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Contract № 89 156
UNIDO PROJECT № DP/IND/88/063

TECHNO-ECONOMIC FEASIBILITY STUDY OF INDUSTRIAL SCALE ELECTRO-SMELTING OF AL-SI ALLOYS BASED ON PILOT TECHNOLOGICAL TESTING OF INDIAN RAW MATERIALS IN INDIA

Final report

VOLUME I

GENERAL EXPLANATORY NOTE

NPO "VAMI" VVO "TECHNOEXPORT"

ST.-PETERSBURG
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of techno-economic feasibility study

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INTRODUCTION

The Final Report on Feasibility Study of industrial scale electrosmelting of aluminium-silicon alloys in India was prepared taking into account the results of discussions of Draft Feasibility Report with participation of Subcontractor's specialists (VAMI) and Indian National Counterpart (NALCO/MECON) in project area in period from January 22 to February 4, 1992.

The financial and economic evaluation was prepared based on estimates of capital and operation costs updated at December 1991 price level and revised economic data in accordance with the Protocol of discussions of the Draft Final Report.

The foreign exchange cost component was estimated on dollar basis at exchange rate of 1 US $ = Rs.26.

1. EXECUTIVE SUMMARY (RESUME)

1.1. Project Background and History (Chapter 2)

The present Report is prepared in compliance with the Contract N° 89/156 signed between UNIDO and VVO "Technoexport", prividing for carrying out of pilot technological tests of Indian raw materials and development on their basis of the Feasibility Study for industrial-scale electrosmelting of aluminium-silicon alloys in India.

In benefitiation and processing of shore sand of Orissa State the sillimanite concentrate is produced as a by-product, which is a high-quality aluminosilicate raw material for production of aluminium-silicon alloys by electrosmelting method.

The technology of electrosmelting production of Al-Si alloys was developed in the Soviet Union (VAMI Institute, Leningrad) and it was established on industrial scale. This method is based on the reduction smelting of aluminosilicate ore (similar to Indian sillimanite) in electric arc reduction furnace followed by delution of produced alloying composition by molten aluminium.

While utilizing the above technology the following basic raw materials are used besides the sillimanite concentrate: kaolin, alumina, hard coal, petroleum coke.

The pilot testing of Indian raw materials revealed that the proposed technology ensures production on their basis the product mix of alloys widely used in India.

The aim of the present Feasibility Report was to evaluate the establishment of Al-Si alloys production by electrosmelting method on industrial scale based on utilization of Indian raw materials.

The Feasibility Report considers the industrial unit including one electric arc reduction furnace, active power rating 17 MW, ensuring production of 9540 tpy of primary refined alloy.

The utilisation of proposed technology on industrial scale enables India to have wasteless processing of natural raw materials and allows to exclude fully the consumption of silicon metal for production of Al-Si alloys.

1.2. Market and Plant Capacity (chapter 3)

Taking into account the trend prevailing in India to replace the heavy steel structures by lighter ones produced of aluminium and its alloys, there are good pre-requisites for dynamic development of Al-Si alloys determined by further development of such large industries - Al alloys consumers, as automobile manufacturing, aviation, railway transport, civil engineering.

The production of alloys based on existing traditional technology by melting of primary aluminium with silicon metal is limited by deficiency of aluminium and silicon.

The considered unit consisting of one electric arc reduction furnace is not designed to meet all the requirements of India in Al-Si alloys, but besides the production of commercial alloys its aim is also to master the technology of electrosmelting production of alloys on industrial scale and training of workers and engineers.

The unit capacity ensures production of commercial Al-Si alloys of grades 4600, 4600A, 4652 assumed for estimations in accordance with Indian Standard IS: 617-1975 in quantity of 29780 tpy.

1.3. Materials and Inputs (chapter 4)

The electrosmelting production of Al-Si alloys the following is used:

- raw materials: sillimanite concentrate, dry cleaned kaolin, hard coal, uncalcined petroleum coke, quartzite;
- industrial materials: alumina, molten aluminium, electrode paste, copper, manganese, nickel, magnesium;
- auxiliary materials: selex, cryolite, table salt, graphitized electrodes 100 mm diameter, electrode shells, cast iron ingot moulds, wooden poles;
- utilities: electric power, fuel oil, compressed air, water.

Nearly all materials required for production of alloys are available in Orissa State.

The annual demand is as follows:

- sillimanite concentrate	- 8,750 t
- dry cleaned kaolin	- 5,830 t
- alumina	- 3,450 t
- hard coal	- 9,000 t
- uncalcined pet.coke	- 4,500 t
- quartzite	- 2,000 t
- selex (dry basis)	- 2,100 t
- molten aluminium	- 21,500 t
- fuel oil	- 4,780 t
- electric power	- 189 mln.kWh

1.4. Location and site (Chapter 5)

The unit location site was determined based on the recommendation of NALCO adjacent to the existing aluminium smelter of the Company in Angul. This location allows to deliver molten aluminium in required quantity from the operating smelter and ensures reduction of infrastructure facilities cost due to connection to the Smelter's service lines(water and power supply, transport, communication).

The plot area is 15.0 hectares.

The annual traffic is estimated in quantity of 121,400 t. Out of this tonnage 47,500 t are for inplant transportation on site, and 73,900 t - outside traffic, including: deliveries - 41,800 t, shipment - 32,100 tpy.

1.5. Technology (Chapter 6)

The method of electrosmelting production of Al-Si alloys was developed in the USSR and it is successfully used on industrial scale. This method is based on direct reduction of aluminium and silicon from natural aluminosilicates and other types of silica-alumina raw materials in electric arc reduction furnaces.

One of the main advantages of this method is the possibility to involve into production the low-modulus types of aluminosilicate raw materials as sillimanite, kyanite, kaolin, etc., which cannot be efficiently processed for primary electrolysis aluminium.

Besides, the utilisation of Al-Si alloys electro-smelting production process allows:

-to exclude completely the utilization of silicon metal for this purpose;

-to reduce the total consumption of primary aluminium by 20-25%;

-to reduce the consumption of electrode products due to replacement of anode paste by a less costly reductants - coal and petrolium coke.

The laboratory and pilot testings carried out revealed, that the industrial processing of sillimanite concentrate may be implemented only using the technology of electrosmelting method for Al-Si alloys production.

The process of production of commercial casting alloys consists of production at first stage of primary crude alloy containing 58-62% of aluminium by reduction smelting of feed followed by delution of this alloy with primary or partly secondary scrap aluminium and master alloying of deluted alloy with copper, nickel, magnesium and other components depending on the grades of produced alloys.

The main process unit is an electric arc reduction furnace where the reduction takes place producing crude Al-Si alloy of aluminium-containing briquetted feed.

1.6. Plant organization, overheads and other costs
(Chapter 7)

Due to the fact that Al-Si alloys production is planned to be sited nearby the aluminium smelter, the economic calculation are worked out in view of cooperation with the above smelter on manning, organization of repairs and maintenance, transport and other services.

The overhead cost includes costes related to maintenance and routine repair of equipment, buildings and structures, non-production costs as well as depreciation and financial charges for credit servicing.

1.7. Manpower (Chapter 8)

Basing on the operating conditions of main process equipment and composition of process units the total number of production personnel is estimated in quantity of 300 persons, including:

- skilled workers - 202 persons;
- semi-skilled workers - 42 persons;
- unskilled workers - 17 persons;
- supervisers and foremen - 27 persons;
- management - 11 persons;
- administration - 1 person.

1.8. Project implementation (Chapter 9)

In accordance with the adopted time-schedule the total duration of project implementation starting from the date of contract award to units commissioning for industrial operation is 39 months. This period includes the preparation of basic engineering of technological part, detailed engineering, transfer of design specifications, construction, equipment supply and installation, start-up and adjustment.

1.9. Financial and economic evaluation (Chapter 10)

The financial and economic evaluation of project for establishment of industrial production of Al-Si alloys is elaborated in accordance with UNIDO methodology and using the COMFAR 2.1 programme

The cost parameters are estimated at price level of I quarter of 1991 without taking into consideration their escalation.

The project economic parameters are summarized below. The profitability parameters of project are shown as average annual parameters for total period of production.

