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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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8. April 1993.
ORIGINAL ENGLISH

ASSISTANCE TO JAWAHARLAL NEHRU ALUMINIUM RESEARCH AND DESIGN CENTRE IN SETTING UP ENGINEERING ACTIVITIES AT THE CENTRE

DP/IND/88/015/11-07/J13207

INDIA

Technical report on the mission of the expert in basic and process engineering of aluminium plants

Prepared for the Government of India by the United Nations Industrial Development Organization acting as executing agency for the United Nations Development Programme

Based on the work of Dr. M. Kelenyi
UNIDO Consultant

Backstopping Officer : Dr. T. Grof , DIO/T/MET

United Nations Industrial Development Organization
Vienna

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ABSTRACT

Data on the Project

- The title of the project is Assistance to the Government of India in setting up a functioning Aluminium Research, Development and Design Centre in Nagpur

- The number of the project is DP/IND/88/015/11-07/J13207

- The immediate objective is to assist in setting up activities in the field of basic and process engineering of aluminium plants at the R & D Centre. The duration of the activity being reported on is three months, which is first phase of a split mission.

Main conclusions and recommendations

The staff members of the R & D Centre are able to start with activities relating engineering/design work.

Recommendations regarding continuation of activities:

1. The training programme should be continued comprising all the elements of the activities described in the job description of the post (Annex 1)

2. In the next training period further studies ought to be prepared on different subjects related to the Indian aluminium production sector

3. Data base of R & D Centre should be enriched for supplying accurate and uptodate data for the preparation of studies

4. In a later stage financial appraisals of the studies ought to be worked out in cooperation with other institutes employing experienced economists for this special job.

I. INTRODUCTION

- This report has been written by Dr. Miklos Kelenyi as a result of the expert mission to the Jawaharlal Nehru Aluminium Research and Design Centre in Nagpur, India, on basic and process engineering of aluminium plants

- Job description of the relating post is attached to the report (Annex 1)

- The activity being reported on has begun on 21.01.1993 and lasted till 17.04.1993.

- The original objectives were to assist in setting up activities at the R & D Centre in the field of engineering and design works for aluminium production plants by providing training for the staff of the Centre dealing with questions of industrial development , and guiding the preparation of different studies.
  The objectives were not revised

- The objectives were attained proportional to the duration of the mission - being the latter first phase of a split mission

- The case study titled " Feasibility Study on Some Possible Investment Stages Relating the Modernization of BALCO's Korba Aluminium Smelter " and attached to this report was based on measurements and results of the report " Modernization of Korba Aluminium Smelter " worked out by JNARDDC in July,1992.
  (DP/IND/88/015/11-10).

II. ACTIVITIES

After the briefing in Vienna at UNIDO's Headquarter on 19. January, 1993. and New Delhi on 21. January I arrived in Nagpur on 22. January, where I was met by Dr.T.R.Ramachandran, director of Jawaharlal Nehru Aluminium Research Development and Design Centre and Dr. J.Zambo UNIDO Chief Technical Adviser. After briefing at the R & D Centre I was put right on the job.
My work programme for the period of my stay at the Centre from 22. January through 22. April 1993. is attached to this report (Annex 2).

During the above period two case studies have been worked out.
One of these was related to the modernization of Bharat Aluminium Company's Korba Aluminium Smelter. In this case study some of the modernization stages were dealt with, and feasibility of the relating Variants (1-4) were examined. The study is attached to this report (Annex 4).
The other study (which has not been included in the work programme) was prepared on the viability of establishing a greenfield aluminium smelter plant for export production based on imported raw materials (Annex 5).

Preparation of these case studies has been part of the training programme for the staff of the Centre. During preparation of the studies I had a series of discussions with the Indian experts taking part in the training, on methodology and practice for working out a feasibility, pre-feasibility or opportunity study.
Building up the body of the studies, UNIDO's guidelines given in the " Manual for Preparation of Industrial Feasibility Studies " have been used as a basis for organizing activities related to the preparation of a study.

For financial appraisal UNIDO's software package named "Computer Model for Feasibility Analysis and Reporting " (COMFAR) has been applied (release 2.1).

To create a data bank needed for the further activities a guideline has been worked out for making easier data collection at visited plants (Aspects to be studied and data to be collected during visits to smelter plants, Annex 3).

III. CONCLUSIONS

Members of the working team taking part in the preparation of the studies were selected from various fields of the Indian Aluminium Industry. They are able to start with activities relating to engineering/design work in the frame of the present organization of the R & D Centre. During the preparation of the studies they have got acquainted with some aspects to be taken into consideration when dealing with development/investment studies.

Studies similar to the attached case studies could be prepared concerning different projects in the field of the aluminium industry to meet the requirements of the Indian alumina/aluminium producers and support their development activities in the existing plants as well as in setting up new production facilities in the future.

RECOMMENDATIONS

The job description of the post titled " Expert in basic and process engineering of aluminium plants " comprehends a wide range of activities for the duration of 12 months (see Annex 1).

Since during the three months reported on two case studies have been worked out, almost all the paragraphs (1-6) of the job description were touched to a certain extent, in different ways.

Nevertheless this short period could only be a part of the training programme for the staff of the R & D Centre.
Recommendations for the next periods can be summarized as follows :

1. For utilization of the experiences gained by the training during this period the training programme should be continued comprising all the elements of activities described in the job description mentioned above

2. Since the setting up engineering activities can grow faster by preparing studies - as it has been proved during this period -further studies ought to be worked out on subjects selected from the existing problems in the field of the Indian aluminium production. Selection of these subjects can be done after short visits to be organized for the UNIDO expert to the smelter plants

3. As data used for preparation of studies have to be accurate and uptodate , data bank of the R & D Centre should be enriched to contain the most important data on the aluminium plants interested in the

activities of the Centre.
Specific unit prices (like building costs/m^3, m^2, steel structures/t, electric lines, cables/m, etc.) needed for the preparation of investment cost estimations should also be collected from the proper sectors of the Indian industry

4. In a later stage, when preparation of techno economic studies becomes a regular activity at the Centre, financial appraisals of the studies have to be prepared in cooperation with another institute (for example with NIDC , New Delhi) where economists experienced in this field are employed for doing this special job.

UNITED NATIONS

Annex-1

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO

PROJECT IN INDIA

DP/IND/88/015/11-07/J/3207

JOB DESCRIPTION

Post title Expert in basic and process engineering of aluminium plants

Duration 12 months - split missions (first mission 3 months in Jan. 1993)

Date required January 1993 (first mission)

Duty station Nagpur, India - with travel within the country

Purpose of project The immediate objective of the project is to assist the Government of India in setting up a functioning Aluminium Research, Development and Design Centre consisting of:

a) Alumina Production Research Department
b) Aluminium Electrolysis Department
c) Analytical Research Department
d) General Services, Instrumentation and Control Department (incl. Workshop and Maintenance)
e) General Administration and Finance Department

The Centre will develop capability of carrying out the following main functions on behalf of and in co-operation with the bauxite processing/alumina production and aluminium smelter industries in the country:

a) Assimilation and adaptation of available technologies
b) Providing recommendations and ad hoc or applied and analytical research to local industries in process improvement, transfer of technology, etc.
c) Setting up and operating a data bank
d) Providing training of Indian engineers

..../..

Duties: The expert will be required to advise on basic and process engineering of aluminium smelting plants and on improvement of aluminium production technology and plant operation.

His main duties will be to:

1. Assist in setting up engineering design activities in the Centre - pre-investment feasibility studies, process and basic engineering, techno-economic justification and calculations, modification of technologies and equipment, etc.

2. Provide training on the counterpart staff of the Centre in the methodology of basic and process engineering design works (processing design, material balances, selection of equipment, layouts, preparation of cost estimates, computer application/modelling,etc.)

3. Provide guidelines in the elaboration of basic and process engineering design for the aluminium production plants and copies of the latest relevant technical literature and information.

4. Deliver a series of lectures on basic and process engineering and feasibility studies on establishment of new and development/improvement of existing aluminium production plants (feasibility reports, conceptional design, basic engineering packages for modernisation, etc.)

5. Analyze and review the existing practice of engineering design works for aluminium industry of India and prepare appropriate recommendations on its improvement, including R+D Centre in Nagpur.

6. Guide in the preparation of a case study for the modernisation of one of the existing aluminium smelters and another one on the expansion of an existing aluminium plant with new production line.

The expert is expected to prepare and submit a technical report in line with UNIDO requirements upon completion of his mission.

Qualifications: University degree, preferably PhD, in chemical or metallurgical engineering with extensive practical experience in basic and process engineering design of aluminium smelting production plants, incl. computer application and mathematical modelling.

Language: English

Dr Kelenyi →

TRR
3rd Feb '93

DR. M. KELENYI, UNIDO EXPERT IN BASIC AND PROCESS ENGINEERING OF ALUMINIUM PLANTS

PERIOD OF STAY : JAN. 22 - APR. 9, 1993

PROGRAMME

During the period of his stay, Dr. Kelenyi is expected to :

1. Start up activities at the Centre in the preparation of pre-investment/feasibility studies by preparation of a case study based on the report "Modernisation of Korba Alumina Smelter" (JNARDDC, July 1992).

2. Provide training and guidelines for the staff of the Centre in the areas of data collection, working and basic concepts and preparing the study.

The structure for the study and the time schedule for preparation are indicated in points 3 and 4.

3. Structure of the study

   i. Executive summary

   ii. Project background and basic idea

   iii. Raw materials and production costs of the existing smelter

   iv. Engineering and technology
   Possibilities to reduce energy consumption
   Selection of machinery and equipment
   Investment cost estimation
   1. Fixed investment
   2. Pre-production expenditure

v. Implementation. Planning & Budgeting

vi. Financial appraisal
Profitability indicators
Sensitivity analyses: investment cost,- energy ~~price~~

4. Time Schedule

i. Assessing possibilities to reduce electrical energy consumption in Korba smelter
Description of selected methods for ensuring process technology steps required
Selection of machinery and equipment
Collection data on production cost (upto 12 March)

ii. Estimation of investment costs (upto 19 March)

iii. Data supply for financial appraisal (upto 22 March)

iv. Financial appraisal (upto 5 April)

v. Executive summary and presentation (upto 7 April)

ASPECTS TO BE STUDIED AND DATA TO BE COLLECTED DURING VISITS TO SMELTER PLANTS

BY DR. M. KELENYI UNIDO CONSULTANT

1. Technical aspects

a. Total plant : product selection, capacity by departments, area of total plant/ specific area of the smelter source of water supply, plant demand m^3/day source of electric energy, power demand MW climatic, meteorologic conditions table of plant organization, number of employees

b. Potlines and pots

Production capacity of reduction plant

Number of potlines

Number of potrooms/potline

Operating pots/potline

Amperage/potline

Potline voltage

Type of pots

Pot arrangement

Current efficiency

Power consumption DC KWh/t AL

Power consumption AC for the total reduction plant

Alumina consumption t/t AL

Aluminium fluoride consumption Kg/t AL

Other additives:

Cryolite consumption (Na_2O content in alumina) kg/t AL

Fluorspar C. Kg/t AL

Soda ash C. Kg/t AL

Type of used alumina (spec. surface)

Anode consumption gross t/t AL

Anode consumption net t/t AL

Size of anode butts %

Weight of cathode insulation

Weight of cathode shell

Weight of anode (total)

Weight of busbars/pot

Current density in busbars

Dimensions of potrooms

Anode effect frequency/pot day

Manpower for reduction plant hours/t AL

Dimensions of potrooms

Building structure of potrooms

Number of cranes/potroom

Special (ECL)

Common

Break - feed system, cycle of operation

Pot tending :

anode changing, cycle

anode sliding, cycle

metal tapping, cycle

Molten metal transport

Size of tapping laddles, number/potroom

Pot life-time

Pot relining, in place or in separate shop

Cathode baking system

Process control software

Pot resistance

Alumina feed

Detection, announciation and suppression of anode effects

Resistance control during tapping

Compensation for heat loss during anode changing

Data collection reporting

Potline load control

Plant electrical demand control

Origin of process control hardware

Gas cleaning system (primary, secondary)

Applied equipment

Values of clean gas : F gas mg/N m^3

F dust mg/N m^3

Total dust mg/N m^3

Means of environmental control

Quantity of fluoride recovered by cleaning system (if any)

Alumina supply and handling system

Unloading and storage

Primary alumina storage for --- days supply------t

Alumina tanks feeding potroom fume control for ------ days supply ----t

Alumina tanks downstream from fume control for---- days supply-----t

Pot day tanks for ..... hours supply .... t

Work schedule: potrooms shift/week, hours/shift

potroom service week, hours/shift

c. Anode plant

Net production t/year

Petroleum coke consumption

Pitch consumption

Gas/oil consumption Nm^3/t anode

Heating value of used fuel K J/Nm^3, t

Water demand m^3/hour

Number of production lines

Number of baking furnaces

Number and type of special cranes

Type of baking furnaces

Type of mixers

Gas cleaning system

Removal of hydrocarbons %

Removal of fluorides %

Used materials:

Calcined petroleum coke

Specific density Kg/dm^3

Bulk density Kg/dm^3

Sulphur content %

Screen analyses Si, F, V

Coal tar pitch (liquid or solid)

Specific weight g/cm^3 min

Sulphur content % max

Coking value Conradson

Green carbon manufacture
mode of forming anodes

green density

Carbon baking and cooling

Carbon rodding

Transport and storage
Coke silos for ..... months supply .... t
Pitch silos for ..... months supply .... t

Baked anodes

Rodded anodes

Working schedule

Rodding hours/shift, shift/week

Carbon plant hours/shift, shift/week

Baking furnace firemen hours/shift, shift/week

d. Foundry

Product selection

Production data

Equipment according to the product selection

Rod casting

Strip casting

Rolling slabs - ingots

Extrusion billets

Remelt ingots

Other products

Number of mixing - melting furnaces

Capacity of mixing - melting furnaces

Number of homogenizing furnaces

Capacity

Number and capacity of other equipment
Required area for foundry building

e. Electrical

Energy supply system and rectifier stations

Number of incoming lines

Step down station voltages KV/KV

Number of main transformers

Power factor and its improvement

Number of distribution voltage substations

Number and capacity of rectifier stations

Number and type of units/station

Standby/station

Cooling of rectifiers (water, demand if any)

Regulation system DC (constant current, power etc)

Mode of regulation (common, individual, transductors, tapchanger)

Range of regulation (off-load ranges, onload ranges)

Back reaction to the network

Rectifier efficiency (transducers if any, saturated)

Required area for switchyard, rectifier stations, main busbars for feeding the potlines

Control room equipment

Manpower requirement for supervision and maintenance

f. Transport facilities

Road

Rail

Special vehicles

Others (pipe, belt conveyors)

g. Hartour Facilities (if any)

Capacity of alumina silos

Capacity of coke silos

Ship unloading

Capacity of unloader (Al_2O_3) t/h

Capacity of unloader (coke) t/h

Unloaders type

Transport to transfer silos

2. Construction

History of construction

Engineering and main contractor firms

Time schedule followed during construction period

Control/monitor system in planning the construction (CPM, PERTH)

If there were overrun (or spill over) in the original time schedule. If so, its main reasons and also its impact on techno-economic aspects

Number and area of subcontractors involved in construction activity

Manpower requirement during construction

a. Owners organization

b. Consultant/contractors organization

c. Mechanism of interfacing

Training of personnel (in house training facilities)

Supervision by technology seller during

Construction

Start-up

Steady operation

3. Techno-economic

- Investment costs by main departments

  General plant

  Potrooms

  Anode plant

    Baking

    Rodding

  Foundry

  Auxiliaries

    Fume treatment

    Process control

    Compressed air system

    Rectifier and switchyard

  Services

    Maintenance

    Warehouses

    Material handling & storage

- Data related to the production costs

  Unit prices of: Alumina

  Petroleum coke

  Coal tar pitch

  Metallurgical coke

  Cast iron

  Fuel oil (for firing baking furnaces)

  Electric energy

Compressed air

Water

Total production cost/t product

Salaries & wages by catagories

Manpower

Chief/foreman

Engineer

Skilled worker

unskilled worker

JAWAHARLAL NEHRU ALUMINIUM RESEARCH DEVELOPMENT AND DESIGN CENTRE NAGPUR

FEASIBILITY STUDY ON POSSIBLE INVESTMENT FOR MODERNIZATION OPTIONS OF BALCO 'S ALUMINIUM SMELTER AT KORBA

Preparation of this case study has been a part of the training programme for setting up engineering activities at the Centre

Prepared by the experts of JNARDDC
with the guidance of Dr. M. KELENYI
UNIDO consultant

MARCH 1993

Participants in preparing the study :

U.B. AGRAWAL (electrolysis process)
Coordinating the work of JNARDDC team and assisting in running the COMFAR

H.MAHADEVAN (alumina process)
H.K. CHANDWANI (alumina process)

G.S. SENGAR (electrolysis process)
A. AGNIHOTRI (electrolysis process)
A.K. BASU (electrolysis process)
S. DAS GUPTA (electrolysis process)
K.G. DESHPANDE (electrolysis process)

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I. EXECUTIVE SUMMARY

JNARDDC has started with activities related to preparations of studies, including financial evaluation applying the UNIDO COMFAR system.
As a possibl e topic for the first case study Modernization of BALCO's Korba Smelter has been selected.
For the modernization of the Korba smelter a series of measurements have been carried out and a study worked out by JNARDDC 's and BALCO's experts along with UNIDO consultants, in 1992.
Based on these measurements and the study, a proposal was prepared and submitted to BALCO, for modernization of the smelter. This envisages the introduction of a process control system together with reorganization of the pot tending operations - thus stabilizing thermal state of the cells - as well as introduction of a semi-automatic crustbreaking system by installation of computer controlled bar breakers on the pots, thereby leading to improvement in current efficiency and power consumption in the reduction plant.

Results of realization of investments needed for the considered modernization have been evaluated in the Base case of the present study.
In the Base case an adaption of the COMFAR system (which was basically developed for evaluation of production plant investments) for the evaluation of a plant modernization has also been worked out.
In a second variant of this case influence of a compression of the construction period on the profitability of this investment was also demonstrated (Variant 2).
Results of evaluation of the Base case:
By this investment current efficiency could be increased by 5 % and power consumption decreased by 1097 kWh/t Al D.C. , among other improvements in performance data.
Utilizing the improvements in current efficiency figure for raising the production capacity an additional 5869.2 t/year metal prodcution could be achieved.
The economic calculations were based on this surplus production.

The most important economic indices:

	Variant 1	Variant 2
Investment cost (thousand rupees)	185724.50	177462.50
Construction period years	2	1
NPV (Net present value at 10% discount rate, the annual net cashflows discounted yearly to the date of beginning of the project construction) (thousand rupees)	717420.60	791484.10
IRR (Internal rate of return on total investment, overall profitability index, or interest rate of return) %	63.45	72.87
Pay-back period (from the first year) years	3	2

The results show that in the presumed Base case in view of the economic indices Variant 2 should be preferred.
These good results are due to the fact that all the advantages of the modernization are utilized to achieve the possible best current efficiency and a smooth operation of the reduction plant.

Presently a contract with a foreign partner regarding modernization of the smelter is under consideration. According to the programme of the modernization, by installation of a process control system and reorganization of the pot tending operations, 87% current efficiency and 16500 kWh/t Al D.C. power consumption could be achieved.
In the present study was also examined (in Variants 3 and 4) the possible situation, in which the results mentioned above have been achieved, and in a next stage of further modernization modifications in the supplying

alumina plant for producing intermediate (coarse) type of alumina as well as introduction of scheduled crustbreaking and crustbreaking at anode effect prediction by installing computer controlled bar breakers on the pots would be realized.

In this presumed modernization stage has been examined the case, when the target was the low energy consumption (Variant 3) and another case, when the target was to reach the highest possible production increase utilizing the improvements in the pot performance data for raising the currrent efficiency (Variant 4).

In the first case (Variant 3) current efficiency has been increased by 1% and power consumption decreased by 1020 kWh/t Al D.C.

The economic calculations were based on part of energy saving as well as on an additional metal production of 1173.2 t/year.

In the second case (Variant 4) current efficiency has been increased by 3.5 %.

Utilizing this improvement for raising the production an additional production of 4108.4 t/year could be achieved and economic calculations were based on this surplus production.

The construction period for both cases was forecast in 24 months with a minimum production foreseen in the second year of construction.

A comparison of the economic indices of the two cases is given below:

	Variant 3	Variant 4
Investment cost (thousand rupees)	396165.00	396165.00
Net present value (NPV) (thousand rupees)	108608.90	423874.80
Internal rate of return (IRR) %	15.03	27.01
Pay-back period (from the first year) years	7	4

In view of the results above, the second case (Variant 4), when all the improvements achieved in pot parameters were utilized for raising the production should be preferred.

Forecasts regarding world aluminium supply-demand are encouraging activities in connection with finding possibilities for putting into operation new capacities in the future. From this point of view the second case (Variant 4) is of great importance.

Furthermore, using an exchange rate of 1 $ = Rs. 30, the present metal price taken into consideration was 1493 US $/t Al.
If metal price increased to 2100 US $/t Al (forecast for 1996), the IRR could reach the figure of 43% (see sensitivity graph of Variant 4, page 103 of the present study).
In these cases was also demonstrated that - in proper market conditions - raising the production is more profitable than utilizing the improvements in performance data simply for decreasing the power consumption.

II. PROJECT BACKGROUND

Project history

The Indian Aluminium Industry looks back to a history of 44 years. At present there are 6 aluminium smelters with an overall capacity of 580,000 tonnes per year. During the past years, India became one of the leading countries in the world having substantial bauxite resouces. The total bauxite reserves of India are estimated to be of the order of 2650 million tonnes.

The existing aluminium plants in India are based almost entirely on technology imported from various sources. The technologies followed in the existing plants are from various countries/suppliers - KAISER, VAMI, ALCAN, MONTECATINI and ALUMINIUM PECHINEY.

BHARAT ALUMINIUM COMPANY is one of the leading producer of primary metal. The annual capacity is 100,000 tonnes. The technology is supplied by VAMI (erstwhile USSR). The smelter was commissioned in different phases as given below:

First phase commissioned on -	1975
Second phase commissioned on-	1977
Third phase commissioned on -	1983
Fourth phase commissioned on-	1984

Basic data on Korba Smelter

Product mix:	
Pigs-	20,000 t/year
Rolled products-	40,000 t/year
Properzi rods-	35,000 t/year
Extrusion products-	5,000 t/year
Total production-	100,000 t/year
No of potlines-	2
No of potrooms-	8
Total No. of pots-	408

Line current (nominal)- 100 kA
Current efficiency- 81%
Specific cryolite consumption- 18 kg/t
Specific AlF_3 consumption- 42 kg/t
Specific power consumption- 17 kWh/kg D.C.
Specific paste consumption- 565 kg/t

Initially up to 1983 the smelter could not run to full capacity because of power problems. Later on third phase and fourth phase were commissioned after availability of power.

Initially up to 1983 current efficiency was very low 79-80% on account of power problems. From 1983-86 efficiency was good about 83-85% as third and fourth phase were commissioned.

From 1986 onwards current efficiency went down caused by operational problems and periodical lack of power to the potrooms.

The technology applied in Korba Smelter is quite old and outdated. dependent on manual labour and lack of process automation. The modern day smelters are much less dependent on human factor and apply point feeding system. dry scrubbers and process automation with pot controllers.

With the energy costs increasing and becoming prohibitive all over the world. the present trend is to increase current efficiency . decrease specific power consumption. In comparison with this scenario at the Korba Smelter the power consumption is very high combined with low current efficiency. The following table gives the comparative figures for Korba Smelter with the best VSS cells and industry average.

Table I Energy consumption and current efficiency figures for Soedberg cells

Consumption	Best	Industrial average data	Korba Smelter
Energy consumption kWh/kg AlD.C.	13.5-14.0	14.5	17
Current efficiency (%)	90.5	87	81

Basic Idea

Major changes such as replacement of rectifiers, alumina transportation and distribution systems, introduction of point feeders, installation of new cranes and end crust breaking vehicles have been the main factors for the modernization of similar smelters all over the world. However these involve high investment costs.

In order to achieve the goals of lowering the energy and raw material consumptions a series of measurements have been carried out respectively a study was worked out by UNIDO expert Dr. J. Horvath along with INARDDC and BALCO experts.

Based on these meausurement and on the study a proposal has been submitted to BALCO for modernization of Korba Smelter.

According to the results of the study by reorganizing the pot tending operations and introducing elements of process control system good parameters could be achieved.

Installation of process control and semi-automatic crust breaking as well as improvements achievable by the relating reorganization-as indicated in the study mentioned above-has been accepted as Base case of the present study(Variants 1 and 2).

In addition to the Base case a possible situation was also examined in which after a first stage of a modernization program (installation of a process control system only) in a second stage installation of semi-automatic crustbreaker system together with application of improved quality (intermediate type) alumina have been taken into consideration (Variants 3 and 4).

III. RAW MATERIALS AND PRODUCTION COSTS

Main raw materials and power

The main raw materials used for production of aluminium metal in this Soderberg type smelter are:

Alumina	198.000 t/year
Fluorides	4,200 t/year
Cryolite	1,800 t/year
Anode paste	56,500 t/year

As to the power consumption the present specific power consumptuion is 16997 kWh/t Al D.C. In the Base case 1097 kWh/t Al D.C. reduction in power consumption could be reached which calculating with 97% conversion efficiency would come to 1131 kWh/t Al A.C.

Quantities of raw materials indicated above as well as labour and utilities consumption have to be decreased due to the results of the investment and reorganization of pot tending operations connected to installation of new equipment.

In spite of this fact, because of the possible improvements in the current efficiency figures increased metal production was the only item on which profitability calculations were based in the Base case as well as in Variant 4.

In Variants 3 and 4 the specific power consumption could be reduced by 1020 kWh/t Al D.C. Using the same conversion efficiency figure as above it would come to 1052.54 kWh/t Al A.C. In Variant 3 both energy saving and increasing in metal production have been taken into account. In this case beside 1173.2 t/year surplus metal production using a power price of 0.9 Rs. kWh and a metal price of 44.8 . 10^3 Rs/t Al. the annual saving in energy comes to :

$$94729 - 44.8 . 10^3 * 1173.2 = 42169.6 * 10^3 \text{ Rs.}$$

Special production cost used for calculations

As to the production cost of the surplus metal produced the general approximation has been applied according to which in case of production increase achieved by raising current efficiency the production cost to be taken into account is equal to the cost of alumina only needed for the reduction process.

IV. ENGINEERING AND TECHNOLOGY

Scope of the Project

Results of measurements carried out at the Korba Smelter as well as evaluation of the same clearly show, that the VSS type pots at BALCO's Korba Smelter could give the opportunity of an improved operating performance if basic problems were eliminated.

The original manual prepared by the know-how suppliers of the Smelter was updated in 1992, by the experts of JNARDDC.

A technical report mentioned in Chapter II. of this study has also been worked out by JNARDDC. Based on the results of the study certain operating parameters of the pots could be improved as shown in the table below:

Table II Operating parameters for the BALCO electrolysis cells at Korba Aluminium Smelter

Parameters	Existing	Expected
Molar ratio	2.75	2.65
AC- distance	4.0 cm	5.5 cm
Cell voltage	4.62 V	4.57 V
Current efficiency	81%	88%
Anode voltage drop	0.5 V	0.40 V
Cathode voltage drop	0.39 V	0.35 V
Voltage components		
Voltage drop on construction elements	1.19 V	1.05 V
Voltage demand for aluminium production	1.83 V	1.94V
Voltage drop in ACD- gap	3.44 V	3.52 V
Voltage drop in electrolyte	1.78 V	1.87 V
Energy components		
Energy for aluminium production	177.6 kW	188.32 kW
Heat losses	270.5 kW	254.79 kW
Energy efficiency	39.6%	42.5%
Energy consumption	16.997 kWh/kg	15.48 kWh/kg

In the present study some variants of stages for modernization have been dealt with.

Process control

At the present level of technology, the control of the Hall-Heroult process for optimal results depends largely on the quality and diligence of the potroom personnel. Even the best efforts of this personnel have a limited impact on improving the operational results. Complexity of the process requires faster means of data analysis and response. A conceptual basis for a step by step progress toward an optimal use of the resources to focus on the first level improvement without design modifications of the pots and all the efforts focused on gaining better control of the process variables through intensive use of relatively inexpensive means such as process control computers. The extreme sensitivity of profit to technical performance puts a heavy burden on the shoulders of the operating personnel. It is therefore of some importance to determine the means necessary the potroom workers to cope with his assigned responsibility. The production of each pot varies with time. At any given time individual pots or group of pots of a potline show significant variations in productivity. This spread in performance occurs despite all efforts at stable and uniform operations. The table below shows a partial list of the more important elements of a pot process control system.

