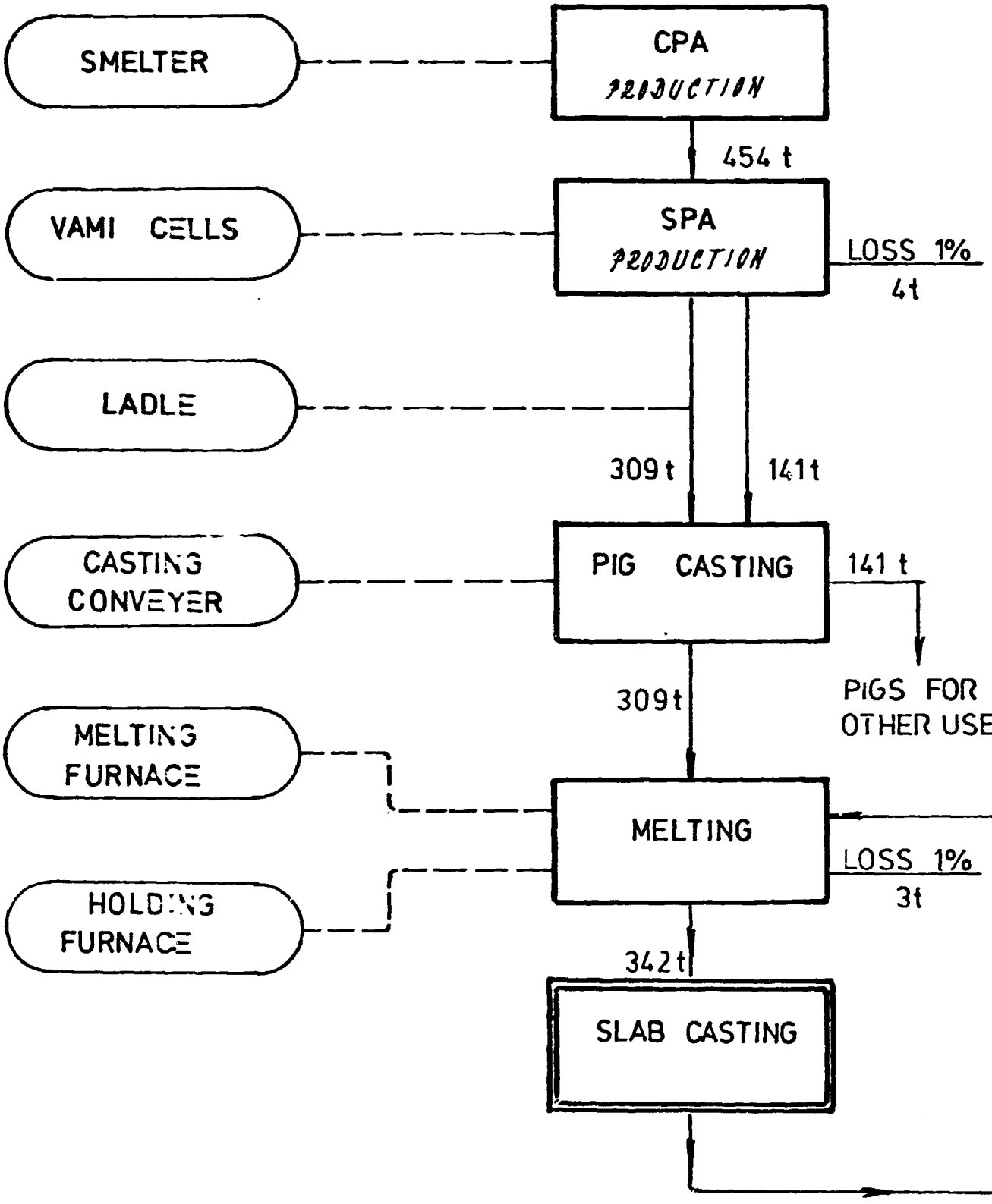
1. METHOD - DIRECT SLAB CASTING



OF ANODE FOIL

CASTING AFTER PURIFICATION.

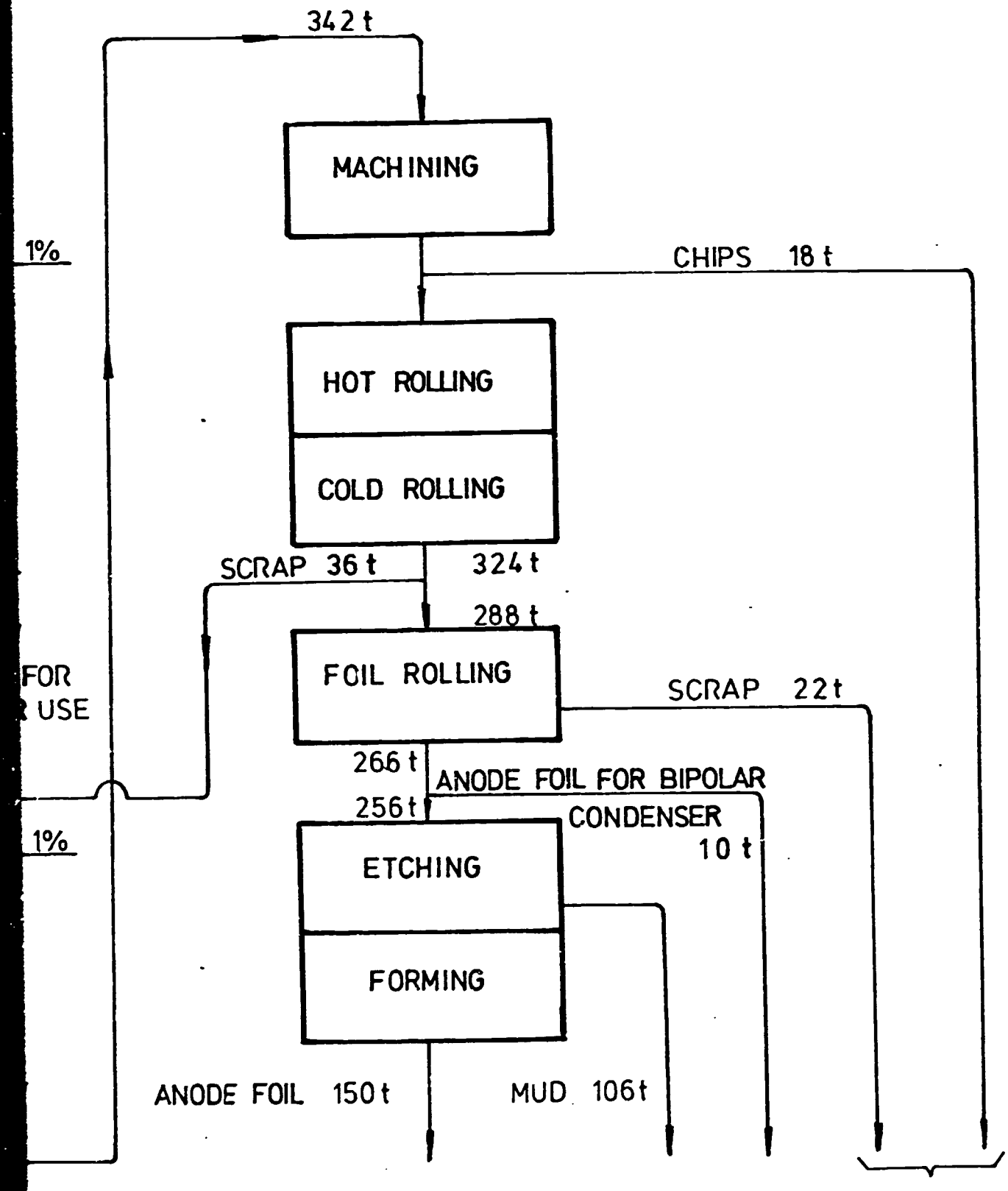
SECTION 2



SECTION 1

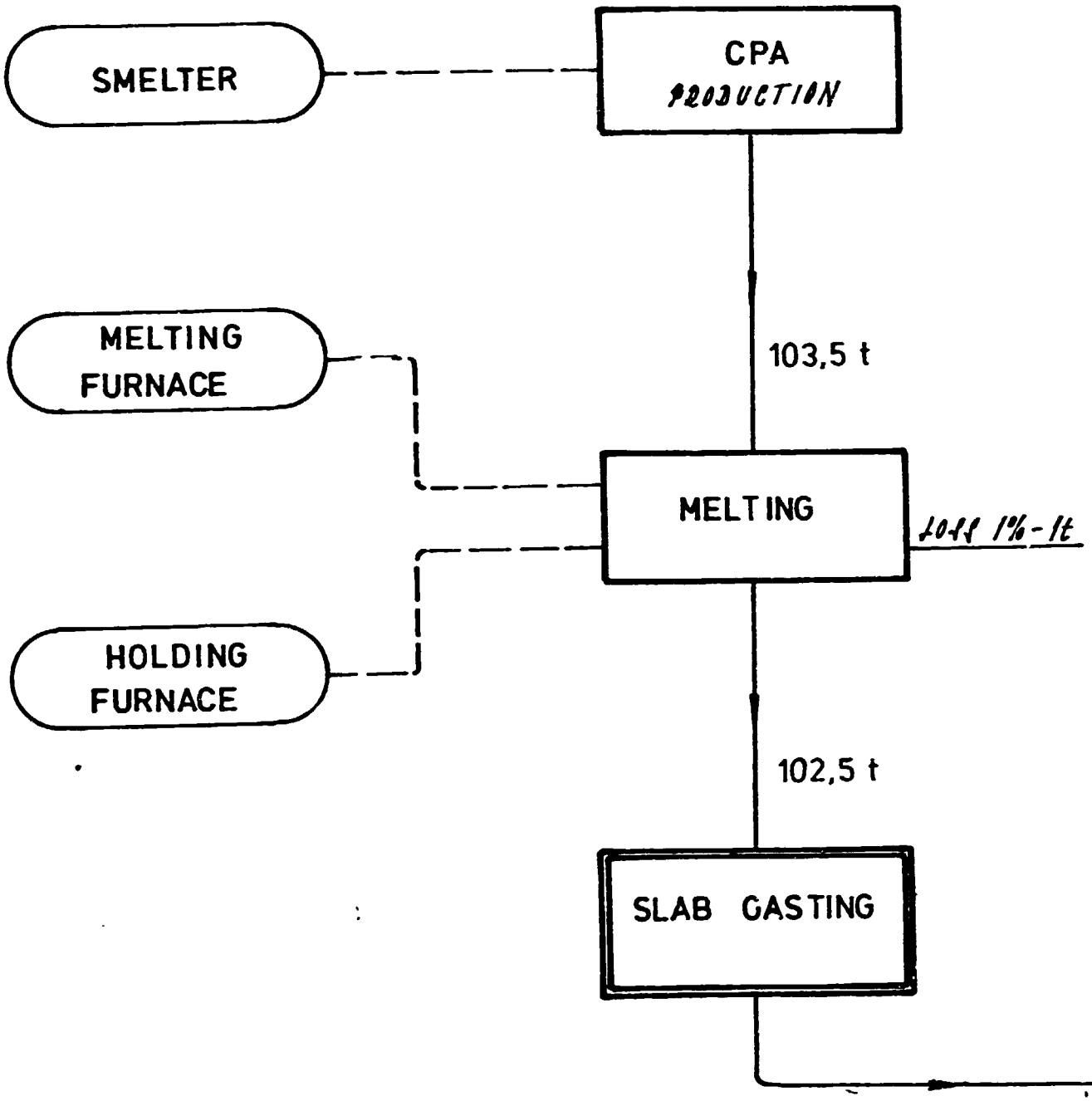
PRODUCTION OF

2. METHOD - SLAB CASTING AFT



N OF ANODE FOIL

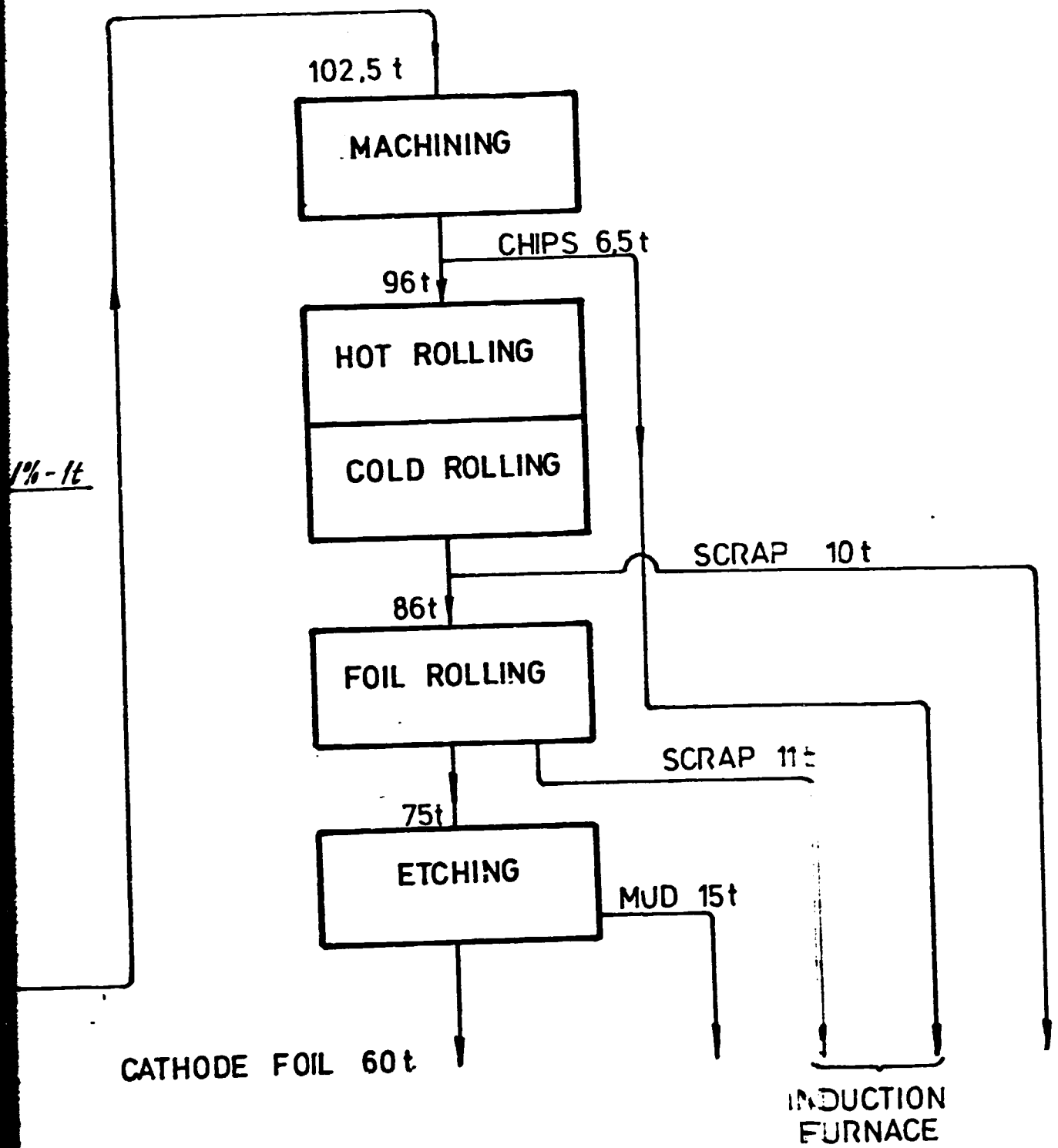
NG AFTER REMELTING OF PIGS AND SCRAP.



PRODUCTION OF CATI

SECTION 1

SLAB CASTI



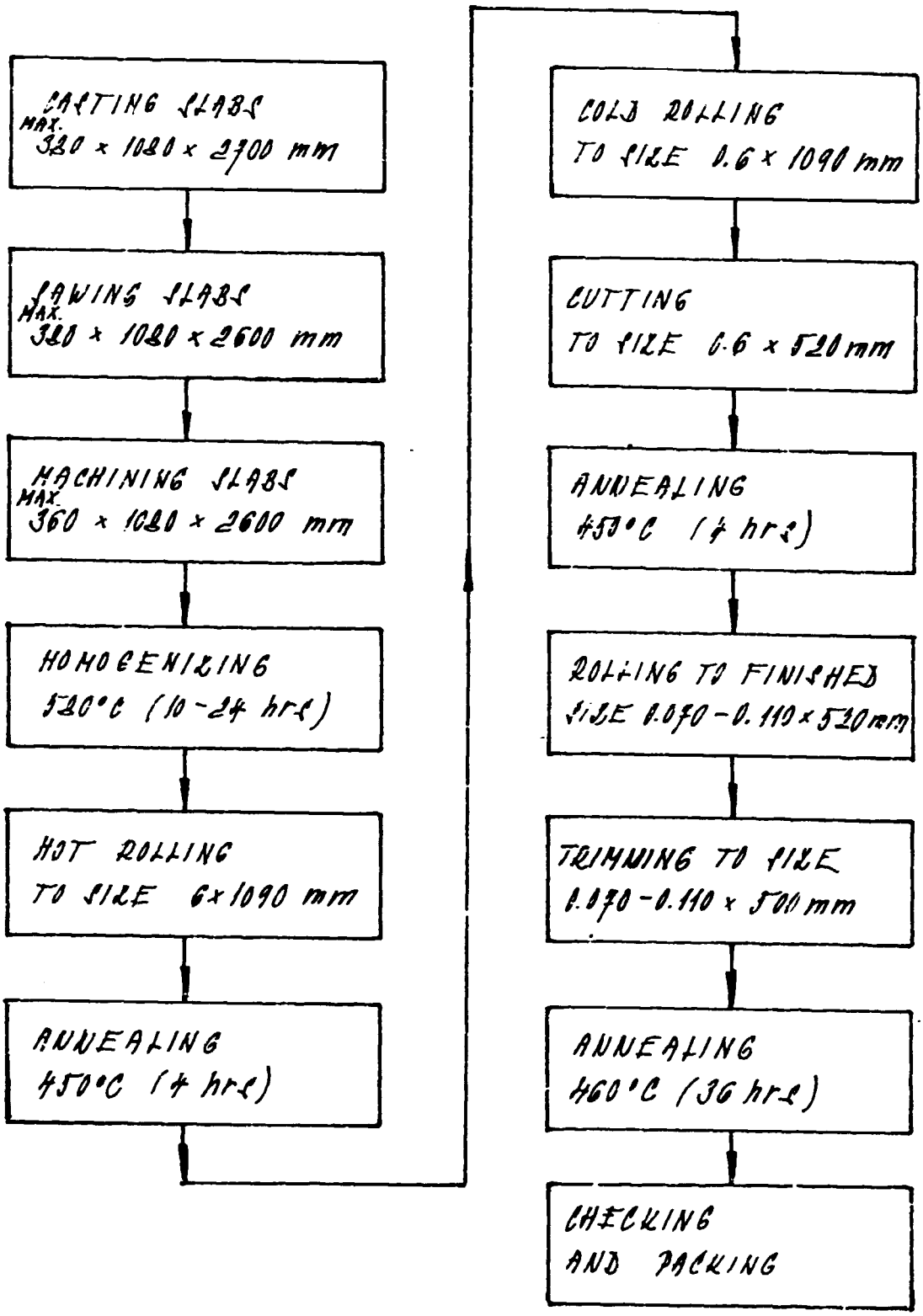
ION OF CATHODE FOIL

SLAB CASTING.

SECTION 2

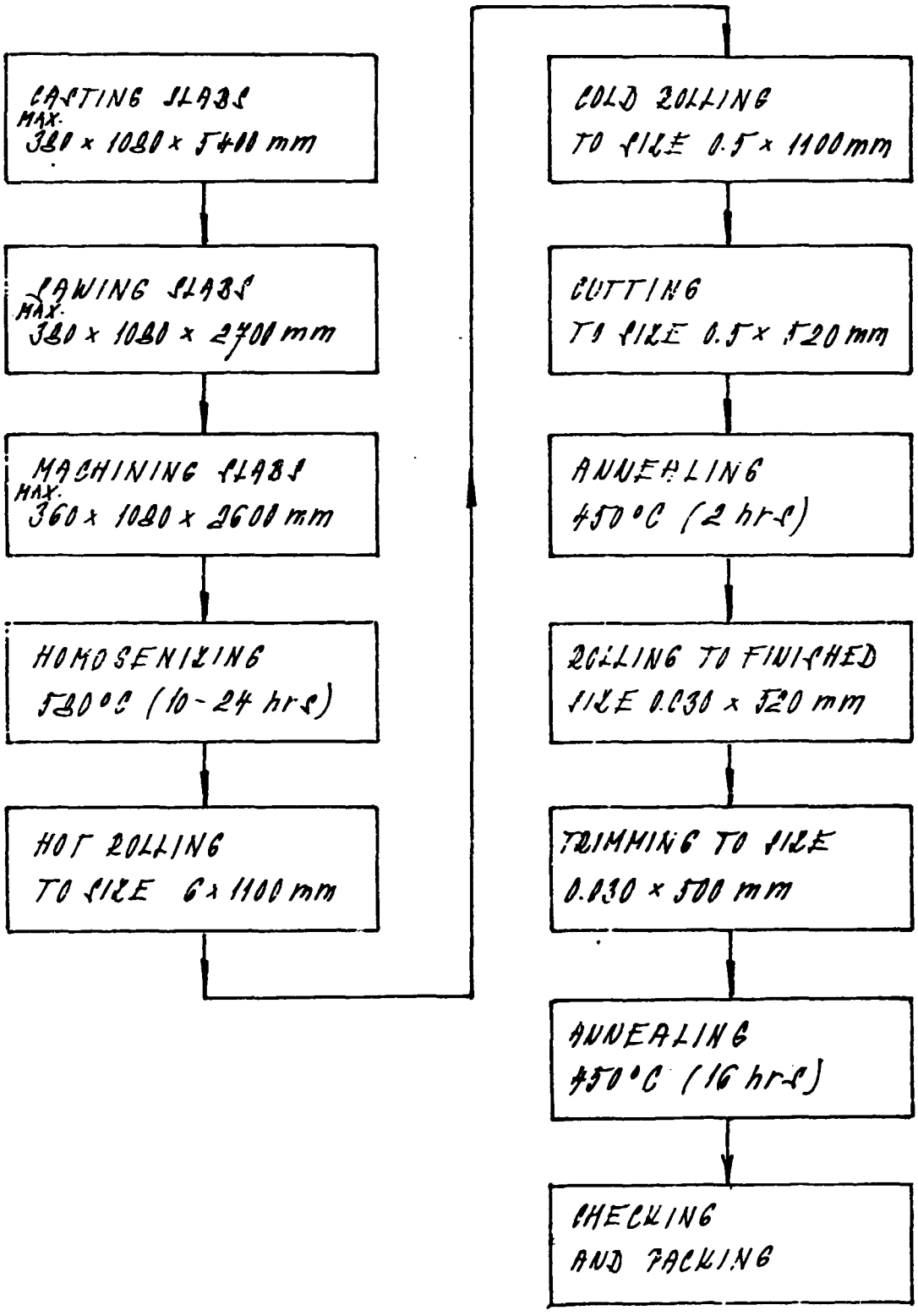
TECHNOLOGY DIAGRAM OF ROLLING OF ANODE FOIL

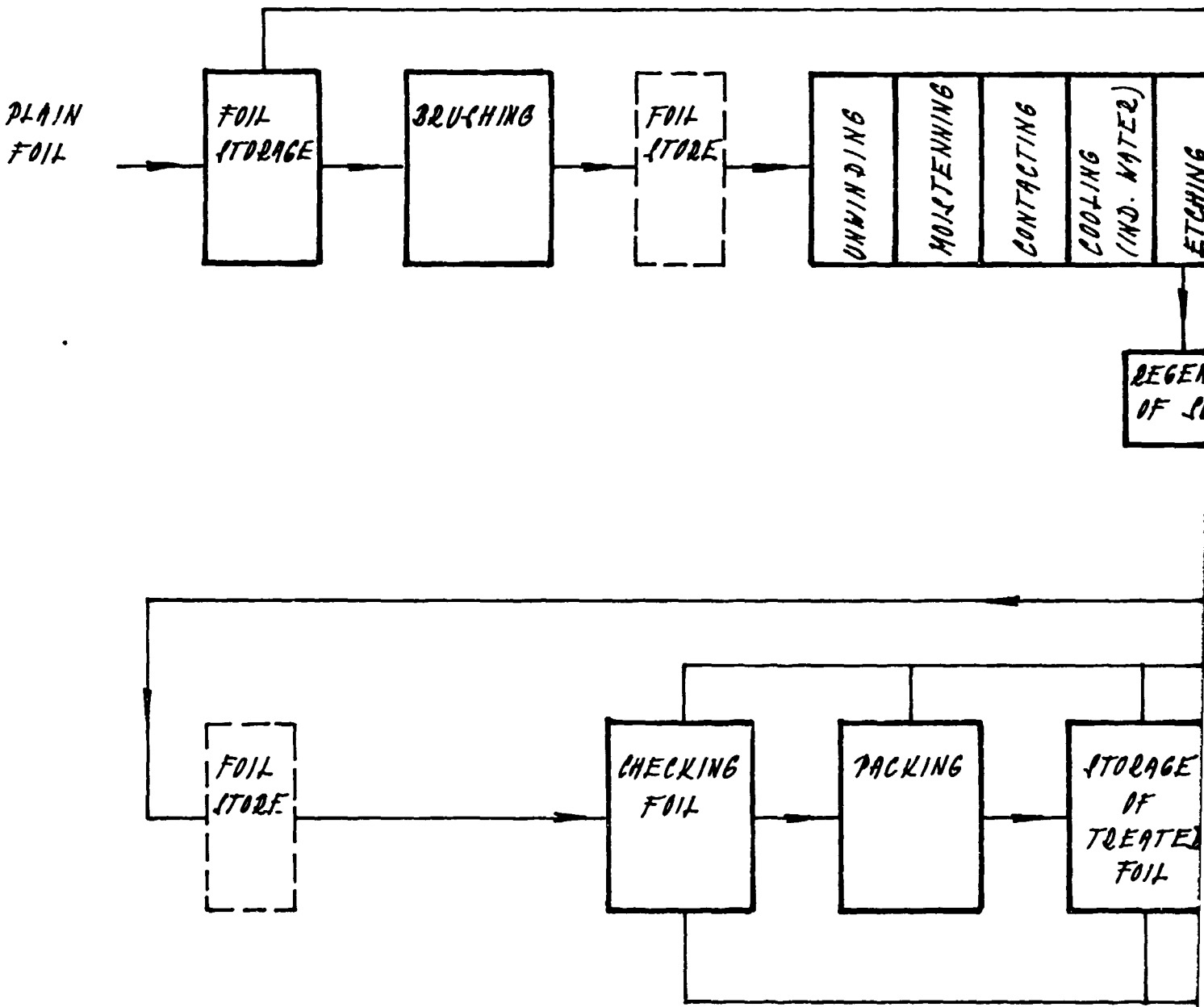
MATERIAL - Al 99.99 % DIMENSION OF FOIL 0.070 - 0.110 x 500 mm
WEIGHT OF COIL - 50-80 kg STATE - SOFT Rm - 80 MPa max.



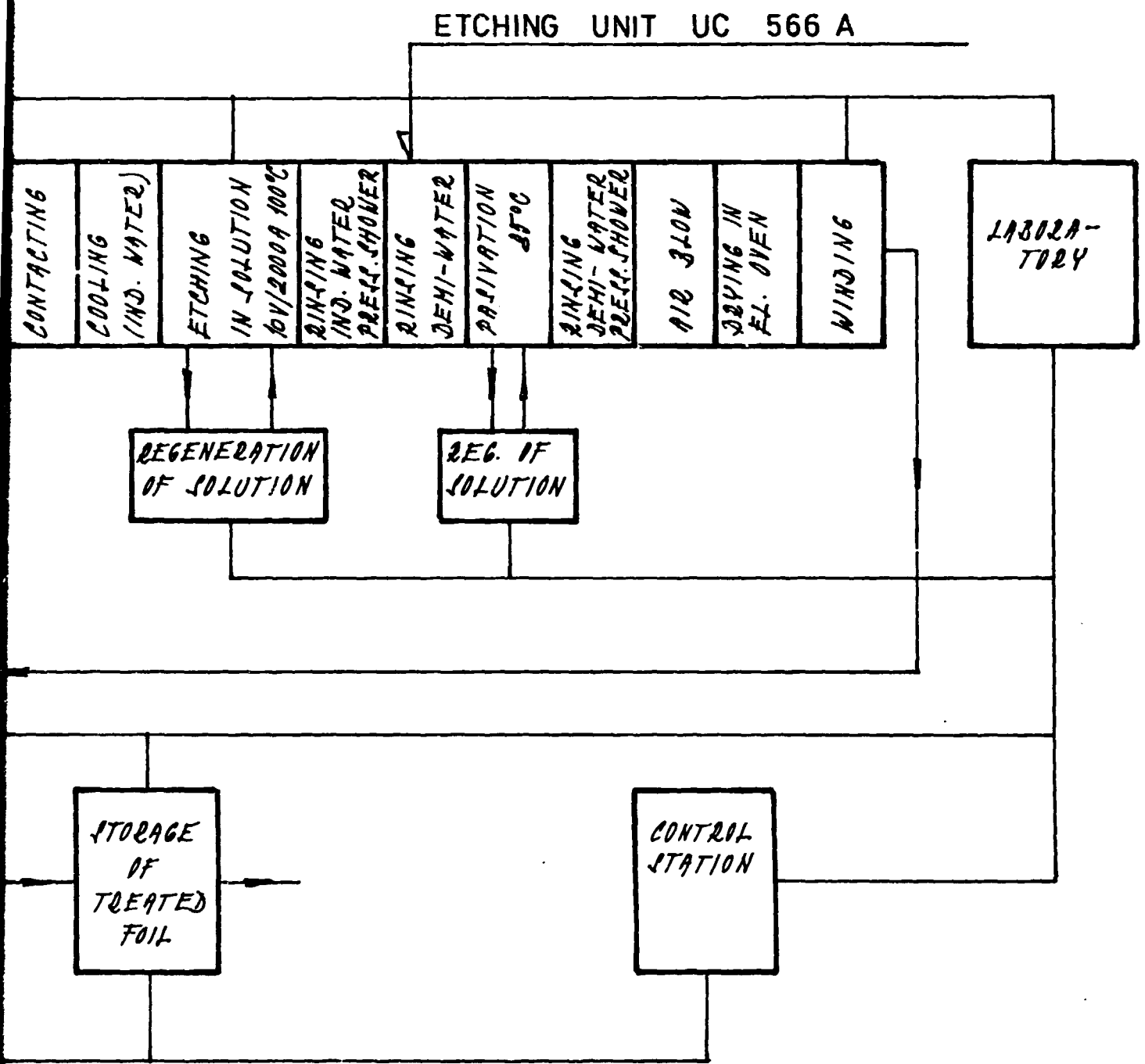
TECHNOLOGY DIAGRAM
OF ROLLING OF CATHODE FOIL

MATERIAL - Al 99.7 %, AlMn, AlCuMn FOIL DIM. - 0.030 x 500mm
WEIGHT OF COIL - 17-20 kg STATE - SOFT σ_m - 90 MPa min.



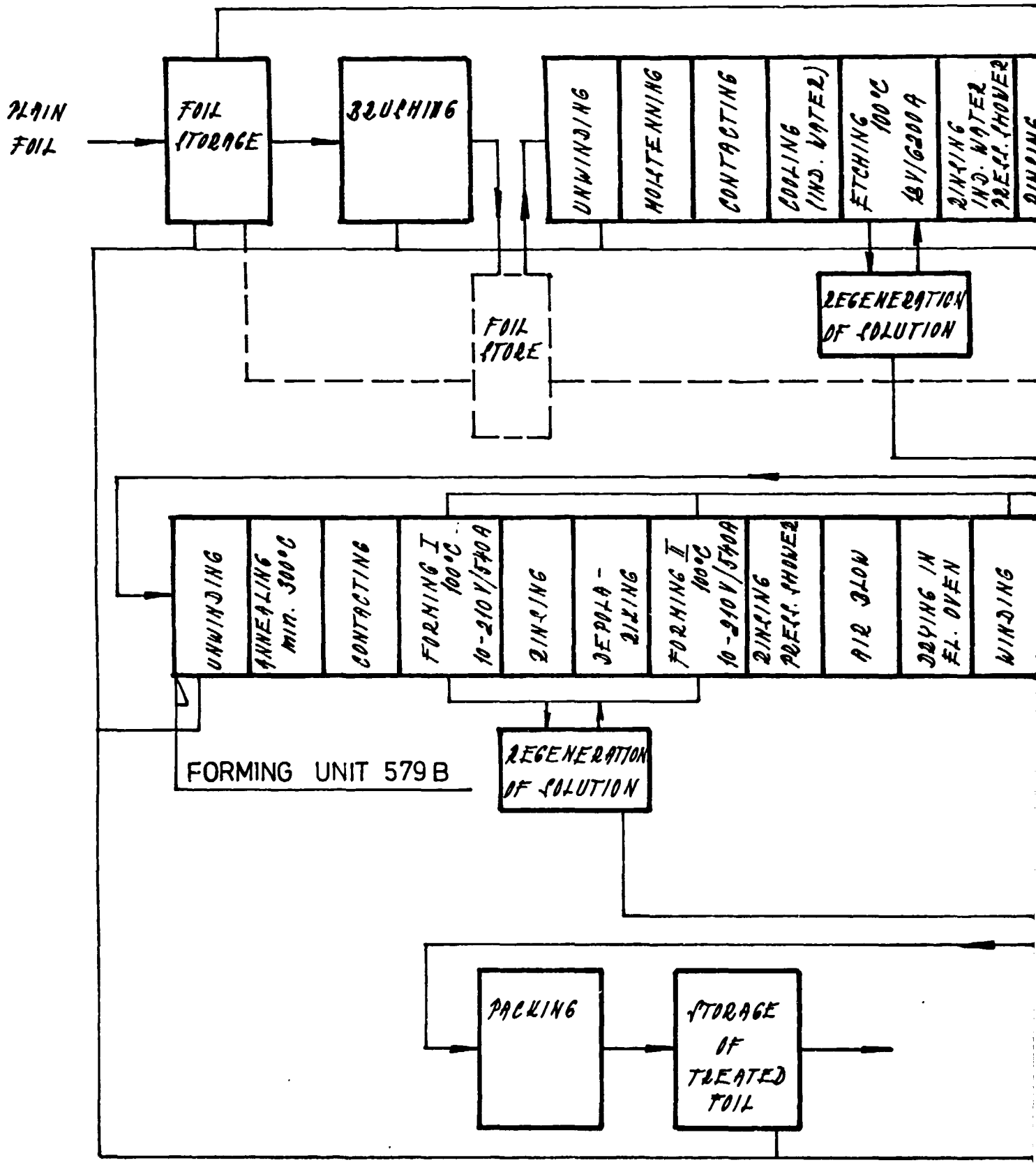

PLAIN FOIL
FOIL STORAGE
BRUSHING
FOIL STORE
UNWINDING
HOLSTENNING
CONTACTING
COOLING (IND. WATER)
ETCHING
REGEN OF
FOIL STORE
CHECKING FOIL
PACKING
STORAGE OF TREATED FOIL

SECTION 1

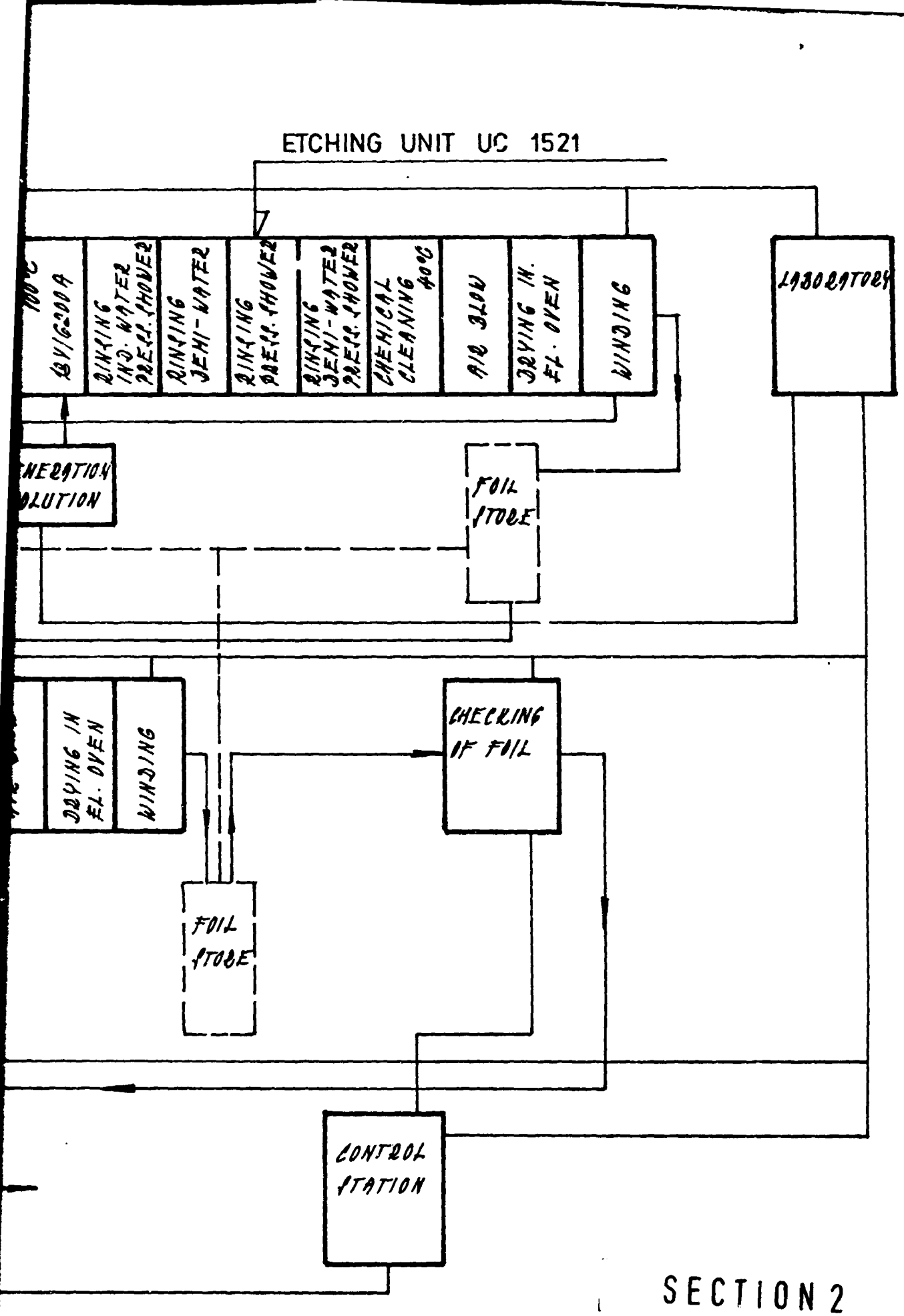


SECTION 2

FLOW CHART OF CATHODE FOIL PRODUCTION

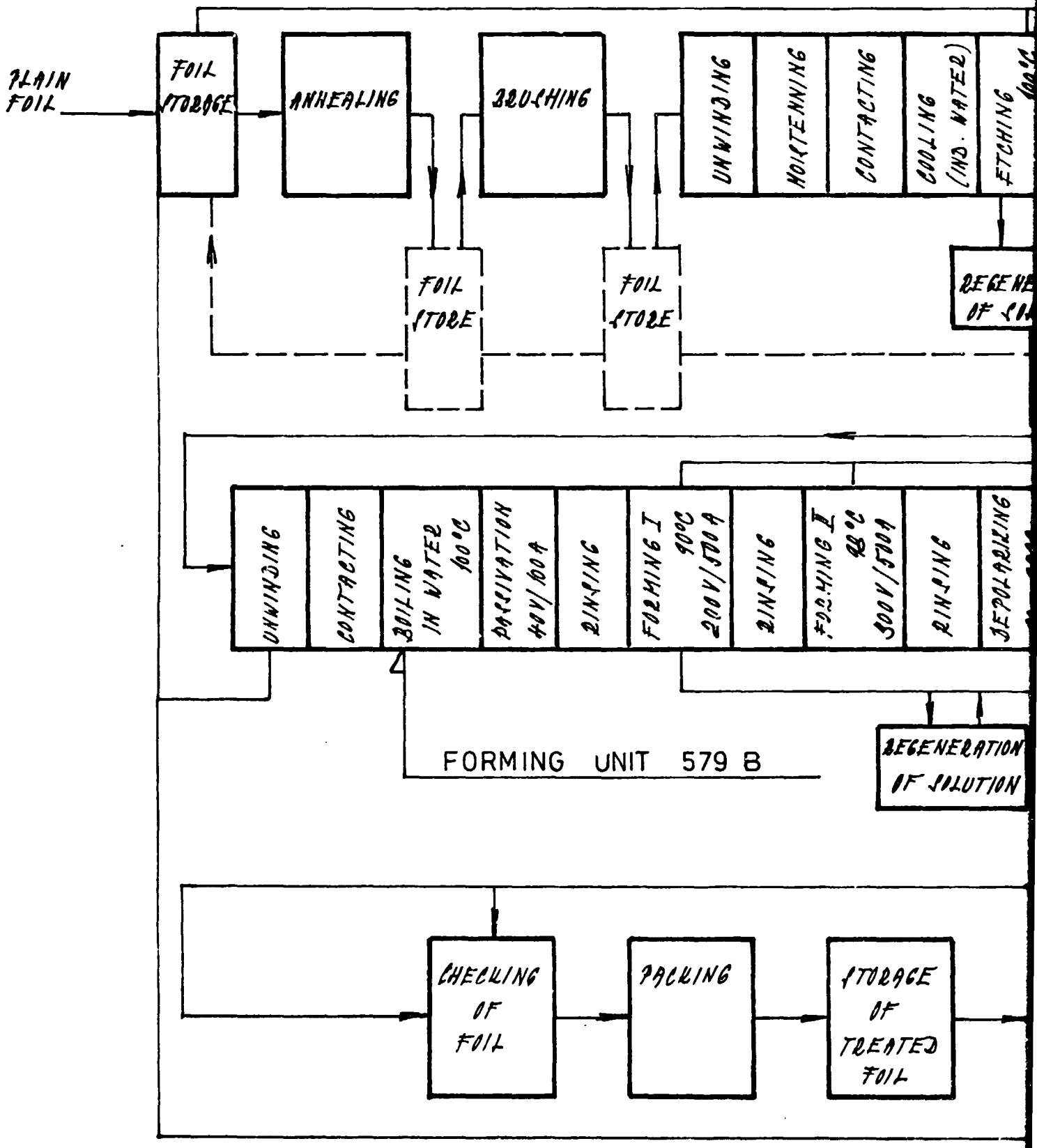

PLAIN FOIL
FOIL STORAGE
BEARBEITUNG
UNWINDING
HOLZTENNING
CONTACTING
COOLING (IND. WATER)
ETCHING 100°C 18V/6200A
RINSING (IND. WATER, REFL. SHOWER)
FOIL STORE
REGENERATION OF SOLUTION
UNWINDING
ANNEALING min. 300°C
CONTACTING
FORMING I 100°C 10-210 V/5400A
RINSING
DEPOLA-RIZING
FORMING II 100°C 10-210 V/5400A
RINSING (REFL. SHOWER)
AIR BLOW
DRYING IN EL. OVEN
WINDING
FORMING UNIT 579 B
REGENERATION OF SOLUTION
PACKING
STORAGE OF TREATED FOIL

