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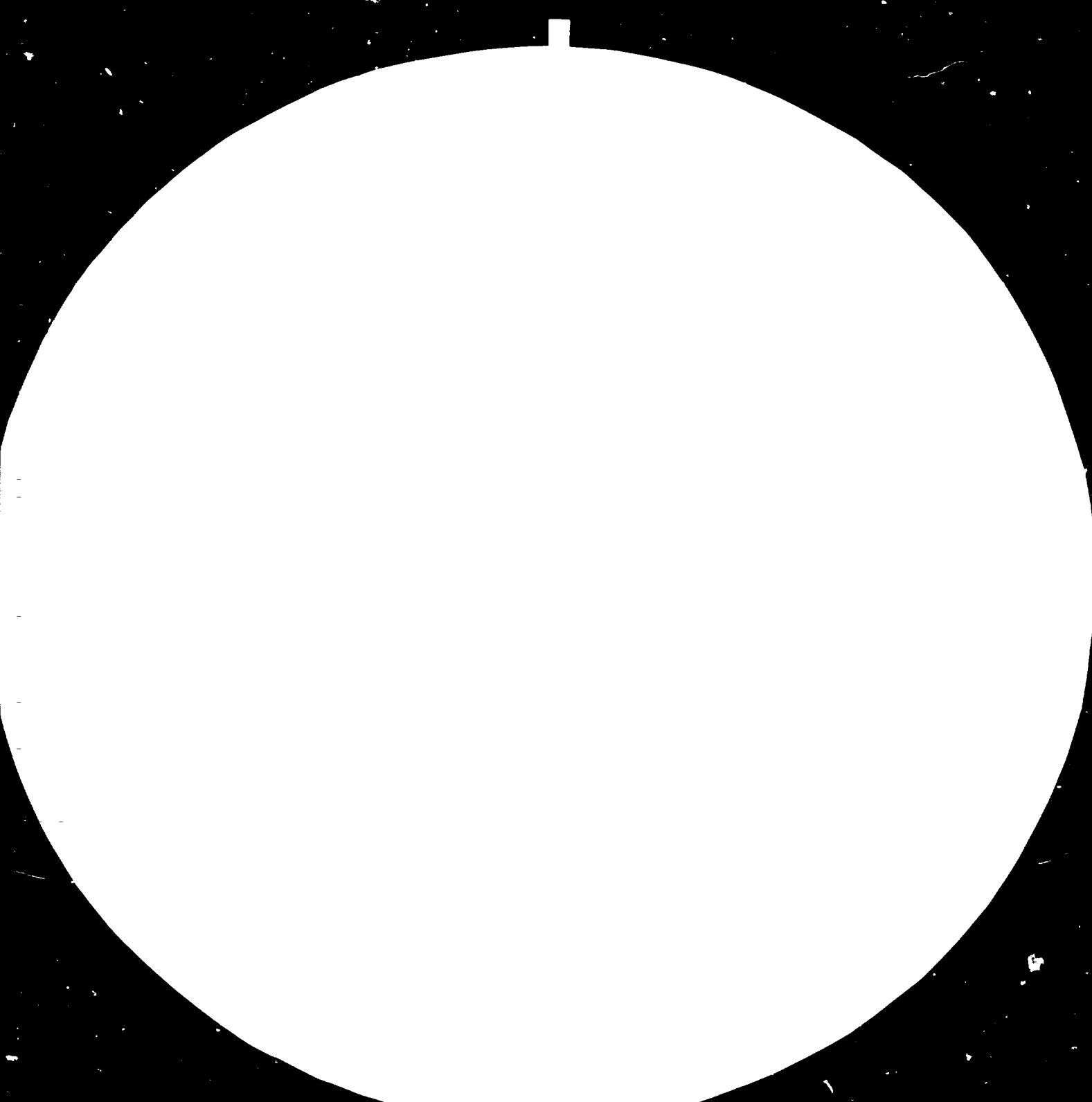


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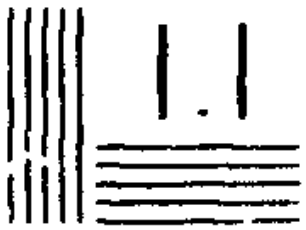
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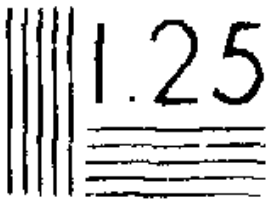
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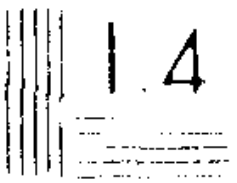
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CONTRACT NO.T 81/91 UNIDO

India.

TECHNO-ECONOMIC EVALUATION OF ESTABLISHING AN EXPERIMENTAL-DEMONSTRATION UNIT FOR PRODUCTION OF ALUMINIUM SILICON ALLOYS IN INDIA.

DP/IND/81/015

VOLUME I

VAMI

V/O TSVETMETPROMEXPORT

NEW DELHI - LENINGRAD

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CONTENTS

C O N T E N T S

INTRODUCTION

According to the contract signed between UNIDO and V/O "Tsvetmetpromexport" (No. T-81/91 of 19.03.82) the Feasibility Study of Silicon-Aluminium Alloys Project (SAAP) in India with the capacity of 90,000 tpy based on electro-smelting process has been developed by VAMI Institute of the Ministry for Non-ferrous Metallurgy of the USSR.

The Project initiators of SAAP in India are the Government of India Undertaking - Indian Rare Earths Ltd (IRE), with place of business in Bombay (India, Bombay - 400 020) and answerable to the Department of Atomic Energy.

Based on the beach sands deposits of the state of Orissa , IRE is setting up a Project called Orissa Sands Complex (OSCOM). OSCOM will produce upto 30,000 tpy of sillimanite concentrate as a by-product with possible expansion upto 60,000 tpy.

The laboratory tests and pilor trials proved in principle fotential of the use of Indian sillimanites for the production of casting aluminium alloys. The Feasibility study of the SAAP proposes conversion of sillimanite concentrate by electro-thermal method to produce Al-Si alloys for the indigenous market.

A sixilar process for the production of aluminium-silicon allys is not available abroad.

The feasibility study carried out have shown the high economic affectiveness of Al-Si alloys production using the electro-smelting method based on sillimanites.

Implementation of SAAP Project will ensure :

Conversion of sillimanite to a value-added product and establishment of waste-free industry on its basis;

- expansion of raw material resource base of the Indian aluminium industry by utilisation of alumino-silicate ores unsuitable for the production of alumina and improvement in consumption structure of primary aluminium;

- reduction in consumption of primary aluminium in the manufacture of Al-Si alloys (by about 20% depending on the grades of alloys) and the corresponding decrease in the import of aluminium for this purpose in power consumption down by 5-6%, and also elimination of consumption of pure silicon.

Taking into consideration the limited funds for the construction of the SAAP at full capacity (90,000 tpy) and the shortage in power supply to meet completely its requirements and with the aim to master the technology and to train the manpower and engineering staff for the first stage it is reasonable to set-up the experimental demonstration unit to produce the Al-Si alloys

with a capacity upto 10000 tpy of primary refined alloy. This capacity is to be ensured by the installation of one electric arc reduction furnace of 17 MW. The establishment of such a unit in Orissa State has been sanctioned already by the Central Government of India by issuance of a Letter of Intent in 1982.

Summary of Techno-Economic parameters of the experimental demonstration unit are given in Table below:

SN	Parameter description	Unit of measure	Value
1.	Annual Production of Primary alloy (about 37%)	000 t	9.54
2.	Annual production of commercial Al-si alloys	000 t	28.1
3.	Sales revenue (@ Rs.23,000 t)	Rs. mln.	646.8
4.	Capital investment, including:	Rs. mln.	217.2
4.1	Fixed capital	-do-	195.7
4.2	Interest during construction	-do-	11.0
4.3	Margin money	-do-	10.5
5.	Total annual operating including costs	-do-	621.1
5.1	Variable costs	-do-	564.3
5.2	Fixed costs	-do-	36.2
5.3	Depreciation (@ 8.9%)	-	18.2
5.4	Interest	-	2.4
6.	Taxable profit	-	25.7
7.	Income tax (@ 57.75%)	-	14.8
8.	~~Internal rate of return~~ Net profit after tax	%	~~10.2~~ 10.9
9.	Internal rate of return	%	15.6
10.	Capital investment pay-back period	years	6
11.	Break-even point	%	76.2

1. BRIEF DESCRIPTION OF THE FEASIBILITY REPORT FOR THREE FURNACE VARIANT

At present the demand for aluminium-silicon alloys in India is estimated to be 45 - 50,000 tpy. By 1985 this demand (estimate based on analysis of development of the industry and consumption structure of primary aluminium) will reach 85 - 90,000 tpy.

The SAAP capacity in the event of conversion of 30,000 tonnes of sillimanite concentrate would be 28,600 tpy of refined primary alloy and 78 - 118,000 tpy of commercial Al-Si alloys (depending on grade).

Basing on the estimated demand on Al-Si alloys as well as on full utilisation of sillimanite concentrate the normal feasible capacity is assumed to be 90,000 tpy which makes about 76% of nominal maximum capacity.

The following raw materials, inputs and auxiliary materials are to be used for production of Al-Si alloys :

- raw materials : Sillimanite concentrate, kaolin (dry cleaned), alumina, coal, petroleum, coke, quartzite;
- Inputs : aluminium (pigs), electrode paste, copper, manganese, nickel, magnesium;
- auxiliary materials (molasses, cryolite, etc), and utilities (power, water, compressed air, fuel oil, steam).

Nearly all materials and inputs required in significant quantities manufacturing the alloys are available in Orissa. Average radius of supply of these materials to the plant amounts to 400 km max.

The annual demand of the various inputs is as follows :

- sillimanite concentrate - 33,500 t
- aluminium (pigs) - 64,800 t
- fuel oil - 10,800 t
- power - 482,400 MWh

Chatrapur, Ganjam District was selected as the most suitable site by IRE and Soviet Engineers for setting-up SAAP.

The area of the SAAP job site is about 30 hectares.

The technology for manufacture of Al-Si alloys by processing sillimanite concentrate consists in reduction smelting of sillimanite-containing feed in electric arc reduction furnaces to produce crude alloys with about 60% Al and 37% Si content. To produce silumin or other types of Al-Si alloys crude alloy is refined and diluted with the appropriate amount of primary and secondary aluminium and various alloying elements (copper, nickel, magnesium, maganese, etc) depending on desired grades of finished alloys.

The major process equipment is electric arc furnace (3 pcs) with power rating of 17 MW each.

Total manpower for the SAAP is calculated to be 700 based on full capacity of the Plant.

It was assumed that planning and functional management of the SAAP is effected in the framework of the OsCOM structure.

The overall time for preparation, construction and commissioning to full capacity of SAAP is 7 years.

Considering possible limitation in power supply and difficulties in financing the project to full capacity (90,000 tpy) the Feasibility Study includes an alternative of successive construction of the SAAP in three stages, one electric furnace per stage of 30,000 tpy of commercial alloys capacity.

The financial and economic evaluation of the project is based on price level of 1982, not considering escalation.

Total investment costs for SAAP construction amount to Rs. 935,4 mln.

The distribution of this amount by major cost items is shown below :

Item	Expenditure category	Amount Rs. mln
1	2	3
1.	Land and site preparation	4.8
2.	Buildings and civ i works	168.2
	including housing colony	13.0
3.	Technology (know-how with tax)	7.7
4.	Equipment	
4.1	Production equipment, including	419.9
	4.1.1. Imported from the USSR	302.6
	4.1.2. Indigenous	98.1
	4.1.3. Imported from third countries	19.2
4.2	Erection	46.6
4.3	Port charges, insurance, transportation to plant site	15.2
4.4	Custom duty	121.0
	Total equipment	783.4
5.	Preliminary expenditures (project engineering, administration recruitment, Soviet experts services etc.)	58.9
6.	Working capital (100%)	93.1
	TOTAL INVESTMENT COSTS	935.4

According to financial scheme the expenditures of BAAP construction would be covered by equity capital and long-term national loan in the ratio of 1:2 and Supplier's credit for the supply of equipment, technology and training of Indian Specialists.

65% of total working capital requirement is to be financed through short-term loan, and the balance of 35% is to be covered by margin money. The break-down of expenditures by sources of finance is represented by following parametres :

The total production costs of commercial Al-Si alloys after reaching the normal plant capacity amount to Rs. 1934.3 mln.

By cost items this amount is distributed as follows :

Item	Cost of item	Amount Rs. mln
1.	Factory costs, including	1707.6
	1.1. Raw materials, utilities and inputs	1684.8
	1.2. Wages and salaries of direct manpower	7.6
	1.3. Factory overhead costs	15.2
2.	Administrative and indirect costs	0.1
3.	Finished product sales and marketing costs	95.0
	Total Operating costs	1802.7
4.	Financial costs (interest)	60.0
5.	Depreciation	71.7
	TOTAL PRODUCTION COSTS	1934.3

The main profitability parametres of SAAP project are as follows :

i) Internal rate of return - 22,3%

ii) Simple rate of return on total investment - 12,5%

iii) Pay-back period - 5,6 years

iv) Break-even point - 64,8%

The sensitivity analysis included at the request of the Indian side, the study of influence on internal rate of return and on break-even point of the variation in process :

i) of commercial alloys of ± 7% from basic price in the range of Rs. 21,500 to Rs. 24,500 per ton.

ii) of primary aluminium in terms of cost of power with fluctuation from basic price of -8% + 12% in the range of Rs. 18,000 to Rs. 22,000 per ton.

iii) of sillimanite concentrate from Rs. 700 to Rs.1,000 per ton with fluctuation of 30%.

Financial evaluation of the project including sensitivity analysis has been carried out with the use of computer and set of programmes developed in VAMI.

Feasibility Study of SAAP construction in India is prepared in accordance with "Manual for the preparation of Industrial Feasibility Studies" (United Nations, New York, 1978) and in full compliance with UNIDO requirements.

2. MAIN CONCEPTS AND ECONOMIC EVALUATION OF THE EXPERIMENTAL DEMONSTRATION UNIT

2.1 PRODUCTION PROGRAMME OF THE EXPERIMENTAL DEMONSTRATION UNIT (ONE FURNACE VARIANT)

The experimental demonstration unit includes one electric arc reduction furnace (17 MW) and the line of technological equipment ensuring the arc furnace operation. Wide product mix of commercial aluminium-silicon alloys corresponding to Indian Standard (IS : 617-1975) can be produced by this experimental unit.

Alloy grades 4600, 4600A and 4652 widely used at present in India have been considered for the production programme of the experimental demonstration unit.

Quantity and nomenclature of these alloys have been assumed on the base of the primary refined alloy (9,540 tpy), produced by one arc furnace.

The specific consumption of raw materials and inputs for production of primary refined and commercial cast Al-Si alloys, annual quantities of produced commercial alloys by grades as well as annual requirements of raw materials and utilities for alloys production are given in tables below:

2.1.1 Specific consumption of raw materials and inputs for primary refined Al-Si alloy.

Sl. No.	Cost item	Unit	Specific consumption	Remarks
1.	Sillimanite concentrate	t/t	1.17	
2.	Dry cleaned kaolin	,,	0.302	
3.	Alumina	,,	0.337	
4.	Coal	,,	0.813	
5.	Petroleum coke	,,	0.604	
6.	Molasses	,,	0.465	
7.	Electrode paste	,,	0.087	
8.	Quartzite	,,	0.186	
9.	Flux (common salt, cryolite potassium chloride)	,,	0.027	
10.	Power (without gas-cleaning)	kwh/t	14,000	
	Including process power	,,	13,000	
11.	Fuel Oil	t/t	0.14	
12.	Water (recycled)	m^3/t	780	
13.	Compressed air	nm^3/t	850	

Note : Consumption figures are identical to figures of the three furnaces variant.

2.1.2 Specific consumptions of raw materials and inputs for conversion of primary refined alloy to commercial Al-Si alloys.

Sl. No.	Cost of item	Unit	Alloy Grade		
			4600	4600A	4652
1.	Refined Al-Si alloy	t/t	0.364	0.337	0.3095
2.	Aluminium	,,	0.737	0.69	0.687
3.	Manganese	Kg/t	9.65	-	-
4.	Copper	,,	-	-	10.2
5.	Nickel	,,	-	-	10.2
6.	Magnesium	,,	-	-	10.2
7.	Flux (cryolite, common salt, potassium chloride sodium flouride)	,,	12.1	8.0	8.0
8.	Power	kwh	620	585	580
9.	Fuel oil	t/t	0.075	0.075	0.075
10.	Water	m^3/t	14	14	14
11.	Compresser air	m^3/t	55	55	

2.1.3 Annual quantities of production by grades of commercial alloys.

Sl. No.	Alloy grade	Annual quantity of production, t	Share of total production, %
1.	4600	11,200	39.8
2.	4600A	8,400	29.9
3.	4652	8,520	30.3
	TOTAL	28,120	100.0

2.1.4 Annual requirements in raw materials and inputs for production of refined primary Al-Si alloy (9,540 tpy)

Sl. No.	Description	Unit	Annual Quantity
1.	Sillimanite concentrate	t	11,162
2.	Kaolin, dry cleaned	t	8,881
3.	Alumina	t	3,215
4.	Coal	t	7,756
5.	Petroleum coke	t	5,762
6.	Molasses	t	4,436
7.	Electrode paste	t	830
8.	Quartzite	t	1,774
9.	Flux		
	- common salt	t	162
	- Cryolite	t	48
	- Potassium chlodide	t	48
10.	Power	mln kwh	42.2
11.	Fuel oil	t	1,336
12.	Process water (recycled)	mln.m^3	7.44
13.	Compressed air	mln.m^3	8.1

2.1.5 Annual requirements of raw materials and inputs for conversion of primary refined alloy to commercial Al-Si alloy (28,120 tpy).

Sl. No.	Description	Unit	Annual Quantity
1.	Refined Al-Si Alloy	t	9,540
2.	Aluminium	t	21,589
3.	Manganese	t	108
4.	Copper	t	-
5.	Nickel	t	87
6.	Magnesium	t	87
7.	Flux		
	- Cryolite	t	15
	- Common salt	t	107
	- Potassium chloride	t	115
	- Sodium flouride	t	34
8.	Quartzite (grist)	t	150
9.	Power	mln.kwh	16,8
10.	Fuel oil	t	2,110
11.	Water	mln.m^3	0,4
12.	Compressed air	mln.nm^3	1,6

In addition to the technological/production programmes of the demonstration unit as described above, two other possible alternatives could be considered from the point of view of the commercial product as follows :-

- primary refined Al-Si alloy with aluminium content of 60% and silicon content of 37% as the commercial product cast in large dimension ingots weighing 100 - 200 kg. These ingots can be used for the production of standard commercial Al-Si alloys at existing units producing similar aluminium alloys now. The techno-economic evaluation of this alternative will be worked out additionally.

- a master Al-Si alloy with silicon content of 20% produced by melting of the primary refined alloy with aluminium as the commercial product. This master alloy can be cast into small dimension pigs weighing 15 - 20 kg and can be used for production of commercial Al-Si alloys at any foundry unit. The techno-economic evaluation of this alternative will be worked out additionally.

Location of the experimental demonstration unit (EDU).