Table - III Some of the control actions in aluminium reduction process

Pot status controls	Pot tending
Resistance	Crust breaking
Alumina cover	Anode effect extinction
Alumina concentration	Anode operations
Anode- cathode distance	Tapping
Crust formation/ledging	Beam raising
Metal level	Alumina feeding
Bath level	
Bath composition	
Bath temperature	
Voltage drops	

Increasing the time and frequency of measurements evaluations and control actions would be prohibitively expensive. The attainable quality of process control by such additional efforts may not be sufficient to reproducible good results. For example the resistance control is a very demanding job and the infrequent checks of the pot voltage by the potroom personnel is totally insufficient to maintain stable and good performance over long time span. By contrast, a computer control system permits an almost continuous collection of pot voltage and line current data with high accuracy. The bath resistance is computed from these data with regard to other voltage drops and subsquently commands for raising and lowering anodes at desired small increments are issued at selected time and interval. Introducing a computer process control system the potroom worker in a computer supported operation can contribute to the sucess of the operation by taking over those tasks which can not be handed over to the instruments. Example tasks are the periodic visual inspection of the alumina cover, frequent checking the thermal balance(heat escape through alumina cover, bath temperature) among others.
Besides choosing introduction of process control we consider in the base case of this study partial automation of crust breaking system by applying computer controlled bar breakers.

In general, it is known, that low energy consumption and high current efficiency cell operations are characterized by:

- Compensated magnetic fields
- Voltage and/or resistance regulation and automation
- Efficient alumina feeding technology
- Stablized bath composition
- Good frozen profile
- Low superheat

To achieve the improvement of the operational parameters the above components have to be modified by the means as under:

Voltage and/or resistance regulation and automation

Nowadays controllers based on microprocessors are used in the aluminium smelters. They measure cell voltage and line current, and check the possible errors like cell instability and control the necessary operations e.g. anode stud replacement, starting of alumina feeding. The measured data are displayed and are helpful in predicting the occurance of anode effect. The controller can follow the operational events e.g. automatic anode adjustment during metal tapping. A set of controllers (say 13) would be controlled by a separate microcomputer.

The main functions of pot controller are :

- Noise analysis- waving, pulsating and fluctuating - suitable for detection of cell failure operation.
  The appearance of waving noise indicates hydrodynamic instability of the melt. The circulation and fluctuation of the melt changes the actual anode-cathode distance and results in a waving cell voltage.
  Pulsating cell voltage can be recognised when the cell has certain anode bottom problems (spike, large amount of skim). Temporary anode-cathode short circuits cause sharp falls in the otherwise normal cell voltage. Fluctuations characterize the thermal state of a cell. The relatively warm cell has a noise of small amplitude and in case of a relatively cold cell, fluctuations are larger, then the cell is called "noisy". Computer control requires a special algorithm for detection of different kinds of noises.

-Prediction of anode effect through an appropriate algorithm. The latter is based on the change of slope of resistance - time curve.

To reach a more stabilized cell operation it is necessary to adjust the target cell voltage. Adjustment of target cell voltage results in stabilized heat balance which leads to improvement in operational parameters.
Special metal tapping procedure will be introduced to stabilize the thermal state of the cell.

Efficient alumina feeding technology

Alumina content of the bath is one of the most important parameters of the process and therefore regulation of alumina feeding is of great significance.The Soederberg aluminium pots with vertical studs are not provided with automatic feeders, so the alumina feeding can hardly be regulated. Some years ago bar-breakers and point feeders were developed for the pots, to improve the alumina feeding technology.

An important feature of the proposed modernization project is to install bar breakers. To avoid the sludge and deposit formation on cathode bottom the alumina content in bath must be maintained at low value. It is possible to maintain low alumina content in the bath with combination of scheduled crust breaking and crust breaking at anode effect prediction. This procedure is expected to lead to sludge-free cathode bottom.

Stabilized bath composition

The optimum electrolyte composition depends on cell construction, alumina quality, and understanding of the cell behaviour by the operators. The electrolyte composition should conform to molar ratio of 2.65 with average alumina content of 4.0% and calcium fluoride 4.0% without other additives.

Taking into account the modifications in cell technology and introduction of computer process control as well as application of bar breakers the expected parameters included in Table II can be easily approached.

Certainly without coarsening the alumina used in the smelting process a current efficiency of 0.86 and a specific electric energy consumption of 15900 kWh/t Al DC can only be achieved (Base case Variants 1 and 2).

A possible situation in which in the first stage of a modernization by introduction of a process control system certain improvements in performance data has only been achieved was also examined (Variants 3 and 4).

Table IV shows the starting parameters and the achievable improvements by installation of semi-automatic crustbreaker system together with

modifications in the supplying alumina plant resulted in the capability of the latter for producing intermediate type of alumina.

Table IV Improvements in parameters applying semi-automatic crustbreakers and using coarse alumina in the reduction process

	Parameters achieved by the end of a first stage	Achievable parameters if the target is the low energy consumption Variant 3	Achievable parameters if the target is the high productivity Variant 4
Current efficiency %	87.0	88.0	90.5
Cell voltage V	4.87	4.57	4.75
Electric energy consumption kWh/t Al D.C.	16500	15480	15640

Coarsening of alumina hydrate at the Korba alumina plant

Background

In Balco's alumina plant the precipitation technology has been designed to produce alumina trihydrate with fineness ranging between 30-35% -45 microns fraction in alumina produced. The low temperature European process without interstage cooling was operative with yield of alumina with high fineness and high alpha content. The designed primary hydrate classification system is also inoperative due to process constraints. However with changing technology it has become pertinent on the part of alumina quality to be as per the smelter requirement which is to be <10% of minus 45 micron (sandy alumina). Persuading the programme the scientists of JNARDDC and UNIDO experts have discussed the problems and actions with complete prefeasibility economic analysis made for the project.

The actions proposed for coarsening of hydrate are as under:

(a) To favour coarser particles agglomeration the change of temperature profile and introduction of intensified interstage coolers

(b) Two stage classification of hydrate is to be introduced.

(c) To favour effective agglomeration the seed washing is to be done in pan/belt filters for the reduction of oxalates.

(d)For efficient seed classification system the seed thickner is to be introduced.

(e) Salt removal system installation for reduction of salt levels which favours precipitation.

(f) Installation of centrifuges for removal of marketable quality vanadium salt to improve byproduct quality.

In order to achieve a coarse product the present simple European process may not be sufficient. instead a double seeding method will have advantage of both American and European process.

Parameters

i) Agglomeration phase:

Conditions similiar to American process.

Caustic concentration around	150 g/l.
Temperature (start)	75-80°C
Residence time	< 6 hours.
Fine seed	70-120 g/l.

ii) Growth phase:

Condition similar to European Process.

Temperature	< 60-65°C.
Coarse seed	> 250-300 g/l.
Residence time	50-55 hours.

In the present system with higher first precipitator temperature 70-75°C with interstage cooling intensification the super-saturation can be improved by fine seed charges. For that the slurry from last precipitator is to be handled in existing primary hydro-separator with modification. Where as the product coarse hydrate is removed as product. The overflow is to be handled in secondary classification system consisting of hydrocyclone. The fines obtained by secondary classification after seed washing in pan /belt filters are to be added in first stage precipitation.

To lower salt levels the installation of efficient salt removal system with centrifuge and chilling unit is to be provided.

Selection of machinery and equipment

Process control equipment

A high level hierarchical process control system has been selected based on a foreign offer.
The system itself is very flexible. It provides for easy adaption to different cell types. Further control or supervisory functions can be easily incorporated. The components are of module type allowing quick repair and replacement possibilities.

Control tasks

The principal control tasks are as follows:
- Pot resistance control, including the ocntrol of programmmed set-point during metal tapping
- Anode effect prediction, effect display
- Control of curst breakers
- Diagnostics of operational status, noise analysis
- Advices supplimentary to process contrl
- Calculation of specific technical data

The control varaibles can be selected by the potline foreman or adjusted automatically. It is based on the calculation of cell voltage components, alumina balance, as well as energy balance. The experimentally determined and the calculated target voltages approach the optimum gradually.

Control system's structure

The different control and supervisory functions are distributed among the intelligent components. The components can be grouped and, with respect to the logical connections, different levels can be defined. The main components of the three level arrangement are:
- Cell controllers
- Communication computers
- Supervisor computer

Scheme of the hierarchical system is shown in Figure 1. At the lower level, closest to the process, are the cell controllers(one controller for each cell). These controllers act at a high degree of autonomy. They can perform nearly all control functions listed above, even if higher system levels are out of order. This arrangement provides a reliable and solid operation.

The cell controllers are mounted close to the cell. The potroom operator can select automatic or manual control, Special routines can be push button started (e.g. metal tapping).

At the medium level, communication computers (team terminals) organize the transmission of data through a local network. One team terminal serves up to the controllers of one potroom. These terminals operate the team displays located in the potrooms. All significant information on the group cells under the supervision of the respective team can be called from the terminal in the form of tables or graphs, together with all emergency and warning messages.

The higher level computer controls the plant. Its task is to log and display data concerning the whole plant and to bring about plant management through team terminals. It operates colour display and printer, serves all function that require long term storage. Both plant controlling and communication computers are located in the plant control office, near the potroom.

As to the above hierarchy, the lower and medium levels should be user specifyable meanwhile the higher level can use a standard process control computer with standard interface.

Algorythms

Because of the nature of the process, cell voltages and line current are the only available process information. The developed control and test algorythms rely on adequate evaluation of the calculated cell resistance.

One part of the built in algorythms controls anode adjustment. Mostly it means constant set-point control, but programmed set-point leading can also be used here. Their essential part is the "prohibitation table" where certain limits are defined. The parameters of anode adjustment as well as of the prohibitation table are adjustable to cells of other control properties.

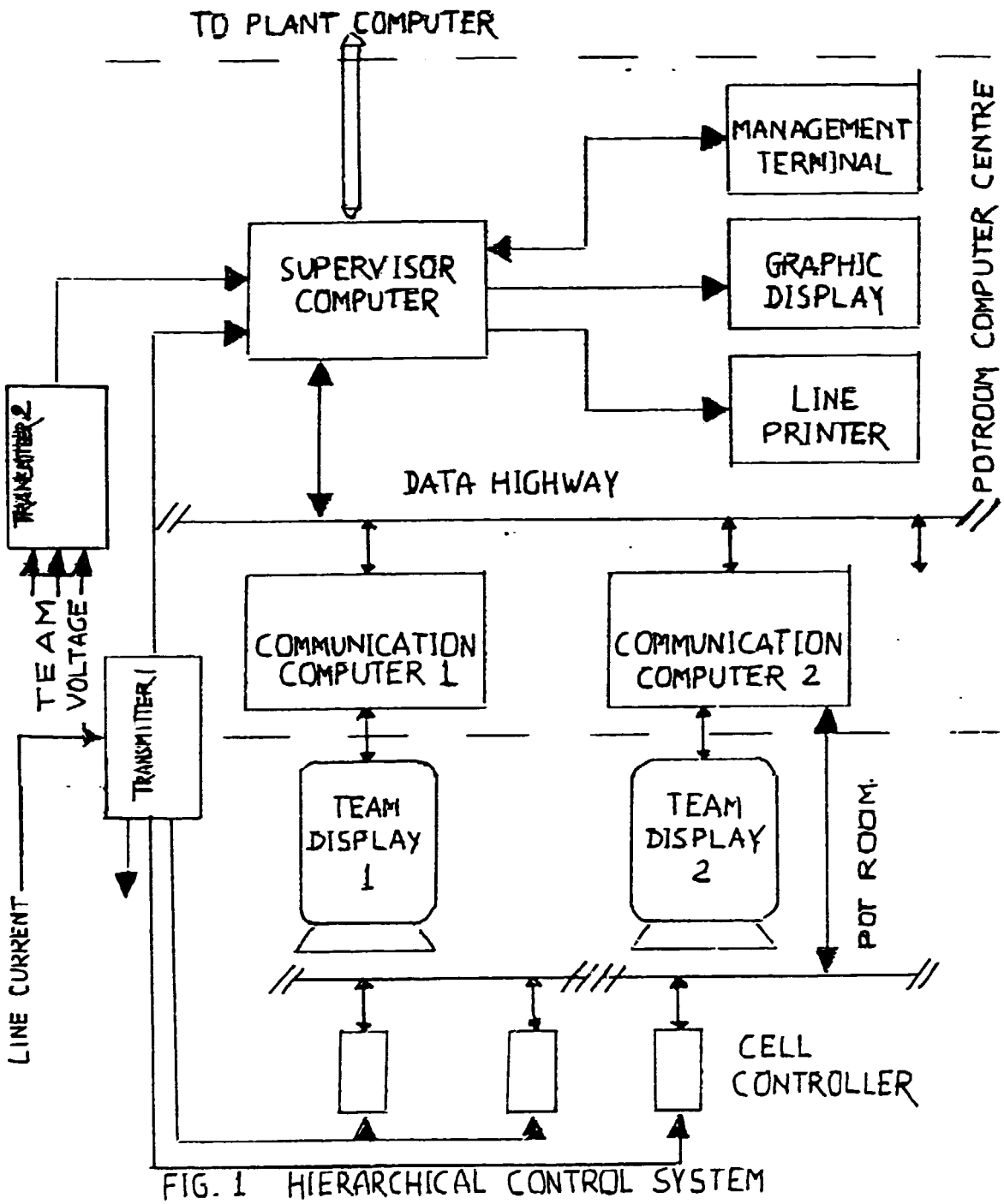


FIG. 1 HIERARCHICAL CONTROL SYSTEM

Knife type crust breakers

Mechanical equipment

The pots can easily be equipped with electro-pneumatically operated bar breakers.

Principle of installation is shown in Figure 2. The installation does not require any changes in anode casing design apart from iinor adjustment of the horizontal stiffening beam to allow enough space for the pneumatic cylinders.

The crust breakers consist of a steel bar held by two cylinders. one unit on each side of the pot. The cylinders are mounted electrically insulated to the anode casing and a shielded heat insulation protects them against heat radiation. The special sealings of the cylinders makes possible the operation under high temperature up to 200 C.

Electro-pneumatic control system

The movements of the knives are controlled by the process control system. The pneumatic elements get the signals from the computer in accordance with the software. but there is also the possibility of turning to manual operation via pneumatic valves. The electro-pneumatic control boxes of the crust-breakers are mounted on the wall or columns nearby the pots. The boxes are of dust free type.

Coarsening of alumina

Proposed modification

- Change of temperature profile in precipitation with intensification of interstage cooling by
  - (a) Spiral heat exchanger
  - (b) Tubular coolers
- Reintroduction of hydroseperator for primary hydrate classification
- Secondary classification of alumina hydrate with installation of hydrocyclone

- Pan /belt filter installation for fines seed washing for removal of organics to provide washed seeds in first stage of precipitator for efficient agglomeration.
- Fine seed thickner for efficient seed classification.
- Salt removal system installation for vanadium/impurities salt level reduction with chilling unit and centrifuges.

Civil engineering work

The activities include site selection preparation of foundation structures for new equipments. The sheds or buildings for operational use are to be made departmentally.

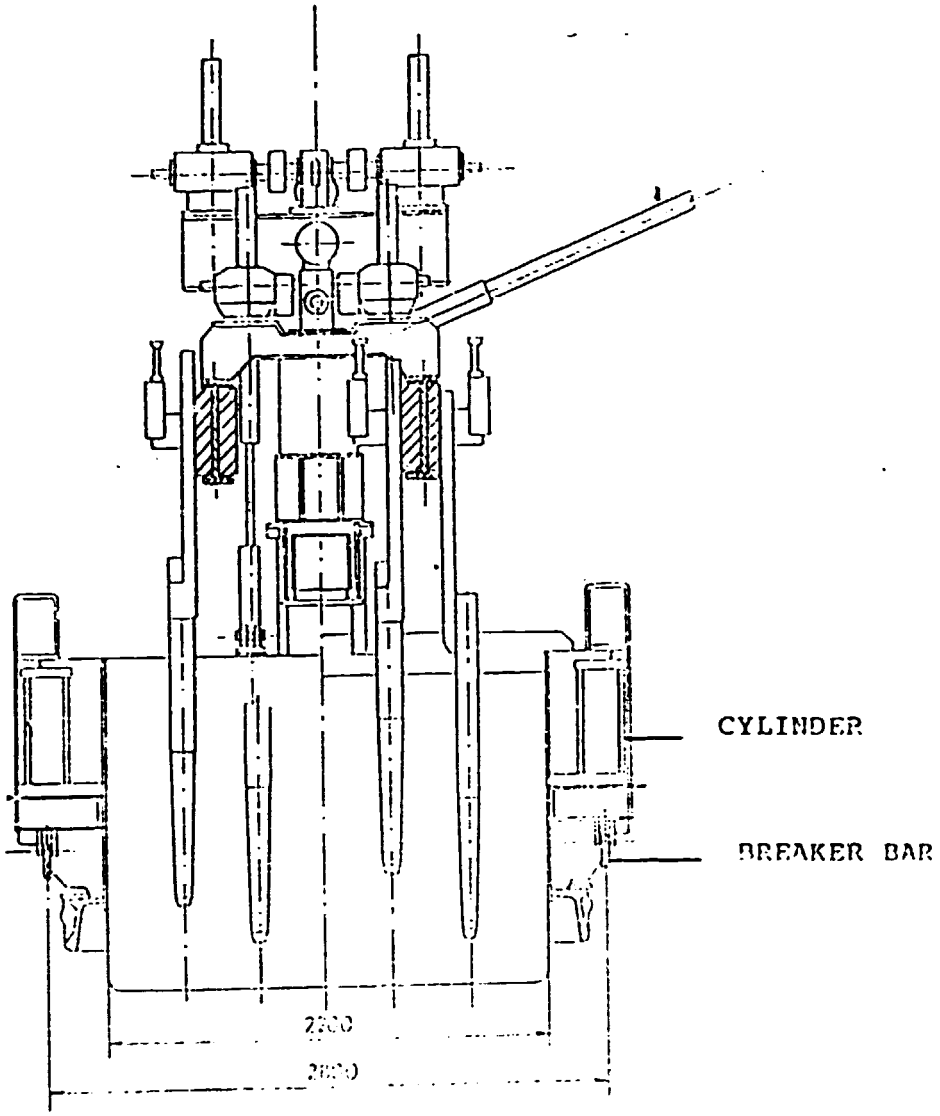


Figure 2

VSS Electrolysis Cell with Knife Type Crust Breaker

Cross Section

Estimation of investment costs

In tables V and VI investment costs of the Base case (Variants 1 and 2) and as well as that of Variants 3 and 4 are given below

Table V Investment costs Base case Costs in thousand Rupees

Sl	Description	Foreign	Local	Total
1	Process control equipment to fulfil control tasks described above complete with control centres. line current transmitters. file server, workstation. system development. including cables and 102 pcs of pot controllers	10209.0	-	10209.0
2	306 pcs of potcontrollers with all the adjusting elements for connection to the above system. including cables	-	18495.0	18495.0
3	Construction and transport (ad1.2)	2340.0	5400.0	7740.0
4	Spare parts for two years of operation (ad1.2)	216.0	648.0	864.0
5	Training at site &abroad (ad1.2)	1035.0	-	1035.0
6	Licence and know-how fees (ad1.2)	4819.5	-	4819.5
7	Crustbreaker system complete with pneumatic cylinders. electropneumatic control boxes. piping/cabling	-	75072.0	75072.0
8	Construction and transport (ad7)	-	18768.0	18768.0
9	Spare part for two years of operation (ad7)	-	3000.0	3000.0
	Subtotal	*18619.5*	*121283.0*	*140002.*
10	Studies. detailed engineering. construction management. supervision.commissioning	-	7000.0	7000.0
	Total	*18619.5*	*128383.0*	*147002.*
11	Contingencies	1862.0	12840.0	14702.
	Grand Total	20481.5	141223.0	161704.

(The estimation does not include interest during construction)

Table VI Investment costs Variants 3 and 4

Costs in thousand Rupees

Sl	Description	Construction Period years	
		1	2
A.	Coarsening of alumina		
1	Site development, structural civil works	45200	-
2	Interstage cooling system	34300	8570
3	Reintroduction of hydroseparator	2870	-
4	Salt removal system	11300	17400
5	Pan filter /belt filter for seed washing	11300	17400
6	Tankage and allied equipment including pumps,motor,valves etc.	2070	2070
7	Hydrocyclone installation	1130	1130
8	Fine seed thickner 2000m3	-	8700
9.	Centrifuge	1300	1300
10	Miscellaneous (5%of equipments)	3030	3030
11	Construction & transport (ad1-10)	16893	8905
12	Spare parts for 2years (ad2-10)	2692	2384
B.	Crust breaking system		
13	Crust breaking system complete with pneumatic cylinders, electro-pneumatic control boxes piping/cabling	-	75072
14	Construction & transport (ad 13)	-	18768
15	Spare parts for two years of operation (ad13)	-	3000
	Subtotal	*132085*	*167729*
16	Studies	6600	8386
	Total	*138685*	*176115*
17	Contingencies	13870	17611
	Grand Total	152555	193726

All costs are local.

(The estimation does not include interest during construction)

V. IMPLEMENTATION

Indicative time schedules for project implementation

The indicative time schedules show the initial and final terms of main activities (Figures 3,4 &5). The sequence of events put into evidence the necessity of the availability of equipment/construction materials at site respectively (in Variants 3&4) the implementation of site preparation/civil works. Activity related to purchase/delivery is critical for the progress of the activities regarding installation of equipments on 13 pots. in all pot rooms as well as in the alumina plant.
Total construction period is forecast basically in 24 months, while in Variant 2 it is compressed to 12 months, starting from the date of beginning of detailed engineering.

Production schedule

Matching with the time schedule the productions for the different variants are given as follows

Table X Production schedule

Description	Variant 1	Variant 2	Variant 3	Variant 4
First year of production corresponds to	Second year of construction	Second year	Second year of construction	Second year of construction
Production in first year t	1869.2	-	500.0	500.0
Production in second year t 100%	5869.2	5869.2	1173.2	4108.4

Implementation Schedule
Base case , Variant 1

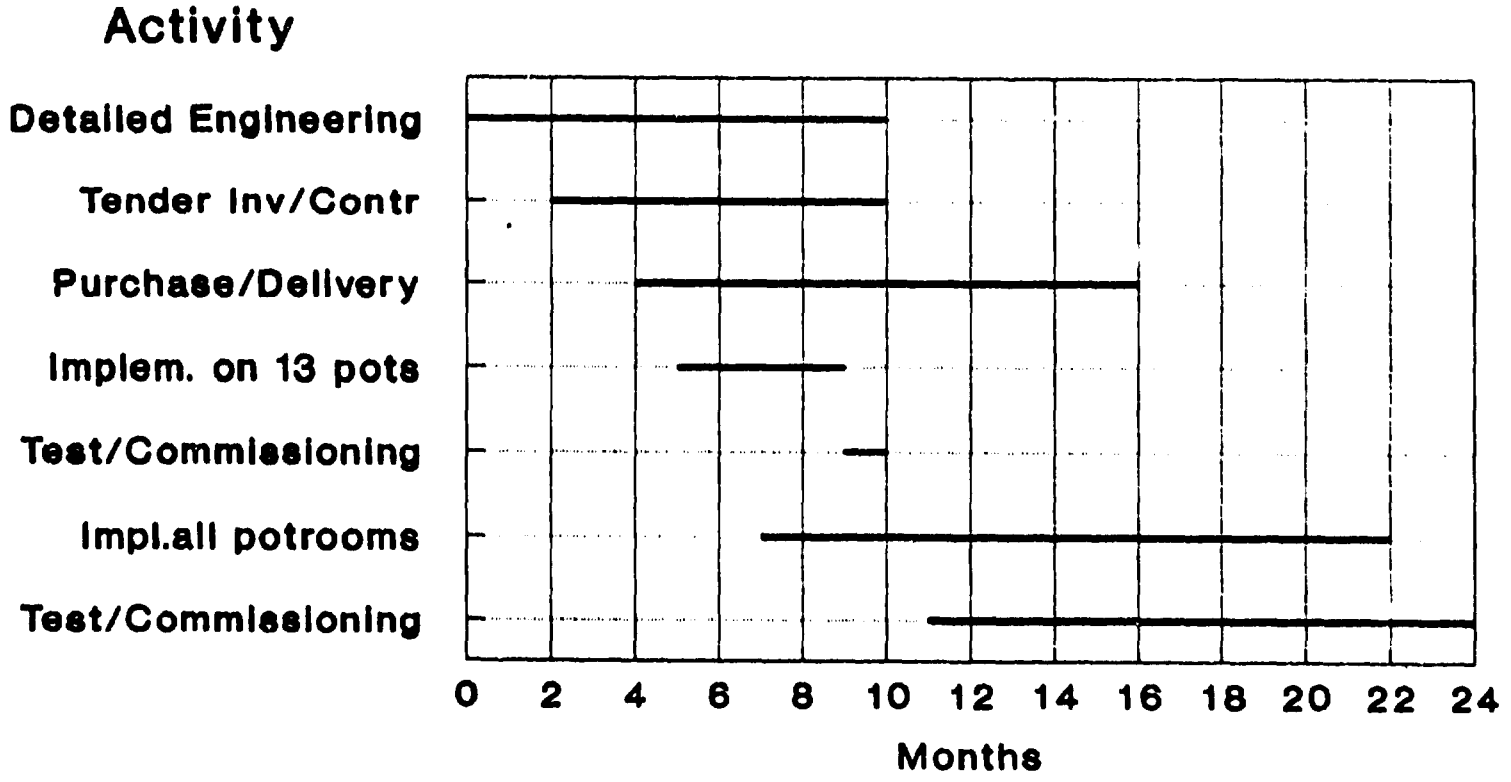


Figure 3
Bar Chart
Indicative Time Schedule

Implementation Schedule
Base case , Variant 2

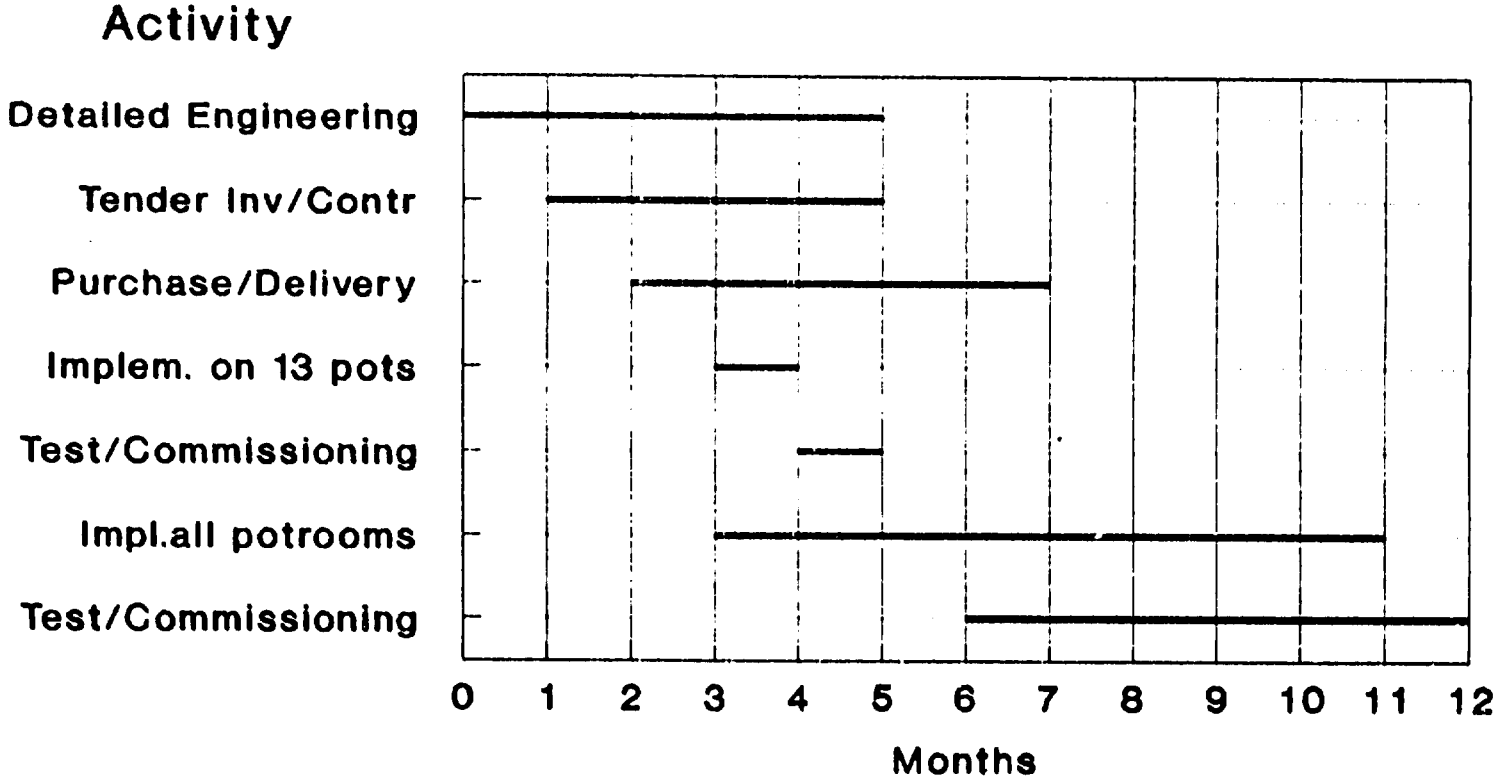


Figure 4
Bar Chart
Indicative Time Schedule

Implementation Schedule
Variant 3 and 4

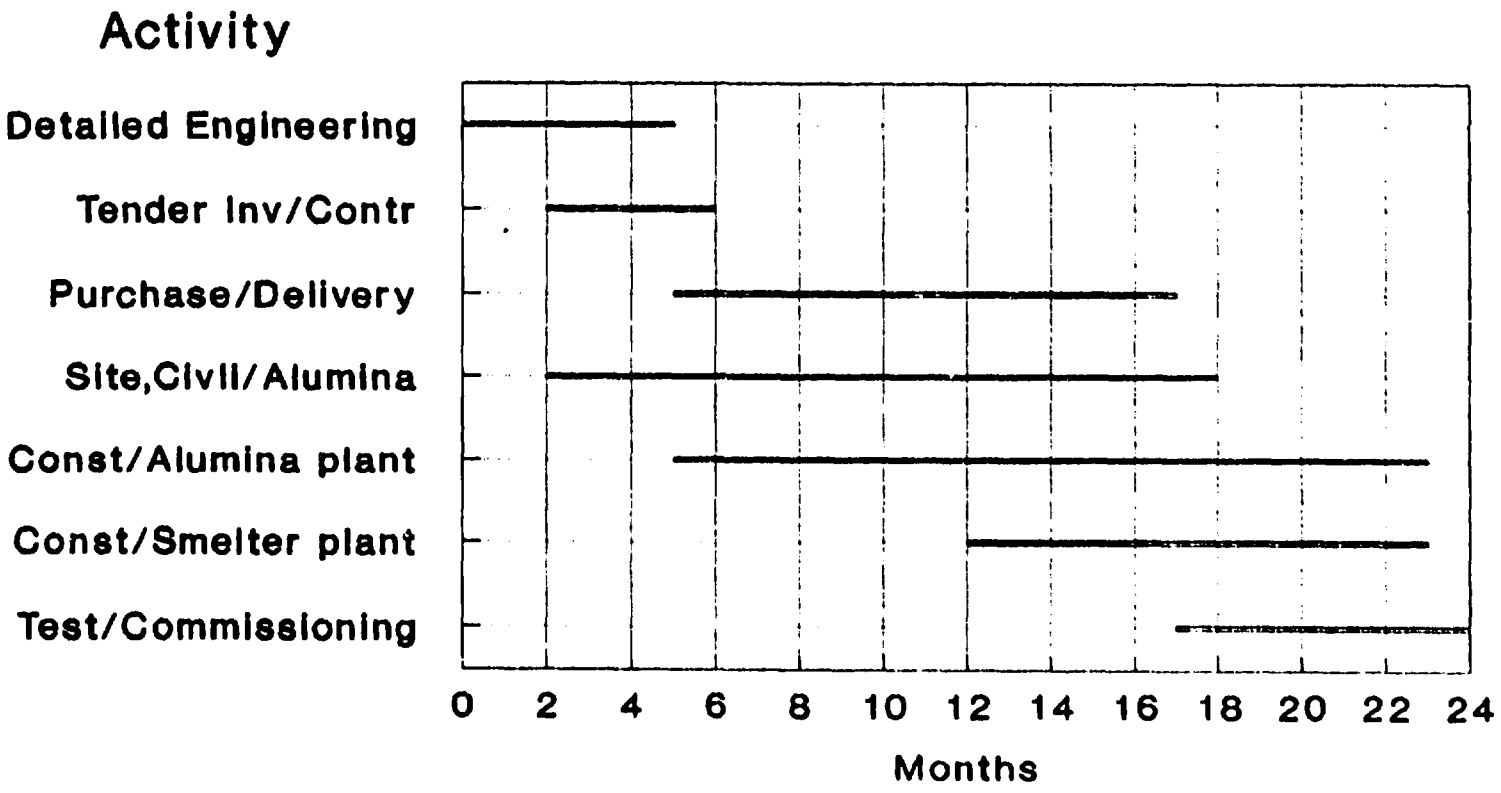


Figure 5
Bar. Chart
Indicative Time Schedule

VI. FINANCIAL APPRAISAL

Methodology applied for calculations

- Economic evaluation was worked out by using the UNIDO COMFAR system
- As the additional production was achieved by improvement in current efficiency, calculating production costs of the same we accepted the general practice according to which the input in this case is the alumina needed for the produced metal only
- When energy savings were also taken into account, using the COMFAR software the annual energy savings were handled as amounts of plus profit generated by results of the relating investment.