SECTION 1

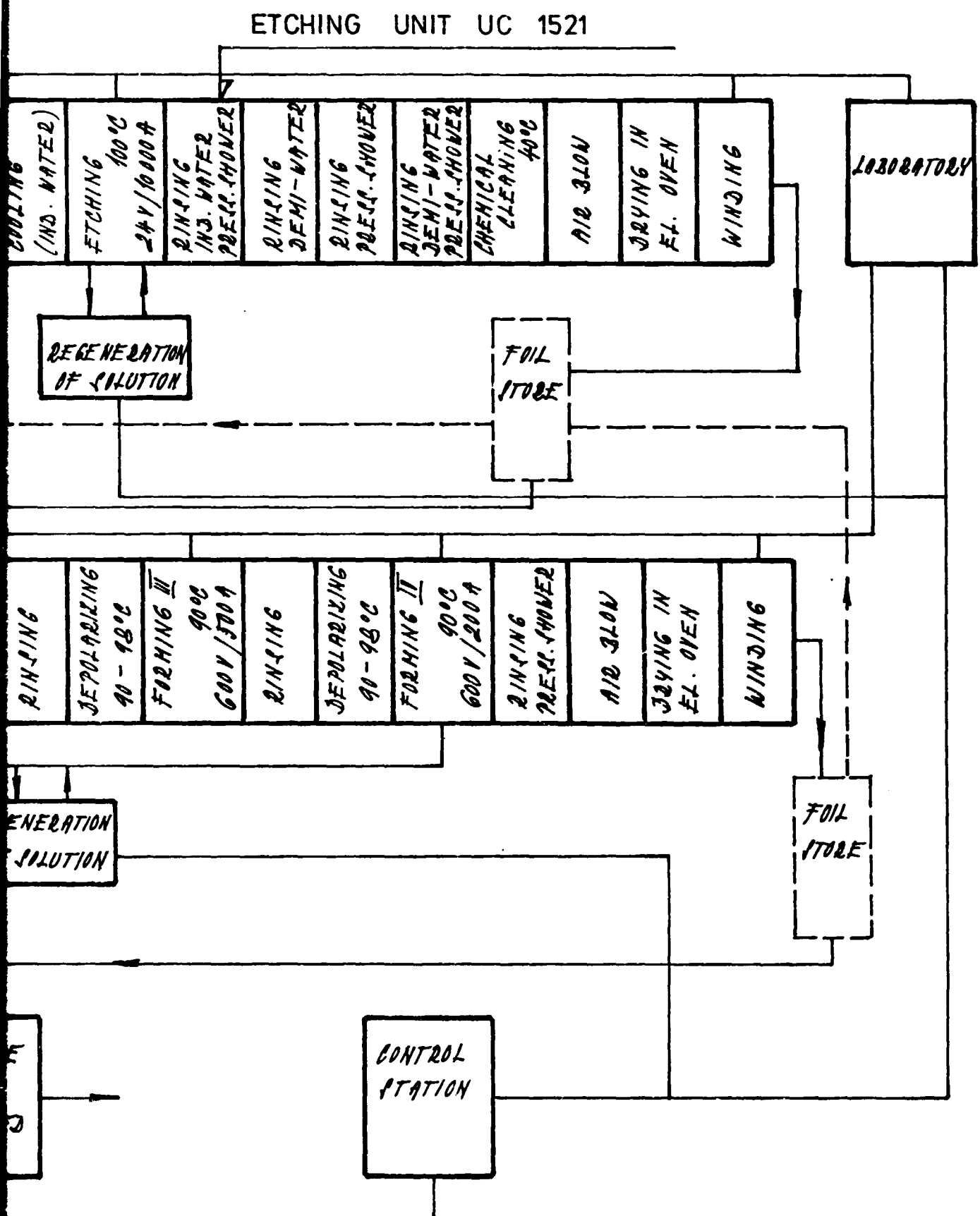


SECTION 2

FLOW CHART OF LV ANODE FOIL PRODUCTION

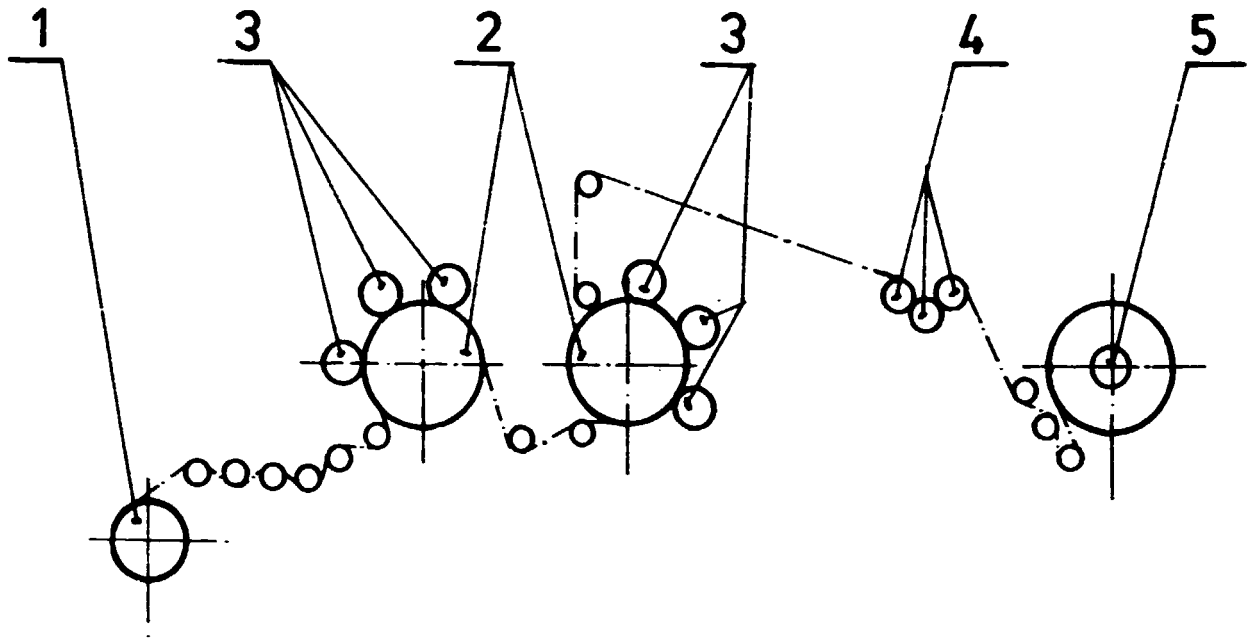

PLAIN FOIL
FOIL STORAGE
ANNEALING
SCORING
UNWINDING
HOLETENNING
CONTACTING
COOLING (IND. WATER)
ETCHING
FOIL STORE
FOIL STORE
REGENE OF SO
UNWINDING
CONTACTING
BOILING IN WATER 100°C
DEFIVATION 40V/60A
RINSING
FORMING I 90°C 200V/5A
RINSING
FORMING II 90°C 300V/10A
RINSING
DEPOLARIZING
REGENERATION OF SOLUTION
FORMING UNIT 579 B
CHECKING OF FOIL
PACKING
STORAGE OF TREATED FOIL

SECTION 1



SECTION 2

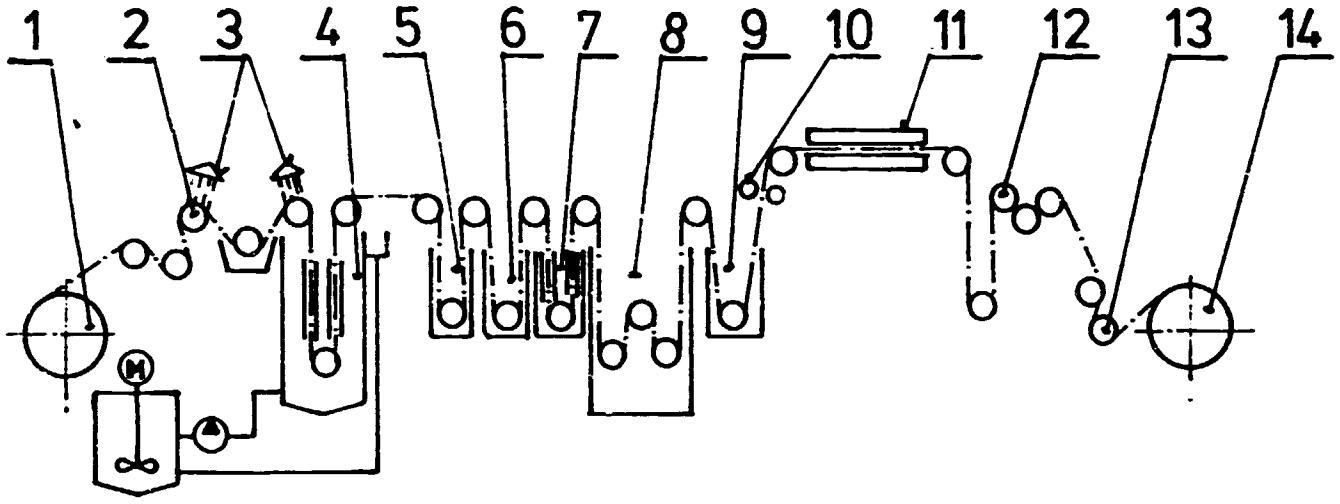
FLOW CHART OF HV ANODE FOIL PRODUCTION



1. FOIL ROLL
2. SUPPORTING ROLLERS
3. BRUSH ROLLERS
4. LIVE ROLLERS
5. WINDING-UP STATION

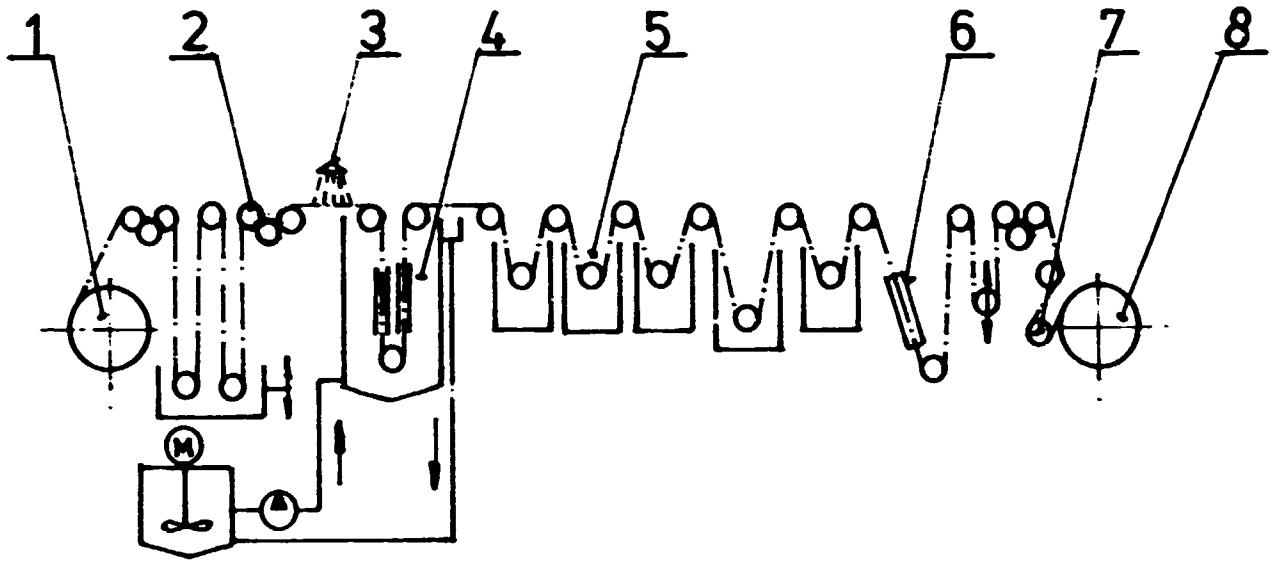
BRUSHING UNIT

UC 536 B



1. UNROLL STATION
2. CONTACTING ROLLERS
3. SHOWER COOLING
4. ETCHING TANK
5. RINSING TANK – RANNINGWATER – 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

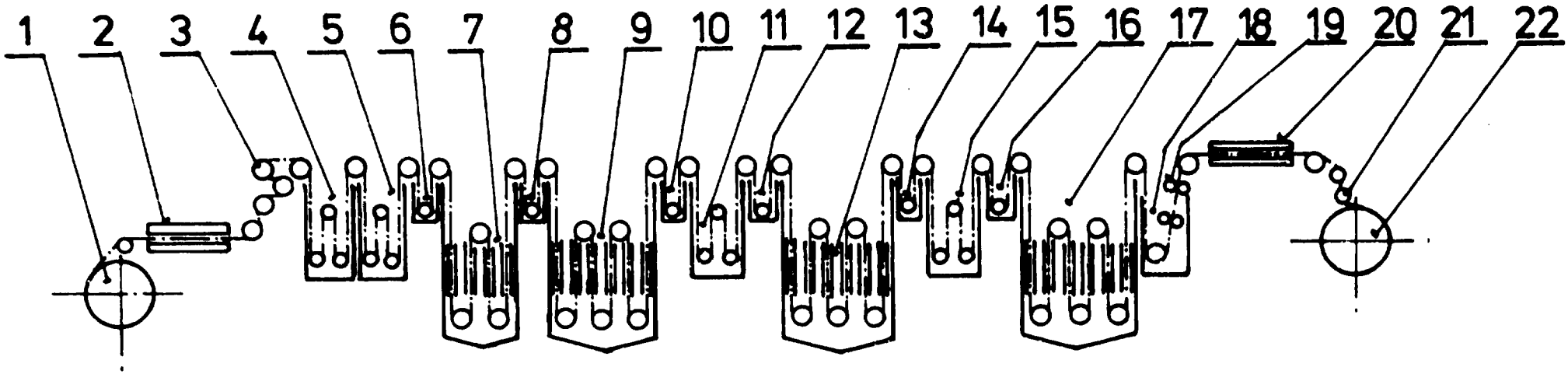
ETCHING UNIT
FOR CATHODE FOIL
UC 566 A



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 UC 1521

6.09



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
UC 579 B

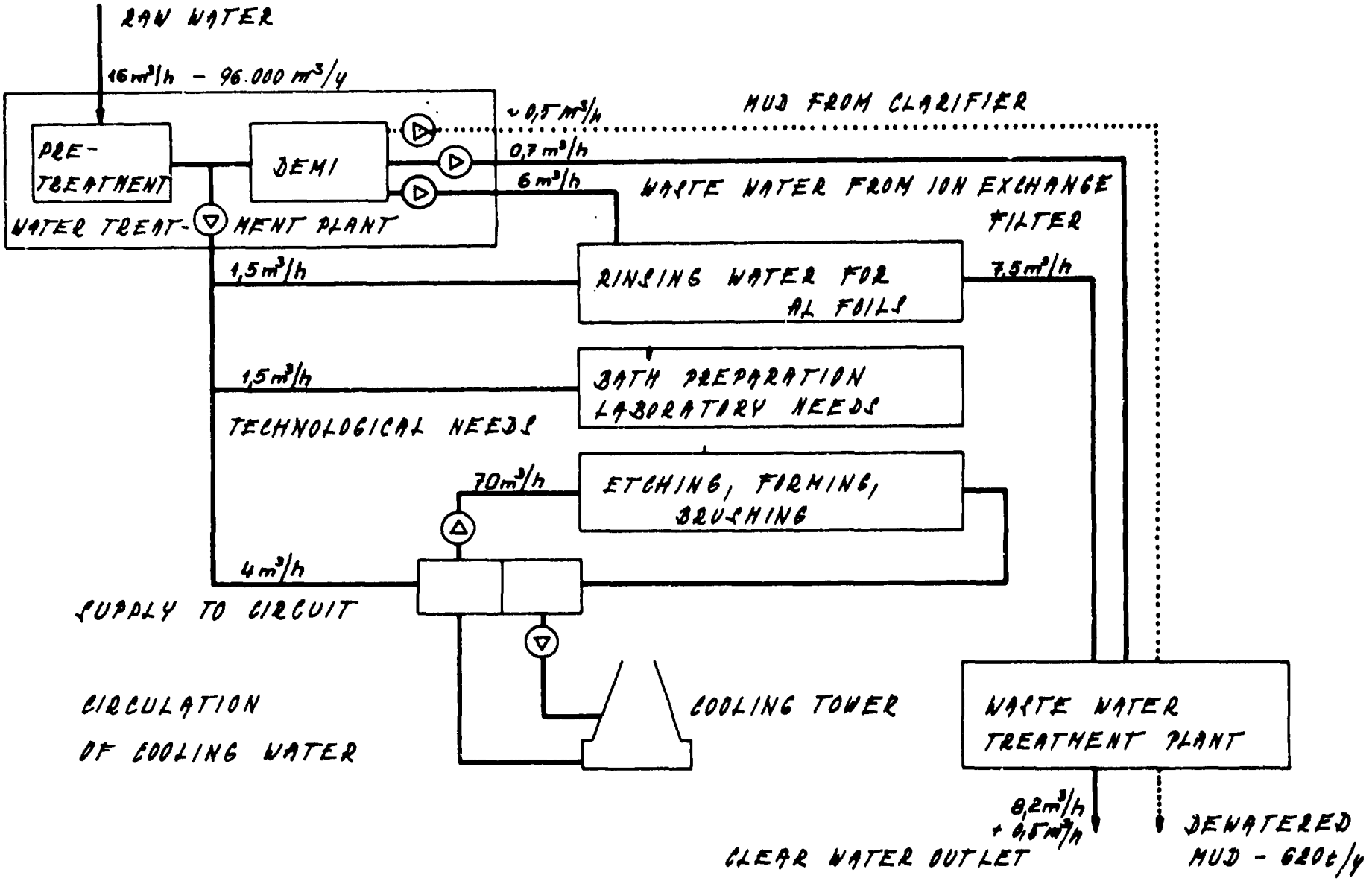


DIAGRAM OF INDUSTRIAL WATER UTILIZATION

NOTE: EXPLANATION TO FIG. 1-10
IS SHOWN ON FOLLOWING PAGE

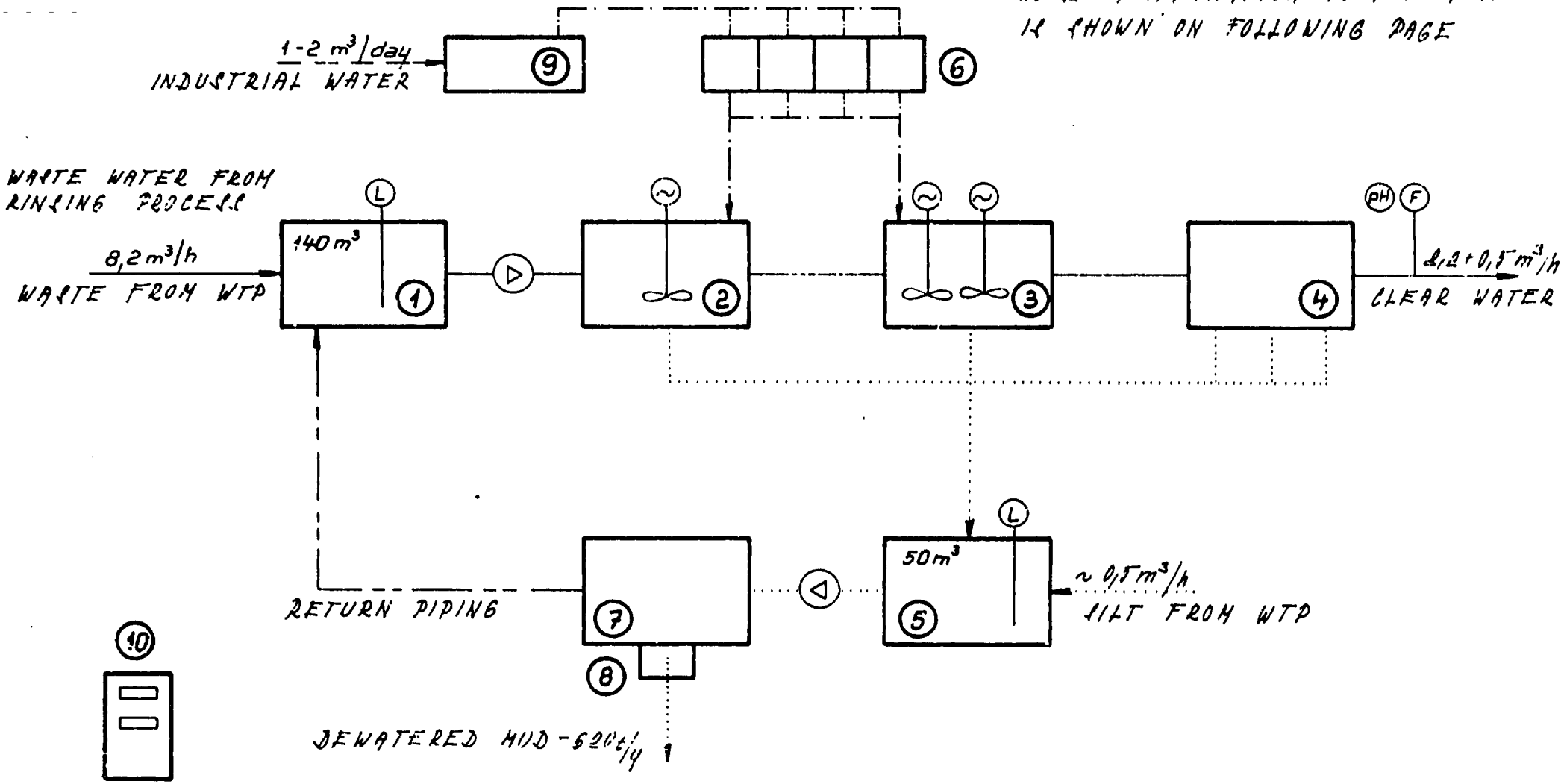


DIAGRAM OF WASTE WATER TREATMENT PLANT /WWTP/

Diagram of waste water treatment plant

Figure

1 Storage and settling tanks

2 Reactor 1 m^3

3 Flocculation 3 m^3

4 Compact plated settler

5 Mud reservoir

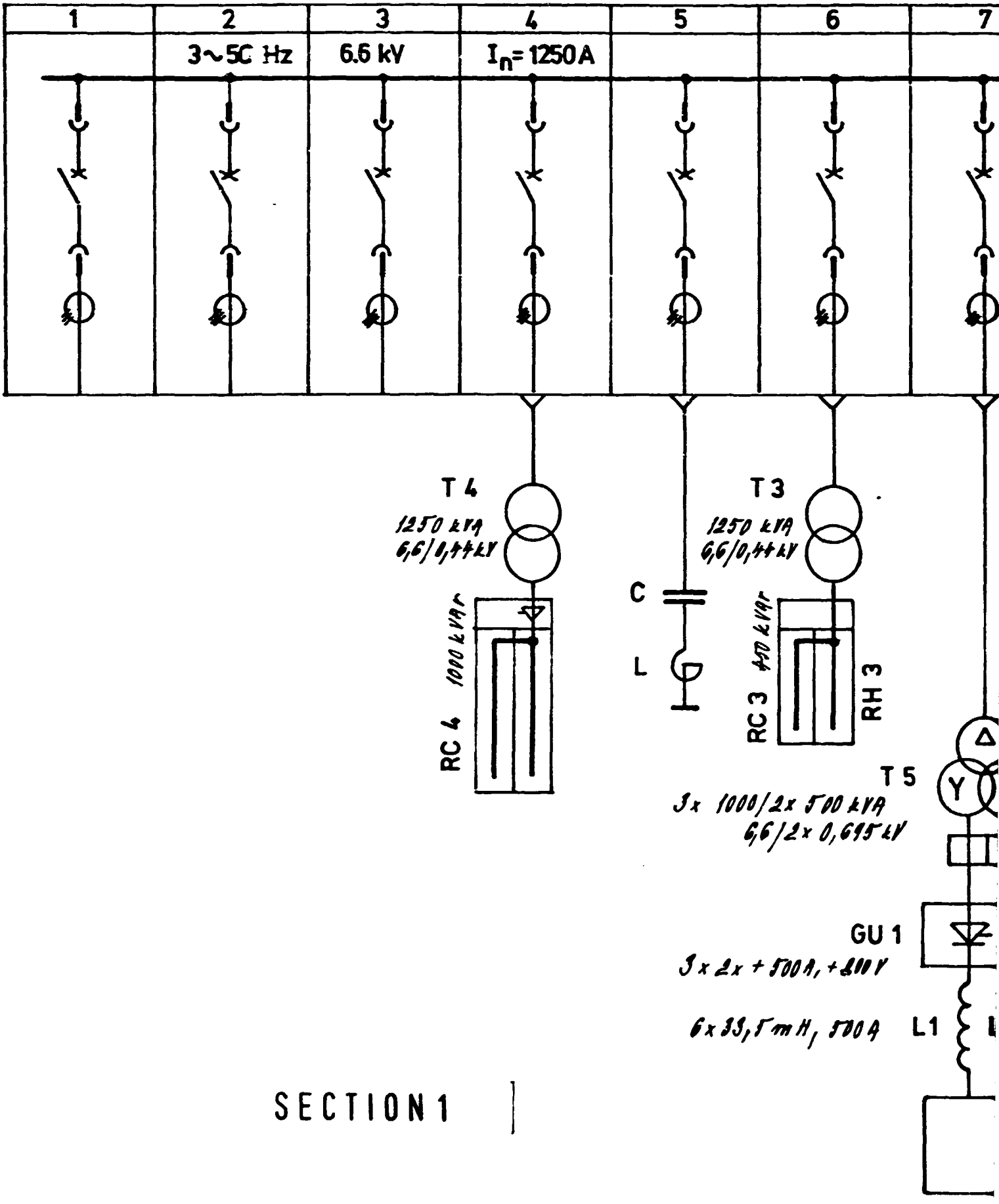
6 Storage containers of chemicals with dosing pums

7 Belt press

8 Container for dewatered mud

9 Container for preparation of reactive agent

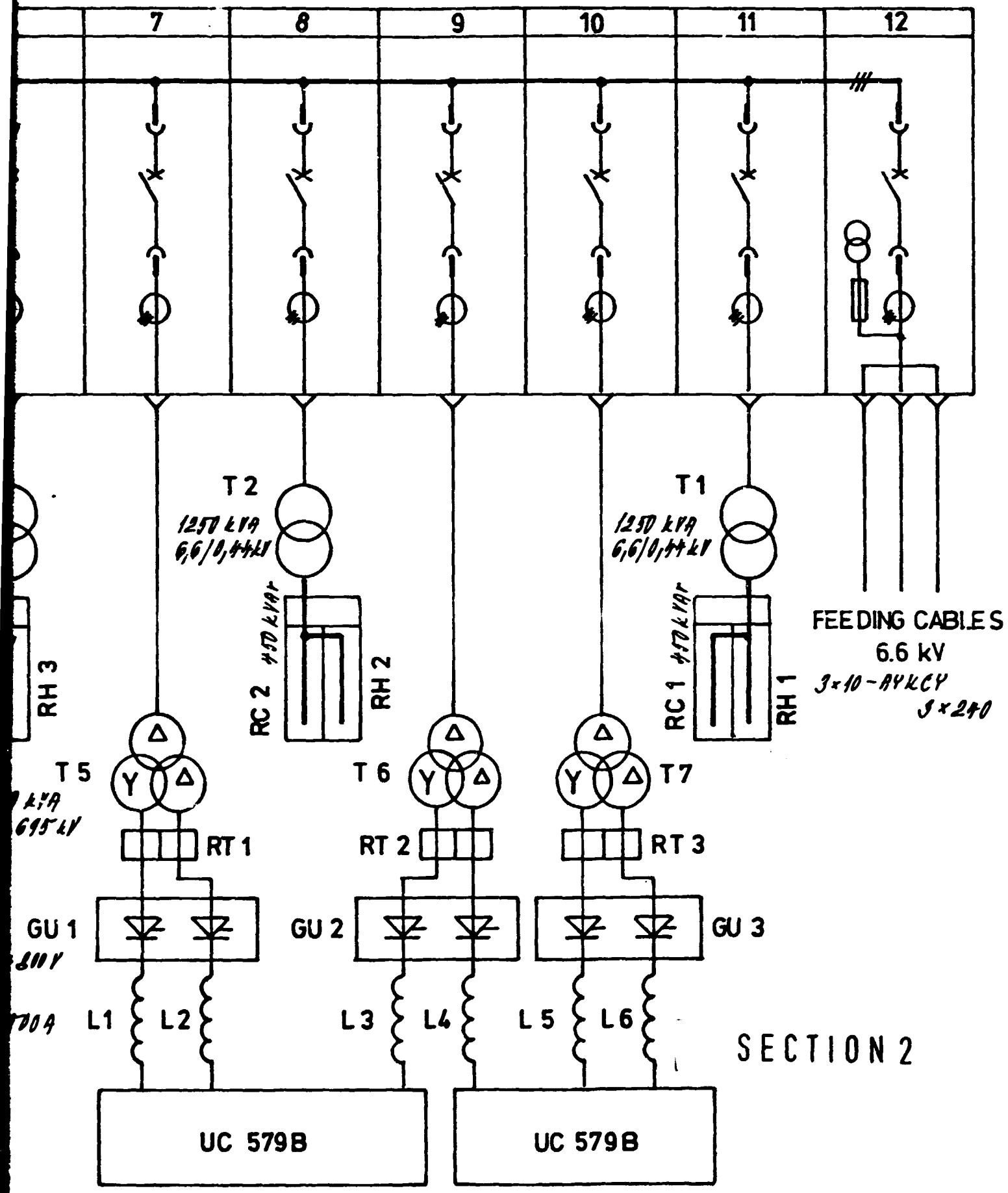
10 Control panel



SECTION 1

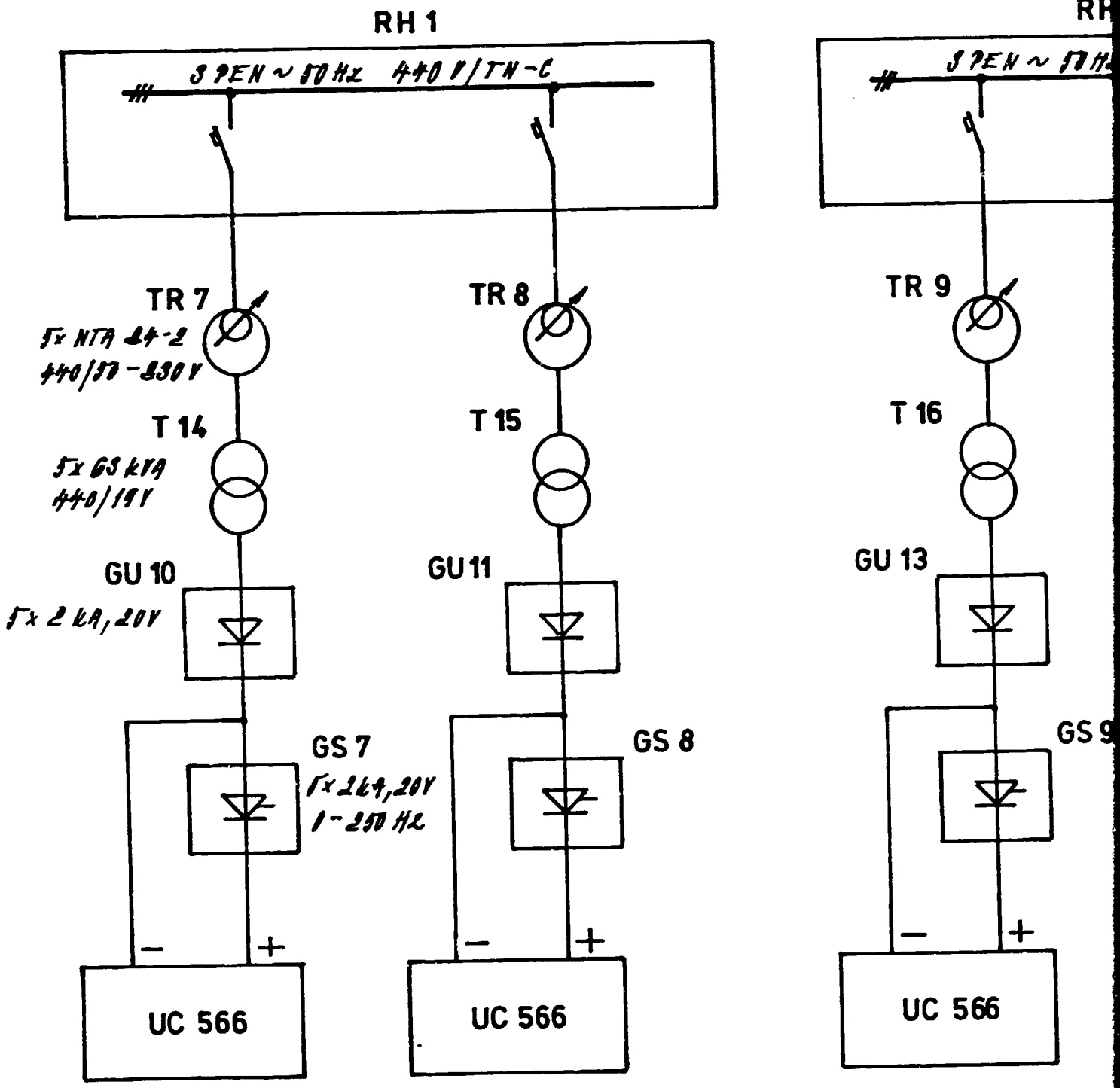
SUBSTATION 6.6 kV; POWER SC

WIRING



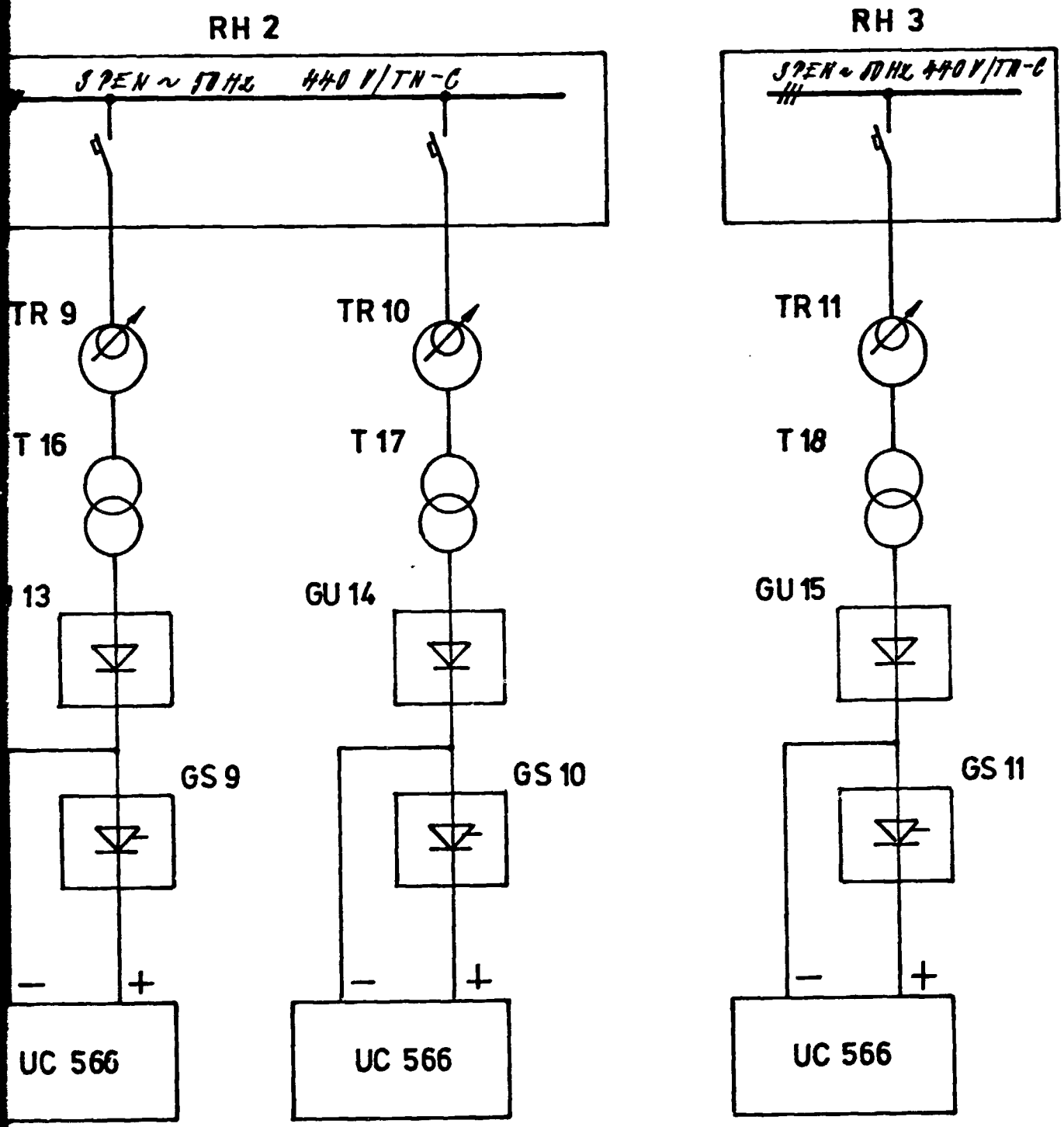
POWER SOURCES FOR FORMING, COMPENSATION cos φ

WIRING DIAGRAM



SECTION 1

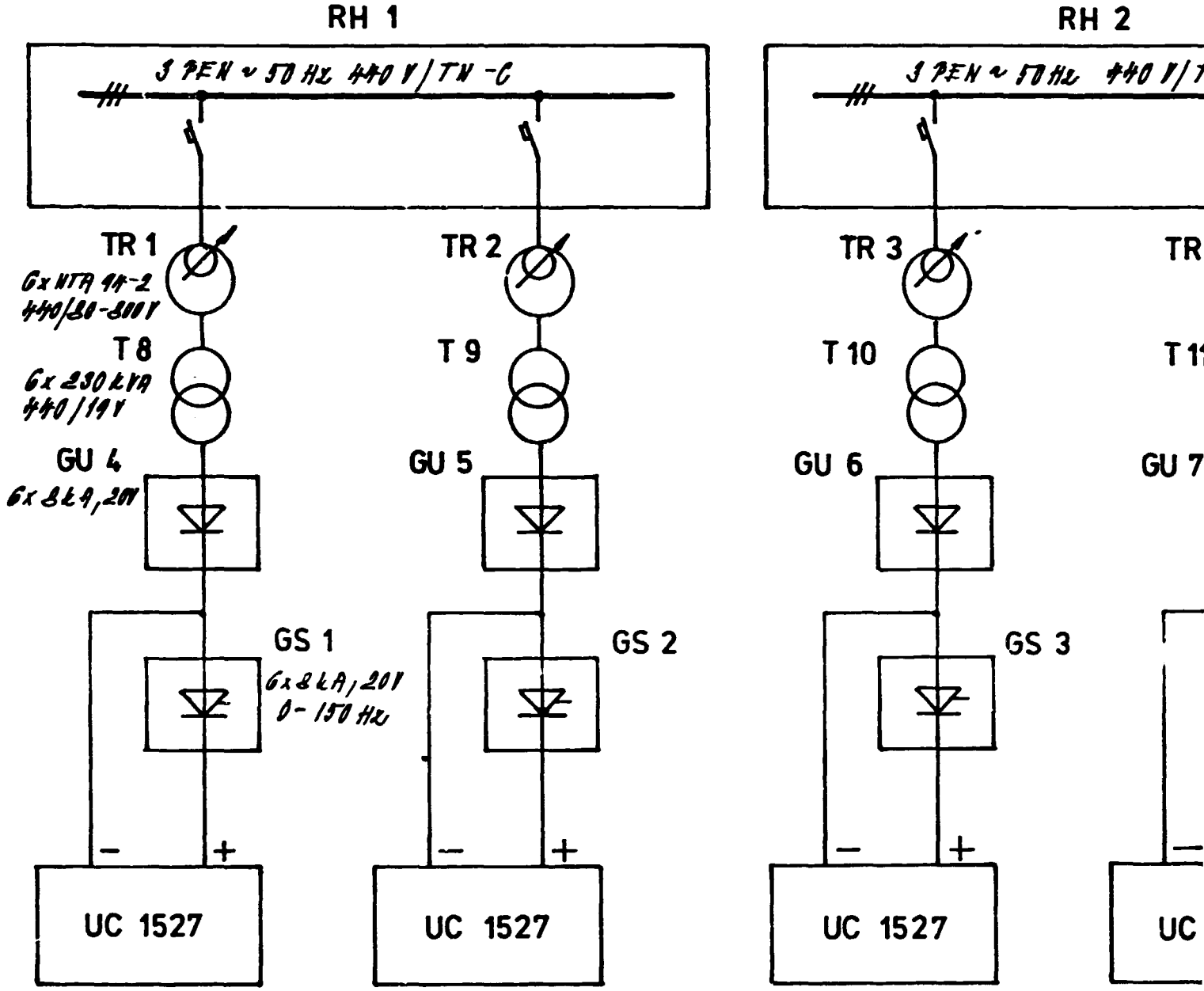
D.C. PO



SECTION 2

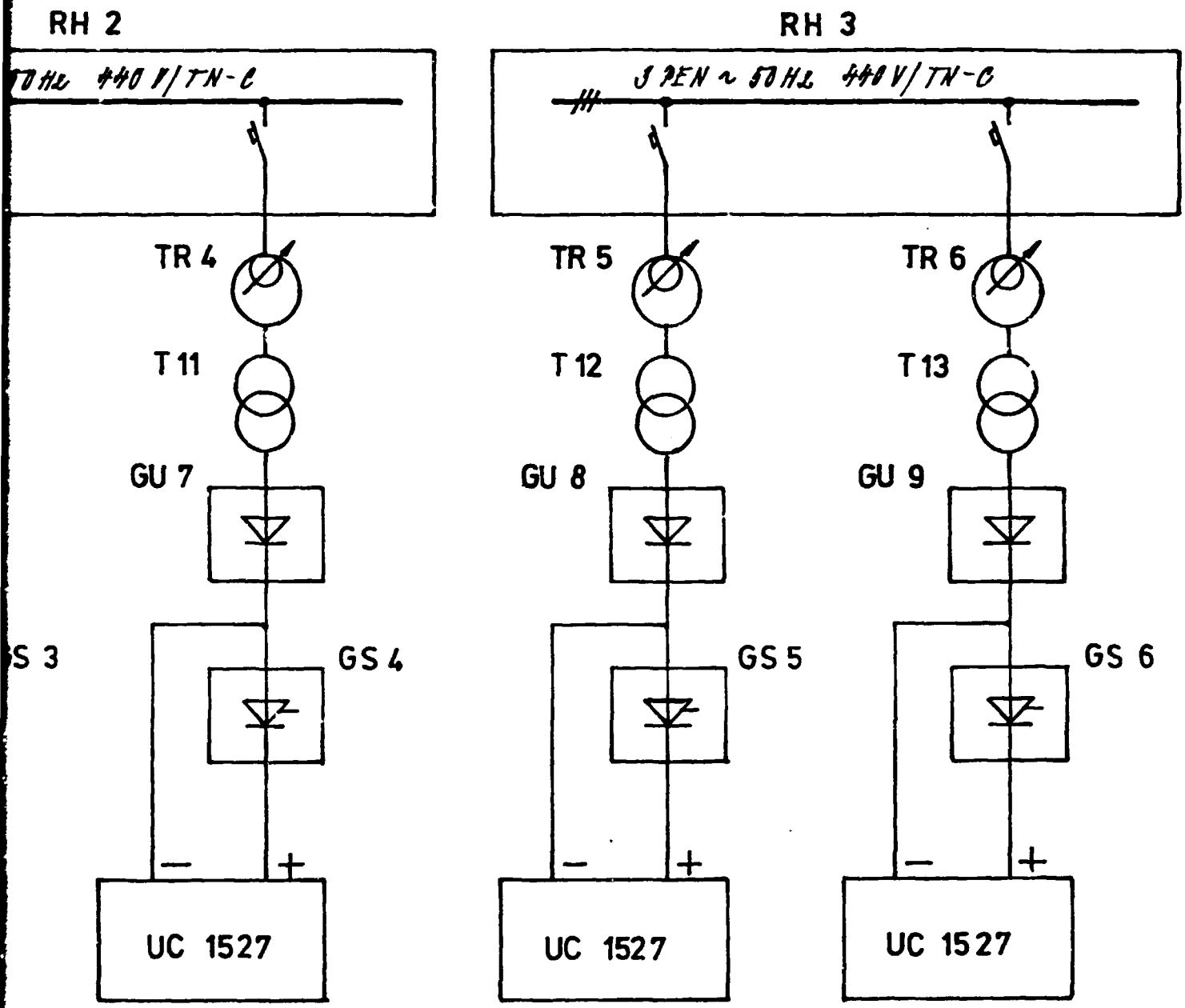
D.C. POWER SOURCES FOR ETCHING, 2 kA, 20V