The EDU is assumed to be located also at OSCOM site in Orissa State. This state has possibilities to supply the EDU with raw and auxiliary materials and power. The sillimanite concentrate being the main raw material for Al-Si alloys

production by electro-smelting method is produced as a by-product at OSCOM. It is essential that nearly all materials required in significant quantities for Al-Si alloys production by this unit are available in Orissa State.

The average radius of their delivery to OSCOM site is not exceeding 400 km.

On the OSCOM Site the construction of major infrastural facilities - power and water supply, access-sector and rail roads- have been already undertaken and the construction of colony is under completion.

2.2 Composition of the EDU and major process equipment

2.2.1 Composition of the experimental demonstration unit.

The unit includes :

- Raw material storage with crushing department serving for storing one month inventory of coal and petroleum coke and for curshing and sizing of these materials (reductants) and slags. To store two-week inventory of bagged kaolin and one month inventory of quartzite an area of about 200 m^2 is to be provided at the existing OSCOM site;

- Reductants grinding department serving for the subsequent grinding of coal and petroleum coke;

- Feed preparation room serving for proportioning of feed components, for their mixing, briquetting and drying of briquetted feed;
- Alloy production and electric furnace room serving for reduction smelting of the feed for production of primary Al-Si alloy. After refining this primary alloy is used for production of commercial alloys by means of its alloying with aluminium and master alloys in accordance with the required product mix of commercial alloys.

2.2.2 The major process equipment is shown in table below.

SN	Description	Type & specification	Number	Weight, Kg	
				of one item	Total
1.	Jaw crusher	CMD-108	1	-	8,500
2.	Roller crusher	02 - 1000x550	1	-	17,500
3.	Tangential hammer mill	MMT 1000/950	1	-	8,300
4.	Dust cyclone	LGH-15-1400	1	-	2,420
5.	Electrostatic precipitator	2BF-1-6.1-8	1	-	30,000
6.	Air drier	YCB-30mm, flow rate, 30 nm^3/min	1	-	5,000
7.	Pneumatic screw	HMB-63-2, flow rate 63 m^3/hr	1	-	2,150
8.	Weigher with weight control	DB 600-2000D DB 300-1000D DB 1200-4000D	10	2,030	20,300
9.	Continuous weigher	C6 - 111 rate 16 t/hr	2	3,400	6,800
10.	Continuous weigher	C6-111, rate 10 t/hr	1	-	1,900

11.	Weigher with weight control	DB 120-400D	2	1,130	2,260
12.	Paddle mixer	capacity 6 t/hr	2	4,800	9,600
13.	Roller press	capacity 6 t/hr	1	-	11,000
14.	Conveyor drying oven	capacity 5-6 t/hr	1	-	95,000
15.	Electric arc reduction furnace	Three phase, tree-electrode. power rating 25MVA	1	-	702,000
16.	Storing and charging machine	Dango & Diementhal	2	7,000	14,000
17.	Induction crucible smelting furance	UAT-6M capacity 6 6	3	23,140	69,420
18.	Alloying holding furnace	tilting rotary furnace, fuel oil fired	2	80,000	160,000
19.	Filtration furnace	Fuel oil fired	2	100,000	200,000
20.	Casting conveyor	12m long	1	-	11,709
21.	Casting conveyor with hudraulic tilter	12 m long	1	-	17,309

2.2.3 Environmental impact.

The main source of dust and sulphur dioxide (SO_2) emissions in operation of the experimental demonstration unit is the electric arc reduction furnace which erits upto 560 kg/hr of dust and upto 28 kg/hr of SO_2 when operating at 17 MW power load.

The calculation of dispersal carried out for the Feasibility Report of SAAP for the three furnace varisnt has shown that the cleaning of furnace and gases from sulphur dioxide (SO_2) is not required even in case of three furnaces operation.

The maximum concentration of dust in the atmospheric surface

strata inmost unfavourable meterological conditions in one kilometer radius circle for one furnace operation without gas-cleaning would be 0.5 - 1.0 mg/m^3, which is not exceeding the tolerance limits for populated area according to current sanitary norms of the USSR.

Basing on the above the setting up of the gas-cleaning unit is not provided for the experimental demonstration operation.

The setting up of the gas-cleaning unit for one furnace operation maybe considered additionally after the full fund elaboration/demonstration of the roan industrial scale technological parameters subsequent to reaching the design capacity of the unit. At this stage the experimental demonstration furnace may be coryarated into an extended, lower scale industrial unit expected to be established in the future at the OSCOM location.

2.3 Location of the experimental demonstration unit (EDU) and its utilities supply.

The experimental demonstration unit (installation of one furnace) may be located at two alternative sities at OSCOM. As per the first alternative the EDU is to be located adjacent to north-eastern boundary of the OSCOM Site at the area provided in the Feasibility Report for SAAP (three furnace variant) location. For this alternative the area for EDU will cover 12.0 hectares against 19.4 hectares assumed in the Feasibility Report for the three furnace variant.

As per the second alternative the EDU is combined in one 600 m long line and located along the north-western boundary of the

OSCOM industrial site and will cover the area of 6.0 hectares taking into consideration that some facilities (main step-down sub-station, recycled water unit, air compressor station and other auxilliary facilities) should be located within the existing OSCOM facilities.

The first alternative has better potential as it provides the possibility to convert the above EDU in future into the first stage of the SAAP with the capacity of 90,000 tpy with three furnaces.

The second alternative is less optimal as it excludes the possibility of OSCOM expansion in north-western direction and does not provide for future expansion Al-Si alloys production.

The utilities for the EDU would be supplied partly from the respective OSCOM net-works and from captive facilities.

The water supply is assumed from OSCOM networks with the construction of additional captive water recycle unit.

The steam supply for fire-fighting and heating of tanks and fuel oil pipelines in the feed preparation room would be provided from OSCOM boiler house.

The compressed air would be supplied from the captive compressor station.

Fuel oil would be supplied through OSCOM networks.

The power supply would be provided from the existing HT 132 KV power transmission line with additional installation of one 32 KVA transformer.

2.4 Power supply

The maximum operational electric power load for the experimental demonstration unit will be 24.31 MW (27 OIMVA) for an annual power consumption of 169.7 mln. kwh. The electric loads and power consumption by project components are shown in the table below.

No.	Description	Consumed power, MW	Annual power consumption mln./kwh.
1.	Raw material storage with grinding department	0.3	1.05
2.	Reductants grinding department	0.33	1.15
3.	Feed preparation room	0.45	1.6
4.	Alloy production of furnace room	20.38	145.8
5.	Gas cleaning unit*	1.25	9.0
6.	Water recycle unit	0.5	3.75
7.	Compressor station	0.4	2.4
8.	Losses in transformers	0.7	4.95
	TOTAL:	24.32	169.7

*The gas cleaning unit will be commissioned after the period of two-three years of experimental demonstration operations.

For the experimental - demonstration period the total operational electric power load will be 23 MW and annual electric power consumption - of 160 mln kwh.

Taking into consideration the location of this unit adjacent to OSCOM site (Chatrapur, GanjamDistrict) the optimal concept is the co-operation in power supply with OSCOM.

OSCOM load is 13.5 MW (15 MVA). The power supply is organised through two H.T. 132 KV power transmission lines with carrying capacity of each line of 160 MW. The OSCOM requirement is covered by two transformers 12.5 MVA each installed in the main step-down sub-station (MSDS).

To serve the experimental demonstration unit an additional 32 MVA transformer with power rating of 132/11 KV is to be installed in the same MSDS connected to one of the existing 132 KV power transmission line.

In case of break-down of this transformer the emergency power consumers of the EDU (water recycle unit, lifting mechanism for furnace electrodes etc) should be supplied from one of the MSDS 12.5 MVA transformers of OSCOM or from the Diesel generating unit of 1 MW.

The power supply of the experimental demonstration unit consumers at 11 KV is assumed from the 11 KV distribution switchboard of the MSDS to be common for the experimental unit and OSCOM.

All technical concepts of cable networks, earthing, lightning protection and power electrical equipment, lighting and automation for experimental unit would be similar to the three-furnace variant of Al-Si alloys plant.

2.5 Fuel oil, steam and compressed air supply.

2.5.1. Fuel oil supply.

SN	Consumers	Unit of Measure	Quantity
1.	Reductant grinding department	kg/hr	13
2.	Feed preparation room	,,	155
3.	Electric furnace and alloy production room	,,	402
	TOTAL:	,,	570

The annual requirement of fuel oil is 3,650 t.

The fuel oil should be supplied by pipe-line from OSCOM fuel oil facilities located at OSCOM site.

2.5.2 Steam supply

Steam supply should be supplied in the amount of 1,000 tpy for eventual fire-fighting and for heating of tanks in feed preparation room and also fuel oil pipe lines.

The steam is to be supplied from the OSCOM boiler house.

2.5.3 Compressed air supply

The demand of compressed air at 5-6 atm by project components is shown below:

No	Project component	Unit	Quantity Flow rate, hr. to 24	to 16	to 8
1	Reductant grinding dpt	nm^3/min	2.5	22	2.5
2	Feed preparation room	same	-	-	3
3	Alloy production and furnace room	same	-	2	7
4	Gas-cleaning plant*	same	-	-	3
	Total	nm^3/min	2.5	24	15.5.

* Note: The gas-cleaning unit will be commissioned after two-three years of experimental demonstration operations.

Total compressed air flowrate makes:

$$Q = 1.15(2.5 + 24 \times 0.8 + 15.5 \times 0.6 = 35.6 \text{ nm}^3/\text{min}.$$

Where: 1.15 - includes compressed air losses in network;

0.8 and 0.6 - coefficient of mechanisms utilisation.

The source of compressed air should be the captive compressor station of the experimental unit equipped with 2 compressors of 30 nm^3/min flowrate each.

2.3.4. Water supply and sewerage;

Total quantities of water and sewerage for the experimental demonstration unit make one third part (excluding the storm water sewerage) of total quantities of water and sewerage determined in the three - furnace Feasibility Report for the SAMP. These quantities are shown in table below:

S/N	Description	Rates of water and sewerage	
		m^3/day	m^3/h
1.	Recycle water supply	20000.0	200. 0
2.	Industrial fresh water for make-up of recycle system	550.0	23.0
3.	Potable water	590.0	25.0
4	Domestic sewage	45.0	15.0
5.	Rain water	900 l/Sec.	

Industrial fresh water is used only for make-up of the recycle water designed for cooling hoods of the electric furnaces, furnace transformers, induction furnaces, compressors and other minor users.

The water recycling system consists of the same units and facilities which were provided in the Feasibility Report for the SAMP (three furnace variant) but with lower capacities and flow - rates.

The industrial and drinking water supply networks would be connected with the respective water mains of OSCOM.

The domestic and storm water drainage is provided separately and their main concepts are similar to concepts adopted for OSCOM and in the Feasibility Report for the three furnaces variant.

2.6 Economic and financial evaluation.

The costs of construction and operation of the experimental demonstration unit were calculated at 1982 price level without taking into account the escalation.

2.6.1 Capital investment costs.

Fixed initial capital investment costs for construction of the E. . have been calculated from the detailed cost figures (ref. annex and the amount to Rs. 191.4 mln (without gas cleaning unit and township)

The cost of township construction for the E.D.U personnel is calculated at Rs. 4.3. mln.

In the calculations the setting-up of the gas-cleaning unit (Rs. mln) is assumed for after the period of experimental-demonstration operations as dust this emissions resulting from the operations this unit would not exceed concentration tolerable limits.

The capital investment costs are summarized below. For determination of total capital investment costs the interest during construction and margin money (35% of working capital) are added to the fixed investments.

Sl	Capital investment costs	Rs. Thousands.
1.	Site preparation.	2,[illegible]
2.	Building & Civil works	45, [illegible]
3.	Equipment incl. erection incl.	117,517
	i) Indian Supply	(94,543)
	ii) Supplied from the USSR	7,419
		107,805
	iii) Supplied from third countries	2,293
		(2,002)
4.	Design work and know-how	6,736
		(3,585)
5.	Training of Indian specialists in the USSR	1,740
		(955)
6.	Technical assistance	4,937
		(2,767)
7.	Other works & expenditures	5,106
8.	Contingencies	7,671
	Total fixed initial capital	(4,846)
9.	investment	191,435
		(106,798)
9.	Township	4,290
10.	Margin money (35% of working capital)	10,500
11.	Interest during construction	10,985
	Total capital investment	217,210

Note: Figures in brackets show the foreign exchange component.

...nder the total amount of the foreign exchange component [illegible] of equipment, materials and services which may be supplied by Soviet side, makes Rs. 104.7 mln (or 54.5%) of fixed capital investment cost). The cost of imported equipment to be purchased by Indian side from third countries is estimated at Rs. 2.0 mln.

The cost of equipment is on CIF bares and it includes also the port charges and the cost of transportation of the imported equipment from the port to the site.

Taking into account that the unit for production of Al-Si alloys is on experimental demonstration unit the customs duty on imported equipment is not considered in the calculations.

2.6.2. Sources of finance:

Government equity capital and ~~borrowed~~ borrowed assets in the ratio of 1 : 2 are assumed to be the sources of financing of the EDU construction excluding the township construction costs to be financed at the expense of the equity capital only.

The port of borrowed assets covering equipment supply from the USSR (Rs. 92.5)mln) is expected to be financed from Supplier's credit granted for 10 years with annual interest rate of 4%. The long-term local is expected to be granted for 10 years with 12% of annual interest rate.

The debt including capitalised interest is to be repaid by equal instalments starting from the year following the commissioning of the EDU.

The assets to cover 65% of total working capital requirements are assumed in form of short-term loan with annual interest rate of 18%. The balance 35% of working capital is to be capitalised and financed on the same terms as the fixed capital.

The construction period of the experimental demonstration unit may take two years. The total capital investments are distributed by the two years construction in the amount of 65% for the first 35% in the second year. The possible additional capital investment for gas-cleaning unit is to be provided from the accumulated cash.

2.6.3. Production costs:

The annual operating costs of commercial Al-si alloys production have been calculated for the first year of operation at normal plant capacity on the basis of detailed annual operating costs calculations (ref annexure 3), of depreciation and interest during construction, as shown below:

SN	PRODUCTION COSTS	RS THOUS
1.	Raw mmk and auxilliary materials	73,860
2.	Primary aluminium	423,144
3.	Power	48,495
4.	Fuel Oil	9,649
5.	Otherutilities	2,352
6.	Cost of man power	3,861
7.	Maintenance & repair (@ 2.5% from cost of equipment)	2,938
	TOTAL VARIABLE COSTS (1 to 7)	564,299
8.	Overhead costs	1,071
9.	Administrative costs and sales costs	31,760
10.	Interest on working capital (18%)	3,330
	TOTAL FIXED COSTS (8 to 10)	36,161
11.	Depreciation*	18,229
12.	Interests	2,420
	TOTAL PRODUCTION COSTS	621,109
	Production cost of 1 t of commercial alloy	22,088

* Depreciation is calculated based on following norms:

i) buildings and civil works - 5%

ii) equipments 10%

iii) pre-production capital costs-10%

2.6.4. Financial analysis

Both the cash-flow and net income statements have been worked out for the period of 15 years.

The financial analysis is made on the basis of prices at mid 1982 price levels as follows:

i) Al-si commercial alloys - Rs.23.000 per ton

ii) Aluminium - Rs.19.600 per ton

iii) Electric power - Rs.305 per 1.000 kwh

The profitability of the EDU project was estimated by calculation of the internal rate of return on the capital investment and on equity capital.

The financial analysis was carried out using the computer programmes developed in VAMI. The computer printing of the results of financial analysis with basic prices is given in Annexures 4-7 including the following estimates:

1. Cash flow for financial analysis
2. Net income statement
3. Projected balance sheet
4. Internal rate of return.

The variant with basic prices has the following parameters.

- internal rate of return on invested capital - 16.3%
- internal rate of return on equity capital - 15.6%
- pay-back period - 6 years
- break-even point- 76.2%

The sensitivity analysis includes the study of the internal rate of return and of the break-even point in function of:

- prices of alloys
- prices of aluminium
- prices of power

For each alloy price the sensitivity analysis in respect to aluminium and power prices is carried out. The influence of each of these parameters is shown in sensitivity Analysis Tables of Annexure 8 (For variants which are not profitable the internal rate of return is shown by conventionsl sign 777.7).

The influence of prices on alloys

The price of alloy is considered over the range of Rs.22000--27000 per ton with an interval of Rs.500. The fluctuation from the basic price level (Rs.23000 per ton) is-5% to+17%.

The analysis reveals that the project can be viable even with minimal level alloy price and it becomes profitable with price increase determined by the increased demand on alloys in Indian economy.

2. The influence of prices on aluminium

The price of aluminium is considered in the range of 18000 to 22000 rupees per ton (with deviation from the basic level of - 8% to+12%).

The influence of this price on the profitability level is rather important since the aluminium cost component in the total amount of operating costs is very high (70%).

The price of metal at the internationsl market tends to fall (considerably less than the minimum level assumed in the calculations). This makes the project economically viable.

The influence of the price of power

The price of power is studied within the range of Rs.305

(basic) to 500 per 1000 k .hour (+64% of basic variant).

The influence of this price is important, and under the condition that the price of aluminium wouldn't be considerably increased, the project as a whole remains viable even with the price of power equal to Rs.500 per 1000 kw.hour.

The relationship of all the parameters and their effect on the internal rate of return (on equities) are shown on the plot given below.