Financial structure

In all the variants the investments were considered to be financed by foreign and local loans as under:

- Foreign loans for three years at 8% interest on loan
- Local loans for five years at 10% interest on loan

No equity has been taken into consideration. Variants 1-4 were evaluated based on different data sheets worked out for COMFAR as well as on other data included in the relevant parts of the study.

Raw material and product prices

For the calculations BALCO's present prices have been taken into consideration as follows :

Selling price of ingots (pigs)	44800 Rs/t
Alumina price	7911 Rs/t
Power price	0.9 Rs/t

Summary of main indices

Based on the COMFAR tables a summary of the most important indices of Variants 1-4 is given in the table below

Table XI. Main economic indices

Indices	Variant			
	1	2	3	4
Internal rate of return (IRR)%	63.45	72.87	15.03	27.01
Net present value (NPV) thousand Rupees	717420.6	791484.1	108608.9	423874.8
Cumulated net cashflow (CNF) (in the 15th year) thousand Rupees	1589786	1676444	459441.6	1132127
Accumulated undistributed profit (in the 15th year) thousand Rupees	1617581	1702002	456414.3	1129100
Net profit. % of sales	45.277	45.277	49.605	52.223
Pay-back:CNF turns to positive after the year	3	2	7	4

The economic indices clearly show the preferable Variants in the Base case respectively in case of Variants 3 and 4.

The discount rates and investment costs in the Base case practically are the same in Variant 1 and in Variant 2. All the indices are more favourable in Variant 2. Therefore this variant has to be preferred.

As to the Variants 3 and 4. discount rates and investment costs are also same regarding these variants.

Based on the economic indices Variant 4 has to be preferred from profitability point of view.

Data sheet , other input data and results
Base case , Variant 1

Table VII Data sheet for COMFAR evaluation
Investment costs in thousand Rupees
Construction period 2 years

Sl	Item		Year 1	Year 2	Total
1	Incorporated fixed assets construction,transport	Foreign	2574.0	-	2574.0
		Local	13293.0	13293.0	26586.0
2	Incorporated fixed assets technology,training spare parts	Foreign	1677.5	5000.0	6677.5
		Local	-	4013.0	4013.0
3	Incorporated fixed assets others,studies,detailed engineering,supervision construction management commissioning	Foreign	-	-	-
		Local	5000.0	2700.0	7700.0
4	Plant equipment & machinery	Foreign	10000.0	1230.0	11230.0
		Local	52924.0	50000.0	102924.0
5	Preproduction expenditures intrest during construction	Foreign	1140.0	1635.0	2775.0
		Local	7122.0	14123.0	21245.0
	Total		93730.5	91994.0	185724.5
	Percentage		50.5%	49.5%	100%

Production in the second year of construction	1869.2 t
Production from the second year of production	5869.2 t/year

Results of COMFAR evaluation are included in the tables and graphs on pages 34-48.

Main economic indices summarized from the tables:

Internal rate of return (IRR)	63.45%
Net present value (NPV)	717420.60*10^3 Rs.
Cumulated net cashflow (CNF) (in the 15 th year)	1589786.00*10^3 Rs.
Accumulated undistributed profit (in the 15 th year)	1617518.00*10^3 Rs.
Net profit . % of sales	45.277
Pay-back : accumulated net cashflow turns positive after the year	3

Sensitivity of IRR relating to sales price. operating cost and investment cost is shown in the COMFAR graph (page 48).

COMFAR 2.1 UNIDO

COMFAR 2.1 - JAWAHARLAL NEHRU CENTRE, NAGPUR, INDIA

MODERNIZATION OF BALCO SMELTER
MARCH 1993
VARIANT 1

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: THOUSAND RUPEES

Total initial investment during construction phase

fixed assets:	93730.50	16.421 % foreign
current assets:	0.00	0.000 % foreign
total assets:	93730.50	16.421 % foreign

Source of funds during construction phase

equity & grants:	0.00	0.000 % foreign
foreign loans :	15391.50	
local loans :	78339.00	
total funds :	93730.50	16.421 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	14804.06	46484.07	46484.07
depreciation :	6292.40	11415.40	11415.40
interest :	0.00	18107.32	14873.03
production costs	21096.46	76006.79	72772.50
thereof foreign	4.74 %	3.93 %	3.31 %
total sales :	83740.16	262940.20	262940.20
gross income :	62643.69	186933.40	190167.70
net income :	34454.03	102813.40	104592.20
cash balance :	40623.06	80189.13	78997.70
net cashflow :	-51370.94	132072.10	130880.60

Net Present Value at: 10.00 % = 717420.60
Internal Rate of Return: 63.45 %
Return on equity1: not found
Return on equity2: not found

Index of Schedules produced by COMFAR

Total Initial Investment in THOUSAND RUPEES

Year	1994
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	0.000
Auxiliary and service facilities	0.000
Incorporated fixed assets	22544.500
Plant machinery and equipment	62924.000
Total fixed investment costs	85468.500
Pre-production capital expenditures	8262.000
Net working capital	0.000
Total initial investment costs	93730.500
Of it foreign, in %	16.421

COMFAR 2.1 UNIDO

Total Current Investment in THOUSAND RUPEES

Year	1995	1996
Fixed investment costs		
Land, site preparation, development	0.000	0.000
Buildings and civil works	0.000	0.000
Auxiliary and service facilities	0.000	0.000
Incorporated fixed assets	25006.000	0.000
Plant, machinery and equipment	51230.000	0.000
Total fixed investment costs	76236.000	0.000
Preproduction capitals expenditures.	15758.000	0.000
Working capital	123.367	264.000
Total current investment costs	92117.370	264.000
Of it foreign, %	8.538	0.000

Cashflow Tables, construction in THOUSAND RUPEES

Year	1994
Total cash inflow . .	93730.500
Financial resources .	93730.500
Sales, net of tax . .	0.000
Total cash outflow . .	93730.500
Total assets	93730.500
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	78339.000
Outflow, local	78339.000
Surplus (deficit) .	0.000
Inflow, foreign . . .	15391.500
Outflow, foreign . . .	15391.500
Surplus (deficit) .	0.000
Net cashflow	-93730.500
Cumulated net cashflow	-93730.500

COMFAR 2.1 UNIDO

Cashflow tables, production in THOUSAND RUPEES

Year	1995	1996	1997	1998	1999	2000
Total cash inflow	175775.300	263028.200	262940.200	262940.200	262940.200	262940.200
Financial resources	92035.130	88.000	0.000	0.000	0.000	0.000
Sales, net of tax	83740.160	262940.200	262940.200	262940.200	262940.200	262940.200
Total cash outflow	135152.200	182839.000	183942.500	185538.300	178263.800	179857.800
Total assets	92158.490	352.000	0.000	0.000	0.000	0.000
Operating costs	14804.060	46484.060	46484.060	46484.060	46484.060	46484.060
Cost of finance	0.000	18107.320	14873.030	11326.780	7438.281	3896.265
Repayment	0.000	33775.620	37009.910	40556.170	35420.360	38962.450
Corporate tax	28189.660	84120.020	85575.450	87171.260	88921.080	90515.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	40623.060	80189.130	78997.700	77401.880	84676.360	83082.390
Cumulated cash balance	40623.060	120812.200	199809.900	277211.800	361888.100	444970.500
Inflow, local	167910.300	263028.200	262940.200	262940.200	262940.200	262940.200
Outflow, local	127287.200	173814.700	174918.200	176514.000	178263.800	179857.800
Surplus (deficit)	40623.060	89213.440	88022.000	86426.190	84676.380	83082.410
Inflow, foreign	7865.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign	7865.000	9024.299	9024.299	9024.307	0.000	0.000
Surplus (deficit)	0.000	-9024.299	-9024.299	-9024.307	0.000	0.000
Net cashflow	-51370.940	132072.100	130880.600	129284.800	127535.000	125941.100
Cumulated net cashflow	-145101.400	-13029.380	117851.300	247136.100	374671.100	500612.200

Cashflow tables, production in THOUSAND RUPEES

Year	2001	2002	2003	2004	2005	2006
Total cash inflow	262940.200	262940.200	262940.200	262940.200	262940.200	262940.200
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	262940.200	262940.200	262940.200	262940.200	262940.200	262940.200
Total cash outflow	138752.400	138752.400	138752.400	141584.000	143889.300	143889.300
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs	46484.060	46484.060	46484.060	46484.060	46484.060	46484.060
Cost of finance	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax	92268.310	92268.310	92268.310	95099.890	97405.240	97405.240
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	124187.800	124187.800	124187.800	121356.200	119050.800	119050.800
Cumulated cash balance	569158.300	693346.000	817533.800	938889.900	1057941.000	1176992.000
Inflow, local	262940.200	262940.200	262940.200	262940.200	262940.200	262940.200
Outflow, local	138752.400	138752.400	138752.400	141584.000	143889.300	143889.300
Surplus (deficit)	124187.800	124187.800	124187.800	121356.200	119050.800	119050.800
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	124187.800	124187.800	124187.800	121356.200	119050.900	119050.900
Cumulated net cashflow	624800.000	748987.800	873175.500	994531.700	1113583.000	1232633.000

Cashflow tables, production in THOUSAND RUPEES

Year	2007	2008	2009
Total cash inflow . .	262940.200	262940.200	262940.200
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	262940.200	262940.200	262940.200
Total cash outflow . .	143889.300	143889.300	143889.300
Total assets	0.000	0.000	0.000
Operating costs . . .	46484.060	46484.060	46484.060
Cost of finance . . .	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax . . .	97405.240	97405.240	97405.240
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	119050.800	119050.800	119050.800
Cumulated cash balance	1296043.000	1415093.000	1534144.000
Inflow, local	262940.200	262940.200	262940.200
Outflow, local	143889.300	143889.300	143889.300
Surplus (deficit) .	119050.800	119050.800	119050.800
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	119050.900	119050.900	119050.900
Cumulated net cashflow	1351684.000	1470735.000	1589786.000

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value ..... 774686.00 at 10.00 %

Internal Rate of Return (IRRE1) .. not found

b) Net Worth versus Net cash return:

Net present value ..... 726681.90 at 10.00 %

Internal Rate of Return (IRRE2) .. not found

c) Internal Rate of Return on total investment:

Net present value ..... 717420.60 at 10.00 %

Internal Rate of Return (IRR) .. 63.45 %

Net Worth = Equity paid plus reserves

Net Income Statement in THOUSAND RUPEES

ar	1995	1996	1997	1998	1999
tal sales, incl. sales tax	83740.160	262940.200	262940.200	262940.200	262940.200
ss: variable costs, incl. sales tax.	14804.060	46484.070	46484.070	46484.070	46484.070
Variable margin	68936.090	216456.100	216456.100	216456.100	216456.100
% of total sales	82.321	82.321	82.321	82.321	82.321
Non-variable costs, incl. depreciation	6292.400	11415.400	11415.400	11415.400	11415.400
perational margin	62643.700	205040.700	205040.700	205040.700	205040.700
As % of total sales	74.807	77.980	77.980	77.980	77.980
st of finance	0.000	18107.320	14873.030	11326.780	7438.281
Gross profit	62643.690	186933.400	190167.700	193713.900	197602.400
llowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	62643.690	186933.400	190167.700	193713.900	197602.400
Tax	28189.660	84120.020	85575.450	87171.260	88921.080
et profit	34454.030	102813.400	104592.200	106542.600	108681.300
vidends paid	0.000	0.000	0.000	0.000	0.000
distributed profit	34454.030	102813.400	104592.200	106542.600	108681.300
Accumulated undistributed profit	34454.030	137267.400	241859.600	348402.200	457083.600
oss profit, % of total sales	74.807	71.094	72.324	73.672	75.151
Net profit, % of equity	41.144	39.101	39.778	40.520	41.333
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
, Net profit+interest, % of invest.	18.539	64.972	64.190	63.333	62.392

Net Income Statement in THOUSAND RUPEES

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	262940.200	262940.200	262940.200	262940.200	262940.200
Less: variable costs, incl. sales tax.	46484.070	46484.070	46484.070	46484.070	46484.070
Variable margin	216456.100	216456.100	216456.100	216456.100	216456.100
As % of total sales	82.321	82.321	82.321	82.321	82.321
Non-variable costs, incl. depreciation	11415.400	11415.400	11415.400	11415.400	5123.004
Operational margin	205040.700	205040.700	205040.700	205040.700	211333.100
As % of total sales	77.980	77.980	77.980	77.980	80.373
Cost of finance	3896.245	0.000	0.000	0.000	0.000
Gross profit	201144.400	205040.700	205040.700	205040.700	211333.100
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	201144.400	205040.700	205040.700	205040.700	211333.100
Tax	90515.000	92268.310	92268.310	92268.310	95099.890
Net profit	110629.400	112772.400	112772.400	112772.400	116233.200
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	110629.400	112772.400	112772.400	112772.400	116233.200
Accumulated undistributed profit	567713.000	680485.400	793257.800	906030.100	1022263.000
Gross profit, % of total sales	76.498	77.980	77.980	77.980	80.373
Net profit, % of total sales	42.074	42.889	42.889	42.889	44.205
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	61.536	60.594	60.594	60.594	62.453

Net Income Statement in THOUSAND RUPEES

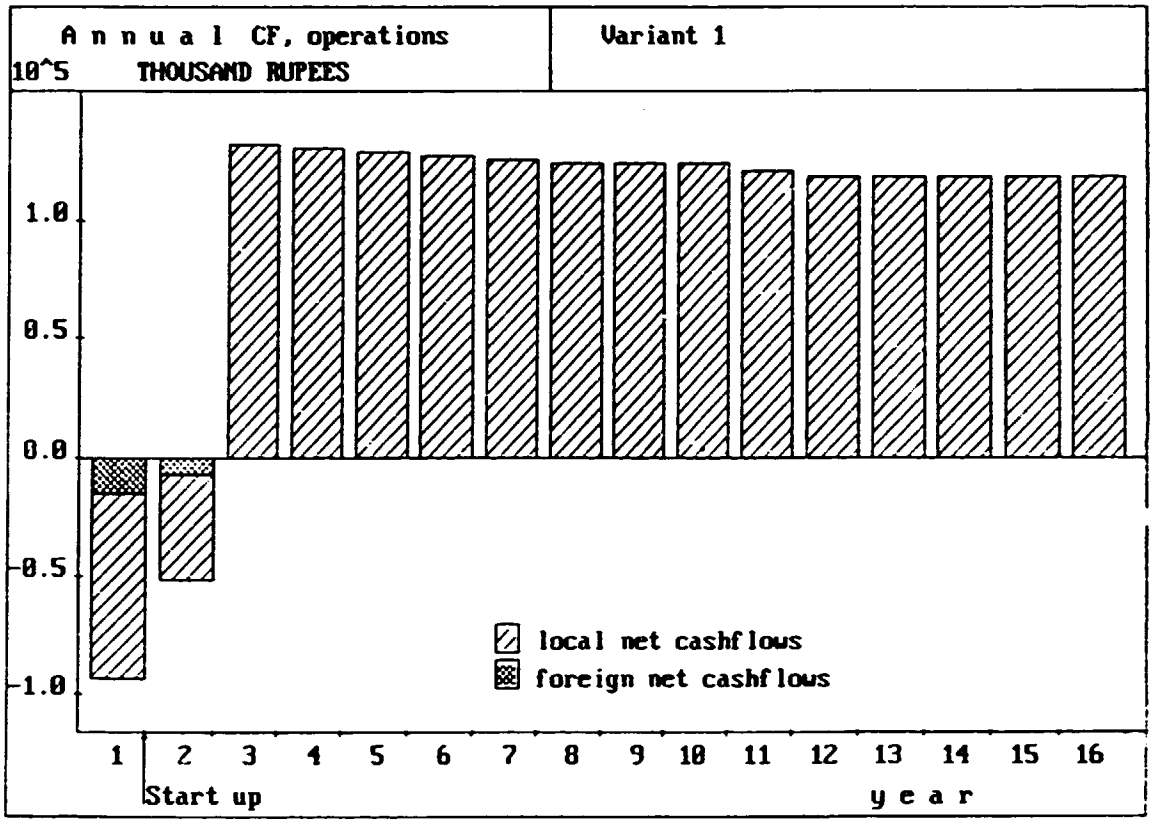
Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	262940.200	262940.200	262940.200	262940.200	262940.200
Less: variable costs, incl. sales tax.	46484.070	46484.070	46484.070	46484.070	46484.070
Variable margin	216456.100	216456.100	216456.100	216456.100	216456.100
As % of total sales	82.321	82.321	82.321	82.321	82.321
Non-variable costs, incl. depreciation	0.000	0.000	0.000	0.000	0.000
Operational margin	216456.100	216456.100	216456.100	216456.100	216456.100
As % of total sales	82.321	82.321	82.321	82.321	82.321
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	216456.100	216456.100	216456.100	216456.100	216456.100
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	216456.100	216456.100	216456.100	216456.100	216456.100
Tax	97405.240	97405.240	97405.240	97405.240	97405.240
Net profit	119050.900	119050.900	119050.900	119050.900	119050.900
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	119050.900	119050.900	119050.900	119050.900	119050.900
Accumulated undistributed profit	1141314.000	1260365.000	1379416.000	1498467.000	1617518.000
Gross profit, % of total sales	82.321	82.321	82.321	82.321	82.321
Net profit, % of total sales	45.277	45.277	45.277	45.277	45.277
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	63.967	63.967	63.967	63.967	63.967

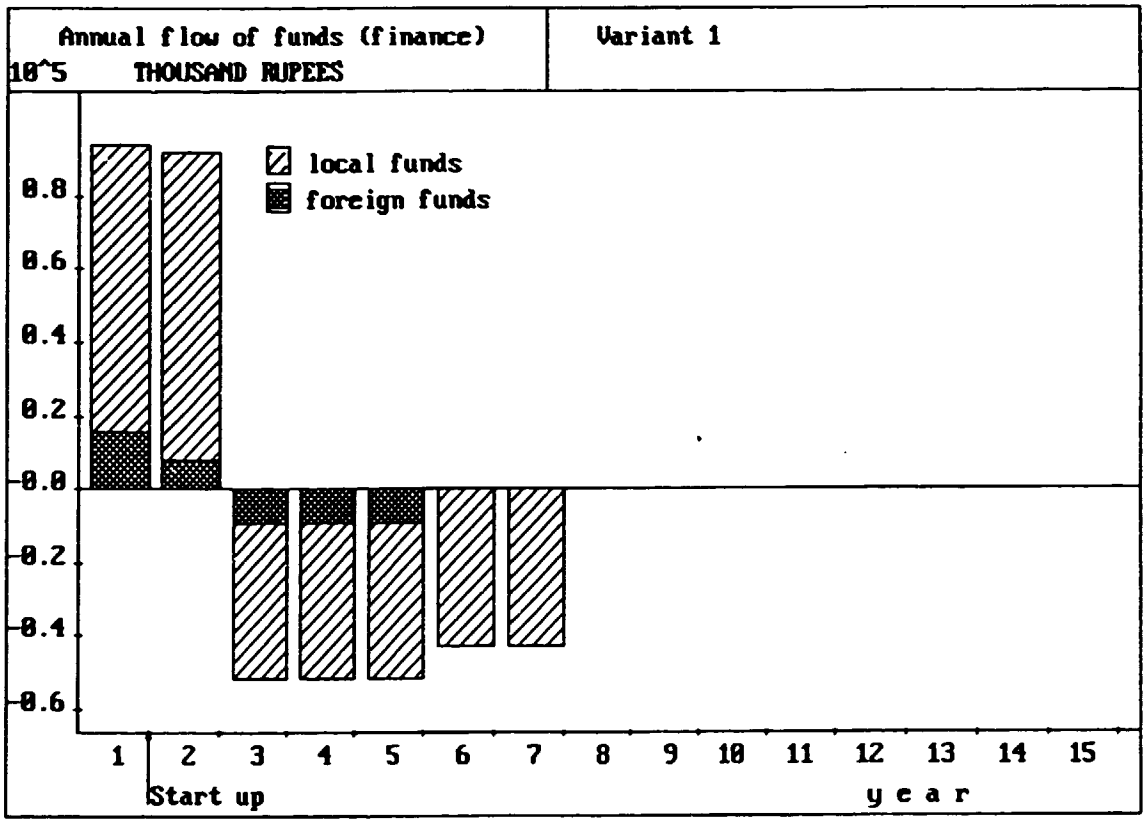
Source of Finance, construction in THOUSAND RUPEES

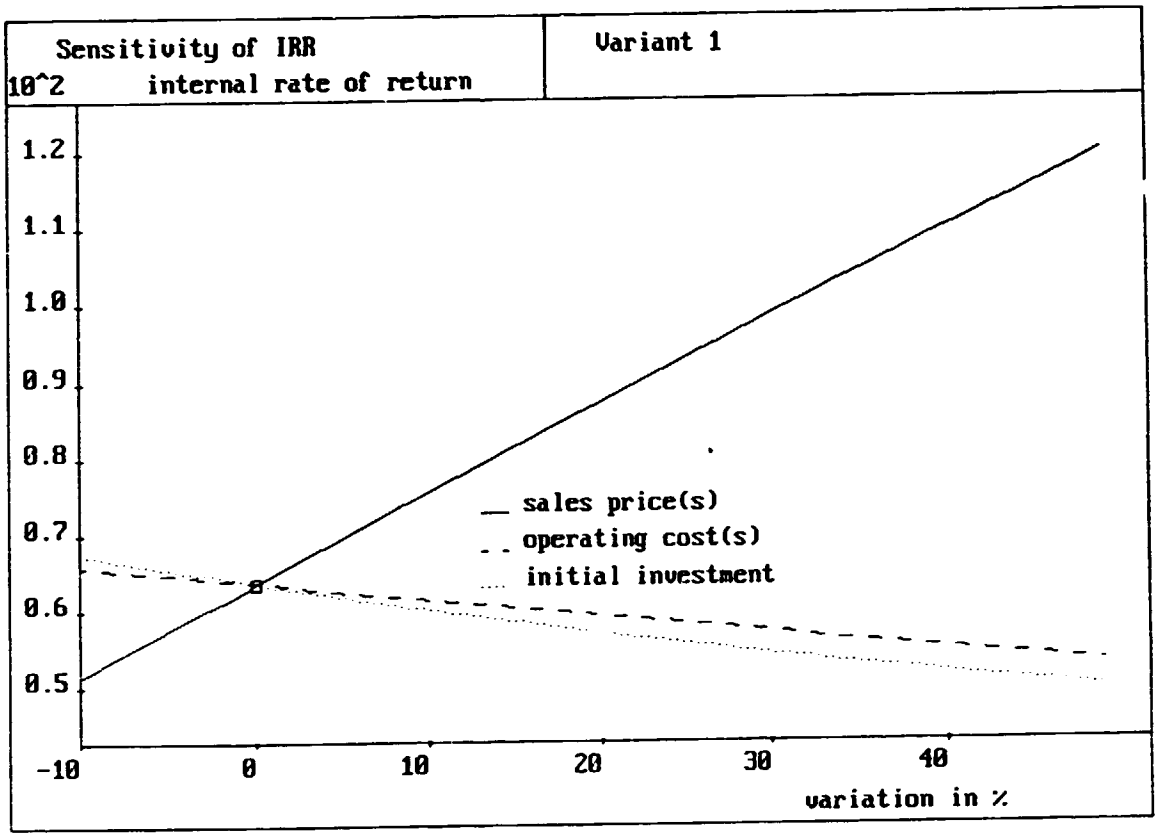
Year	1994
Equity, ordinary ..	0.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	15391.500
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	78339.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	93730.500
Current liabilities	0.000
Bank overdraft	0.000
Total funds	93730.500

Source of Finance, production in THOUSAND RUPEES

Year	1995	1996	1997	1998	1999	2000
Equity, ordinary ..	0.000	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	7865.000	-7163.779	-7736.881	-8355.840	0.000	0.000
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local....	84129.000	-26611.840	-29273.020	-32200.330	-35420.360	-38962.450
Loan B, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	91994.000	-33775.620	-37009.910	-40556.170	-35420.360	-38962.450
Current liabilities	41.122	88.000	0.000	0.000	0.000	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000	0.000
Total funds	92035.130	-33687.620	-37009.910	-40556.170	-35420.360	-38962.450


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


Annual flow of funds (finance)
Variant 1
10^5 THOUSAND RUPEES
local funds
foreign funds
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


Sensitivity of IRR
10^2 internal rate of return
Variant 1
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
sales price(s)
operating cost(s)
initial investment
-10
0
10
20
30
40
variation in %

Data sheet , other input data and results
Base case , Variant 2

Table VIII Data sheet for COMFAR evaluation
Investment costs in thousand Rupees
Construction period 1 year

Sl	Item		Total
1	Incorporated fixed assets construction, transport	Foreign	2574.0
		Local	26586.0
2	Incorporated fixed assets technology, training spareparts	Foreign	6677.5
		Local	4013.0
3	Incorporated fixed assets others,studies,detailed engineering,supervision construction management commissioning	Foreign	-
		Local	7700.0
4	Plant equipment & machinery	Foreign	11230.0
		Local	102924.0
5	Preproduction expenditures intrest during construction	Foreign	1635.0
		Local	14123.0
	Total		177462.5

Production from the second year	5869.2 t/year

Results of COMFAR evaluation are included in the tables and graphs on pages 52-67.

Main economic indices summarized from the tables:

Internal rate of return (IRR)	72.87%
Net present value (NPV)	791484.60 * 10^3 Rs.
Cumulated net cashflow (CNF) (in the 15 th year)	1676444.00 * 10^3 Rs.
Accumulated undistributed profit (in the 15 th year)	1702002.00 * 10^3 Rs.
Net profit , % of sales	45.277
Pay-back : accumulated net cashflow turns positive after the year	2

Sensitivity of IRR relating to sales price, operating cost and investment cost is shown in the COMFAR graph (page 67).