WIRING DIAGRAM



SECTION 1

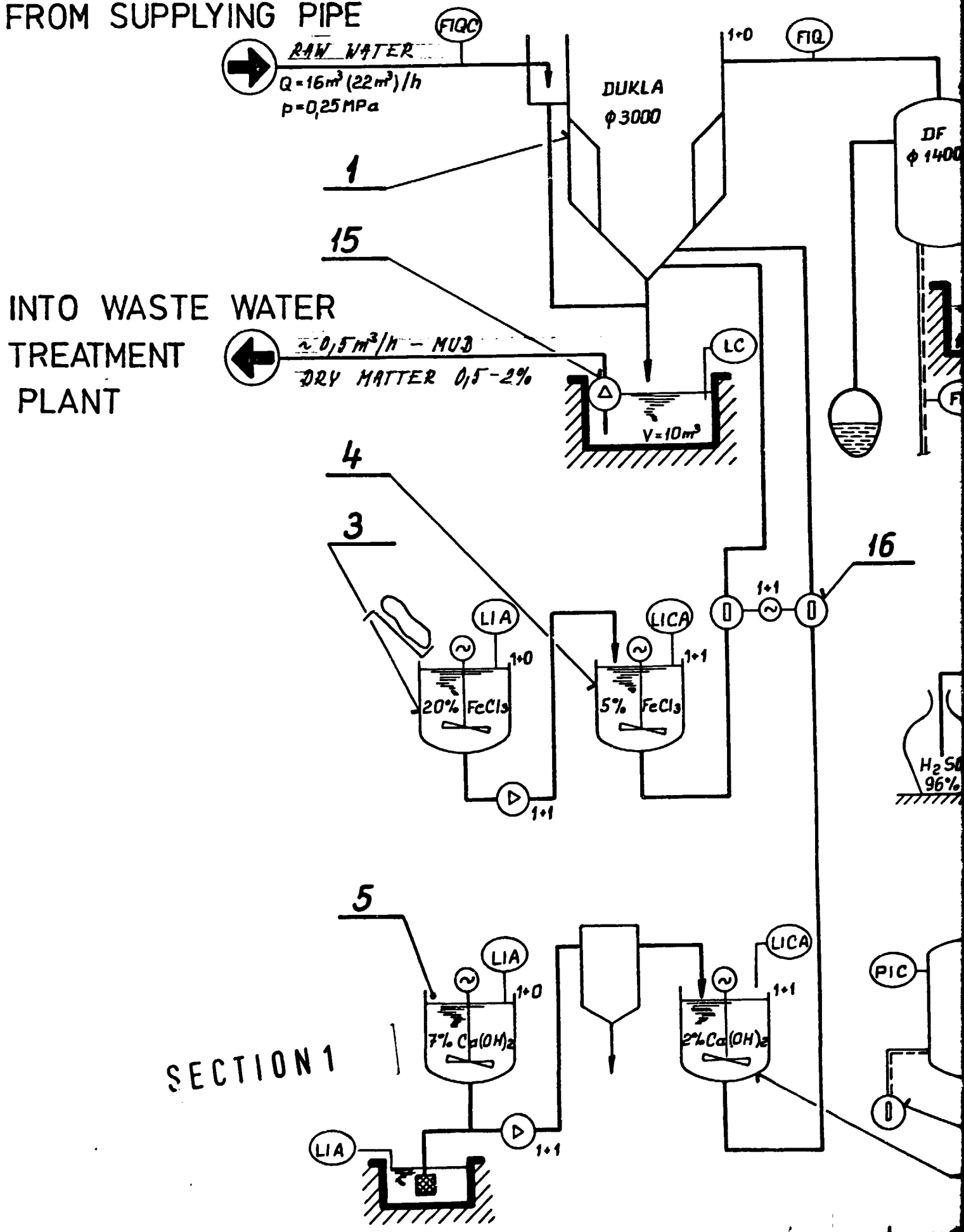
D.C. F

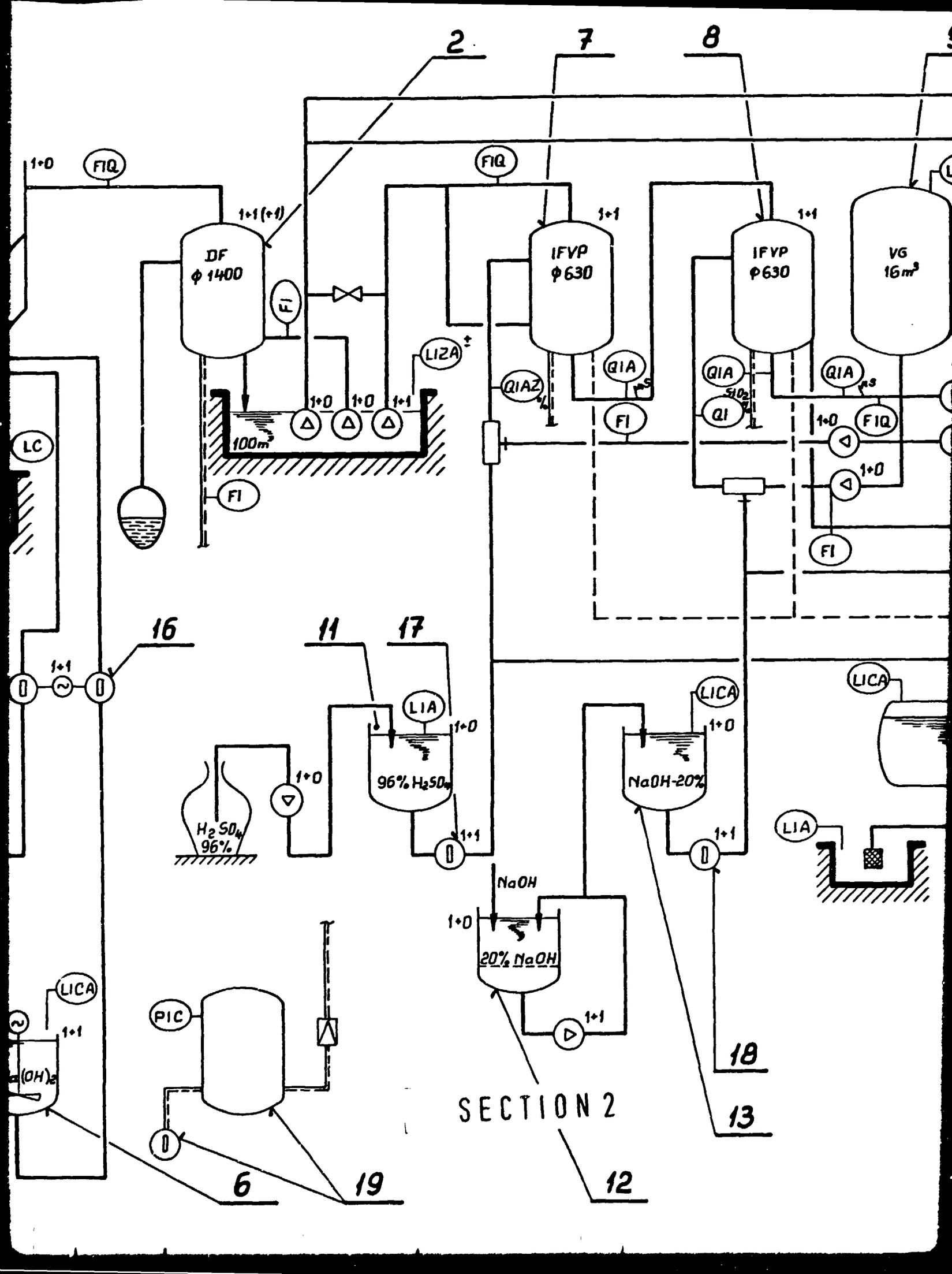


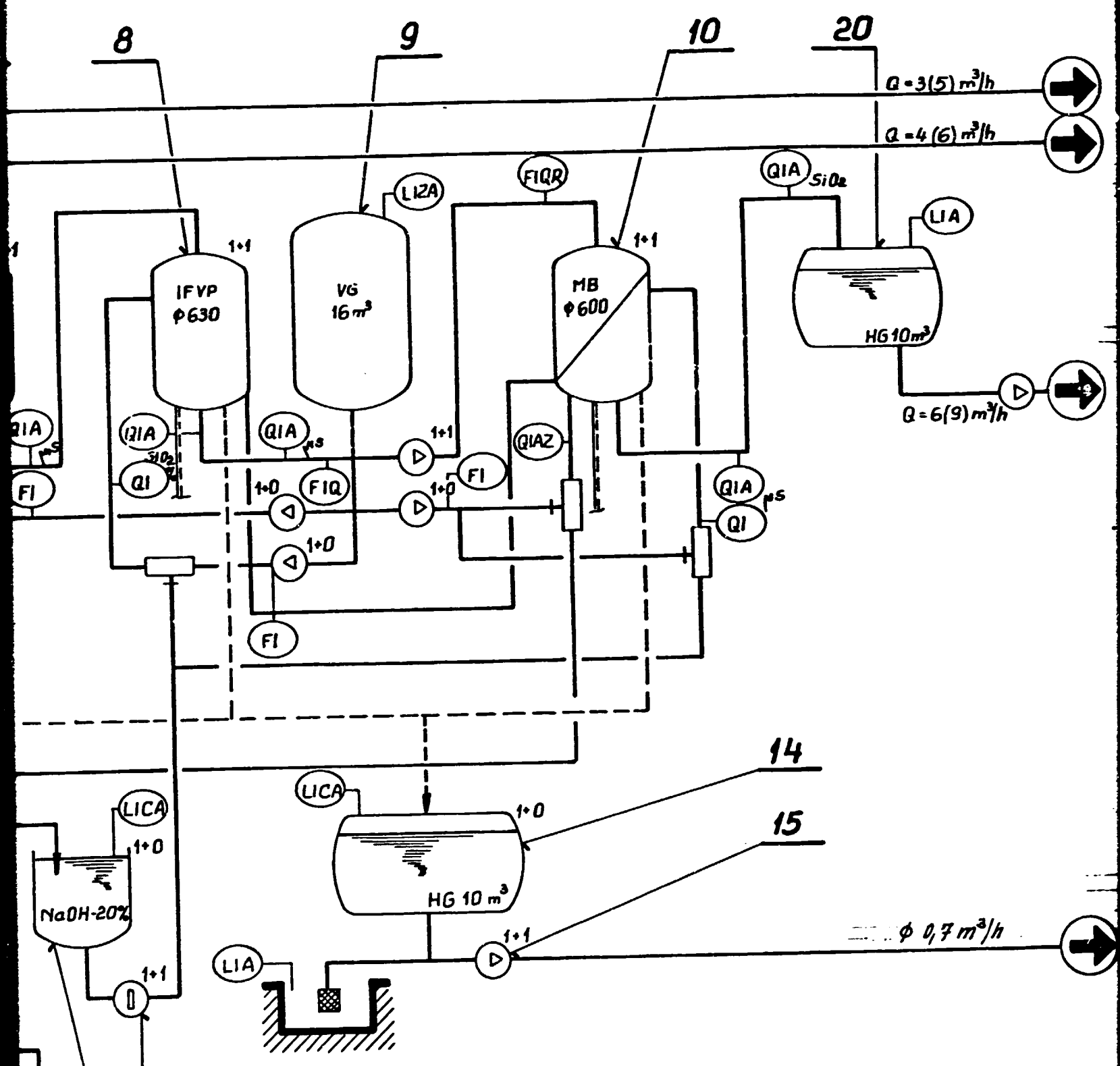
SECTION 2

D.C. POWER SOURCES FOR ETCHING 8 kA, 20 V

WIRING DIAGRAM


FROM SUPPLYING PIPE
FIQC
RAW WATER
Q=16m³(22m³)/h
p=0,25MPa
1+0
FIQ
DUKLA
φ3000
DF
φ1400
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
H2SO
96%
5
7% Ca(OH)2
2% Ca(OH)2
PIC
SECTION 1

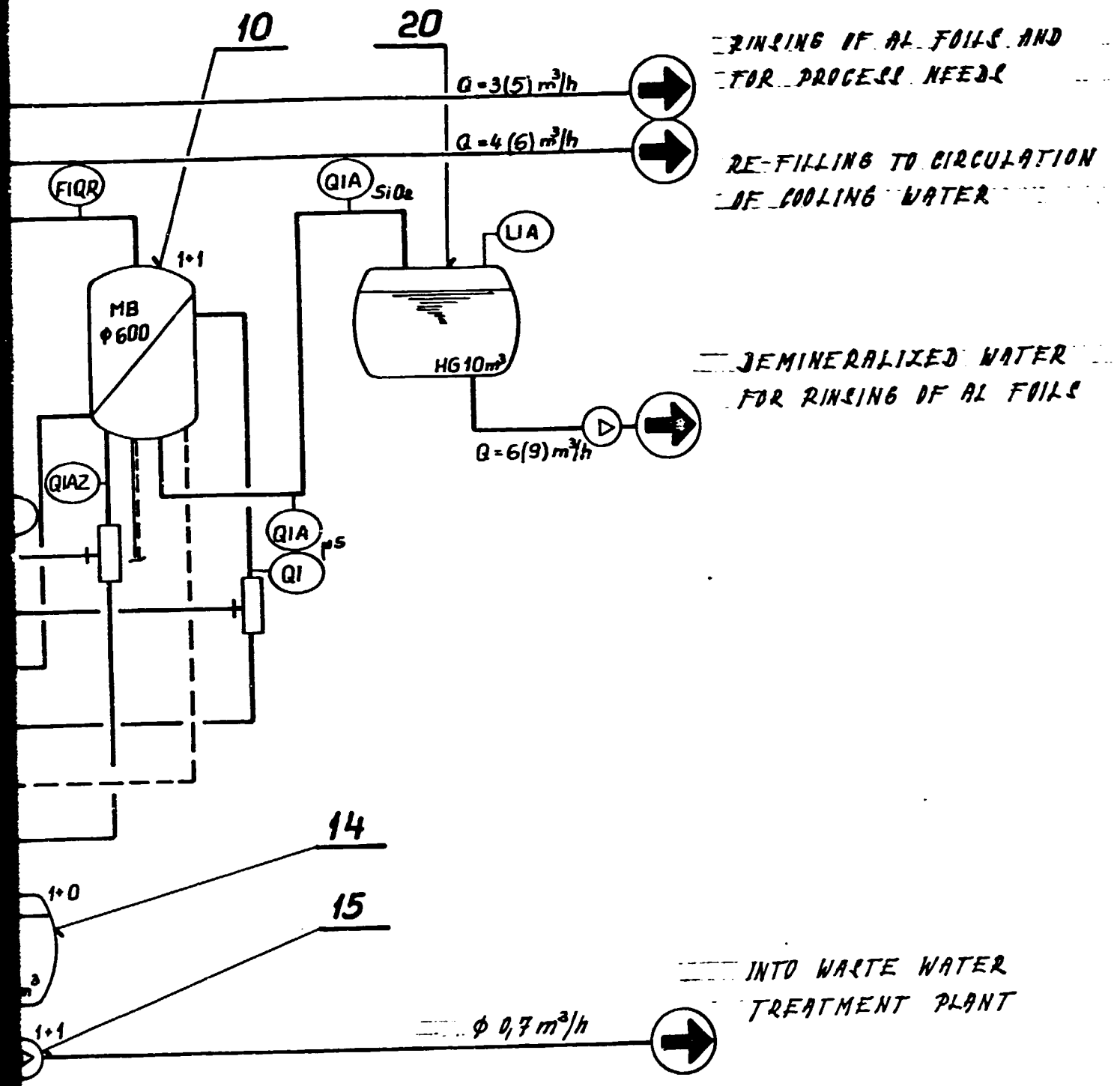

2
7
8
1+0
FIQ
1+1 (+1)
DF
ϕ 1400
FI
LIZA
100m³
LC
FI
1+1
IFVP
ϕ 630
QIAZ
QIA
FI
1+1
IFVP
ϕ 630
QIA
QI
SiO2
QIA
FIQ
1+0
1+0
VG
16m³
FI
16
11
17
1+1
LIA
1+0
96% H2SO4
1+1
H2SO4
96%
1+0
NaOH
1+0
20% NaOH
1+1
LICA
1+0
NaOH-20%
1+1
LICA
LIA
LICA
1+1
(OH)2
PIC
6
19
18
13
12
SECTION 2



NOTE: EXPLANATION TO FIGURES I
TECHNICAL REPORT SECTION

SECTION 3

WATER TREAT



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 tan 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

Chemical Quantities

QIAZ	Twice	- metering to concentration of 10 % H_2SO_4 for regeneration
QIA	Twice	- metering to conductivity on cation filters
QI	Twice	- metering to concentration of NaOH
QIA	Twice	- metering to conductivity on anion filters
QIA	Twice	- metering to SiO_2 on anion filters
QIA	Twice	- metering to conductivity on MB filters
QIA	Once	- metering to SiO_2 on MB filters

Pressure Metering

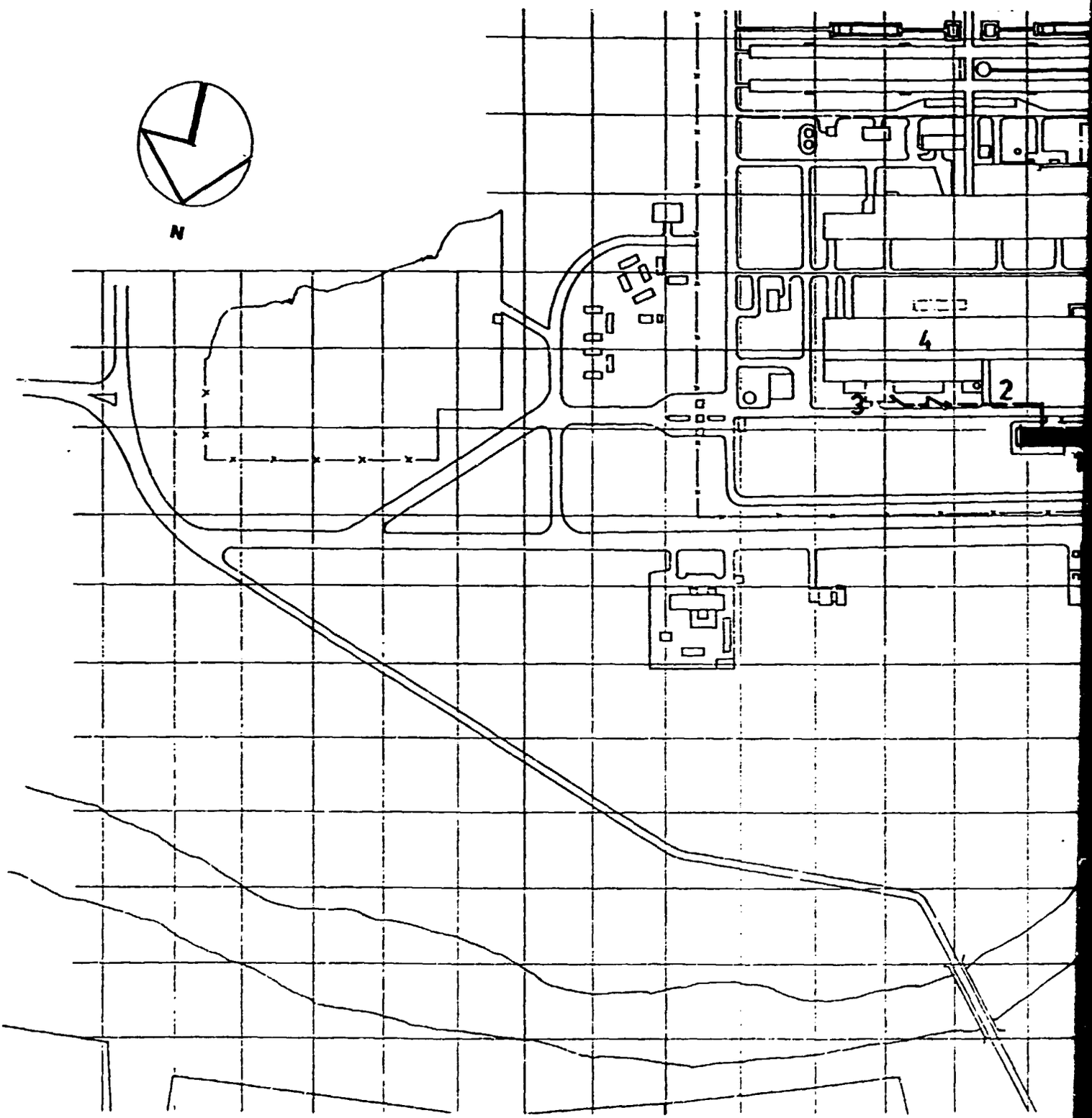
PIC	Once	- metering to air pressure in air chamber and to compressor switching mechanism

All process will be controlled by sequences.

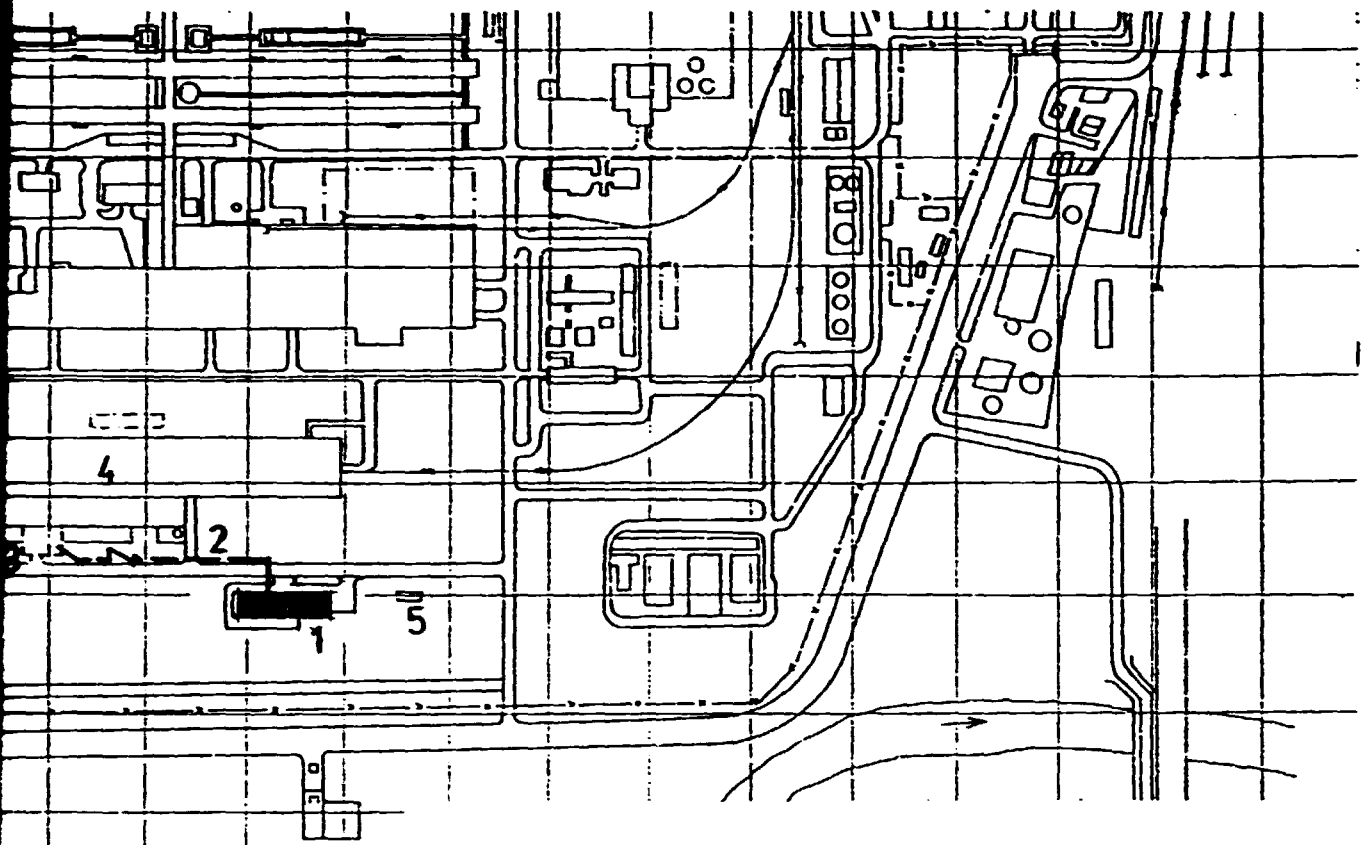
2. Drawings

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



SECTION 1



KEY :

1 Proposed Foil Treatment Plant

Proposed mains

2 Electrical cable

Existing buildings

3 Open switch yard

4 Rolling mill

5 Weight bridge

SECTION 2

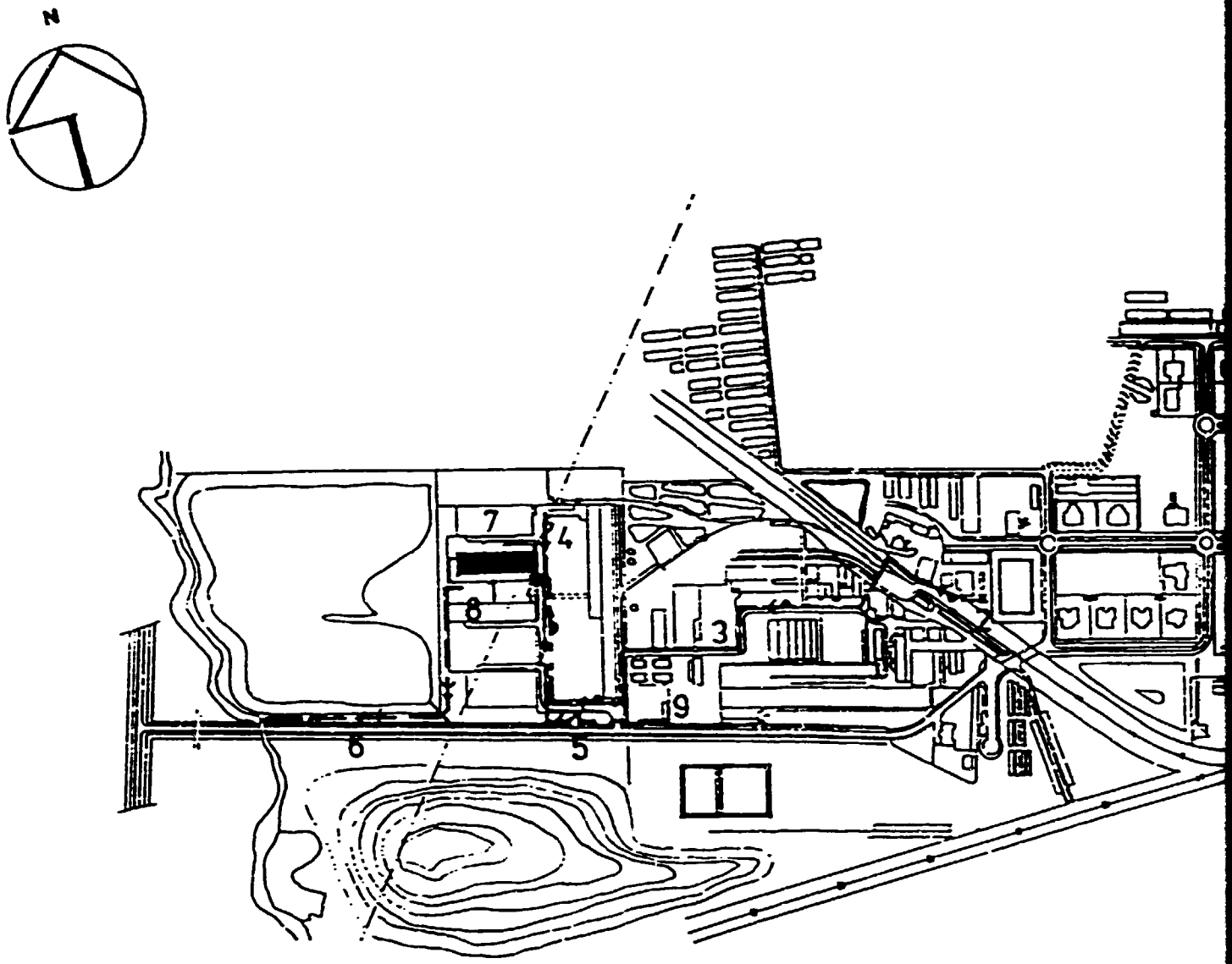
FOIL TREATMENT PLANT

KORBA

General Layout Plan in Scale 1: 7000

BALCO, INDIA

D.1



SECTION 1

KEY:

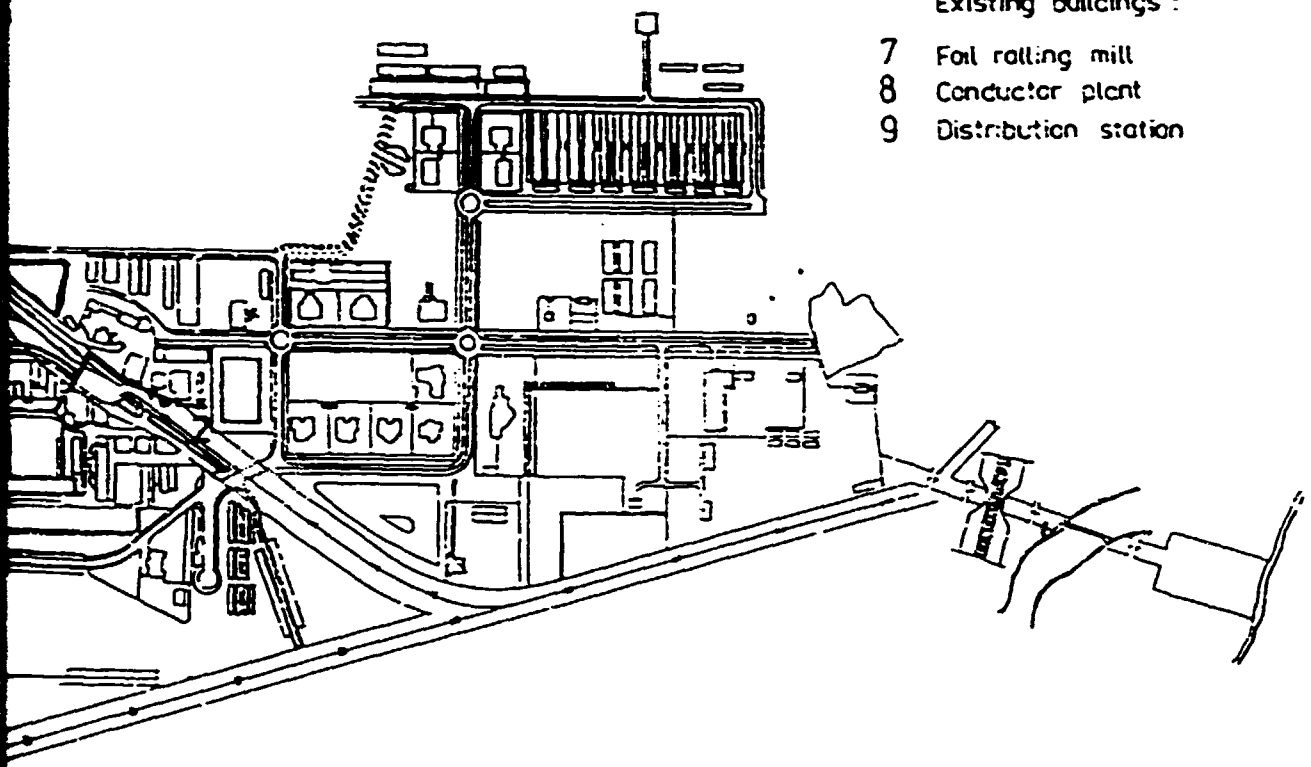
1 Proposed Foil Treatment Plant
2 Proposed Raw Water Pumping Station

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

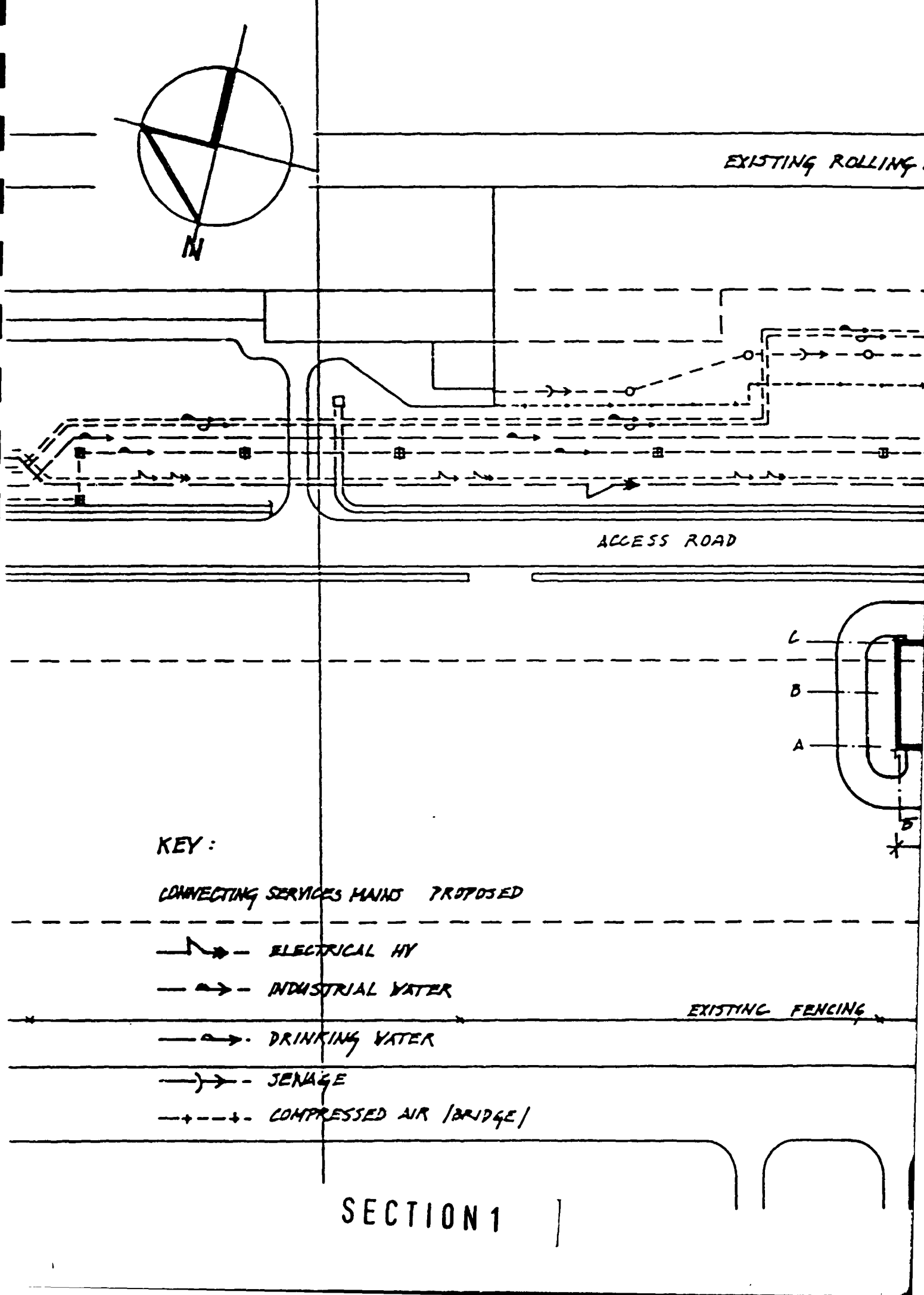


SECTION 2

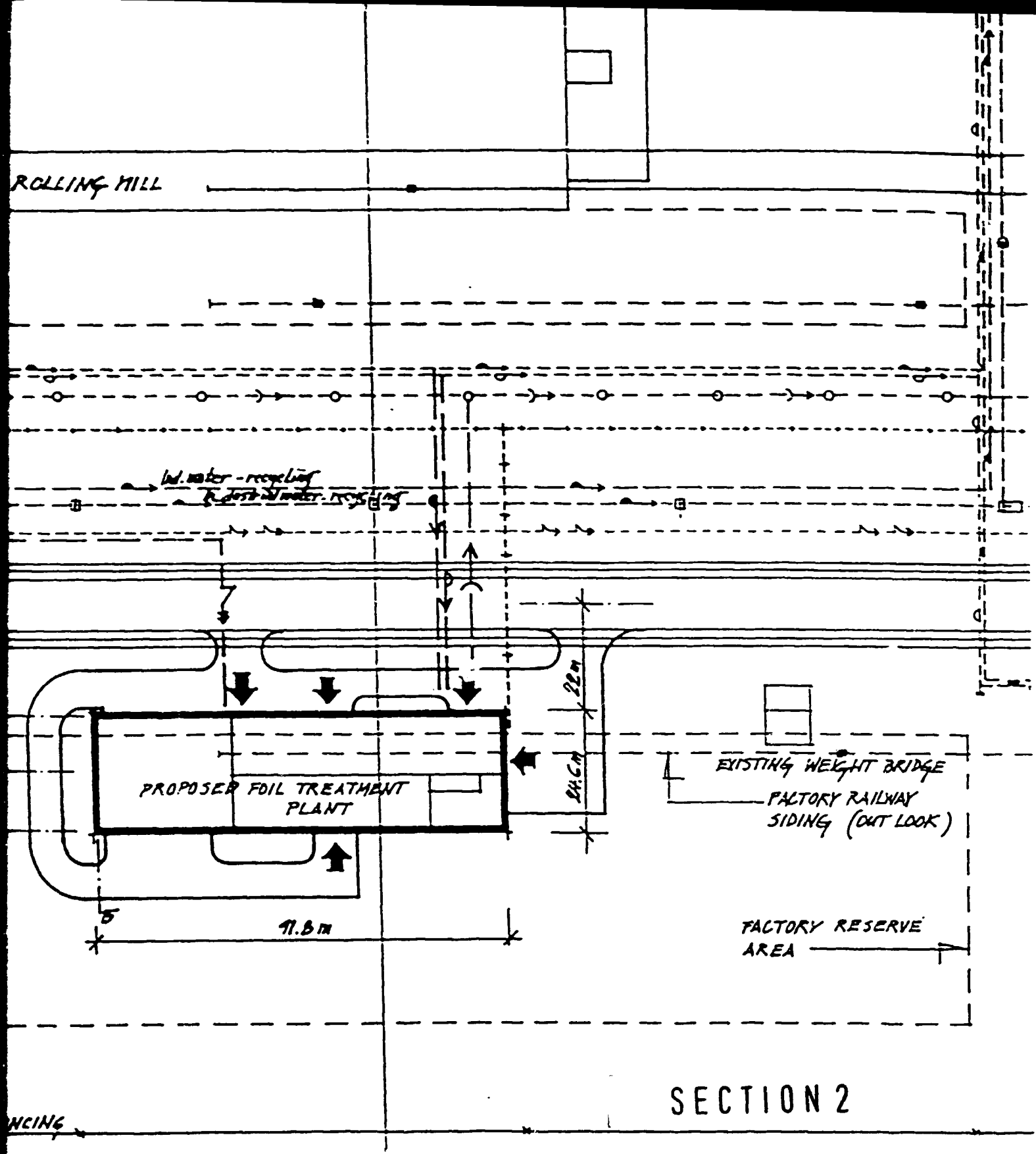
FOIL TREATMENT PLANT
BIDHANBAG

General Layout Plan in Scale 1:7000
BALCO, INDIA

D.2


N
EXISTING ROLLING
ACCESS ROAD
C
B
A
KEY :
CONNECTING SERVICES MAINS PROPOSED
ELECTRICAL HV
INDUSTRIAL WATER
EXISTING FENCING
DRINKING WATER
SEWAGE
COMPRESSED AIR /BRIDGE/

SECTION 1

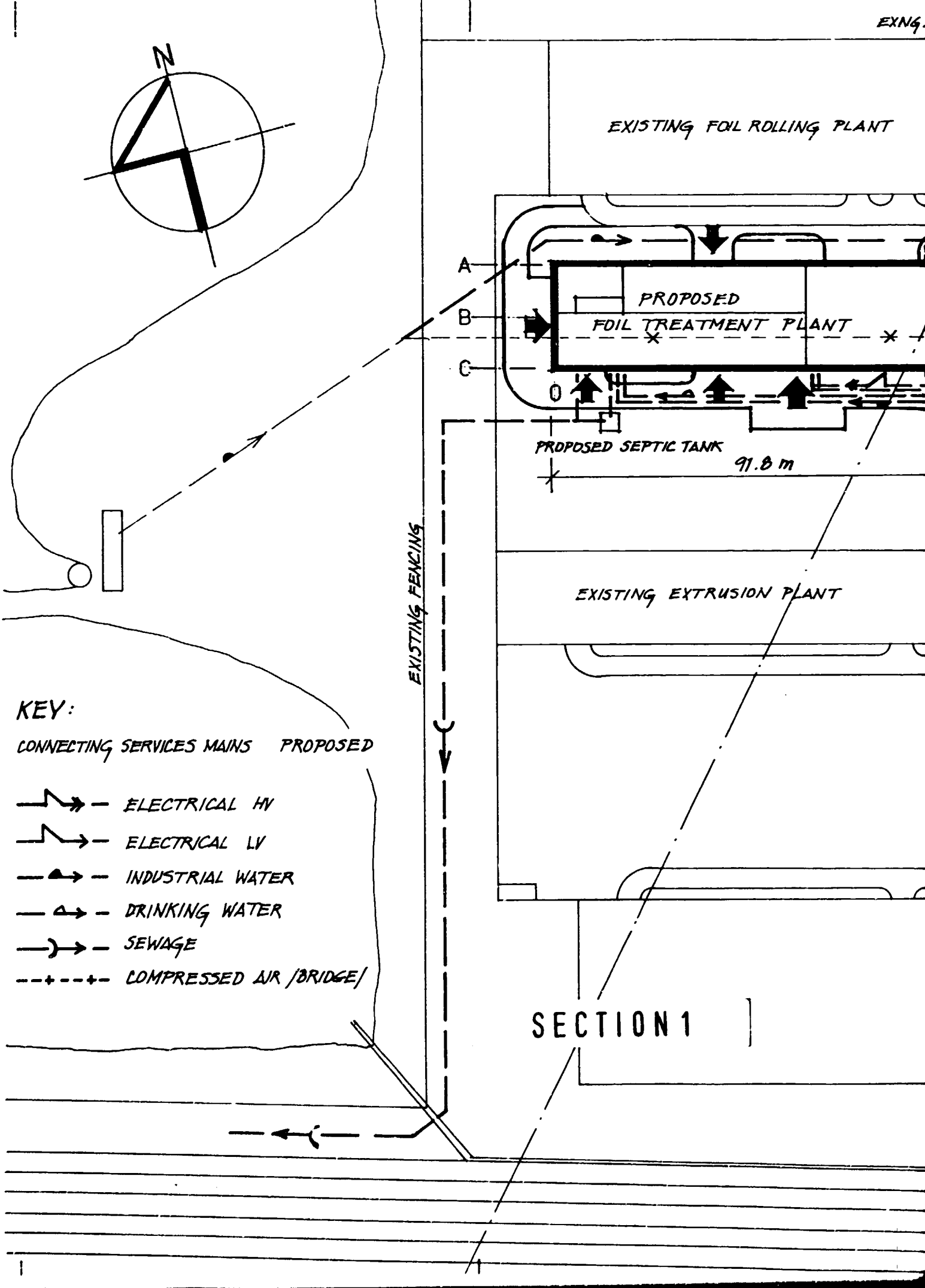


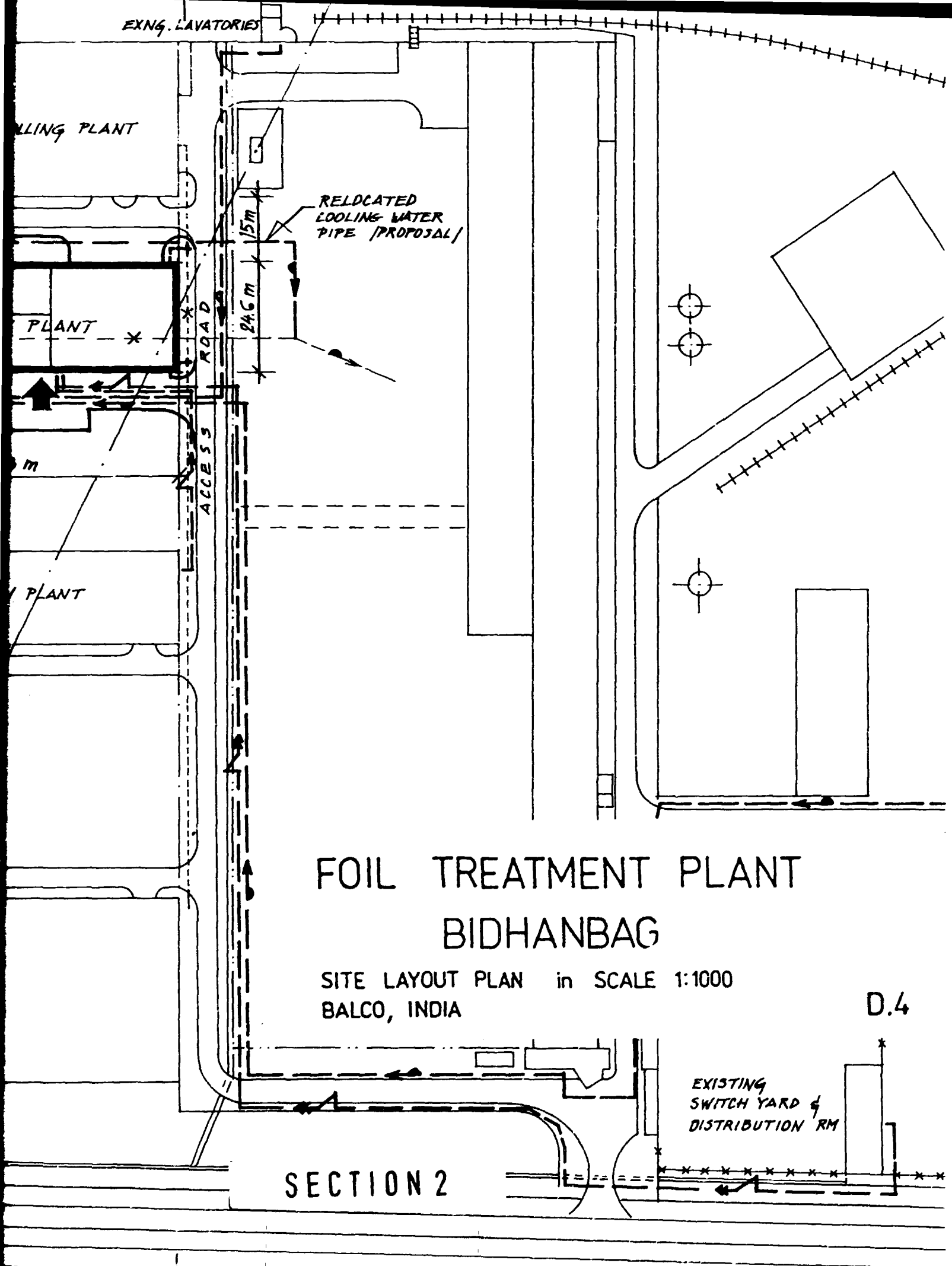
FOIL TREATMENT PLANT
KORBA

SITE LAYOUT PLAN in SCALE 1:1000

BALCO, INDIA

D.3


EXNG.
N
EXISTING FOIL ROLLING PLANT
A
B
C
D
PROPOSED
FOIL TREATMENT PLANT
PROPOSED SEPTIC TANK
91.8 m
EXISTING FENCING
EXISTING EXTRUSION PLANT
KEY:
CONNECTING SERVICES MAINS PROPOSED
ELECTRICAL HV
ELECTRICAL LV
INDUSTRIAL WATER
DRINKING WATER
SEWAGE
COMPRESSED AIR /BRIDGE/
SECTION 1