1.9.1. Requirements in capital investment and sources of financing

1. Total capital investment cost:	Rs.mln
1.1. Fixed capital investment	1151.24
1.2. Interest during construction	42.76
Total initial investment	1194.00
1.3. Working capital, total	132.5
- as margin money for WC (35%)	46.4
- as current assets (65%)	86.1
Grand total	1326.5

2. Sources of financing:	Rs.mln
2.1. Equities	621.23
2.2. Foreign credit on equipment supply & services	153.22
2.3. Long-term local loan	465.05
2.4. Short-term loan on working capital	86.1
Total	1326.5

1.9.2. Project viability

1. Sales revenue, Rs.mln	1353.6
2. Production costs, total	1238.6
including:	
- operation, Rs.mln	1122.4
- depreciation, Rs.mln	64.6
- interest, Rs.mln	51.6
3. Gross income, Rs.mln	115.0
4. Net profit after tax, Rs. mln.	47.0
5. Balance cash-in-hand, Rs. mln.	69.2
6. Break-even point:	
- excluding finance, %	53.3
- including finance, %	68.9

1.9.3. Project efficiency

1. Internal rate of return:	
- on total investment, %	11.65
- on equities, %	7.8
2. Pay-back period, years	6.0

1.9.4. Conclusions

The Feasibility Report makes it possible to draw the following conclusions:

1. As a whole the viability of the project is ensured by the following factors:

- continuous increase of demand for Al-Si alloys at the local market of India;
- practically unlimited reserves of natural alumosilicate raw materials - beach sands in Orissa State.
- possibility to locate the alloys production plant in the area of production of main raw material - sillimanite concentrate - and in close vicinity with the source of production of aluminium in molten form (at the site close to NALCO Smelter in Angul), ensuring reduction of losses and saving of costs related to its remelting.

2. The pilot technological tests of Indian raw materials revealed their basic amenability for utilizing in the production of Al-Si alloys according to electrosmelting method.

3. The technical and economic parameters are estimated in prices as of December 1991, and they are acceptable for making a decision on project implementation on the industrial scale.

For the establishment of Al-Si alloys production of 29780 tpy the required initial capital investment amounts to Rs. 1194 mln. The internal rate of return on total investment will be 11.65 %, the pay-back period - 6.0 years. The project implementation period from the signing date of the contract to the commissioning of the plant is 39 months.

4. The sensitivity analysis revealed, that the project is most stable to the variation of the investment cost. The greatest effect on economic parameters of the project gives the cost of aluminium, which is the most expensive project component. Its share in the finished products is 84-87% and in the composition of the production costs it is more than 60%.

5. The implementation of the project of Al-Si alloys production by electro-smelting method ensures for India as a whole the following:

- increase of the complex processing of sillimanite-bearing sands of Orissa state and the establishment on this basis the wasteless production;

- the enlargement of raw materials basis of India due to processing alumosilicate ores unsuitable for alumina production and levelling at this account the demend structure of electrolytic aluminium;

- industrial scale mastering the process of electro-smelting method of alloys production;

- salving of utilities, primary alumihium and complete exclusion of pure silicon metal consumption in production of Al-Si alloys as compared with traditional method of their production;

- training of labour, technicians and engineers, for new industrial production.

The data specifying technical and financial status of the project are summarized below in Schedule 2-1 "Salient features at a glance".

N A T I O N A L A

A L U M I

S A L I E N

1. **LOCATION** Angul, Orissa

2. **AREA OF PLANT PROPER** Hectares 15

3. **ANNUAL PRODUCTION** Refined allov - 9.540 t/vr
Casting allovs - 29.780 t/vr

4. **IMPLEMENTATION SCHEDULE** 39 months after arroval of project

5. **MAJOR FACILITIES**

SL	UNITS	No
1	RAW MATERIAL STORAGE & CRUSHING	
(i)	JAW CRUSHER	1
(ii)	ROLLER CRUSHER	1
2	REDUCTANTS GRINDING AREA	
(i)	HAMMER MILL	1
3	FEED PREPARATION ROOM	
(i)	BLADE MIXER	2
(ii)	ROLLER PRESS	1
(iii)	CONVEYOR DRYER	1
4	ALLOYS PRODUCTION ROOM	
(i)	ELECTRIC ARC FURNACE	1
(ii)	HOLDING FURNACE	3
(iii)	FILTRATION FURNACE	3
(iv)	INDUCTION FURNACE	2
(v)	CASTING CONVEYOR	4
(vi)	INGOT STACKER	4

6. **REQUIREMENT OF MAJOR RAW MATERIALS & SERVICES**

SL No	I T E M S
1	SILLIMANITE CONCENTRAT
2	KAOLIN
3	ALUMINA
4	COAL
5	PETROLEUM COKE
6	SELEX
7	ELECTRODE PASTE
8	QUARTZITE
9	MOLTEN ALUMINIUM
10	FUEL OIL
11	WATER (FRESH)
12	POWER

7. **CAPITAL INVESTMENT**

SL No	I T E M S
1	TECHNOLOGY
2	PLANT PROPER
3	GAS CLEANING PLANT
4	REPAIR SHOP,POWER,WAT SUPPLY AND OTHERS
5	TOWNSHIP
6	INTEREST DURING CONSTRUCTION
	TOTAL FIXED CAPITAL
	INCLUDING FOREIGN EXCHA
7	MARGIN MONEY FOR WORK CAPITAL

SECTION 1

NATIONAL ALUMINIUM COMPANY LIMITED

ALUMINIUM-SILICON PROJECT

SALIENT FEATURES AT A GLANCE

6. REQUIREMENT OF MAJOR RAW MATERIALS & SERVICES

SL No	ITEMS	QUANITITY/YR
1	SILLIMANITE CONCENTRATE	8,750t
2	KAOLIN	5,830t
3	ALUMINA	3,450t
4	COAL	9,000t
5	PETROLEUM COKE	4,500t
6	SELEX	2,000t
7	ELECTRODE PASTE	810t
8	QUARTZITE	2,000t
9	MOLTEN ALUMINIUM	21,500t
10	FUEL OIL	4,780t
11	WATER (FRESH)	550×10^3 m^3
12	POWER	189×10^6 kwh

7. CAPITAL INVESTMENT

SL No	ITEMS	COST (MILLION Rs)
1	TECHNOLOGY	8,77
2	PLANT PROPER	767,46
3	GAS CLEANING PLANT	128,41
4	REPAIR SHOP, POWER, WATER, SUPPLY AND OTHERS	201,79
5	TOWNSHIP	44,81
6	INTEREST DURING CONSTRUCTION	42,76
	TOTAL FIXED CAPITAL	1194,00
	INCLUDING FOREIGN EXCHANGE	135,47
7	MARGIN MONEY FOR WOKING CAPITAL	46,40

8. MODE OF FINANCING

SL No	ITEMS	AMOUNT (Million Rs)
1	EQUITY CAPITAL	621,23
2	LOAN CAPITAL	465,05
3	SUPPLIER'S CREDIT	153,22

9. PRODUCTION COST

SL No	ITEMS	COST (Rs/t)
1	WORKS COST	37,690
2	DEPRECIATION AND INTEREST	3,900
	TOTAL	41,590

10. SELLING PRICE

SL No	ITEMS	PRICE (Rs/t)
1	ALLOY GRADE 4600	45,800
2	ALLOY GRADE 4600A	45,800
3	ALLOY GRADE 4652	51,800

11. MAN POWER

SL No	CATEGORY	NUMBER
1	EXECUTIVES	39
2	NON-EXECUTIVES	261

SECTION 2

COMPANY LIMITED

ON PROJECT

AT A GLANCE

Schedule 2-1

8. MODE OF FINANCING

SL No	ITEMS	AMOUNT (Million Rs)
1	EQUITY CAPITAL	621,23
2	LOAN CAPITAL	465,05
3	SUPPLIER'S CREDIT	153,22

9. PRODUCTION COST

SL No	ITEMS	COST (Rs/t)
1	WORKS COST	37,690
2	DEPRECIATION AND INTEREST	3,900
	TOTAL	41,590

10. SELLING PRICE

SL No	ITEMS	PRICE (Rs/t)
1	ALLOY GRADE 4600	45,800
2	ALLOY GRADE 4600A	45,800
3	ALLOY GRADE 4652	51,800

11. MAN POWER

SL No	CATEGORY	NUMBER
1	EXECUTIVES	39
2	NON-EXECUTIVES	261

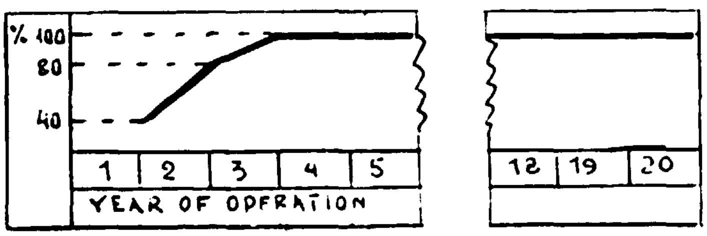
12. PROFITABILITY
(Average)