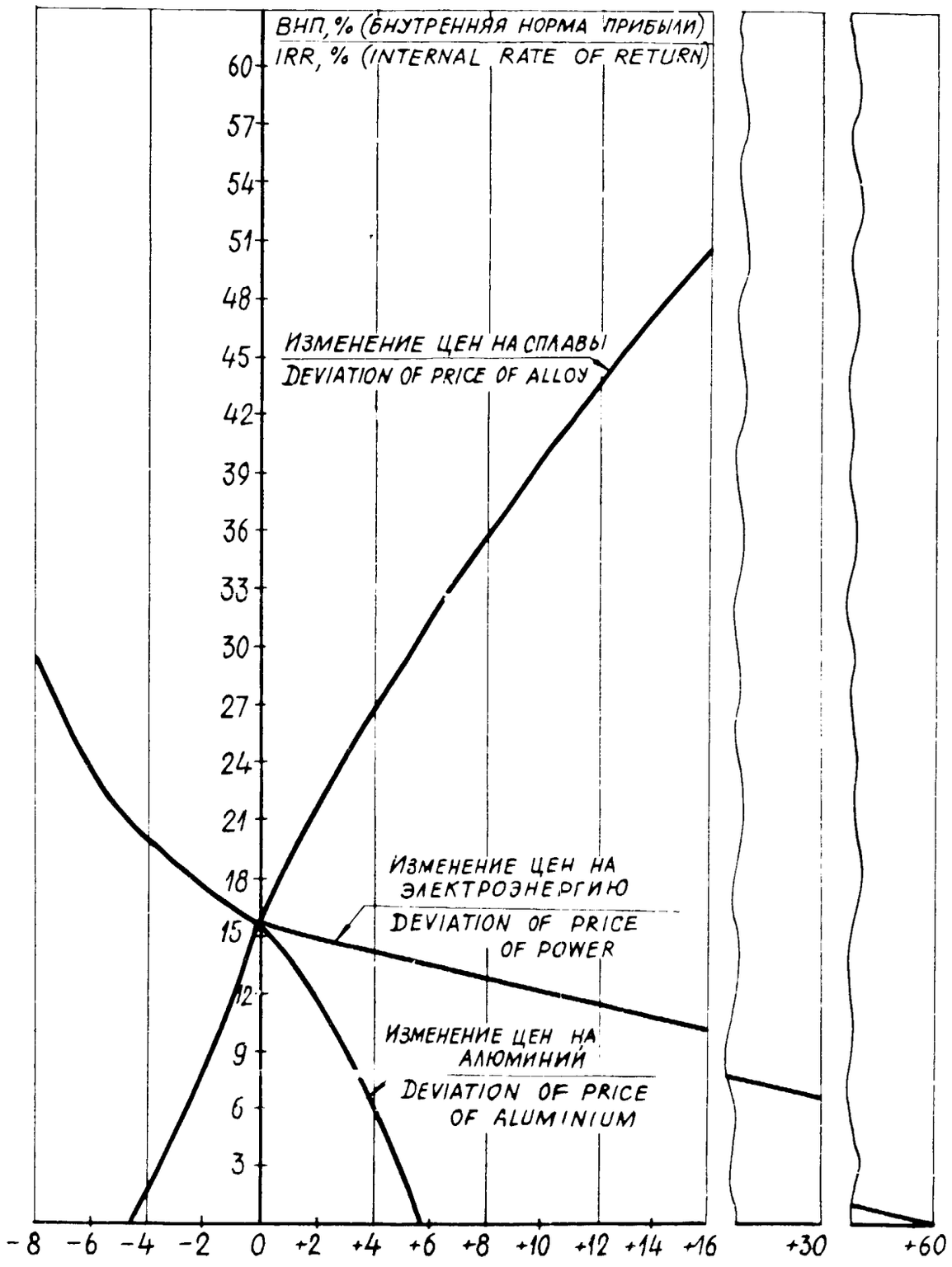
ЗАВИСИМОСТЬ ВНП ОТ УРОВНЯ ЦЕН
EFFECT OF PRICE LEVEL ON IRR

БАЗОВЫЕ ЦЕНЫ:
BASE PRICES:

- АЛЮМИНИЙ - 19600 РУП/Т
- ALUMINIUM - Rs 19600/T

- СПЛАВЫ - 23000 РУП/Т
- ALLOY - Rs 23000/T

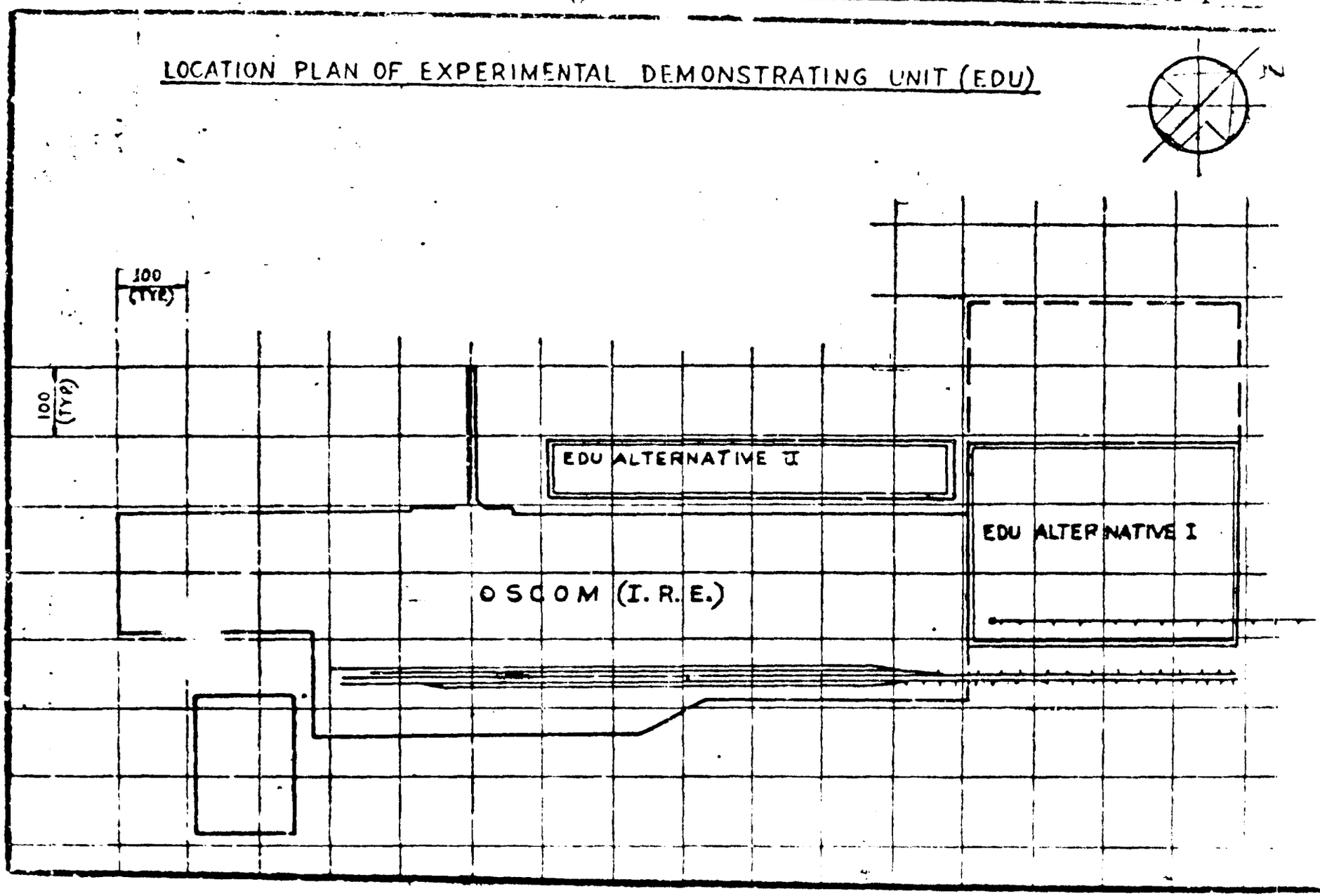
- ЭЛЕКТРОЭНЕРГИЯ - 305 РУП/1000 КВТ.Ч
- POWER - Rs 305/1000 KW.h



ОТКЛОНЕНИЕ ЦЕН ОТ БАЗОВЫХ, %
DEVIATION OF PRICES FROM BASE CASE, %

A N N E X T U R E S

LOCATION PLAN OF EXPERIMENTAL DEMONSTRATING UNIT (EDU)



ANNEXURE - II

SUMMARY COST ESTIMATE OF SETTING-UP OF EXPERIMENTAL DEMONSTRATING UNIT FOR THE PRODUCTION OF AL-SI ALLOYS IN ORISSA STATE

Sl. No.	Description	Calculated cost, Thous. Rupees				
		Civil Works	Erection works	Equip-ment	Other costs	Total cost
1	2	3	4	5	6	7
1.	A Site preparation					
	Land Unit					
2.	Site levelling	2620,0	-	-	-	2620,0
	Total for A	2620,0	-	-	-	2620,0
	Components of the experimental demonstrating Unit					
3.	Raw material storage	2220,0	496,2	5336,8	-	8655,8
	Foreign exchange component (FEC)			(4882.4)		(4882,4)
4.	Raw material grinding	755.5	258.9	2281.6	-	3296.0
	F.E.C.			(1860,7)		(1860,7)
5.	Feed Preparation Room	5485,5	1079,2	9930,6	-	16495,3
	F.E.C.			(8418.7)		(8418.7)

1	2
6.	Furnace and Alloy production & Electric Room F.E.C. Including equipment from third countries
7.	Pneumatic transport rack
8.	Conveyor Gallery
9.	Power supply F.E.C.
10.	Compressor station
11.	Motor roads & areas
12.	Water cooling Unit F.E.C.
13.	Water supply and sewerage net works F.E.C.
14.	Site Development and Greenery

3	4	5	6	7
30849,7	7248,3	64314,5		102412,5
		(63165.9)		(63165,9)
		(2002.0)		(2002,0)
76,0	-	-	-	76,0
1312,3	-	-	-	1312,3
694.3	1919,8	13276,9	-	15891,0
		(13254,1)		(13254,1)
285,5				
1223,6	-	-	-	1223,6
8.3,5	415,4	3631,6	-	4893,5
		(1364.6)		(1364.6)
634,0	85,5	854,7	-	1574,2
		(125,1)	-	(125,1)
75,6	-	-	-	75,6

1	2
15.	Lighting
	F.E.C.
	Total for B
	F.E.C.
	Including equipment from Third Countries
	Total for A + B
	F.E.C.
	Including equipment from Third Countries
	C. Other costs
16.	Port charges, transportation & insurance
17.	Required rents for construction including temporary buildings and structures
18.	Design
19.	Start-up & commissioning
20.	Build-up of Administrative structure, hiring & training of Personnel

3	4	5	6	7
20,0	33,4	227,2	-	280,6
		(225,2)		(225,2)
45079,3	11696,9	101192,7	-	157968,9
		(94543,4)		(94543,4)
		(2002,0)		(2002,0)
47699,3	11696,9	101192,7	-	160588,9
		(94543,4)		(94543,4)
		(2002,0)		(2002,0)
			4627,1	4627,1
			1781,9	1781,9
			3964,7	3964,7
			910,5	910,5
-	-	-	5,0	5,0

1	2.	3.
21.	Know-how	-
22	F.E.C.	
22.	Tax on Know-how	-
23.	Training of Indian Experts in the U.S.S.R.	-
24.	Allocation for Soviet Experts deputed to India for construction and erection supervision, start-up and commissioning during early operations and performance guarantee tests, collection of initial data for detailed engineering F.E.C.	-
25.	Income-tax on services of Soviet Experts	-
26.	Control, co-ordination and commissioning	
	Total for C	
	F.E.C.	
	Total for A + B + C	47699,3

4.	5.	6.	7.
-	-	2000,0	2000,0
		(2000,0)	(2000,0)
-	-	800,0	800,0
-	-	1740,0	1740,0
-	-	3830,0	3830,0
		(2767,0)	(2767,0)
-	-	(1107,0	1107,0
		2408,8	2408,8
		23175,0	23175,0
		(7307,9)	(7307,9)
11696,9	101192,7	(23175,0)	183763,9

1	2
	F.E.C.
	Including equipment from Third Countries
27.	Contingencies (3% of civil works and 5% of equipment cost)
	F.E.C.
	Total without gas cleaning and township
	F.E.C.
	Including equipment from Third Countries

3	4	5	6	7
		(94543,4)	(7307,9)	(101851,3)
		(2002,0)	-	(2002,0)
1431,0	584,8	4959,5	695,3	5670,6
		(4627,1)	(219,2)	(4746,3)
49130,7	122281,7	106152,2	23870,3	191434,5
		(99170,5)	(7527,1)	(106697,6)
		(2002,0)	-	(2002,0)

1	2	3	4	5	6	7

ADDITIONAL INVESTMENT COSTS AFTER CONCLUSION
OF THE EXPERIMENTAL DEMONSTRATION OPERATIONS
AFTER 2-3 YEARS PERIOD

Gas Clearing				31183,3	31183,3
Infrastructure (Town-ship)				4289,3	4289,3
Total	49130,3	12281,7	106152,2	59432,9	226907,1
F.E.C.			(99170,5)	(7527,1)	(106697,6)
Including equipment from Third countries			(2002,0)	-	(2002,0)

ANNEXURE - III

COST ESTIMATE OF ANNUAL OPERATING COSTS

PRODUCTION OF PRIMARY ALLOY - 9,540 t py

PRODUCTION OF COMMERCIAL AL-SI ALLOYS - 28,120 t py

Sl. No.	Cost of Item	Unit of measure	Price Rs.	Quantity	Costs Rs. '000
1.	2.	3.	4.	5.	6.
	A. Production of Primary Alloy				
1.	Raw Materials	t	[illegible]	[illegible]	[illegible]
1.1	Silimanite concentrate	t	1000	11162	11162
1.2	Kaolin	,,	2200	2881	6338
1.3	Alumina	,,	2810	3215	9034
1.4	Quartzite	,,	200	1774	355
1.5	Coal	,,	300	7756	2327
1.6	Petroleum coke	,,	3500	5762	20167
1.7	Molasses	,,	95	4436	421
1.8	Electrode paste	,,	7810	830	6481
1.9	Flux	-	-	-	1057
	Total for item 1				57343
2.	Utilities				
2.1	Power	000 kwhr	305	142100	43371
2.2	Fuel Oil	Tt	2800	1336	3741
2.3	Industrial water	1000 M^3	300	7440	2232
	Total for item 2				49344
3.	Cost of Manpower				2877
4.	Repair & Maintenance @ 25%				1959
	TOTAL VARIABLE COSTS				11523

1.	2	3	4	5	6
5.	Overhead costs	-	-	-	67
6.	Interest on working capital (@ 18%)	-	-	-	2[illegible]
	Total fixed cost				2861
	Total operating costs for production of primary alloy, Item A	-	-	-	11[illegible]
	same, per 1 t	-	-	-	11[illegible]
	B. Conversion of Primary Alloy to Commercial Alloy				
7.	Materials	Tt	19600	21589	423[illegible]
7.1	Aluminium				
7.2	Master Alloys	,,	-	360	1[illegible]
7.3	Flux	-	-	-	1[illegible]
	Total for item 7		-	-	43[illegible]
8.	Utitilities				
8.1	Power	000, kWh	305	16800	5[illegible]
8.2	Fuel Oil	Tt	2800	2110	59[illegible]
8.3	Industrial Water	1000 M^3	300	400	1[illegible]
	Total for item 8		-	-	11162
9.	Cost of manpower	-	-	-	984
10.	Repair & Maintenance	-	-	-	979
	Total variable costs		-	-	482776

1.	2.	3.	4.	5.	6.
11.	Overhead costs	-	-	-	401
12.	Administrative and sales costs	-	-	-	31740
13.	Interest on working capital	-	-	-	1116
	Total fixed costs		-	-	33277
	Total for B		-	-	43053
	Total Operating costs A + B		-	-	60046
14.	Depreciation	-	-	-	18229
15.	Interest	-	-	-	2420
	Total production costs		-	-	80795
	Same, per 1 t of commercial alloys, rup es				22088

PERIOD			
YEAR			
PRODUCTION PROGRAMME			
A. CASH INFLOW	646760	646760	646760
1. FINANCIAL RESOURCES TOTAL	0	0	0
2. SALES REVENUE	646760	646760	646760
3. BANK OVERDRAFTS	0	0	0
B. CASH OUTFLOW	633295	632890	632465
1. TOTAL ASSETS INCLUDING REPLACEMENTS	0	0	0
2. OPERATING COSTS	600460	600460	600460
3. DEBT SERVICE (TOTAL)	18187	17228	16270
3.1. INTEREST :	3814	2855	1917
3.1.1. SUPPLIERS' CREDITS	1527	1145	763
3.1.2. BANK TERM LOANS	2306	1729	1153
3.1.3. WORKING CAPITAL LOAN	0	0	0
3.1.4. BANK OVERDRAFTS	0	0	0
3.2. REPAYMENTS :	14373	14373	14373
3.2.1. SUPPLIERS' CREDITS	9569	9569	9569
3.2.2. BANK TERM LOANS	4804	4804	4804
3.2.3. BANK OVERDRAFTS	0	0	0
4. CORPORATE TAX	14648	14258	13868
5. DIVIDENDS	0	0	0
C. SURPLUS / DEFICIT	13465	14870	14295
D. CUMULATIVE CASH BALANCE	75465	90335	104630

SECTION 1

PERIOD			
YEAR			
PRODUCTION PROGRAMME			
A. CASH INFLOW	646760	646760	646760
1. FINANCIAL RESOURCES TOTAL	0	0	0
2. SALES REVENUE	646760	646760	646760
3. BANK OVERDRAFTS	0	0	0
B. CASH OUTFLOW	633295	632890	632465
1. TOTAL ASSETS INCLUDING REPLACEMENTS	0	0	0
2. OPERATING COSTS	600460	600460	600460
3. DEBT SERVICE (TOTAL)	18187	17228	16270
3.1. INTEREST :	3814	2855	1917
3.1.1. SUPPLIERS' CREDITS	1527	1145	763
3.1.2. BANK TERM LOANS	2306	1729	1153
3.1.3. WORKING CAPITAL LOAN	0	0	0
3.1.4. BANK OVERDRAFTS	0	0	0
3.2. REPAYMENTS :	14373	14373	14373
3.2.1. SUPPLIERS' CREDITS	9569	9569	9569
3.2.2. BANK TERM LOANS	4804	4804	4804
3.2.3. BANK OVERDRAFTS	0	0	0
4. CORPORATE TAX	14648	14258	13868
5. DIVIDENDS	0	0	0
C. SURPLUS / DEFICIT	13465	14870	14295
D. CUMULATIVE CASH BALANCE	75465	90335	104630