FOIL TREATMENT PLANT
BIDHANBAG

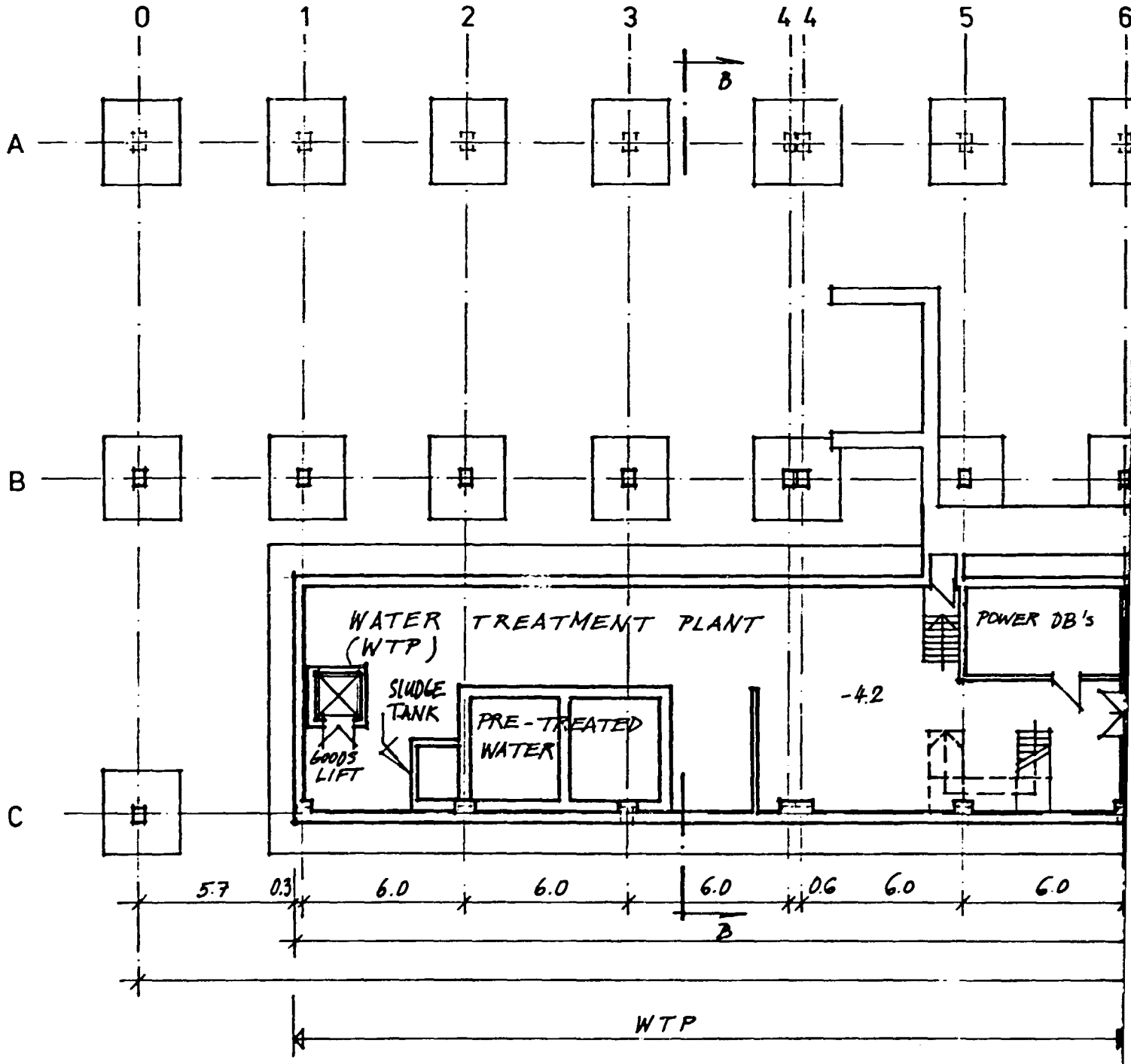
SITE LAYOUT PLAN in SCALE 1:1000

BALCO, INDIA

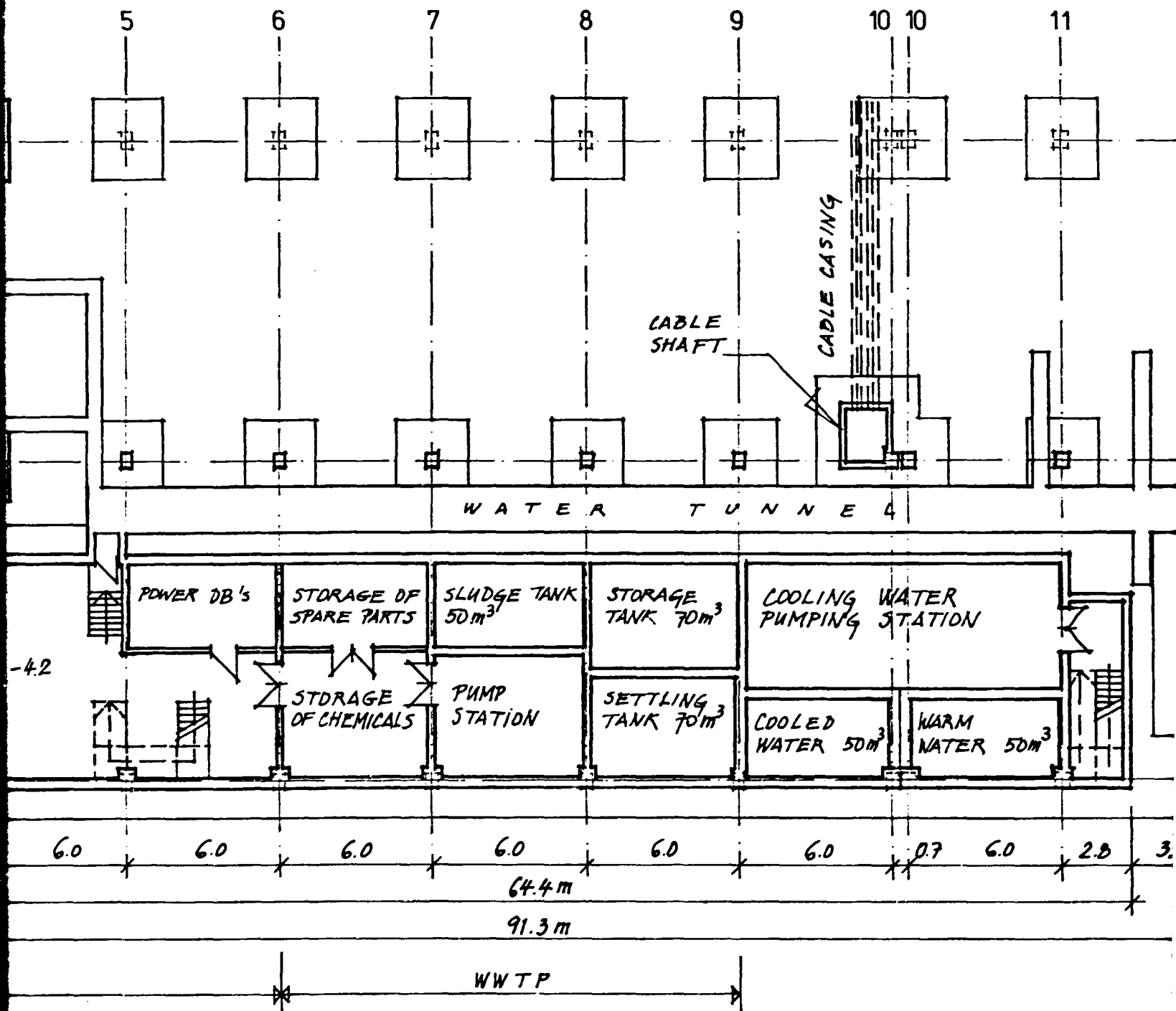
D.4

SECTION 2

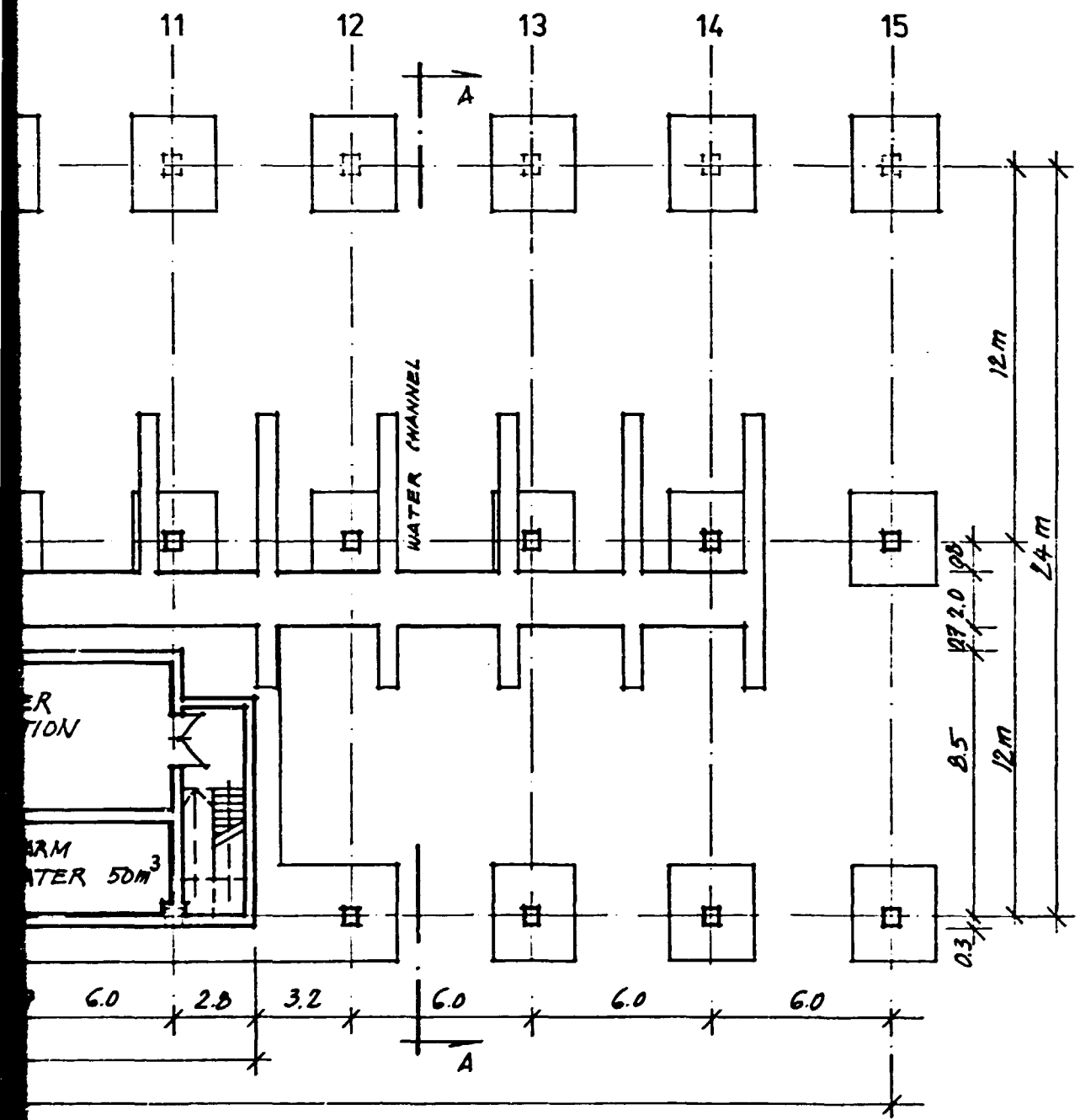
BASEMENT PLAN



SECTION 1


5
6
7
8
9
10
10
11
CABLE CASING
CABLE SHAFT
WATER TUNNEL
POWER DB's
STORAGE OF SPARE PARTS
SLUDGE TANK 50m³
STORAGE TANK 70m³
COOLING WATER PUMPING STATION
-4.2
STORAGE OF CHEMICALS
PUMP STATION
SETTLING TANK 70m³
COOLED WATER 50m³
WARM WATER 50m³
6.0
6.0
6.0
6.0
6.0
6.0
0.7
6.0
2.8
64.4m
91.3m
WWTP

SECTION 2



SECTION 3

FOIL TREATMENT PLANT

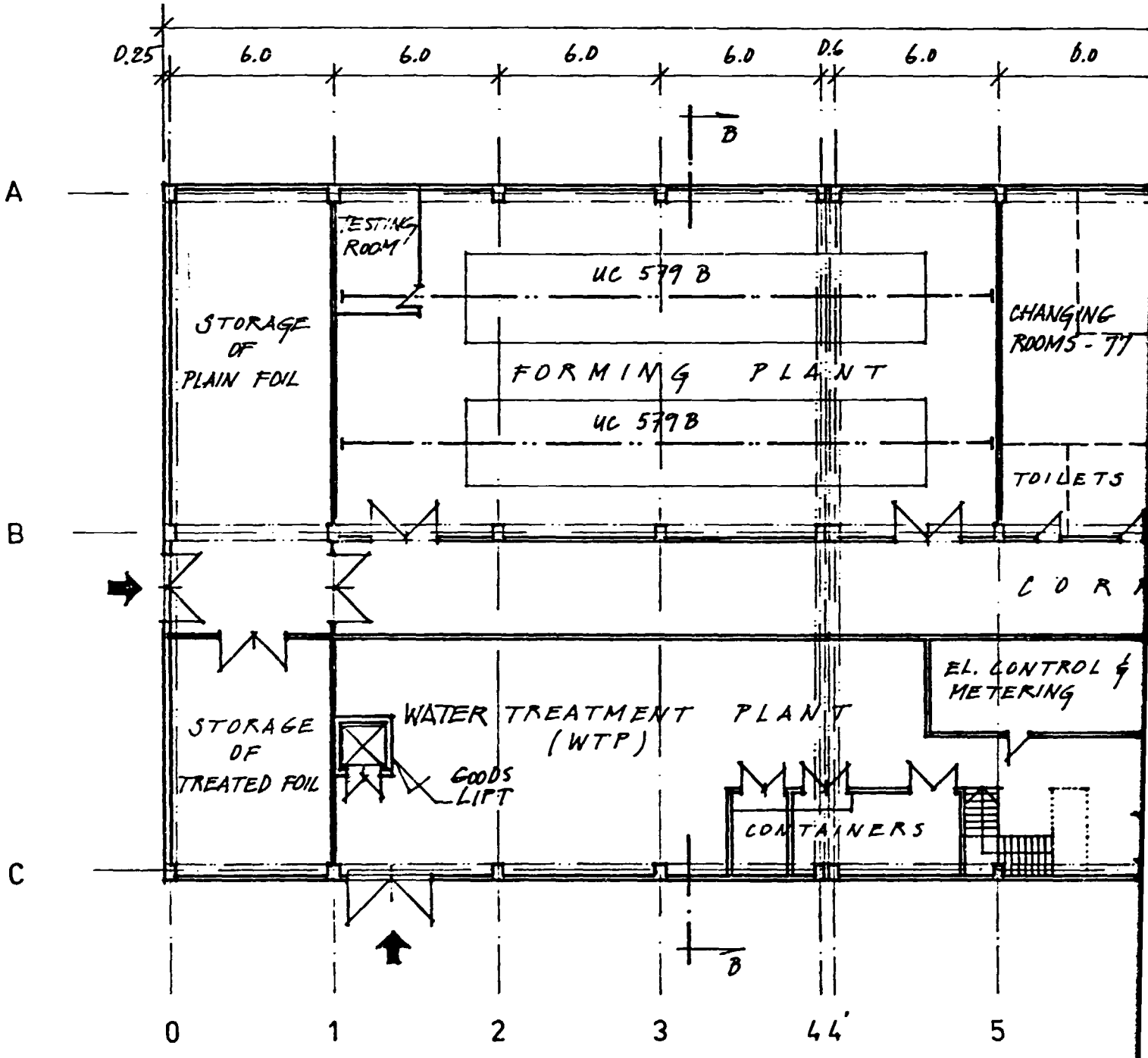
GENERAL ARRANGEMENT

Basement Plan in Scale 1:200

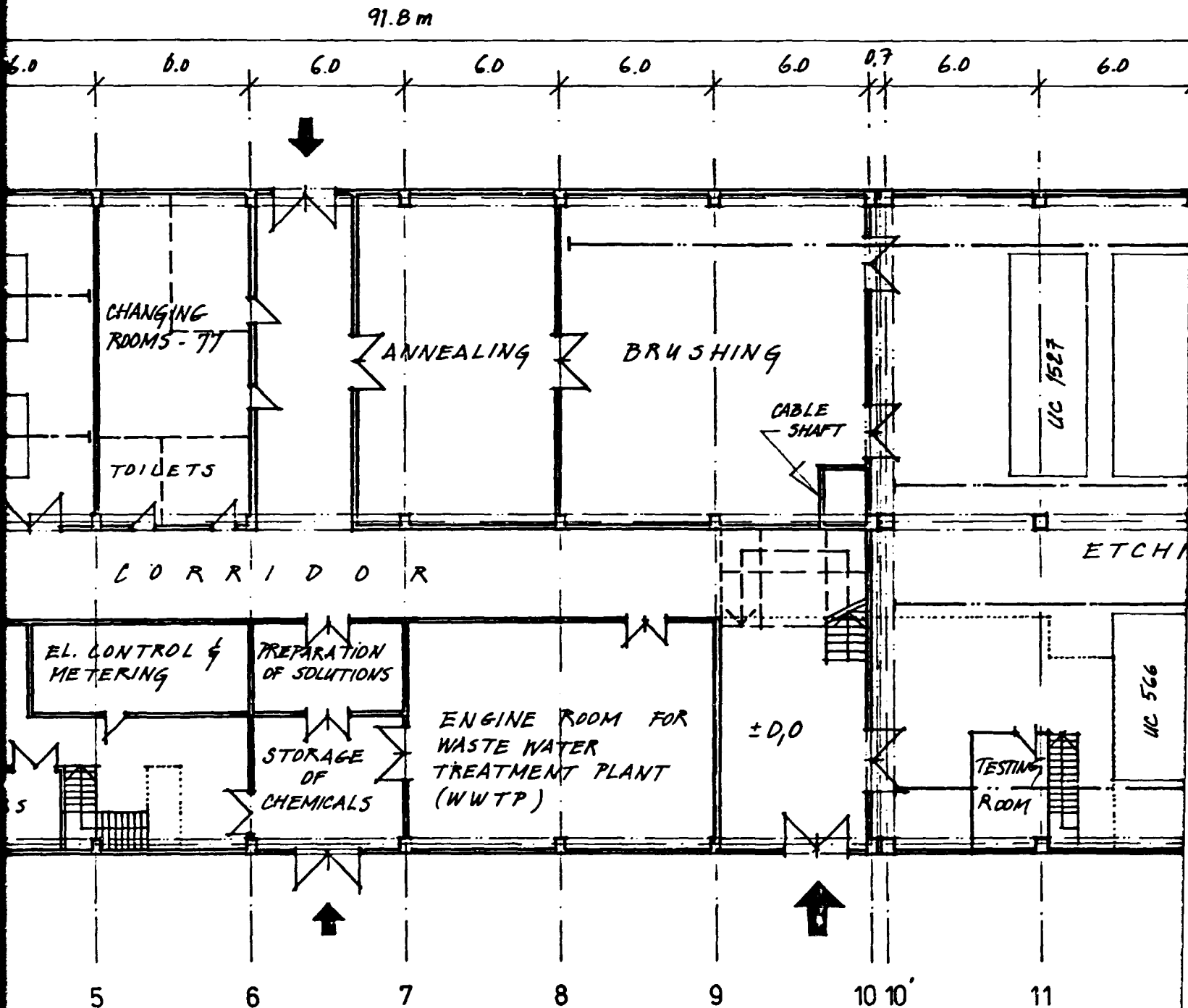
BALCO, INDIA

D.5

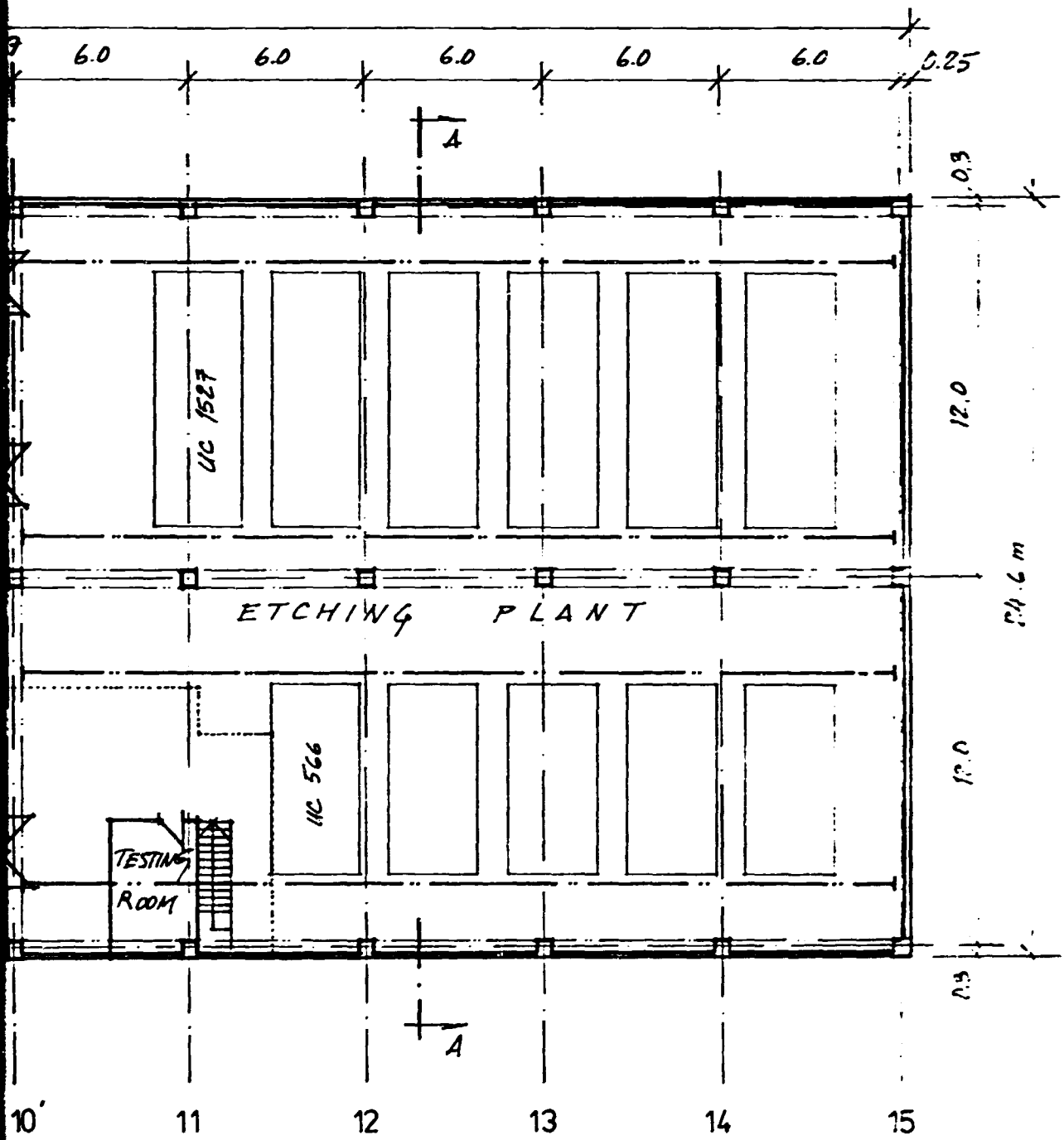
GROUND FLOOR PLAN



SECTION 1


91.8 m
6.0
6.0
6.0
6.0
6.0
6.0
0.7
6.0
6.0
CHANGING ROOMS - TT
ANNEALING
BRUSHING
CABLE SHAFT
UC 1527
TOILETS
CORRIDOR
ETCH
EL. CONTROL & METERING
PREPARATION OF SOLUTIONS
ENGINE ROOM FOR WASTE WATER TREATMENT PLANT (WWTP)
±0,0
STORAGE OF CHEMICALS
TESTING ROOM
UC 566
5
6
7
8
9
10
10'
11

SECTION 2



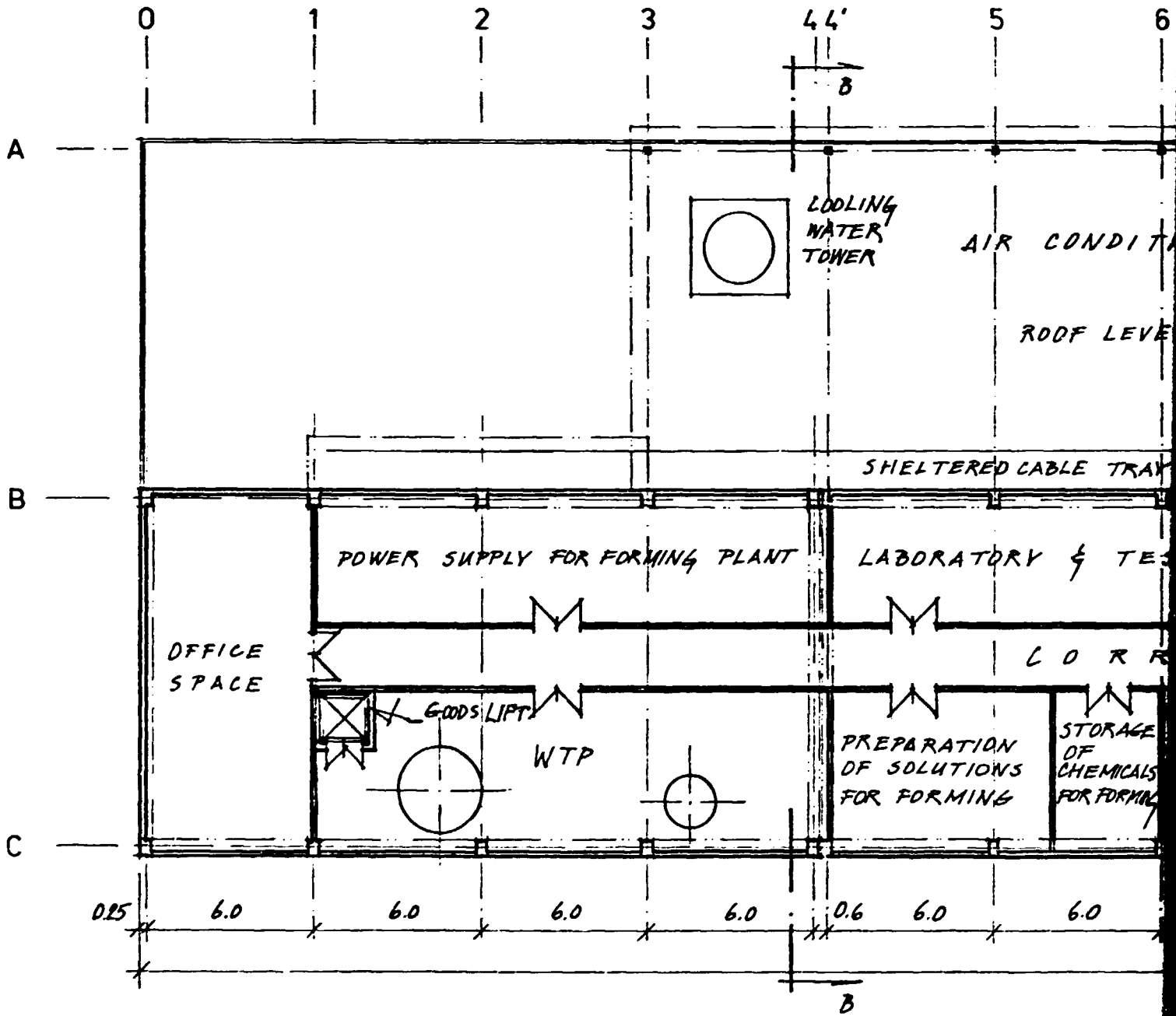
SECTION 3

FOIL TREATMENT PLANT

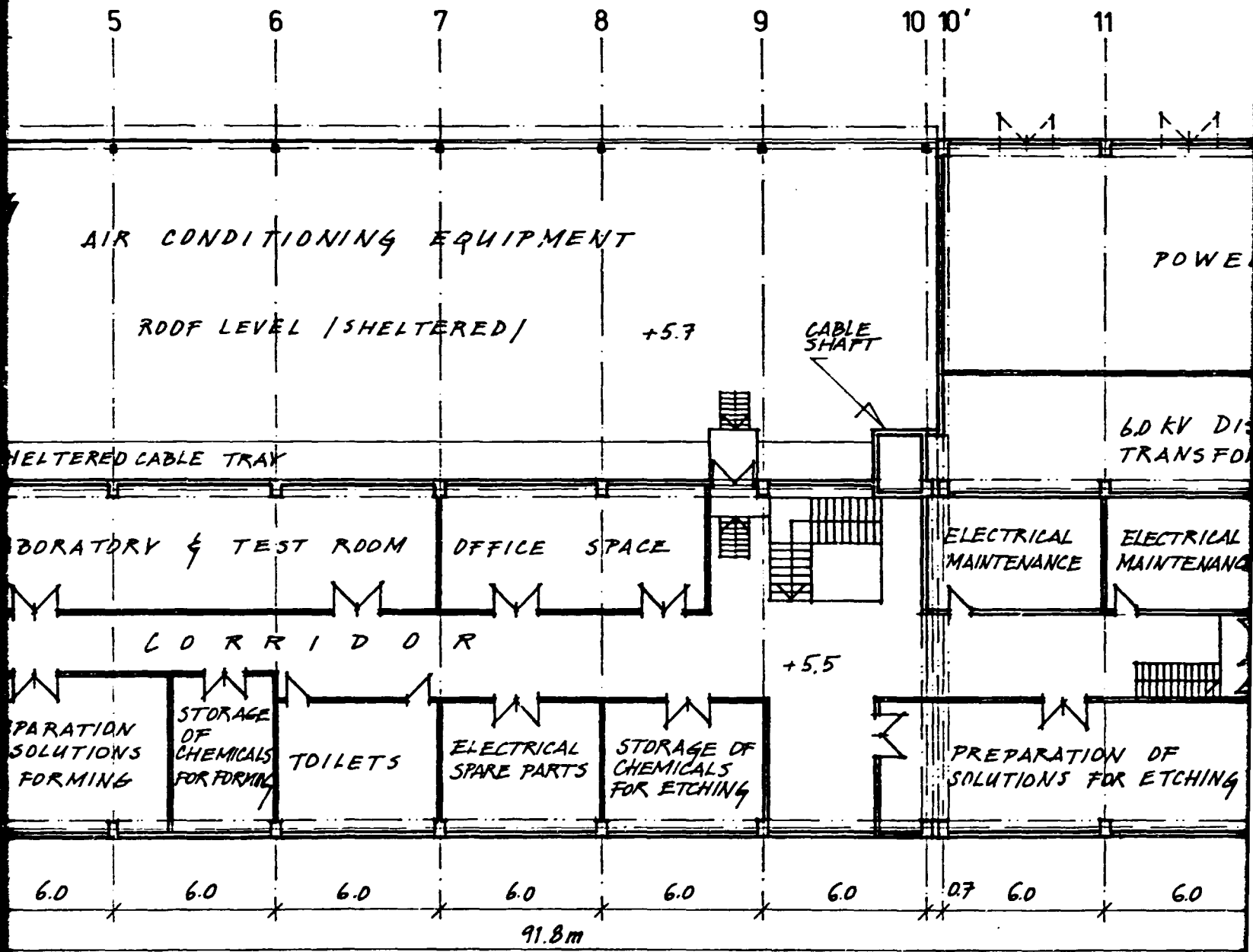
GENERAL ARRANGEMENT
Ground Floor Plan in Scale 1:200
BALCO, INDIA

D.6

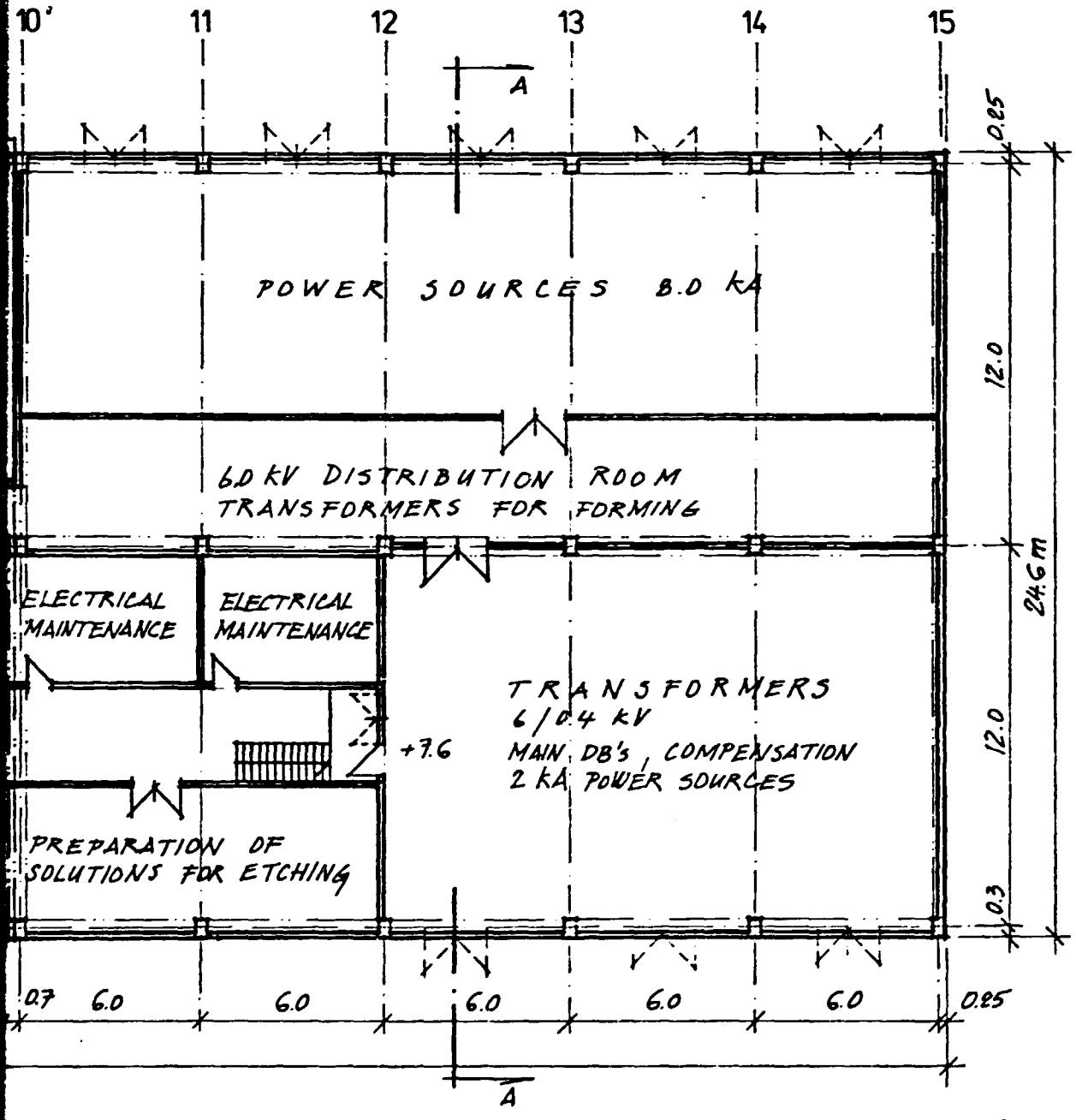
FIRST FLOOR PLAN



SECTION 1


5
6
7
8
9
10
10'
11
AIR CONDITIONING EQUIPMENT
ROOF LEVEL /SHELTERED/
+5.7
CABLE SHAFT
POWE
6.0 KV DI
TRANSFO
HELTERED CABLE TRAY
BORATORY & TEST ROOM
OFFICE SPACE
ELECTRICAL MAINTENANCE
ELECTRICAL MAINTENANC
CORRIDOR
+5.5
PARATION SOLUTIONS 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
0.7
6.0
6.0
91.8m