SL No	ITEM	AMOUNT (Rs.mln.)
1	CAPITAL EMPLOYED	
(i)	FIXED CAPITAL	1,194
(ii)	WORKING CAPITAL	132.5
	TOTAL	1,326.5
2	NET SALES REALISATION	1,353.6
3	MANUFACTURING EXPENSES	1,122.4
4	GROSS MARGIN	231.2
5	DEPRECIATION	64.6
6	INTEREST	51.6
7	NET MARGIN BEFORE TAX	115.0
8	TAX	68.0
9	NET MARGIN AFTER TAX	47.0
10	RETURN ON FIXED CAPITAL	4.0%

13. SALIENT ECONOMIC INDICED
(Over 25 years operation)

SL No	ITEM	UNIT	QUANTITY
1	CUMULATIVE PROFIT BEFORE TAX	M.Rs	2,299.8
2	CUMULATIVE PROFIT AFTER TAX	M.Rs	939.3
3	AVERAGE PROFIT PER YEAR	M.Rs	47.0
4	INTERNAL RATE OF RETURN	%	11.7
5	PAY-BACK PERIOD (AFTER INTEREST AND TAX)	YEARS	6.0
6	BREAK-EVEN CAPA-CITY (excl.finance)	%	53.3

14. CAPACITY BUILD-UP %



SECTION 3

2. PROJECT BACKGROUND AND HISTORY

2.1. Project Background

At present Al-Si alloys are produced in India by means of smelting primary aluminium with adding silicon metal and other metals as alloying components in required proportions.

The project aims at establishment of Al-Si alloys production using the alternative method of their direct manufacturing from the sillimanite concentrate.

The given method was elaborated by VAMI Institute, USSR, and is based on the reduction smelting of aluminosilicate ore (like Indian sillimanites) in electric arc reduction furnaces followed by delution of the alloying composition by molten aluminium.

As raw materials for the new method the following materials, besides the sillimanite concentrate, are used as well: kaolin, alumina, hard coal, petroleum coke, which are fed in proportions in powder condition with addition of binder.

The aim of this Feasibility Report is to evaluate the establishment of the industrial scale production of Al-Si alloys based on pilot technological testings of samples of these raw materials, carried out at Subcontractor's Pilot Plant.

The proposed process makes it possible to manufacture alloys within the grade range widely used in India.

The present evaluation considers the industrial unit made up of one electric arc reduction furnace which ensures manufacturing of 9.54 th.tpy of refined alloys.

The industrial implementation of the new technology, besides the reduction of capital investments and consumption of utilities as compared to the traditional method, will also allow to enlarge the field of usage of secondary aluminium and fully exclude consumption of pure silicon metal, and consequently, its import for these purposes.

The proposed production can be implemented in one stage with commissioning within 39 months from the date of signing the relevant Contract.

2.2. Project Promoter

National Aluminium Company Limited (A Government of India Enterprise) "NALCO" (IDCO Tower, Bhubaneshwar - 751007, Orissa) is the project promoter.

The Company was established in January 1981 within the framework of the project for bauxite-alumina-aluminium complex construction in the State of Orissa.

The construction of the above complex was accomplished in May 1989 by commissioning the second stage of the aluminium Smelter.

Electric power station with the power rating of 600 mW was constructed within the complex and it is envisaged as a source of electric power supply for the Al-Si alloys production.

2.3. Project History

In 1982 VAMI Institute in compliance with UNIDO Contract and in collaboration with the Indian Company "Indian Rare Earths" (IRE) elaborated the Feasibility Study for the construction of the plant producing Al-Si alloys with the capacity of 90000 tpy.

On the basis of the said Feasibility Study VAMI prepared technical and economic evaluation in 1983 for the capacity of 30,000 tpy of Al-Si alloys utilizing the equipment mainly supplied from the USSR.

In March 1984 the Indian consultants "MECON" prepared their own Report on the basis of the technical and economic evaluation of VAMI. In July 1984 this Report was submitted to NALCO and included the survey of market, capacity investigations on location site selection as well as financial and economic evaluation of capital and operation costs and profitability calculated in prices of the Ist quarter of 1984. The question of increasing the Indian portion in equipment supply was not raised in the Report. It was supposed to be considered while preparing the detailed project report at further stages of project implementation.

In 1989 in compliance with the Contract N° 88/98 between VVO "Technoexport" and UNIDO, VAMI Institute has carried-out the laboratory testing of Indian raw materials, which confirmed the principal suitability of these materials for the production of aluminium-silicon alloys following the proposed process. The results of laboratory testing were discussed jointly by Soviet and Indian specialists. Based on these results and taking into account the new price basis the Report prepared in 1983 was reestimated and updated.

In November 1989 a Contract was signed between VVO "Techno-export" and UNIDO for the execution of pilot testings of Indian raw materials samples in VAMI, USSR and preparation of Feassibility Report on this basis. In accordance with this Contract NALCO has submitted the samples of sillimanite concentrate, kaolin, alumina, coal, calcined petroleum coke and selex with a total weight of 34 t aiming at determining their suitability for the electro-smelting production of Al-Si alloys on industrial scale as well for specifying the influence of the obtained results on the main technological parameters. In June of 1990 the samples were supplied to Subcontractor's Pilot Plant in Leningrad.

Chemical and mineralogical compositions of the materials were investigated as well as their suitability for briquetting, roasting and electroreduction was tested.

The results of the pilot testing proved, in principle, the suitability of the Indian raw materials for the production of Al-Si alloys according to the proposed technology and were given in the Interim Report.

This Report was considered in March 1991 with the participation of the Soviet specialists and the Indian National partner and is taken as basis of the present Feasibility Report for defining of the process parameters.

2.4. Technical and Economic Investigation

The present Report in the volume determined by Contract N° 89/156 (Annes E, Section C, item 2) is performed by All-Union and design Institute of Aluminium, Magnesium and Electrode Industry (VAMI), the Department of Metallurgy, Sredny pr. 86, St-Petersburg, 199026, CIS.

From the Indian side the assistance is rendered by NALCO and MECON.

3. MARKET AND PLANT CAPACITY

3.1. Demand and Market Brief Study

Aluminium industry of India is a rapidly developing branch of economy.

The rates of consumption increase of primary aluminium in 1988-1995 will amount to average 8 per cent per annum and in 1996-2000 6 per cent per annum while the forecasted increase of its production will go from 290 th.tpy in 1988 up to 580 th.tpy in 1998 or approximately 11 per cent average per annum.

In view of the fact that minimum 15-20 per cent of primary metal in the countries - manufactures of aluminium are used for the production of casting aluminium alloys it can be supposed that the production and consumption in India shall amount to 90-120 th.tpy in the period beginning with the second half of the 90^{ies}.

Al-Si alloys are mainly used for the production of parts for internal combustion engines for cars, scooters, motorcycles, mopeds which are widely used in India. The consumption of Al-Si alloys for these purposes shall amount to 30-33 th.tpy.

The production of the above kinds of transport is supposed to increase in 1995 twice as much as compared with the present time.

Proceeding from the above the conclusion can be drawn that India has rather favourable possibilities for developing home market for the production and consumption of Al-Si alloys.

The industrial unit considered consisting of one arc reduction furnace is not designed to meet all requirements of India in commercial Al-Si alloys, but besides of their production its aim is also to master the technology of electrosmelting production of alloys on industrial scale and training of personnel.