ANNEXURE 4

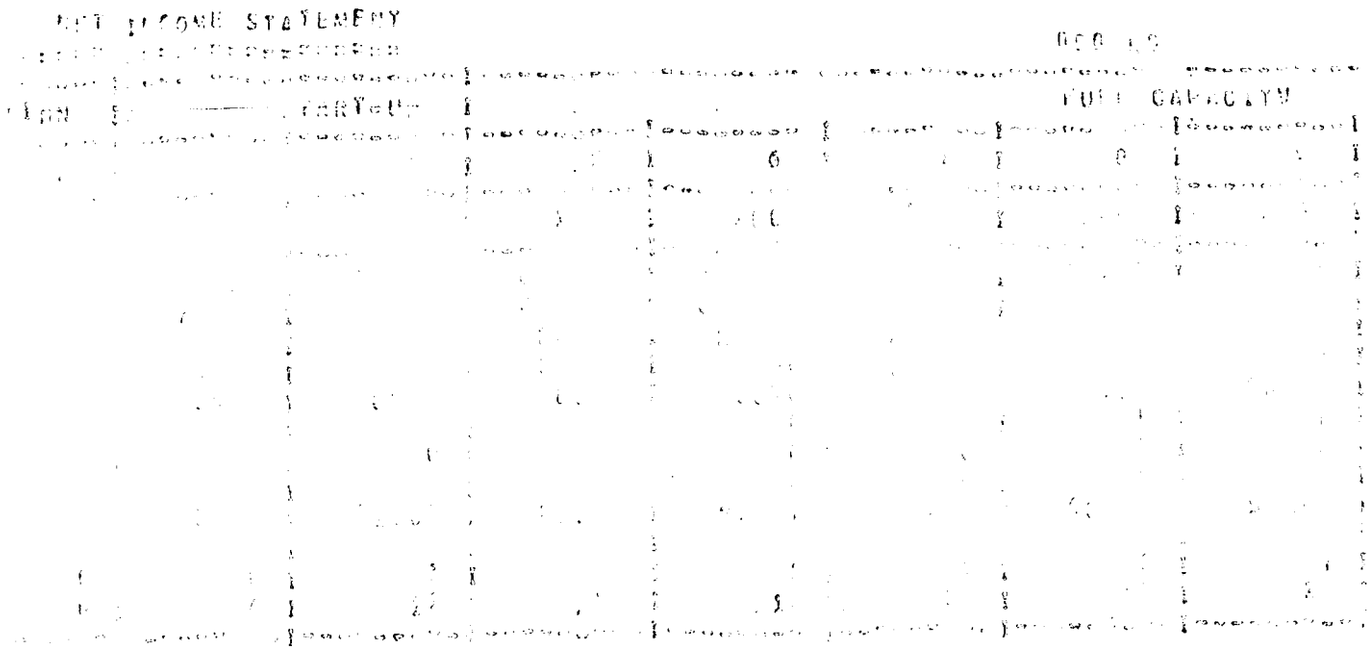
SECTION 2

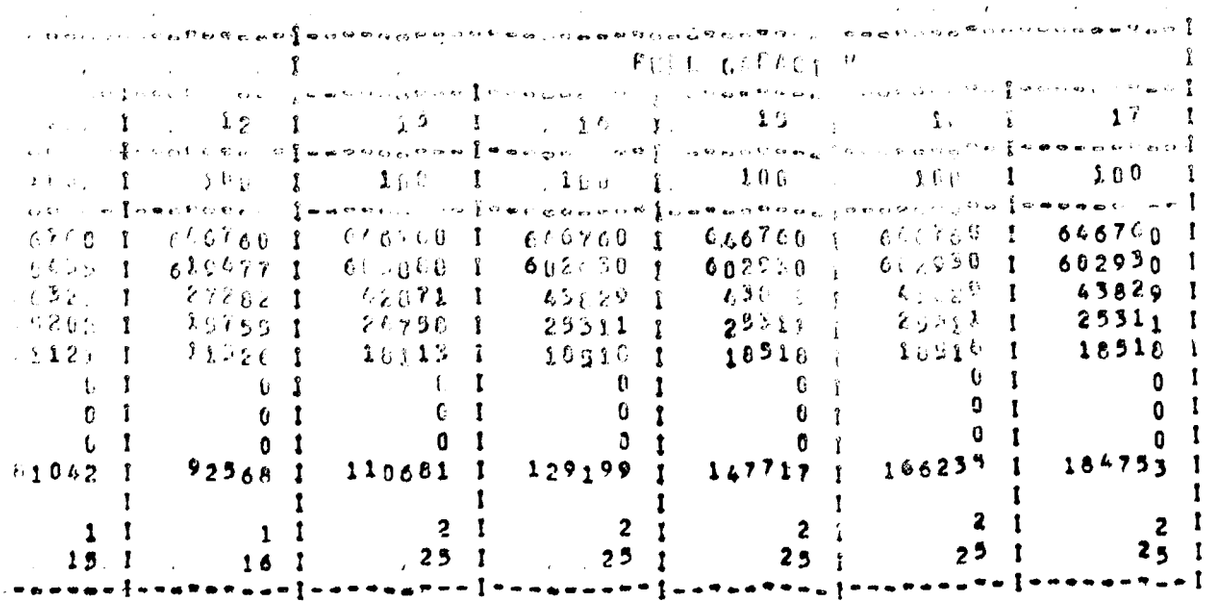
NET INCOME STATE

PERIOD	CONSTRUCTION	
YEAR		
PRODUCTION PROGRAMME		
8. GROSS OR TAXABLE PROFIT	0	0
9. NET PROFIT	0	0

PERIOD				
YEAR	10	11	12	
PRODUCTION PROGRAMME	100	100	100	
11. SALES	666760	666760	666760	6
12. PRODUCTION COSTS	621394	620455	619477	6
13. GROSS OR TAXABLE PROFIT	29365	26305	27284	
14. TAX	17648	15184	15764	
15. NET PROFIT	10716	11121	11520	1
16. DIVIDENDS	0	0	0	
17. UNDISTRIBUTED PROFITS	0	0	0	
18. ACCUMULATED UNDISTRIBUTED PROFITS	0	0	0	
19. ACCUMULATED NET PROFIT	69921	81042	92562	1
RATIOS				
110. NET PROFIT : SALES (P.C.)	1	1	1	
111. NET PROFIT : EQUITY (P.C.)	14	15	16	

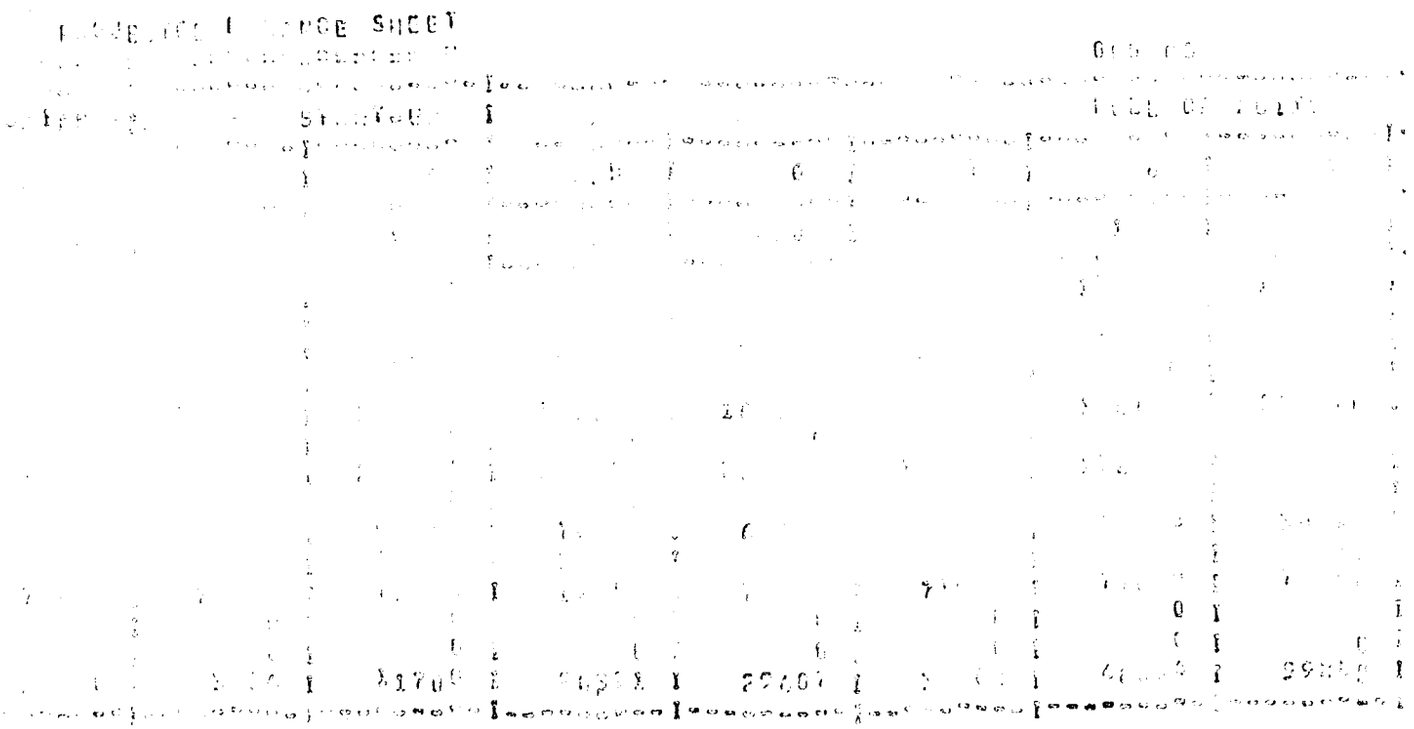
SECTION 1





SECTION 2

PERIOD			
YEAR	10	11	12
PRODUCTION PROGRAM	100	100	100
A.ASSETS (TOTAL)	184575	181341	178512
1.CAPITALIZED EXPEND.	8940	8940	8940
2. CASH BALANCE	79069	76529	73934
3. CURRENT ASSETS	0	0	0
4.FIXED ASSETS (NET OF DEPRECIATION)	100966	95462	89638
5.LOSSES	0	0	0
B.LIABILITIES(TOTAL)	184575	181341	178512
1.CURRENT LIABILITY	0	0	0
2.SUPPLIER'S CREDIT	28642	19092	9542
3.LONG TERM LOANS	14412	9607	4802
4.EQUITY CAPITAL	71600	71600	71600
5.WORKING CAPITAL LOAN	0	0	0
6.SHORT-TERM LOAN	0	0	0
7.RESERVES	69921	81042	92568



	12						
100	100	100	100	100	100	100	100
101341	178512	182271	200769	219307	237829	256343	
0	0	0	0	0	0	0	
10092	9942	-7	-7	-7	-7	-7	
9607	4802	-3	-3	-3	-3	-3	
71600	71600	71600	71600	71600	71600	71600	
0	0	0	0	0	0	0	
0	0	0	0	0	0	0	
81042	92568	110681	129199	147717	166235	184753	

SECTION 2

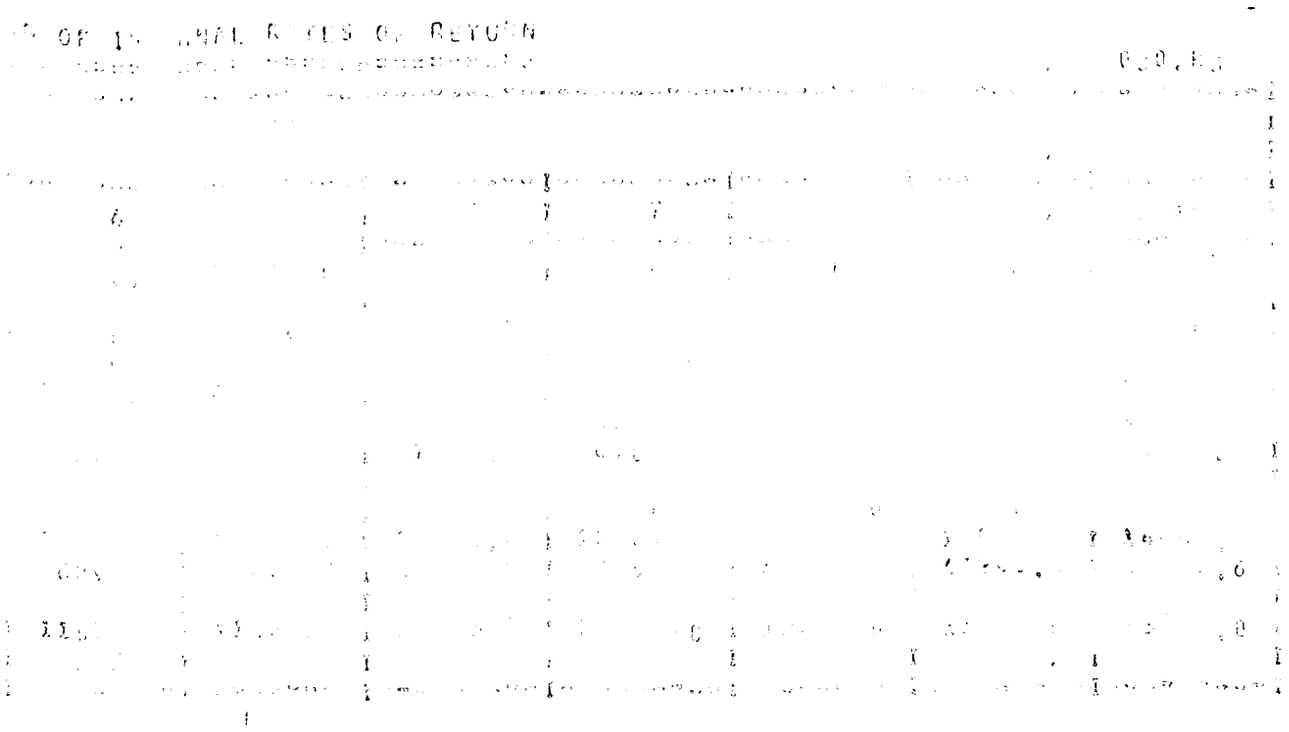
CALCULATION OF INTERNAL R

DESCRIPTION	YEARS FROM THE BEGINNING OF THE CONSTRUCTION				
	11	12	13	14	
1.CAPITAL COST INVESTMENT	0.0	0.0	0.0	0.0	0.
2.EQUITY CAPITAL	0.0	0.0	0.0	0.0	0.
3.WORKING CAPITAL	0.0	0.0	0.0	0.0	0.
4.GROSS PROFIT	46299.6	46299.6	46299.6	46299.6	46299.
5.DEBTS REPAYMENT	14333.0	14333.0	13359.0	0.0	0.
6.INTEREST PAYMENTS	2075.7	1917.2	958.3	0.0	0.
7.RESIDUAL VALUE	0.0	0.0	0.0	0.0	0.
8.INCOME TAX	15202.1	15359.6	24758.0	25311.6	25311.
9.THE RETURN ON INVESTMENT	46299.6	46299.6	46299.6	46299.6	46299.
10.THE RETURN ON EQUITY	13868.0	14272.9	6228.0	20988.0	20988.

INTERNAL RATE OF RETURN ON INVES
INTERNAL RATE OF RETURN ON EQUIT

* ОТЛАДКА. INDRI. КОНЕЦ. 17.48

SECTION 1



0.	0.0		0.0
0.0	0.0	0.	0.0
0.	0.0	0.	0.0
46299.6	46299.6	46299.	46299.
0.0	0.0	0.0	0.
0.0	0.0	0.0	
0.0	0.0	0.0	22900.0
25311.6	25311.6	25311.6	25311.6
46299.6	46299.6	46299.6	46299.6
20988.0	20988.0	20988.0	20988.0

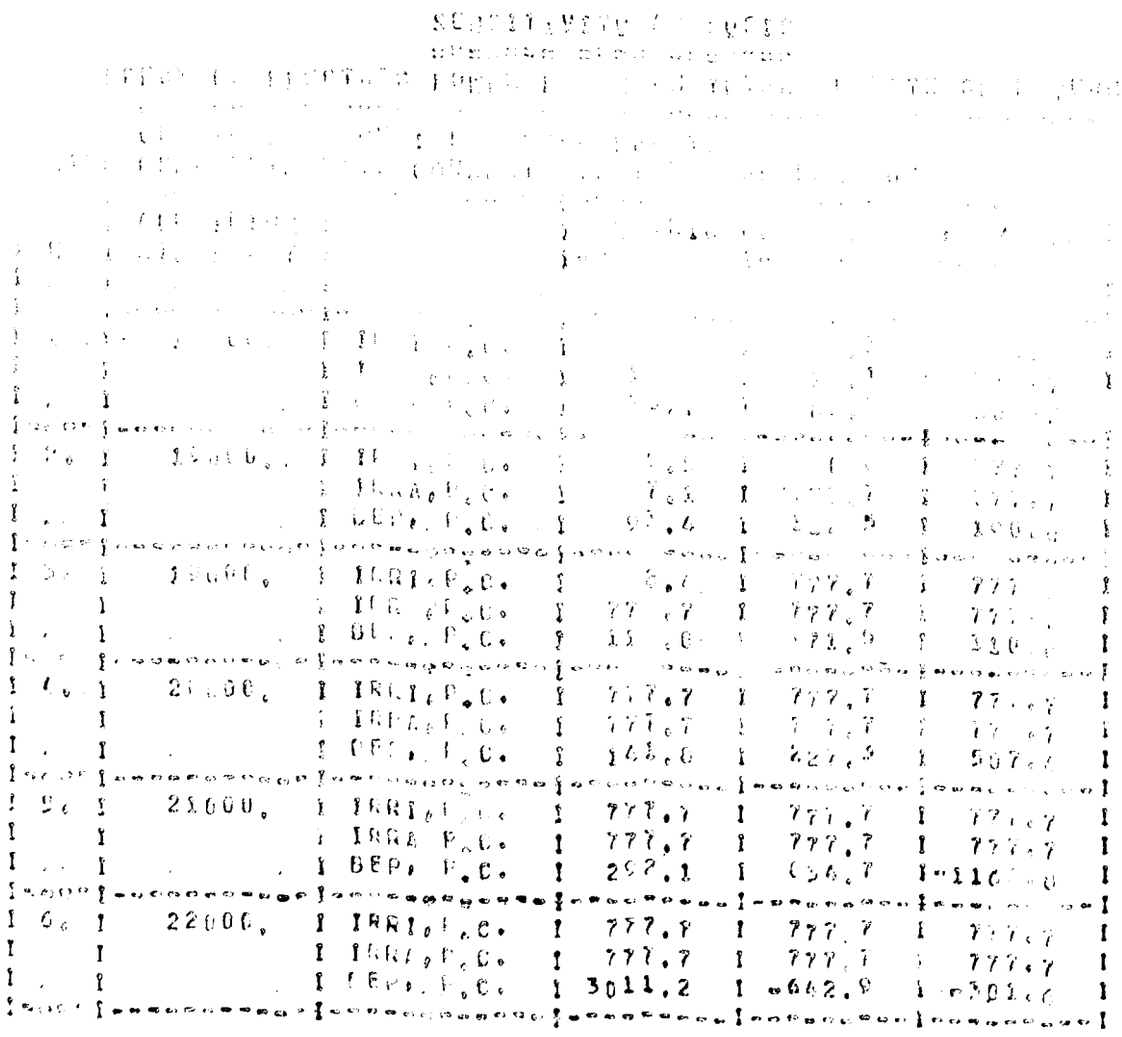
OF RETURN ON INVESTMENT : 16.50 P.C.
OF RETURN ON EQUITY : 15.62 P.C.