SECTION 2



SECTION 3

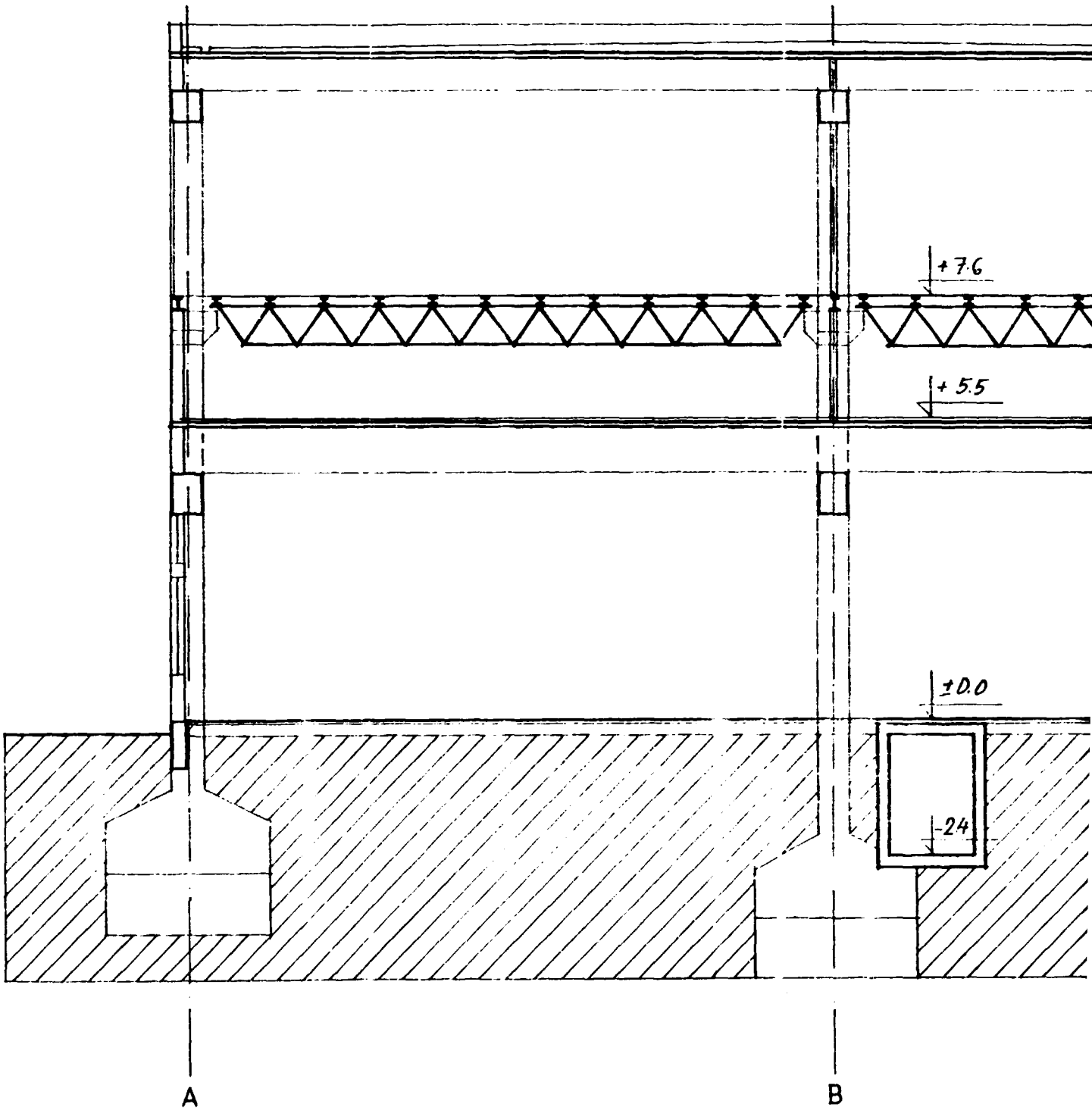
FOIL TREATMENT PLANT

GENERAL ARRANGEMENT

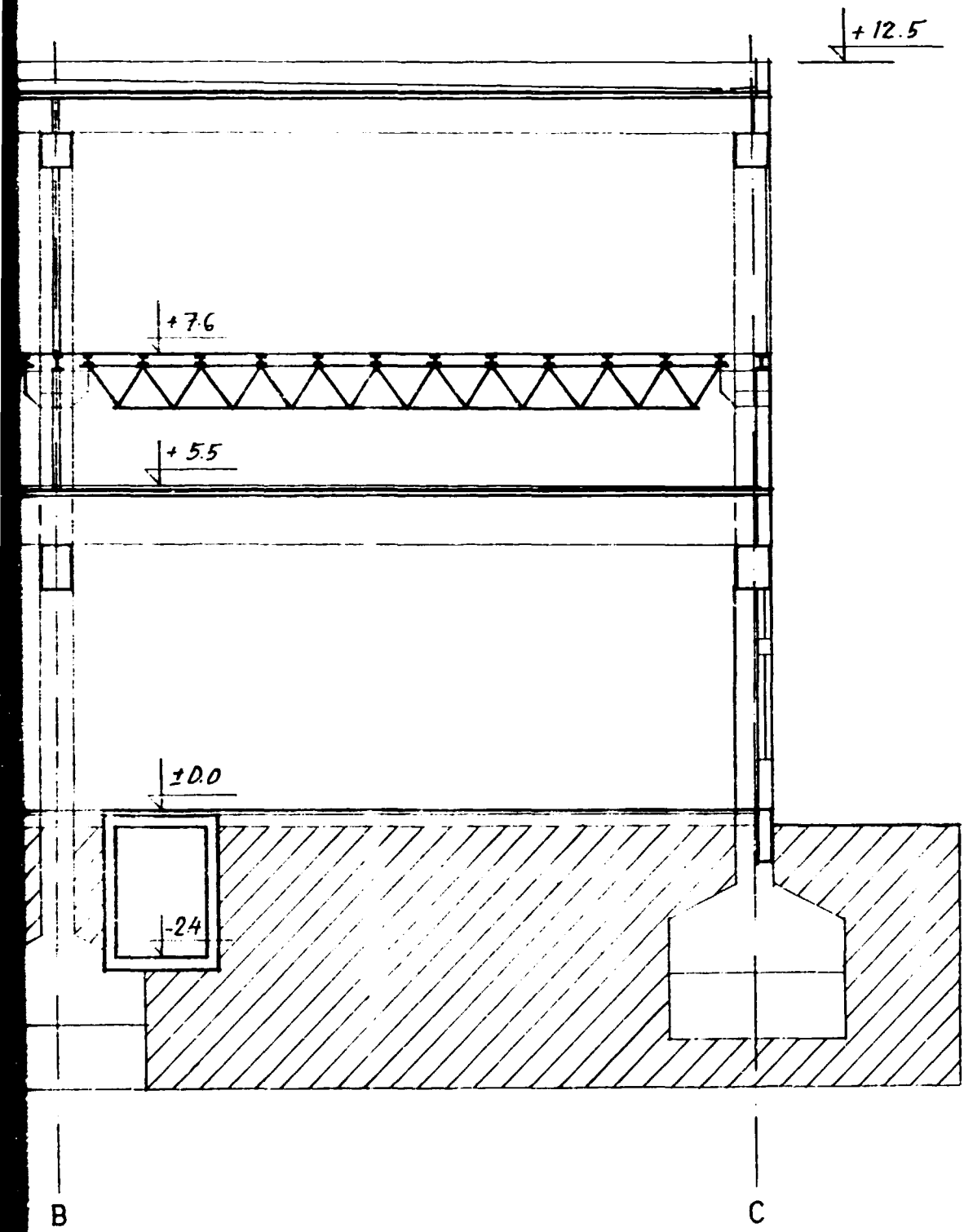
First Floor Plan in Scale 1:200

BALCO, INDIA

SECTION A - A

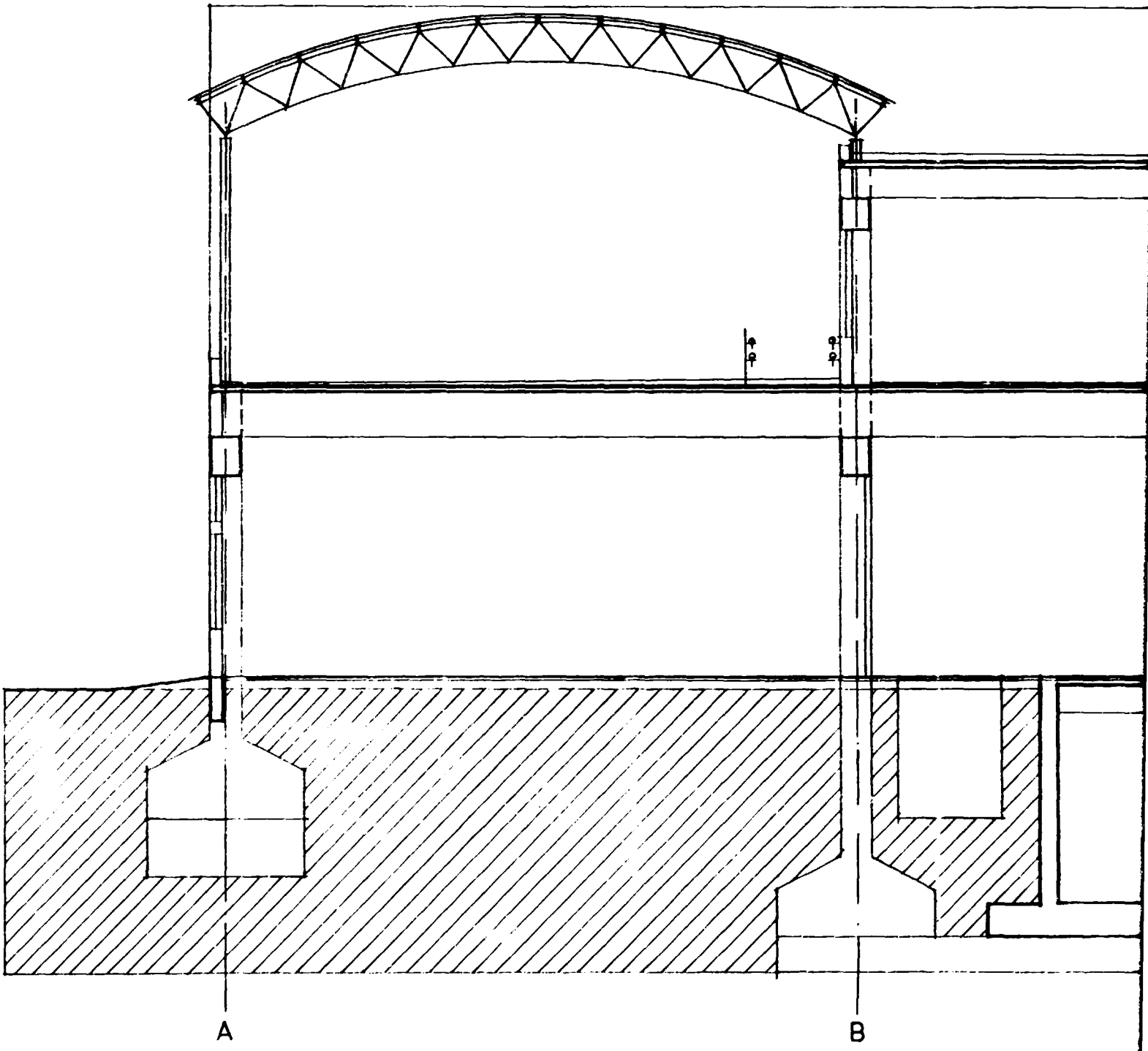


SECTION 1

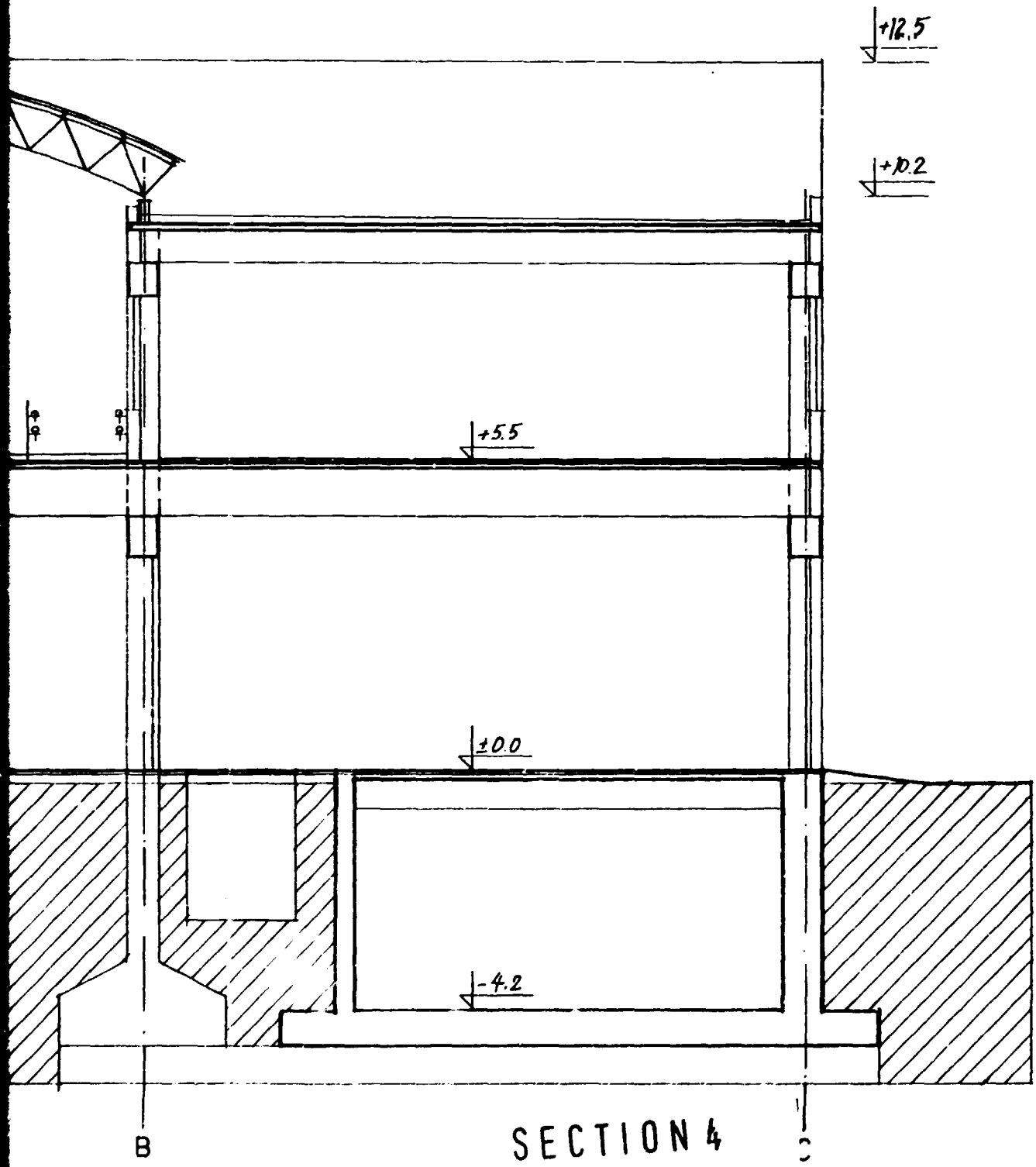


SECTION 2

SECTION B - B



SECTION 3



SECTION 4

FOIL TREATMENT PLANT

GENERAL ARRANGEMENT
Section A-A, B-B in Scale 1: 100
BALCO, INDIA

D.8

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 tan 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

Chemical Quantities

QIAZ	Twice	- metering to concentration of 10 % H_2SO_4 for regeneration
QIA	Twice	- metering to conductivity on cation filters
QI	Twice	- metering to concentration of NaOH
QIA	Twice	- metering to conductivity on anion filters
QIA	Twice	- metering to SiO_2 on anion filters
QIA	Twice	- metering to conductivity on MB filters
QIA	Once	- metering to SiO_2 on MB filters

Pressure Metering

PIC	Once	- metering to air pressure in air chamber and to compressor switching mechanism

All process will be controlled by sequences.

3. COMFAR tables - KORBA

BALCO - SPA foils for capacitors
19.3.1993 (BALBK1)
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:	152686.30	0.000 % foreign
current assets:	0.00	0.000 % foreign
total assets:	152686.30	0.000 % foreign

Source of funds during construction phase

equity & grants:	152686.30	0.000 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	152686.30	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	46117.17	69187.81	80811.04
depreciation :	7652.95	31636.01	31636.01
interest :	12890.53	25781.06	23202.95
production costs	66660.66	126604.90	135650.00
thereof foreign	0.00 %	0.00 %	0.00 %
total sales :	234200.00	381500.20	475740.00
gross income :	167339.30	254895.30	340090.00
net income :	71119.23	108330.50	144538.30
cash balance :	0.03	125325.80	161705.80
net cashflow :	-130337.50	165429.60	199231.60

Net Present Value at: 15.00 % = 669102.40
Internal Rate of Return: 51.23 %
Return on equity1: 69.57 %
Return on equity2: 60.66 %

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	28327.780
Auxiliary and service facilities	0.000
Incorporated fixed assets	21334.400
Plant machinery and equipment	42947.140
Total fixed investment costs	93577.760
Pre-production capital expenditures.	59108.500
Net working capital	0.000
Total initial investment costs	152686.300
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	221351.000	0.000	0.000
Total fixed investment costs	221351.000	0.000	0.000
Preproduction capitals expenditures.	0.000	0.000	0.000
Working capital	849.217	317.919	145.629
Total current investment costs	222200.200	317.919	145.629
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	8724.610	18501.880	22971.000	22971.000	22971.000
Other raw materials	946.674	2146.087	2660.876	2660.876	2660.876
Utilities	6719.812	12887.610	16030.190	16030.190	16030.190
Energy	9765.230	13800.220	16401.860	16401.860	16401.860
Labour, direct	9415.512	9814.191	9814.191	9814.191	9814.191
Repair, maintenance	904.889	1077.570	1158.027	1153.027	1158.027
Spares	2536.832	2915.824	3127.939	3127.939	3127.939
Factory overheads	3588.262	4310.230	4582.916	4582.916	4582.916
Factory costs	42601.820	65453.610	76747.000	76747.000	76747.000
Administrative overheads	2497.070	2603.622	2655.580	2655.580	2655.580
Indir. costs, sales and distribution	1018.276	1130.576	1408.458	1408.458	1408.458
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	7852.952	31636.010	31636.010	31636.010	31636.010
Financial costs	12890.530	25781.060	23202.950	20624.850	18046.740
Total production costs	66860.660	126604.900	135650.000	133071.900	130493.800
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,%	37.613	37.684	43.739	44.587	45.468
Total labour	10062.460	10481.570	10495.190	10495.190	10495.190

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	22971.000	22971.000	22971.000	22971.000	22971.000
Other raw materials	2660.876	2660.876	2660.876	2660.876	2660.876
Utilities	16030.190	16030.190	16030.190	16030.190	16030.190
Energy	16401.860	16401.860	16401.860	16401.860	16401.860
Labour, direct	9814.191	9814.191	9814.191	9814.191	9814.191
Repair, maintenance	1158.027	1158.027	1158.027	1158.027	1158.027
Spares	3127.939	3127.939	3127.939	3127.939	3127.939
Factory overheads	4582.916	4582.916	4582.916	4582.916	4582.916
Factory costs	76747.000	76747.000	76747.000	76747.000	76747.000
Administrative overheads	2655.580	2655.580	2655.580	2655.580	2655.580
Indir. costs, sales and distribution	1408.458	1408.458	1408.458	1408.458	1408.458
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	31636.010	31636.010	31636.010	31636.000	24729.270
Financial costs	15468.630	12890.530	10312.420	7734.314	5156.209
Total production costs	127915.700	125337.600	122759.500	120181.400	110696.500
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,%	46.384	47.338	48.332	49.369	53.599
Total labour	10495.190	10495.190	10495.190	10495.190	10495.190

Total Production Costs in 1,000 Rs

Year	2005- 8	2009
% of nom. capacity (single product).	0.000	0.000
Raw material 1	22971.000	22971.000
Other raw materials	2660.876	2660.876
Utilities	16030.190	16030.190
Energy	16401.860	16401.860
Labour, direct	9814.191	9814.191
Repair, maintenance	1158.027	1158.027
Spares	3127.939	3127.939
Factory overheads	4582.916	4582.916
Factory costs	76747.000	76747.000
Administrative overheads	2655.580	2655.580
Indir. costs, sales and distribution	1408.458	1408.458
Direct costs, sales and distribution	0.000	0.000
Depreciation	946.221	946.228
Financial costs	0.000	0.000
Total production costs	81757.260	81757.270
Costs per unit (single product)	0.000	0.000
Of it foreign, %	0.000	0.000
Of it variable,%	72.572	72.572
Total labour	10495.190	10495.190

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	23.1	694.821	1455.057	1806.891	1806.891
Energy	0	---	0.000	0.000	0.000	0.000
Spares	180	2.0	1268.416	1457.912	1563.970	1563.970
Work in progress	10	36.0	1183.384	1818.156	2131.861	2131.861
Finished products	10	36.0	1252.747	1890.479	2205.627	2205.627
Cash in hand	0	---	0.000	0.000	0.000	0.000
Total current assets			4399.369	6621.604	7708.349	7708.349
Current liabilities and						
Accounts payable	30	12.0	3550.152	5454.468	6395.583	6395.583
Net working capital			849.217	1167.136	1312.765	1312.765
Increase in working capital			849.217	317.919	145.629	0.000
Net working capital, local			849.217	1167.136	1312.765	1312.765
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 ..	152686.300
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....	0.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	0.000
Current liabilities	0.000
Bank overdraft	0.000
Total funds	152686.300

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....	143228.100	-14322.810	-14322.810	-14322.810	-14322.800
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	143228.100	-14322.810	-14322.810	-14322.810	-14322.800
Current liabilities	3550.152	1904.316	941.116	0.000	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000
Total funds	146778.300	-12418.490	-13381.690	-14322.810	-14322.800

Cashflow Tables, construction in 1,000 Rs

Year	1994
Total cash inflow . .	152686.300
Financial resources .	152686.300
Sales, net of tax . .	0.000
Total cash outflow . .	152686.300
Total assets	152686.300
Operating costs . . .	0.000
Cost of finance . . .	0.000
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	0.000
Cumulated cash balance	0.000
Inflow, local	152686.300
Outflow, local	152686.300
Surplus (deficit) .	0.000
Inflow, foreign . . .	0.000
Outflow, foreign . . .	0.000
Surplus (deficit) .	0.000
Net cashflow	-152686.300
Cumulated net cashflow	-152686.300

Cashflow tables, production in 1,000 Rs

Year	1995	1996	1997	1998	1999	2000
Total cash inflow	380978.300	383404.500	476681.200	475740.000	475740.000	475740.000
Financial resources	146778.300	1904.316	941.116	0.000	0.000	0.000
Sales, net of tax	234200.000	381500.200	475740.000	475740.000	475740.000	475740.000
Total cash outflow	380978.200	258078.700	314975.300	312792.900	311697.200	310601.500
Total assets	225750.400	2222.236	1086.745	0.000	0.000	0.000
Operating costs	46117.190	69187.810	80811.030	80811.030	80811.030	80811.030
Cost of finance	12890.530	25781.060	23202.950	20624.850	18046.740	15468.630
Repayment	0.000	14322.810	14322.810	14322.810	14322.810	14322.810
Corporate tax	96220.120	146564.800	195551.800	197034.200	198516.600	199999.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	0.031	125325.800	161705.800	162947.200	164042.800	165138.600
Cumulated cash balance	0.031	125325.800	287031.600	449978.800	614021.600	779160.200
Inflow, local	380978.300	383404.500	476681.200	475740.000	475740.000	475740.000
Outflow, local	380978.200	258078.700	314975.300	312792.900	311697.200	310601.500
Surplus (deficit)	0.031	125325.800	161705.800	162947.200	164042.800	165138.600
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	-130337.500	165429.600	199231.600	197894.800	196412.400	194930.000
Cumulated net cashflow	-283023.800	-117594.200	81637.420	279532.300	475944.700	670874.600

Cashflow tables, production in 1,000 Rs

Year	2001	2002	2003	2004	2005	
Total cash inflow	475740.000	475740.000	475740.000	475740.000	475740.000	475740.00
Financial resources	0.000	0.000	0.000	0.000	0.000	0.00
Sales, net of tax	475740.000	475740.000	475740.000	475740.000	475740.000	475740.00
Total cash outflow	309505.800	308410.100	307314.400	310190.100	321673.900	307351.10
Total assets	0.000	0.000	0.000	0.000	0.000	0.00
Operating costs	80811.030	80811.030	80811.030	80811.030	80811.030	80811.03
Cost of finance	12890.530	10312.420	7734.314	5156.209	0.000	0.00
Repayment	14322.810	14322.810	14322.810	14322.810	14322.800	0.00
Corporate tax	201481.400	202963.800	204446.200	209900.000	226540.100	226540.10
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.00
Surplus (deficit)	166234.300	167330.000	168425.700	165550.000	154066.100	168388.90
Cumulated cash balance	945394.400	1112724.000	1281150.000	1446700.000	1600766.000	1769155.00
Inflow, local	475740.000	475740.000	475740.000	475740.000	475740.000	475740.00
Outflow, local	309505.800	308410.100	307314.400	310190.100	321673.900	307351.10
Surplus (deficit)	166234.300	167330.000	168425.700	165550.000	154066.100	168388.90
Inflow, foreign	0.000	0.000	0.000	0.000	0.000	0.00
Outflow, foreign	0.000	0.000	0.000	0.000	0.000	0.00
Surplus (deficit)	0.000	0.000	0.000	0.000	0.000	0.00
Net cashflow	193447.600	191965.200	190482.800	185029.000	168388.900	168388.90
Cumulated net cashflow	864322.200	1056287.000	1246770.000	1431799.000	1600188.000	1768577.00

Cashflow tables, production in 1,000 Rs

Year	2007	2008	2009
Total cash inflow	475740.000	475740.000	475740.000
Financial resources	0.000	0.000	0.000
Sales, net of tax	475740.000	475740.000	475740.000
Total cash outflow	307351.100	307351.100	307351.100
Total assets	0.000	0.000	0.000
Operating costs	80811.030	80811.030	80811.030
Cost of finance	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax	226540.100	226540.100	226540.100
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	168388.900	168388.900	168388.900
Cumulated cash balance	1937544.000	2105933.000	2274322.000
Inflow, local	475740.000	475740.000	475740.000
Outflow, local	307351.100	307351.100	307351.100
Surplus (deficit)	168388.900	168388.900	168388.900
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	168388.900	168388.900	168388.900
Cumulated net cashflow	1936966.000	2105355.000	2273744.000

Cashflow Discounting:

a) Equity paid versus Net income flow:
Net present value ..... 631306.30 at 15.00 %
Internal Rate of Return (IRRE1) .. 69.57 %

b) Net Worth versus Net cash return:
Net present value ..... 646039.60 at 15.00 %
Internal Rate of Return (IRRE2) .. 60.66 %

c) Internal Rate of Return on total investment:
Net present value ..... 669102.40 at 15.00 %
Internal Rate of Return (IRR) .. 51.23 %

Net Worth = Equity paid plus reserves

Net Income Statement in 1,000 Rs

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	234200.000	381500.200	475740.000	475740.000	475740.000
Less: variable costs, incl. sales tax.	25148.570	47709.310	59332.540	59332.540	59332.540
Variable margin	209051.400	333790.800	416407.500	416407.500	416407.500
As % of total sales	89.262	87.494	87.528	87.528	87.528
Non-variable costs, incl. depreciation	28821.560	53114.510	53114.510	53114.510	53114.500
Operational margin	180229.900	280676.300	363293.000	363293.000	363293.000
As % of total sales	76.956	73.572	76.364	76.364	76.364
Cost of finance	12890.530	25781.060	23202.950	20624.850	18046.740
Gross profit	167339.300	254895.300	340090.000	342668.100	345246.300
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	167339.300	254895.300	340090.000	342668.100	345246.300
Tax	96220.120	146564.800	195551.800	197034.200	198516.600
Net profit	71119.230	108330.500	144538.300	145633.900	146729.700
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	71119.230	108330.500	144538.300	145633.900	146729.700
Accumulated undistributed profit	71119.230	179449.700	323988.000	469621.900	616351.600
Gross profit, % of total sales	71.451	66.814	71.487	72.028	72.570
Net profit, % of total sales	30.367	28.396	30.382	30.612	30.842
ROE, Net profit, % of equity	46.579	70.950	94.664	95.381	96.099
ROI, Net profit+interest, % of invest.	22.409	35.744	44.689	44 294	43.899

Net Income Statement in 1,000 Rs

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	475740.000	475740.000	475740.000	475740.000	475740.000
Less: variable costs, incl. sales tax.	59332.540	59332.540	59332.540	59332.540	59332.540
Variable margin	416407.500	416407.500	416407.500	416407.500	416407.500
As % of total sales	87.528	87.528	87.528	87.528	87.528
Non-variable costs, incl. depreciation	53114.510	53114.510	53114.510	53114.500	46207.770
Operational margin	363293.000	363293.000	363293.000	363293.000	370199.800
As % of total sales	76.364	76.364	76.364	76.364	77.816
Cost of finance	15468.630	12890.530	10312.420	7734.314	5156.209
Gross profit	347824.300	350402.500	352980.600	355558.700	365043.500
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	347824.300	350402.500	352980.600	355558.700	365043.500
Tax	199999.000	201481.400	202963.800	204446.200	209900.000
Net profit	147825.300	148921.000	150016.800	151112.500	155143.500
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	147825.300	148921.000	150016.800	151112.500	155143.500
Accumulated undistributed profit	764177.000	913098.100	1063115.000	1214227.000	1369371.000
Gross profit, % of total sales	73.112	73.654	74.196	74.738	76.732
Net profit, % of total sales	31.073	31.303	31.533	31.764	32.611
ROE, Net profit, % of equity	96.816	97.534	98.252	98.969	101.609
ROI, Net profit+interest, % of invest.	43.504	43.110	42.715	42.320	42.707

Net Income Statement in 1,000 Rs

Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	475740.000	475740.000	475740.000	475740.000	475740.000
Less: variable costs, incl. sales tax.	59332.540	59332.540	59332.540	59332.540	59332.540
Variable margin	416407.500	416407.500	416407.500	416407.500	416407.500
As % of total sales	87.528	87.528	87.528	87.528	87.528
Non-variable costs, incl. depreciation	22424.720	22424.720	22424.720	22424.720	22424.730
Operational margin	393982.800	393982.800	393982.800	393982.800	393982.800
As % of total sales	82.815	82.815	82.815	82.815	82.815
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	393982.800	393982.800	393982.800	393982.800	393982.800
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	393982.800	393982.800	393982.800	393982.800	393982.800
Tax	226540.100	226540.100	226540.100	226540.100	226540.100
Net profit	167442.700	167442.700	167442.700	167442.700	167442.700
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	167442.700	167442.700	167442.700	167442.700	167442.700
Accumulated undistributed profit	1536814.000	1704256.000	1871699.000	2039142.000	2206585.000
Gross profit, % of total sales	82.815	82.815	82.815	82.815	82.815
Net profit, % of total sales	35.196	35.196	35.196	35.196	35.196
ROE, Net profit, % of equity	109.665	109.665	109.665	109.665	109.665
ROI, Net profit+interest, % of invest.	44.610	44.610	44.610	44.610	44.610

Projected Balance Sheets, construction in 1,000 Rs

Year	1994
Total assets	152686.300
Fixed assets, net of depreciation	0.000
Construction in progress	152686.300
Current assets	0.000
Cash, bank	0.000
Cash surplus, finance available	0.000
Loss carried forward	0.000
Loss	0.000
Total liabilities	152686.300
Equity capital	152686.300
Reserves, retained profit	0.000
Profit	0.000
Long and medium term debt	0.000
Current liabilities	0.000
Bank overdraft, finance required.	0.000
Total debt	0.000
Equity, % of liabilities	100.000

Projected Balance Sheets, Production in 1,000 Rs

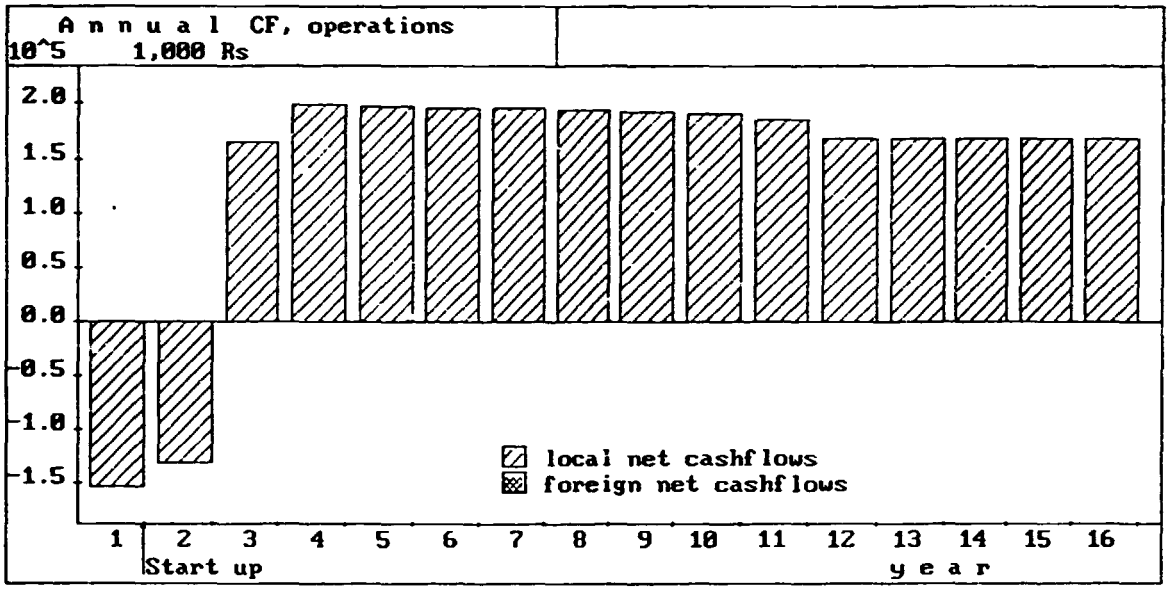
Year	1995	1996	1997	1998	1999
Total assets	370583.700	466495.700	597652.300	728963.400	861370.300
Fixed assets, net of depreciation	144833.300	334548.300	302912.300	271276.300	239640.300
Construction in progress	221351.000	0.000	0.000	0.000	0.000
Current assets	4399.369	6621.604	7708.350	7708.350	7708.350
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	0.031	125325.800	287031.700	449978.800	614021.700
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	370583.700	466495.700	597652.300	728963.400	861370.300
Equity capital	152686.300	152686.300	152686.300	152686.300	152686.300
Reserves, retained profit	0.000	71119.230	179449.700	323988.000	469621.900
Profit	71119.230	108330.500	144538.300	145633.900	146729.700
Long and medium term debt	143226.100	128905.300	114582.500	100259.700	85936.840
Current liabilities	3550.152	5454.468	6395.583	6395.583	6395.583
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	146778.300	134359.800	120978.100	106655.200	92332.430
Equity, % of liabilities	41.202	32.730	25.548	20.946	17.726

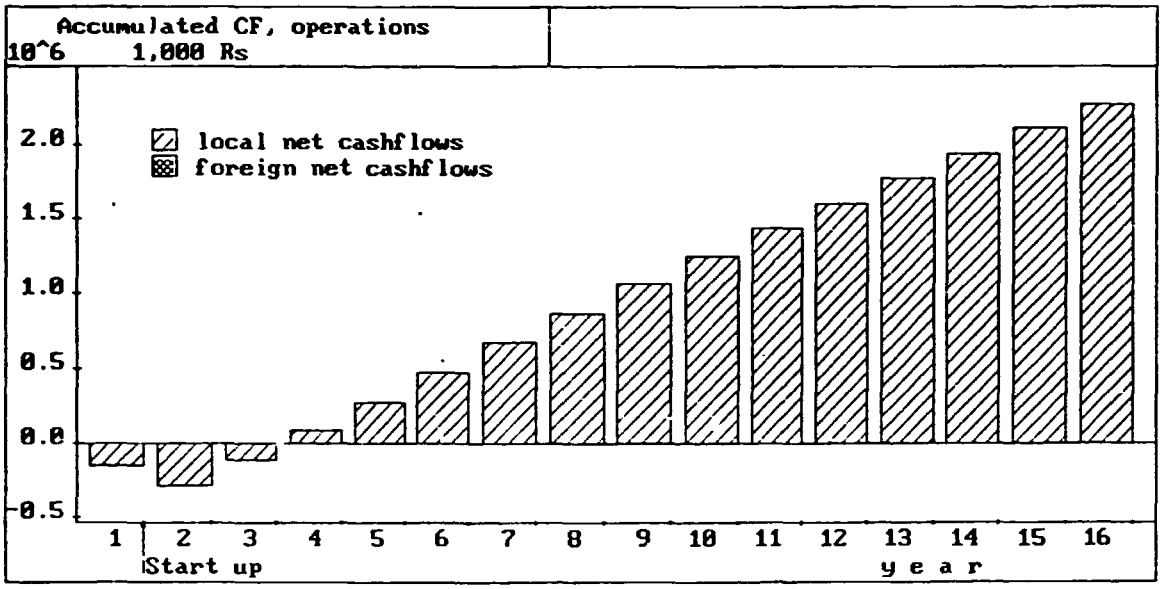
Projected Balance Sheets, Production in 1,000 Rs

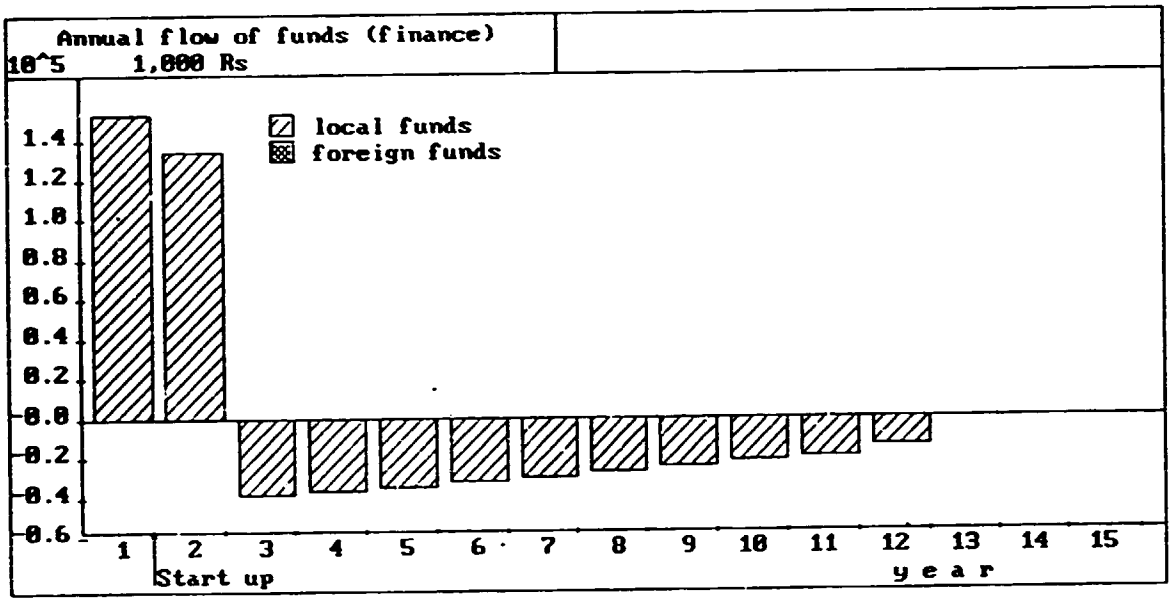
Year	2000	2001	2002	2003	2004
Total assets	994872.900	1129471.000	1265165.000	1401955.000	1542775.000
Fixed assets, net of depreciation	208004.300	176368.200	144732.200	113096.200	88366.950
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	7708.350	7708.350	7708.350	7708.350	7708.350
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	779160.300	945394.600	1112725.000	1281150.000	1446700.000
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	994872.800	1129471.000	1265165.000	1401955.000	1542775.000
Equity capital	152686.300	152686.300	152686.300	152686.300	152686.300
Reserves, retained profit	616351.600	764177.000	913098.100	1063115.000	1214227.000
Profit	147825.300	148921.000	150016.800	151112.500	155143.500
Long and medium term debt	71614.030	57291.220	42968.410	28645.610	14322.800
Current liabilities	6395.583	6395.583	6395.583	6395.583	6395.583
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	78009.620	63686.800	49364.000	35041.190	20718.380
Equity, % of liabilities	15.347	13.518	12.068	10.891	9.897

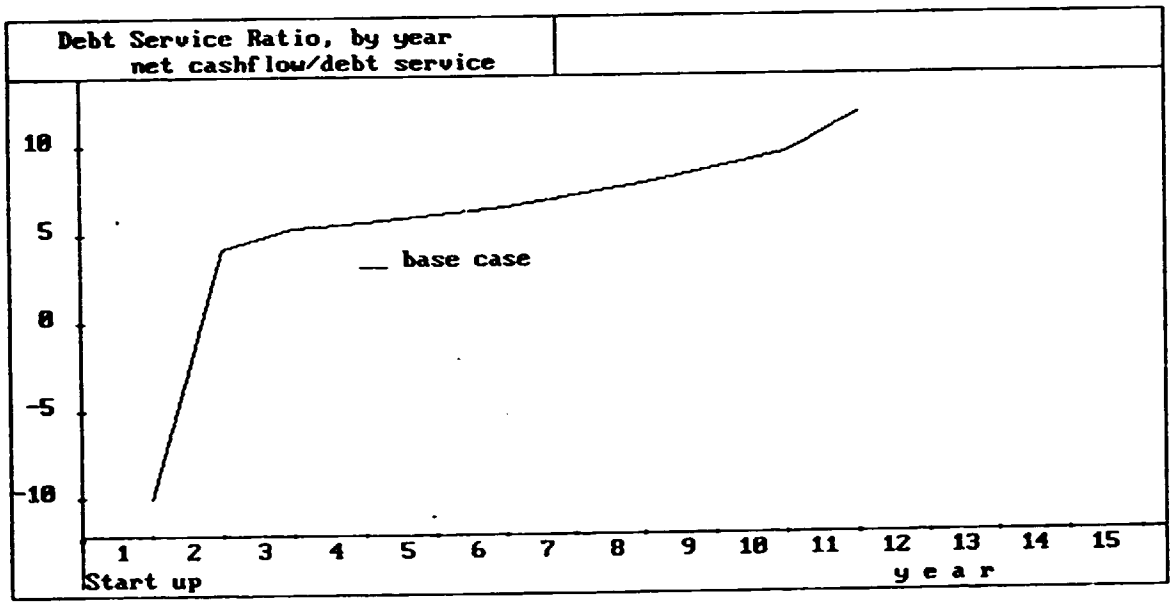
Projected Balance Sheets, Production in 1,000 Rs

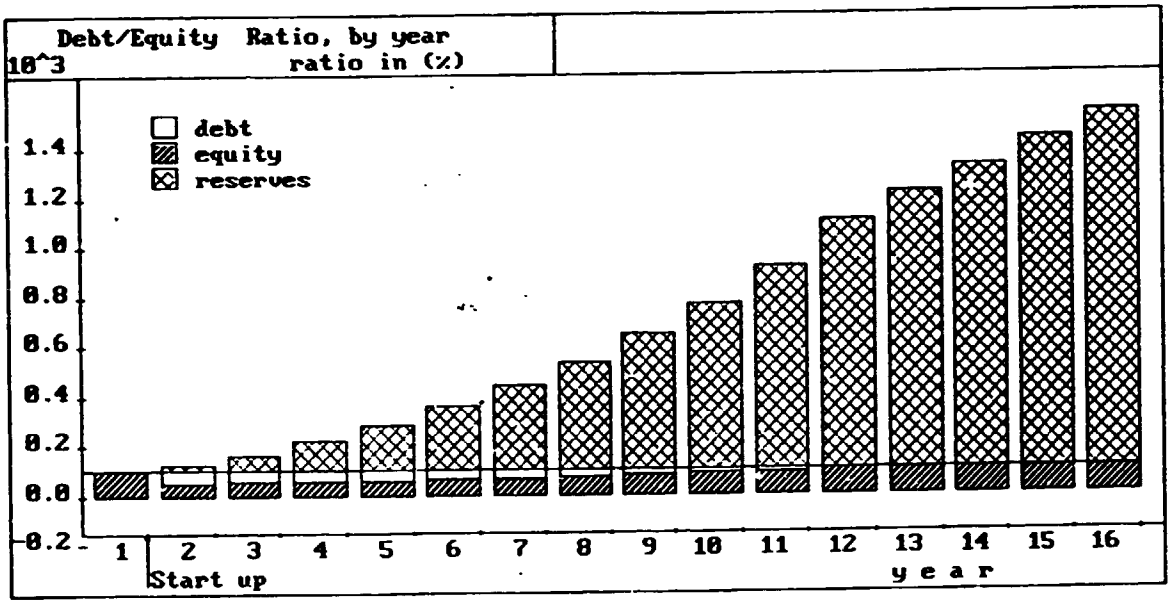
Year	2005	2006	2007	2008	2009
Total assets	1695895.000	1863338.000	2030781.000	2198224.000	2365666.000
Fixed assets, net of depreciation	87420.730	86474.520	85528.300	84582.080	83635.850
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	7708.350	7708.350	7708.350	7708.350	7708.350
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	1600766.000	1769155.000	1937544.000	2105933.000	2274322.000
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	1695895.000	1863338.000	2030781.000	2198224.000	2365666.000
Equity capital	152686.300	152686.300	152686.300	152686.300	152686.300
Reserves, retained profit	1369371.000	1536814.000	1704256.000	1871699.000	2039142.000
Profit	167442.700	167442.700	167442.700	167442.700	167442.700
Long and medium term debt	-0.001	-0.001	-0.001	-0.001	-0.001
Current liabilities	6395.583	6395.583	6395.583	6395.583	6395.583
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	6395.583	6395.583	6395.583	6395.583	6395.583
Equity, % of liabilities	9.003	8.194	7.519	6.946	6.454

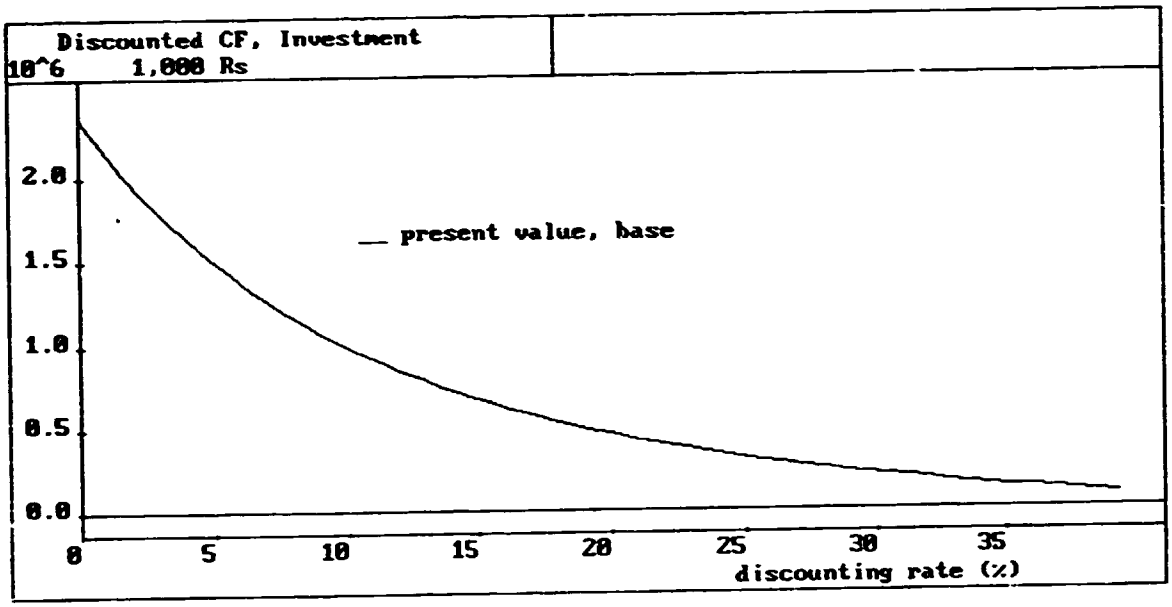

Annual CF, operations
10^5 1,000 Rs
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
local net cashflows
foreign net cashflows
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
year

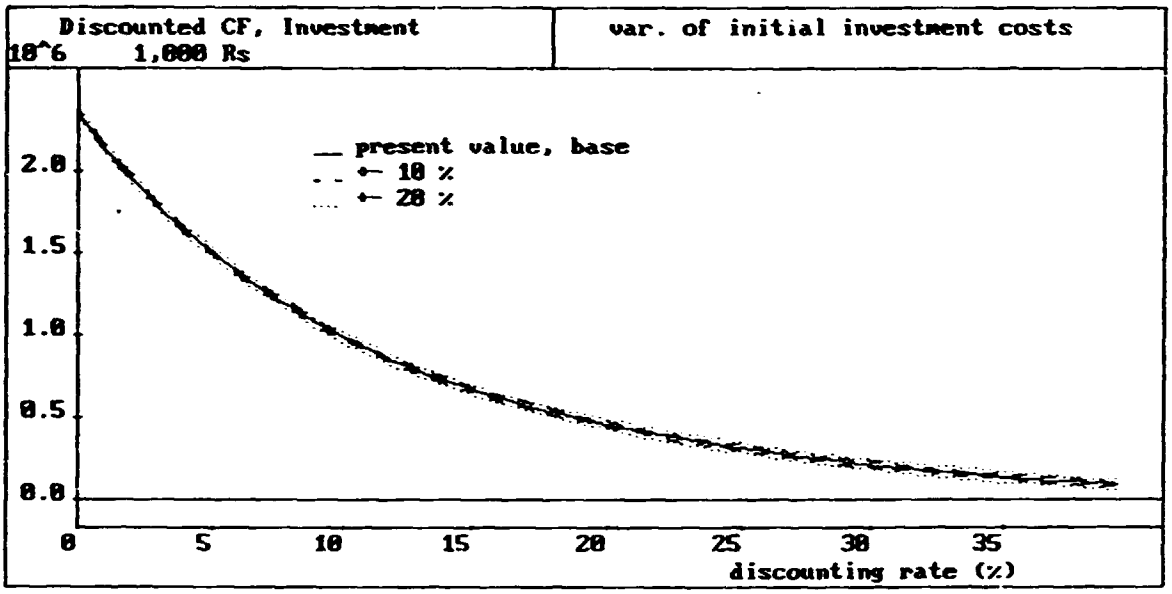

Accumulated CF, operations
10^6 1,000 Rs
local net cashflows
foreign net cashflows
2.0
1.5
1.0
0.5
0.0
-0.5
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
year

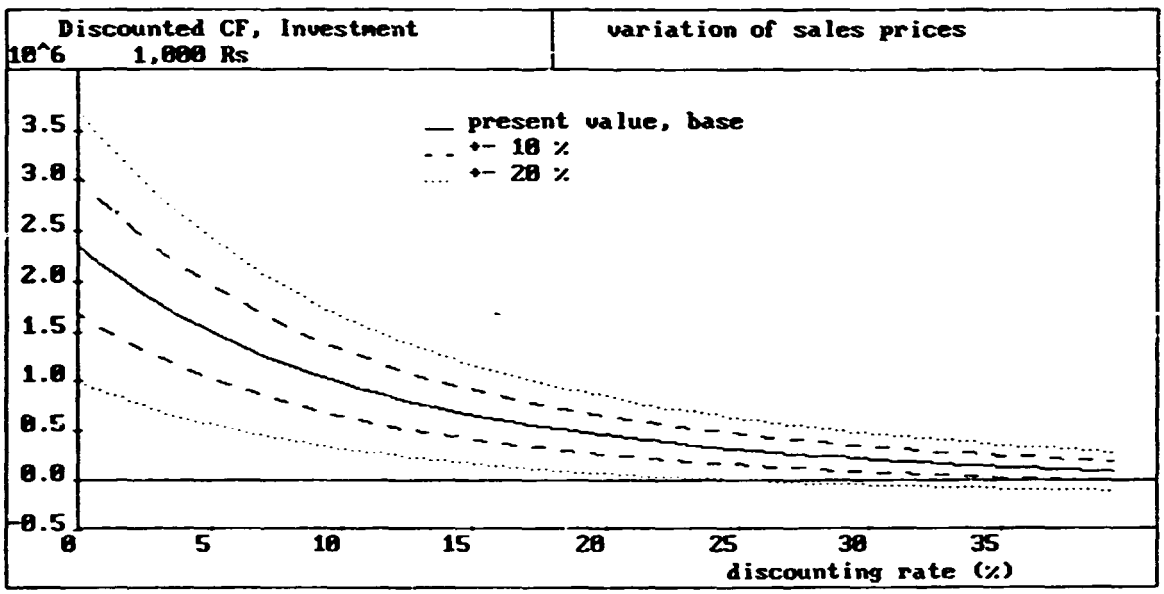

Annual flow of funds (finance)
10^5 1,000 Rs
local funds
foreign funds
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.2
0.4
0.6
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Start up
year