COMFAR 2.1 - JAWAHARLAL NEHRU CENTRE, NAGPUR, INDIA

MODERNIZATION OF BALCO SMELTER
MAR. 1993
VARIANT 2

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: THOUSAND RUPEES

Total initial investment during construction phase

fixed assets:	177462.50	12.463 % foreign
current assets:	0.00	0.000 % foreign
total assets:	177462.50	12.463 % foreign

Source of funds during construction phase

equity & grants:	0.00	0.000 % foreign
foreign loans :	22116.50	
local loans :	155346.00	
total funds :	177462.50	12.463 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	46484.07	46484.07	46484.07
depreciation :	11415.40	11415.40	11415.40
interest :	15534.60	12990.07	10191.09
production costs	73434.07	70889.54	68090.56
thereof foreign	1.53 %	1.58 %	1.65 %
total sales :	262940.20	262940.20	262940.20
gross income :	189506.10	192050.60	194849.60
net income :	104228.40	105627.80	107167.30
cash balance :	82438.94	81681.27	80421.73
net cashflow :	130791.00	130033.30	128773.80

Net Present Value at: 10.00 % = 791484.10
Internal Rate of Return: 72.87 %
Return on equity1: not found
Return on equity2: not found

Index of Schedules produced by COMFAR

Total initial investment
Total investment during production
Total production costs
Working Capital requirements
Cashflow Tables
Projected Balance
Net income statement
Source of finance

Total Initial Investment in THOUSAND RUPEES

Year	1994
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	0.000
Auxiliary and service facilities	0.000
Incorporated fixed assets	47550.500
Plant machinery and equipment	114154.000
Total fixed investment costs	161704.500
Pre-production capital expenditures.	15758.000
Net working capital	0.000
Total initial investment costs	177462.500
Of it foreign, in %	12.463

Total Current Investment in THOUSAND RUPEES

Year	1995
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	0.000
Auxiliary and service facilities	0.000
Incorporated fixed assets	0.000
Plant, machinery and equipment	0.000
Total fixed investment costs	0.000
Preproduction capitals expenditures.	0.000
Working capital	387.367
Total current investment costs	387.367
Of it foreign, %	0.000

Cashflow Tables, construction in THOUSAND RUPEES

Year	1994
Total cash inflow . .	177462.500
Financial resources .	177462.500
Sales, net of tax . .	0.000
Total cash outflow . .	177462.500
Total assets	177462.500
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	155346.000
Outflow, local	155346.000
Surplus (deficit) .	0.000
Inflow, foreign . . .	22116.500
Outflow, foreign . . .	22116.500
Surplus (deficit) .	0.000
Net cashflow	-177462.500
Cumulated net cashflow	-177462.500

Cashflow tables, production in THOUSAND RUPEES

Year	1995	1996	1997	1998	1999	2000
Total cash inflow	263069.300	262940.200	262940.200	262940.200	262940.200	262940.200
Financial resources	129.122	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	262940.200	262940.200	262940.200	262940.200	262940.200	262940.200
Total cash outflow	180630.300	181258.900	182518.400	176531.800	178055.900	138752.400
Total assets	516.490	0.000	0.000	0.000	0.000	0.000
Operating costs	46484.060	46484.060	46484.060	46484.060	46484.060	46484.060
Cost of finance	15534.600	12990.070	10191.090	7112.214	3725.448	0.000
Repayment	32817.440	35361.970	38160.950	33867.660	37254.480	0.000
Corporate tax	85277.740	86422.780	87682.320	89067.810	90591.860	92268.310
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	82438.940	81681.270	80421.720	86408.410	84884.300	124187.800
Cumulated cash balance	82438.940	164120.200	244541.900	330950.300	415834.600	540022.400
Inflow, local	263069.300	262940.200	262940.200	262940.200	262940.200	262940.200
Outflow, local	173258.200	173886.700	175146.300	176531.800	178055.800	138752.400
Surplus (deficit)	89811.110	89053.440	87793.910	86408.410	84884.310	124187.800
Inflow, foreign	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign	7372.167	7372.167	7372.167	0.000	0.000	0.000
Surplus (deficit)	-7372.167	-7372.167	-7372.167	0.000	0.000	0.000
Net cashflow	130791.000	130033.300	128773.800	127388.300	125864.200	124187.800
Cumulated net cashflow	-46671.520	83361.790	212135.600	339523.800	465388.100	589575.900

Cashflow tables, production in THOUSAND RUPEES

Year	2001	2002	2003	2004	2005	2006
Total cash inflow	262940.200	262940.200	262940.200	262940.200	262940.200	262940.200
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	262940.200	262940.200	262940.200	262940.200	262940.200	262940.200
Total cash outflow	138752.400	138752.400	138752.400	143889.300	143889.300	143889.300
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs	46484.060	46484.060	46484.060	46484.060	46484.060	46484.060
Cost of finance	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax	92268.310	92268.310	92268.310	97405.240	97405.240	97405.240
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	124187.800	124187.800	124187.800	119050.800	119050.800	119050.800
Cumulated cash balance	664210.100	788397.900	912585.600	1031637.000	1150687.000	1269738.000
Inflow, local	262940.200	262940.200	262940.200	262940.200	262940.200	262940.200
Outflow, local	138752.400	138752.400	138752.400	143889.300	143889.300	143889.300
Surplus (deficit)	124187.800	124187.800	124187.800	119050.800	119050.800	119050.800
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	124187.800	124187.800	124187.800	119050.900	119050.900	119050.900
Cumulated net cashflow	713763.600	837951.400	962139.100	1081190.000	1200241.000	1319292.000

Cashflow tables, production in THOUSAND RUPEES

Year	2007	2008	2009
Total cash inflow	262940.200	262940.200	262940.200
Financial resources	0.000	0.000	0.000
Sales, net of tax	262940.200	262940.200	262940.200
Total cash outflow	143889.300	143889.300	143889.300
Total assets	0.000	0.000	0.000
Operating costs	46484.060	46484.060	46484.060
Cost of finance	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax	97405.240	97405.240	97405.240
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	119050.800	119050.800	119050.800
Cumulated cash balance	1388789.000	1507840.000	1626891.000
Inflow, local	262940.200	262940.200	262940.200
Outflow, local	143889.300	143889.300	143889.300
Surplus (deficit)	119050.800	119050.800	119050.800
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	119050.900	119050.900	119050.900
Cumulated net cashflow	1438343.000	1557394.000	1676444.000

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value ..... 847525.10 at 10.00 %

Internal Rate of Return (IRRE1) .. not found

b) Net Worth versus Net cash return:

Net present value ..... 795267.00 at 10.00 %

Internal Rate of Return (IRRE2) .. not found

c) Internal Rate of Return on total investment:

Net present value ..... 791484.10 at 10.00 %

Internal Rate of Return (IRR) .. 72.87 %

Net Worth = Equity paid plus reserves

COMFAR 2.1 UNIDO

COMFAR 2.1 - JAWAHARLAL NEHRU CENTRE, NAGPUR, INDIA ---

Net Income Statement in THOUSAND RUPEES

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	262940.200	262940.200	262940.200	262940.200	262940.200
Less: variable costs, incl. sales tax.	46484.070	46484.070	46484.070	46484.070	46484.070
Variable margin	216456.100	216456.100	216456.100	216456.100	216456.100
As % of total sales	82.321	82.321	82.321	82.321	82.321
Non-variable costs, incl. depreciation	11415.400	11415.400	11415.400	11415.400	11415.400
Operational margin	205040.700	205040.700	205040.700	205040.700	205040.700
As % of total sales	77.980	77.980	77.980	77.980	77.980
Cost of finance	15534.600	12990.070	10191.090	7112.214	3725.448
Gross profit	189506.100	192050.600	194849.600	197928.500	201315.200
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	189506.100	192050.600	194849.600	197928.500	201315.200
Tax	85277.740	86422.780	87682.320	89067.810	90591.860
Net profit	104228.400	105627.800	107167.300	108860.700	110723.400
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	104228.400	105627.800	107167.300	108860.700	110723.400
Accumulated undistributed profit	104228.400	209856.200	317023.500	425884.100	536607.500
Gross profit, % of total sales	72.072	73.040	74.104	75.275	76.563
Net profit, % of total sales	39.640	40.172	40.757	41.401	42.110
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
RI, Net profit+interest, % of invest.	67.339	66.696	65.987	65.208	64.351

Net Income Statement in THOUSAND RUPEES

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	262940.200	262940.200	262940.200	262940.200	262940.200
Less: variable costs, incl. sales tax.	46484.070	46484.070	46484.070	46484.070	46484.070
Variable margin	216456.100	216456.100	216456.100	216456.100	216456.100
As % of total sales	82.321	82.321	82.321	82.321	82.321
Non-variable costs, incl. depreciation	11415.400	11415.400	11415.400	11415.410	0.000
Operational margin	205040.700	205040.700	205040.700	205040.700	216456.100
As % of total sales	77.980	77.980	77.980	77.980	82.321
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	205040.700	205040.700	205040.700	205040.700	216456.100
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	205040.700	205040.700	205040.700	205040.700	216456.100
Tax	92268.310	92268.310	92268.310	92268.310	97405.240
Net profit	112772.400	112772.400	112772.400	112772.400	119050.900
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	112772.400	112772.400	112772.400	112772.400	119050.900
Accumulated undistributed profit	649379.900	762152.300	874924.600	987697.000	1106748.000
Gross profit, % of total sales	77.980	77.980	77.980	77.980	82.321
Net profit, % of total sales	42.889	42.889	42.889	42.889	45.277
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	63.409	63.409	63.409	63.409	66.939

Net Income Statement in THOUSAND RUPEES

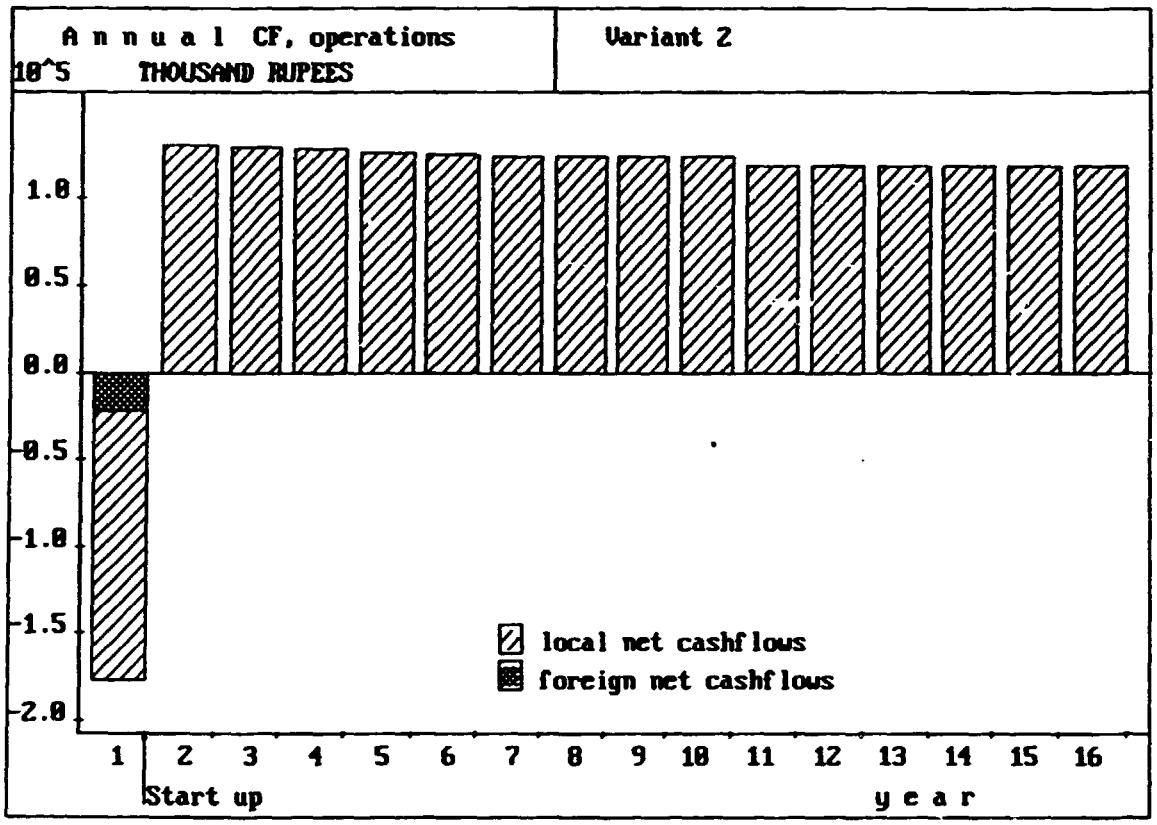
Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	262940.200	262940.200	262940.200	262940.200	262940.200
Less: variable costs, incl. sales tax.	46484.070	46484.070	46484.070	46484.070	46484.070
Variable margin	216456.100	216456.100	216456.100	216456.100	216456.100
As % of total sales	82.321	82.321	82.321	82.321	82.321
Non-variable costs, incl. depreciation	0.000	0.000	0.000	0.000	0.000
Operational margin	216456.100	216456.100	216456.100	216456.100	216456.100
As % of total sales	82.321	82.321	82.321	82.321	82.321
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	216456.100	216456.100	216456.100	216456.100	216456.100
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	216456.100	216456.100	216456.100	216456.100	216456.100
Tax	97405.240	97405.240	97405.240	97405.240	97405.240
Net profit	119050.900	119050.900	119050.900	119050.900	119050.900
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	119050.900	119050.900	119050.900	119050.900	119050.900
Accumulated undistributed profit	1225799.000	1344850.000	1463901.000	1582951.000	1702002.000
Gross profit, % of total sales	82.321	82.321	82.321	82.321	82.321
Net profit, % of total sales	45.277	45.277	45.277	45.277	45.277
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	66.939	66.939	66.939	66.939	66.939

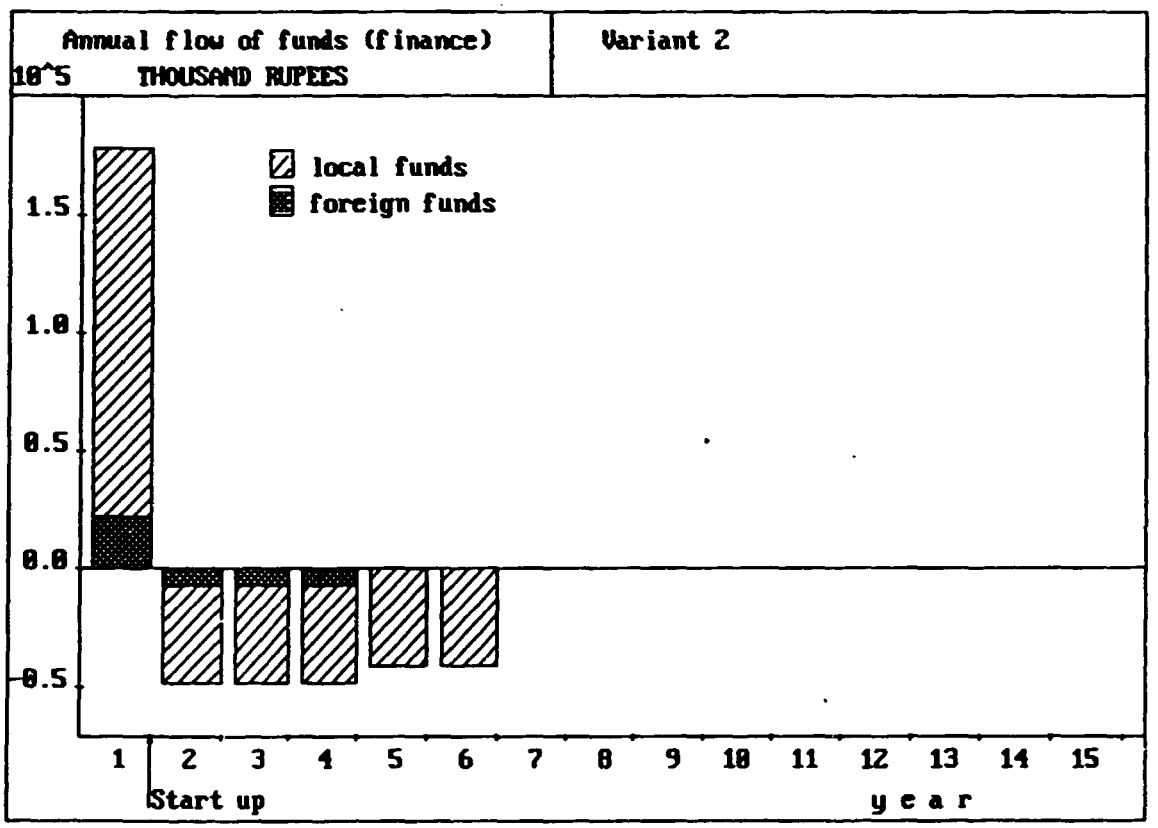
Source of Finance, production in THOUSAND RUPEES

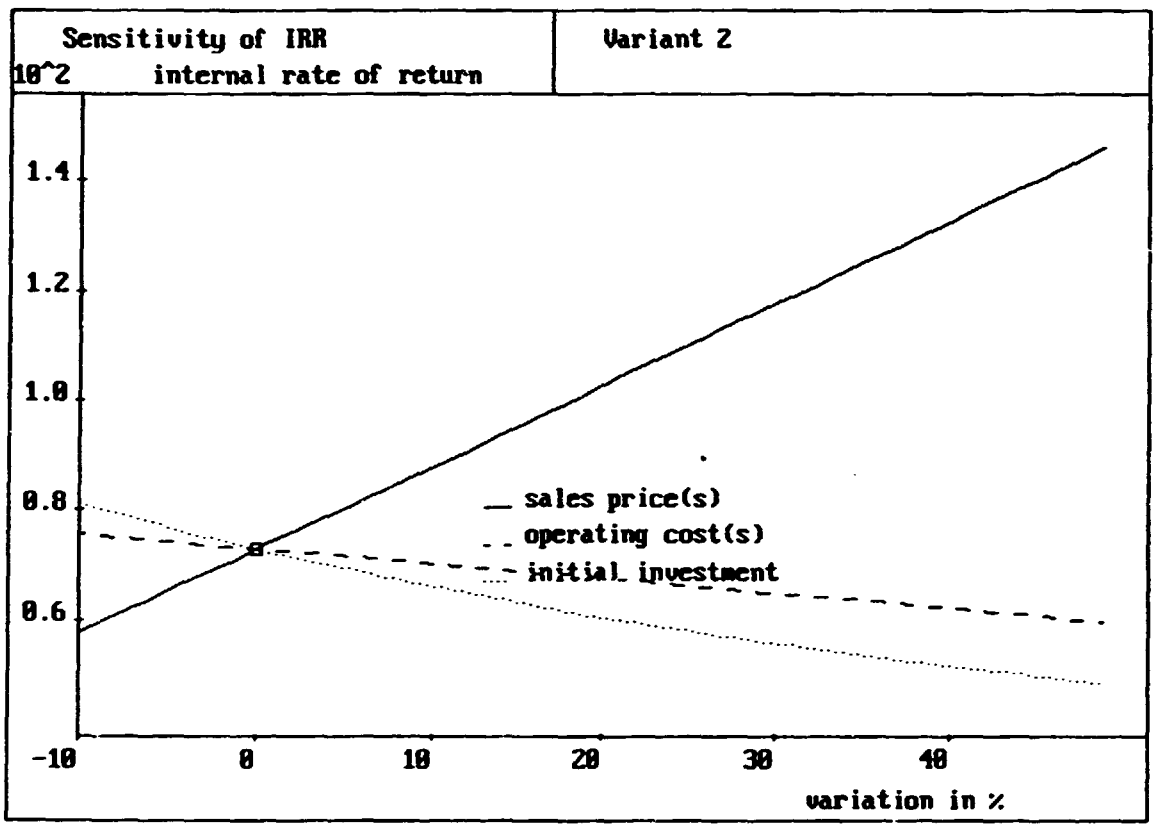
Year	1995	1996	1997	1998	1999
Equity, ordinary ..	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	-7372.167	-7372.167	-7372.167	0.000	0.000
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000
Loan A, local....	-25445.270	-27989.800	-30788.780	-33867.660	-37254.480
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	-32817.440	-35361.970	-38160.950	-33867.660	-37254.480
Current liabilities	129.122	0.000	0.000	0.000	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000
Total funds	-32688.320	-35361.970	-38160.950	-33867.660	-37254.480

Source of Finance, construction in THOUSAND RUPEES

Year	1994
Equity, ordinary ..	0.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	22116.500
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	155346.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	177462.500
Current liabilities	0.000
Bank overdraft	0.000
Total funds	177462.500


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


Annual flow of funds (finance)
Variant 2
10^5 THOUSAND RUPEES
local funds
foreign funds
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
Start up
year


Sensitivity of IRR
Variant 2
10^2 internal rate of return
1.4
1.2
1.0
0.8
0.6
sales price(s)
operating cost(s)
initial investment
-10
0
10
20
30
40
variation in %

Data sheet , other input data and results
Variant 3

Table IX Data sheet for COMFAR evaluation
Investment costs in thousand rupees
Variant 3 and 4
Construction period 2 years

Sl	Item	Construction period years		
		1	2	Total
1	Civil Structures	49720.0		49720.0
2	Incorporated fixed assets construction,transport	18583.0	30441.0	49024.0
3	Incorporated fixed assets technology,training , spare parts	2962.0	5922.0	8884.0
4	Incorporated fixed assets others,studies,detailed engineering,supervision construction management commissioning	7260.0	9225.0	16485.0
5	Plant equipment & machinery	74030.0	148138.0	222168.0
6	Preproduction expenditures interest during construction	15256.0	34628.0	49884.0
	Total	167811.0	228354.0	396165.0

Production in the second year of construction	500.0 t
Production from the second year of production	1173.2 t/year

Results of COMFAR evaluation are included in the tables and graphs on pages 70-85.

Main economic indices summarized from the tables:

Internal rate of return (IRR)	15.03%
Net present value (NPV)	108608.90 * 10^3 Rs.
Cumulated net cashflow (CNF) (in the 15 th year)	459441.00 * 10^3 Rs.
Accumulated undistributed profit (in the 15 th year)	456414.30 * 10^3 Rs.
Net profit . % of sales	49.605
Pay-back : accumulated net cashflow turns positive after the year	7

Sensitivity of IRR relating to sales price. operating cost and investment cost is shown in the COMFAR graph (page 85).

MODERNIZATION OF BALCO SHELTER
MAR. 1993
VARIANT 3

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: THOUSAND RUPEES

Total initial investment during construction phase

fixed assets:	167811.00	0.000 % foreign
current assets:	0.00	0.000 % foreign
total assets:	167811.00	0.000 % foreign

Source of funds during construction phase

equity & grants:	0.00	0.000 % foreign
foreign loans :	0.00	
local loans :	167811.00	
total funds :	167811.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	3960.00	9291.74	9291.74
depreciation :	12375.00	27188.80	27188.80
interest :	28198.80	39616.50	33127.42
production costs	44533.80	76097.05	69607.97
thereof foreign	0.00 %	0.00 %	0.00 %
total sales :	40364.25	94728.97	94728.97
gross income :	-4169.55	18631.92	25121.00
net income :	-4169.55	10247.56	13816.55
cash balance :	8172.45	-27498.88	-30374.53
net cashflow :	-191982.80	77008.43	74132.78

Net Present Value at: 10.00 % = 108608.90
Internal Rate of Return: 15.03 %
Return on equity1: not found
Return on equity2:

Index of Schedules produced by COMFAR

Total Initial Investment in THOUSAND RUPEES

Year	1994
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	49720.000
Auxiliary and service facilities	0.000
Incorporated fixed assets	28805.000
Plant machinery and equipment	74030.000
Total fixed investment costs	152555.000
Pre-production capital expenditures.	15256.000
Net working capital	0.000
Total initial investment costs	167811.000
Of it foreign, in %	0.000

Total Current Investment in THOUSAND RUPEES

Year	1995	1996
Fixed investment costs		
Land, site preparation, development	0.000	0.000
Buildings and civil works	0.000	0.000
Auxiliary and service facilities	0.000	0.000
Incorporated fixed assets	45588.000	0.000
Plant, machinery and equipment	148138.000	0.000
Total fixed investment costs	193726.000	0.000
Preproduction capitals expenditures	34628.000	0.000
Working capital	33.000	44.431
Total current investment costs	228387.000	44.431
Of it foreign, %	0.000	0.000

Cashflow Tables, construction in THOUSAND RUPEES

Year	1994
Total cash inflow . .	167811.000
Financial resources .	167811.000
Sales, net of tax . .	0.000
Total cash outflow . .	167811.000
Total assets	167811.000
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	167811.000
Outflow, local	167811.000
Surplus (deficit) .	0.000
Inflow, foreign . . .	0.000
Outflow, foreign . . .	0.000
Surplus (deficit) .	0.000
Net cashflow	-167811.000
Cumulated net cashflow	-167811.000

Cashflow tables, production in THOUSAND RUPEES

Year	1995	1996	1997	1998	1999	2000
Total cash inflow . .	268729.300	94743.780	94728.970	94728.970	94728.970	94728.970
Financial resources .	228365.000	14.810	0.000	0.000	0.000	0.000
Sales, net of tax . .	40364.250	94728.970	94728.970	94728.970	94728.970	94728.970
Total cash outflow . .	260556.800	122242.700	125103.500	128315.600	131848.900	135735.700
Total assets	228398.000	59.242	0.000	0.000	0.000	0.000
Operating costs . . .	3960.000	9291.742	9291.742	9291.742	9291.742	9291.742
Cost of finance . . .	28198.800	39616.500	33127.420	25989.430	18137.640	9500.674
Repayment	0.000	64890.810	71379.890	78517.880	86369.670	95006.750
Corporate tax . . .	0.000	8384.365	11304.450	14516.550	18049.850	21936.490
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	8172.453	-27498.880	-30374.530	-33586.630	-37119.940	-41006.690
Cumulated cash balance	8172.453	-19326.430	-49700.960	-83287.590	-120407.500	-161414.200
Inflow, local	268729.300	94743.780	94728.970	94728.970	94728.970	94728.970
Outflow, local	260556.800	122242.700	125103.500	128315.600	131848.900	135735.700
Surplus (deficit) .	8172.453	-27498.880	-30374.530	-33586.630	-37119.940	-41006.690
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	-191982.800	77008.430	74132.770	70920.680	67387.380	63500.740
Cumulated net cashflow	-359793.800	-282785.300	-208652.500	-137731.800	-70344.470	-6843.730

Cashflow tables, production in THOUSAND RUPEES

Year	2001	2002	2003	2004	2005	2006
Total cash inflow	94728.970	94728.970	94728.970	94728.970	94728.970	94728.970
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	94728.970	94728.970	94728.970	94728.970	94728.970	94728.970
Total cash outflow	35503.530	35503.530	35503.530	41072.270	47738.500	47738.500
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs	9291.742	9291.742	9291.742	9291.742	9291.742	9291.742
Cost of finance	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax	26211.790	26211.790	26211.790	31780.530	38446.750	38446.750
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	59225.440	59225.440	59225.440	53656.700	46990.470	46990.470
Cumulated cash balance	-102188.800	-42963.340	16262.090	69918.790	116909.300	163899.700
Inflow, local	94728.970	94728.970	94728.970	94728.970	94728.970	94728.970
Outflow, local	35503.530	35503.530	35503.530	41072.270	47738.500	47738.500
Surplus (deficit)	59225.440	59225.440	59225.440	53656.700	46990.470	46990.470
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	59225.440	59225.440	59225.440	53656.700	46990.470	46990.470
Cumulated net cashflow	52381.710	111607.100	170832.600	224489.300	271479.800	318470.200

Cashflow tables, production in THOUSAND RUPEES

Year	2007	2008	2009
Total cash inflow . .	94728.970	94728.970	94728.970
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	94728.970	94728.970	94728.970
Total cash outflow . .	47738.500	47738.500	47738.500
Total assets	0.000	0.000	0.000
Operating costs . . .	9291.742	9291.742	9291.742
Cost of finance . . .	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax . . .	38446.750	38446.750	38446.750
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	46990.470	46990.470	46990.470
Cumulated cash balance	210890.200	257880.700	304871.200
Inflow, local	94728.970	94728.970	94728.970
Outflow, local	47738.500	47738.500	47738.500
Surplus (deficit) .	46990.470	46990.470	46990.470
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	46990.470	46990.470	46990.470
Cumulated net cashflow	365460.700	412451.200	459441.600

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value ..... 184634.40 at 10.00 %

Internal Rate of Return (IRRE1) .. not found

b) Net Worth versus Net cash return:

Net present value ..... 98229.20 at 10.00 %

Internal Rate of Return (IRRE2) ..

c) Internal Rate of Return on total investment:

Net present value ..... 108608.90 at 10.00 %

Internal Rate of Return (IRR) .. 15.03 %

Net Worth = Equity paid plus reserves

Net Income Statement in THOUSAND RUPEES

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	40364.250	94728.970	94728.970	94728.970	94728.970
Less: variable costs, incl. sales tax.	3960.000	9291.744	9291.744	9291.744	9291.744
Variable margin	36404.250	85437.230	85437.230	85437.230	85437.230
% of total sales	90.189	90.191	90.191	90.191	90.191
Non-variable costs, incl. depreciation	12375.000	27188.800	27188.810	27188.800	27188.800
Operational margin	24029.250	58248.420	58248.420	58248.420	58248.420
As % of total sales	59.531	61.490	61.490	61.490	61.490
Cost of finance	28198.800	39616.500	33127.420	25989.430	18137.640
Gross profit	-4169.551	18631.920	25121.000	32258.990	40110.780
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-4169.551	18631.920	25121.000	32258.990	40110.780
Tax	0.000	8384.365	11304.450	14516.550	18049.850
Net profit	-4169.551	10247.560	13816.550	17742.450	22060.930
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-4169.551	10247.560	13816.550	17742.450	22060.930
Accumulated undistributed profit	-4169.551	6078.006	19894.550	37637.000	59697.930
Gross profit, % of total sales	-10.330	19.669	26.519	34.054	42.343
Net profit, % of total sales	-10.330	10.818	14.585	18.730	23.288
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	6.065	12.584	11.847	11.037	10.145

Net Income Statement in THOUSAND RUPEES

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	94728.970	94728.970	94728.970	94728.970	94728.970
Less: variable costs, incl. sales tax.	9291.744	9291.744	9291.744	9291.744	9291.744
Variable margin	85437.230	85437.230	85437.230	85437.230	85437.230
As % of total sales	90.191	90.191	90.191	90.191	90.191
Non-variable costs, incl. depreciation	27188.800	27188.800	27188.800	27188.800	14813.810
Operational margin	58248.420	58248.420	58248.420	58248.420	70623.410
As % of total sales	61.490	61.490	61.490	61.490	74.553
Cost of finance	9500.674	0.000	0.000	0.000	0.000
Gross profit	48747.750	58248.420	58248.420	58248.420	70623.410
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	48747.750	58248.420	58248.420	58248.420	70623.410
Tax	21936.490	26211.790	26211.790	26211.790	31780.530
Net profit	26811.260	32036.630	32036.630	32036.630	38842.880
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	26811.260	32036.630	32036.630	32036.630	38842.880
Accumulated undistributed profit	86509.190	118545.800	150582.500	182619.100	221462.000
Gross profit, % of total sales	51.460	61.490	61.490	61.490	74.553
Net profit, % of total sales	28.303	33.819	33.819	33.819	41.004
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	9.164	8.085	8.085	8.085	9.803

Net Income Statement in THOUSAND RUPEES

Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	94728.970	94728.970	94728.970	94728.970	94728.970
Less: variable costs, incl. sales tax.	9291.744	9291.744	9291.744	9291.744	9291.744
Variable margin	85437.230	85437.230	85437.230	85437.230	85437.230
As % of total sales	90.191	90.191	90.191	90.191	90.191
Non-variable costs, incl. depreciation	-0.003	0.000	0.000	0.000	0.000
Operational margin	85437.230	85437.230	85437.230	85437.230	85437.230
As % of total sales	90.191	90.191	90.191	90.191	90.191
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	85437.230	85437.230	85437.230	85437.230	85437.230
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	85437.230	85437.230	85437.230	85437.230	85437.230
Tax	38446.750	38446.750	38446.750	38446.750	38446.750
Net profit	46990.470	46990.470	46990.470	46990.470	46990.470
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	46990.470	46990.470	46990.470	46990.470	46990.470
Accumulated undistributed profit . . .	268452.400	315442.900	362433.400	409423.800	456414.300
Gross profit, % of total sales	90.191	90.191	90.191	90.191	90.191
Net profit, % of total sales	49.605	49.605	49.605	49.605	49.605
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	11.859	11.859	11.859	11.859	11.859

Source of Finance, construction in THOUSAND RUPEES

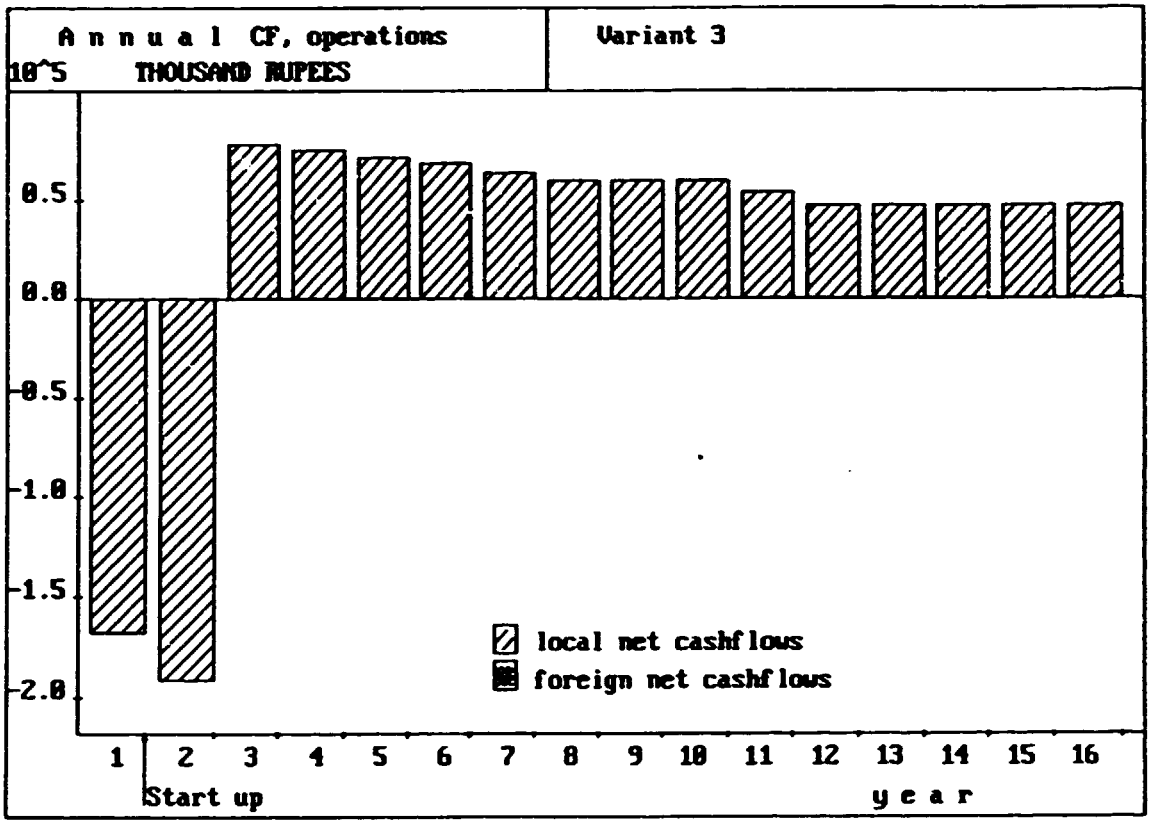
Year	1994
Equity, ordinary ..	0.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	0.000
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	167811.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	167811.000
Current liabilities	0.000
Bank overdraft	0.000
Total funds	167811.000

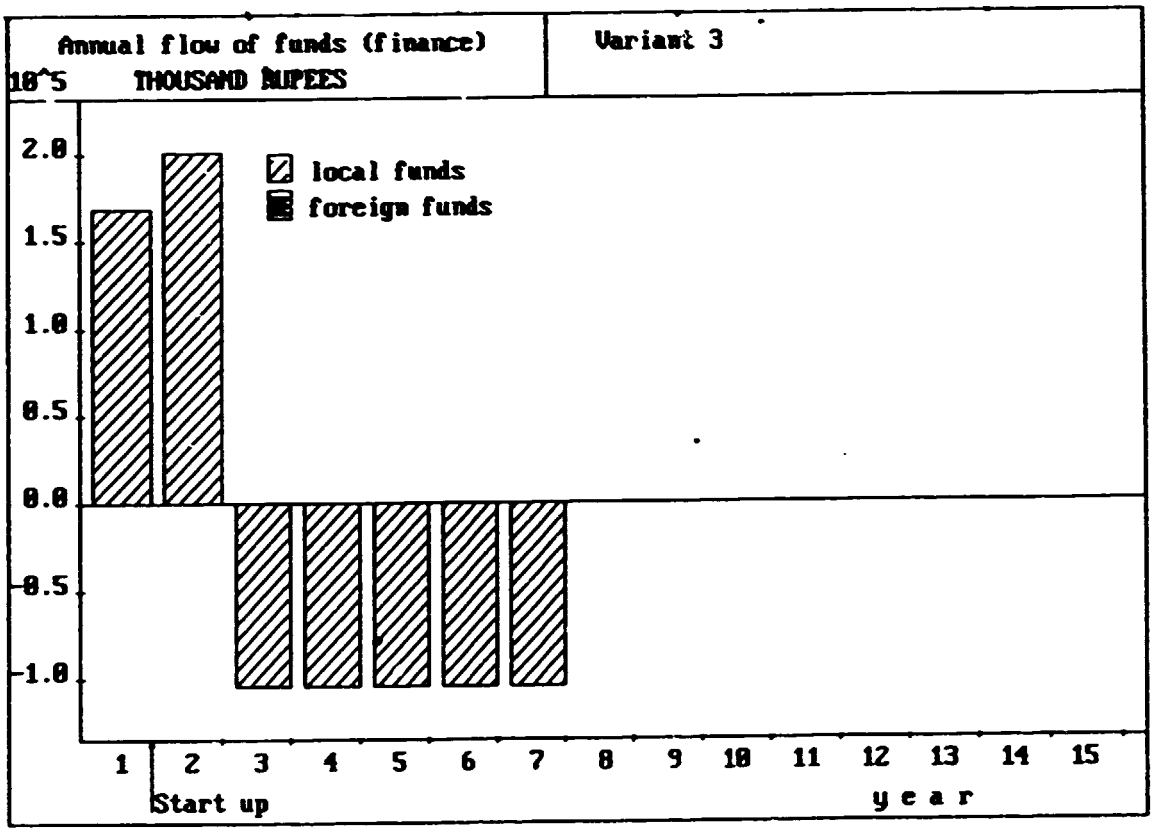
Source of Finance, production in THOUSAND RUPEES

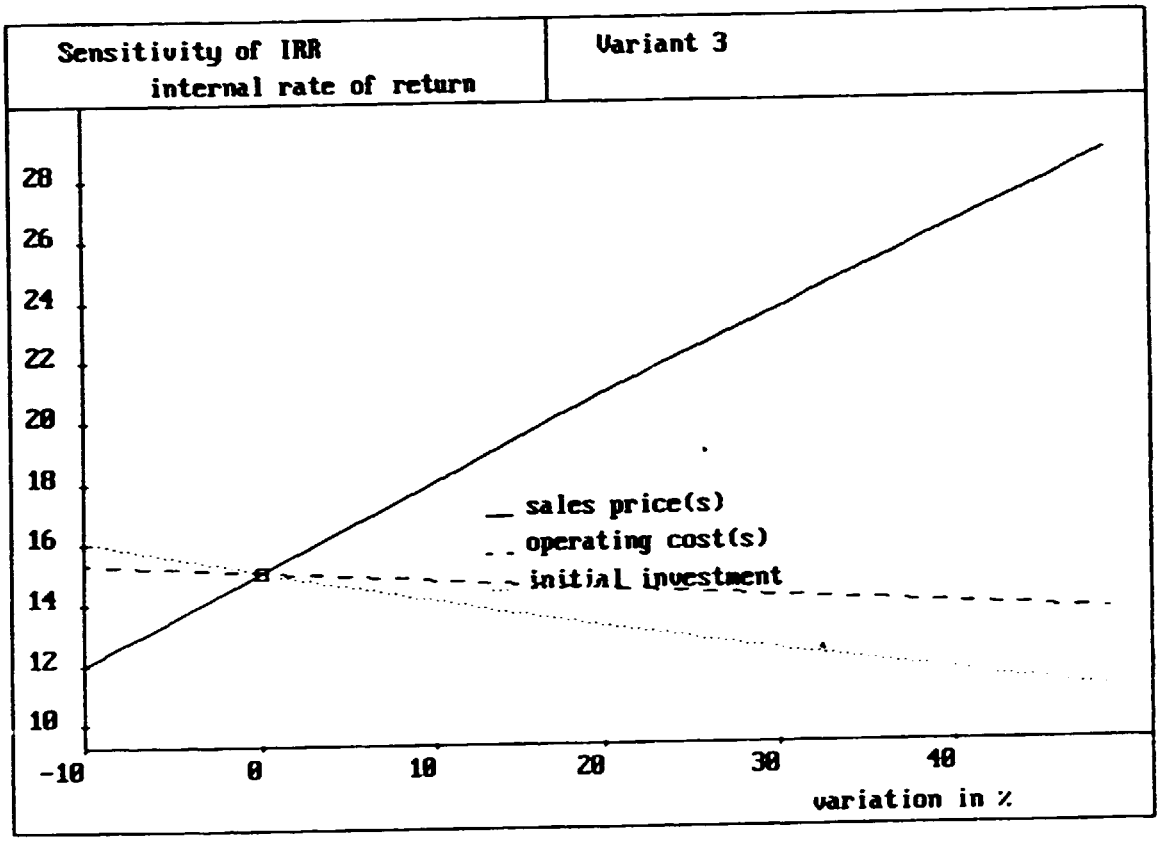
Year	1995	1996	1997	1998	1999	2000
Equity, ordinary ..	0.000	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local....	228354.000	-64890.810	-71379.890	-78517.880	-86369.670	-95006.750
Loan B, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	228354.000	-64890.810	-71379.890	-78517.880	-86369.670	-95006.750
Current liabilities	11.000	14.810	0.000	0.000	0.000	0.000
Bank overdraft	0.000	19326.440	30374.530	33586.630	37119.940	41006.670
Total funds	228365.000	-45549.570	-41005.360	-44931.260	-49249.730	-54000.080

Source of Finance, production in THOUSAND RUPEES

Year	2001- 2	2003
Equity, ordinary ..	0.000	0.000
Equity, preference.	0.000	0.000
Subsidies, grants .	0.000	0.000
Loan A, foreign .	0.000	0.000
Loan B, foreign..	0.000	0.000
Loan C, foreign .	0.000	0.000
Loan A, local....	0.000	0.000
Loan B, local....	0.000	0.000
Loan C, local....	0.000	0.000
Total loan	0.000	0.000
Current liabilities	0.000	0.000
Bank overdraft	-59225.430	-42963.340
Total funds	-59225.430	-42963.340


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


Annual flow of funds (finance)
Variant 3
10^5 THOUSAND RUPEES
local funds
foreign funds
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Start up
year


Sensitivity of IRR
internal rate of return
Variant 3
28
26
24
22
20
18
16
14
12
10
-10
0
10
20
30
40
variation in %
sales price(s)
operating cost(s)
initial investment

Data sheet, other input data and results
Variant 4

Table IX Data sheet for COMFAR evaluation
Investment costs in thousand rupees
Variant 3 and 4
Construction period 2 years

Sl	Item	Construction period in years		
		1	2	Total
1	Civil Structures	49720.0		49720.0
2	Incorporated fixed assets construction.transport	18583.0	30441.0	49024.0
3	Incorporated fixed assets technology,training , spare parts	2962.0	5922.0	8884.0
4	Incorporated fixed assets others.studies,detailed engineering,supervision construction management commissioning	7260.0	9225.0	16485.0
5	Plant equipment & machinery	74030.0	148138.0	222168.0
6	Preproduction expenditures interest during construction	15256.0	34628.0	49884.0
	Total	167811.0	228354.0	396165.0

Production in the second year of construction	500.0 t
Production from the second year of production	4108.4 t/year

Results of COMFAR evaluation are included in the tables and graphs on pages 88-103.

Main economic indices summarized from the tables:

Internal rate of return (IRR)	27.01%
Net present value (NPV)	423874.80 * 10^3 Rs.
Cumulated net cashflow (CNF) (in the 15 th year)	1132127.00 * 10^3 Rs.
Accumulated undistributed profit (in the 15 th year)	1129100.00 * 10^3 Rs.
Net profit . % of sales	52.223
Pay-back : accumulated net cashflow turns positive after the year	4

Sensitivity of IRR relating to sales price, operating cost and investment cost is shown in the COMFAR graph (page 103).

COMFAR 2.1 UNIDO

MODERNIZATION OF BALCO SMELTER
MAR. 1993
VARIANT 4

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: THOUSAND RUPEES

Total initial investment during construction phase

fixed assets:	167811.00	0.000 % foreign
current assets:	0.00	0.000 % foreign
total assets:	167811.00	0.000 % foreign

Source of funds during construction phase

equity & grants:	0.00	0.000 % foreign
foreign loans :	0.00	
local loans :	167811.00	
total funds :	167811.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	1130.82	9291.74	9291.74
depreciation :	12375.00	27188.80	27188.80
interest :	28198.80	39616.50	33127.42
production costs	41704.63	76097.05	69607.97
thereof foreign	0.00 %	0.00 %	0.00 %
total sales :	22400.00	184056.30	184056.30
gross income :	-19304.63	107959.30	114448.30
net income :	-19304.63	59377.59	62946.59
cash balance :	-6939.05	21607.56	18755.50
net cashflow :	-207094.30	126114.90	123262.80

Net Present Value at: 10.00 % = 423874.80
Internal Rate of Return: 27.01 %
Return on equity1: not found
Return on equity2: not found

Index of Schedules produced by COMFAR

Total Initial Investment in THOUSAND RUPEES

Year	1994
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	49720.000
Auxiliary and service facilities	0.000
Incorporated fixed assets	28805.000
Plant machinery and equipment	74030.000
Total fixed investment costs	152555.000
Pre-production capital expenditures.	15256.000
Net working capital	0.000
Total initial investment costs	167811.000
Of it foreign, in %	0.000

Total Current Investment in THOUSAND RUPEES

Year	1995	1996
Fixed investment costs		
Land, site preparation, development	0.000	0.000
Buildings and civil works	0.000	0.000
Auxiliary and service facilities	0.000	0.000
Incorporated fixed assets	45588.000	0.000
Plant, machinery and equipment	148138.000	0.000
Total fixed investment costs	193726.000	0.000
Preproduction capitals expenditures.	34628.000	0.000
Working capital	9.424	68.008
Total current investment costs	228363.400	68.008
Of it foreign, %	0.000	0.000

Cashflow Tables, construction in THOUSAND RUPEES

Year	1994
Total cash inflow . .	167811.000
Financial resources .	167811.000
Sales, net of tax . .	0.000
Total cash outflow . .	167811.000
Total assets	167811.000
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	167811.000
Outflow, local	167811.000
Surplus (deficit) .	0.000
Inflow, foreign . . .	0.000
Outflow, foreign . . .	0.000
Surplus (deficit) .	0.000
Net cashflow	-167811.000
Cumulated net cashflow	-167811.000

Cashflow tables, production in THOUSAND RUPEES

Year	1995	1996	1997	1998	1999	2000
Total cash inflow	250757.100	184079.000	184056.300	184056.300	184056.300	184056.300
Financial resources	228357.100	22.669	0.000	0.000	0.000	0.000
Sales, net of tax	22400.000	184056.300	184056.300	184056.300	184056.300	184056.300
Total cash outflow	257696.200	162471.400	165300.800	168512.900	172046.200	175933.000
Total assets	228366.600	90.677	0.000	0.000	0.000	0.000
Operating costs	1130.822	9291.750	9291.750	9291.750	9291.750	9291.750
Cost of finance	28198.800	39616.500	33127.420	25989.430	18137.640	9500.674
Repayment	0.000	64890.810	71379.890	78517.880	86369.670	95006.750
Corporate tax	0.000	48581.670	51501.750	54713.850	58247.160	62133.790
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	-6939.047	21607.580	18755.500	15543.410	12010.090	8123.344
Cumulated cash balance	-6939.047	14668.530	33424.030	48967.440	60977.530	69100.880
Inflow, local	250757.100	184079.000	184056.300	184056.300	184056.300	184056.300
Outflow, local	257696.200	162471.400	165300.800	168512.900	172046.200	175933.000
Surplus (deficit)	-6939.047	21607.580	18755.500	15543.410	12010.090	8123.344
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	-207094.300	126114.900	123262.800	120050.700	116517.400	112630.800
Cumulated net cashflow	-374905.300	-248790.400	-125527.500	-5476.836	111040.600	223671.300

Cashflow tables, production in THOUSAND RUPEES

Year	2001	2002	2003	2004	2005	2006
Total cash inflow	184056.300	184056.300	184056.300	184056.300	184056.300	184056.300
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	184056.300	184056.300	184056.300	184056.300	184056.300	184056.300
Total cash outflow	75700.840	75700.840	75700.840	81269.590	87935.810	87935.800
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs	9291.750	9291.750	9291.750	9291.750	9291.750	9291.750
Cost of finance	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax	66409.090	66409.090	66409.090	71977.840	78644.060	78644.050
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	108355.500	108355.500	108355.500	102786.700	96120.500	96120.510
Cumulated cash balance	177456.300	285811.800	394167.300	496954.000	593074.500	689195.000
Inflow, local	184056.300	184056.300	184056.300	184056.300	184056.300	184056.300
Outflow, local	75700.840	75700.840	75700.840	81269.590	87935.810	87935.800
Surplus (deficit)	108355.500	108355.500	108355.500	102786.700	96120.500	96120.510
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	108355.500	108355.500	108355.500	102786.700	96120.500	96120.510
Cumulated net cashflow	332026.800	440382.300	548737.800	651524.500	747645.000	843765.500

Cashflow tables, production in THOUSAND RUPEES

Year	2007	2008	2009
Total cash inflow . .	184056.300	184056.300	184056.300
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	184056.300	184056.300	184056.300
Total cash outflow . .	87935.800	87935.800	87935.800
Total assets	0.000	0.000	0.000
Operating costs . . .	9291.750	9291.750	9291.750
Cost of finance . . .	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax . . .	78644.050	78644.050	78644.050
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	96120.510	96120.510	96120.510
Cumulated cash balance	785315.500	881436.000	977556.500
Inflow, local	184056.300	184056.300	184056.300
Outflow, local	87935.800	87935.800	87935.800
Surplus (deficit) .	96120.510	96120.510	96120.510
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	96120.510	96120.510	96120.510
Cumulated net cashflow	939886.000	1036007.000	1132127.000

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	499898.30	at	10.00 %
Internal Rate of Return (IRRE1) ..	not found		

b) Net Worth versus Net cash return:

Net present value	413495.20	at	10.00 %
Internal Rate of Return (IRRE2) ..	not found		

c) Internal Rate of Return on total investment:

Net present value	423874.80	at	10.00 %
Internal Rate of Return (IRR) ..	27.01 %		

Net Worth = Equity paid plus reserves

Net Income Statement in THOUSAND RUPEES

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	22400.000	184056.300	184056.300	184056.300	184056.300
Less: variable costs, incl. sales tax.	1130.823	9291.744	9291.744	9291.744	9291.744
Variable margin	21269.180	174764.600	174764.600	174764.600	174764.600
As % of total sales	94.952	94.952	94.952	94.952	94.952
Non-variable costs, incl. depreciation	12375.000	27188.800	27188.810	27188.800	27188.800
Operational margin	8894.178	147575.800	147575.800	147575.800	147575.800
As % of total sales	39.706	80.180	80.180	80.180	80.180
Cost of finance	28198.800	39616.500	33127.420	25989.430	18137.640
Gross profit	-19304.630	107959.300	114448.300	121586.300	129438.100
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-19304.630	107959.300	114448.300	121586.300	129438.100
Tax	0.000	48581.670	51501.750	54713.850	58247.160
Net profit	-19304.630	59377.590	62946.590	66872.480	71190.970
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-19304.630	59377.590	62946.590	66872.480	71190.970
Accumulated undistributed profit	-19304.630	40072.970	103019.600	169892.000	241083.000
Gross profit, % of total sales	-86.181	58.656	62.181	66.059	70.325
Net profit, % of total sales	-86.181	32.261	34.200	36.333	38.679
RE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
RI, Net profit+interest, % of invest.	2.245	24.983	24.246	23.436	22.544

Net Income Statement in THOUSAND RUPEES

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	184056.300	184056.300	184056.300	184056.300	134056.300
Less: variable costs, incl. sales tax.	9291.744	9291.744	9291.744	9291.744	9291.744
Variable margin	174764.600	174764.600	174764.600	174764.600	174764.600
As % of total sales	94.952	94.952	94.952	94.952	94.952
Non-variable costs, incl. depreciation	27188.800	27188.800	27188.800	27188.800	14813.810
Operational margin	147575.800	147575.800	147575.800	147575.800	159950.800
As % of total sales	80.180	80.180	80.180	80.180	86.903
Cost of finance	9500.674	0.000	0.000	0.000	0.000
Gross profit	138075.100	147575.800	147575.800	147575.800	159950.800
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	138075.100	147575.800	147575.800	147575.800	159950.800
Tax	62133.790	66409.090	66409.090	66409.090	71977.840
Net profit	75941.300	81166.670	81166.670	81166.670	87972.910
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	75941.300	81166.670	81166.670	81166.670	87972.910
Accumulated undistributed profit	317024.300	398191.000	479357.700	560524.400	648497.300
Gross profit, % of total sales	75.018	80.180	80.180	80.180	86.903
Net profit, % of total sales	41.260	44.099	44.099	44.099	47.797
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	21.563	20.484	20.484	20.484	22.202

Net Income Statement in THOUSAND RUPEES

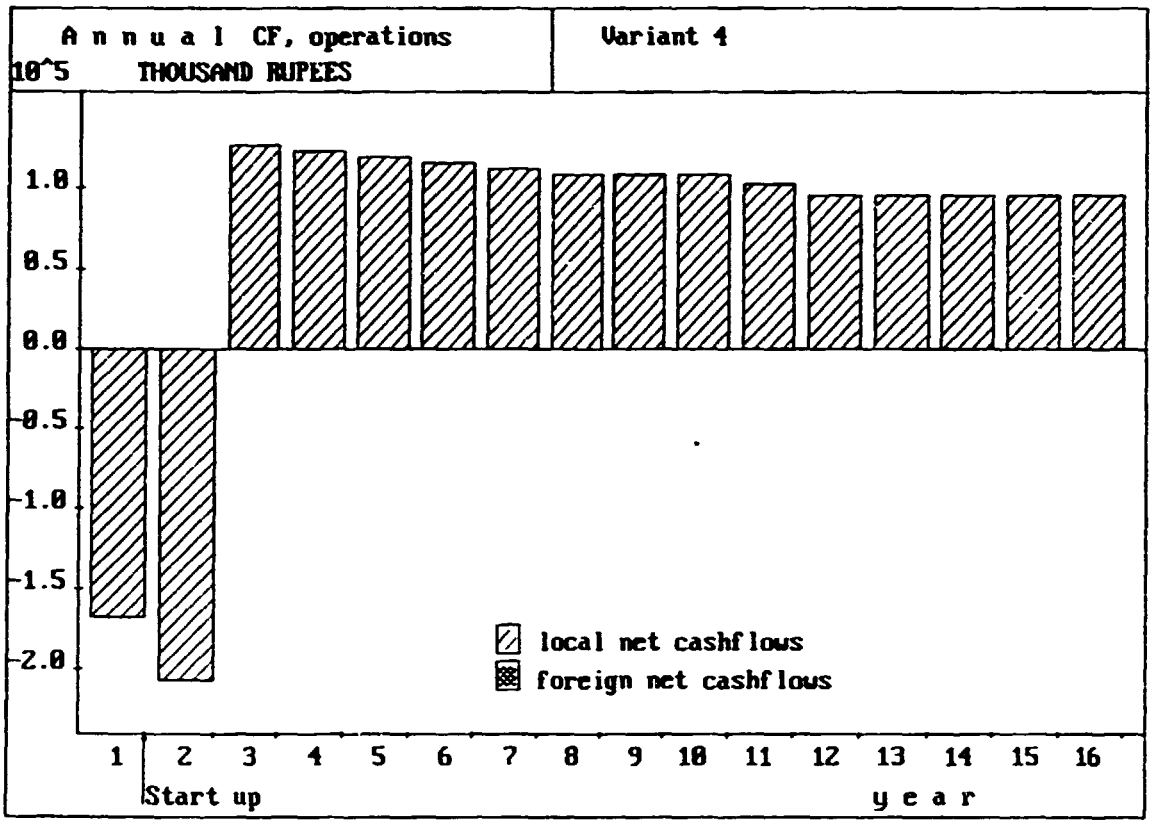
Year	2005	2006	2007	2008	2009
Total sales, incl. sales tax	184056.300	184056.300	184056.300	184056.300	184056.300
Less: variable costs, incl. sales tax.	9291.744	9291.744	9291.744	9291.744	9291.744
Variable margin	174764.600	174764.600	174764.600	174764.600	174764.600
As % of total sales	94.952	94.952	94.952	94.952	94.952
Non-variable costs, incl. depreciation	-0.003	0.000	0.000	0.000	0.000
Operational margin	174764.600	174764.600	174764.600	174764.600	174764.600
As % of total sales	94.952	94.952	94.952	94.952	94.952
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	174764.600	174764.600	174764.600	174764.600	174764.600
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	174764.600	174764.600	174764.600	174764.600	174764.600
Tax	78644.060	78644.050	78644.050	78644.050	78644.050
Net profit	96120.520	96120.510	96120.510	96120.510	96120.510
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	96120.520	96120.510	96120.510	96120.510	96120.510
Accumulated undistributed profit	744617.800	840738.300	936858.800	1032979.000	1129100.000
Gross profit, % of total sales	94.952	94.952	94.952	94.952	94.952
Net profit, % of total sales	52.223	52.223	52.223	52.223	52.223
ROE, Net profit, % of equity	0.000	0.000	0.000	0.000	0.000
ROI, Net profit+interest, % of invest.	24.258	24.258	24.258	24.258	24.258