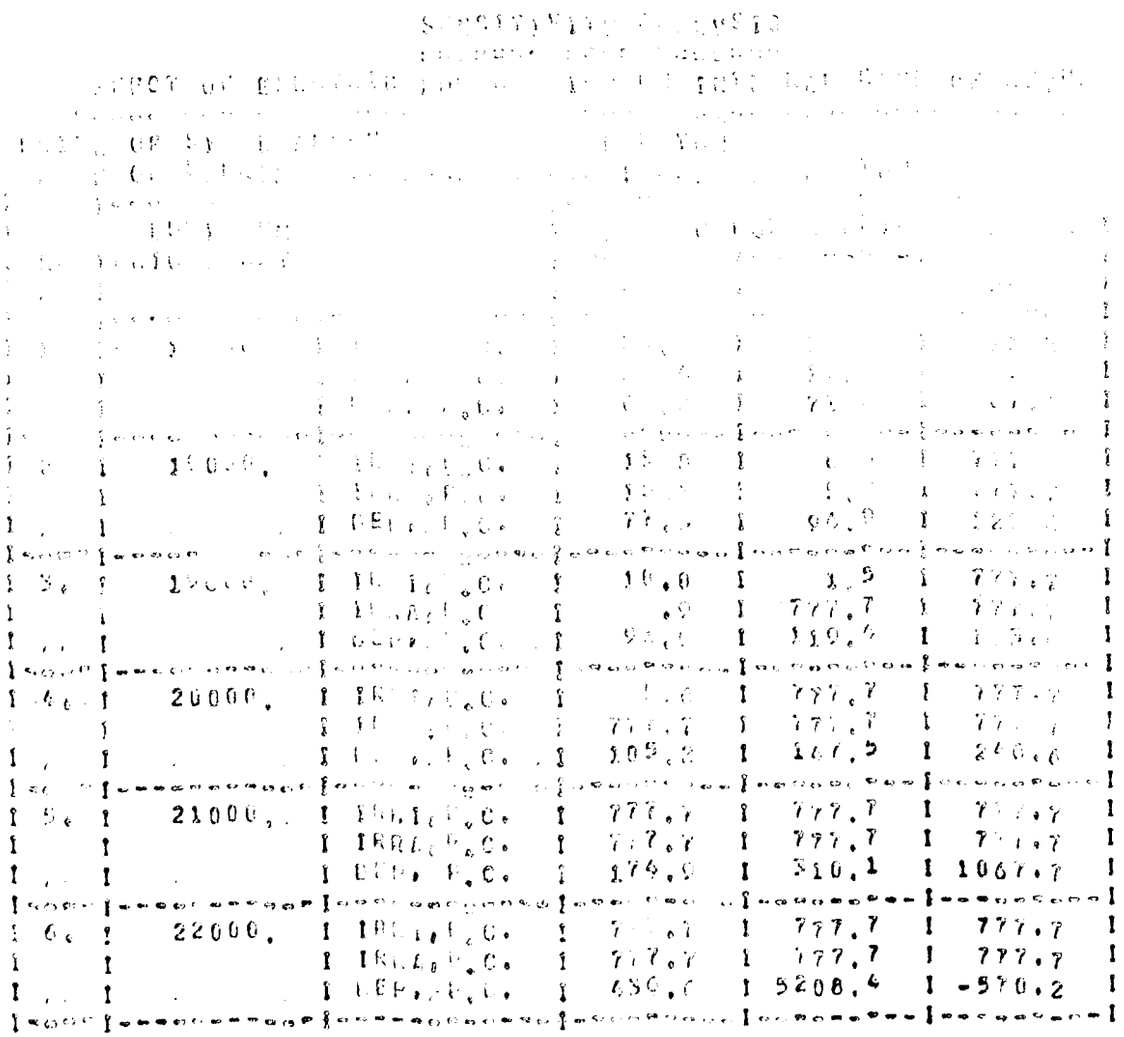
SECTION 2

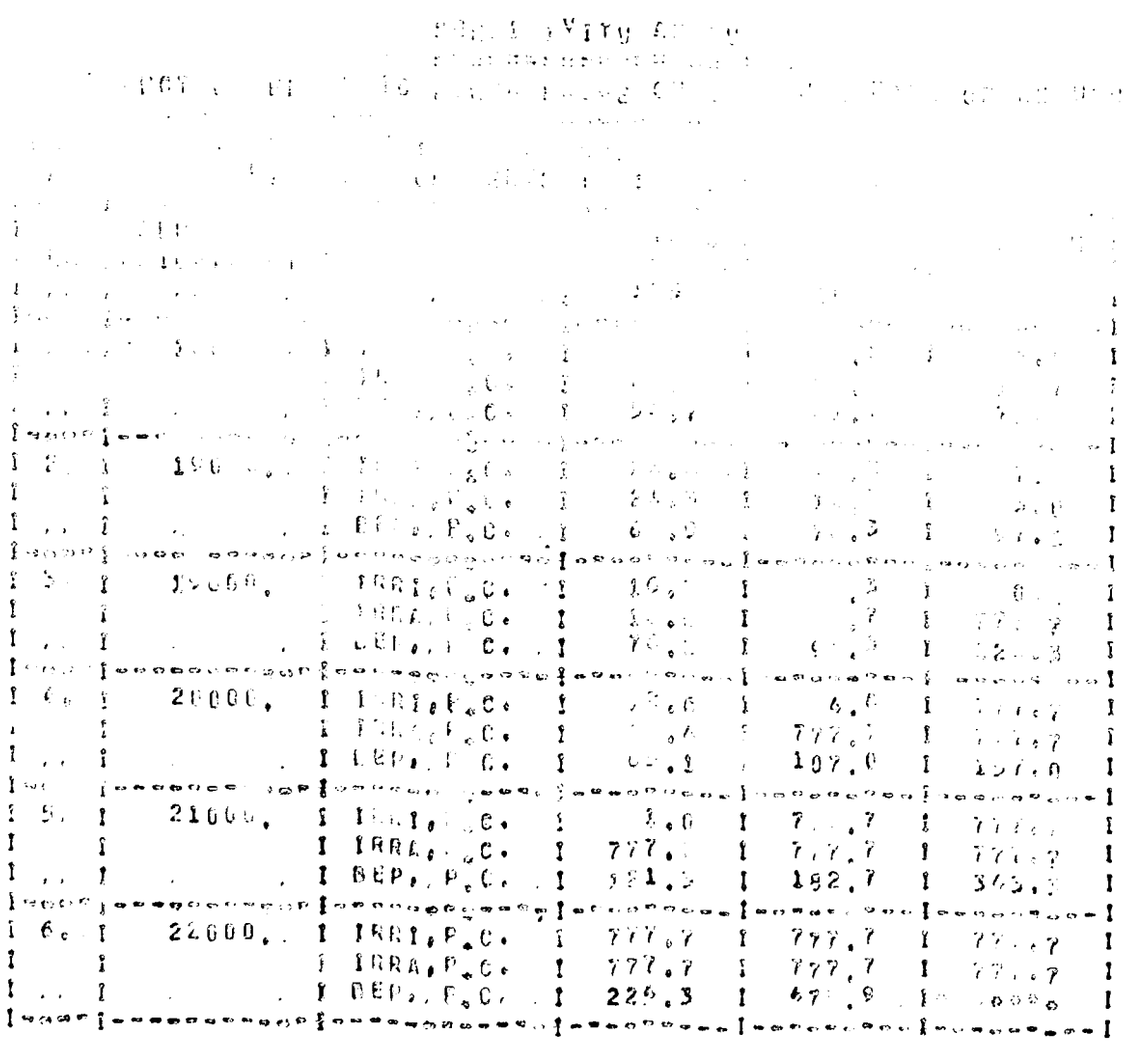
Annexure 8

SENSITIVITY ANALYSIS

THE INFLUENCE OF THE LEVEL OF PRICES OF ALLOYS, ALUMINIUM AND POWER ON THE INTERNAL RATE OF RETURN



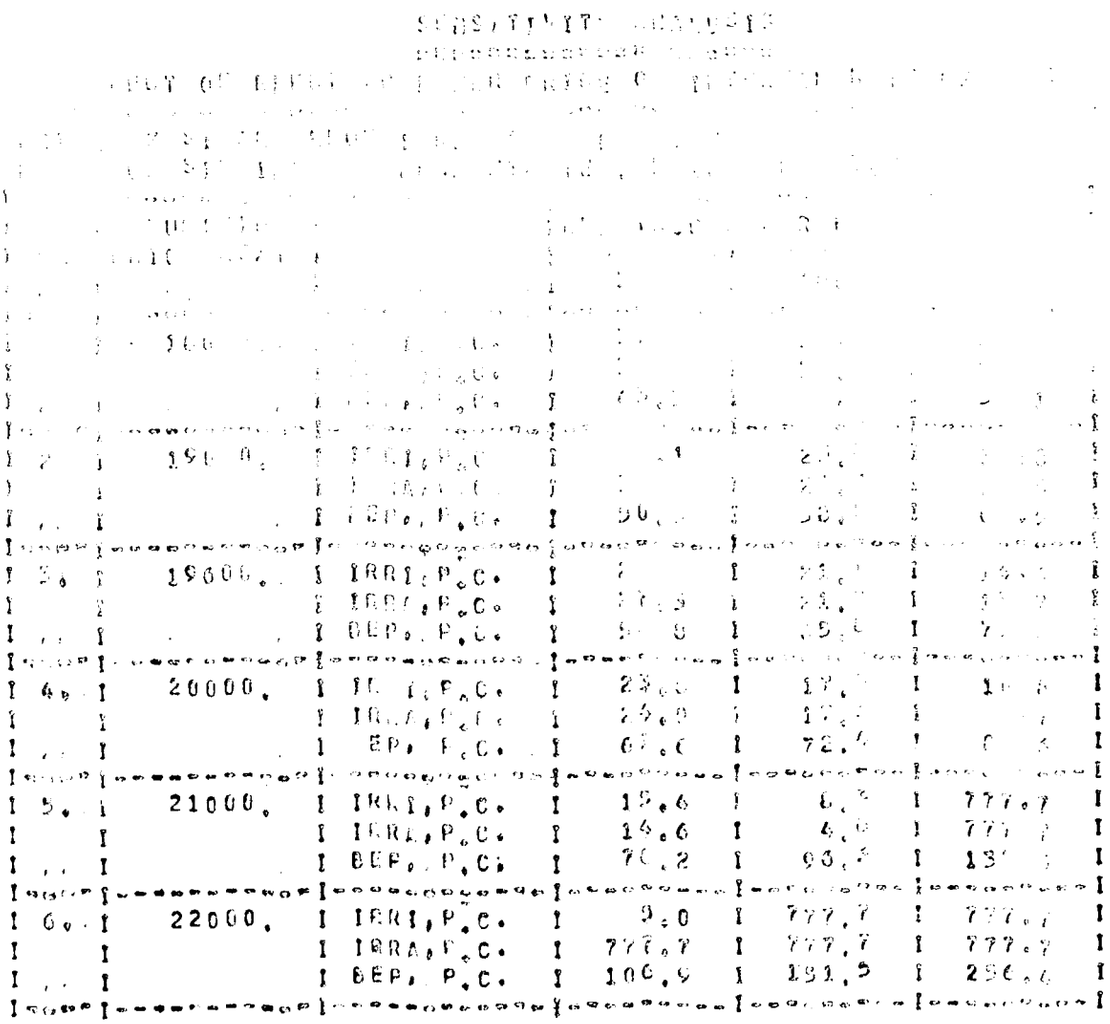




SENSITIVITY ANALYSIS

[illegible]

[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	22.[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]
2.	[illegible]	IRRI,P.C.	[illegible]	21.[illegible]	[illegible]
		IRRA,P.C.	[illegible]	20.6	[illegible]
		BEP,P.C.	37.6	66.6	[illegible]
3.	19000.	IRRI,P.C.	[illegible]	[illegible]	6.[illegible]
		IRRA,P.C.	[illegible]	1[illegible].9	6.2
		BEP,P.C.	[illegible]	77.3	9[illegible]
4.	20000.	IRRI,P.C.	[illegible].5	13.9	3.5
		IRRA,P.C.	[illegible]	10.4	777.7
		BEP,P.C.	71.[illegible]	66.4	11[illegible].7
5.	21000.	IRRI,P.C.	9.6	6.2	777.7
		IRRA,P.C.	6.[illegible]	777.7	777.7
		BEP,P.C.	94.8	125.4	196.1
6.	22000.	IRRI,P.C.	777.7	777.7	777.7
		IRRA,P.C.	777.7	777.7	777.7
		BEP,P.C.	145.5	239.9	546.3



SPECIAL VIEW ANALYSIS

COST OF PRODUCTION

2.	19000.	IRRI,P.C.	49.7	57.[illegible]	[illegible]	
		IRRA,P.C.	[illegible]	[illegible]	[illegible]	
		BEP,P.C.	[illegible]	[illegible]	[illegible]	
3.	19000.	IRRI,P.C.	51.[illegible]	[illegible]	[illegible]	
		IRRA,P.C.	53.[illegible]	[illegible]	[illegible]	
		BEP,P.C.	90.4	97.9	[illegible]	
4.	20000.	IRRI,P.C.	20.7	[illegible]	[illegible]	
		IRRA,P.C.	23.3	[illegible]	[illegible]	
		BEP,P.C.	58.2	68.[illegible]	73.[illegible]	
5.	21000.	IRRI,P.C.	21.0	14.7	[illegible]	
		IRRA,P.C.	20.9	13.9	0.[illegible]	
		BEP,P.C.	66.6	79.2	99.1	
6.	22000.	IRRI,P.C.	15.1	[illegible]	777.7	
		IRRA,P.C.	10.9	771.7	777.7	
		BEP,P.C.	86.3	103.9	161.[illegible]	

SENSITIVITY ANALYSIS

2	18000.	IRRI, P.C.	41.0	39.9	2	
		IRRA, P.C.	41.0	39.9	2	
		BEP, P.C.	41.4	46.8	5	
3	19600.	IRRI, P.C.	39.9	30.0	2	
		IRRA, P.C.	37.8	31.6	2	
		BEP, P.C.	65.3	50.8	10	
4	20000.	IRRI, P.C.	33.2	28.0	22.2	
		IRRA, P.C.	31.2	28.0	21.2	
		BEP, P.C.	60.3	54.7	6	
5	21000.	IRRI, P.C.	20.1	20.4	13.7	
		IRRA, P.C.	20.5	20.2	12.7	
		BEP, P.C.	57.9	67.3	81.1	
6	22000.	IRRI, P.C.	16.1	11.4	2.9	
		IRRA, P.C.	17.6	9.8	777.7	
		BEP, P.C.	72.3	87.6	116.2	

SENSITIVITY ANALYSIS

Effect of Different Possible Future Interest Rate on Internal Rate of Return

S.No.	Project Cost (Rs.)	Alternatives	Internal Rate of Return (%)	Net Present Value (Rs.)	Benefit Cost Ratio
1.	15000.	IRR1, P.C.	38.0	3.2	1.0
		IRR2, P.C.	40.2	3.8	1.0
		BEP, P.C.	39.9	4.7	1.0
2.	19000.	IRR1, P.C.	29.9	3.2	0.9
		IRR2, P.C.	30.6	3.8	1.0
		BEP, P.C.	34.3	4.7	1.0
3.	20000.	IRR1, P.C.	27.1	3.2	0.9
		IRR2, P.C.	27.6	3.8	1.0
		BEP, P.C.	33.0	4.7	1.0
4.	21000.	IRR1, P.C.	25.4	3.2	0.9
		IRR2, P.C.	19.1	3.8	1.0
		BEP, P.C.	30.8	4.7	1.0
5.	21000.	IRR1, P.C.	31.0	3.2	0.9
		IRR2, P.C.	25.8	3.8	1.0
		BEP, P.C.	51.3	4.7	1.0
6.	22000.	IRR1, P.C.	23.6	3.2	0.9
		IRR2, P.C.	23.6	3.8	1.0
		BEP, P.C.	62.3	4.7	1.0

SENSITIVITY ANALYSIS

Effect of Reducing the Internal Rate of Return

(1) Sr. No.	(2) Particulars of Sensitivity Variable	(3) Internal Rate of Return	(4)	(5)
1.	16000.	IRR, P.C.	[illegible]	[illegible]
		IRRA, P.C.	[illegible]	[illegible]
		BEP, P.C.	[illegible]	[illegible]
2.	19000.	IRR, P.C.	47.7	[illegible]
		IRRA, P.C.	[illegible]	43.9
		BEP, P.C.	39.0	36.2
3.	19600.	IRR, P.C.	46.1	39.[illegible]
		IRRA, P.C.	43.6	40.7
		BEP, P.C.	37.7	41.[illegible]
4.	20000.	IRR, P.C.	45.[illegible]	38.9
		IRRA, P.C.	[illegible]	37.0
		BEP, P.C.	36.7	43.9
5.	21000.	IRR, P.C.	35.3	30.2
		IRRA, P.C.	36.3	30.9
		BEP, P.C.	46.0	51.7
6.	22000.	IRR, P.C.	28.9	22.8
		IRRA, P.C.	28.9	22.[illegible]
		BEP, P.C.	57.0	62.9

SENSITIVITY ANALYSIS

EFFECT OF ELEVATION ON FINAL OPTIMUM PLAN OF [illegible]

[illegible] OF SMALL ALLOT : [illegible]

[illegible] OF SMALL [illegible] : [illegible]

[illegible]	[illegible]/Ha		[illegible]	[illegible]	[illegible]
[illegible]	10000.	IRRI, P.C.	[illegible]	59.7	47.
		IRRA, P.C.	[illegible]	54.	47.
		BEP, P.C.	[illegible]	52.	54.1
2.	15000.	IRRI, P.C.	53.7	47.0	47.3
		IRRA, P.C.	58.	47.6	43.8
		BEP, P.C.	38.6	34.2	36.6
3.	19000.	IRRI, P.C.	0.0	43.9	36.6
		IRRA, P.C.	49.3	46.6	52.7
		BEP, P.C.	34.7	37.9	41.9
4.	20000.	IRRI, P.C.	46.6	41.0	36.0
		IRRA, P.C.	47.8	42.3	37.1
		BEP, P.C.	36.5	40.0	44.5
5.	21000.	IRRI, P.C.	39.5	34.6	29.2
		IRRA, P.C.	40.7	35.6	29.9
		BEP, P.C.	41.7	40.4	32.5
6.	22000.	IRRI, P.C.	32.9	27.7	21.8
		IRRA, P.C.	33.6	28.2	21.8
		BEP, P.C.	48.7	55.1	54.1

SENSITIVITY ANALYSIS

EFFECT OF ELECTRIC [illegible] ON INTERNAL RATE OF RETURN

PRICE OF SPARE [illegible]

[illegible]

				[illegible]		
	[illegible]			5%	6%	9%
1	18000,	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		IRRA	P.C.	[illegible]	[illegible]	[illegible]
		BEP	P.C.	[illegible]	[illegible]	[illegible]
2	19000,	IRRI	P.C.	[illegible]	[illegible]	[illegible]
		IRRA	P.C.	[illegible]	[illegible]	[illegible]
		BEP	P.C.	[illegible]	[illegible]	[illegible]
3.	19600,	IRRI	P.C.	[illegible]	[illegible]	[illegible]
		IRRA	P.C.	[illegible]	[illegible]	[illegible]
		BEP	P.C.	[illegible]	[illegible]	[illegible]
4.	20000,	IRRI	P.C.	[illegible]	[illegible]	[illegible]
		IRRA	P.C.	[illegible]	[illegible]	[illegible]
		BEP	P.C.	[illegible]	[illegible]	[illegible]
5.	21000,	IRRI	P.C.	[illegible]	[illegible]	[illegible]
		IRRA	P.C.	[illegible]	[illegible]	[illegible]
		BEP	P.C.	[illegible]	[illegible]	[illegible]
6.	22000,	IRRI	P.C.	[illegible]	[illegible]	[illegible]
		IRRA	P.C.	[illegible]	[illegible]	[illegible]
		BEP	P.C.	[illegible]	[illegible]	[illegible]

IMPLEMENTATION TIME SCHEDULE OF E.D.U.

	Construction Stages	Year / Quarter	I	II	III
1.	CONTRACT				
2.	SITE GEO-TECHNICAL SERVEY		———		
3.	PREPARATIONAL WORKS (SITE DEVELOPMENT)				———
4.	4.1 BASIC ENGINEERING		———		
	4.2 DETAILED ENGINEERING				———
	4.3 SPECIFICATIONS TRANSMISSION				
5.	TENDERING				
6.	CONSTRUCTION				
7.	EQUIPMENT SUPPLY				
8.	EQUIPMENT ERECTION				
9.	START-UP				
10.	PRODUCTION				
11.	DESIGNED CAPACITY				

ANNEXURE 9

2					3				4			
IV	I	II	III	IV	I	II	III	IV	I	II	III	IV

12

	% 79	100

12617
(2 of 2)

CONTRACT NO. T 81/91

UNIDO

TECHNO-ECONOMIC EVALUATION OF ESTABLISHING AN EXPERIMENTAL - DEMONSTRATION UNIT FOR DEMONSTRATION UNIT FOR PRODUCTION OF ALUMINIUM - SILICON ALLOYS IN INDIA.