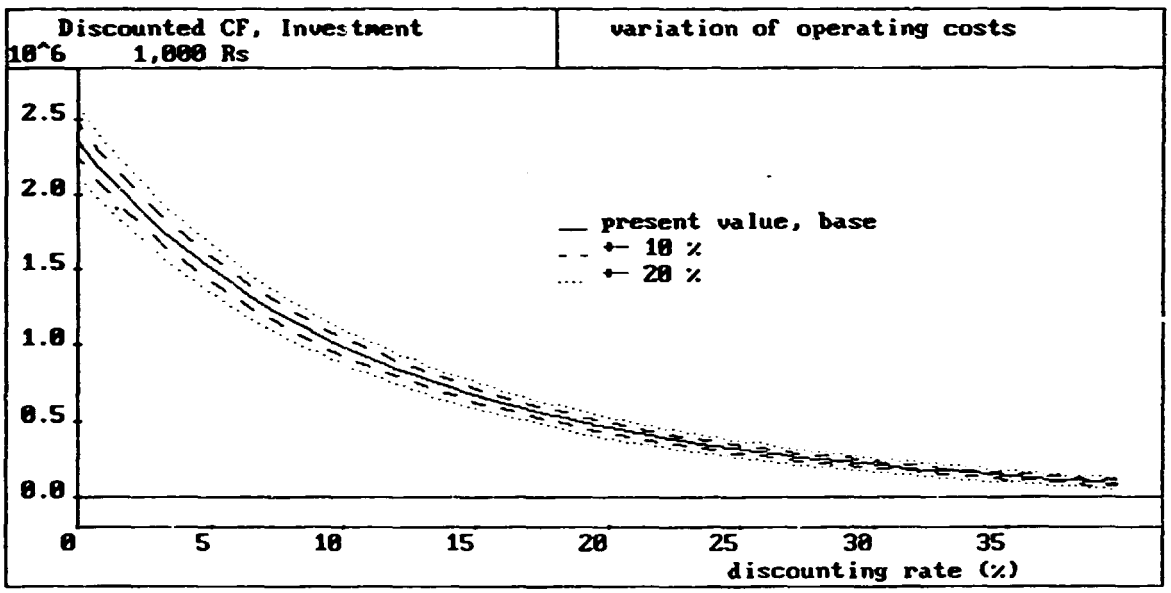

Debt Service Ratio, by year
net cashflow/debt service
10
5
0
-5
-10
__ base case
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Start up
year

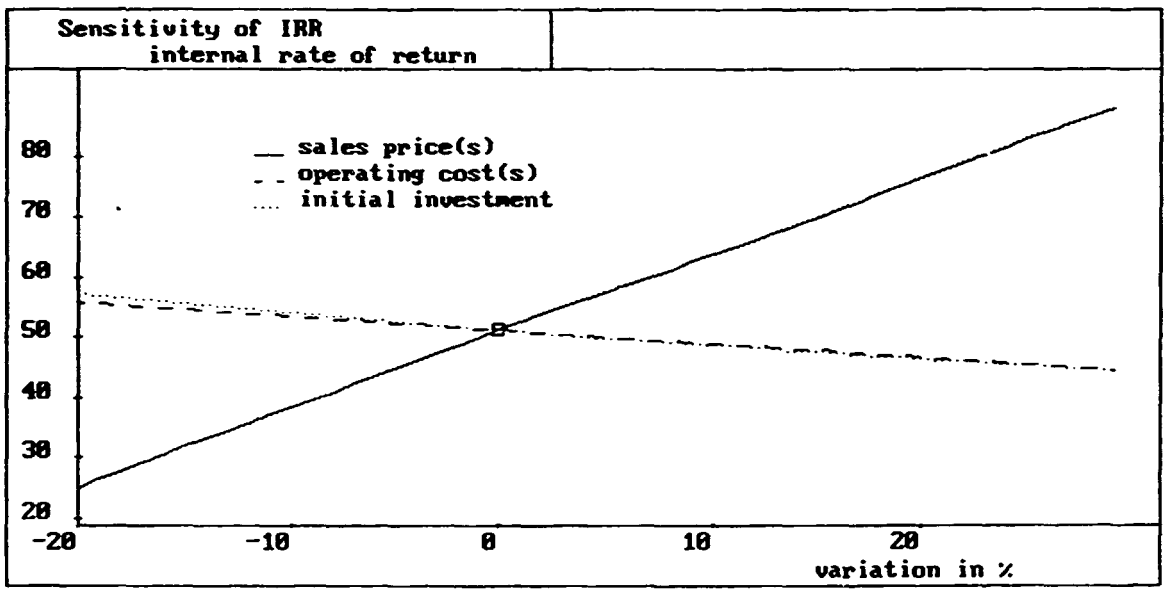

Debt/Equity Ratio, by year
10^3
ratio in (%)
debt
equity
reserves
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
year

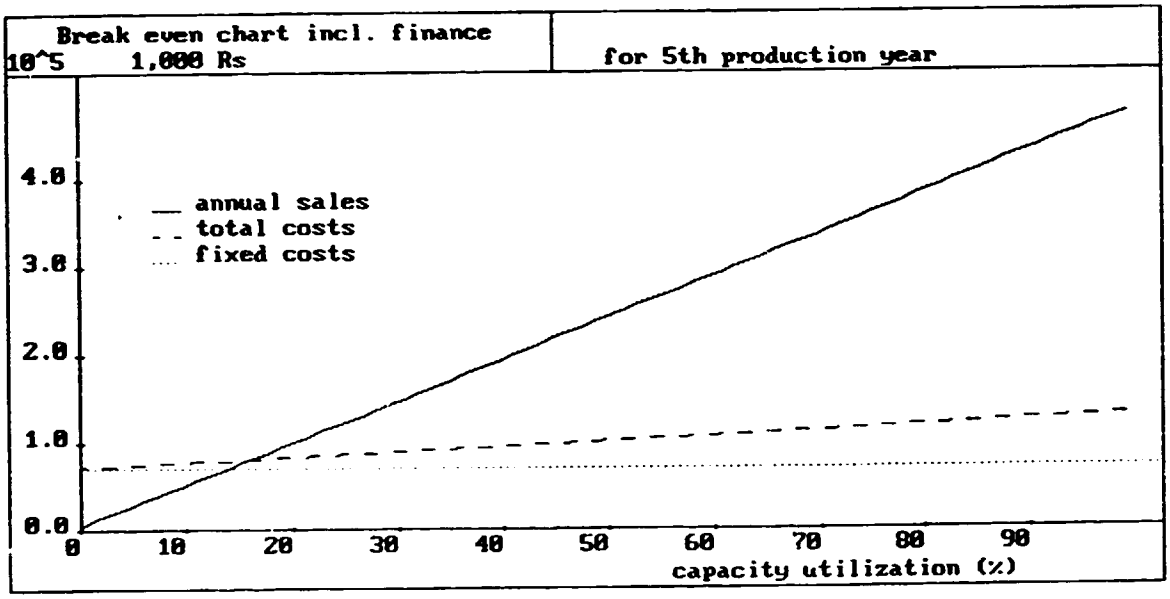

Discounted CF, Investment
10^6 1,000 Rs
2.0
1.5
1.0
0.5
0.0
present value, base
0
5
10
15
20
25
30
35
discounting rate (%)

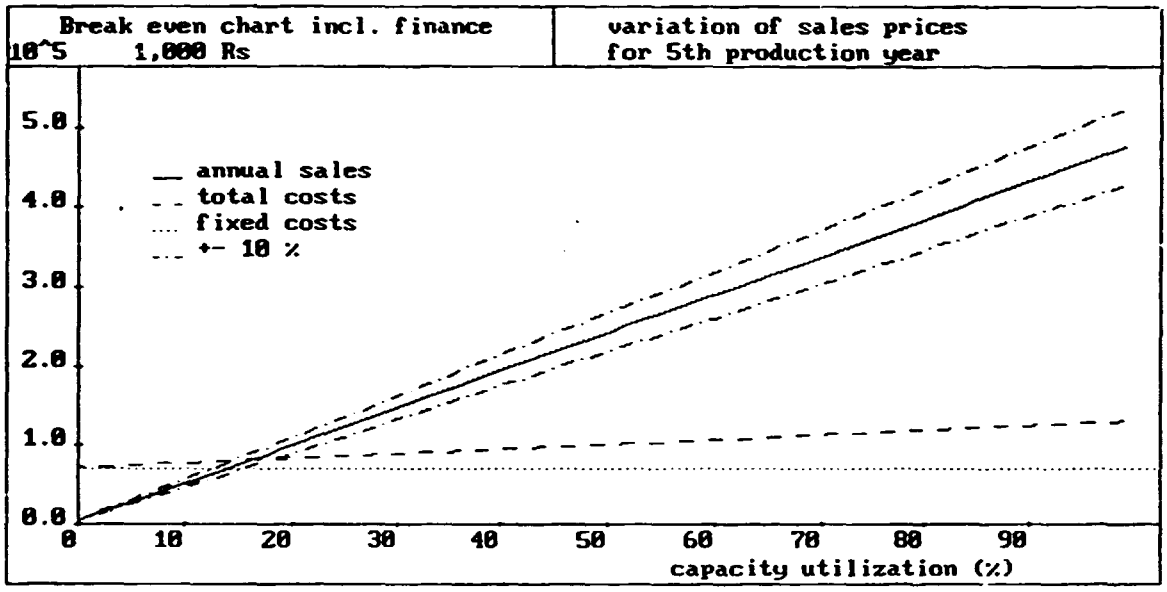

Discounted CF, Investment
var. of initial investment costs
10^6 1,000 Rs
present value, base
← 10 %
← 20 %
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
discounting rate (%)

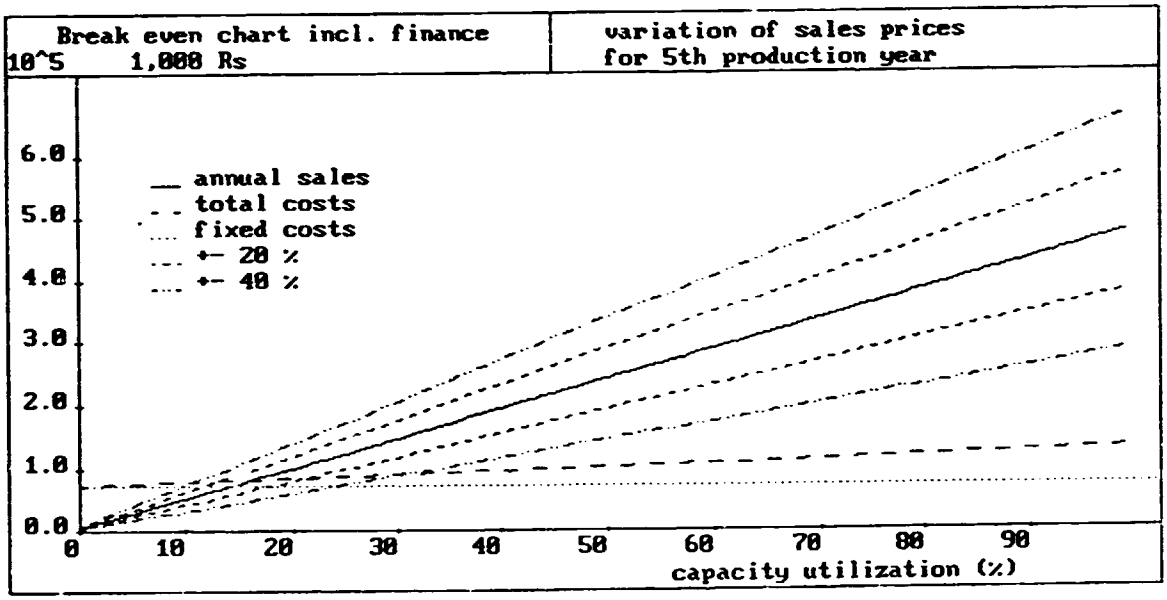

Discounted CF, Investment
variation of sales prices
10^6 1,000 Rs
present value, base
+- 10 %
+- 20 %
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
0
5
10
15
20
25
30
35
discounting rate (%)

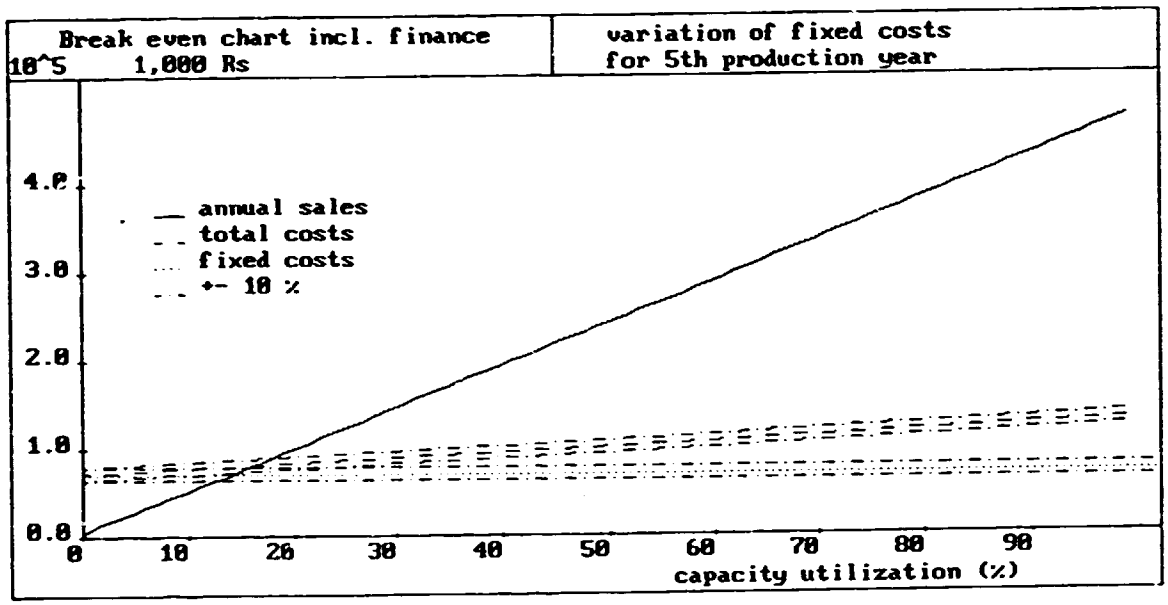

Discounted CF, Investment
variation of operating costs
10^6 1,000 Rs
2.5
2.0
1.5
1.0
0.5
0.0
present value, base
10 %
20 %
0
5
10
15
20
25
30
35
discounting rate (%)

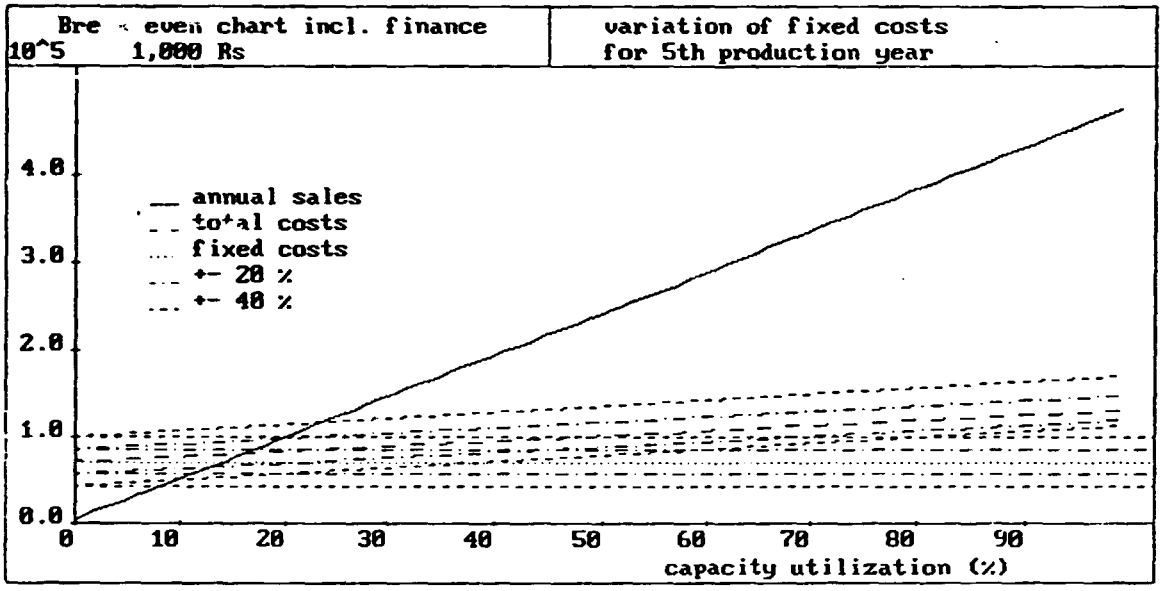

Sensitivity of IRR
internal rate of return
sales price(s)
operating cost(s)
initial investment
80
70
60
50
40
30
20
-20
-10
0
10
20
variation in %

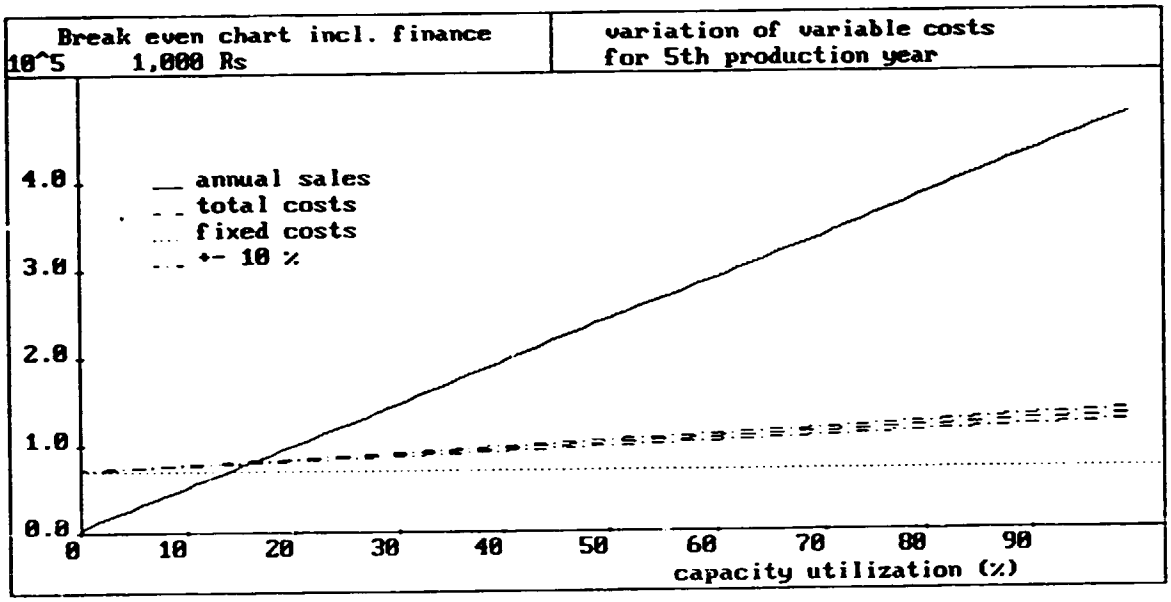

Break even chart incl. finance
10^5 1,000 Rs
for 5th production year
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)

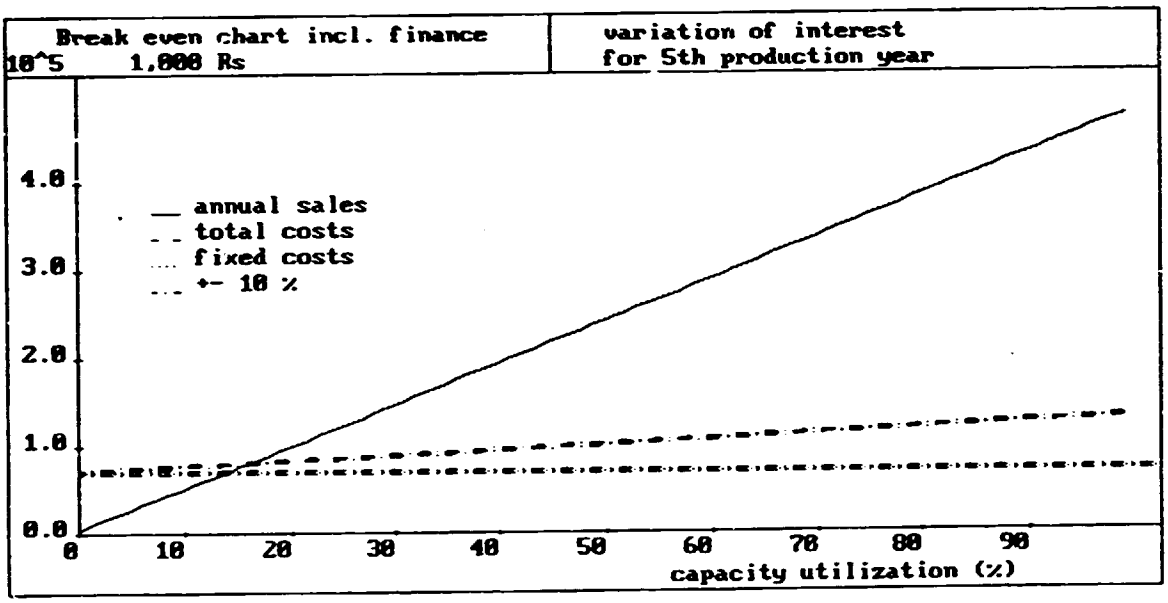

Break even chart incl. finance
10^5 1,000 Rs
variation of sales prices
for 5th production year
5.0
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 10 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)


Break even chart incl. finance
10^5 1,000 Rs
variation of sales prices
for 5th production year
6.0
5.0
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 20 %
+- 40 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)


Break even chart incl. finance
10^5 1,000 Rs
variation of fixed costs
for 5th production year
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 10 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)

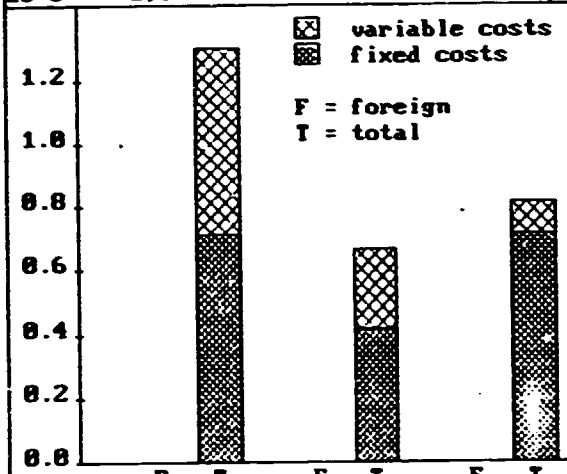

Bre - even chart incl. finance
10^5 1,000 Rs
variation of fixed costs
for 5th production year
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 20 %
+- 40 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)


Break even chart incl. finance
variation of variable costs
for 5th production year
10^5 1,000 Rs
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 10 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)

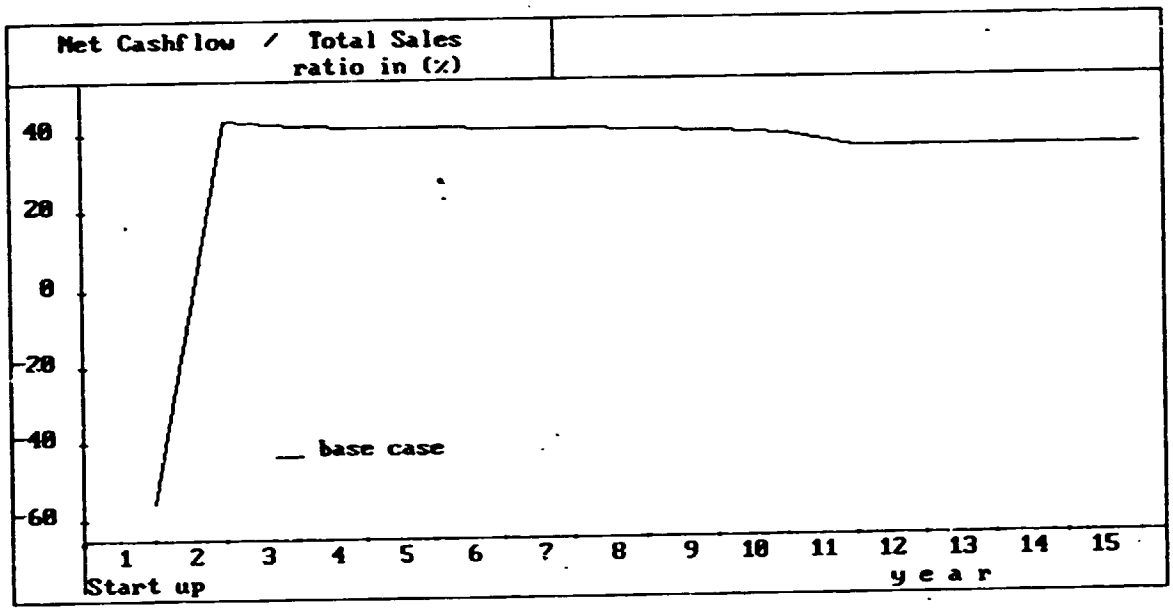

Break even chart incl. finance
10^5 1,000 Rs
variation of interest
for 5th production year
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 10 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)

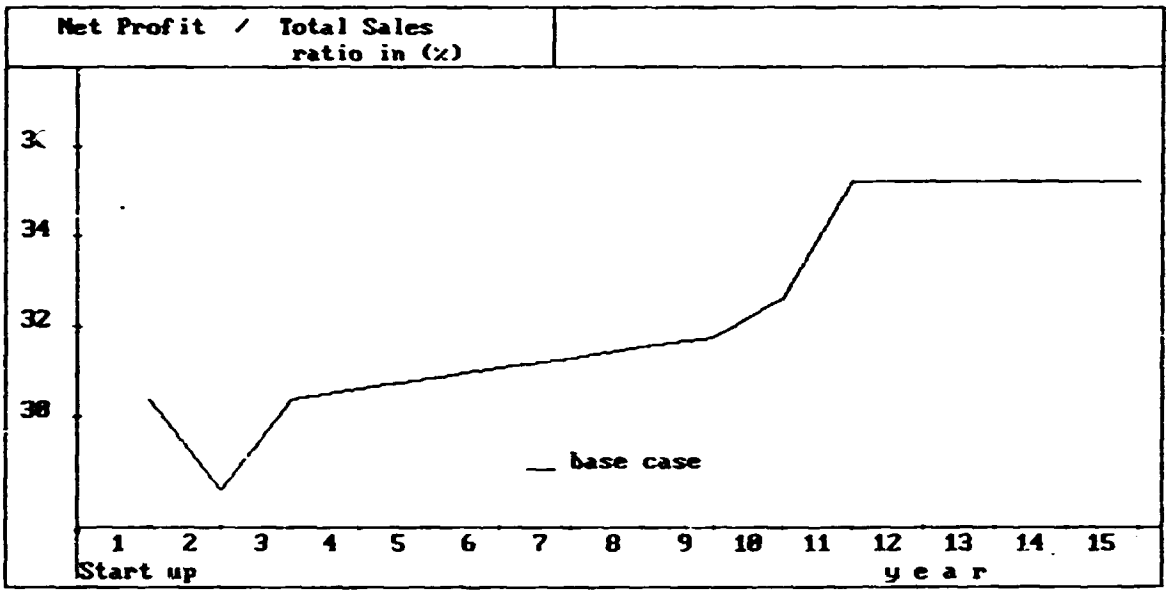
Structure of Production Costs
10^5 1,000 Rs

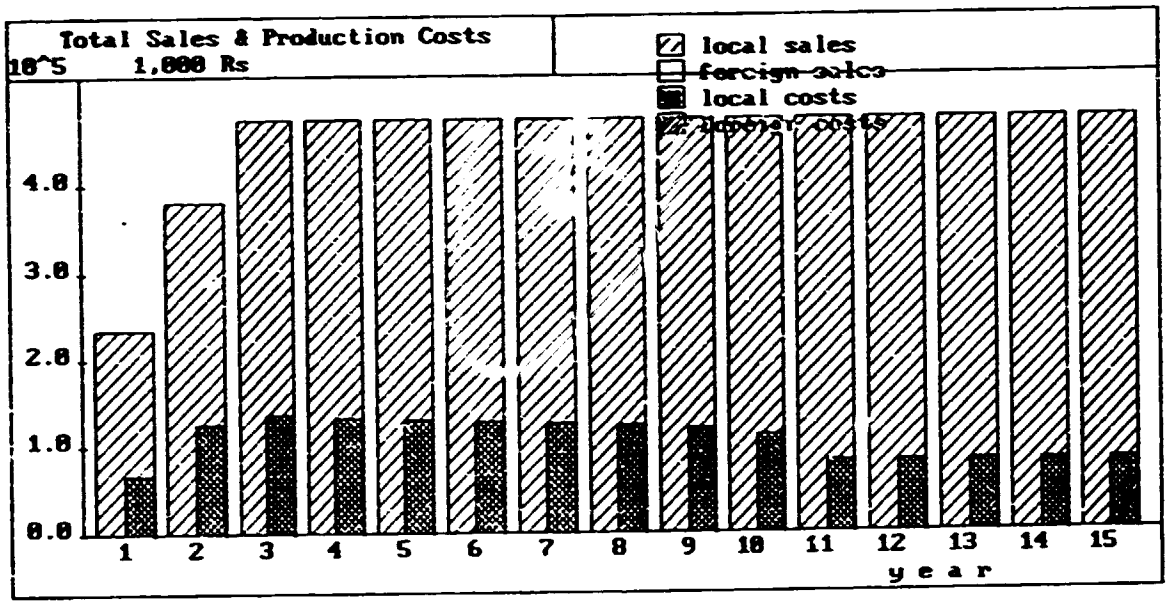
for 5th production year



Nominal	Start up	
17.60	13.85	raw material
2.04	1.42	other RM
12.28	10.05	utilities
12.57	14.61	energy
7.52	14.00	labour
0.89	1.35	maintenance
2.40	3.79	spares
6.63	10.62	overheads
24.24	11.75	depreciation
13.83	19.28	interest
100.00	100.00	Total Prod C.


Net Cashflow / Total Sales ratio in (%)
40
20
0
-20
-40
-60
__ 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 (%)
36
34
32
30
base case
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Start up
year


Total Sales & Production Costs
10^5 1,000 Rs
local sales
foreign sales
local costs
foreign costs
4.0
3.0
2.0
1.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
year

Cashflow Tables, construction in 1,000 Rs

Year	1994
Total cash inflow . .	152686.300
Financial resources .	152686.300
Sales, net of tax . .	0.000
Total cash outflow . .	152686.300
Total assets	152686.300
Operating costs . . .	0.000
Cost of finance . . .	0.000
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	0.000
Cumulated cash balance	0.000
Inflow, local	152686.300
Outflow, local	152686.300
Surplus (deficit) .	0.000
Inflow, foreign . . .	0.000
Outflow, ign . . .	0.000
Surplus (eficit) .	0.000
Net cashflow	-152686.300
Cumulated net cashflow	-152686.300

Cashflow tables, production in 1,000 Rs

Year	1995	1996	1997	1998	1999	2000
Total cash inflow	380978.300	422099.900	577384.200	633983.900	697382.300	767120.500
Financial resources	146778.300	2449.762	1738.742	773.865	851.253	936.377
Sales, net of tax	234200.000	419650.200	575645.400	633210.100	696531.000	766184.100
Total cash outflow	380978.200	283617.600	380589.900	415638.900	455617.300	499703.200
Total assets	225750.400	2884.396	2043.337	932.710	1025.981	1128.579
Operating costs	46117.190	76106.590	97781.380	107559.500	118315.400	130147.000
Cost of finance	12890.530	25781.060	23202.950	20624.850	18046.740	15468.630
Repayment	0.000	14322.810	14322.810	14322.810	14322.810	14322.810
Corporate tax	96220.120	164522.700	243239.400	272199.100	303906.400	339636.200
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	0.031	138482.300	196794.300	218345.000	241764.900	267417.300
Cumulated cash balance	0.031	138482.300	335276.600	553621.600	795386.500	1062804.000
Inflow, local	380978.300	422099.900	577384.200	633983.900	697382.300	767120.500
Outflow, local	380978.200	283617.600	380589.900	415638.900	455617.300	499703.200
Surplus (deficit)	0.031	138482.300	196794.300	218345.000	241764.900	267417.300
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	-130337.500	178586.200	234320.000	253292.600	274134.400	297208.800
Cumulated net cashflow	-283023.800	-104437.600	129882.500	383175.100	657309.500	954518.300

Cashflow tables, production in 1,000 Rs

Year	2001	2002	2003	2004	2005	2006
Total cash inflow	843832.500	928215.900	1021037.000	1123141.000	1235455.000	1359001.000
Financial resources	1030.016	1133.018	1246.316	1370.953	1508.044	1658.852
Sales, net of tax	842802.500	927082.900	1019791.000	1121770.000	1233947.000	1357342.000
Total cash outflow	548307.100	601881.300	660922.100	729948.100	814197.200	879916.400
Total assets	1241.437	1365.583	1502.138	1652.355	1817.588	1999.348
Operating costs	143161.700	157477.900	173225.700	190548.300	209603.000	230563.400
Cost of finance	12890.530	10312.420	7734.314	5156.209	0.000	0.000
Repayment	14322.810	14322.810	14322.810	14322.810	14322.800	0.000
Corporate tax	376690.700	418402.500	464137.200	518268.500	588453.800	647353.700
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	295525.400	326334.600	360115.300	393193.100	421258.100	479084.600
Cumulated cash balance	1358329.000	1684664.000	2044779.000	2437972.000	2859230.000	3338315.000
Inflow, local	843832.500	928215.900	1021037.000	1123141.000	1235455.000	1359001.000
Outflow, local	548307.100	601881.300	660922.100	729948.100	814197.200	879916.400
Surplus (deficit)	295525.400	326334.600	360115.300	393193.100	421258.100	479084.600
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	322738.700	350969.900	382172.400	412672.100	435580.800	479084.500
Cumulated net cashflow	1277257.000	1628227.000	2010399.000	2423072.000	2858652.000	3337737.000

Cashflow tables, production in 1,000 Rs

Year	2007	2008	2009
Total cash inflow . .	1494901.000	1644391.000	1808830.000
Financial resources .	1824.734	2007.207	2207.934
Sales, net of tax . .	1493076.000	1642384.000	1806622.000
Total cash outflow . .	967962.400	1064813.000	1171349.000
Total assets	2199.282	2419.209	2661.134
Operating costs . . .	253619.800	278981.600	306879.900
Cost of finance . . .	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax . . .	712143.400	783412.300	861807.800
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	526938.500	579578.100	637481.500
Cumulated cash balance	3865253.000	4444831.000	5082313.000
Inflow, local	1494901.000	1644391.000	1808830.000
Outflow, local	967962.400	1064813.000	1171349.000
Surplus (deficit) .	526938.500	579578.100	637481.500
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	526938.500	579578.100	637481.500
Cumulated net cashflow	3865675.000	4444254.000	5081735.000

Cashflow Discounting:

a) Equity paid versus Net income flow:
Net present value .....1290799.00 at 15.00 %
Internal Rate of Return (IRRE1) .. 82.04 %

b) Net Worth versus Net cash return:
Net present value .....1294868.00 at 15.00 %
Internal Rate of Return (IRRE2) . 72.64 %

c) Internal Rate of Return on total investment:
Net present value .....1317931.00 at 15.00 %
Internal Rate of Return (IRR) .. 62.06 %

Net Worth = Equity paid plus reserves

Net Income Statement in 1,000 Rs

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	234200.000	419650.200	575645.400	633210.100	696531.000
Less: variable costs, incl. sales tax.	25148.570	52480.240	71792.380	78971.620	86868.770
Variable margin	209051.400	367169.900	503853.100	554238.400	609662.300
As % of total sales	89.262	87.494	87.528	87.528	87.528
Non-variable costs, incl. depreciation	28821.560	55262.360	57625.000	60223.880	63082.700
Operational margin	180229.900	311907.600	446228.100	494014.600	546579.600
As % of total sales	76.956	74.326	77.518	78.017	78.472
Cost of finance	12890.530	25781.060	23202.950	20624.850	18046.740
Gross profit	167339.300	286126.500	423025.100	473389.700	528532.800
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	167339.300	286126.500	423025.100	473389.700	528532.800
Tax	96220.120	164522.700	243239.400	272199.100	303906.400
Net profit	71119.230	121603.800	179785.700	201190.600	224626.400
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	71119.230	121603.800	179785.700	201190.600	224626.400
Accumulated undistributed profit	71119.230	192723.000	372508.700	573699.300	798325.800
Gross profit, % of total sales	71.451	68.182	73.487	74.760	75.881
Net profit, % of total sales	30.367	28.977	31.232	31.773	32.249
ROE, Net profit, % of equity	46.579	79.643	117.748	131.767	147.116
ROI, Net profit+interest, % of invest.	22.409	39.269	54.040	59.027	64.538

Net Income Statement in 1,000 Rs

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	766184.100	842802.500	927082.900	1019791.000	1121770.000
Less: variable costs, incl. sales tax.	95555.640	105111.200	115622.300	127184.600	139903.300
Variable margin	670628.500	737691.300	811460.500	892605.500	981867.200
As % of total sales	87.528	87.528	87.528	87.528	87.528
Non-variable costs, incl. depreciation	66227.380	69686.490	73491.550	77677.110	75374.450
Operational margin	604401.100	668004.800	737968.900	814929.400	906492.800
As % of total sales	78.885	79.260	79.601	79.911	80.809
Cost of finance	15468.630	12890.530	10312.420	7734.314	5156.209
Gross profit	588932.500	655114.300	727656.600	807195.100	901336.600
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	588932.500	655114.300	727656.600	807195.100	901336.600
Tax	338636.200	376590.700	418402.500	464137.200	518268.500
Net profit	250296.300	278423.600	309254.000	343057.900	383068.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	250296.300	278423.600	309254.000	343057.900	383068.000
Accumulated undistributed profit	1048622.000	1327046.000	1636300.000	1979357.000	2362426.000
Gross profit, % of total sales	76.866	77.730	78.489	79.153	80.349
Net profit, % of total sales	32.668	33.035	33.358	33.640	34.149
ROE, Net profit, % of equity	163.929	182.350	202.542	224.682	250.883
ROI, Net profit-interest, % of invest.	70.654	77.402	84.857	93.085	102.941

Net Income Statement in 1,000 Rs

Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	1233947.000	1357342.000	1493076.000	1642384.000	1806622.000
Less: variable costs, incl. sales tax.	153893.300	169282.700	186210.900	204832.000	225315.300
Variable margin	1080054.000	1188060.000	1306865.000	1437552.000	1581307.000
As % of total sales	87.528	87.528	87.528	87.528	87.528
Non-variable costs, incl. depreciation	56655.920	62226.910	68355.000	75095.880	82510.800
Operational margin	1023398.000	1125833.000	1238510.000	1362456.000	1498796.000
As % of total sales	82.937	82.944	82.950	82.956	82.961
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	1023398.000	1125833.000	1238510.000	1362456.000	1498796.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	1023398.000	1125833.000	1238510.000	1362456.000	1498796.000
Tax	588453.800	647353.700	712143.400	783412.300	861807.800
Net profit	434944.200	478478.800	526366.900	579043.900	636988.400
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	434944.200	478478.800	526366.900	579043.900	636988.400
Accumulated undistributed profit	2797370.000	3275849.000	3802216.000	4381260.000	5018248.000
Gross profit, % of total sales	82.937	82.944	82.950	82.956	82.961
Net profit, % of total sales	35.248	35.251	35.254	35.256	35.259
ROE, Net profit, % of equity	284.861	313.374	344.738	379.238	417.188
ROI, Net profit+interest, % of invest.	115.235	126.655	139.193	152.956	168.061

Cashflow Tables, construction in 1,000 Rs

Year	1994
Total cash inflow . .	152686.300
Financial resources .	152686.300
Sales, net of tax . .	0.000
Total cash outflow . .	152686.300
Total assets	152686.300
Operating costs . . .	0.000
Cost of finance . . .	0.000
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	0.000
Cumulated cash balance	0.000
Inflow, local	152686.300
Outflow, local	152686.300
Surplus (deficit) .	0.000
Inflow, foreign . . .	0.000
Outflow, foreign . . .	0.000
Surplus (deficit) .	0.000
Net cashflow	-152686.300
Cumulated net cashflow	-152686.300

Cashflow tables, production in 1000 Rs

Year	1995	1996	1997	1998	1999	2000
Total cash inflow	380978.300	383404.500	476681.200	475740.000	475740.000	475740.000
Financial resources	146778.300	1904.316	941.116	0.000	0.000	0.000
Sales, net of tax	234200.000	381500.200	475740.000	475740.000	475740.000	475740.000
Total cash outflow	284758.100	111513.900	119423.500	115758.700	113160.600	110602.500
Total assets	225750.400	2222.236	1086.745	0.000	0.000	0.000
Operating costs	46117.190	69187.810	80811.030	80811.030	80811.030	80811.030
Cost of finance	12690.530	25781.060	23202.950	20624.850	18046.740	15468.630
Repayment	0.000	14322.810	14322.810	14322.810	14322.810	14322.810
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)	96220.160	271890.600	357257.600	359981.300	362559.400	365137.600
Cumulated cash balance	96220.160	368110.700	725368.400	1085350.000	1447909.000	1813047.000
Inflow, local	380978.300	383404.500	476681.200	475740.000	475740.000	475740.000
Outflow, local	284759.100	111513.900	119423.500	115758.700	113180.600	110602.500
Surplus (deficit)	96220.160	271890.600	357257.600	359981.300	362559.400	365137.600
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	-34117.410	311994.400	394783.400	394929.000	[illegible]	[illegible]
Cumulated net cashflow	-186603.700	125190.800	519974.100	914903.100	[illegible]	[illegible]

Cashflow tables, production in 1.000 Rs

Year	2001	2002	2003	2004	2005	2006
Total cash inflow	475740.000	475740.000	475740.000	475740.000	475740.000	475740.000
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	475740.000	475740.000	475740.000	475740.000	475740.000	475740.000
Total cash outflow	108024.400	105446.300	102868.200	100290.100	95133.830	80811.030
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs	80811.030	80811.030	80811.030	80811.030	80811.030	80811.030
Cost of finance	12890.530	10312.420	7734.314	5156.209	0.000	0.000
Repayment	14322.810	14322.810	14322.810	14322.810	14322.800	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)	367715.700	370293.800	372871.900	375450.000	380606.200	394929.000
Cumulated cash balance	2180763.000	2551056.000	2923928.000	3299378.000	3679984.000	4074913.000
Inflow, local	475740.000	475740.000	475740.000	475740.000	475740.000	475740.000
Outflow, local	108024.400	105446.300	102868.200	100290.100	95133.830	80811.030
Surplus (deficit)	367715.700	370293.800	372871.900	375450.000	380606.200	394929.000
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	394929.000	394929.000	394929.000	394929.000	394929.000	394929.000
Cumulated net cashflow	2099690.000	2494619.000	2889548.000	3284477.000	3679406.000	4074335.000

Cashflow tables, production in 1,000 Rs

Year	2007	2008	2009
Total cash inflow . .	475740.000	475740.000	475740.000
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	475740.000	475740.000	475740.000
Total cash outflow . .	80811.030	80811.030	80811.030
Total assets	0.000	0.000	0.000
Operating costs . . .	80811.030	80811.030	80811.030
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) .	394929.000	394929.000	394929.000
Cumulated cash balance	4469842.000	4864771.000	5259700.000
Inflow, local	475740.000	475740.000	475740.000
Outflow, local	80811.030	80811.030	80811.030
Surplus (deficit) .	394929.000	394929.000	394929.000
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	394929.000	394929.000	394929.000
Cumulated net cashflow	4469264.000	4864193.000	5259122.000

Cashflow Discounting:

a) Equity paid versus Net income flow:
Net present value .....1692002.00 at 15.00 %
Internal Rate of Return (IRRE1) .. 142.87 %

b) Net Worth versus Net cash return:
Net present value .....1706735.00 at 15.00 %
Internal Rate of Return (IRRE2) .. 125.36 %

c) Internal Rate of Return on total investment:
Net present value .....1729799.00 at 15.00 %
Internal Rate of Return (IRR) .. 102.69 %