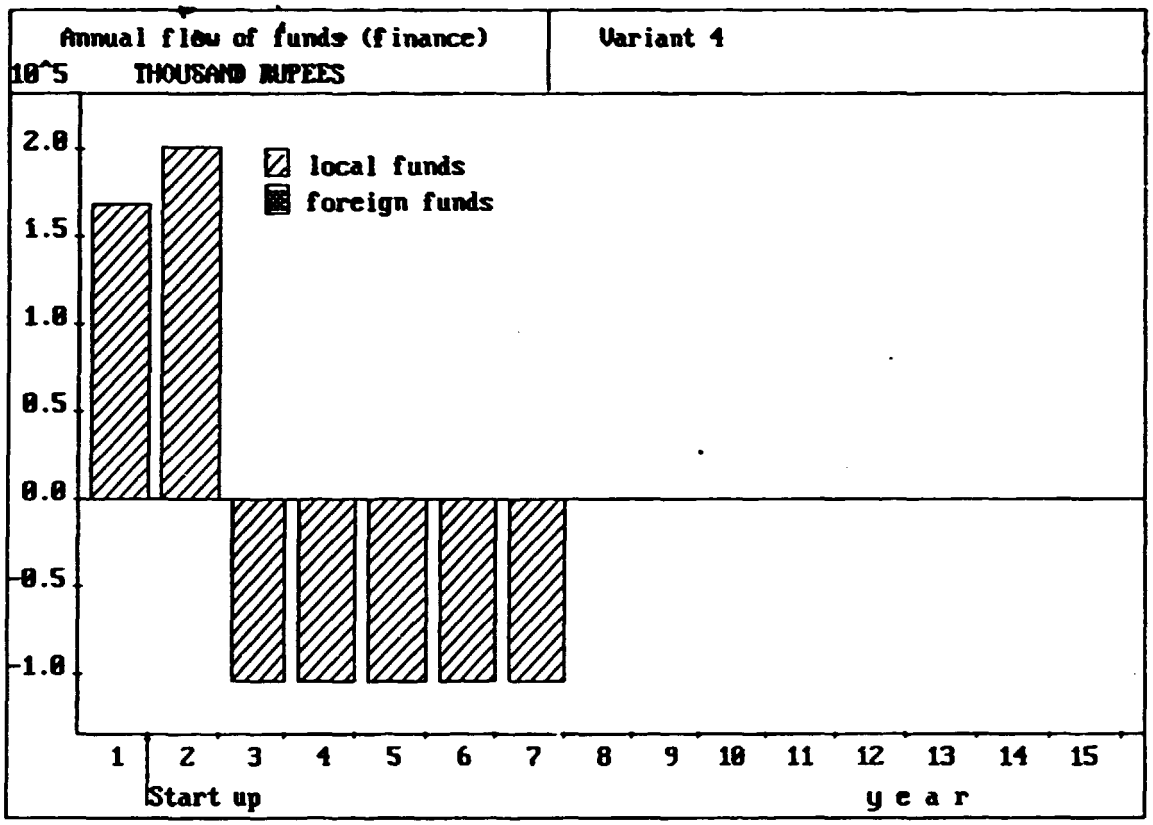
Source of Finance, construction in THOUSAND RUPEES

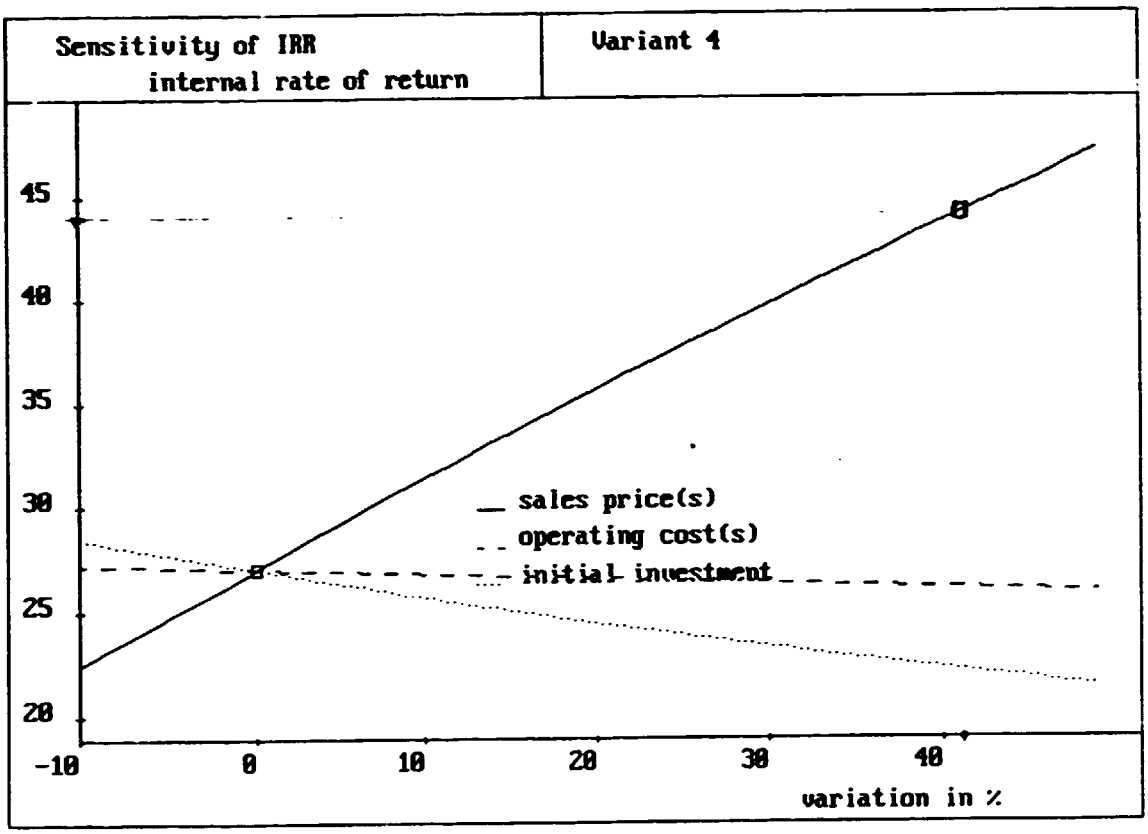
Year	199%
Equity, ordinary ..	0.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	0.000
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	167811.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	167811.000
Current liabilities	0.000
Bank overdraft	0.000
Total funds	167811.000

Source of Finance, production in THOUSAND RUPEES

Year	1995	1996	1997	1998	1999	2000
Equity, ordinary ..	0.000	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local....	228354.000	-64890.810	-71379.890	-78517.880	-86369.670	-95006.750
Loan B, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	228354.000	-64890.810	-71379.890	-78517.880	-86369.670	-95006.750
Current liabilities	3.141	22.669	0.000	0.000	0.000	0.000
Bank overdraft	6939.031	-6939.031	0.000	0.000	0.000	0.000
Total funds	235296.200	-71807.170	-71379.890	-78517.880	-86369.670	-95006.750


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


Annual flow of funds (finance)
Variant 4
10^5 THOUSAND RUPEES
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
local funds
foreign funds
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Start up
year


Sensitivity of IRR
internal rate of return
Variant 4
45
40
35
30
25
20
sales price(s)
operating cost(s)
initial investment
-10
0
10
20
30
40
variation in %

JAWAHARLAL NEHRU ALUMINIUM RESEARCH DEVELOPMENT AND DESIGN CENTRE NAGPUR

VIABILITY STUDY ON MAXIMUM PERMISSIBLE ENERGY COST FOR ESTABLISHMENT OF A GREENFIELD ALUMINIUM SMELTER PLANT IN INDIA OR IN A NEIGHBOURING COUNTRY

Preparation of this case study has been a part of the training programme for setting up engineering activities at the Centre

Prepared by the experts of JNARDDC
with the guidance of Dr. M. KELENYI
UNIDO consultant

APRIL 1993

Participants in preparing the study :

U.B. AGRAWAL (electrolysis process)
Coordinating the work of JNARDDC team and assisting in running the COMFAR

G.S. SENGAR (electrolysis process)
A. AGNIHOTRI (electrolysis process)
A.K. BASU (electrolysis process)
S. DAS GUPTA (electrolysis process)
K.G. DESHPANDE (electrolysis process)

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I. EXECUTIVE SUMMARY

India and Bangladesh have a significant resources of natural gas at the Bangladesh/Tripura border. Electric power being one of the main inputs for the production of primary aluminium metal, establishment of an aluminium smelter plant provides a ready means for utilizing part of the idle energy by exporting electric energy in the form of aluminium metal.

This study has been prepared to find out the price limit for electrical energy generated from natural gas to justify profitability of the investment for a new aluminium smelter with presently existing prices for raw materials in India used for calculation of production costs while investment costs were taken similar to those of other - not industrial- areas in the world.

At present aluminium metal is in excess supply. According to the forecasts, by 1995 the world consumption is expected to reach the figure of 16.715 million tons, while the western production at 97.8 % capacity utilization would be 15.956 million tons.

Thus a slow recovery of prices can also be expected, reaching the price of 2315 US $/t by 1997, the earliest date when a new smelter can come on stream if construction started in 1994.

Raw materials and utilities were taken into consideration in quantities needed for a reduction plant of 125000 t/year capacity. Data for prices of raw materials and energy were obtained from NALCO and from BALCO statistics.

The site location should be in the vicinity of a sea port. Therefore Bangladesh has been selected for consideration, [illegible] this country is providing the most convenient conditions for the transport requirements of the smelter [illegible] and relatively low infrastructure investment costs.

For calculations of the investment costs a pot type of prebaked anodes, representing a medium level technology with a nominal current of 180 kA has been chosen. Cost estimations include the reduction plant, anode plant, foundry and all the general facilities within the plant. The investment cost figures were taken from a pre-feasibility study made for a similar smelter plant in 1990 and adjusted for matching with the present prices.

Investment costs of the smelter plant within the plant	US $ 658 M
Investment costs for infrastructures	US $ 76 M
Total investment costs without working capital	US $ 734 M
Specific investment cost within the plant	5264 US$/t Al capacity
Specific investment cost including infrastructures	5872 US$/t Al capacity

The implementation period for the whole smelter plant together with infrastructures has been planned to be 36 months. According to the production schedule the first year of operation corresponds to the third year of construction. 100 % production can be reached in the 5th year.

Economic analyses were made by using the UNIDO COMFAR system. In the first approach in Variants 1 - 3 the IRR values have been calculated at the power prices of 26.3 which is the present electricity price at NALCO's Angul smelter, 20, 15, 10 and 5 mills/kWh. In this step 100% equity has been considered to finance the investment, for simplifying the calculations. [illegible] Variant 3 was selected, [illegible]

In Variant 6 foreign equity of 51%, local equity of 20%, foreign loan of 9% with 8% interest, for 12 years, and local loan of 20% with 10% interest, for 12 years have been taken into account.

Results are shown in the COMFAR schedules and graphs. The main indices taken from the schedules:

IRR (Internal rate of return on total investment, overall profitability index or interest rate of return) 14.29%

NPV (Net present value at 10% discount rate, the annual net cashflows discounted yearly to the date of beginning the project construction) US $ 188.45 M

Pay-back:(from the first year of operation) 5 years

A sensitivity analysis has also been made using the COMFAR GRAFIX MODULE regarding the IRR (see page 64 of this study). The results show that the IRR is most sensitive to the sale price. A 10% increase leads to an IRR of about 18% and 10% decrease to an IRR of about 10%, which is unacceptable. As to the variables of operational costs and initial investment costs, 10% increase corresponds to IRR figures of about 12-13%, while decrease in the same variables results in an IRR of 16%.

Finally (in Variant 7) has also been examined, how the profitability would change if the metal price increased by 10% and this increase used for buying electrical energy at a higher price.

As it is shown in the summary sheets at a metal price of US $ 2546/t and an energy price of 30 mills/kWh the main profitability indices of Variant 6 and Variant 7 are:

IRR in Variant 6	14.29 %
IRR in Variant 7	14.49 %
NPV in Variant 6	US $ 188.45 M
NPV in Variant 7	US $ 197.62 M

In the meantime as graphs of the structure of production costs show, percentage of energy cost in the total production costs increases from 14.41 % to 25.18 % (see graphs on pages 63 and 66).
The analysis shows, that if the metal price were 10 % higher than according to the forecast expected, the upper limit for price of power would be 30 mills/kWh.
As in the selected base case (Variant 6) the NPV is positive and the IRR is higher than the 10 % discount rate, it can not be stated, that the project has to be dropped, but the establishment of the smelter at the moment can not be attractive for the investors.
Nevertheless it could be useful if accurate data as well as other possibilities for the utilization of natural gas resources of India/Bangladesh were examined. This way the relative ranking of the different utilization projects could be worked out.

THE MAIN FINDINGS OF THE PRESENT STUDY ARE THE FOLLOWING :

Using the present Indian raw material prices in the calculations, we can reach a minimal profitability limit only if the metal price is not less than US $ 2315/t Al and the maximum energy price is 15 mills/kWh.
If the metal price could move up 10% higher, energy price could also be raised to 30 mills/kWh, but in this case the surplus profit realized in the selling price of the metal would be consumed by the increased production costs.

II. PROJECT BACKGROUND AND BASIC IDEA

Bangladesh and India have a significant resource of natural gas in the vicinity of the Bangladesh/Tripura border.

One of the possibilities to utilize this energy. source is to convert it to electric power for supplying energy to industrial and other consumers.

Electric power being one of the inputs for the production of primary aluminium metal establishing an aluminium reduction plant provides a ready means for utilizing part of the energy by exporting electric energy in the form of aluminium metal. This gave the basic idea for preparing an analysis to find out how much could be the price of the electric energy generated from the natural gas available in the gas fields mentioned above, to justify profitability of establishment of a new aluminium smelter, if raw material prices existing at present in India used in the calculations relating the project and investment costs were the same as in case of establishing the smelter plant in other undeveloped, not industrial areas in the world.

This kind of analysis if the economic indices were advantageous could serve as a basis for discussions with potential partners who are also able for supplying technology and smelter design construction and organizing finance for the investment.

III MARKET SITUATION AND PLANT CAPACITY

Aluminium supply - demand

At present, aluminium metal is in excess supply. A forecast of supply-demand is given in the table below :

Table I : World aluminium supply-demand forecast

Units : 10^6 tons

Years	1992	1993	1994	1995
Consumption	14656	15607	16199	16715
Capacity	15537	15908	16081	16312
Utilization %	93.3	90.0	95.1	97.8
Production	14488	14310	15295	15956
Net eastern (earlier socialist) export	.758	.534	.395	.243
Balance	.591	-.764	-.508	-.516
IPAI and market stocks	3069	2838	2115	1587

The CIS (earlier Soviet) exports continue at a high rate, but are likely to fall back before long, in the face of the country's severe problems.

The tentative smelters are being persued with no great vigour at today's low metal prices. Thus in 1993 and 1994 the supply-demand will gradually tighten.

[illegible] slow recovery in aluminium prices can be expected [illegible] and in the medium term prices can't stay where they are today.

[illegible] forecast, prices should average [illegible] 2100 US $/t in [illegible]. [illegible] aluminium Report[illegible]

If after 1995 a slow rise of 5% per year considered, by 1997 - the earliest when a smelter like this dealt with in the present study can come on stream- an aluminium price of 2315 US $/t could be expected.

For calculation purposes 2315 US $/t aluminium price has been choosen in the present study.

Capacity and product mix

The estimation of investment costs of a 125000 t/year capacity aluminium smelter was based on the product mix as follows :

Ingots, slabs & billets	120000 t/year
Wire rods	5000 t/year
Total	125000 t/year

The products can be cast in standard sizes and transported as well as sold on all markets easily - if aluminium market conditions are adventageous.

IV RAW MATERIALS AND SUPPLIES

Raw Materials

In the tables below quantities and costs of main raw materials and utilities needed for the operation of an aluminium smelter of 125000 t/year capacity are shown.

Prices for annual cost calculation were given by NALCO and represent their effective figures in March 1993, except prices of water and compressed air which were taken from BALCO statistics.

Exchange rate used : 1 US$ = 30 Rs.

Table II : Raw material consumption (at 100% capacity)

Material	Specific consumption kg/t Al	Quantity t/year	Price US$/t	Annual cost 10^6 US$
Alumina	1945	24312	158	38.41
Al fluoride	12	1500	1290	1.94
Calcined pet. coke	405	50625	323	16.35
Coal tar pitch	110	13750	483	6.64
Metallurgical coke	24	3000	200	0.6
Cast iron	6	750	108	0.08
	Total	312750		64.02

Utilities

Table III Utilities consumption (at 100% capacity)

Energy	Specific consumption kg/t Al	Quantity 10^3 units/year	Price US$/unit	Annual cost US$
Electric power	14228 kWh	1781 MWh	0.0288	50885300
Heat fuel oil	50 l	6.25 l	0.171	1068750
Water	20 m³	2.5 m³	0.01	25000
Compressed air	330 m³	41.3 m³	0.01	413000
			Total	52317050

V LOCATION AND SITE

Site location

The site of the smelter should be located in the vicinity of a seaport in Bangladesh, providing the most convenient conditions including relatively low infrastructure costs for the aluminium smelter. For infrastructure development provisions have been envisaged as under :

1. The seaport has to be able for receiving ships up to the capacity of 30000 tonnes. One wharf of the port will be part- time utilize' transporting raw materials to and metal from the smelter. The needed investment is the installation of a loading - unloading equipment

2. To connect the smelter to the supplying power station - which is probably located closer to the natural gas fields than to the seaport - costs for construction of overhead lines and a step down transformer station have to be foreseen

3. Costs of an intermediate storage at the seaport, camp for construction, road connections to the smelter as well as a township also has been envisaged when calculating the infrastructure costs.

Infrastructure costs

In the table below costs of infrastructure are shown.

Table IV. Infrastructure investment costs

10^6 US $

Item	f Equipment	l Civil	Total
Electric overhead lines and substation	25.2	11.0	36.2
Port handling facilities	13.9	0.3	14.2
Intermediate storage	9.2	0.3	9.5
Camp for construction	-	0.3	0.3
Connection to smelter	-	1.3	1.3
Township	-	7.5	7.5
Subtotal	48.3	20.7	69.0
Contingencies	4.8	2.2	7.0
Total	53.1	22.9	76.0

f = Foreign, all the equipment

l = Local, all the civil works

Specific investment cost/t Al capacity including infrastructure 5672 US $

VI ENGINEERING AND TECHNOLOGY

Applied technology

Aluminium metal, is produced according to the Hall-Heroult process. Considering the size of the plant under evaluation a pot type of the prebaked anodes, representing a good medium level technology with a nominal current intensity of 180 kA has been choosen for the calculations of the present study.

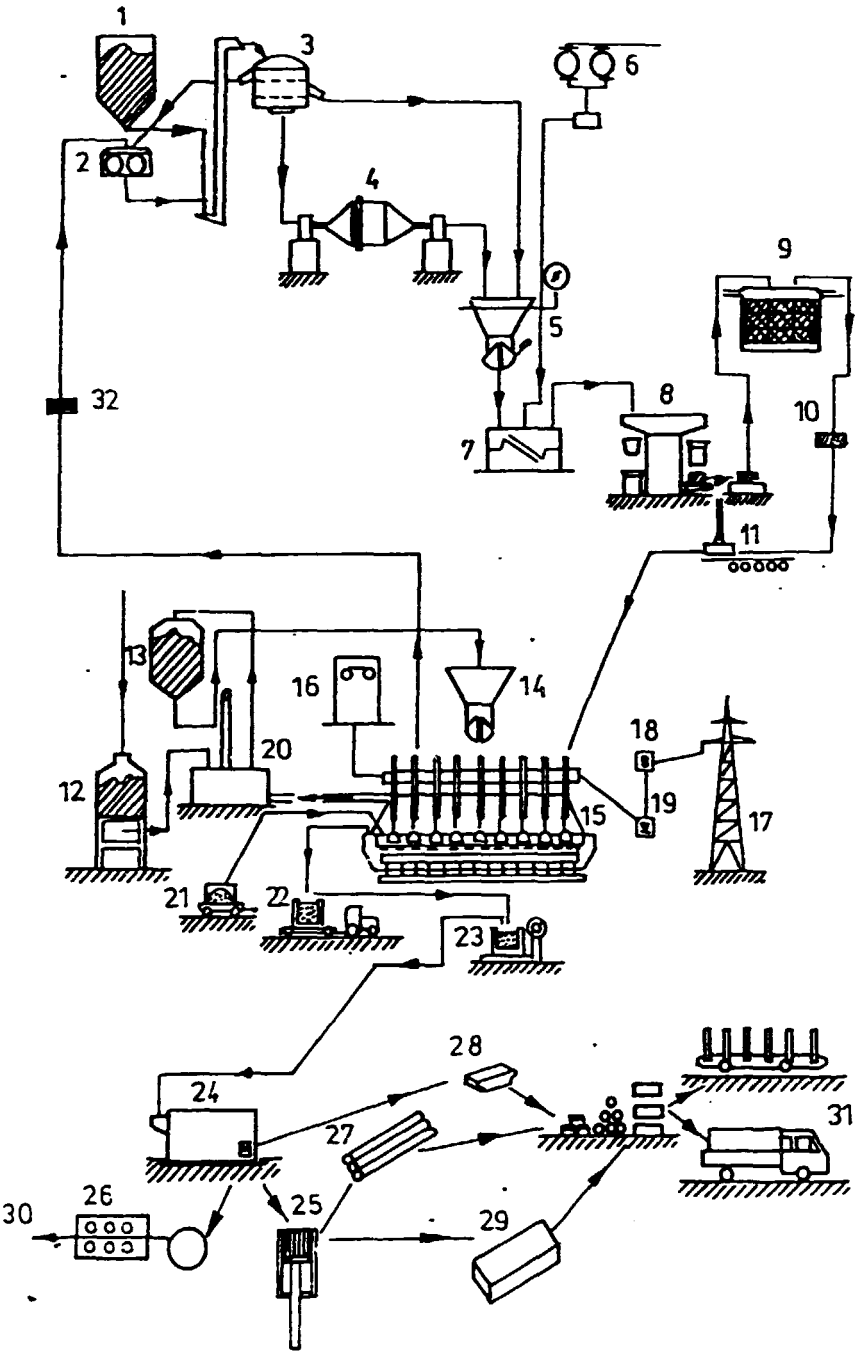
A simplfied process flow sheet is shown in Figure 1.

Other basic data on the smelter plant

Reduction plant	
Pot voltage	4,2 V
Current efficiency	93 %
Alumina consumption	1945 kg/t Al
Aluminium fluoride consumption	12 kg/t Al
Gross anode consumption	563 kg/t Al
Net anode consumption	435 kg/t Al
Electric energy consumption	13458 kWh/t Al D.C.
Production/pot	491,29 t/year
Number of pots	360
Number of potlines	2

Anode plant	
[illegible]	435 kg/t Al
[illegible]	118 kg/t Al
[illegible]	14 kg/t Al
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

Simplified process flow-sheet of the aluminium production



1. Petrol coke
2. Crusher
3. Screen
4. Ball mill
5. Weighfeeder
6. Pitch bin
7. Paste mixer
8. Anode forming machine
9. Baking furnace
10. Transport and cooling
11. Anode rodding
12. Fresh alumina
13. Secondary alumina silo
14. Charging bin
15. Pot
16. Computer
17. Electric energy
18. Alternative current
19. Direct current
20. Dry scrubbing system
21. Fluorides
22. Molten metal
23. Weighbridge
24. Holding furnace
25. Vertical casting machine
26. Rod casting machine
27. Slabs
28. Pigs
29. Billets
30. Rods
31. Shipping
32. Anode butts

Figure-I

The aluminium smelter plant incorporates within battery limits the subsectors as follows :

- Electric system and rectifier stations
- Reduction plant
- Foundry
- Anode plant
- Other general facilities such as :
  - Transportation and unloading of raw/auxiliary materials
  - Storage of raw/auxiliary materials and finished products
  - Maintenace workshops
  - Water cooling station
  - Laboratories
  - Locker rooms
  - Canteen
  - Office building
  - Fire station
  - Medical care centre

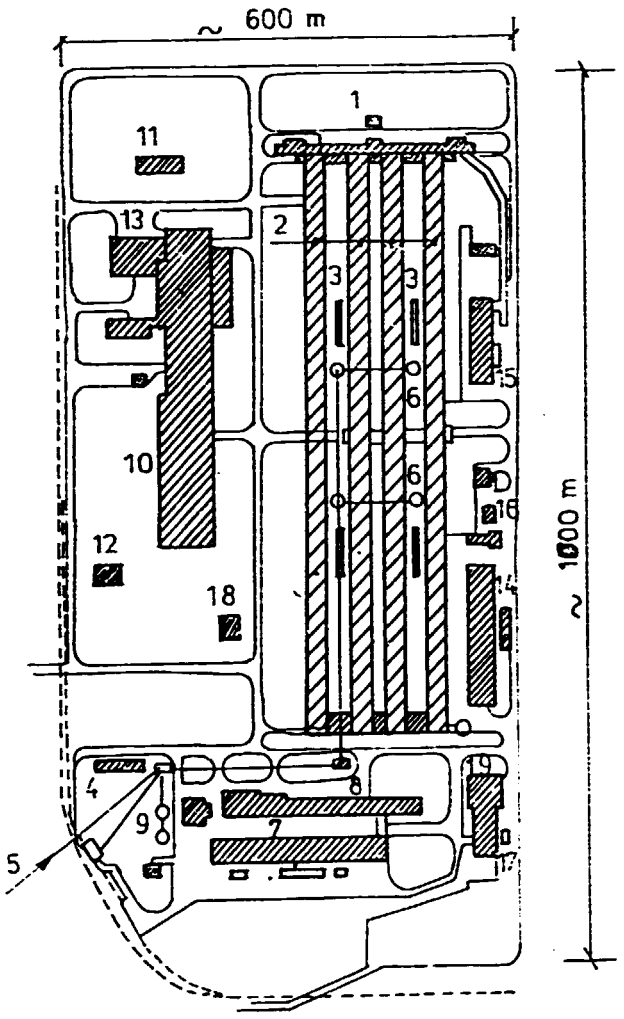
A possible general layout is given in Figure 2.

Pots are arranged side by side and provided with [illegible] breaking and feeding system.

For pot tending operations multipurpose cranes [illegible] for transportation of anodes, molten metal etc. [illegible] equipment have been foreseen. The [illegible] plant is provided with process control system.

[illegible] requirements of environmental control [illegible] to be the same as those applied [illegible] most modern smelters. [illegible] has been foreseen as [illegible] treatment for [illegible] is conveyed to the base [illegible] system.

General layout of an aluminium smelter plant of 125.000 MTPY capacity



1. Electric supply
2. Potrooms
3. Dry scrubbing system
4. Flux storage
5. Alumina transport system
6. Alumina silos
7. Anode baking
8. Anode rodding
9. Petrol coke silos
10. Foundry
11. Water cooling
12. Laboratory
13. Shipping of products
14. Maintenance / repair workshop
15. Pot maintenance workshop
16. Fire guard
17. Gate house
18. Canteen
19. Washer / locker rooms

Figure 2

Estimation of investment costs.

All figures are given in 10^6 US $ valid up to March 1993, basis overnight.

The figures do not include :

- Taxes & duties
- Customs duties
- Cost of land
- Any inflation starting from March 1993
- Financing costs (i.e. estimation is based on cash payment)
- Refer to hypothetical overnight construction (i.e.do not include any cost escalation)

Fixed assets

-	Plant machinery & equipment		
	Production equipment		
	Electric system, piping		
	Process control/instrumentation		
	General utilities	258.0	
-	Civil engineering works		
	site preparation (3,0)		
	Buildings		
	Roads		
	Yards	201.0	
-	Construction	65.0	
	Subtotal	524.0	524.0

Other investment costs		
- Technology fee/know-how, trainingin licensor's smelte	10.5	
- Start up training on site, supervision on start up, assistance to operation, project organization and follow up	10.5	
Subtotal	27.0	27.0
Other assets		
- Spare parts for two years of operation	10.0	
- Contingencies	32.5	
Subtotal	42.5	42.5
- Pre-investment capital expenditures, pre-feasibility, feasibility studies	2.5	
- Detailed engineering, supervision, management, procurement	42.0	
Subtotal	44.5	44.5
Total within battery limits		87.5
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

VII. PLANT ORGANIZATION AND MANPOWER

Plant organization

A sketch of plant organization is given in Figure 3.

Manpower requirements

Manpower requirements have been estimated based on the sketch of Plant Organization shown in Figure 3.