3.2. Sales and Marketing of Products

In calculations it is assumed that the whole volume of Al-Si alloys will be consumed in Indian home market. On the basis of prices as of December 1991 revised during discussions of the Draft Feasibility Report.

quarter of 1991 and the volumes of finished alloys production the estimate of sales revenues is given in Schedule 3-1.

While making the calculations the results of sales revenues of silicoaluminium produced as a by-product from reciduals on the filter in quantity of 735 tpy are also taken into account.

This product can be utilized in ferrous metallurgy as a deoxidizer for steel production.

3.3. Production Programme

As it was shown by pilot testing the proposed technology allows to produce out of samples of Indian raw materials submitted, a wide range of finished Al-Si alloys corresponding to Indian standard (IS:617-1975).

For the purpose of calculations the widely used alloys grades 4600, 4600A and special grade 4652 were chosen out of finished alloys production.

For the calculations of the industrial program it is assumed that 37.6% of refined Al-Si alloy would be used for production of alloy gra e 4600A, 30.15% -grade 4600 and 32.25% - grade 4652.

As far as the unit construction period is 3 years and 3 months, the operation period on the first year of production (the fourth year from the beginning of construction) is assumed of 9 months, based on total estimated operation period of 20 years.

Taking this into account as well as the period of mastering of industrial capacity, Schedule 3-2 shows the industrial program for alloys grades under consideration.

3.4. Plant Capacity

The normal achievable capacity for production of commercial Al-Si alloys is determined by quantity of primary refined alloy containing about 56% of aluminium and 39% of silicon smelted in arc reduction furnace.

The nominal active power rating of arc reduction furnace is 17 MW, ensuring production of 9540.0 t of primary refined alloy per year.

On this basis the normal achievable capacity of the plant producing commercial Al-Si alloys is assumed at 29780 tpy, incliding:

Grade 4600	- 8500 tpy
Grade 4600 A	- 11000 tpy
Grade 4652	- 10280 tpy

Schedule 3-1

Estimate of Sales Revenues

Alloy grade	Unit price Rs.000 /t	Years from begining of operation							
		1-st(9 months)		2-nd		3-rd		4-th and following	
		Q-ty t.000	Sales reve-nues Rs.mln	Q-ty t,000	Sales reve-nues Rs.mln	Q-ty t,000	Sales reve-nues Rs.mln	Q-ty t,000	Sales reve-nues Rs.mln
4600	45.80	1.87	85.64	5.52	252.82	7.86	359.99	8.50	389.30
4600A	45.80	2.42	110.84	7.15	327.47	10,17	465.79	11.00	503.80
4652	51.80	2.26	117.07	6.69	346.54	9.52	493.14	10.28	532.50
Sub-total		6.55	313.55	19.36	926.83	27.55	1318.92	29.78	1425.60
Silico-aluminium	21.0	-	-	-	-	0.66	13.86	0.74	15.54
TOTAL			313.55		926.83		1332.78		1441.14

Schedule 3-2

Production Programme

Al-Si finished alloy grade	At 100% capacity, t	Years from begining of operaton							
		1-st (9 months)		2-nd		3-rd		4-th and following	
		Capacity %	Quantity t	Capacity %	Quantity t	Capacity %	Quantity t	Capacity %	Quantity t
4600	8500	22	1870	65	5525	92.5	7862	100	8500
4600 A	11000	"	2420	"	7150	"	10175	"	11000
4652	10280	"	2262	"	6682	"	9509	"	10280
TOTAL	29780		6552		19357		27546		29780

4. MATERIALS AND INPUTS

4.1. Characteristics of Raw Materials and Inputs

4.1.1. Classification of Materials

The following is used for the production of Al-Si alloys:

- raw materials: sillimanite concentrate, dry cleaned kaolin, alumina, coal, uncalcined petroleum coke, quartzite;
- industrial materials: aluminium (in molten state), electrode paste, manganese, copper, nickel, magnesium;
- auxiliary materials: selex, fluxes (table salt, cryolite), refractories;
- utilities: electric power, water, fuel oil, compressed air, nitrogen, etc.

4.1.2. Specifications of raw materials and inputs

To produce primary Al-Si alloys of optimum composition with 60-65 per cent aluminium content it is required that the sillimanite concentrate and kaolin contain maximum quantity of Al_2O_3. This will make it possible to reduce addition of alumina to the charge.

Harmful impurities include iron, titanium and zirconium oxides. The metals of these oxides pass to the melt in full quantity and their extraction as intermetalloids of the process of finished casting Al-Si alloys production results in lower recovery of products and extra costs.

The electrode paste should have electrical resistance of 90 hm.mm^2/m maximum, ash content of 7% max., and volatiles of 12-20%. The requirements to electrode paste are specified by need to maintain preset power parameters during electrosmelting process in arc reduction furnace.

The coal, used in process as a reducing agent, should have high activity, increasing with the increase of volatiles content and decrease of ash content. The content of iron oxides in coal is limited based on general requirements of their content in feed.

Petroleum coke should contain minimum sulphur content based on requirements of environment protection from SO_2 and SO_3 and equipment corrosion resistance.

Based on the above, the following requirements to raw materials chemical composition are specified:

- Sillimanite concentrate - aluminium oxide content - 56% minimum, iron and titanium oxides - 0.6% max. of each, zirconium oxide - 0.5% max:
- Dry cleaned kaolin - aluminium oxide - 36% min., iron and titanium oxides-0.7% max. of each;
- Alumina - Al_2O_3 - 98.5% min., iron oxides - 0.1% max;
- Quartzite - silica - 98.5% min., iron oxides - 0.2% max.;
- Petroleum coke - volatiles - 7-12%, sulphur - 1.5% max., fixed carbon - 85-90%, iron oxides - 0.1% max.

The increase of iron, titanium and zirconium oxides content will result in reduction of aluminium recovery from raw materials, decrease of product output and consequently to decrease of process techno-economic parameters.

To ensure the production of commercial Al-Si casting alloys grades 4600, 4600A and 4652, containing (as per Indian Standard) from 0.6% to 1.0% of iron, the following iron content is admissible in industrial materials to be used for production of above alloys grades: in aluminium - 0.2%, in manganese - 2.3%, in master alloys (Cu, Ni, Mg) - 0.6% per each element.

To ensure the required strength and thermal stability of briquetted feed, the binder is to be added to feed besides the kaolin. Selex is used as a binder, beeing a by-product of paper industry.

Selex should meet the requirements on iron and titenium oxides content and have all binding properties to ensure purity of produced alloys.

- Table (common) salt and cryolite used in process as fluxes should not contain more than 0.5% of wated as per safety norms for operation with molten metals.

- Electric power - frequency - 50 Hertz, voltage for electric motors up to 320 kW and electric lighting - 415/240V, 11 kV - supply of plant transformer substations.

Current intensity is determined by specifications of each consumer.

- Water supplier for make-up of plant water recirculating system for cooling of arc reduction furnace elements, induction furnaces, transformers, filtering furnaces as well as for cooling of furnaces in Reductants grinding area, should meet the following requirements:

- total hardness - 3 mg-eq/l max.;
- carbonate hardness - 2.5 mg-eq/l max;
- suspended solids - 20 mg/l max.;
- iron salts content - 0.1 mg/l max.;
- total salts content - 100 mg/l max.;
- acidity - pH = 6.5 to 8.5;
- temperature $\leqslant$ 30°C.

- Fuel oil used for process needs grade "HV" (Indian Standard 1593-1982) is specified as follows:

- Non-organic acifity - none
- Ash content, wt.%, max. - 0.1
- Gross calorific value, kcal/h - abt.10000
- Relative density at 15/15°C - < 0.8
- Flash point, max. - 66°C
- Kinetic viscosity, cst., at 50°C - 370
- Precipitate, wt.%, max. - 0.25
- Sulphur content, wt.%, max. - 4.5
- Moisture, wt.%, max. - 1.0

4.1.3. Selection and characteristics of raw materials and inputs

The following raw materials and inputs are assumed for technological calculations of the Feasibility Report in accordance with the data supplied by NALCO, India:

- For production of primary (crude) Al-Si alloy; sillimanite concentrate, alumina, dry cleaned kaolin, coal, uncalcine pet. coke, quartzite, selex, electrode paste;

- For production of commercial casting Al-Si alloys: molten aluminium, manganese metal for production of a lloy grade 4600 and master alloys: copper, nickel and magnesium - for alloy grade 4652. Besides, table (common) salt and cryolite are adopted as fluxes for refining of crude alloy and production of commercial casting alloys.