Net Worth = Equity paid plus reserves

Net Income Statement in 1,000 Rs

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	234200.000	381500.200	475740.000	475740.000	475740.000
Less: variable costs, incl. sales tax.	25148.570	47709.310	59332.540	59332.540	59332.540
Variable margin	209051.400	333790.800	416407.500	416407.500	416407.500
As % of total sales	89.262	87.494	87.528	87.528	87.528
Non-variable costs, incl. depreciation	28821.560	53114.510	53114.510	53114.510	53114.500
Operational margin	180229.900	280676.300	363293.000	363293.000	363293.000
As % of total sales	76.956	73.572	76.364	76.364	76.354
Cost of finance	12890.530	25781.060	23202.950	20624.850	18046.740
Gross profit	167339.300	254895.300	340090.000	342668.100	345246.300
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	167339.300	254895.300	340090.000	342668.100	345246.300
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	167339.300	254895.300	340090.000	342668.100	345246.300
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	167339.300	254895.300	340090.000	342668.100	345246.300
Accumulated undistributed profit	167339.300	422234.600	762324.600	1104993.000	1450239.000
Gross profit, % of total sales	71.451	66.814	71.487	72.028	72.570
Net profit, % of total sales	71.451	66.814	71.487	72.028	72.570
ROE, Net profit, % of equity	109.597	166.941	222.736	224.426	226.115
ROI, Net profit+interest, % of invest.	48.076	74.806	96.788	96.788	96.788

Net Income Statement in 1,000 Rs

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	475740.000	475740.000	475740.000	475740.000	475740.000
Less: variable costs, incl. sales tax.	59332.540	59332.540	59332.540	59332.540	59332.540
Variable margin	416407.500	416407.500	416407.500	416407.500	416407.500
As % of total sales	87.528	87.528	87.528	87.528	87.528
Non-variable costs, incl. depreciation	53114.510	53114.510	53114.510	53114.500	46207.770
Operational margin	363293.000	363293.000	363293.000	363293.000	370199.800
As % of total sales	76.364	76.364	76.364	76.364	77.816
Cost of finance	15468.630	12890.530	10312.420	7734.314	5156.209
Gross profit	347824.300	350402.500	352980.600	355558.700	365043.500
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	347824.300	350402.500	352980.600	355558.700	365043.500
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	347824.300	350402.500	352980.600	355558.700	365043.500
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	347824.300	350402.500	352980.600	355558.700	365043.500
Accumulated undistributed profit	1798663.000	2148466.000	2501446.000	2857005.000	3222049.000
Gross profit, % of total sales	73.112	73.654	74.196	74.738	76.732
Net profit, % of total sales	73.112	73.654	74.196	74.738	76.732
ROF, Net profit, % of equity	227.603	229.492	231.180	232.869	239.081
ROI, Net profit-interest, % of invest.	96.788	96.788	96.788	96.788	96.628

Net Income Statement in 1,000 Rs

Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	475740.000	475740.000	475740.000	475740.000	475740.000
Less: variable costs, incl. sales tax.	59332.540	59332.540	59332.540	59332.540	59332.540
Variable margin	416407.500	416407.500	416407.500	416407.500	416407.500
As % of total sales	87.528	87.528	87.528	87.528	87.528
Non-variable costs, incl. depreciation	22424.720	22424.720	22424.720	22424.720	22424.730
Operational margin	393982.800	393982.800	393982.800	393982.800	393982.800
As % of total sales	82.815	82.815	82.815	82.815	82.815
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	393982.800	393982.800	393982.800	393982.800	393982.800
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	393982.800	393982.800	393982.800	393982.800	393982.800
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	393982.800	393982.800	393982.800	393982.800	393982.800
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	393982.800	393982.800	393982.800	393982.800	393982.800
Accumulated undistributed profit	3616031.000	4010014.000	4403997.000	4797980.000	5191963.000
Gross profit, % of total sales	82.815	82.815	82.815	82.815	82.815
Net profit, % of total sales	82.815	82.815	82.815	82.815	82.815
ROE, Net profit, % of equity	258.034	258.034	258.034	258.034	258.034
ROI, Net profit-interest, % of invest.	104.964	104.964	104.964	104.964	104.964

4. COMFAR tables - BIDHANBAG

BALCO - SPA foils for capacitors
19.3.1993 (BALSB1)
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:	152594.30	0.000 % foreign
current assets:	0.00	0.000 % foreign
total assets:	152594.30	0.000 % foreign

Source of funds during construction phase

equity & grants:	152594.30	0.000 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	152594.30	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	48559.04	72528.63	84751.17
depreciation :	7852.23	31635.29	31635.29
interest :	12980.34	25960.68	23364.61
production costs	69391.59	130124.60	139751.10
thereof foreign	0.00 %	0.00 %	0.00 %
total sales :	234200.00	381500.20	475740.00
gross income :	164808.40	251375.50	335989.00
net income :	70043.58	106834.60	142795.30
cash balance :	0.19	123760.80	159883.30
net cashflow :	-131245.50	164144.10	197670.60

Net Present Value at: 15.00 % = 660570.80
Internal Rate of Return: 50.81 %
Return on equity1: 68.83 %
Return on equity2: 60.20 %

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	21334.400
Plant machinery and equipment	42947.140
Total fixed investment costs	93500.760
Pre-production capital expenditures.	59093.500
Net working capital	0.000
Total initial investment costs	152594.300
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	221351.000	0.000	0.000
Total fixed investment costs	221351.000	0.000	0.000
Preproduction capitals expenditures.	0.000	0.000	0.000
Working capital	770.583	286.467	124.660
Total current investment costs	222121.600	286.467	124.660
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	8724.610	18501.680	22971.000	22971.000	22971.000
Other raw materials	946.674	2146.087	2660.876	2660.876	2660.876
Utilities	6719.810	12887.610	16030.180	16030.180	16030.180
Energy	12596.030	17763.340	21119.860	21119.860	21119.860
Labour, direct	9415.512	9814.191	9814.191	9814.191	9814.191
Repair, maintenance	904.889	1077.570	1158.027	1158.027	1158.027
Spares	2536.832	2915.824	3127.939	3127.939	3127.939
Factory overheads	3588.262	4310.230	4582.916	4582.916	4582.916
Factory costs	45432.620	69416.730	81465.000	81465.000	81465.000
Administrative overheads	2497.070	2603.622	2655.580	2655.580	2655.580
Indir. costs, sales and distribution	629.342	508.281	630.590	630.590	630.590
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	7852.228	31635.290	31635.290	31635.290	31635.290
Financial costs	12980.340	25960.680	23364.610	20768.540	18172.470
Total production costs	69391.600	130124.600	139751.100	137155.000	134558.900
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,%	38.401	38.507	44.600	45.444	46.321
Total labour	10062.460	10481.570	10495.190	10495.190	10495.190

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	22971.000	22971.000	22971.000	22971.000	22971.000
Other raw materials	2660.876	2660.876	2660.876	2660.876	2660.876
Utilities	16030.180	16030.180	16030.180	16030.180	16030.180
Energy	21119.860	21119.860	21119.860	21119.860	21119.860
Labour, direct	9814.191	9814.191	9814.191	9814.191	9814.191
Repair, maintenance	1158.027	1158.027	1158.027	1158.027	1158.027
Spares	3127.939	3127.939	3127.939	3127.939	3127.939
Factory overheads	4582.916	4582.916	4582.916	4582.916	4582.916
Factory costs	81465.000	81465.000	81465.000	81465.000	81465.000
Administrative overheads	2655.580	2655.580	2655.580	2655.580	2655.580
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	31635.290	31635.290	31635.290	31635.280	24728.540
Financial costs	15576.410	12980.340	10384.270	7788.202	5192.134
Total production costs	131962.900	129366.800	126770.700	124174.700	114671.900
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,%	47.232	48.180	49.167	50.195	54.354
Total labour	10495.190	10495.190	10495.190	10495.190	10495.190

Total Production Costs in 1,000 Rs

Year	2005- 8	2009
% of nom. capacity (single product).	0.000	0.000
Raw material 1	22971.000	22971.000
Other raw materials	2660.876	2660.876
Utilities	16030.180	16030.180
Energy	21119.860	21119.860
Labour, direct	9814.191	9814.191
Repair, maintenance	1158.027	1158.027
Spares	3127.939	3127.939
Factory overheads	4582.916	4582.916
Factory costs	81465.000	81465.000
Administrative overheads	2655.580	2655.580
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	85696.670	85696.680
Costs per unit (single product)	0.000	0.000
Of it foreign, %	0.000	0.000
Of it variable,%	72.732	72.732
Total labour	10495.190	10495.190

Net Working Capital in 1,000 Rs

Year	mdc	coto	1995	1996	1997	1998-2009
Current assets &						
Accounts receivable	0	---	0.000	0.000	0.000	0.000
Inventory and materials	16	23.1	694.821	1455.057	1806.891	1806.891
Energy	0	---	0.000	0.000	0.000	0.000
Spares	180	2.0	1268.416	1457.912	1563.970	1563.970
Work in progress	10	36.0	1262.017	1928.242	2262.917	2262.917
Finished products	10	36.0	1331.380	2000.565	2336.683	2336.683
Cash in hand	0	---	0.000	0.000	0.000	0.000
Total current assets			4556.635	6841.777	7970.460	7970.460
Current liabilities and Accounts payable	30	12.0	3786.052	5784.727	6788.750	6788.750
Net working capital			770.583	1057.050	1181.710	1181.710
Increase in working capital			770.583	286.467	124.660	0.000
Net working capital, local			770.583	1057.050	1181.710	1181.710
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 ..	152594.300
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....	0.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	0.000
Current liabilities	0.000
Bank overdraft	0.000
Total funds	152594.300

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....	144226.000	-14422.600	-14422.600	-14422.600
Loan B, local....	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000
Total loan	144226.000	-14422.600	-14422.600	-14422.600
Current liabilities	3786.052	1998.675	1004.023	0.000
Bank overdraft	0.000	0.000	0.000	0.000
Total funds	148012.000	-12423.920	-13418.580	-14422.600

Cashflow Tables, construction in 1,000 Rs

Year	1994
Total cash inflow . .	152594.300
Financial resources .	152594.300
Sales, net of-tax . .	0.000
Total cash outflow . .	152594.300
Total assets	152594.300
Operating costs . . .	0.000
Cost of finance . . .	0.000
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	0.000
Cumulated cash balance	0.000
Inflow, local	152594.300
Outflow, local	152594.300
Surplus (deficit) .	0.000
Inflow, foreign . . .	0.000
Outflow, foreign . . .	0.000
Surplus (deficit) .	0.000
Net cashflow	-152594.300
Cumulated net cashflow	-152594.300

Cashflow tables, production in 1,000 Rs

Year	1995	1996	1997	1998	1999	2000
Total cash inflow . .	382212.100	383498.800	476744.100	475740.000	475740.000	475740.000
Financial resources .	148012.000	1998.675	1004.023	0.000	0.000	0.000
Sales, net of tax . .	234200.000	381500.200	475740.000	475740.000	475740.000	475740.000
Total cash outflow . .	382211.900	259738.000	316850.700	314628.700	313525.400	312422.000
Total assets	225907.600	2285.142	1128.683	0.000	0.000	0.000
Operating costs . . .	48559.030	72528.630	84751.160	84751.160	84751.160	84751.160
Cost of finance . . .	12930.340	25960.680	23364.610	20768.540	18172.470	15576.410
Repayment	0.000	14422.600	14422.600	14422.600	14422.600	14422.600
Corporate tax . . .	94764.630	144540.900	193193.700	194686.400	196179.100	197671.900
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	0.188	123760.900	159893.300	161111.300	162214.700	163318.000
Cumulated cash balance	0.188	123761.000	283644.400	444755.700	606970.400	770288.400
Inflow, local	382212.100	383498.800	476744.100	475740.000	475740.000	475740.000
Outflow, local	382211.900	259738.000	316850.700	314628.700	313525.400	312422.000
Surplus (deficit) .	0.188	123760.900	159893.400	161111.300	162214.700	163318.000
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	-131249.500	161144.100	197670.500	196382.500	194809.700	193317.000
Cumulated net cashflow	-283339.700	-118695.600	77974.970	274277.400	469087.200	662404.200

Cashflow tables, production in 1,000 Rs

Year	2001	2002	2003	2004	2005	200
Total cash inflow . .	475740.000	475740.000	475740.000	475740.000	475740.000	475740.00
Financial resources .	0.000	0.000	0.000	0.000	0.000	0.00
Sales, net of tax . .	475740.000	475740.000	475740.000	475740.000	475740.000	475740.00
Total cash outflow . .	311318.700	310215.400	309112.100	311980.100	323448.700	309026.10
Total assets	0.000	0.000	0.000	0.000	0.000	0.00
Operating costs . . .	84751.160	84751.160	84751.160	84751.160	84751.160	84751.16
Cost of finance . . .	12980.340	10384.270	7788.202	5192.134	0.000	0.00
Repayment	14422.600	14422.600	14422.600	14422.600	14422.590	0.00
Corporate tax . . .	199164.600	200657.400	202150.100	207614.200	224274.900	224274.90
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.00
Surplus (deficit) .	164421.300	165524.700	166628.000	163759.900	152291.300	166713.90
Cumulated cash balance	934709.700	1100234.000	1266862.000	1430622.000	1582914.000	1749628.00
Inflow, local	475740.000	475740.000	475740.000	475740.000	475740.000	475740.00
Outflow, local	311318.700	310215.400	309112.100	311980.100	323448.700	309026.10
Surplus (deficit) .	164421.300	165524.700	166628.000	163759.900	152291.300	166713.90
Inflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.00
Outflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.00
Surplus (deficit) .	0.000	0.000	0.000	0.000	0.000	0.00
Net cashflow	191824.300	190331.500	188838.800	183374.700	166713.900	166713.90
Cumulated net cashflow	854228.400	1044560.000	1233399.000	1416773.000	1583487.000	1750201.00

Cashflow tables, production in 1,000 Rs

Year	2007	2008	2009
Total cash inflow	475740.000	475740.000	475740.000
Financial resources	0.000	0.000	0.000
Sales, net of tax	475740.000	475740.000	475740.000
Total cash outflow	309026.100	309026.100	309026.100
Total assets	0.000	0.000	0.000
Operating costs	84751.160	84751.160	84751.160
Cost of finance	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax	224274.900	224274.900	224274.900
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	166713.900	166713.900	166713.900
Cumulated cash balance	1916342.000	2083056.000	2249770.000
Inflow, local	475740.000	475740.000	475740.000
Outflow, local	309026.100	309026.100	309026.100
Surplus (deficit)	166713.900	166713.900	166713.900
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	166713.900	166713.900	166713.900
Cumulated net cashflow	1916915.000	2083629.000	2250343.000

Cashflow Discounting:

a) Equity paid versus Net income flow:
Net present value ..... 622102.60 at 15.00 %
Internal Rate of Return (IRRE1) .. 68.63 %

b) Net Worth versus Net cash return:
Net present value ..... 637347.30 at 15.00 %
Internal Rate of Return (IRRE2) .. 60.20 %

c) Internal Rate of Return on total investment:
Net present value ..... 660570.80 at 15.00 %
Internal Rate of Return (IRR) .. 50.61 %

Net Worth = Equity paid plus reserves

Net Income Statement in 1,000 Rs

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	234200.000	381500.200	475740.000	475740.000	475740.000
Less: variable costs, incl. sales tax.	26646.830	50106.540	62329.070	62329.070	62329.070
Variable margin	207553.200	331393.600	413411.000	413411.000	413411.000
As % of total sales	88.622	86.866	86.898	86.898	86.898
Non-variable costs, incl. depreciation	29764.420	54057.400	54057.380	54057.390	54057.380
Operational margin	177788.800	277336.200	359353.600	359353.600	359353.600
As % of total sales	75.913	72.696	75.536	75.536	75.536
Cost of finance	12980.340	25960.660	23364.610	20768.540	18172.470
Gross profit	164808.400	251375.500	335989.000	338585.000	341181.100
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	164808.400	251375.500	335989.000	338585.000	341181.100
Tax	94764.830	144540.900	193193.700	194686.400	196179.100
Net profit	70043.580	106834.600	142795.300	143898.600	145002.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	70043.580	106834.600	142795.300	143898.600	145002.000
Accumulated undistributed profit	70043.580	176878.200	319673.500	463572.100	608574.100
Gross profit, % of total sales	70.371	65.891	70.624	71.170	71.719
Net profit, % of total sales	29.908	28.004	30.015	30.247	30.479
ROE, Net profit, % of equity	45.902	70.012	93.578	94.391	95.028
ROI, Net profit+interest, % of invest.	22.157	35.412	44.294	43.895	43.496

Net Income Statement in 1,000 Rs

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	475740.000	475740.000	475740.000	475740.000	475740.000
Less: variable costs, incl. sales tax.	62329.070	62329.070	62329.070	62329.070	62329.070
Variable margin	413411.000	413411.000	413411.000	413411.000	413411.000
As % of total sales	86.898	86.898	86.898	86.898	86.898
Non-variable costs, incl. depreciation	54057.380	54057.380	54057.380	54057.380	47150.640
Operational margin	359353.600	359353.600	359353.600	359353.600	366260.300
As % of total sales	75.536	75.536	75.536	75.536	76.988
Cost of finance	15576.410	12980.340	10384.270	7788.202	5192.134
Gross profit	343777.200	346373.300	348969.300	351565.400	361068.200
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	343777.200	346373.300	348969.300	351565.400	361068.200
Tax	197671.900	199164.600	200657.400	202150.100	207614.200
Net profit	146105.300	147208.600	148312.000	149415.300	153454.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	146105.300	147208.600	148312.000	149415.300	153454.000
Accumulated undistributed profit	754679.400	901888.100	1050200.000	1199615.000	1353069.000
Gross profit, % of total sales	72.262	72.807	73.353	73.899	75.896
Net profit, % of total sales	30.711	30.943	31.175	31.407	32.259
ROE, Net profit, % of equity	95.748	96.471	97.194	97.917	100.563
ROI, Net profit+interest, % of invest.	43.101	42.703	42.305	41.907	42.291

Net Income Statement in 1,000 Rs

Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	475740.000	475740.000	475740.000	475740.000	475740.000
Less: variable costs, incl. sales tax.	62329.070	62329.070	62329.070	62329.070	62329.070
Variable margin	413411.000	413411.000	413411.000	413411.000	413411.000
As % of total sales	86.898	86.898	86.898	86.898	86.898
Non-variable costs, incl. depreciation	23367.590	23367.590	23367.590	23367.590	23367.600
Operational margin	390043.400	390043.400	390043.400	390043.400	390043.400
As % of total sales	81.987	81.987	81.987	81.987	81.987
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	390043.400	390043.400	390043.400	390043.400	390043.400
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	390043.400	390043.400	390043.400	390043.400	390043.400
Tax	224274.900	224274.900	224274.900	224274.900	224274.900
Net profit	165768.400	165768.400	165768.400	165768.400	165768.400
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	165768.400	165768.400	165768.400	165768.400	165768.400
Accumulated undistributed profit	1518838.000	1684606.000	1850375.000	2016143.000	2181912.000
Gross profit, % of total sales	81.987	81.987	81.987	81.987	81.987
Net profit, % of total sales	34.844	34.844	34.844	34.844	34.844
ROE, Net profit, % of equity	108.633	108.633	108.633	108.633	108.633
ROI, Net profit+interest, % of invest.	44.190	44.190	44.190	44.190	44.190

Projected Balance Sheets, construction in 1,000 Rs

Year	1994
Total assets	152594.300
Fixed assets, net of depreciation	0.000
Construction in progress	152594.300
Current assets	0.000
Cash, bank	0.000
Cash surplus, finance available	0.000
Loss carried forward	0.000
Loss	0.000
Total liabilities	152594.300
Equity capital	152594.300
Reserves, retained profit	0.000
Profit	0.000
Long and medium term debt	0.000
Current liabilities	0.000
Bank overdraft, finance required.	0.000
Total debt	0.000
Equity, % of liabilities	100.000

Projected Balance Sheets, Production in 1,000 Rs

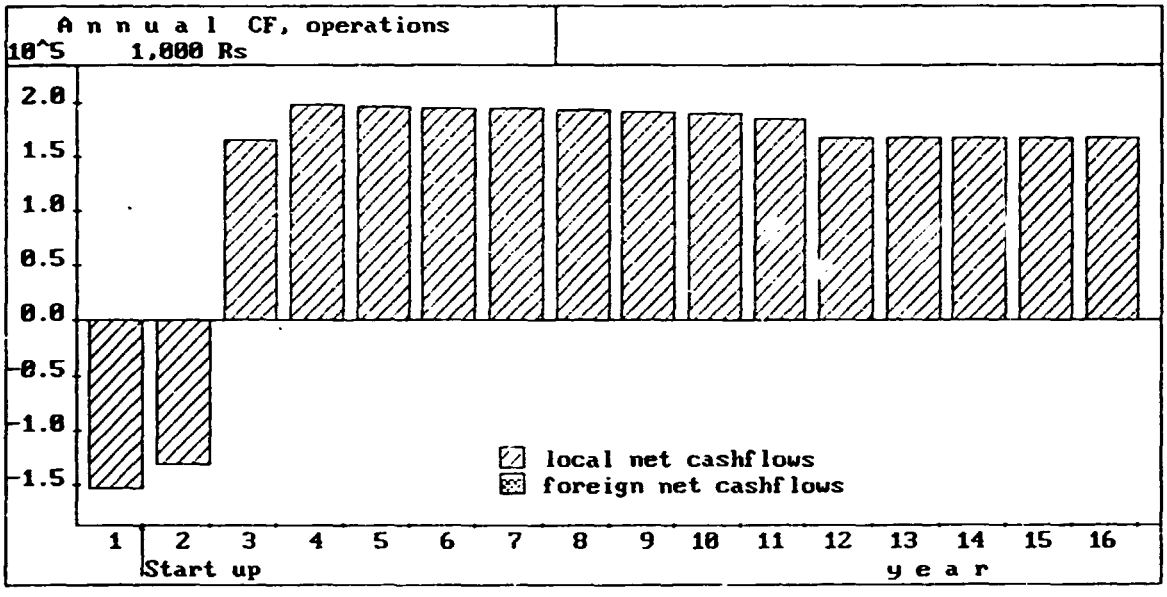
Year	1995	1996	1997	1998	1999
Total assets	370649.900	465060.600	594437.300	723913.300	854492.800
Fixed assets, net of depreciation	144742.000	334457.700	302822.400	271187.200	239551.900
Construction in progress	221351.000	0.000	0.000	0.000	0.000
Current assets	4556.635	6841.777	7970.460	7970.460	7970.460
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	0.250	123761.100	283644.400	444755.700	606970.400
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	370649.900	465060.600	594437.300	723913.300	854492.800
Equity capital	152594.300	152594.300	152594.300	152594.300	152594.300
Reserves, retained profit	0.000	70043.580	176878.200	319673.500	463572.100
Profit	70043.580	106834.600	142795.300	143898.600	145002.000
Long and medium term debt	144226.000	129603.400	115380.800	100958.200	86535.590
Current liabilities	3786.052	5784.727	6768.750	6768.750	6768.750
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	148012.000	135588.100	122149.500	107746.900	93324.340
Equity, % of liabilities	41.169	32.812	25.670	21.079	17.858

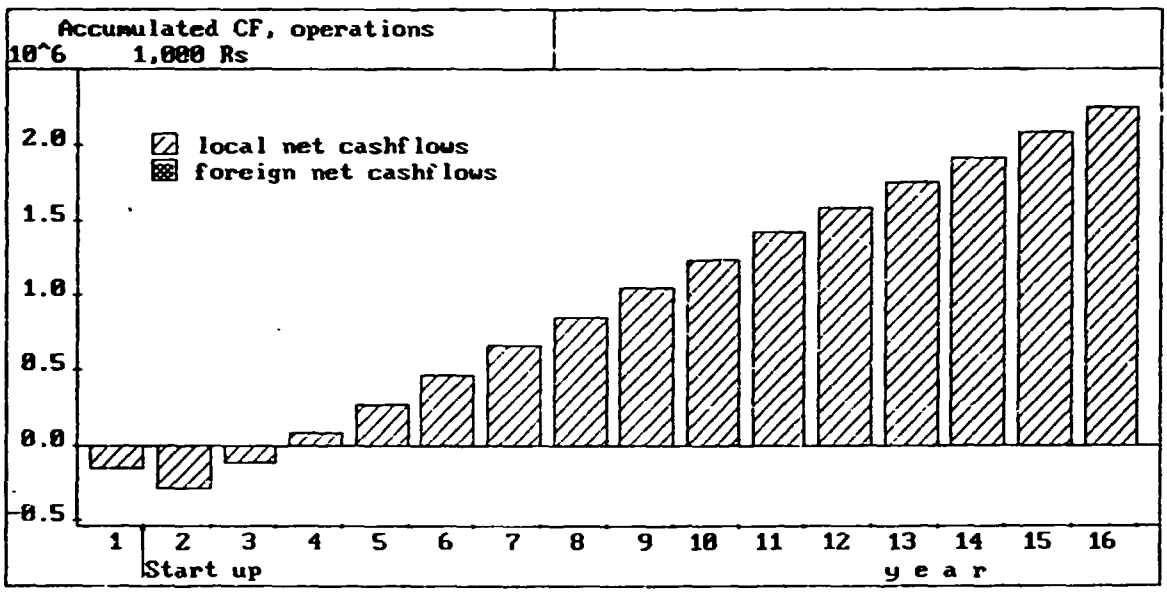
Projected Balance Sheets, Production in 1,000 Rs

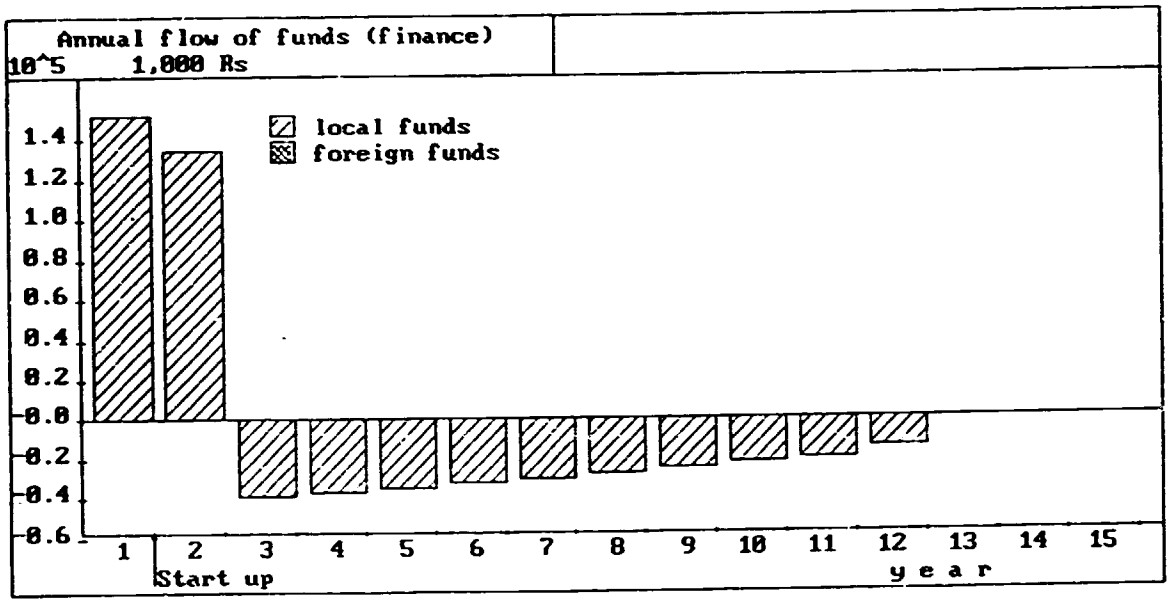
Year	2000	2001	2002	2003	2004
Total assets	986175.400	1118961.000	1252851.000	1387844.000	1526875.000
Fixed assets, net of depreciation	207916.600	176281.300	144646.000	113010.800	88282.200
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	7970.460	7970.460	7970.460	7970.460	7970.460
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	770288.400	934709.600	1100234.000	1266862.000	1430622.000
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	986175.400	1118961.000	1252851.000	1387844.000	1526875.000
Equity capital	152594.300	152594.300	152594.300	152594.300	152594.300
Reserves, retained profit	608574.100	754679.400	901888.100	1050200.000	1199615.000
Profit	146105.300	147208.600	148312.000	149415.300	153454.000
Long and medium term debt	72112.990	57690.390	43267.790	28845.190	14422.590
Current liabilities	6788.750	6788.750	6788.750	6788.750	6788.750
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	78901.740	64479.140	50056.540	35633.940	21211.340
Equity, % of liabilities	15.473	13.637	12.180	10.995	9.994

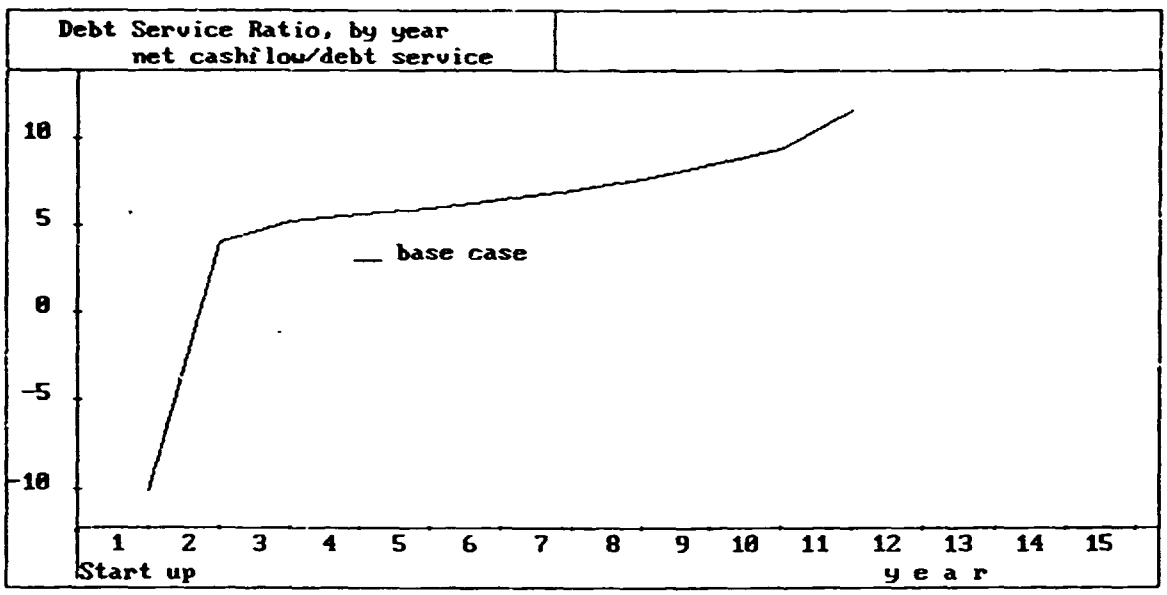
Projected Balance Sheets, Production in 1,000 Rs

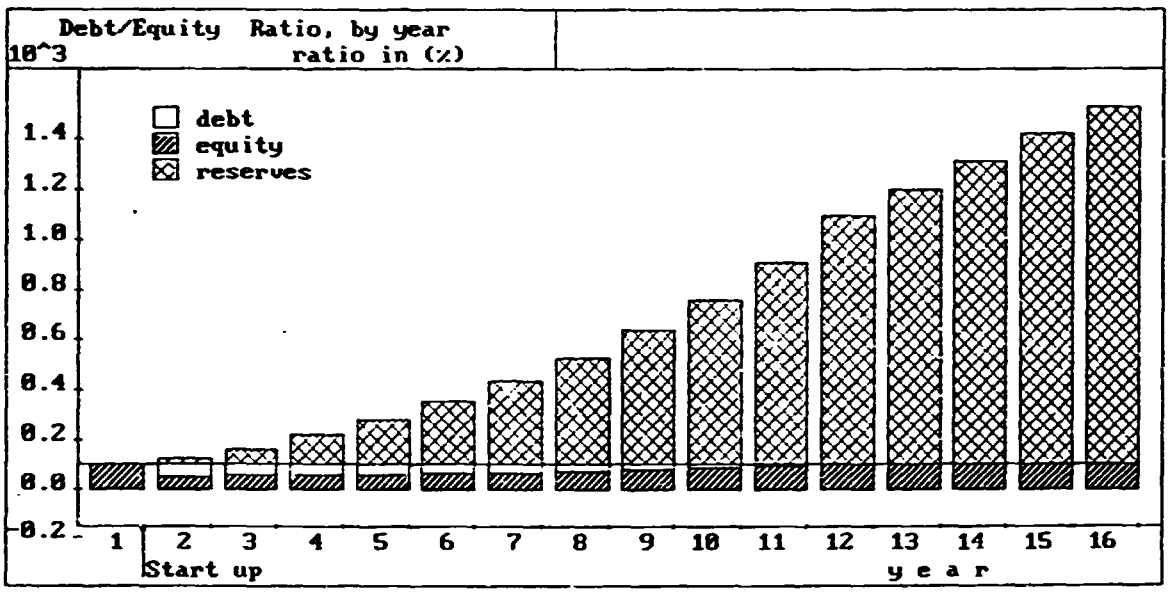
Year	2005	2006	2007	2008	2009
Total assets	1678221.000	1843989.000	2009758.000	2175526.000	2341295.000
Fixed assets, net of depreciation	87336.700	86391.200	85445.700	84500.200	83554.700
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	7970.460	7970.460	7970.460	7970.460	7970.460
Cash, bank	0.000	0.000	0.000	0.000	0.000
Cash surplus, finance available	1582914.000	1749628.000	1916342.000	2083056.000	2249770.000
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	1678221.000	1843989.000	2009758.000	2175526.000	2341295.000
Equity capital	152594.300	152594.300	152594.300	152594.300	152594.300
Reserves, retained profit	1353069.000	1518838.000	1684606.000	1850375.000	2016143.000
Profit	165768.400	165768.400	165768.400	165768.400	165768.400
Long and medium term debt	-0.004	-0.004	-0.004	-0.004	-0.004
Current liabilities	6788.750	6788.750	6788.750	6788.750	6788.750
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	6788.746	6788.746	6788.746	6788.746	6788.746
Equity, % of liabilities	9.093	8.275	7.593	7.014	6.518

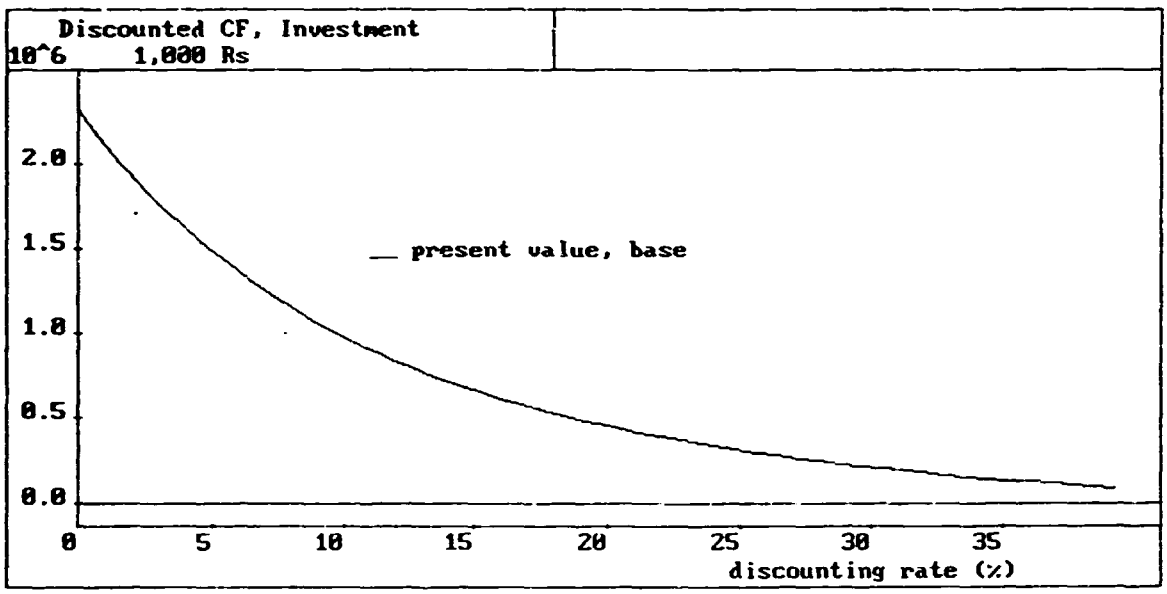

A n n u a l CF, operations
10^5 1,000 Rs
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
local net cashflows
foreign net cashflows
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
y e a r

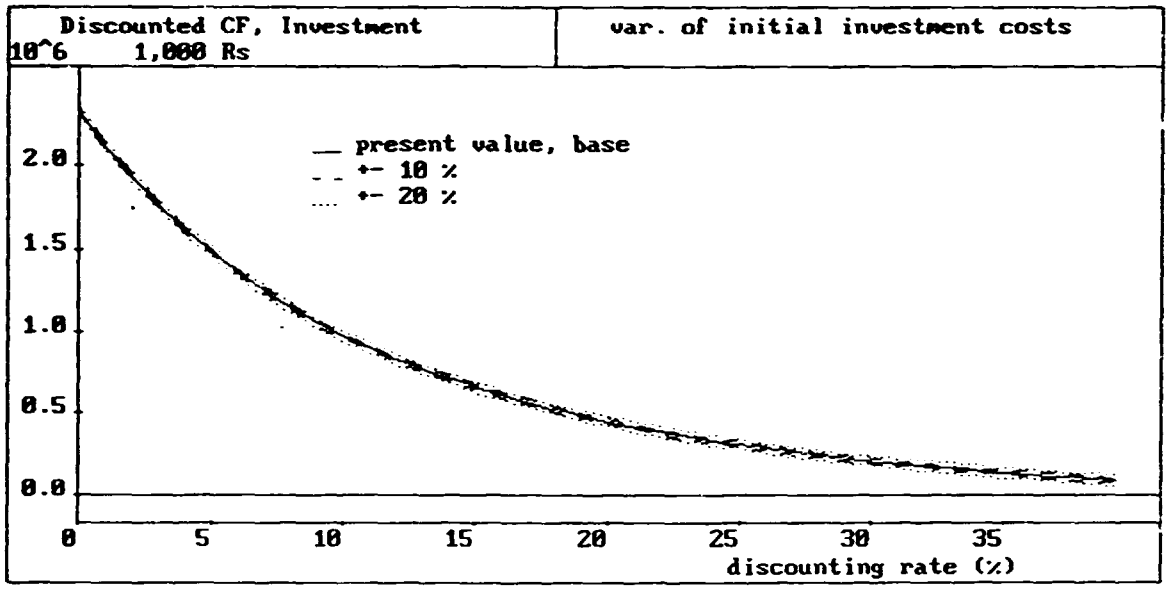

Accumulated CF, operations
10^6 1,000 Rs
local net cashflows
foreign net cashflows
2.0
1.5
1.0
0.5
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Start up
year

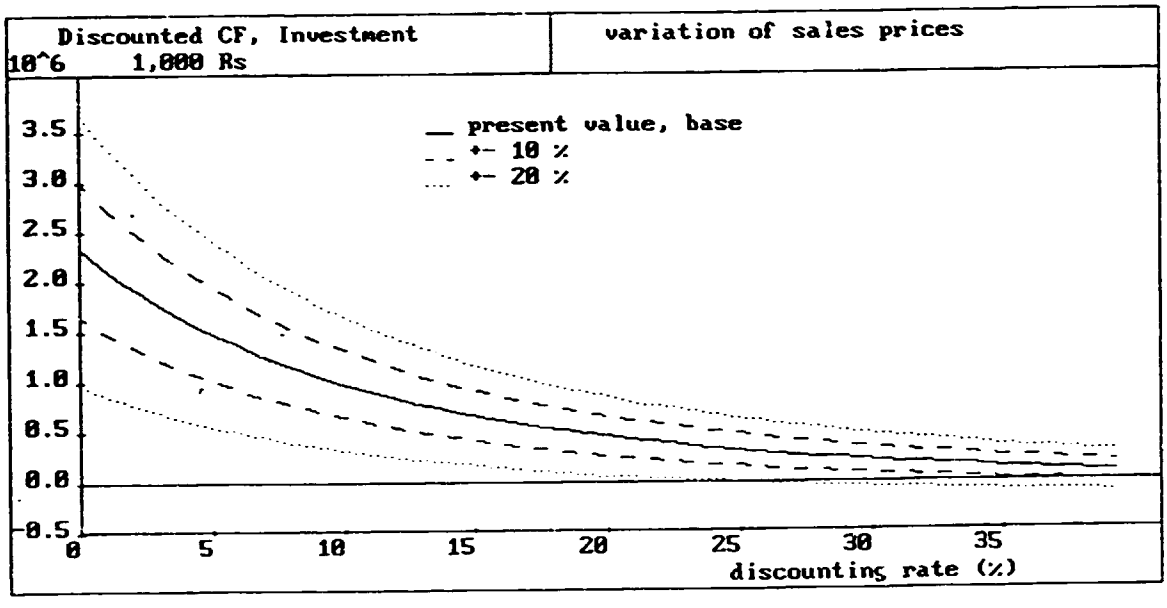

Annual flow of funds (finance)
10^5 1,000 Rs
local funds
foreign funds
1.4
1.2
1.0
0.8
0.6
0.4
0.2
-0.0
-0.2
-0.4
-0.6
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Start up
year

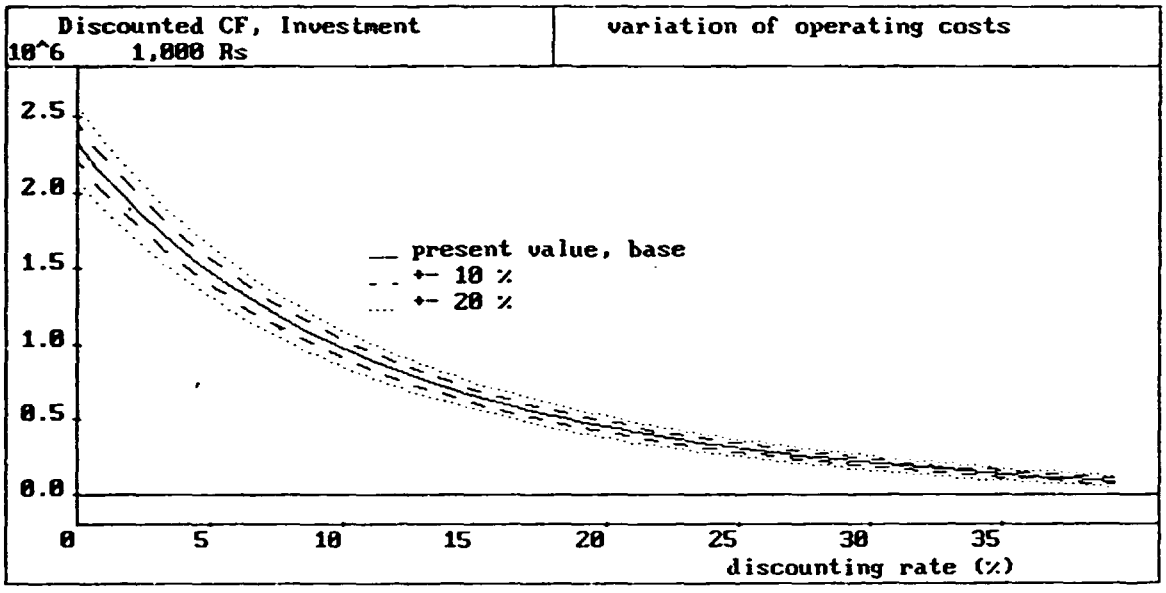

Debt Service Ratio, by year
net cashflow/debt service
10
5
0
-5
-10
base case
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Start up
year

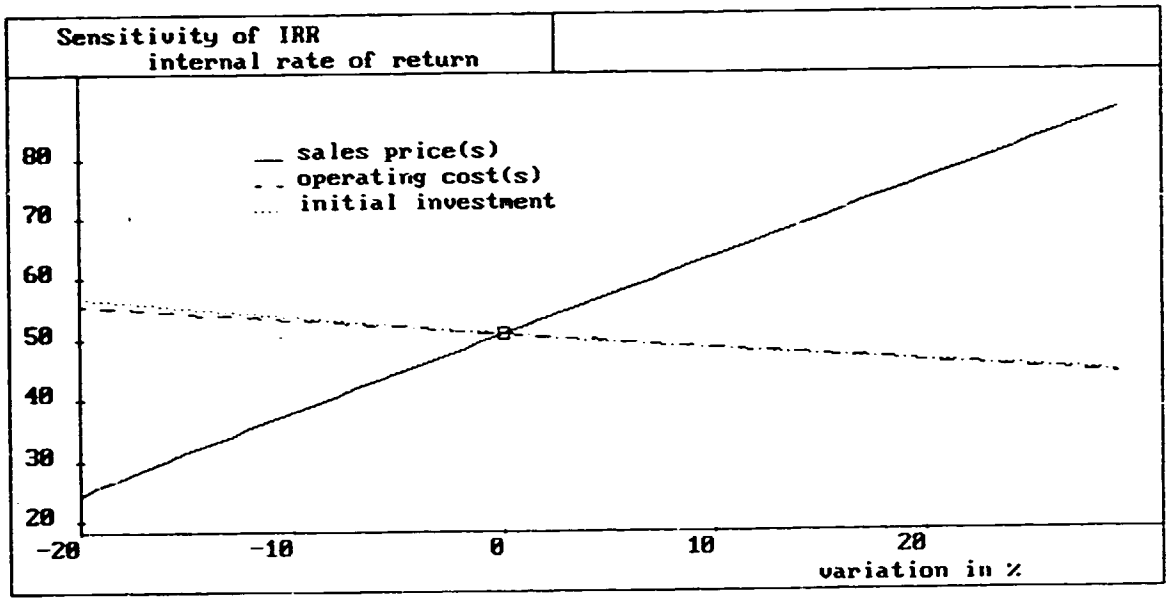

Debt/Equity Ratio, by year
10^3
ratio in (%)
debt
equity
reserves
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
year