Table V Manning table

	Working area	Expatriates	Local	Total
1	Direct production personnel Reduction, foundry, anode plant	71	623	714
2.	Indirect production personnel (factory overhead) Production & general utilities	32	551	583
3.	Administrative overhead Management, administration, vehicles	13	171	184
4.	Sales	4	22	26
	Total	120	1367	1527

Sketch of Plant Organization

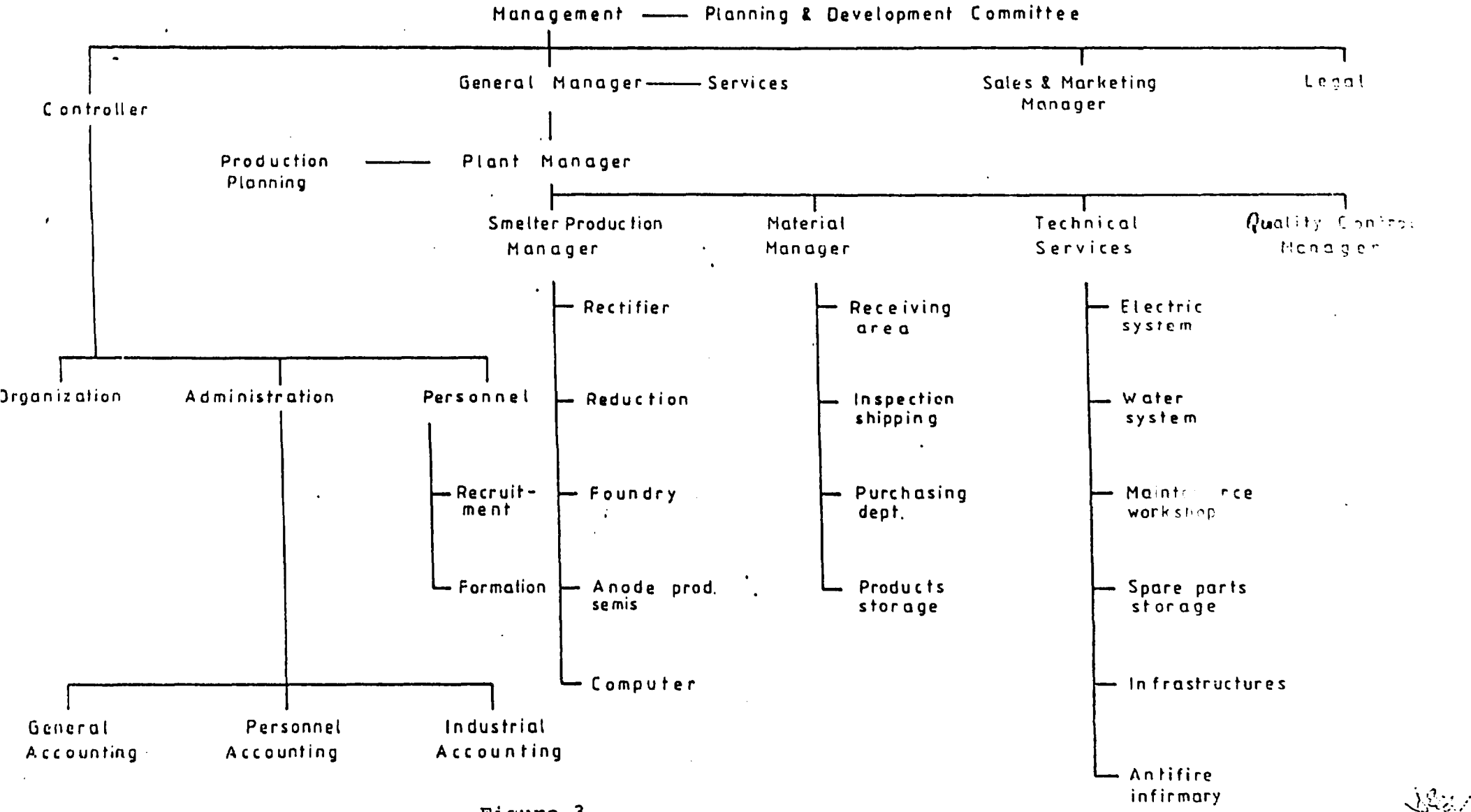


Figure 3

Table VI Break-up of personnel according to qualification

	Direct production	Factory overhead	Aminist Overhead	Sales
Manager	-	5	3	1
Chief/foreman	85	43	3	1
Engineer/ assistant	43	53	22	20
Skilled worker	490	228	50	-
Unskilled worker	96	274	106	4
Total	714	603	184	26

Cost of labour

For estimation of labour costs the following categories of wages and salaries have been considered :

Table VII Categories of wages and salaries

Personnel	Category	Annual average US $
Manager (expatriates)	I.	114,333
Chief/foreman (expatriates)	II.	49,467
Engineer	III.	21.000
Skilled worker	IV	9.333
Unskilled worker	V.	4.667

Direct labour cost

Using the tables above we come to the figures of direct labour costs as follows :

	US $ / Year
f	4204666
l	5924334
Total	10129000

Factory overhead cost

Factory overhead cost includes indirect production personnel labour cost and cost of maintenance and consumables

	f	l	Total US $ per year
Indirect production personnel	2606924	4365908	6972832
Maintenance and consumables	3266667	3266667	6533334
Total	5893591	7632575	13506166

f = foreign

l = local

Administrative overhead cost

Administrative overhead cost includes labour, insurance, office supply etc.

	f	l	Total US $ per year
Administrative personnel	491400	1423333	1914733
Insurance, supply etc	116083	1839600	1955683
Total	607483	3262933	3870416

Sales cost

Sales cost includes labour and other sales expenses

	f	l	Total US $/year
Sales personnel	163800	438667	602467
Other sales cost	290209	290208	580417
Total	454009	728875	1182884

f = foreign

l = Local

VIII. IMPLEMENTATION AND PRODUCTION SCHEDULING

Indicative time schedule for construction

The indicative time schedule of implementation shows the initial and final terms of main activities during the construction period (Figure 4).

The sequence of the events exponed put into evidence the necessity of performing the activities related to the implementation of infrastructures. Implementation of infrastructures is critical for the progress of the activities related to the construction of the smelter. The whole realization time is forecast in 36 months starting from the date of entering into force of the implementation contract.

Production schedule

Matching with the time schedule the productions for the initial years are as follows (first year of operation corresponds to the third year of construction) :

Table VIII Production schedule

Years	t	%
1	-	-
2	-	-
3	37500	30
4	112500	90
5	125000	100

Implementation Schedule
Smelter plant and Infrastructure

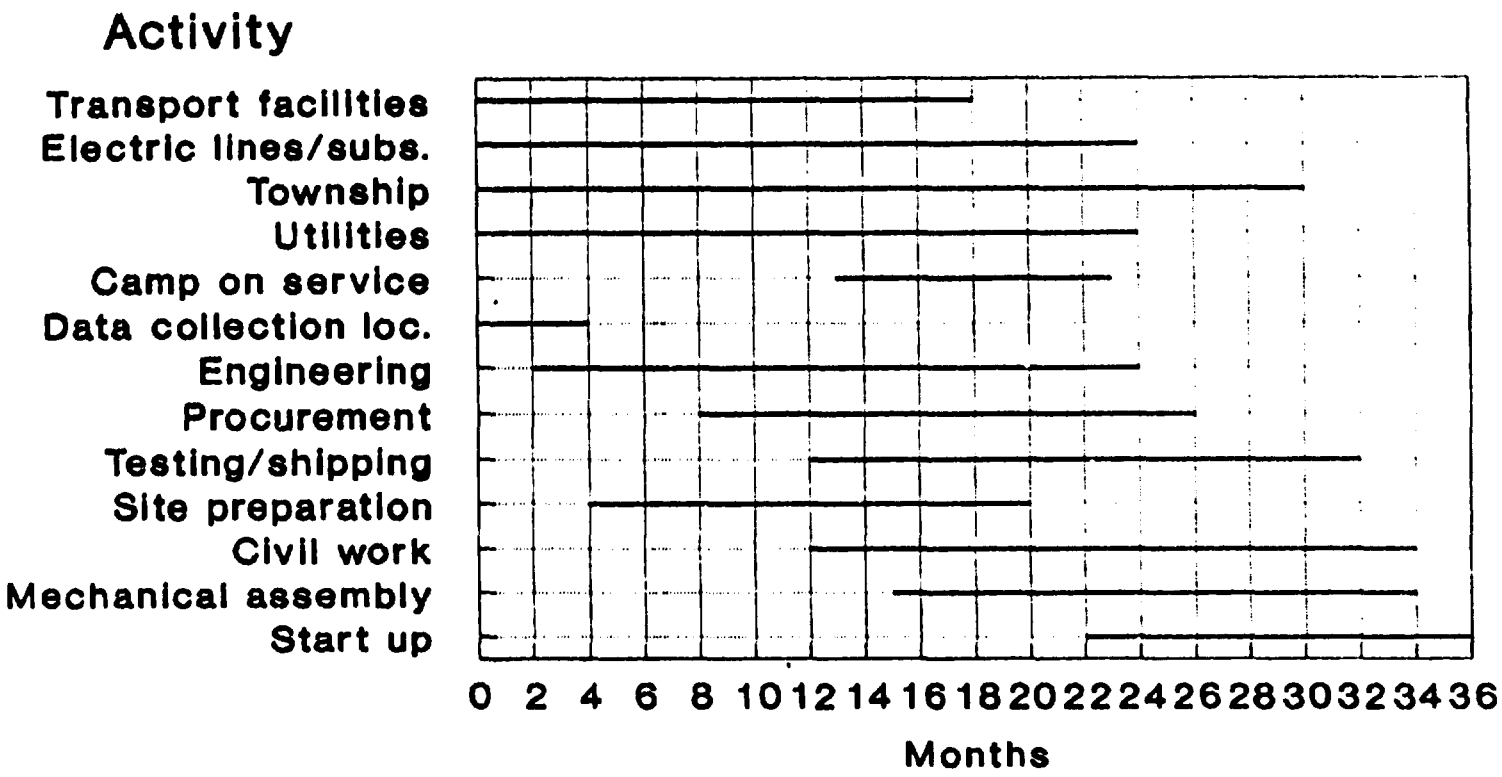


Figure 4
Bar Chart
Indicative Time Schedule

IX. FINANCIAL APPRAISAL

Methodology applied for calculations

Economic analyses were worked out by using the UNIDO COMFAR system.

This system uses the two main discounting methods for the appraisal of investment projects, as far as the evaluation of financial feasibility is concerned : the net present value (NPV) method as well as the internal rate of return (IRR) method.

The net present value is the value obtained by discounting - at a constant interest rate, separately for each year - the difference of all annual cash inflows accrueing throughout the life of the project. The difference is discounted to the point, at which the implementation of the project supposed to start. This discount rate should be equal either to the actual rate of interest on long term loans or the the interest rate (cost of capital) paid by the borrower.

If the NPV is positive, the profitability of the investment is above the discount rate and the project can be considered acceptable - if a sufficient margin of error above zero has been included.

The internal rate of return is the discount rate, at which the present value of cash inflows is equal to the present value of outflows or in other words, the rate at which the present value of the receipts from the project equals the present value of investment, and the NPV is zero.

The investment proposal acceptable, if the IRR is greater than the discount rate (cost of capital plus any margin for risk), which is the lowest acceptable interest rate for the invested capital.

Data sheets for COMFAR evaluation

Data sheet for COMFAR evaluation No. 1

Table IX Investment costs including infrastructure

in 10^6 US $

Construction period 3 years

Item / Years	1	2	3	1-3
Site preparation and development l	3.0	-	-	3.0
Structures and civil engineering l	49.0	80.0	69.0	198.0
Infrastructures civil engineering l	14.00	9.0	-	23.0
Incorporated fixed assets construction, transport l	30.00	20.0	15.0	65.0
Incorporated fixed assets technology, start-up f	8.0	9.0	10.0	27.0
Incorporated fixed assets others f	15.5	25.0	22.0	62.5
Plant machinery & equipment f	65.0	103.0	90.0	258.0
Infrastructure machinery & equipment f	32.0	21.0	-	53.0
Pre-production expenditures f	17.5	15.0	12.0	44.5
Total	234.0	282.0	218.0	734.0
%	32.0	38.0	30.0	100.

f = foreign

l = local

Data Sheet for COMFAR evaluation No. 2

Table X Operating costs excluding return on capital

in 10^6 US $

Item	f	l	Total	%
Direct material (raw materials)	64.0	-	64.0	44
Direct labour	4.2	5.9	10.1	7
Utilities without power	1.1	0.5	1.6	
Power	50.7	-	50.7	35
Factory overhead				9
1 Labour	2.6	4.4	7.0	
2. Maintenance	3.3	3.3	6.6	
Administrative overhead				3
1. Labour	0.5	1.4	1.9	
2. Insurance, supplies etc.	0.1	1.9	2.0	
Sales				1
1. Labour	0.2	0.4	0.6	
2. Other	0.3	0.3	0.6	
Total	127.0	18.1	145.1	100

Specific operating cost: 1160.1 US $/t Al

f = foreign

l = local

Data Sheet for COMFAR evaluation No. 3

Table XI Working capital requirements

(requirements in days)

Item		Requirement
Raw materials	f	40
Utilities	f	30
Spares	f	180
Finished products	f	20
Accounts receivable	f	30
Cash in hand	f	10
	l	5
Work in progress	l	10
Accounts payable	f	25
	l	5

Steps of the evaluation, financial structure and results

To approach the problem, in the first step in Variants 1-5 the IRR values have been calculated at the power prices of 28,3 (which is the present electricity price at NALCO's Angul smelter), 20,15,10 and 5 mills.

In this step 100% equity has been considered to finance the investment.

For further examination Variant 3 was selected, being the price of 15 mills closer to the reality in case of a gas resource based power generation.

In the second step, during the evaluation of Variant 6, data of Variant 3 have been used with a financial structure as follows :

Foreign equity : 51% (share of a foreign joint venture partner)

Local equity : 20%

Long - terms loans for 12 years :

Foreign 9%, at 8% interest on loan

Local 20%, at 10% interest on loan

2 years of grace period, 5 years of tax holiday as well as 45% income tax have been taken into account in the calculations.

Results of evaluation are included in the COMFAR schedules and graphs. Main results taken from the schedules:

Discounted cashflow rates:	
IRR (Internal rate of return on total investment)	14.29%
IRRE1 (Total equity versus net income)	10.31%
IRRE2 (Net worth versus net cash return)	16.18%
NPV (Net present value at 10% discount rate)	188.45 mUS $
Cumulated net cashflow (in the 16th year of operation)	977.08 mUS $
Net Income Statement (in the 10th year of operation)	
Gross profit % of sales	46.63%
Net profit % of sales	25.10%
Pay-back : the cumulated cashflow turns to positive in the year of operation	5

The study relies on aggregate estimations and cost data were taken from comparable existing and planned projects and not from quotations of technology and equipment suppliers.
There are also uncertainties in the forecast of the price of aluminium metal.
Production costs were taken from statistics of smelter plants existing in India.
Therefore a sensitivity analysis has been made using the COMFAR GRAFIX MODULE , regarding the most important profitability index , the IRR , taking into consideration sales price , operating costs and initial investment as variable parameters.

The results show that the IRR most sensitive with respect to the sales price. A 10 % increase in the sales price would lead to an IRR of about 18 % respectively 20 % increase to a figure of 21.5 %.
10 % and 20 % decrease in operation or initial investment costs would correspond to IRR figures of about 16 % and 17.5%.
10 % increase in operation or initial investment costs would result in an IRR of 12.5 % and 13 % , while 20 % increase would reduce the IRR to 10.5 % and 12 % (see IRR sensitivity graph on page 64 of this study).

Finally in Variant 7 has also been examined , how would the main economic indices change if the metal price increased by 10 % and this increase used for buying electric energy at a higher price.

In Variant 7 a metal price of 2546 US $/t and an energy price of 30 mills/kWh have been taken into account. As it is shown in the summary sheets , main economic indices of Variant 6 and Variant 7 are practically the same:

IRR in Variant 6	14.29%
IRR in Variant 7	14.49%
NPV in Variant 6	188.45 mUS $
NPV in Variant 7	197.63 mUS $

In the meantime , as graphs of the structure of production costs show (see pages 64 and 66), percentage of [illegible] cost in the total production costs increases [illegible] % (Variant 6) to 25.18% (Variant 7).

In other words , if the metal price were 10 % higher than according to the forecast expected , the upper limit price of power paid for the electric energy would be 30 mills/kWh.

As in the selected base case (Variant 6) the NPV is positive, and the IRR is higher than the discount rate, it can not be stated that the project discussed in the present study has to be dropped.

Based on the available data as well as on the COMFAR evaluation, establishment of the smelter at the moment can not be attractive for local and foreign investors.

Nevertheless it could be useful if data - especially regarding infrastructure and local civil engineering costs - were accurated as well as other possibilities for utilization of natural gas resources of India/Bangladesh were examined. This way a ranking of different utilization projects could be worked out.

GREENFIELD SMELTER
MARCH 1993
VARIANT 1

2 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: THOUSAND US DOLLARS

Total initial investment during construction phase

fixed assets:	516000.00	60.271 % foreign
current assets:	0.00	0.000 % foreign
total assets:	516000.00	60.271 % foreign

Source of funds during construction phase

equity & grants:	516000.00	60.271 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	516000.00	60.271 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	56632.00	132496.00	150140.00
depreciation :	29700.00	42150.00	42150.00
interest :	0.00	0.00	0.00
production costs	86332.00	174646.00	192290.00
thereof foreign	75.41 %	83.65 %	84.82 %
total sales :	86812.50	260437.50	289375.00
gross income :	480.50	85791.50	97085.00
net income :	480.50	85791.50	97085.00
cash balance :	-192238.80	121686.80	135456.40
net cashflow :	-192238.80	121686.80	135456.40

Net Present Value at: 10.00 % = 59176.81
Internal Rate of Return: 11.38 %
Return on equity1: 8.95 %
Return on equity2: 11.38 %

Index of Schedules produced by COMFAR

GREENFIELD SMELTER
MARCH 1993
VARIANT 2

2 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: THOUSAND US DOLLARS

Total initial investment during construction phase

fixed assets:	516000.00	60.271 % foreign
current assets:	0.00	0.000 % foreign
total assets:	516000.00	60.271 % foreign

Source of funds during construction phase

equity & grants:	516000.00	60.271 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	516000.00	60.271 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	52162.00	119086.00	135240.00
depreciation :	29700.00	42150.00	42150.00
interest :	0.00	0.00	0.00
production costs	81862.00	161236.00	177390.00
thereof foreign	74.06 %	82.30 %	83.54 %
total sales :	86812.50	260437.50	289375.00
gross income :	4950.50	99201.50	111985.00
net income :	4950.50	99201.50	111985.00
cash balance :	-187669.50	135295.40	150389.50
net cashflow :	-187669.50	135295.40	150389.50

Net Present Value at: 10.00 % = 129397.80
Internal Rate of Return: 12.99 %
Return on equity1: 11.22 %
Return on equity2: 12.99 %

Index of Schedules produced by COMFAR

GREENFIELD SMELTER
MARCH 1993
VARIANT 3

2 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: THOUSAND US DOLLARS

Total initial investment during construction phase

fixed assets:	516000.00	60.271 % foreign
current assets:	0.00	0.000 % foreign
total assets:	516000.00	60.271 % foreign

Source of funds during construction phase

equity & grants:	516000.00	60.271 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	516000.00	60.271 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	49477.00	111031.00	126290.00
depreciation :	29700.00	42150.00	42150.00
interest :	0.00	0.00	0.00
production costs	79177.00	153181.00	168440.00
thereof foreign	73.18 %	81.36 %	82.67 %
total sales :	86812.50	260437.50	289375.00
gross income :	7635.50	107256.50	120935.00
net income :	7635.50	107256.50	120935.00
cash balance :	-184924.80	143469.30	159359.40
net cashflow :	-184924.80	143469.30	159359.40

Net Present Value at: 10.00 % = 171577.60
Internal Rate of Return: 13.95 %
Return on equity1: 12.52 %
Return on equity2: 13.95 %

Index of Schedules produced by COMFAR

GREENFIELD SMELTER
MARCH 1993
VARIANT 4

2 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: THOUSAND US DOLLARS

Total initial investment during construction phase

fixed assets:	516000.00	60.271 % foreign
current assets:	0.00	0.000 % foreign
total assets:	516000.00	60.271 % foreign

Source of funds during construction phase

equity & grants:	516000.00	60.271 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	516000.00	60.271 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	46792.00	102976.00	117340.00
depreciation :	29700.00	42150.00	42150.00
interest :	0.00	0.00	0.00
production costs	76492.00	145126.00	159490.00
thereof foreign	72.24 %	80.33 %	81.70 %
total sales :	86812.50	260437.50	289375.00
gross income :	10320.50	115311.50	129885.00
net income :	10320.50	115311.50	129885.00
cash balance :	-182180.20	151644.10	168329.30
net cashflow :	-182180.20	151644.10	168329.30

Net Present Value at: 10.00 % = 213757.20
Internal Rate of Return: 14.90 %
Return on equity1: 13.79 %
Return on equity2: 14.90 %

Index of Schedules produced by COMFAR

COMFAR 2.1 UNIDO

COMFAR 2.1 - JAWAHARLAL NEHRU CENTRE, NAGPUR, INDIA

GREENFIELD SMELTER
MARCH 1993
VARIANT 5

2 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: THOUSAND US DOLLARS

Total initial investment during construction phase

fixed assets:	516000.00	60.271 % foreign
current assets:	0.00	0.000 % foreign
total assets:	516000.00	60.271 % foreign

Source of funds during construction phase

equity & grants:	516000.00	60.271 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	516000.00	60.271 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	44107.00	94921.00	108390.00
depreciation :	29700.00	42150.00	42150.00
interest :	0.00	0.00	0.00
production costs	73807.00	137071.00	150540.00
thereof foreign	71.23 %	79.17 %	80.61 %
total sales :	86812.50	260437.50	289375.00
gross income :	13005.50	123366.50	138835.00
net income :	13005.50	123366.50	138835.00
cash balance :	-179435.50	159818.40	177299.20
net cashflow :	-179435.50	159818.40	177299.20

Net Present Value at: 10.00 % = 255936.90
Internal Rate of Return: 15.84 %
Return on equity1: 15.03 %
Return on equity2: 15.84 %

Index of Schedules produced by COMFAR

GREENFIELD SHELTER
MARCH 1993
VARIANT 6

2 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: THOUSAND US DOLLARS

Total initial investment during construction phase

fixed assets:	516000.00	60.271 % foreign
current assets:	0.00	0.000 % foreign
total assets:	516000.00	60.271 % foreign

Source of funds during construction phase

equity & grants:	366360.00	71.831 % foreign
foreign loans :	46440.00	
local loans :	103200.00	
total funds :	516000.00	60.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	49477.00	111031.00	126290.00
depreciation :	29700.00	42150.00	42150.00
interest :	17000.00	19964.80	19964.80
production costs	96177.00	173145.80	188404.80
thereof foreign	64.93 %	75.03 %	76.72 %
total sales :	86812.50	260437.50	289375.00
gross income :	-9364.50	87291.70	100970.20
net income :	-9364.50	87291.70	100970.20
cash balance :	16075.19	123505.00	129048.80
net cashflow :	-184924.80	143469.80	159359.40

Net Present Value at: 10.00 % = 188450.40
Internal Rate of Return: 14.29 %
Return on equity1: 10.31 %
Return on equity2: 16.18 %

Index of Schedules produced by COMFAR

Total Initial Investment in THOUSAND US DOLLARS

Year	1994	1995
Fixed investment costs		
Land, site preparation, development	3000.000	0.000
Buildings and civil works	63000.000	89000.000
Auxiliary and service facilities	0.000	0.000
Incorporated fixed assets	53500.000	54000.000
Plant machinery and equipment	97000.000	124000.000
Total fixed investment costs	216500.000	267000.000
Pre-production capital expenditures.	17500.000	15000.000
Net working capital	0.000	0.000
Total initial investment costs	234000.000	282000.000
Of it foreign, in %	58.974	61.348

Total Current Investment in THOUSAND US DOLLARS

Year	1996	1997	1998
Fixed investment costs			
Land, site preparation, development	0.000	0.000	0.000
Buildings and civil works	69000.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000
Incorporated fixed assets	47000.000	0.000	0.000
Plant, machinery and equipment	90000.000	0.000	0.000
Total fixed investment costs	206000.000	0.000	0.000
Preproduction capitals expenditures.	12000.000	0.000	0.000
Working capital	4260.311	5936.734	3725.567
Total current investment costs	222260.300	5936.734	3725.567
Of it foreign, %	61.725	94.395	98.511

Total Production Costs in THOUSAND US DOLLARS

Year	1996	1997	1998	1999	2000
% of nom. capacity (single product).	30.000	90.000	100.000	100.000	100.000
Raw material 1	19200.000	57600.000	64000.000	64000.000	64000.000
Other raw materials	0.000	0.000	0.000	0.000	0.000
Utilities	492.000	1476.000	1640.000	1640.000	1640.000
Energy	8055.000	24165.000	26850.000	26850.000	26850.000
Labour, direct	3030.000	9090.000	10100.000	10100.000	10100.000
Repair, maintenance	6600.000	6600.000	6600.000	6600.000	6600.000
Spares	0.000	0.000	5000.000	5000.000	5000.000
Factory overheads	7000.000	7090.000	7000.000	7000.000	7000.000
Factory costs	44377.000	105931.000	121190.000	121190.000	121190.000
Administrative overheads	3900.000	3900.000	3900.000	3900.000	3900.000
Indir. costs, sales and distribution	1200.000	1200.000	1200.000	1200.000	1200.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	29700.000	42150.000	42150.000	42150.000	42150.000
Financial costs	17000.000	19964.800	19964.800	18999.830	17943.940
Total production costs	96177.000	173145.800	188404.800	187439.800	186383.900
Costs per unit (single product)	2.565	1.539	1.507	1.500	1.491
Of it foreign, %	64.927	75.035	76.715	76.961	77.236
Of it variable,%	32.000	53.326	54.452	54.732	55.042
Total labour	5530.000	11590.000	12600.000	12600.000	12600.000

Total Production Costs in THOUSAND US DOLLARS

Year	2001	2002	2003	2004	2005
% of nom. capacity (single product).	100.000	100.000	100.000	100.000	100.000
Raw material 1	64000.000	64000.000	64000.000	64000.000	64000.000
Other raw materials	0.000	0.000	0.000	0.000	0.000
Utilities	1640.000	1640.000	1640.000	1640.000	1640.000
Energy	26850.000	26850.000	26850.000	26850.000	26850.000
Labour, direct	10100.000	10100.000	10100.000	10100.000	10100.000
Repair, maintenance	6600.000	6600.000	6600.000	6600.000	6600.000
Spares	5000.000	5000.000	5000.000	5000.000	5000.000
Factory overheads	7000.000	7000.000	7000.000	7000.000	7000.000
Factory costs	121190.000	121190.000	121190.000	121190.000	121190.000
Administrative overheads	3900.000	3900.000	3900.000	3900.000	3900.000
Indir. costs, sales and distribution	1200.000	1200.000	1200.000	1200.000	1200.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	42150.000	42150.000	42150.000	42150.000	20050.000
Financial costs	16788.470	15523.950	14139.990	12625.220	10967.150
Total production costs	185228.500	183964.000	182580.000	181065.200	157307.200
Costs per unit (single product)	1.482	1.472	1.461	1.449	1.258
Of it foreign, %	77.542	77.885	78.268	78.696	76.252
Of it variable,%	55.366	55.766	56.189	56.659	65.216
Total labour	12600.000	12600.000	12600.000	12600.000	12600.000

Total Production Costs in THOUSAND US DOLLARS

Year	2006	2007	2008	2009	2010
% of nom. capacity (single product).	100.000	100.000	100.000	100.000	100.000
Raw material 1	64000.000	64000.000	64000.000	64000.000	64000.000
Other raw materials	0.000	0.000	0.000	0.000	0.000
Utilities	1640.000	1640.000	1640.000	1640.000	1640.000
Energy	26850.000	26850.000	26850.000	26850.000	26850.000
Labour, direct	10100.000	10100.000	10100.000	10100.000	10100.000
Repair, maintenance	6600.000	6600.000	6600.000	6600.000	6600.000
Spares	5000.000	5000.000	5000.000	5000.000	5000.000
Factory overheads	7000.000	7000.000	7000.000	7000.000	7000.000
Factory costs	121190.000	121190.000	121190.000	121190.000	121190.000
Administrative overheads	3900.000	3900.000	3900.000	3900.000	3900.000
Indir. costs, sales and distribution	1200.000	1200.000	1200.000	1200.000	1200.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	11050.000	11050.000	11050.000	11050.000	11050.000
Financial costs	9152.119	7165.125	4989.741	2607.953	0.000
Total production costs	146492.100	144505.100	142329.700	139948.000	137340.000
Costs per unit (single product)	1.172	1.156	1.139	1.120	1.099
Of it foreign, %	75.412	76.092	76.864	77.743	78.746
Of it variable,%	70.031	70.994	72.079	73.306	74.698
Total labour	12600.000	12600.000	12600.000	12600.000	12600.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - JAWAHARLAL NEHRU CENTRE, NAGPUR, INDIA

Net Working Capital in THOUSAND US DOLLARS

Year			1996	1997	1998	1999-2010
Coverage	mdc	coto				
Current assets &						
Accounts receivable	26	14.0	3024.950	7843.184	9062.889	9062.889
Inventory and materials	40	9.0	2186.000	6558.000	7286.667	7286.667
Energy	1	360.0	22.375	67.125	74.583	74.583
Spares	180	2.0	0.000	0.000	2500.000	2500.000
Work in progress	2	173.1	364.069	631.653	690.139	690.139
Finished products	4	96.5	816.625	1191.542	1267.917	1267.917
Cash in hand	7	48.9	392.917	512.083	670.833	670.833
Total current assets			6806.936	16803.590	21553.030	21553.030
Current liabilities and						
Accounts payable	23	15.9	2546.625	6606.542	7630.417	7630.417
Net working capital			4260.311	10197.040	13922.610	13922.610
Increase in working capital			4260.311	5936.730	3725.566	0.000
Net working capital, local			1069.700	1402.433	1457.889	1457.889
Net working capital, foreign			3190.611	8794.611	12464.720	12464.720

Note: mdc = minimum days of coverage ; coto = coefficient of turnover .