VOLUME - II

PRODUCTION OF PRIMARY REFINED ALLOY AND OF MASTER ALLOY WITH SILICON CONTENT OF 20%

VAMI TSVETMETPROMEXPORT

NEW DELHI - LENINGRAD

1983

CONTENTS

CONTENTS

ANNEXURES

TECHNO-ECONOMIC CALCULATION OF ESTABLISHING AN EXPERIMENTAL DEMONSTRATION UNIT FOR THE PRODUCTION OF AL-SI ALLOYS IN INDIA

INTRODUCTION

Taking into consideration that OSCOM does not have captive aluminium production of its own and since aluminium is required in large amounts for the production of Al-Si casting alloys, two alternatives of establishing of the EDU are additionally considered.

Alternative I provides for production of the primary refined Al-Si alloy as a commercial product about 37% Si content, and alternative II for the production of the master alloy with silicon content of 20%.

The first alternative excludes completely the aluminium consumption at OSCOM production, while the second alternative reduces this figure by 12,409 t which will require 9,180 t against 21,589 t as per basic varient of producing commercial goods alloys.

1. Experimental-demonstration unit (EDU) for production of the primary refined alloy as commercial product - Alternative-I

1.1 Production Programme.

For this alternative the EDU will be composed of one 17 MV electric are reduction furnace and of the tech-nological equipment line. Without the equipment of alloy production room for alloying the refined alloys to produce aluminium alloys. Capital investment cost for setting - up of the EDU will decrease by Rs.43.7 mln. against the main variant and will be Rs.147.7 mln. excluding the cost of township and of gas-cleaning unit.

The primary refined Al-Si alloy produced with aluminium content of 59.6-60.0% and silicon content of 37.5-37.6% will be cast in large dimension ingots weighing 100-200 kg. and will be sold to consumers. This

This alloy can be used for production of casting Al-Si alloys at existing plants producing similar alloys by synthetic method. In this case for the production of Al-Si casting alloys the aluminium consumption will be reduced by 20-25% as compared with synthetic method of aluminium and silcon remelting and the silcon metal will not be required.

As per Indian data the specific consumption of technological power for the production of one ton of aluminium is 17,000 kwh, and of silcon 15,000 kwh.

Thus the utilisation of primary refined alloy reduces the specific power consumption per ton of casting aluminium alloys by about 2,000 kwh depending on the grade of alloy produced.

The volume of primary refined alloy production in ingots will be :

$$\frac{9,540 \quad 100 - 1}{100} = 9,445 \text{ tpy}$$

Where: 9,540 t - the annual capacity of the electric ore reduction furnace producing liquid refined alloy;

1% - casting losses.

The annual consumption of raw materials, auxiliary materials and utilities for production of primary refined Al-Si alloy in ingots, as well as the annual requirements of raw materials and utilities for its production are given in tables below.

1.2 SPECIFIC CONSUMPTIONS OF RAW MATERIALS ANCILLARY MATERIALS AND UTILITIES

SN	COST ITEM	UNIT	SPECIFIC CONSUMPTION
1.	Sillimanite concentrate	t/t	1.182
2.	Dry cleaned kaolin	"	0.305
3.	Alumina	"	0.340
4.	Coal	"	0.821
5.	Petroleum coke	"	0.61
6.	Molasses	"	0.47
7.	Electrode paste	"	0.088
8.	Quartzite	"	0.188
9.	Flux (common salt, cryolite, potassium cloride)	"	0.0273
10.	Power (without gas-cleaning) - incl.process power.	1000 kwh/t	14.15 13.15 -
11.	Fuel oil	t/t	0.142
12.	Water (recyled)	m^3/t	790
13.	Compressed air	nm^3/t	860

1.3 ANNUAL REQUIREMENTS IN RAW MATERIALS & INPUTS FOR PRODUCTION OF REFINED PRIMARY AL-SI ALLOY IN INGOTS

SN.	DESCRIPTION	UNIT	ANNUAL QUANTITY	REMARKS
1.	Sillimanite Concentrate	t	11,162	
2.	Kaolin, dry cleaned	t	2,881	
3.	Alumina	t	3,215	
4.	Coal	t	7,756	
5.	Petroleum coke	t	5,762	
6.	Molasses	t	4,436	
7.	Electtode paste	t	830	
8.	Quartzite	t	1,774	
9.	Flux			
	- common salt	t	162	
	- cryolite	t	48	
	- potassium cloride	t	48	
10.	Power	mln.kwh	142.2	Incl.gas cleaning without gas-cleaning- 133.6
11.	Fuel oil	t	1,336	
12.	Process water(recycled)	mln.m^3	7.44	
13.	Compressed air	mln.nm^3	8.1	

To compare with basic variant for this alternative the annual requirements of utilities are reduced:

power - by 16.8 mln. kwh
fuel-oil - by 2,110 t, recycled water by 0.4 mln.m^3,
compressed air by 1.6 mln nm^3

1.4 Composition of EDU components and list of major process equipment

As in case of the basic variant the EDU components shall include the raw material storage, reductant graining section and feed preparation room. Instead of combined electric furnace and alloy production (metallurgical) room only the construction of electric furnace will be required. This furnace room is provided for briquetted feed reduction in electric arc reduction furnace, for refining of the primary Al-Si alloy and its casting in ingots, which can be delivered to consumers as commercial product.

The EDU major technological equipment is given in the Table below"-

SN.	DESCRIPTION	TYPE AND SPECIFICATION	NUMBER	WEIGHT, KG OF ONE ITEM	WEIGHT, KG TOTAL
1.	Jaw crusher	CRD-106	1	-	8500
2.	Roll crusher	)Z-1000x550	1	-	17500
3.	Tangential hammer mill	NMP-1000/990	1	-	8300
4.	Dust cyclone	IGR-15-1400	1	-	2420
5.	Electrostatic Precipatator.	2BE-1-6,1-S	1	-	30000
6.	Air drier	YOB-30M3 flow rate, 30 nm^3/min	1	-	5000
7.	Pneumatic screw pump	HMB 63-Z, flow rate 63 m^3/hr	1	-	2150
8.	Weigher with weight control	DB 600-20000 DB 300-10000	10	2030	20300
9.	Continuous weighter	C6 - 111 rate 10t/hr	2	3400	6800
10.	Continuous weigher	C6 - 111 rate 10t/hr	1	-	1900
11.	Weigher with weight control	DB 120-400D	2	1130	2260
12.	Paddle mixer	Capacity 6t/hr	2	4800	9600
13.	Roller press	Capacity 6t/hr	1	-	11000
14.	Convayor drying oven	Capacity 5-6t/hr	1	-	95000
15.	Electric arc reduction furnace	Three phase - electrode power rating 25 MVA	1	-	702000
16.	Stacking and charging machine	Dango and Dienenthal	2	7000	14000

2. Experimental demonstration unit for production of commercial casting Al-Si alloys with silicon content up to 20%

Alternative - II

2.1 Production Programme.

For this alternative the capital investment of the EDU construction will be reduced by Rs.6.6 mln as compared with the basic variant due to the exclusion of some equipment of Alloy Production Room (Metallurgical Room) and the reduction of Metallurgical Room dimensions. The capital investment cost amounts to Rs.164.6 mln excluding the costs of township construction and of gas-cleaning unit.

After refining, the primary Al-Si alloy is added to already melted aluminium pigs in induction furnaces. In these furnaces the aluminium alloy is additionally refined with flux to bring the silicon content to 20%. It is then analysed and cast into small dimension pigs weighing 15-20 kg and delivered to consumers as the commercial product. This alloy is a master Al-Si alloy and can be used for the production of casting Al-Si alloy at any foundry unit producing casting alloys by synthetic method.

The aluminium consumption for the production of one ton of master Al-Si is 0.51 and the total requirements of aluminium for the production of casting Al-Si alloys in this case will be reduced by about 20% against the synthetic method of production.

The power consumption for the production of casting aluminium alloys will be significantly lower when compared with their production by synthetic method.

The major technological equipment to be provided in the metallurgical room at OSCOM include the induction furnaces, the casting conveyor with the hydraulic tilter, the pig piler and the stand for ladle heating.

9,450 tpy of primary refined alloy will be produced, and after its melting with 9,180 t of pig aluminium it can produce 18,000 tpy of master alloy of aluminium with silicon content of 20%.

The specific consumptions and annual requirements of raw materials and inputs for production of primary refined alloy and of Al-Si alloy with silicon content of 20% are given in tables below.

2.2 Specific consumptions of raw materials and inputs for production of primary refined alloy.

S.No.	Cast item	Unit	Specific consumption.
1.	Sillimanite Concentrate	t/t	1.17
2.	Dry cleaned Kaolin	"	0.302
3.	Alumina	"	0.337
4.	Coal	"	0.813
5.	Petroleum coke	"	0.604
6.	Molasses	"	0.465
7.	Electrode paste	"	0.087
8.	Quartzite	"	0.186
9.	Flux (common salt, cryolite, potassium chloride)	"	0.027
10.	Power (without gas-cleaning unit)	1,000 kwh/t	14.0
	- including process power	"	13.0 -
11.	Fuel oil	t/t	0.14
12.	Water(recycled)	m^3/t	780
13.	Compressed air	nm^3/t	850

2.3 Annual requirements of raw materials and inputs for production of primary refined Al-Si alloy.

S.No.	Description	Unit	Annual quantity	Remarks
1.	Sillimanite concentrate	t	11,162	
2.	Kaolin, dry cleaned	t	2,881	
3.	Alumina	t	3,215	
4.	Coal	t	7,756	
5.	Petroleum coke	t	5,762	
6.	Molasses	t	4,436	
7.	Electrode paste	t	830	
8.	Quartzite	t	1,774	
9.	Flux			
	- Common salt	t	162	
	- Cryolite	t	48	
	- Potassium chloride	t	48	
10.	Power	mln kwh	142.2	including gas-cleaning unit. Without gas-cleaning unit-133.6
11.	Fuel oil	t	1,336	
12.	Process water (recycled)	mln.m^3	7.44	
13.	Compressed air	mln.nm^3		8.1

2.4 Specific consumptions of raw materials and inputs for production of Al-Si alloy with silicon content of 20%

Sl.No.	Cast item	Unit	Specific consumption	Trm
1.	Primary refined Al-Si alloy	t/t	0.53	
2.	Aluminium in pigs	"	0.51	
3.	Flux (common salt, cryolite, potassium chloride, sodium (fluoride)	"	0.012	
4.	Power	kwh/t	580	
5.	Fuel Oil	t/t	0.02	
6.	Water(recycled)	m^3/t	14	
7.	Compressed air	nm^3/t	55	

2.5 Annual requirements of raw materials and inputs for production of Al-Si alloy with silicon content of 20%

Sl.No.	Description	Unit	Annual quantity	Remark
1.	Primary refined Al-Si alloy	t	9,540	
2.	Aluminium in pigs	"	9,180	
3.	Flux:			
	- Common salt	"	90	
	- Cryolite	"	11	
	- Potassium chloride	"	90	
	- Sodium fluoride	"	27	
4.	Power	mln kwh	10.5	
5.	Fuel Oil	t	360	
6.	Water(recycled)	mln. m^3	0.25	
7.	Compressed air	mln.nm^3	1.0	

For this alternative the annual requirements of fuel oil are reduced by 1,750 t as compared with the basic variant.

2.6 Composition of the EDU components and list of major process equipment.

2.6.1. EDU Components.

As in basic variant the EDU components include the raw material storage, reductant grinding section, feed preparation room and electric furnace and alloy production room (metallurgical room). But the dimensions of the metallurgical building will be reduced by volume of about 18,000 m^3 due to the exclusion of holding furnaces and of filtration furnances fired with fuel oil for this alternative.

2.6.2. The major technological equipment of the EDU is given in the Table below :

S.No.	Description	Type & Specification	Number	Weight of one item.	Weight Total
1.	Jaw crusher	CMD - 108	1	-	8,500
2.	Roller crusher	D 2-1000,550	1	-	17,500
3.	Tangential hammer mill	MMT 1000/950	1	-	8,300
4.	Dust cyclone	M 15-1400	1	-	2,420
5.	Electrostatic pracipitator	83-1-6,1-8	1	-	30,000
6.	Air dryer	Y08-30 MI, flow-rate 30 nm^3/min	1	-	5,000
7.	Pneumatic screw pump	H B-63-2, flow rate 63 m^3/hr	1	-	2,150
8.	Weigher with weight control	DS 600-20000 DS 300-10000 DS 1200-40000	10	2,030	20,300
9.	Continuous weigher	CS-111 rate 18/t/hr	2	3,400	6,800
10.	Continuous weigher	C 5-111 rate 10t/hr	1	-	1,900
11.	Weigher with weight control	DB 120-4000	2	1,130	2,260
12.	Paddle mixer	Capacity 6t/hr	2	4,800	9,600
13.	Roller press	Capacity 6t/hr	1	-	11,000
14.	Conveyor drying oven	Capacity 5-6t/hr	1	-	95,000
15.	Electric arc reduction furnace	Three-phases three-electrode, 25 MVA power rating.	1	-	702,000

S.No.	Description	Type & specification	Number	Weight kg. of one item	Weight kg. Total
16.	Stocking and charging machine	Dango & Dienenthal	2	7,000	14,000
17.	Induction crucible smelting furnance	UAT - 6 M capacity 6 t	3	23,140	69,420
18.	Casting conveyor with hydrolic tilter	12 m long, rate 4-6 t/hr	-	17,309	
19.	Pig piler with accumulating conveyor	rate 4-6 t/hr	1	[illegible]	8,200
20.	Stand for ladle heating	Fuel-oil fired	1	-	1,090

3. Location of the experimental demonstration unit and its utilities supply for the two alternatives.

3.1 EDU Location

As it was stated above the EDU components do not differ significantly from Alternatives I to Alternative II and as compared with the basic variant described in Volume I. Thus the areas provided for the both Alternatives of the EDU will be practically the same and will not differ to a great extent from the areas determined for basic variant. Based on this statement the location of Alternatives I and II is assumed the same as that of the basic variant i.e. adjacent to north-eastern boundary of the CCCM site.

3.2 EDU utilities supply

The utilities consumptions given above show that their requirements for both alternatives are reduced against the basic variant. This reduction in utilities consumption as compared with the basic variant is indicated below:

Power consumption	- 4 to 10%
Fuel Oil	- 50 to 50%
Water	- 2 to 5%
Compressed air	- 6 to 10%

Taking into consideration that the reduction in the utilities consumption in general is not significant (except for fuel-oil) the supply of the utilities for the EDU is assumed similar to that adopted for the basic variant.

- Water supply - from CSCOM networks with the construction of the captive water recycle unit

- Compressed air - from the captive compressor station

- Fuel Oil - through respective CSCOM networks

- Power - from the existing HT 132 KV power transmission line with additional installation of one 32 KVA transformer

- Steam for fire-fighting and heating of molasses tanks in the feed preparation room and fuel oil pipelines coming from CSCOM boiler house.

4. Duration of the project implementation

The duration of implementation of the EDU for production of commercial Al-Si alloys (basic variant) is estimated to be 4 years including the period required to reach the design capacity of the EDU as shown in Annexure-5 of Volume -1. The cost of construction of this EDU amounts to Rs. 191.4 mln.

The costs estimated for the construction of such an EDU for the production of only primary Al-Si alloys (Alternative I) amount to Rs. 147.7 mln, and for the production of casting Al-Si alloys with silicon content of 20% (Alternative II) is Rs. 184.8 mln.

From the comparison of the costs of construction of Alternatives I and II with the basic variant, it can be seen that for the Alternative I the cost is reduced by 23% and for Alternative II by 3%.

Basing on the above, the duration of the project implementation for Alternatives I & II is assumed to be 4 years as per the basic variant for this stage. At the stage of a detaled study, it appears that the implementation period for Altenative I can be reduced by half-a-year to 3.5 years.

5. Economic and financial evaluation of the production of primary refined alloy (Si content of 37%) and of master Al-Si alloy (Si content of 20%).

The economic evaluation for estimation of capital and operating costs of production of primary refined alloy (Si content 37% - Alternative I) and master alloy (Si content 20% - Alternative II) is based on prices of 1982 price levels.

5.1 Capital costs

The main initial capital costs for construction of industrial units as per Alternatives I and II are given in cost estimates (Annexures 2 and 3 respectively) and amount to Rs. 147.7 mln and Rs. 184.6 mln respectively.

The township cost for both alternatives amounts to Rs. 4.3 mln.

The cost of the gas-cleaning unit amounts to Rs. 31.2 mln. and its construction is provided for both alternatives from the accumulated cash reserves, at a later stage of operation.

The capital investments by project components are given below. To estimate the total capital cost the margin money (35% of working capital) and the interest during construction are added to fixed capital cost.

(mln)

Sl. No.	Cost item	Primary Alloy (Si 37%)	Master Alloy (Si 20%)
1	2	3	4
1.	Site preparation	2.6	2.6
2.	Buildings & civil works	28.1	42.1
3.	Equipment incl. erection and local costs, total incl.	94.8 (74.4)	114.7 (92.7)
3.1	Indigenous	8.2	6.4
3.2	Supplied from the U.S.S.R.	84.3 (72.4)	105.7 (90.7)
4.	Technology (incl. know-how tax on know-how)	2.8 (2.0)	2.8 (2.0)
5.	Design work	3.0 (1.2)	3.8 (1.5)
6.	Training of Indian specialists in the U.S.S.R.	1.7 (0.9)	1.7 (0.9)
7.	Other costs	8.7 (2.8)	9.9 (2.8)
8.	Contingencies	6.0 (3.8)	7.5 (4.9)
	Total fixed initial capital investment for industrial construction	147.7 (85.1)	184.8 (104.8)
9.	Township	4.3	4.3
10.	Margin Money (30% of working capital)	4.0	6.5
11.	Interest during construction	7.1	8.9
	Total capital investment	163.1 (85.1)	204.5 (104.8)

NOTE: Figures in brackets show the foreign exchange component.

From the total amount of the foreign exchange component, the cost of equipment, technology and services which may be supplied by Soviet side makes Rs. 83.1 mln for Alternative I and Rs. 102.8 mln for Alternative II, or in both cases about 56% of respective main capital investments costs of industrial construction. The cost of imported equipment to be purchased by Indian side from third countries is estimated for both Alternatives at Rs. 2.0 mln.

The cost of equipment includes the port charges, insurance and the cost of transportation of the imported equipment from the port to the site. The customs duty has not been taken into account.

5.2 Financing

For both alternatives the sources and terms of financing are assumed to be similar to the basic variant of construction of the BDU producing commercial Al-Si alloys:

- The ratio between government equities and borrowed assets is of 1:2. From the total amount of borrowed assets the U.S.S.R. credit for equipment and technology supply and the training of Indian specialists in the U.S.S.R. makes Rs. 75.3 mln (Alternative I) and Rs. 93.6 mln (Alternative II).

- The township construction is completely financed by the equity capital (for both alternatives).

- The U.S.S.R. credit is granted for 10 years at annual interest rate of 4%.

- The long-term local loan is granted for 10 years at annual interest rate of 12%.

- The credit and loan including capitalised interest during construction are to be repaid by equal instalments starting from the year following the commissioning for both the alternatives.

- 65% of the working capital is covered by short-term loan at interest rate of 18% per annum and the balance 35% by margin money.

The construction period for both alternatives is assumed to take two years with following distribution of capital costs:-

	Alternative I	Alternative II
	mln. rupees	
1 Year	100.2	127.8
2 Year	62.9	79.7
Total	163.1	204.5

The additional capital investment for gas-cleaning unit for both alternatives is to be provided after accumulation of required cash.