The specifications of above raw materials and inputs are shown in Tables below (chemical analysis are adopted in accordance with the VAMI analysis of Indian raw materials for pilot testing.

Sillimanite concentrate

Srl. No	Chemical analysis and properties	Unit of measure	Average value
1	Al_2O_3	%	57.65
2	SiO_2	%	36.08
3	Fe_2O_3	%	0.49
4	TiO_2	%	0.94
5	ZrO_2	%	2.42
6	CaO + MgO	%	0.35
7	Moisture	%	0.37
8	Bulk weight	g/cm^3	1.88
9	Average particle size	mcm	+297 (3.7%)

Alumina

Srl. No	Chemical analysis and properties	Unit of measure	Average value
1	Al_2O_3	%	98.9
3	L.O.I.	0.5	
3	SiO_2	%	0.022
4	Fe_2O_3	%	0.008
5	$Na_2O + K_2O$	%	0.42
6	TiO_2	%	0.05
7	Bulk weight	G/cm^3	0.95 + 1.05
8	Angle of repose	degree	34
9	Average particle size	mcm	-45 (12%) -125 (15%)

Dry cleaned kaolin

Srl. No	Chemical analysis and properties	Unit of measure	Average value
1	Al_2O_3	%	37.25
2	SiO_2	%	46.95
3	Fe_2O_3	%	0.86
4	TiO_2	%	0.46
5	CaO + MgO	%	0.11
6	Moisture	%	2
7	L.O.I.	%	13
8	Bulk weight	g/cm^3	0.35
9	Average particle size	mcm	-2 (68%) +10 (5%)

Coal

Srl. No	Chemical analysis and properties	Unit of measure	Average value
1	Ash content	%	15.76
2	Content in ash:		
	Al_2O_3	%	23.65
	SiO_2	%	62.35
	Fe_2O_3	%	5.95
	TiO_2	%	1.1
	CaO + MgO	%	2.8
	Sulphur	%	0.54
3	Volatiles	%	38.14
4	Fixed carbon	%	46.1
5	Moisture	%	8.9
6	Bulk weight	g/cm^3	0.7
7	Lump size	mm	200 max

Petroleum coke

Srl. No	Chemical analysis & properties	Unit of measure	Average value
1	Ash content	%	0.16
2	Content in ash:		
	Al_2O_3	%	50.6
	SiO_2	%	40.2
	Fe_2O_3	%	3.1
	TiO_2	%	0.76
	CaO + MgO	%	2.07
	Sulphur	%	0.98
3	Volatiles	%	7.1
4	Fixed carbon	%	92.74
5	Moistire	%	10
6	Bulk weight	g/cm^3	0.7
7	Lump size	mm	-150 (94%) +250 (1%)

Quartzite

Srl. No	Chemical analysis & properties	Unit of measure	Average value
1	SiO_2	%	99.5
2	Al_2O_3	%	0.2
3	Fe_2O_3	%	0.3
4	Bulk weight	g/cm^3	1.5
5	Lump size	mm	10-70

Selex

Srl. No	Chemical composition & properties	Unit of measure	Average value
1	Dry matters	%	62.55
2	Ash content	%	11.77
3	Content in ash:		
	MgO	%	48.1
	S	%	5.67
	$Na_2O + K_2O$	%	9.52
4	Volatiles	%	65.5
5	Fixed carbon	%	22.73

Electrode paste

Srl. No	Chemical composition & properties	Unit of measure	Average value
1	Ash content	%	1
2	Volatiles	%	14
3		%	86
4	Electrical resistance	$\frac{Ohm.mm^2}{m}$	87
5	Apparent density		
	- green paste	g/cm^3	1.58
	- prebaked paste	-"-	1.4
6	Porosity	%	30
7	Strength: compressive	kg/cm^2	150-250
	breaking	-"-	150

Primary aluminium (molten)

Srl No	Chemical analysis & properties	Unit of measure	Average value
1	Fe	%	0.15
2	Si	%	0.15
3	Al	%	99.7

Menganese metal

Srl No	Chemical analysis & properties	Unit of measure	Average value
1	Mn	%	97
2	S	%	not specified
3	C	%	
4	Si	%	
5	O_2	%	
6	H_2	%	
7	Fe, max	%	2
8	Lump size	mm	powder

Chemical analysis of copper, nickel and magnesium, used in production of commercial casting alloys as master alloys are assumed in accordance with relevant Indian Standards.

Chemical composition of fluxes is also adopted as per Indian Standards with limitations of water content of 0.5% maximum.

Power for the unit is supplied from captive Main Step-down Substation (MSDS) located outside the fence of operating Smelter. One transformer, voltage 220/11 kV and power rating of 37.5 MVA is to be installed at MSDS. The stand-by transformer of similar power rating installed at Smelter site will be used as emergency unit.

The fresh potable and industrial water is to be supplied from NALCO Smelter. The recirculating water will be supplied from water recirculating unit.

4.2. Supply Programme

4.2.1. Initial data

The programme for supply of raw materials and inputs is determined based on product range of commercial Al-Si alloys; the composition of these alloys is shown in Section 4.2.1.1.

The specific consumptions of raw materials, inputs and utilities for production of primary (crude) alloy and commercial casting alloys are given below in Sections 4.2.1.2 and 4.2.1.3.

The annual output of produced alloys by grades is given in Section 4.2.1.4.

4.2.1.1. Alloys composition

Srl No	Alloy grade	Components, % (balance - aluminium)								
		silicon	iron	titanium	zirco-nium	Mn	Cu	Ni	Mg	Ca
1	4600	11.9	0.56	0.07	0.02	0.3	-	-	-	0.002
2	4600 A	11.9	0.67	0.11	0.07	-	-	-	-	0.07
3	4652	11.6	0.64	0.12	0.07	-	1.05	1.0	1.15	0.005
4	Silicoaluminium (by-product)	14-24	4.5	2.0	2.0	3.5	-	-	-	-

4.2.1.2. Specific, annual, daily and monthly consumptions of raw materials and inputs for production of crude refined alloy

Srl No	Description of consumption item	Unit of measure	Consumptions			
			specific	annual	daily	monthly
1	Sillimanite concentrate	t	0.917	8748	27.3	820
2	Dry-cleaned kaolin	t	0.611	5829	18.2	546
3	Alumina	t	0.362	3454	10.8	324
4	Coal	t	0.944	9006	28.1	844
5	Petroleum coke	t	0.472	4503	14.1	422
6	Selex (dry basis)	t	0.22	2099	6.56	197
7	Quartzite	t	0.21	2004	6.26	188
8	Electrode paste	t	0.085	811	2.54	76
9	Electrode shells	t	0.0035	34	0.106	3.2
	Fluxes					
10	Common salt	t	0.022	210	0.66	19.7
11	Cryolite	t	0.005	43	0.15	4.5
	Recycled wastes					
12	Gas-cleaning dust	t	0.260	2480	7.75	232.5
13	Slag (fraction 5-40 mm)	t	0.280	2671	8.35	250.4
	Auxiliary materials					
14	Graphitized electrodes dia 100 mm	t	0.003	29	0.09	2.72
15	Wooden poles	m^3	0.03	286	0.9	26.8
16	Refractories	t	0.02	191	0.6	18.0
	Utilities					
17	Electric power					
	process	kWh	13000	124.10^6	$387,6.10^3$	$11,63.10^6$
	power	"	3000	$28,62.10^6$	$89,44.10^3$	$2,68.10^6$
18	Fuel oil	thous.m^3	0.22	2099	6.56	197
19	Compressed air	thous.m^3	0.85	8109	25.3	760
20	Industrial water	m^3	1.2	11448	35.77	1073.1
21	Recirculating water	thous.m^3	0.5	4770	14.9	447

4.?.1.3. Specific, annual, daily and monthly consumptions of materials for production of commercial casting alloys