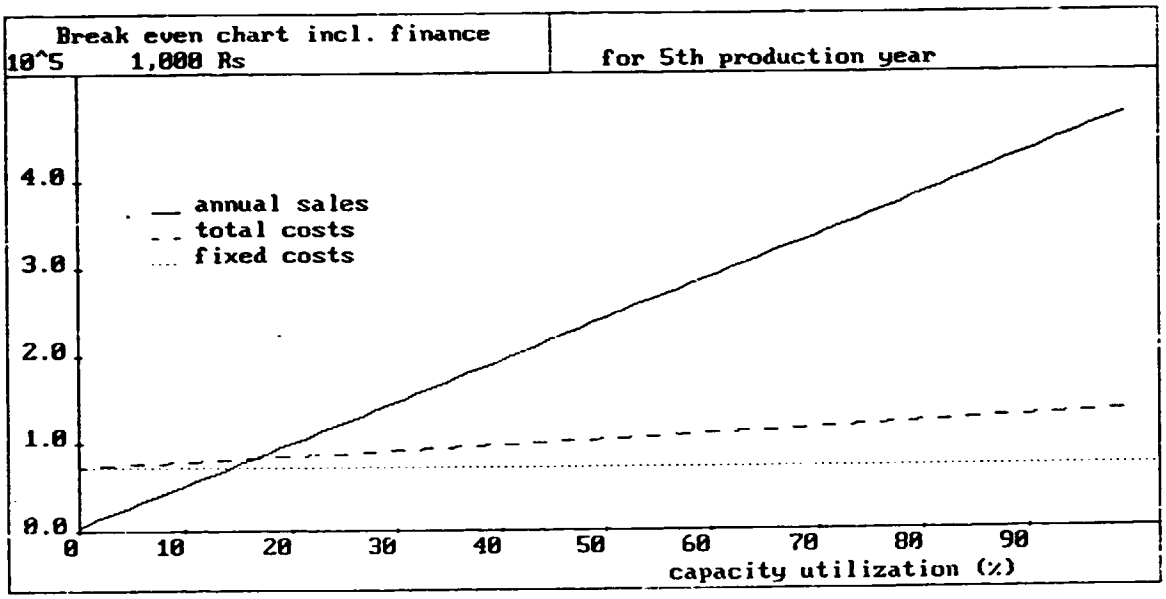

Discounted CF, Investment
10^6 1,000 Rs
2.0
1.5
1.0
0.5
0.0
present value, base
0
5
10
15
20
25
30
35
discounting rate (%)

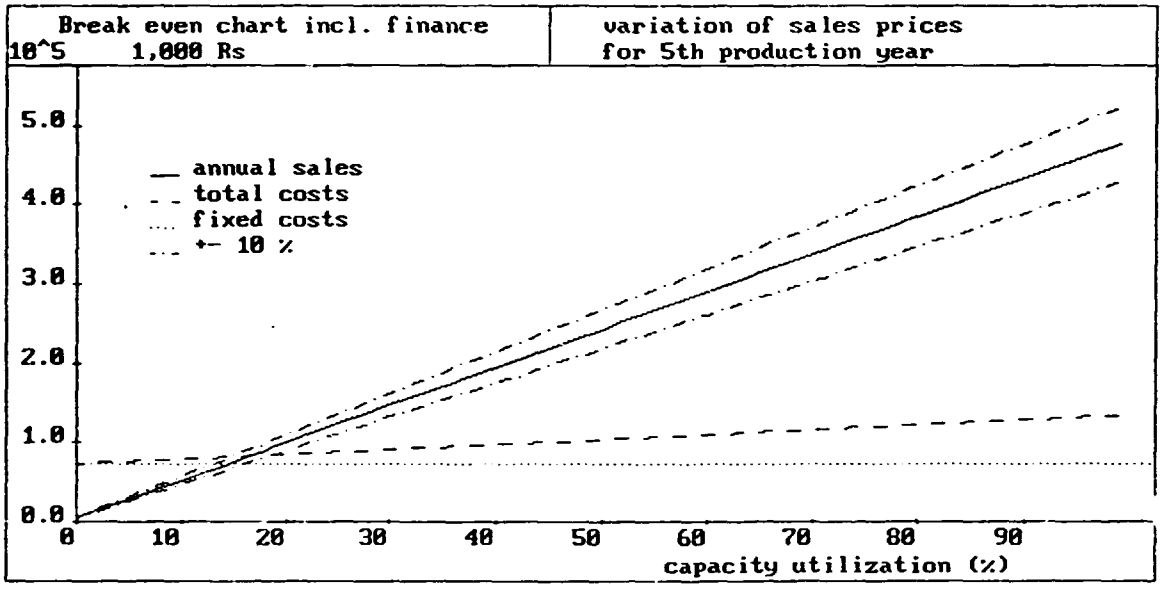

Discounted CF, Investment
10^6 1,000 Rs
var. of initial investment costs
present value, base
+- 10 %
+- 20 %
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
discounting rate (%)

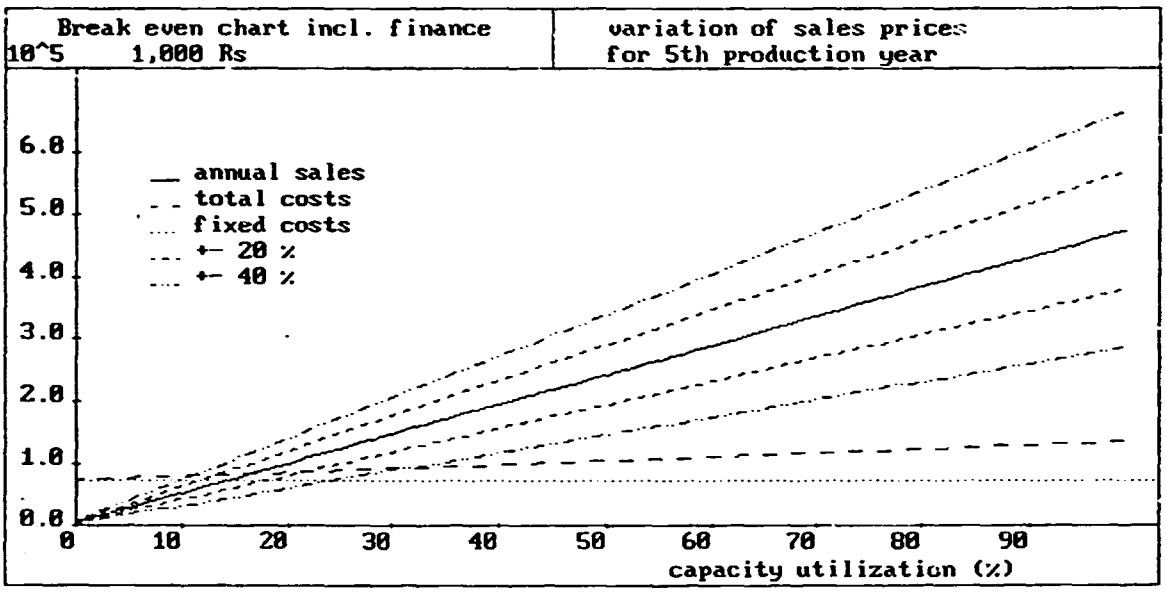

Discounted CF, Investment
variation of sales prices
10^6 1,000 Rs
present value, base
+- 10 %
+- 20 %
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
0
5
10
15
20
25
30
35
discounting rate (%)

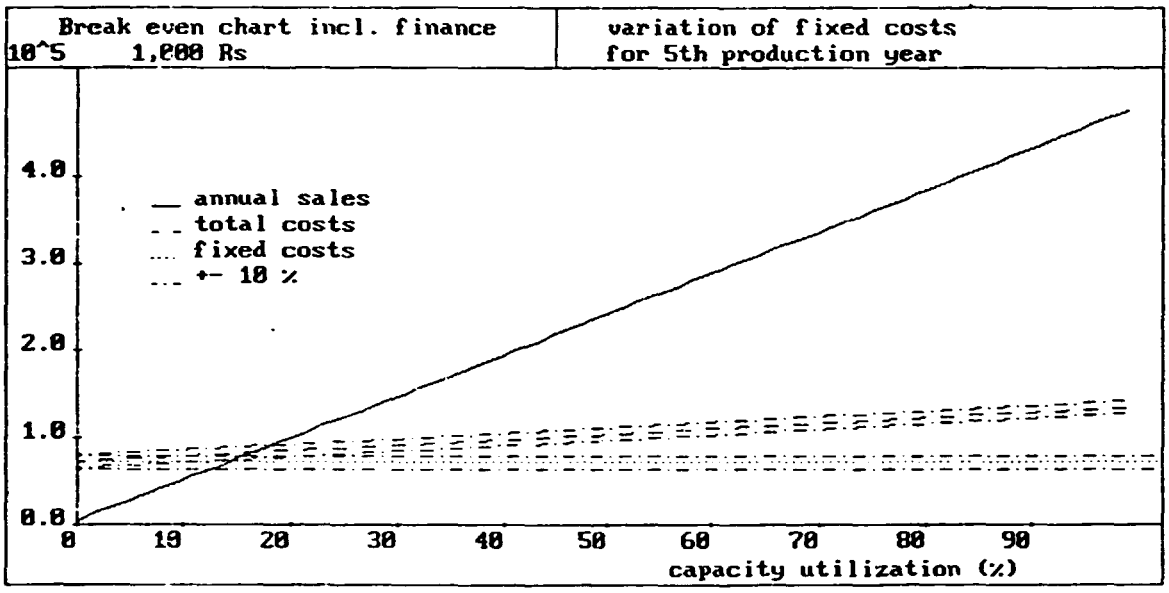

Discounted CF, Investment
10^6 1,000 Rs
variation of operating costs
2.5
2.0
1.5
1.0
0.5
0.0
present value, base
+- 10 %
+- 20 %
0
5
10
15
20
25
30
35
discounting rate (%)

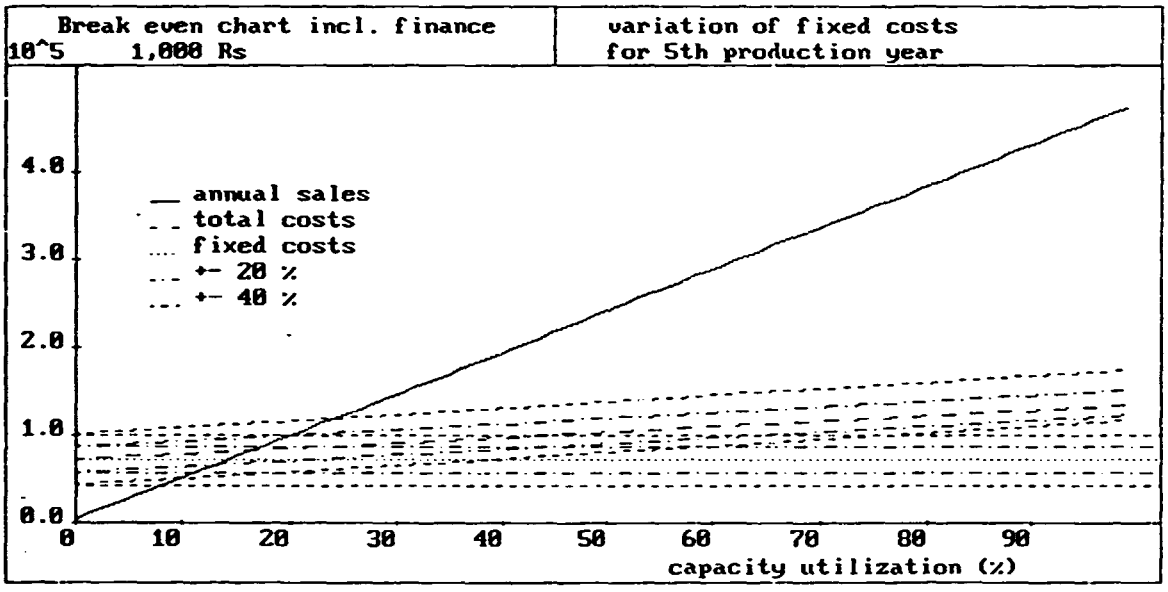

Sensitivity of IRR
internal rate of return
sales price(s)
operating cost(s)
initial investment
80
70
60
50
40
30
20
-20
-10
0
10
20
variation in %

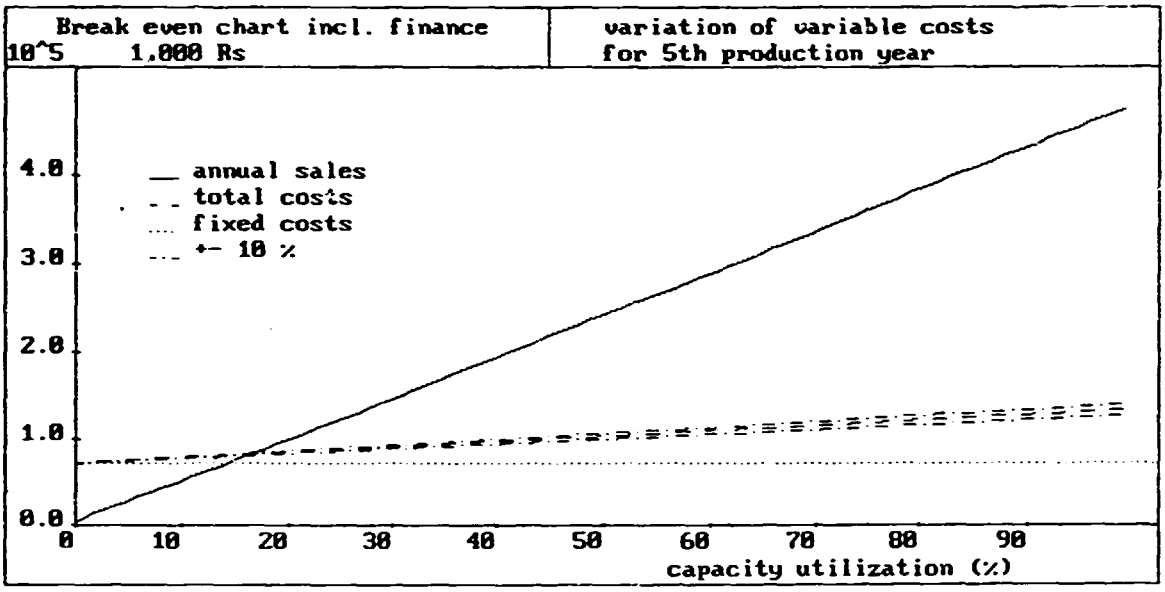

Break even chart incl. finance
for 5th production year
10^5 1,000 Rs
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)

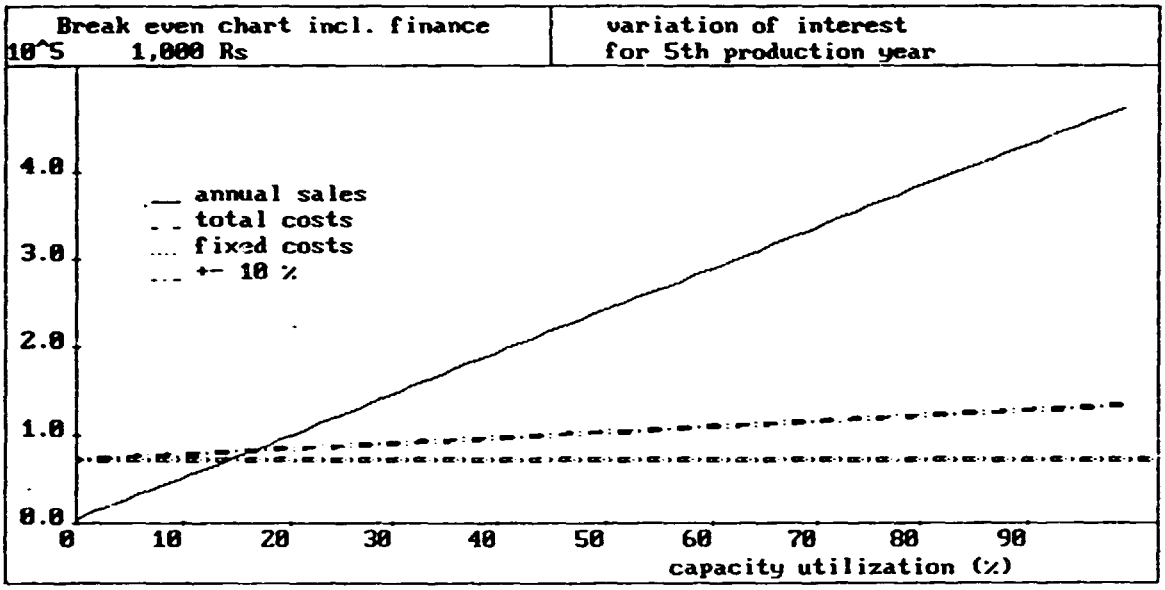

Break even chart incl. finance
variation of sales prices
for 5th production year
10^5 1,000 Rs
5.0
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 10 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)


Break even chart incl. finance
10^5 1,000 Rs
variation of sales prices
for 5th production year
6.0
5.0
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 20 %
+- 40 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)


Break even chart incl. finance
10^5 1,000 Rs
variation of fixed costs
for 5th production year
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 10 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)

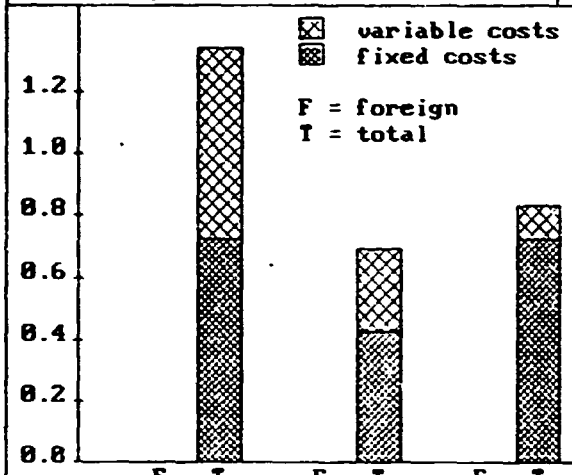

Break even chart incl. finance
variation of fixed costs
for 5th production year
10^5 1,000 Rs
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 20 %
+- 40 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)


Break even chart incl. finance
10^5 1,000 Rs
variation of variable costs
for 5th production year
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 10 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)

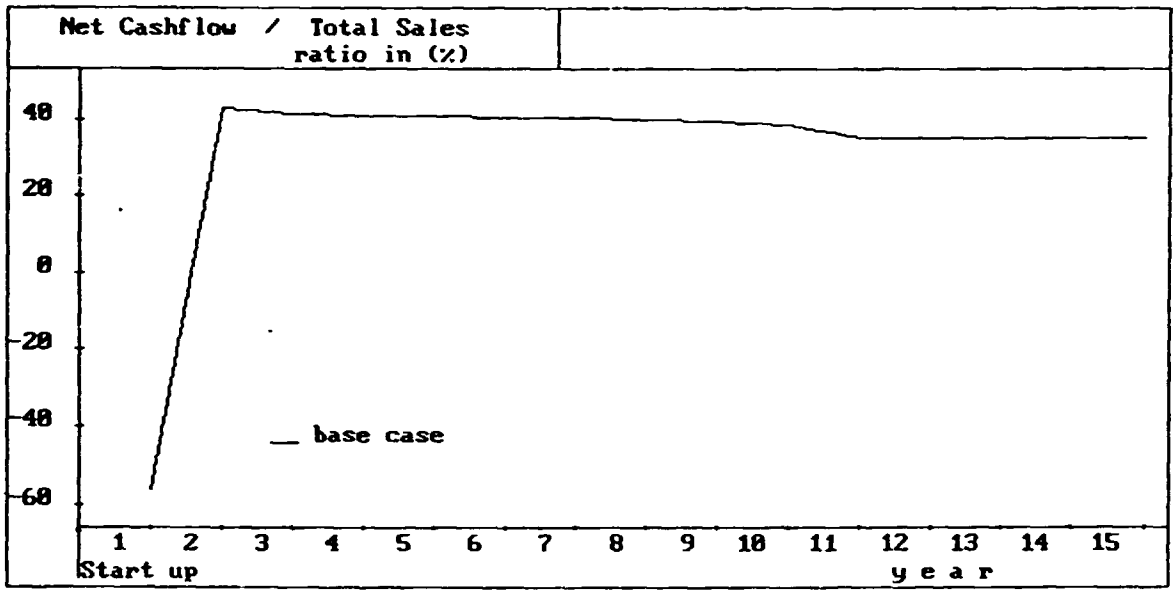

Break even chart incl. finance
10^5 1,000 Rs
variation of interest
for 5th production year
4.0
3.0
2.0
1.0
0.0
annual sales
total costs
fixed costs
+- 10 %
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)

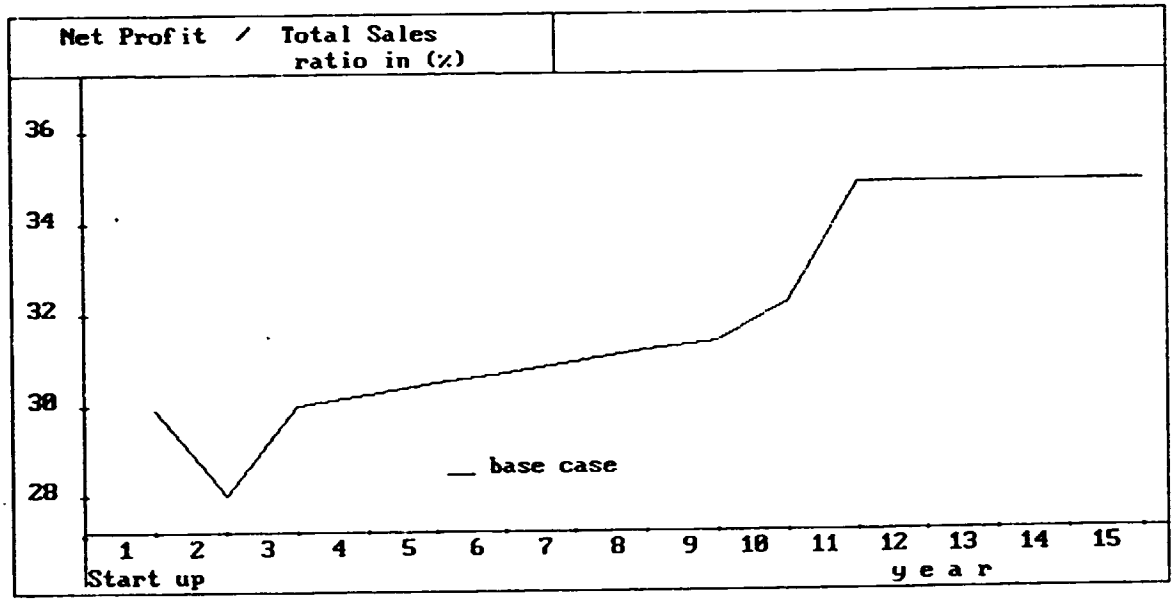
Structure of Production Costs for 5th production year

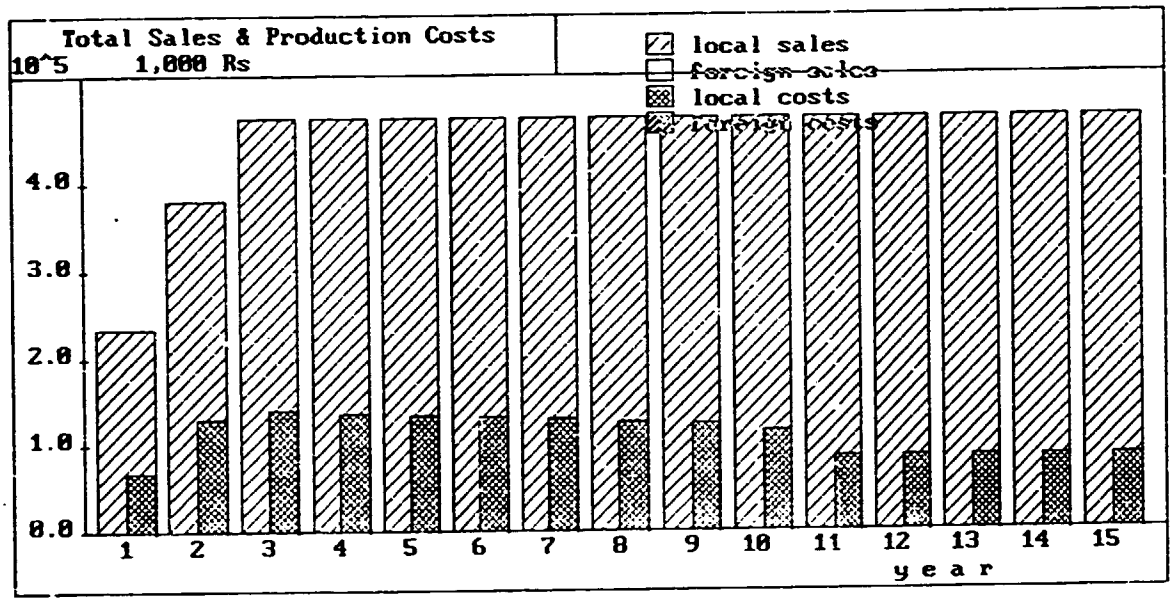
10^5 1,000 Rs



Nominal	Start up	
17.07	12.57	raw material
1.98	1.36	other RM
11.91	9.68	utilities
15.70	18.15	energy
7.29	13.57	labour
0.86	1.30	maintenance
2.32	3.66	spares
5.85	9.68	overheads
23.51	11.32	depreciation
13.51	18.71	interest
100.00	100.00	Total Prod C.


Net Cashflow / Total Sales
ratio in (%)
40
20
0
-20
-40
-60
base case
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Start up
y e a r


Net Profit / Total Sales
ratio in (%)
36
34
32
30
28
__ base case
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Start up
year


Total Sales & Production Costs
10^5 1,000 Rs
local sales
foreign sales
local costs
foreign costs
4.0
3.0
2.0
1.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
year

Cashflow Tables, construction in 1,000 Rs

Year	1994
Total cash inflow . .	152594.300
Financial resources .	152594.300
Sales, net of tax . .	0.000
Total cash outflow . .	152594.300
Total assets	152594.300
Operating costs . . .	0.000
Cost of finance . . .	0.000
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	0.000
Cumulated cash balance	0.000
Inflow, local	152594.300
Outflow, local	152594.300
Surplus (deficit) .	0.000
Inflow, foreign . . .	0.000
Outflow, foreign . . .	0.000
Surplus (deficit) .	0.000
Net cashflow	-152594.300
Cumulated net cashflow	-152594.300

Cashflow tables, production in 1,000 Rs

Year	1995	1996	1997	1998	1999	2000
Total cash inflow	382212.100	422227.300	577496.600	634031.500	697434.500	767178.100
Financial resources	148012.000	2577.149	1851.187	821.438	903.583	993.941
Sales, net of tax	234200.000	419650.200	575645.400	633210.100	696531.000	766184.100
Total cash outflow	382211.900	285440.900	382860.000	418060.800	458257.600	502584.500
Total assets	225907.600	2969.321	2118.301	964.426	1060.868	1166.956
Operating costs	48559.030	79781.500	102548.900	112803.800	124084.200	136492.600
Cost of finance	12980.340	25960.680	23364.610	20768.540	18172.470	15576.410
Repayment	0.000	14422.600	14422.600	14422.600	14422.600	14422.600
Corporate tax	94764.830	162306.800	240405.600	269101.400	300517.500	334925.900
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	0.188	136786.400	194636.600	215970.700	239177.000	264593.600
Cumulated cash balance	0.188	136786.600	331423.200	547393.900	786570.900	1051165.000
Inflow, local	382212.100	422227.300	577496.600	634031.500	697434.600	767178.100
Outflow, local	382211.900	285440.900	382860.000	418060.800	458257.600	502584.500
Surplus (deficit)	0.188	136786.400	194636.600	215970.700	239177.000	264593.600
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	-131245.500	177169.700	232423.800	251161.800	271772.100	294592.600
Cumulated net cashflow	-283839.700	-106670.000	125753.800	376915.700	648687.800	943280.400

Cashflow tables, production in 1,000 Rs

Year	2001	2002	2003	2004	2005	2006
Total cash inflow	843895.800	928285.600	1021114.000	1123226.000	1235548.000	1359103.000
Financial resources	1093.333	1202.671	1322.934	1455.231	1600.752	1760.828
Sales, net of tax	842802.500	927082.900	1019791.000	1121770.000	1233947.000	1357342.000
Total cash outflow	551454.400	605321.700	664685.800	734068.400	818702.700	884762.500
Total assets	1283.650	1412.018	1553.216	1708.541	1879.394	2067.333
Operating costs	150141.900	165156.100	181671.700	199838.900	219822.800	241805.000
Cost of finance	12980.340	10384.270	7788.202	5192.134	0.000	0.000
Repayment	14422.600	14422.600	14422.600	14422.600	14422.590	0.000
Corporate tax	372625.900	413946.700	459250.100	512906.200	582577.900	640890.200
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	292441.400	322963.900	356428.200	389157.100	416845.300	474340.500
Cumulated cash balance	1343606.000	1666570.000	2022998.000	2412155.000	2829000.000	3303341.000
Inflow, local	843895.800	928285.600	1021114.000	1123226.000	1235548.000	1359103.000
Outflow, local	551454.400	605321.700	664685.800	734068.400	818702.700	884762.500
Surplus (deficit)	292441.400	322963.900	356428.200	389157.100	416845.300	474340.500
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	319844.500	347770.700	378639.000	408771.900	431267.900	474340.400
Cumulated net cashflow	1263125.000	1610896.000	1989535.000	2398307.000	2829575.000	3303915.000

Cashflow tables, production in 1,000 Rs

Year	2007	2008	2009
Total cash inflow	1495013.000	1644515.000	1808966.000
Financial resources	1936.910	2130.600	2343.664
Sales, net of tax	1493076.000	1642384.000	1806622.000
Total cash outflow	973293.000	1070677.000	1177799.000
Total assets	2274.066	2501.471	2751.622
Operating costs	265985.500	292584.000	321842.600
Cost of finance	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax	705033.400	775591.400	853204.800
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	521720.000	573837.800	631167.000
Cumulated cash balance	3825061.000	4398899.000	5030066.000
Inflow, local	1495013.000	1644515.000	1808966.000
Outflow, local	973293.000	1070677.000	1177799.000
Surplus (deficit)	521720.000	573837.800	631167.000
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 cash-flow	521720.000	573837.800	631167.000
Cumulated net cashflow	3825635.000	4399473.800	5030640.000

Cashflow Discounting:

a) Equity paid versus Net income flow:
Net present value .....1265108.00 at 15.00 %
Internal Rate of Return (IRRE1) .. 81.38 %

b) Net Worth versus Net cash return:
Net present value .....1279754.00 at 15.00 %
Internal Rate of Return (IRRE2) .. 72.17 %

c) Internal Rate of Return on total investment:
Net present value .....1302978.00 at 15.00 %
Internal Rate of Return (IRR) .. 61.61 %

Net Worth = Equity paid plus reserves

Net Income Statement in 1,000 Rs

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	234200.000	419650.200	575645.400	633210.100	696531.000
Less: variable costs, incl. sales tax.	26646.830	55117.190	75418.180	82959.980	91255.980
Variable margin	207553.200	364533.000	500227.300	550250.100	605275.000
As % of total sales	88.622	86.866	86.898	86.899	86.898
Non-variable costs, incl. depreciation	29764.420	56299.600	58766.030	61479.110	64463.480
Operational margin	177788.800	308233.400	441461.200	488770.900	540811.500
As % of total sales	75.913	73.450	76.690	77.189	77.644
Cost of finance	12980.340	25960.680	23364.610	20768.540	18172.470
Gross profit	164808.400	282272.700	418096.600	468002.400	522639.100
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	164808.400	282272.700	418096.600	468002.400	522639.100
Tax	94764.830	162306.800	240405.600	269101.400	300517.500
Net profit	70043.580	119965.900	177691.100	198901.000	222121.600
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	70043.580	119965.900	177691.100	198901.000	222121.600
Accumulated undistributed profit	70043.580	190009.500	367700.500	566601.600	788723.100
Gross profit, % of total sales	70.371	67.264	72.631	73.910	75.035
Net profit, % of total sales	29.908	28.587	30.868	31.412	31.890
ROE, Net profit, % of equity	45.902	78.618	116.447	130.346	145.564
ROI, Net profit+interest, % of invest.	22.157	38.903	53.561	58.498	63.963

Net Income Statement in 1,000 Rs

Year	2000	2001	2002	2003	200
Total sales, incl. sales tax	766184.100	842802.500	927082.900	1019791.000	1121770.00
Less: variable costs, incl. sales tax.	100381.600	110419.700	121461.700	133607.900	146968.70
Variable margin	665802.500	732382.800	805621.100	886183.200	974801.600
As % of total sales	86.898	86.898	86.898	86.899	86.899
Non-variable costs, incl. depreciation	67746.310	71357.410	75329.640	79699.060	77598.700
Operational margin	598056.200	661025.300	730291.500	806484.100	897202.900
As % of total sales	78.056	78.432	78.773	79.083	79.981
Cost of finance	15576.410	12980.340	10384.270	7788.202	5192.13
Gross profit	582479.800	648045.000	719907.300	798695.900	892010.800
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	582479.800	648045.000	719907.300	798695.900	892010.900
Tax	334925.900	372625.900	413946.700	459250.100	512906.20
Net profit	247553.900	275419.100	305960.600	339445.800	379104.600
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	247553.900	275419.100	305960.600	339445.800	379104.600
Accumulated undistributed profit	1036277.000	1311696.000	1617657.000	1957103.000	2336207.00
Gross profit, % of total sales	76.023	76.892	77.653	78.320	79.51
Net profit, % of total sales	32.310	32.679	33.003	33.286	33.79
ROE, Net profit, % of equity	162.230	180.491	200.506	222.450	248.44
ROI, Net profit+interest, % of invest.	70.010	76.694	84.079	92.232	102.00

Net Income Statement in 1,000 Rs

Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	1233947.000	1357342.000	1493076.000	1642384.000	1806622.000
Less: variable costs, incl. sales tax.	161665.600	177832.100	195615.300	215176.900	236694.600
Variable margin	1072282.000	1179510.000	1297461.000	1427207.000	1569928.000
As % of total sales	86.898	86.899	86.898	86.899	86.898
Non-variable costs, incl. depreciation	59102.670	64918.390	71315.690	78352.700	86093.410
Operational margin	1013179.000	1114592.000	1226145.000	1348854.000	1483834.000
As % of total sales	82.109	82.116	82.122	82.128	82.133
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	1013179.000	1114592.000	1226145.000	1348855.000	1483834.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	1013179.000	1114592.000	1226145.000	1348855.000	1483834.000
Tax	582577.900	640890.200	705033.400	775591.400	853204.800
Net profit	430601.100	473701.400	521111.700	573263.100	630629.600
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	430601.100	473701.400	521111.700	573263.100	630629.600
Accumulated undistributed profit	2766808.000	3240510.000	3761621.000	4334885.000	4965514.000
Gross profit, % of total sales	82.109	82.116	82.122	82.128	82.133
Net profit, % of total sales	34.896	34.899	34.902	34.904	34.907
ROE, Net profit, % of equity	282.187	310.432	341.502	375.678	413.272
ROI, Net profit+interest, % of invest.	114.215	125.545	137.987	151.647	166.642

Cashflow Tables, construction in 1,000 Rs

Year	1994
Total cash inflow . .	152594.300
Financial resources .	152594.300
Sales, net of tax . .	0.000
Total cash outflow . .	152594.300
Total assets	152594.300
Operating costs . . .	0.000
Cost of finance . . .	0.000
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	0.000
Cumulated cash balance	0.000
Inflow, local	152594.300
Outflow, local	152594.300
Surplus (deficit) .	0.000
Inflow, foreign . . .	0.000
Outflow, foreign . . .	0.000
Surplus (deficit) .	0.000
Net cashflow	-152594.300
Cumulated net cashflow	-152594.300

Cashflow tables, production in 1,000 Rs

Year	1995	1996	1997	1998	1999	2000
Total cash inflow	382212.100	422227.300	577496.600	634031.500	697434.600	767178.100
Financial resources	148012.000	2577.149	1851.187	821 438	903.583	993.941
Sales, net of tax	234200.000	419650.200	575645.400	633210.100	696531.000	766184.100
Total cash outflow	287447.000	123134.100	142454.500	148959.400	157740.100	167658.600
Total assets	225907.600	2969.321	2118.301	964.426	1060.868	1166.956
Operating costs	48559.030	79781.500	102548.900	112803.800	124084.200	136492.600
Cost of finance	12980.340	25960.680	23364.610	20768.540	18172.470	15576.410
Repayment	0.000	14422.600	14422.600	14422.600	14422.600	14422.600
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)	94765.030	299093.200	435042.200	485072.100	539694.400	599519.500
Cumulated cash balance	94765.030	393858.300	828900.400	1313973.000	1853667.000	2453187.000
Inflow, local	382212.100	422227.300	577496.600	634031.500	697434.600	767178.100
Outflow, local	287447.000	123134.100	142454.500	148959.400	157740.100	167658.600
Surplus (deficit)	94765.030	299093.200	435042.200	485072.100	539694.400	599519.500
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	-36480.620	339476.500	472829.400	520263.300	572289.500	629518.500
Cumulated net cashflow	-169074.900	150401.600	623231.000	1143494.000	1715784.000	2345302.000

Cashflow tables, production in 1,000 Rs

Year	2001	2002	2003	2004	2005	2006
Total cash inflow . .	843895.800	928285.600	1021114.000	1123226.000	1235548.000	1359103.000
Financial resources .	1093.333	1202.671	1322.934	1455.231	1600.752	1760.828
Sales, net of tax . .	842802.500	927082.900	1019791.000	1121770.000	1233947.000	1357342.000
Total cash outflow . .	178828.500	191375.000	205435.700	221162.200	236124.700	243872.300
Total assets	1283.650	1412.018	1553.216	1708.541	1879.394	2067.333
Operating costs . . .	150141.900	165156.100	181671.700	199838.900	219822.800	241805.000
Cost of finance . . .	12980.340	10384.270	7788.202	5192.134	0.000	0.000
Repayment	14422.600	14422.600	14422.600	14422.600	14422.590	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) .	665067.400	736910.600	815678.300	902063.400	999423.300	1115231.000
Cumulated cash balance	3118254.000	3855165.000	4670843.000	5572907.000	6572330.000	7687561.000
Inflow, local	843895.800	928285.600	1021114.000	1123226.000	1235548.000	1359103.000
Outflow, local	178828.500	191375.000	205435.700	221162.200	236124.700	243872.300
Surplus (deficit) .	665067.400	736910.600	815678.300	902063.400	999423.300	1115231.000
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	692470.300	761717.400	837869.100	921678.100	1013846.000	1115231.000
Cumulated net cashflow	3037773.000	3799490.800	4637379.000	5559057.000	6572903.000	7688134.000

Cashflow tables, production in 1,000 Rs

Year	2007	2008	2009
Total cash inflow	1495013.000	1644515.000	1808966.000
Financial resources	1936.910	2130.600	2343.664
Sales, net of tax	1493076.000	1642384.000	1806622.000
Total cash outflow	268259.600	295085.500	324594.300
Total assets	2274.056	2501.471	2751.622
Operating costs	265985.500	292584.000	321842.600
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)	1226754.000	1349429.000	1484372.000
Cumulated cash balance	8914314.000	10263740.000	11748120.000
Inflow, local	1495013.000	1644515.000	1808966.000
Outflow, local	268259.600	295085.500	324594.300
Surplus (deficit)	1226754.000	1349429.000	1484372.000
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	1226753.000	1349429.000	1484372.000
Cumulated net cashflow	8914887.000	10264320.000	11748690.000

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value .....3183175.00 at 15.00 %

Internal Rate of Return (IRRE1) .. 155.27 %

b) Net Worth versus Net cash return:

Net present value .....3197822.00 at 15.00 %

Internal Rate of Return (IRRE2) .. 138.41 %

c) Internal Rate of Return on total investment:

Net present value .....3221046.00 at 15.00 %

Internal Rate of Return (IRR) .. 115.53 %

Net Worth = Equity paid plus reserves

Net Income Statement in 1,000 Rs

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	234200.000	419650.200	575645.400	633210.100	696531.000
Less: variable costs, incl. sales tax.	26646.830	55117.190	75418.180	82959.980	91255.980
Variable margin	207553.200	364533.000	500227.300	550250.100	605275.000
As % of total sales	88.622	86.866	86.898	86.899	86.898
Non-variable costs, incl. depreciation	29764.420	56299.600	58766.030	61479.110	64463.480
Operational margin	177788.800	308233.400	441461.200	488770.900	540811.500
As % of total sales	75.913	73.450	76.690	77.189	77.644
Cost of finance	12980.340	25960.680	23364.610	20768.540	18172.470
Gross profit	164808.400	282272.700	418096.600	468002.400	522639.100
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	164808.400	282272.700	418096.600	468002.400	522639.100
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	164808.400	282272.700	418096.600	468002.400	522639.100
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	164808.400	282272.700	418096.600	468002.400	522639.100
Accumulated undistributed profit	164808.400	447081.100	865177.800	1333180.000	1855819.000
Gross profit, % of total sales	70.371	67.264	72.631	73.910	75.035
Net profit, % of total sales	70.371	67.264	72.631	73.910	75.035
ROE, Net profit, % of equity	108.004	184.953	273.992	306.697	342.502
ROI, Net profit+interest, % of invest.	47.446	82.172	117.605	130.159	143.957

Net Income Statement in 1,000 Rs

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	766184.100	842802.500	927082.900	1019791.000	1121770.000
Less: variable costs, incl. sales tax.	100381.600	110419.700	121461.700	133607.900	146968.700
Variable margin	665802.500	732382.800	805621.100	886183.200	974801.600
As % of total sales	86.898	86.898	86.898	86.899	86.899
Non-variable costs, incl. depreciation	67746.310	71357.410	75329.640	79699.060	77598.700
Operational margin	598056.200	661025.300	730291.500	806484.100	897202.900
As % of total sales	78.056	78.432	78.773	79.083	79.981
Cost of finance	15576.410	12980.340	10384.270	7788.202	5192.134
Gross profit	582479.800	648045.000	719907.300	798695.900	892010.800
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	582479.800	648045.000	719907.300	798695.900	892010.800
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	582479.800	648045.000	719907.300	798695.900	892010.800
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	582479.800	648045.000	719907.300	798695.900	892010.800
Accumulated undistributed profit	2438299.000	3086344.000	3806251.000	4604947.000	5496958.000
Gross profit, % of total sales	76.023	76.892	77.653	78.320	79.518
Net profit, % of total sales	76.023	76.892	77.653	78.320	79.518
ROE, Net profit, % of equity	381.718	424.685	471.779	523.411	584.564
ROI, Net profit+interest, % of invest.	159.122	175.786	194.098	214.218	238.151

Net Income Statement in 1,000 Rs

Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	1233947.000	1357342.000	1493076.000	1642384.000	1806622.000
Less: variable costs, incl. sales tax.	161665.600	177832.100	195615.300	215176.900	236694.600
Variable margin	1072282.000	1179510.000	1297461.000	1427207.000	1569928.000
As % of total sales	86.898	86.899	86.898	86.899	86.898
Non-variable costs, incl. depreciation	59102.670	64918.390	71315.690	78352.700	86093.410
Operational margin	1013179.000	1114592.000	1226145.000	1348854.000	1483834.000
As % of total sales	82.109	82.116	82.122	82.128	82.133
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	1013179.000	1114592.000	1226145.000	1348855.000	1483834.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	1013179.000	1114592.000	1226145.000	1348855.000	1483834.000
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	1013179.000	1114592.000	1226145.000	1348855.000	1483834.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	1013179.000	1114592.000	1226145.000	1348855.000	1483834.000
Accumulated undistributed profit	6510137.000	7624729.000	8850874.000	10199730.000	11683560.000
Gross profit, % of total sales	82.109	82.116	82.122	82.128	82.133
Net profit, % of total sales	82.109	82.116	82.122	82.128	82.133
ROE, Net profit, % of equity	663.969	730.428	803.533	883.948	972.405
ROI, Net profit+interest, % of invest.	268.740	295.399	324.674	356.816	392.100