5.3 Production costs

The operating costs of/alternatives of Al-Si alloys /both production are given in the cost estimate of annual operating costs in Annexure - III.

The summarised form of the annual production costs including depreciation and interest are as follows:

i. for the production of primary refined alloy (Si 37%) - Rs. 130.4 mln

ii. for the production of master alloy (Si 20%) - Rs. 324.5 mln

S.No	Cost item	Primary alloy (Si 37%)	Master alloy (20%)
		in Rs mln	in Rs mln
1.	Raw materials	59.7	57.3
2.	Primary aluminium	-	179.9
3.	Power	40.7	43.7
4.	Fuel oil	2.7	5.8
5.	Other utilities	2.2	2.3
6.	Manpower	2.9	3.4
7.	Repair & Maintenance (@ 2.5% of equipment cost)	2.4	2.9
	Total variable costs (1 to 7)	110.6	295.3
8.	Overhead costs	0.2	0.6
9.	Administrative costs and sales costs	3.2	7.9
10.	Interest on working capital (@ 18%)	1.4	2.2
	Total fixed costs (8 to 10)	4.8	10.7

1	2	3	4
11.	Total operating (1 to 10)	115.4	306.0
12.	Depreciation	13.3	16.4
13.	Interest	1.7	2.1
	Total production costs (11 to 13)	130.4	324.5
	Production cost of 1 ton of alloy, rupees	13,806	18,030

5.4 Financial analysis

5.4.1 The financial analysis is made on the following prices:

i. primary alloy - Rs. 17,250 per 1 t and
ii. master alloy - Rs. 19,700 per 1 t

The prices of primary and master alloys in calculations are assumed at the cost of production of synthetic silumin (content of silicon of 12% and content of aluminium of 88%) based on the prices of silicon and of aluminium of Rs. 20,000 and Rs. 19,600 respectively.

The price of primary refined alloy is assumed taking into account the profit of users in amount of 10% due to utilisation of this alloy.

Both the cash-flow and the net income statements have been worked out for a period of 15 years.

The designed capacity is assumed to reach in the second year after commissioning.

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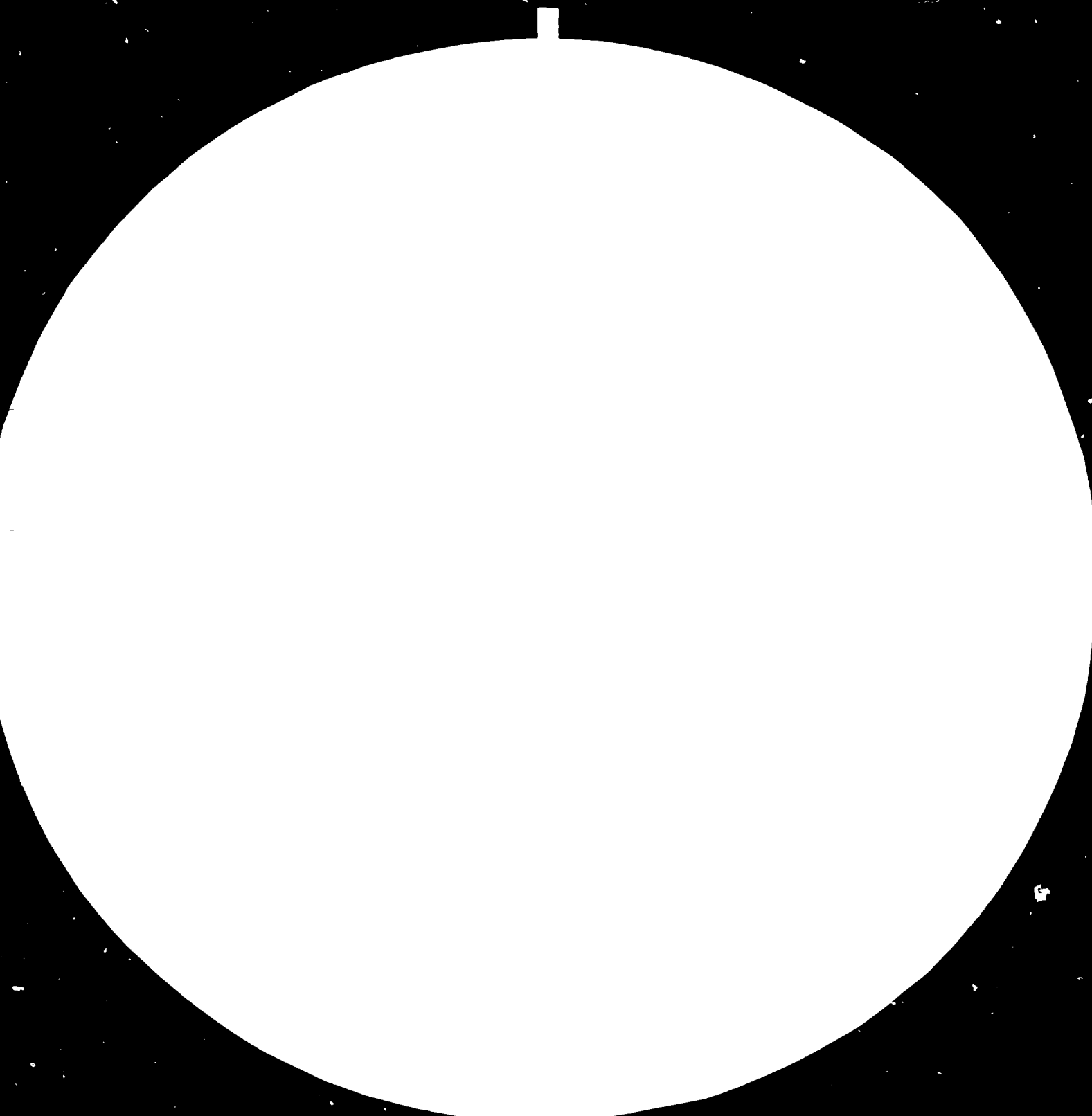


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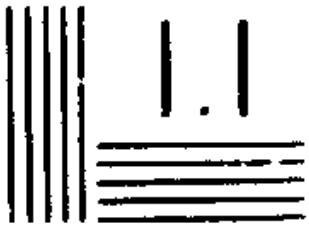
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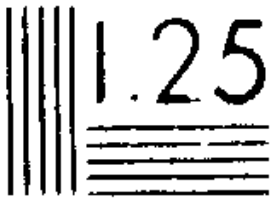
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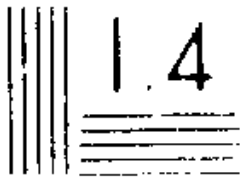
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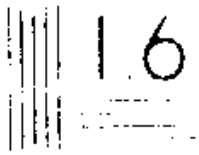
1.6

5,4,2,1 CASH FLOW TABLE FOR FINANCIAL PLANNING FOR PRODUCTION OF PRIMARY REFINED ALLOY WITH SILICON CONTENT OF 37%
ALTERNATIVE 1

P.No.	COSTS / YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	SALVAGE VALUE	TOTAL
	A. CASH INFLOW	100.2	62.9	122.7	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	-	2567.8
1.	FINANCIAL RESOURCES' TOTAL	100.2	62.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	163.1
2.	SALES REVENUE	-	-	122.7	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	-	2404.7
	B. CASH OUTFLOW	100.2	62.9	102.6	148.8	148.5	148.2	148.0	147.8	147.4	147.1	146.9	177.8	151.4	140.2	140.2	140.2	140.2	-37.8	2330.6
1.	CAPITAL INVESTMENT	100.2	62.9	-	-	-	-	-	-	-	-	-	31.2	-	-	-	-	-	-37.8	156.5
2.	OPERATING COSTS	-	-	86.6	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	-	1702.2
3.	DEBT SERVICE	-	-	6.6	17.4	16.8	16.1	15.4	14.7	14.1	13.5	12.8	12.1	11.6	-	-	-	-	-	151.1
3.1	INTEREST	-	-	6.6	6.6	6.0	5.3	4.6	3.9	3.3	2.7	2.0	1.3	0.6	-	-	-	-	-	42.9
3.2	REPAYMENT	-	-	-	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	11.0	-	-	-	-	-	108.2
	- SUPPLIER'S CREDIT	-	-	-	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.9	-	-	-	-	-	79.9
	- LONG-TERM LOCAL LOAN	-	-	-	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3.1	-	-	-	-	-	28.3
4.	INCOME TAX (@ 57.75%)	-	-	9.4	16.0	16.3	16.7	17.2	17.7	17.9	18.2	18.7	19.1	24.4	24.8	24.8	24.8	24.8	-	290.8
5.	PRES ENT CASH FLOW (A-B)	0	0	20.1	14.2	14.5	14.8	15.0	15.2	15.6	15.9	16.1	-14.8	11.6	22.8	22.8	22.8	22.8	37.8	267.2
6.	CUMULATIVE CASH BALANCE	0	0	20.1	34.3	48.8	63.6	78.6	93.8	109.4	125.3	141.4	126.6	138.2	161.0	183.8	206.6	229.4	-	-

5.4.2.2

NET INCOME STATEMENT
FOR PRODUCTION OF PRIMARY REFINED ALLOY
(SILICON CONTENT OF 37%)
ALTERNATIVE I

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	SALES REVENUE	-	-	122.7	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0
2.	PRODUCTION COSTS																	
2.1	OPERATING COSTS	-	-	86.6	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4	115.4
2.2	DEPRECIATION	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	4.7	4.7	4.7	4.7	4.7
2.3	INTEREST	-	-	6.6	6.6	6.0	5.3	4.6	3.9	3.3	2.7	2.0	1.3	0.6	-	-	-	-
	- ON SUPPLIER'S CREDIT	-	-	3.2	3.2	2.9	2.6	2.2	1.9	1.6	1.3	1.0	0.6	0.3	-	-	-	-
	- LONG TERM LOAN	-	-	3.4	3.4	3.1	2.7	2.4	2.0	1.7	1.4	1.0	0.7	0.3	-	-	-	-
	SUB TOTAL FOR ITEM 2	-	-	106.5	135.3	134.7	134.0	133.3	132.4	132.0	131.4	130.7	130.0	120.7	120.1	120.1	120.1	120.1
3.	PROFIT/LOSSES	-	-	16.2	27.7	28.3	29.0	29.7	30.6	31.0	31.6	32.3	33.0	42.3	42.9	42.9	42.9	42.9
4.	INCOME TAX (@57.75%)	-	-	9.4	16.0	16.3	16.7	17.2	17.7	17.9	18.2	18.7	19.1	24.4	24.8	24.8	24.8	24.8
5.	NET PROFIT AFTER TAX	-	-	6.8	11.7	12.0	12.3	12.5	12.9	13.1	13.4	13.6	13.9	17.9	18.1	18.1	18.1	18.1
6.	ACCUMULATED PROFIT	-	-	6.8	18.5	30.5	42.8	55.3	68.2	81.3	94.7	108.3	122.2	140.1	158.2	176.3	194.4	212.5

5.4.3.1

S.No.	COSTS/YEARS	1	2	3	4	5	6	7
	A. CASH IN FLOW	124,8	79,7	265,5	354,6	354,6	354,6	354,6
1.	FINANCIAL RESOURCES TOTAL	124,8	79,7	-	-	-	-	-
2.	SALES REVENUE	-	-	265,5	354,6	354,6	354,6	354,6
	B. CASH OUTFLOW	124,8	79,7	244,4	341,8	341,4	341,1	340,7
1.	CAPITAL INVESTMENT	124,8	79,7	-	-	-	-	-
2.	OPERATING COSTS	-	-	229,5	306,0	306,0	306,0	306,0
3.	DEBT SERVICE	-	-	8,5	22,1	21,2	20,4	19,5
3.1	INTEREST	-	-	8,5	8,5	7,6	6,8	5,9
3.2	REPAYMENT	-	-	-	13,6	13,6	13,6	13,6
	- SUPPLIER'S CREDIT	-	-	-	9,9	9,9	9,9	9,9
	- LONG-TERM LOCAL LOAN	-	-	-	3,7	3,7	3,7	3,7
4.	INCOME TAX(957.75%)	-	-	6,4	13,7	14,2	14,7	15,2
5.	PRESENT CASH FLOW(A-B)	0	0	21,1	12,8	13,2	13,5	13,9
6.	CUMULATIVE CASH BALANCE	0	0	21,1	33,9	47,1	60,6	74,5

CASH FLOW TABLE FOR FINANCIAL PLANNING FOR PRODUCTION OF MASTER AL-SI ALLOY WITH SILICON CONTENT OF 20%

ALTERNATIVE II

8	9	10	11	12	13	14	15	16	17	SALVAGE VALUE	TOTAL
354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	-	5434.4
-	-	-	-	-	-	-	-	-	-	-	204.5
354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	-	5229.9
340.4	340.0	339.6	339.3	370.1	339.4	325.1	325.1	325.1	325.1	-43.7	5139.4
-	-	-	-	31.2	-	-	-	-	-	-43.7	192.0
306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	-	4513.5
18.7	17.8	17.0	16.1	15.3	14.8	-	-	-	-	-	191.4
5.1	4.2	3.4	2.5	1.7	0.8	-	-	-	-	-	55.0
13.6	13.6	13.6	13.6	13.6	14.0	-	-	-	-	-	136.4
9.9	9.9	9.9	9.9	9.9	10.2	-	-	-	-	-	99.3
3.7	3.7	3.7	3.7	3.7	3.8	-	-	-	-	-	37.1
15.7	16.2	16.6	17.2	17.6	18.6	19.1	19.1	19.1	19.1	-	242.5
14.2	14.6	15.0	15.3	-15.5	15.2	29.5	29.5	29.5	29.5	43.7	295.0
88.7	103.3	118.3	133.6	118.1	134.3	162.8	192.3	221.8	251.3	-	-

$5_1 4_1 3_1 2_1$

NET INCOME STATEMENT
FOR PRODUCTION OF MASTER AL-SI ALLOY
(SILICON CONTENT OF 20%)
ALTERNATIVE II

S.No.	COSTS/YEARS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	SALES REVENUE	-	-	265.5	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6
2.	PRODUCTION COSTS																	
2.1	OPERATING COSTS	-	-	229.5	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0
2.2	DEPRECIATION	-	-	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	5.6	5.6	5.6	5.6	5.6
2.3	INTEREST	-	-	8.5	8.5	7.6	6.8	5.9	5.1	4.2	3.4	2.5	1.7	0.8	-	-	-	-
	- ON SUPPLIER'S CREDIT	-	-	4.0	4.0	3.6	3.2	2.8	2.4	2.0	1.6	1.2	0.8	0.4	-	-	-	-
	- LONG-TERM LOCAL LOAN	-	-	4.5	4.5	4.0	3.6	3.1	2.7	2.2	1.8	1.3	0.9	0.4	-	-	-	-
	SUB TOTAL FOR ITEM 2	-	-	254.4	330.9	330.0	329.2	328.3	327.5	326.6	325.8	324.9	324.1	312.4	311.6	311.6	311.6	311.6
3.	PROFIT/LOSSES	-	-	11.1	23.7	24.6	25.4	26.3	27.1	28.0	28.8	29.7	30.5	32.2	33.0	33.0	33.0	33.0
4.	INCOME TAX (@57.75%)	-	-	6.4	13.7	14.2	14.7	15.2	15.7	16.2	16.6	17.2	17.6	18.6	19.1	19.1	19.1	19.1
5.	NET PROFIT AFTER TAX	-	-	4.7	10.0	10.4	10.7	11.1	11.4	11.8	12.2	12.5	12.9	13.6	13.9	13.9	13.9	13.9
6.	ACCUMULATED PROFIT	-	-	4.7	14.7	25.1	35.8	46.9	58.3	70.1	82.3	94.8	107.7	121.3	135.2	149.1	163.0	176.9

5.4.4 Internal rate of return

Based on calculations of Net Cash-flow and of present Value by Alternatives of production of primary and master Al-Si alloys given in Annexure IV and V the internal rate of return would be:

i) for production of primary refined alloy (silicon content of 37%)

$$22 + \frac{1.0(23-22)}{2} = 22.5\%$$

ii) for production of master Al-Si (silicon content of 20%)

$$18 + \frac{0.9(19-18)}{0.9+2.5} = 18.3\%$$

5.4.5 Pay-back period

i) for production of primary refined alloy (silicon content of 37%)

Total capital investment (excluding working capital)

163.1 - 4.0 = Rs. 159.1 mln.

Rs. mln.

Years of Operation	Net profit	Depre-ciation	Interest	Total profit	Accumulated profit
1	6.8	13.3	6.6	16.1	26.7
2	11.7	13.3	6.6	31.6	59.3
3	12.2	13.3	6.0	31.5	89.8
4	12.3	13.3	5.3	30.9	120.7
5	12.5	13.3	4.6	30.4	151.1
6	12.9	13.3	3.9	30.1	181.2

$$5 + \frac{159.1 - 151.1}{30.1} = 5.3 \text{ years}$$

ii) The total capital investment (excluding working capital) for production of master Al-Si alloy (silicon content of 20%) 204.5 - 6.5 = Rs. 198 mln.

Years of Operation	Net profit	Depre-ciation	Interest	Total profit	Accumulated profit
1	4.7	16.4	8.5	29.6	29.6
2	10.0	16.4	8.5	34.9	64.5
3	10.4	16.4	7.6	34.4	98.9
4	10.7	16.4	6.8	33.9	132.8
5	11.1	16.4	5.9	33.4	166.2
6	11.4	16.4	5.1	32.9	199.1

$$5 + \frac{198 - 166.2}{32.9} = 6 \text{ years}$$

6. Comparative Table of major technological and techno-economic parameters by Alternatives of EDU for production of Al-Si alloys.

Sl. No.	Parameter Description	Unit	Basic variant for production of Commercial Al-Si alloys.	Additional alternatives for production of primary alloy	
				Alternative I Production of primary Al-Si alloy	Alternative II Production of master alloy with 20% of silicon.
1	2	3	4	5	6
1	Annual capacity -production	tpy	28120	9445	18000
	-refined liquid Al-Si alloy	"	9540	9540	9540
2.	Annual requirements of raw materials and inputs				
2.1	Sillimanite	tpy	11162	11162	11162
2.2	Kaolin	"	2881	2881	2881
2.3	Alumina	"	3215	3215	3215
2.4	Coal	"	7756	7756	7756
2.5	Petrolium Coke	"	5762	5762	5762
2.6	Molasses	"	4436	4436	4436
2.7	Aluminium in pigs	"	21589	—	9180
2.8	Manganese	"	108	—	—

5.4.6 Break-even point

		Alternative I Primary Alloy (Si 37%)	Alternative II Master Alloy (Si 20%)
		mln. rupees	
1.	Annual production cost, incl.	130.4	324.5
i)	Variable costs	110.6	295.3
ii)	fixed costs incl. depreciation.	19.8	29.2
2.	Sales revenue at full capacity operation.	163.0	354.6
3.	Break-even point at assumed prices of primary and master alloy will be reached at the following rate of utilisation of production capacity	$\frac{19.8}{163-110.6} = 37.8\%$	$\frac{29.2}{354.6-295.3} = 49.2\%$

1	2	3	4	5	6
2.9	Copper	tpy	87	-	-
2.10	Nickel	"	87	-	-
2.11	Magnesium	"	37	-	-
3.	Annual requirements in utilities				
3.1	Power*	mln.Kwh.	159.0	142.2	152.7
3.2	Fuel Oil	"	3448	1338	1698

*NOTE: Power requirements are given taking into account the gas-cleaning unit. For the unit without gas-cleaning unit the power requirement will be reduced by 8.6 mln.kwh. for both alternatives.