Cashflow Tables, construction in THOUSAND US DOLLARS

Year	1994	1995
Total cash inflow	235000.000	281000.000
Financial resources	235000.000	281000.000
Sales, net of tax	0.000	0.000
Total cash outflow	234000.000	282000.000
Total assets	234000.000	282000.000
Operating costs	0.000	0.000
Cost of finance	0.000	0.000
Repayment	0.000	0.000
Corporate tax	0.000	0.000
Dividends paid	0.000	0.000
Surplus (deficit)	1000.000	-1000.000
Cumulated cash balance	1000.000	0.000
Inflow, local	94000.000	112400.000
Outflow, local	96000.000	109000.000
Surplus (deficit)	-2000.000	3400.000
Inflow, foreign	141000.000	168600.000
Outflow, foreign	138000.000	173000.000
Surplus (deficit)	3000.000	-4400.000
Net cashflow	-234000.000	-282000.000
Cumulated net cashflow	-234000.000	-516000.000

Cashflow tables, production in THOUSAND US DOLLARS

Year	1996	1997	1998	1999	2000	2001
Total cash inflow	307359.100	264497.400	290398.900	289375.000	289375.000	289375.000
Financial resources	220546.600	4059.917	1023.875	0.000	0.000	0.000
Sales, net of tax	86812.500	260437.500	289375.000	289375.000	289375.000	289375.000
Total cash outflow	291283.900	140992.500	161350.100	156600.700	156600.700	203466.600
Total assets	224806.900	9996.650	4749.442	0.000	0.000	0.000
Operating costs	49477.000	111031.000	126290.000	126290.000	126290.000	126290.000
Cost of finance	17000.000	19964.800	19964.800	18999.830	17943.940	16788.470
Repayment	0.000	0.000	10345.880	11310.850	12366.740	13522.210
Corporate tax	0.000	0.000	0.000	0.000	0.000	46865.940
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	16075.190	123505.000	129048.800	132774.300	132774.300	85908.380
Cumulated cash balance	16075.190	139580.100	268628.900	401403.200	534177.500	620085.900
Inflow, local	87333.780	53.667	8.944	0.000	0.000	0.000
Outflow, local	111335.500	32562.400	39749.250	39684.850	39684.850	86550.800
Surplus (deficit)	-24001.700	-32508.740	-39740.310	-39684.850	-39684.850	-86550.800
Inflow, foreign	220025.300	264443.800	290389.900	289375.000	289375.000	289375.000
Outflow, foreign	179948.500	108430.000	121600.900	116915.800	116915.800	116915.800
Surplus (deficit)	40076.890	156013.700	168789.100	172459.200	172459.200	172459.200
Net cashflow	-184924.800	143469.800	159359.400	163085.000	163085.000	116219.100
Cumulated net cashflow	-700924.800	-557455.100	-398095.600	-235010.600	-71925.630	44293.440

Cashflow tables, production in THOUSAND US DOLLARS

Year	2002	2003	2004	2005	2006	2007
Total cash inflow	289375.000	289375.000	289375.000	289375.000	289375.000	289375.000
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	289375.000	289375.000	289375.000	289375.000	289375.000	289375.000
Total cash outflow	204035.700	204658.400	205340.100	216031.200	220898.000	221792.100
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs	126290.000	126290.000	126290.000	126290.000	126290.000	126290.000
Cost of finance	15523.950	14139.990	12625.220	10967.150	9152.119	7165.125
Repayment	14786.730	16170.690	17685.460	19343.530	21158.560	23145.560
Corporate tax	47434.980	48057.750	48739.400	59430.530	64297.300	65191.450
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	85339.330	84716.560	84034.910	73343.780	68477.020	67582.880
Cumulated cash balance	705425.200	790141.800	874176.600	947520.400	1015997.000	1083580.000
Inflow, local	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, local	87119.830	87742.610	88424.250	99115.380	103982.100	104876.300
Surplus (deficit)	-87119.830	-87742.610	-88424.250	-99115.380	-103982.100	-104876.300
Inflow, foreign	289375.000	289375.000	289375.000	289375.000	289375.000	289375.000
Outflow, foreign	116915.800	116915.800	116915.800	116915.800	116915.800	116915.800
Surplus (deficit)	172459.200	172459.200	172459.200	172459.200	172459.200	172459.200
Net cashflow	115650.000	115027.300	114345.600	103654.500	98787.700	97893.550
Cumulated net cashflow	159943.500	274970.700	389316.300	492970.800	591758.400	689652.000

Cashflow tables, production in THOUSAND US DOLLARS

Year	2008	2009	2010
Total cash inflow	289375.000	289375.000	289375.000
Financial resources	0.000	0.000	0.000
Sales, net of tax	289375.000	289375.000	289375.000
Total cash outflow	222771.000	223843.000	194705.800
Total assets	0.000	0.000	0.000
Operating costs	126290.000	126290.000	126290.000
Cost of finance	4989.741	2607.953	0.000
Repayment	25320.940	27702.830	0.000
Corporate tax	66170.360	67242.170	68415.750
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	66603.970	65532.050	94669.250
Cumulated cash balance	1150184.000	1215716.000	1310386.000
Inflow, local	0.000	0.000	0.000
Outflow, local	105855.200	106927.100	86555.750
Surplus (deficit)	-105855.200	-106927.100	-86555.750
Inflow, foreign	289375.000	289375.000	289375.000
Outflow, foreign	116915.800	116915.900	108150.000
Surplus (deficit)	172459.200	172459.100	181225.000
Net cashflow	96914.640	95842.830	94669.250
Cumulated net cashflow	786566.600	882409.400	977078.700

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	9163.16	at	10.00 %
Internal Rate of Return (IRRE1) ..	10.31 %		

b) Net Worth versus Net cash return:

Net present value	198622.60	at	10.00 %
Internal Rate of Return (IRRE2) ..	16.18 %		

c) Internal Rate of Return on total investment:

Net present value	188450.40	at	10.00 %
Internal Rate of Return (IRR) ..	14.29 %		

Net Worth = Equity paid plus reserves

Projected Balance Sheets, construction in THOUSAND US DOLLARS

Year	1994	1995
Total assets	235000.000	516000.000
Fixed assets, net of depreciation	0.000	234000.000
Construction in progress	234000.000	282000.000
Current assets	0.000	0.000
Cash, bank	0.000	0.000
Cash surplus, finance available	1000.000	0.000
Loss carried forward	0.000	0.000
Loss	0.000	0.000
Total liabilities	235000.000	516000.000
Equity capital	166850.000	366360.000
Reserves, retained profit	0.000	0.000
Profit	0.000	0.000
Long and medium term debt	68150.000	149640.000
Current liabilities	0.000	0.000
Bank overdraft, finance required.	0.000	0.000
Total debt	68150.000	149640.000
Equity, % of liabilities	71.000	71.000

Projected Balance Sheets, Production in THOUSAND US DOLLARS

Year	1996	1997	1998	1999	2000
Total assets	736546.600	827898.300	910181.900	1000806.000	1091431.000
Fixed assets, net of depreciation	486300.000	662150.000	620000.000	577850.000	535700.000
Construction in progress	218000.000	0.000	0.000	0.000	0.000
Current assets	6414.020	16291.500	20882.200	20882.200	20882.200
Cash, bank	392.917	512.083	670.833	670.833	670.833
Cash surplus, finance available	16075.190	139580.200	268628.900	401403.300	534177.500
Loss carried forward	0.000	9364.500	0.000	0.000	0.000
Loss	9364.500	0.000	0.000	0.000	0.000
Total liabilities	736546.600	827898.300	910181.900	1000806.000	1091431.000
Equity capital	521140.000	521140.000	521140.000	521140.000	521140.000
Reserves, retained profit	0.000	0.000	77927.200	178897.400	280832.600
Profit	0.000	87291.700	100970.200	101935.200	102991.100
Long and medium term debt	212860.000	212860.000	202514.100	191203.300	178836.500
Current liabilities	2546.625	6606.542	7630.417	7630.417	7630.417
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	215406.600	219466.500	210144.500	198833.700	186467.000
Equity, % of liabilities	70.755	62.947	57.257	52.072	47.748

Projected Balance Sheets, Production in THOUSAND US DOLLARS

Year	2001	2002	2003	2004	2005
Total assets	1135189.000	1178378.000	1220945.000	1262830.000	1316124.000
Fixed assets, net of depreciation	493550.000	451400.000	409250.000	367100.000	347050.000
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	20882.200	20882.200	20882.200	20882.200	20882.200
Cash, bank	670.833	670.833	670.833	670.833	670.833
Cash surplus, finance available	620085.900	705425.300	790141.900	874176.600	947520.500
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	1135189.000	1178378.000	1220945.000	1262830.000	1316124.000
Equity capital	521140.000	521140.000	521140.000	521140.000	521140.000
Reserves, retained profit	383823.600	441104.200	499080.300	557817.600	617387.900
Profit	57280.590	57976.080	58737.260	59570.380	72637.310
Long and medium term debt	165314.300	150527.600	134356.900	116671.400	97327.900
Current liabilities	7630.417	7630.417	7630.417	7630.417	7630.417
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	172944.700	158158.000	141987.300	124301.800	104958.300
Equity, % of liabilities	45.908	44.225	42.683	41.268	39.597

Projected Balance Sheets, Production in THOUSAND US DOLLARS

Year	2006	2007	2008	2009	2010
Total assets	1373551.000	1430083.000	1485637.000	1540119.000	1623739.000
Fixed assets, net of depreciation	336000.000	324950.000	313900.000	302850.000	291800.000
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	20882.200	20882.200	20882.200	20882.200	20882.200
Cash, bank	670.833	670.833	670.833	670.833	670.833
Cash surplus, finance available	1015998.000	1083580.000	1150184.000	1215716.000	1310386.000
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	1373551.000	1430083.000	1485637.000	1540119.000	1623739.000
Equity capital	521140.000	521140.000	521140.000	521140.000	521140.000
Reserves, retained profit	690025.300	768610.800	848289.300	929164.100	1011349.000
Profit	78585.580	79678.430	80874.890	82184.880	83619.250
Long and medium term debt	76169.340	53023.780	27702.840	0.008	0.008
Current liabilities	7630.417	7630.417	7630.417	7630.417	7630.417
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	83799.750	60654.200	35333.250	7630.425	7630.425
Equity, % of liabilities	37.941	36.441	35.079	33.838	32.095

Net Income Statement in THOUSAND US DOLLARS

Year	1996	1997	1998	1999	2000
Total sales, incl. sales tax	86812.500	260437.500	289375.000	289375.000	289375.000
Less: variable costs, incl. sales tax.	30777.000	92331.000	102590.000	102590.000	102590.000
Variable margin	56035.500	168106.500	186785.000	186785.000	186785.000
As % of total sales	64.548	64.548	64.548	64.548	64.548
Non-variable costs, incl. depreciation	48400.000	60850.000	65850.000	65850.000	65850.000
Operational margin	7635.500	107256.500	120935.000	120935.000	120935.000
As % of total sales	8.795	41.183	41.792	41.792	41.792
Cost of finance	17000.000	19964.800	19964.800	18999.830	17943.940
Gross profit	-9364.500	87291.700	100970.200	101935.200	102991.100
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-9364.500	87291.700	100970.200	101935.200	102991.100
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	-9364.500	87291.700	100970.200	101935.200	102991.100
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-9364.500	87291.700	100970.200	101935.200	102991.100
Accumulated undistributed profit	-9364.500	77927.200	178897.400	280832.600	383823.600
Gross profit, % of total sales	-10.787	33.517	34.893	35.226	35.591
Net profit, % of total sales	-10.787	33.517	34.893	35.226	35.591
ROE, Net profit, % of equity	-1.797	16.750	19.375	19.560	19.763
ROI, Net profit+interest, % of invest.	1.034	14.412	16.169	16.169	16.169

Net Income Statement in THOUSAND US DOLLARS

Year	2001	2002	2003	2004	2005
Total sales, incl. sales tax	289375.000	289375.000	289375.000	289375.000	289375.000
Less: variable costs, incl. sales tax.	102590.000	102590.000	102590.000	102590.000	102590.000
Variable margin	186785.000	186785.000	186785.000	186785.000	186785.000
As % of total sales	64.548	64.548	64.548	64.548	64.548
Non-variable costs, incl. depreciation	65850.000	65849.980	65849.990	65850.000	43750.000
Operational margin	120935.000	120935.000	120935.000	120935.000	143035.000
As % of total sales	41.792	41.792	41.792	41.792	49.429
Cost of finance	16788.470	15523.950	14139.990	12425.220	10967.150
Gross profit	104146.500	105411.100	106795.000	108309.800	132067.800
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	104146.500	105411.100	106795.000	108309.800	132067.800
Tax	46865.940	47434.980	48057.750	48739.400	59430.530
Net profit	57280.590	57976.080	58737.260	59570.380	72637.310
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	57280.590	57976.080	58737.260	59570.380	72637.310
Accumulated undistributed profit	441104.200	499080.300	557817.600	617387.900	690025.300
Gross profit, % of total sales	35.990	36.427	36.905	37.429	45.639
Net profit, % of total sales	19.795	20.035	20.298	20.586	25.101
ROE, Net profit, % of equity	10.991	11.125	11.271	11.431	13.938
ROI, Net profit+interest, % of invest.	9.903	9.827	9.744	9.653	11.178

Net Income Statement in THOUSAND US DOLLARS

Year	2006	2007	2008	2009	2010
Total sales, incl. sal. tax	289375.000	289375.000	289375.000	289375.000	289375.000
Less: variable costs, incl. sales tax.	102590.000	102590.000	102590.000	102590.000	102590.000
Variable margin	186785.000	186785.000	186785.000	186785.000	186785.000
As % of total sales	64.548	64.548	64.548	64.548	64.548
Non-variable costs, incl. depreciation	34750.010	34750.000	34750.010	34750.000	34750.000
Operational margin	152035.000	152035.000	152035.000	152035.000	152035.000
As % of total sales	52.539	52.539	52.539	52.539	52.539
Cost of finance	9152.119	7165.125	4989.741	2607.953	0.000
Gross profit	142882.900	144869.900	147045.300	149427.000	152035.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	142882.900	144869.900	147045.300	149427.000	152035.000
Tax	64297.300	65191.450	66170.360	67242.170	68415.750
Net profit	78585.580	79678.430	80874.890	82184.880	83619.250
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	78585.580	79678.430	80874.890	82184.880	83619.250
Accumulated undistributed profit	768610.800	848289.300	929164.100	1011349.000	1094968.000
Gross profit, % of total sales	49.376	50.063	50.815	51.638	52.539
Net profit, % of total sales	27.157	27.535	27.948	28.401	28.897
ROE, Net profit, % of equity	15.080	15.289	15.519	15.770	16.045
ROI, Net profit+interest, % of invest.	11.731	11.611	11.480	11.337	11.180

Source of Finance, construction in THOUSAND US DOLLARS

Year	1994	1995
Equity, ordinary ..	166850.000	199510.000
Equity, preference.	0.000	0.000
Subsidies, grants .	0.000	0.000
Loan A, foreign .	21150.000	25290.000
Loan B, foreign..	0.000	0.000
Loan C, foreign .	0.000	0.000
Loan A, local....	47000.000	56200.000
Loan B, local....	0.000	0.000
Loan C, local....	0.000	0.000
Total loan	68150.000	81490.000
Current liabilities	0.000	0.000
Bank overdraft	0.000	0.000
Total funds	235000.000	281000.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - JAWAHARLAL NEHRU CENTRE, NAGPUR, INDIA

Source of Finance, production in THOUSAND US DOLLARS

Year	1996	1997	1998	1999	2000	2001
Equity, ordinary	154780.000	0.000	0.000	0.000	0.000	0.000
Equity, preference	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign	19620.000	0.000	-3481.031	-3759.514	-4060.275	-4385.097
Loan B, foreign	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local	43600.000	0.000	-6864.852	-7551.336	-8306.470	-9137.117
Loan B, local	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, local	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	63220.000	0.000	-10345.880	-11310.850	-12366.740	-13522.210
Current liabilities	2546.625	4059.917	1023.875	0.000	0.000	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000	0.000
Total funds	220546.600	4059.917	-9322.008	-11310.850	-12366.740	-13522.210

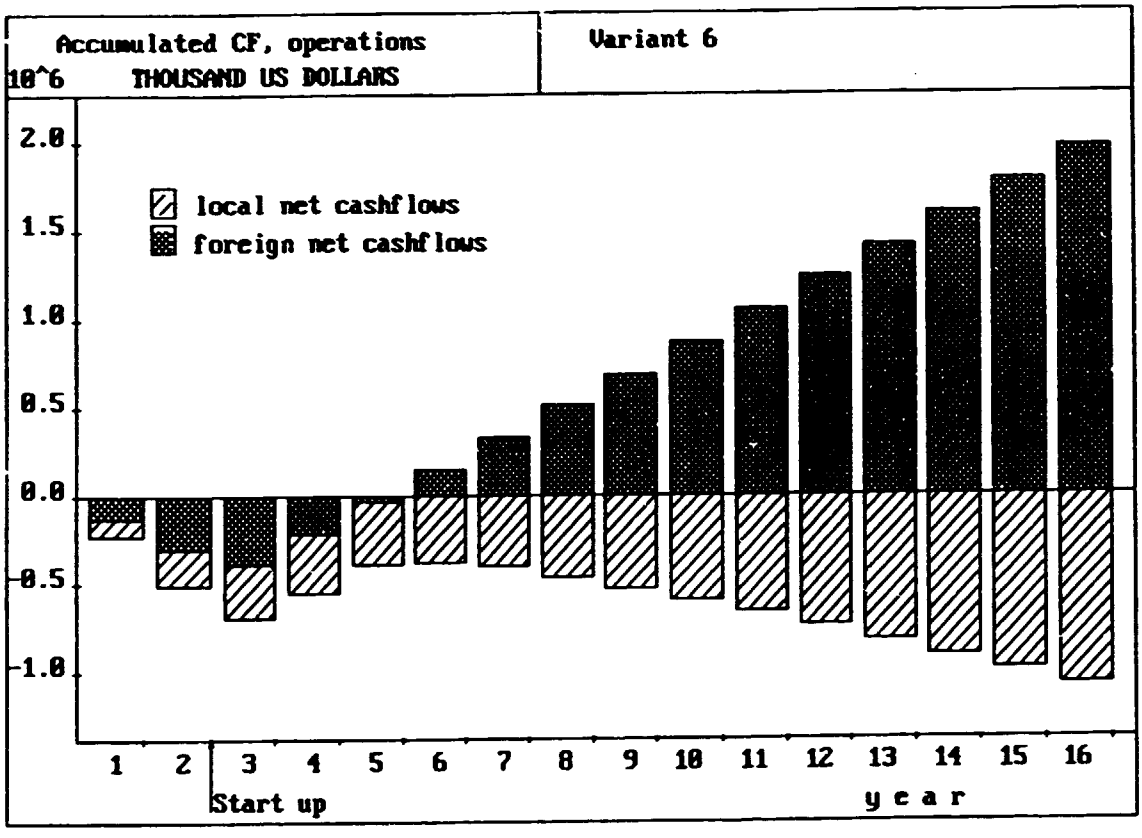
COMFAR 2.1 - JAWAHARLAL NEHRU CENTRE, NAGPUR, INDIA

Source of Finance, production in THOUSAND US DOLLARS

Year	2002	2003	2004	2005	2006	2007
Equity, ordinary	0.000	0.000	0.000	0.000	0.000	0.000
Equity, preference	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign	-4735.904	-5114.777	-5523.959	-5965.875	-6443.146	-6958.597
Loan B, foreign	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local	-10050.830	-11055 910	-12161.500	-13377.650	-14715.420	-16186.960
Loan B, local	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, local	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	-14786.730	-16170.690	-17685.460	-19343.530	-21158.560	-23145.560
Current liabilities	0.000	0.000	0.000	0.000	0.000	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000	0.000
Total funds	-14786.730	-16170.690	-17685.460	-19343.530	-21158.560	-23145.560

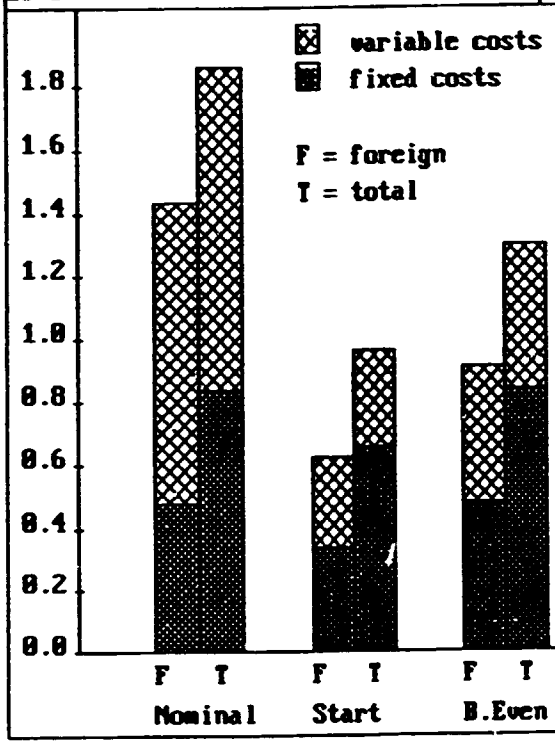
Source of Finance, production in THOUSAND US DOLLARS

Year	2008	2009
Equity, ordinary ..	0.000	0.000
Equity, preference.	0.000	0.000
Subsidies, grants .	0.000	0.000
Loan A, foreign .	-7515.285	-8116.539
Loan B, foreign..	0.000	0.000
Loan C, foreign .	0.000	0.000
Loan A, local....	-17805.660	-19586.290
Loan B, local....	0.000	0.000
Loan C, local....	0.000	0.000
Total loan	-25320.940	-27702.830
Current liabilities	0.000	0.000
Bank overdraft	0.000	0.000
Total funds	-25320.940	-27702.830

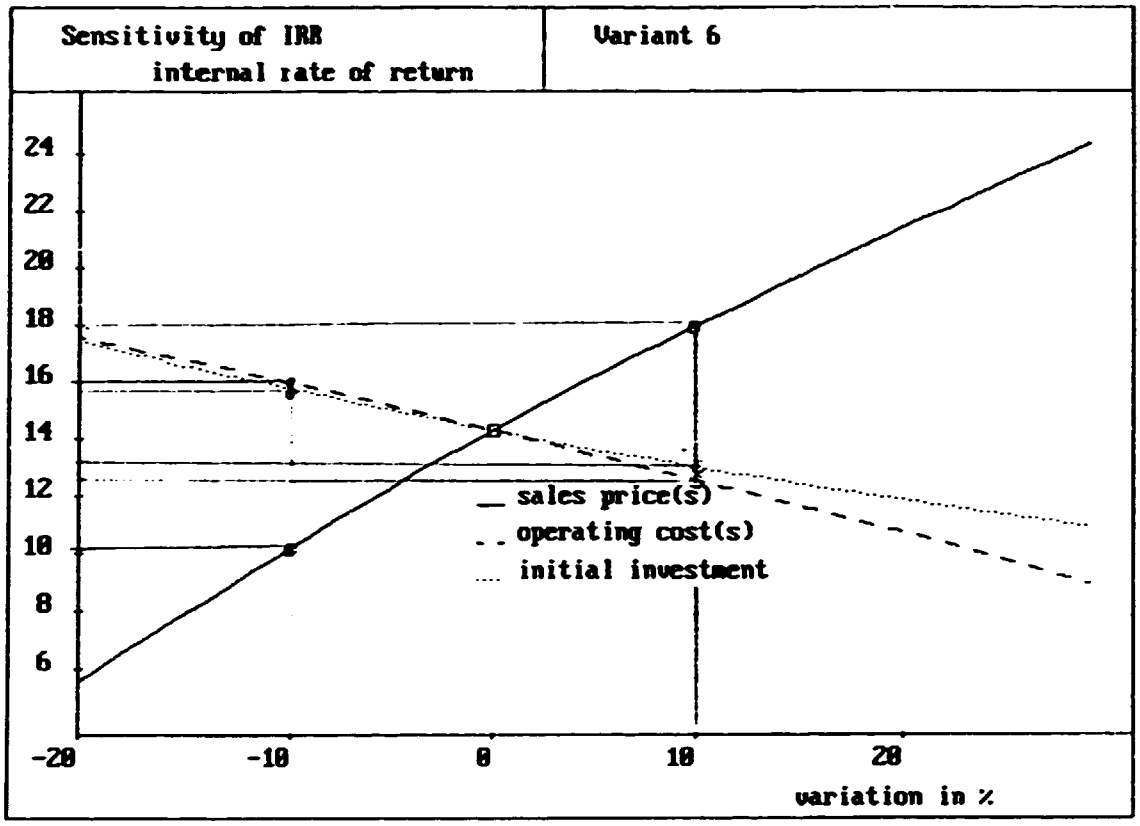

Accumulated CF, operations
Variant 6
10^6 THOUSAND US DOLLARS
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
local net cashflows
foreign net cashflows
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
year

Structure of Production Costs
10^5 THOUSAND US DOLLARS

Variant 6
for 5th production year



Nominal	Start up	
34.34	19.96	raw material
0.00	0.00	other RM
0.00	0.51	utilities
14.41	8.30	energy
5.42	3.15	labour
3.54	6.86	maintenance
2.68	0.00	spares
6.49	12.58	overheads
22.61	30.00	depreciation
9.63	17.60	interest
100.00	100.00	Total Prod C.


Sensitivity of IRR
internal rate of return
Variant 6
24
22
20
18
16
14
12
10
8
6
sales price(s)
operating cost(s)
initial investment
-20
-10
0
10
20
variation in %

COMFAR 2.1 UNIDO

COMFAR 2.1 - JAWAHARLAL NEHRU CENTRE, NAGPUR, INDIA

GREENFIELD SHELTER
MARCH 1993
VARIANT 7

2 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: THOUSAND US DOLLARS

Total initial investment during construction phase

fixed assets:	516000.00	60.271 % foreign
current assets:	0.00	0.000 % foreign
total assets:	516000.00	60.271 % foreign

Source of funds during construction phase

equity & grants:	366360.00	71.831 % foreign
foreign loans :	46440.00	
local loans :	103200.00	
total funds :	516000.00	60.000 % foreign

Cashflow from operations

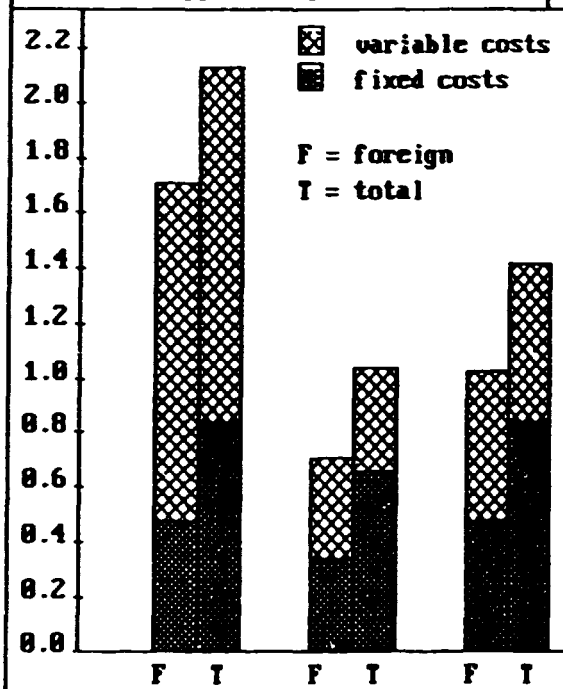
Year:	1	2	3
operating costs:	57532.00	135196.00	153140.00
depreciation :	29700.00	42150.00	42150.00
interest :	17000.00	19964.80	19964.80
production costs	104232.00	197310.80	215254.80
thereof foreign	67.64 %	78.09 %	79.62 %
total sales :	95475.00	286425.00	318250.00
gross income :	-8757.00	89114.20	102995.20
net income :	-8757.00	89114.20	102995.20
cash balance :	16503.69	124969.50	131014.10
net cashflow :	-184496.30	144934.30	161324.80

Net Present Value at: 10.00 % = 197628.60
Internal Rate of Return: 14.49 %
Return on equity1: 10.63 %
Return on equity2: 16.45 %

Index of Schedules produced by COMFAR

Structure of Production Costs
10^5 THOUSAND US DOLLARS

Variant 7
for 5th production year



Nominal	Start up	
30.81	18.42	raw material
0.00	0.00	other RM
0.77	0.47	utilities
25.18	15.46	energy
4.74	2.91	labour
3.18	6.33	maintenance
2.34	0.00	spares
5.67	11.61	overheads
19.77	28.49	depreciation
8.42	16.31	interest
100.00	100.00	Total Prod C.