Srl No	Description of consumjption items	Unit of mea-sure	Consumptions for production of alloy grade 4600				Consumptions for production of alloy grade 4600A				Consumptions for production of alloy grade 4652			
			specific	annual	daily	monthly	specific	annual	daily	monthly	specific	annual	daily	monthly
1	Aluminium	t	0.7318	6220	19.4375	583.12	0.7208	7929	24.778	743.344	0.7153	7353	22.978	689.34
2	Refined alloy	t	0.3384	2876.4	8.9887	269.66	0.3262	3588.2	11.2131	336.394	0.2993	3076.8	9.615	288.45
3	Manganese	t	0.0074	62.9	0.1966	5.9	-	-	-	-	-	-	-	-
4	Copper	t	-	-	-	-	-	-	-	-	0.0111	114.1	0.3566	10.70
5	Nickel	t	-	-	-	-	-	-	-	-	0.0111	114.1	0.3566	10.70
6	Magnesium	t	-	-	-	-	-	-	-	-	0.0121	124.4	0.3887	11.70
7	Cryolite	t	0.0021	26.35	0.0823	2.47	0.0022	24.2	0.0756	2.27	0.0022	22.62	0.0707	2.12
8	Common salt	t	0.0100	85.0	0.2660	7.97	0.0065	71.5	0.2230	6.70	0.0065	66.8	0.209	6.26
9	Quartzite	t	0.005	42.5	0.1330	3.98	0.005	55.0	0.1720	5.16	0.005	51.4	0.161	4.82
10	Cast iron	t	0.001	8.5	-	-	0.001	11.0	-	-	0.001	10.3	-	-
11	Electric power	kWH	450	3825.10^3	$11,95.10^3$	$318,75.10^3$	450	4950.10^3	$15,46.10^3$	$412,5.10^3$	450	4626.10^3	$14,46.10^3$	$385,5.10^3$
12	Fuel oil	t	0.09	765	2.39	71.7	0.09	990	3.09	92.7	0.09	925	2.89	86.7
13	Water	m^3	18.0	153.10^3	478.12	$14,34.10^3$	18.0	198.10^3	618.75	$18,56.10^3$	18.0	185.10^3	578.25	$17,35.10^3$
14	Compressed air	nm^3	55.0	$467,5.10^3$	$1,46.10^3$	$43,83.10^3$	55.0	605.10^3	$1,89.10^3$	$56,72.10^3$	55.0	$565,4.10^3$	$1,77.10^3$	53.10^3
15	Spare parts	t	0.001	8.50	0.026	0.80	0.001	110	0.034	1.03	0.001	10.28	0.032	0.96
16	Refractories	t	0.003	25.5	0.080	2.39	0.003	33.0	0.103	3.09	0.003	30.84	0.096	2.89
	By-products													
1	Filter residue	t	0.0453	385.05	1.20	36.10	0.0156	171.6	0.536	16.09	0.0174	179.28	0.560	16.81
2	Slags	t	0.0323	274.55	0.858	25.74	0.0314	345.4	1.079	32.38	0.0315	323.82	1.012	30.36

4.2.1.4. Annual output of produced alloys

Srl No	Alloy grade	Annual tonnage of produced alloys
1	4600	8500
2	4600 A	11000
3	4652	10280
	TOTAL:	29780

4.3. Selection of Delivery Programme

The selection of delivery programme is determined by consumption of materials in production, conditions to ensure continuous operation, availability of storage capacities, regularity of transport equipment loading and sources of raw materials and inputs supplies.

The main raw material for production of Al-Si alloys is sillimanite concentrate produced as a by-product of beneficiation of ilmenite ores in the State of Orissa.

Alumina supply will be ensured from NALCO Alumina Plant (Damanjodi) situated in the same State.

Coal should be delivered from Talcher Coal Mine, quartzite - from Hirakud region, Balangir mine, electrode paste - from Hirakud, kaolin - Dokoshipur mine, selex - from Calcutta.

The total electric power requirement is about 189 mln. kW.h per year, which will be met by power generating facilities of NALCO Works.

The characteristics of delivery programme of raw materials and inputs and their inventories after reaching design capacity are shown in Sections 4.3.1 and 4.3.2.

4.3.1. Characteristics of delivery program of raw materials and inputs

Srl No	Raw material and input description	Inventory, t	Frequency of deliveries	Single delivery tonnage	Type of transport
1	Sillimanite concentrate	2000	8 times per month	105	Motor transport
2	Kaolin	320	8 "	70	"
3	Alumina	300	4 "	80	"
4	Coal	990	4 "	210	"
5	Quartzite	650	4 "	50	"
6	Pet.coke	670	4 "	110	"
7	Selex	350	3 "	25	Tank cars
8	Electrode paste	125	4 "	20	Motor transport
9	Aluminium (molten)	-		-	
10	Manganese	10	2 "	5	Motor transport
11	Copper	10	2 "	5	"
12	Nickel	10	2 "	5	"
13	Magnesium	10	2 "	5	"
14	Cryolite	10	2 "	5	"
15	Table salt	40	4 "	10	"
16	Spare parts	-	as required	Average 70 t per month	"
17	Refractories	-	"	30	"
18	Fuel oil	500	4 times per month	120	Tank cars

4.3.2. Inventory of raw materials

Srl. No	Description of raw materials and inputs	Inventory					
		at storages		feed preparation room		total	
		tonnes	days	tonnes	days	tonnes	days
1	Sillimanite concentrate	1700	60	300	11	2000	71
2	Kaolin	270	15	50	2.5	320	17.5
3	Alumina	170	15	130	12	300	27
4	Coal	900	30	90	4	990	34
5	Petroleum coke	600	40	70	5	670	45
6	Quartzite	650	90	-	-	650	90
7	Selex	350	25	-	-	350	25
8	Electrode paste	125	50	-	-	125	50
9	Fluxes (at storage of electrode paste)	55	30	-	-	55	30

4.4. Cost Estimate

The estimate of expenses for materials and utilities at 100 per cent capacity is summerized in Schedule 4-1.

The calculations are based on the annual requirements for material and utilities determined proceeding from the specific consumption, adopted production programme and prices of utilities of to be utilized as specified in March 1991.

The updating of cost estimates at December 1991 price level was implemented in Schedule 4-2 using the escalation factor for materials and utilities at 7% and the prices for molten aluminium of Rs.38700 per 1 t in accordance with the Protocol of discussions of Draft Feasibility Report.

Schedule 4-1

Estimate of Production Costs					
Materials and Inputs					
1. Production of primary (crude) refined alloy - 9540.0 tpy					
Srl. No	Q-ty	Unit of meas.	Cost Item	Unit price, Rs	Costs Rs.mln
1			Raw Materials		
1.1	8748	t	Sillimanite concentrate	1850	16.18
1.2	5829	t	Dry cleaned kaolin	1210	7.05
1.3	3454	t	Alumina	4400	15.20
1.4	9006	t	Coal	770	6.93
1.5	4503	t	Pet. Coke	3630	16.35
1.6	2099	t	Selex	5430	11.40
1.7	811	t	Electrode paste	11550	9.37
1.8	2004	t	Quartzite	470	0.94
			Total of Item 1		83.42
2			Auxiliary Materials		
2.1	210	t	Common salt	1100	0.23
2.2	48	t	Cryolite	29700	1.43
2.3	34	t	Electrodes casings	9900	0.34
2.4	29	t	Graphitized electrodes	52800	1.53
2.5	191	t	Refractories		1.58
			Total of Item 2		5.11
3			Utilities		
3.1	2099	t	Fuel oil	3850	8.08
3.2	124038	thous. kWH	Process power	715	88.69
3.3	28620	-"-	Power, including gas cleaning system	715	20.46
			Total of item 3		117.23
			GRAND TOTAL		205.76

Schedule 4-1 (contd.)