1	2	3	4	5	6
4.	Total investment (without gas-cleaning unit)	Rs.mln.	217.2	163.1	204.5
	including				
4.1	Fixed capital costs	"	191.4	147.7	184.8
4.2	Township	"	4.3	4.3	4.3
4.3	Margin money (35% of working capital)	"	10.5	4.0	6.5
4.4	Interest during construction	"	11.0	7.1	8.9
5.	Total production cost including	"	621.1	130.4	324.5
5.1	Operating costs	"	600.5	115.4	306.0
5.2	Depreciation	"	18.2	13.3	16.4
5.3	Interest	"	3.4	1.7	2.1
6.	Taxable profit	"	25.7	32.6	30.1
7.	Income tax	"	14.8	18.8	17.4
8.	Net profit	"	10.9	13.8	12.7
9.	Simple rate of return	%	6.1	9.5	7.2
10.	Internal rate of return	%	13.4	22.5	18.3
11.	Pay-back period	year	6.0	5.3	6.0
12.	Break-even point	%	68.9	37.8	49.2

ANNEXURES

ANNEXURE - I

SUMMARY COST ESTIMATE OF SETTING-UP OF EXPERIMENTAL DEMONSTRATION UNIT INCLUDING ONE FURNACE FOR PRODUCTION OF PRIMARY REFINED AL-SI ALLOY IN ORISSA STATE

(ALTERNATIVE-I)

Sl No.	Description	Calculated cost - Thou. Rupees				
		Civil Works	Erection Works	Equipment	Other costs	Total Costs
1	2	3	4	5	6	7
	A. Site preparation					
1.	Site levelling	2619.5	-	-	-	2619.5
	Total for A	2619.5	-	-	-	2619.5
	B. Components of the experimental demonstrating Unit					
2.	Raw material Storage	2820.8	493.2	5336.8	-	8655.8
	Foreign Exchange component (FEC)	-	-	(4882.4)	-	(4882.4)
3.	Raw material grinding	775.5	253.9	2281.6	-	3296.0
	F.E.C.	-	-	(1860.7)	-	(1860.7)
4.	Feed preparation Room	5435.5	1079.2	9930.6	-	16495.3
	F.E.C.	-	-	(8418.7)	-	(8418.7)
5.	Electric Furnace Room	13863.6	5039.6	44803.4	-	63706.6
	F.E.C.	-	-	(42998.7)	-	(42998.7)
	Including equipment from third parties	-	-	(2002.0)	-	(2002.0)

1	2
6.	Pneumatic Transport rack
7.	Conveyor Gallery
8.	Power supply
	F.E.C.
9.	Compressor Station
	F.E.C.
10.	Motor roads & areas
11.	Water recycling unit
	F.E.C.
12.	Water supply and sewerage net works
	F.E.C.
13.	Site development and greenery
14.	Lighting;
	F.E.C.
	Total for B
	F.E.C.
	Including equipment from Third Countries
	C. Other costs
15.	Port charges, transportation & Insurance
16.	Requirements for construction including temporary buildings and structure

3	4	5	6	7
76.0	-	-	-	76.0
1312.3	-	-	-	1312.3
391.3	1519.8	13276.9	-	15801.0
-	-	(13254.1)	-	(13254.1)
285.5	158.2	1338.8	-	1782.5
-	-	(1246.7)	-	(1246.7)
1223.6	-	-	-	1223.6
846.5	415.4	3631.6	-	4893.5
-	-	(1364.8)	-	(1364.8)
684.0	85.5	854.2	-	1574.2
-	-	(125.1)	-	(125.1)
75.6	-	-	-	75.6
20.0	33.4	227.2	-	280.6
-	-	(225.2)	-	(225.2)
23093.2	9483.2	81681.6	-	119263.0
-	-	(74376.2)	-	(74376.2)
-	-	(2002.0)	-	(2002.0)
-	-	-	3618.7	3618.7
-	-	-	1206.0	1206.0

1	2	3	4	5	6	7
17.	Design work -	-	-	-	3047.1	3047.1
	F.E.C.	-	-	-	(1218.8)	(1218.8)
18.	Start-up and Commissioning	-	-	-	691.0	619.0
19.	Build-up of administrative structure, hiring and training of Personnel	-	-	-	5.0	5.0
20.	Know-how	-	-	-	2000.0	2000.0
	F.E.C.	-	-	-	(2000.0)	(2000.0)
21.	Tax on Know-how	-	-	-	800.0	800.0
22.	Training of Indian Experts in the USSR	-	-	-	1740.0	1740.0
	F.E.C.	-	-	-	(955.0)	(955.0)
23.	Allocation for Soviet Experts deputed to India for construction and erection supervision, start-up and commissioning during early operation and performance guarantee tests, collection of initial data for detailed engineering	-	-	-	3830.0	3830.0
	F.E.C.	-	-	-	(2767.0)	(2767.0)
24.	Income-Tax on services of Soviet Experts	-	-	-	1107.0	1107.0
25.	Control, Co-ordination & Commissioning	-	-	-	1828.2	1828.2
	Total for C	-	-	-	19873.0	19873.0
	F.E.C.	-	-	-	(6940.8)	(6940.8)
	Total for A + B + C	30712.7	9438.2	81681.6	19873.0	141735.5
	F.E.C.	-	-	(74370.2)	(6940.8)	(81317.0)

1	2	3
	Including Equipment from Third Countries	-
	Contingencies (3% of civil works and 5% of equipment cost)	821.4
	F.E.C.	-
	Total without gas cleaning and township	31634.1
	F.E.C.	-
	Including equipment from Third countries	-
	Gas cleaning	-
	Infracture (Township)	-
	Total	31634.1
	F.E.C.	-
	Including equipment from Third countries	-

4	5	6	7
-	(2000.0)	-	(2002.0)
474.4	3984.0	596.2	5976.0
-	(3618.7)	(208.2)	(3826.9)
9962.6	85665.6	20469.2	147731.5
-	(77994.9)	(7149.0)	(85143.9)
-	(2002.0)	-	(2002.0)
-	-	31183.3	31183.3
-	-	4289.3	4289.3
9962.6	85665.6	55941.8	183204.1
-	(77994.9)	(7149.0)	(85143.9)
-	(2002.0)	-	(2002.0)

ANNEXURE - II

SUMMARY COST ESTIMATE OF SETTING-UP OF EXPERIMENTAL DEMONSTRATION UNIT INCLUDING ONE FURNACE FOR PRODUCTION OF AL-SI ALLOYS IN ORISSA STATE

(ALTERNATIVE II)

Sl. No.	Description	Calculated cost - Thou. Rupees				
		Civil Works	Erection Works	Equipment	Other costs	Total Cost
1	2	3	4	5	6	7
	A. Site Preparation					
1.	Site Levelling	2619.5	-	-	-	2619.5
	Total for A	2619.5	-	-	-	2619.5
	B. Components of the Experimental-Demonstration Unit.					
2.	Raw material storage	2220.8	493.2	5336.8	-	8655.8
	Foreign Exchange Component (F.E.C.)	-	-	(4882.4)	-	(4882.4)
3.	Raw material grinding	755.5	258.9	2281.6	-	3236.0
	F.E.C.	-	-	(1860.7)	-	(1860.7)
4.	Food Preparation Room	5485.5	1072.2	9930.6	-	16495.3
	F.E.C.	-	-	(8418.7)	-	(8418.7)
5.	Electric Furnace and Metallurgical Room	27920.0	6983.3	61555.9	-	96459.4
	F.E.C.	-	-	(61324.7)	-	(61324.7)
	Including equipment from third countries	-	-	(2002.0)	-	(2002.0)
6.	Pneumatic transport rack	76.0	-	-	-	76.0
7.	Conveyor gallery	1312.3	-	-	-	1312.3

1	2	3
8.	Power supply	891.3
	F.E.C.	-
9.	Compressor station	285.5
	F.E.C.	-
10.	Motor roads and areas	1223.6
11.	Water recycling Unit	846.5
	F.E.C.	-
12.	Water supply and sewerage networks	634.0
	F.E.C.	-
13.	Site development and greenery	75.6
14.	Lighting	20.0
	F.E.C.	-
	Total for B	42149.8
	F.E.C.	-
	Including Equ t from third countries	-
	Total for A + .	44769.3
	F.E.C.	-
	Including Equipment from third countries	-
C.	Other charges	
	[illegible]	-

4	5	6	7
1919.8	13276.9	- -	15801.0
-	(13254.1)	-	(13254.1)
158.2	1338.8	-	1782.5
-	(1346.7)	-	(1243.7)
-	-	- -	1223.6
415.4	3331.6	-	4826.5
-	(1334.6)	-	(1334.6)
85.5	854.7	-	1574.2
-	(125.1)	-	(125.1)
-	-	-	75.6
33.34	227.2	-	280.6
-	(225.2)	-	(225.2)
11431.9	98434.1	-	152015.8
-	(92702.2)	-	(92702.2)
-	(2002.0)	-	(2002.0)
11431.9	98434.1	-	154635.3
-	(92702.2)	-	(92702.2)
-	(2002.0)	-	(2002.0)
-	-	4535.0	4535.0

1	2	3
16.	Requirements for construction including temporary buildings and structures.	- -
17.	Design	-
	F.E.C.	-
18.	Start-up and commissioning	-
19.	Build-up of administrative structure hiring and training of personnel	-
20.	Know-how	-
	F.E.C.	-
21.	Tax on Know = how	-
22.	Training of Indian Experts in the USSR	-
	F.E.C.	-
23.	Allocation for Soviet Experts deputed to India for construction and erection supervision, start-up and commissioning during early operations and performance guarantee tests collection of initial data for detailed engineering	-
	F.E.C.	-
24.	Income-tax on services of Soviet Experts	-
25.	Control, co-ordination and commissioning	-
	Total for C	-

4	5	6	7
-	-	1666.0	1666.0
-	-	3815.8	3815.8
-	-	(1526.3)	(1526.3)
-	-	910.5	910.5
-	-	5.0	5.0
-	-	2000.0	2000.0
-	-	(2000.0)	(2000.0)
-	-	800.0	800.0
-	-	1740.0	1740.0
-	-	(955.0)	(955.0)
-	-	3830.0	3830.0
-	-	(2767.0)	(2767.0)
-	-	1107.0	1107.0
-	-	2319.5	2319.5
-	-	22748.8	22748.8

1	2	3	4	5	6	7
	F.E.C.	-	-	-	(7248.3)	(7248.3)
	Total for A + B + C	41769.3	11431.9	93434.1	22746.8	177384.1
	F.E.C.	-	-	(92432.2)	(7248.3)	(99680.5)
	Including Equipment from third countries	-	-	(2002.0)	-	(2002.0)
	Contingencies (3% of civil works and 5% of equipment costs)	1243.1	571.6	4821.8	682.5	7418.8
	F.E.C.	-	-	(4535.1)	(217.4)	(4752.5)
	Total	46112.4	12003.5	103455.7	25431.3	184802.9
	F.E.C.	-	-	(97337.3)	(7465.7)	(104803.0)
	Including Equipment from third countries	-	-	(2002.0)	-	(2002.0)
	Gas Clearing Unit	-	-	-	31133.3	31133.3
	Infrastructure (Township)	-	-	-	4269.3	4269.3
	Total	46112.4	12003.5	103255.7	58903.9	(220275.5
	F.E.C.	-	——	(97337.3)	(7465.7)	(104803.0)
	Including Equipment from third countries	-	-	(2002.0)	-	(2002.0)

ANNEXURE - III

Cost estimate of annual operating costs for production of primary (Silicon content of 37%) and master (Silicon content of 20% Al-Si Alloys.

Primary alloy production is 9.445 tpy
Master alloy production is 18.000 tpy

Sl No.	Cost item	Unit	Unit Price	Primary Alloy Si content is 37%		Master Alloy Si content is 20%	
				Quant.	Cost Th.Rs.	Quant.	Cost Th. Rs.
1	2	3	4	5	6	7	8
1.	Raw materials & inputs						
1.1	Sillimanite concentrate	t	1000	11173	11173	11160	11160
1.2	Kaolin, dry cleaned	t	2200	2881	6338	2880	6336
1.3	Quartzite	t	200	1776	355	1782	353
1.4	Alumina	t	2810	3221	9051	3222	9054
1.5	Coal	t	300	7764	2329	7758	2327
1.6	Petroleum coke	t	3500	6432	22512	5760	20160
1.7	Molasses	t	95	4439	422	4446	422
1.8	Electrode paste	t	7810	831	6490	828	6467
	Total for 1				58670		56232
2.	Flux						
2.1	Common salt	t	300	162	49	162	49
2.2	Cryolite	t	17000	47	799	49	799]
2.3	Potassium chloride	t	4000	47	188	49	188
	Total for 2				1036		1036

1	2	3	4	5	6	7	8
3.	Utilities						
3.1	Power	1000 kw.	305	133373	40679	143676	43727
3.2	Fuel oil	t	2800	1332	2730	2070	5796
3.3	Industrial Water	1000 M³	300	7467	2239	7560	2268
	Total for 3				45648		51791
4.	Primary aluminium	t	10000	-	-	9180	139828
5.	Cost of manpower	1000 Rs.	-	-	2877	-	3417
6.	Repair and maintenance (2.5% of equipment cost)	"	-	-	2370	-	2850
	Total variable costs (items 1 to 5)				110601		295314
7.	Overhead costs (0.2% of 1-5)	-	-	-	221	-	591
8.	Interest on working capital (13%)	-	-	-	1350	-	2178
9.	Administrative and sales costs	-	-	-	3200	-	7900
	Total fixed costs (items 7 to 9)				4771	-	10669
	Total Operating costs (items 1 to 9)				115372		305983
10.	Depreciation*	-	-	-	13344		16374
11.	Interest	-	-	-	1650		2103
	Total production costs	-	-	-	130366		324460
	Production costs per ton of allow	-	-	-	13.3		18.0

*Depreciation is calculated basing on following norms

- building and civil works - 5%
- equipment -10%
- pre- production costs - 10%
- tooling - 8%

ANNEX IV

CALCULATION OF NET CASH FLOW AND OF PRESENT VALUE FOR PRODUCTION OF PRIMARY REFINED ALLOY WITH SILICON CONTENT OF 37%

(ALTERNATIVE 1)

COSTS / YEARS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	SCRAP VALUE	T
A. CASH INFLOW																			
SALES REVENUE	-	-	122.7	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	-	24
B. CASH OUTFLOW, TOTAL	-52.8	-2.1	-102.6	-148.8	-148.5	-148.2	-148.0	-147.8	-147.4	-147.1	-146.9	-177.8	-151.4	-140.2	-140.2	-140.2	-140.2	- 37.8	-31
EQUITY CAPITAL	-52.8	-2.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- 37.8	-
ADDITIONAL COST OF GAS CLEANING UNIT	-	-	-	-	-	-	-	-	-	-	-	- 31.2	-	-	-	-	-	-	-
DEBT REPAYMENT	-	-	- 6.6	- 17.4	- 16.8	- 16.1	- 15.4	- 14.7	- 14.1	- 13.5	- 12.8	- 12.1	- 11.6	-	-	-	-	-	- 1
OPERATING COSTS	-	-	- 86.6	-115.4	-115.4	-115.4	-115.4	-115.4	-115.4	-115.4	-115.4	-115.4	-115.4	-115.4	-115.4	-115.4	-115.4	-	-17
INCOME-TAX	-	-	- 9.4	- 16.0	- 16.3	- 16.7	- 17.2	- 17.7	-17.9	- 18.2	- 18.7	- 19.1	- 24.4	- 24.8	- 24.8	- 24.8	- 24.8	-	- 2
C. NET CASH FLOW (A-B)	-52.8	-2.1	20.1	14.2	14.5	14.8	15.0	15.2	15.6	15.9	16.1	- 14.8	11.6	22.8	22.8	22.8	22.8	37.8	2
D. PRESENT VALUE																			
@ 23%	-42.9	-1.4	10.8	6.2	5.2	4.3	3 5	2.9	2.4	2.0	1.7	- 1.2	0.8	1.3	1.0	0.8	0.7	0.9	-
@ 22%	-43.3	-1.4	11.1	8.9	5.4	4.5	3.7	3.1	2.6	2.2	1.8	- 1.4	0.9	1.4	1.2	0.9	0.8	1.1	+

CALCULAT
PRODUCTI

SN	CASH / YEARS	1	2	3	4	5	6
	A. CASH FLOW						
1.	SALES REVENUE	-	-	565.5	354.6	354.6	354.6
	B. CASH OUTFLOW, TOTAL	-66.0	-2.1	-244.9	-391.8	-341.4	-341.1
1.	EQUITY CAPITAL	-66.0	-2.1	-	-	-	-
2.	ADDITIONAL COST OF GAS CLEANING UNIT	-	-	-	-	-	-
3.	DEBT REPAYMENT	-	-	- 8.5	- 22.1	- 21.2	- 20.4
4.	OPERATING COSTS	-	-	-229.5	-306.0	-306.0	-306.0
5.	INCOME TAX	-	-	- 6.9	- 13.7	- 14.2	- 14.7
	C. NET CASH FLOW (A-B)	-66.0	-2.1	-21.1	12.8	13.2	13.5
	D. PRESENT VALUE						
	@ 19%	-55.5	-1.5	-12.5	6.4	5.5	4.8
	@ 18%	-55.9	-1.5	12.8	6.6	5.8	5.0

ANNEXURE V

TION OF NET CASH FLOW AND PRESENT VALUE FOR
ON OF MASTER Mn-Si ALLOY WITH SILICON CONTENT
OF 20%
(ALTERNATIVE II)

7	8	9	10	11	12	13	14	15	16	17	SCRAP VALUE	PRESENT WORTH VALUE
354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	354.6	-	5229.-
-340.7	-340.4	-340.0	-339.6	-339.3	-320.1	-339.4	-325.1	-325.1	-325.1	-325.1	43.7	-5003.-
-	-	-	-	-	-	-	-	-	-	-	43.7	- 21.1
-	-	-	-	-	- 31.2	-	-	-	-	-	-	- 31.2
- 19.5	- 18.7	- 17.8	- 17.0	- 16.1	- 15.3	- 14.8	-	-	-	-	-	- 191.1
-306.0	-306.0	-306.0	-306.0	-306.-	-306.0	-306.0	-306.0	-306.0	-306.0	-306.0	-	-1513.5
-15.2	- 15.7	- 16.2	- 16.6	- 17.2	- 17.6	- 18.6	-19.1	- 19.1	- 19.1	- 19.1	-	- 242.5
13.9	14.2	14.6	15.0	15.3	- 15.5	15.2	29.5	29.5	29.5	29.5	43.7	226.9
4.1	3.5	3.1	2.6	2.3	- 1.9	1.6	2.6	2.2	1.8	1.5	1.9	- 2.5
4.4	3.8	3.3	2.9	2.5	2.1	1.8	2.9	2.5	2.1	1.8	2.2	+ 0.9