Estimate of Production Costs					
Materials and Inputs					
2. Production of alloy grade 4600 - 8500 tpy					
Srl. No	Q-ty	Unit of meas.	Cost Items	Unit price, Rs	Costs Rs.mln
1			Industrial materials		
1.1	6220	t	Liquid aluminium	35700	222.05
1.2	62.9	t	Manganese	49500	3.11
			Total of item 1		225.16
2			Auxiliary materials		
2.1	26.35	t	Cryolite	29700	0.78
2.2	85.0	t	Table salt	1100	0.09
2.3	42.5	t	Quartzite	470	0.02
2.4	8.5	t	Cast iron	13200	0.11
2.5	25.5	t	Refractories	8250	0.21
			Total of item 2		1.21
3			Utilities		
3.1	765	t	Fuel oil	3850	2.95
3.2	3825	thous. kW.h	Electric power	715	2.73
3.3	157	thous. m3	Industrial water	55	0.01
			Totel of item 3		5.69
			GRAND TOTAL		232.06

Schedule 4-1 (contd.)

Estimate of Production Costs					
Materials and Inputs					
3. Production of alloy 4600A - 11000 tpy					
Srl. No	Quan-tity	Unit of meas.	Cost items	Unit pri-ce, Rs.	Costs, Rs.mln
1			Industrial meteriels		
1.1	7929	t	Liquid aluminium	35700	283.07
2			Auxiliary materials		
2.1	24.2	t	Cryolite	29700	0.72
2.2	71.5	t	Table salt	1100	0.08
2.3	55.0	t	Quartzite	470	0.03
2.4	11.0	t	Cast iron	13200	0.15
2.5	33.0	t	Refractories	8250	0.27
			Total of item 2		1.25
3			Utilities		
3.1	990	t	Fuel oil	3850	3.81
3.2	4950	thous. kW.h	Electric power	715	3.54
3.3	202	thous.	Industrial water	55	0.01
			Total of item 3		7.36
			GRAND TOTAL		291.68

Schedule 4-1 (contd.)

Estimate of Production Costs

Materiels and Inputs

4. Production of alloy 4652 - 10280 tpy

Srl. No	Quan-tity	Unit of meas.	Cost item	Unit price, Rs	Costs, Rs.mln
1			Industrial materiels		
1.1	7353	t	Liquid aluminium	35700	262.50
1.2	114.1	t	Copper	99000	11.30
1.3	114.1	t	Nickel	49500	5.65
1.4	124.4	t	Magnesium	93500	11.63
			Total of item 1		291.08
2			Auxiliary materials		
2.1	22.62	t	Cryolite	29700	0.67
2.2	66.8	t	Table salt	1100	0.07
2.3	51.4	t	Quartzite	470	0.02
2.4	10.3	t	Cast iron	13200	0.14
2.5	30.84	t	Refractories	8250	0.25
			Total of item 2		1.15
3			Utilities		
3.1	925	t	Fuel oil	3850	3.56
3.2	4626	thous. kW.h	Electric power	715	3.31
3.3	189	thous. m3	Industrial water	55	0.01
			Total of item 3		6.88
			GRAND TOTAL		299.11

Schedule 4-1 (contd.)

Estimate of Production Costs

Materials and Inputs

5. Production of compressed air, recirculating water, fuel oil heating, electric lighting

Srl. No	Quantity	Unit of meas.	Cost items	Unit price, Rs.	Costs, Rs.mln
1	22911	thous. kW.h	Electric power	715	16.38
2	30	% of power cost	Materials	16.38×10^6	4.91
			TOTAL		21.29

Schedule 4-2

Summary sheet: Estimate of Production Costs		
MATERIALS AND UTILITIES		
No. Description	Costs, Rs.mln.	
	Prices of III-1991	Prices of XII-1991
1.Raw materials	83.42	89.26
2.Auxiliary materials and inputs (w/o aluminium)	45.32	48.49
3.Molten aluminium (21502 t)	767.62	832.13
4.Electric power	135.11	144.57
5.Fuel oil	18.40	19.69
6. Industrial water	0.03	0.03
GRAND TOTAL	1049.90	1134.17

5. LOCATION AND SITE

5.1. Location

Location and site adjacent to the site of NALCO aluminium plant in Angul (its southern border) were adopted at the recommendations of the Indian companies NALCO and MECON with the consideration of the above factors:

- the availability and location of the sources or raw materials and electric power supply;
- availability of infrastructure;
- possibility of molten electrolytic aluminium supply.

There is the opportunity of connection to the engineering systems of water-, el.power supply, transportation and communication network of the operating aluminium smelter.

The plan the site has a shape of triangle with surface area of 15.0 hecters.

The general layout is developed for this site. The gaps between structures for the arrangement of general layout are specified based on sanitary and fire-fighting norms.

All units of general layout are located taking into account the sequence of technological process and conditions of raw meterials and inputs delivery and shipment of finished products.

The dominating factor was the location of alloy production building (metallurgical) with connecting corridor to the existing Smelter. The Al-Si alloy from furnace room and molten aluminium in ladles from the Smelter are to be supplied to the Alloy production building.

All service and auxiliary facilities are located taking into account their proximity to units to be serviced.

The topography of the site is mild with some drop to norheast and south-west. The levelling elevation of the site is adopted equal to 121.00 m according to the Protocol.

The estimated scope of earthworks is:

- back filling - 43700 m^3
- escavation - 149300 m^3.

The site levelling provides for removing (for back filling as well as for escavation) and temporary storing of vegetable soil in quantity of 45000 m^3.

5.1.1. Main parameters of general layout

Srl. No	Description	Unit of measure	Quantity	Remark
1	Site area in fence	hecrar	15	
2	Built-up area	-"-	4.5	
3	Built-up density	%	30	
4	Roads pavement area and length of motor roads	m^2 / km	33000 / 4.5	
5	Greenery area	hecrar	3.0	

The arrangement of units at general layout is shown on drg.N° 1408014- ГП . The vicinity map with location of production facilities is given at drg.N° 1408013- ГП .

5.2. Logistics

The annual quantities of traffic based on data of process design are 121.4 thous.t, including: in-plant deliveries - 47.5 thous.t and outside traffic - 73.9 thous.t. In agreement with the Contract the outside traffic will be implemented by NALCO, thus the present chapter doesn't study the issues of outside traffic.

The outside and in-plant traffic by types of cargo are shown in Sections 5.2.1 and 5.2.2.

To handle the inplant traffic it will be required to purchase the following transport machines:

- truck, capacity 7-8 t - 1 N°
- dump-truck, capacity 7-8 t - 1 N°.

The molten aluminium will be transported from the Smelter to the Alloy Production building (Metallurgical) by special transport in ladles with capacity of 9.5 t of aluminium.

To ensure the transport communication between the plant areas, the fire-fighting serwicing of plant territory and areas the network of motor roads and passage ways is provided.

The type of motor roads and access roads, parameters and design of pavement are determined by the Customer.

The width of main roads at plant area is adopted equal to 7.0 m; the width of secondary access roads - 4.0 m.

The waysides of 2.0 m each.

5.2.1. List of outside traffic by motor transport

Srl. No	Cargo description	Transport route: exit	Transport route: entrance	Quantity: annual, thous. t	Quantity: daily, t	Irregularity factor	Tonnage per day accounting for irregularity factor	Type of transport vehicle	Capacity	Remarks
	Delivery									
1	Dry-cleaned kaolin	Jeshiour mine	Raw material storage	5.8	15.9	2	31.8	Side truck		All outside traffic is to be provided by NALCO. Present Report does not provide for transport facilities
2	Sillimanite concentrate	IRE, Chatrapur	-"-	8.7	23.8	2	47.6	Dump truck		
3	Alumina	NALCO, Damanjodi	-"-	3.5	9.6	1.5	14.4	Side truck		
4	Coal	Coal India Ltd	-"-	9.0	24.7	2	49.4	Dump truck		
5	Selex	India Paper Pulp	Selex tank	2.1	5.7	2	11.4	Tank car		
6	Quartzite	Bolangie Mine	Raw material storage	2.0	5.5	3	16.5	Dump truck		
7	Petroleum coke		-"-	4.5	12.3	2	24.6	-"-		
8	Electrode paste	INDAL, Hirakud	Electrode paste storage	0.8	2.2	5	11.0	Side truck		
9	Fluxes		All production building	0.6	1.6	10	16	-"-		
10	Manganese		-"-	0.06	0.2	10	2	-"-		
11	Fuel oil		Fuel oil storage	4.78	13.1	1	13.1	Tank car		
	TOTAL:			41.84			237.8			
	Shipment									
1	Finished products	Finished products storage	Consumers	29.78	81.6	1.5	122.4			
2	Silicoaluminium	-"-	-"-	0.73	2.0	1.5	3.0			
3	Slag	Raw material storage	Dump	0.67	1.8	2	3.6			
4	Slag	Alloy production building	to Consumer	0.94	2.6	2	5.4			
	TOTAL:			32.12			134.4			
	GRAND TOTAL of delivery and shipment			73.96			372.2			

5.2.2. List of inter-plant traffic by motor transportation

Srl. No	Cargo description	Transport route: exit	Transport route: entrance	Quantity: annual, thous. t	Quantity: daily, t	Irregularity factor	Tonnage per day accounting for irregularity factor	Type of transport vehicle	Capacity	Remark
1	Dry cleaned kaolin	Raw material storage	Feed preparation building	5.8	15.9	2	31.8	Truck	8	
2	Quartzite	-"-	-"-	2.0	5.5	3	16.5	Dump truck	8	
3	Sillimanite concentrate	-"-	-"-	8.7	23.8	2	47.6	-"-	8	
4	Primary aluminium	Smelter	Alloy production building	21.5	58.9	1	58.9	In molten state. Ladles	-	Process design provides for transport facilities
5	Metallised slags	Alloy production building	Raw material storage	3.3	9.0	1	9.0	Dump truck	8	
6	Metallised slags	Raw material storage	Feed preparation bldg.	2.7	7.4	1	7.4	Truck	8	
7	Alumina	-"-	-"-	3.5	9.6	1.5	14.4	-"-	8	
	GRAND TOTAL:			47.5			185.6			

5.2.3. Scope of works for General layout and transport

Srl. No	Description	Unit of measure	Quantity	Remark
	I. General Layout			
	a) Eartwork			
1	Cutting of vegetable soil layer	m^3	45000	h = 0.30 m
2	Escavation	m^3	149300	
3	Back filling	m^3	43700	
4	Levelling of escavation area	m^2	116500	
5	Levelling of back-filling area			
	b) Site arrangement and greenery			
6	Pavements	m^2	6500	Asphalt- concrete - 3 cm, broken stone - 7 cm, gravel - 10 cm
7	Greenery of tertain	hectar	3.0	
	II. Transport			
8	Road trough	$\frac{m^2}{m^3}$	$\frac{33000}{13800}$	h = 0.42 m
9	Road pavement	m^2	33000	Asphalt - concrete - 5 cm, broken stone - 15 cm, gravel - 22 cm
10	Sideways	$\frac{m^2}{m^3}$	$\frac{18800}{3800}$	
11	Road side ditches	m^3	3600	
12	RCC fencing			

5.3. Environmental Impacts

The main factors of environmental impacts are the effluents of dust and gases from the technological units.

It is supposed that as per the quantities of dust (8.4 kg/h) and sulphur dioxide (8.0 kg/h) after gascleaning the Al-Si alloys production will not encrease the sizes of already existing sanitary zone of the operating aluminium smelter.

5.4. Cost Estimate

As far as the land for location of the Industrial Unit is already available with NALCO, the Feasibility Report doesn't include the cost of land acquisition.

The estimate of investment cost (Schedule 5-1) includes only site preparation in amount of Rs.22.40 mln.

Schedule 5-1

Estimate of investment cost

SITE PREPARATION

No	Quantity	Unit	Item description	Unit cost, Rs. thous	Cost, Rs.mln		
					foreign	local	Total
1	149300	m^3	Site preparation and levelling	0.15	-	22.40	22.40

6. PROJECT ENGINEERING

6.1. Initial data

The following is assumed as an initial data for process calculations, arrangement drawings, layouts and general layout:

- unit capacity - 29780 t of casting aluminium-silicon alloys per annum;
- technology of electro-smelting production of Al-Si alloys;
- arc reduction furnace of active power rating of 17 Mw;
- continuous operation of process areas;
- operation time of arc reduction furnace and metallurgical equipment - 320 days a year;
- initial data related to the industrial site supplied by NALCO.

6.2. Composition of engineering design documentation

The industrial unit consists of:

a) main production process areas:

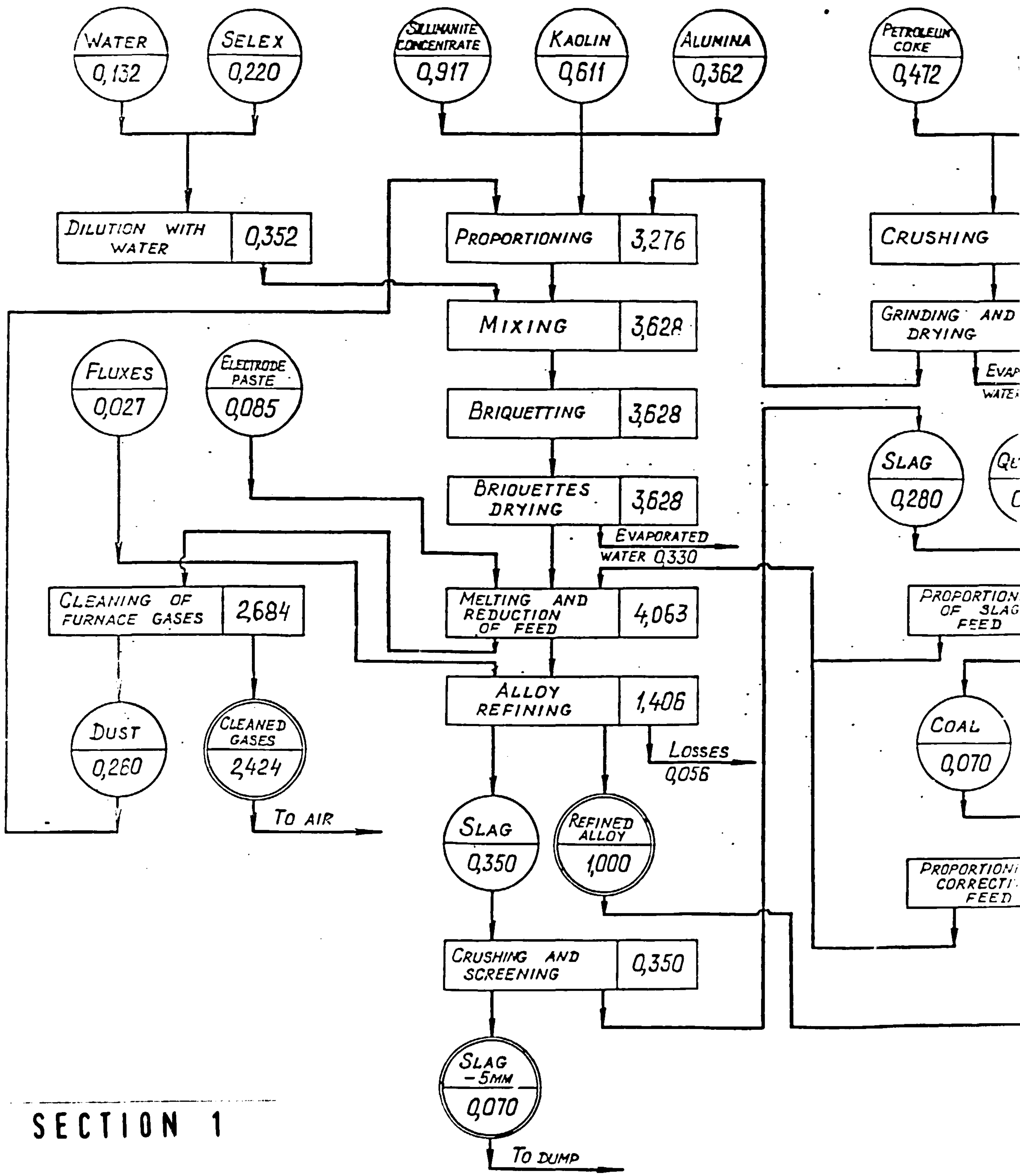
- raw materials storage,
- reductants grinding area,
- feed preparation room,
- electrometallurgical (alloy production) room with electrode paste storage and finished products storage, crucible lining area, ventilation chambers and substations;

b) auxiliary facilities:

- gas cleaning system,
- compressor station,
- main step-down substation,
- fuel oil storage,
- water recirculating facilities,
- administrative building.

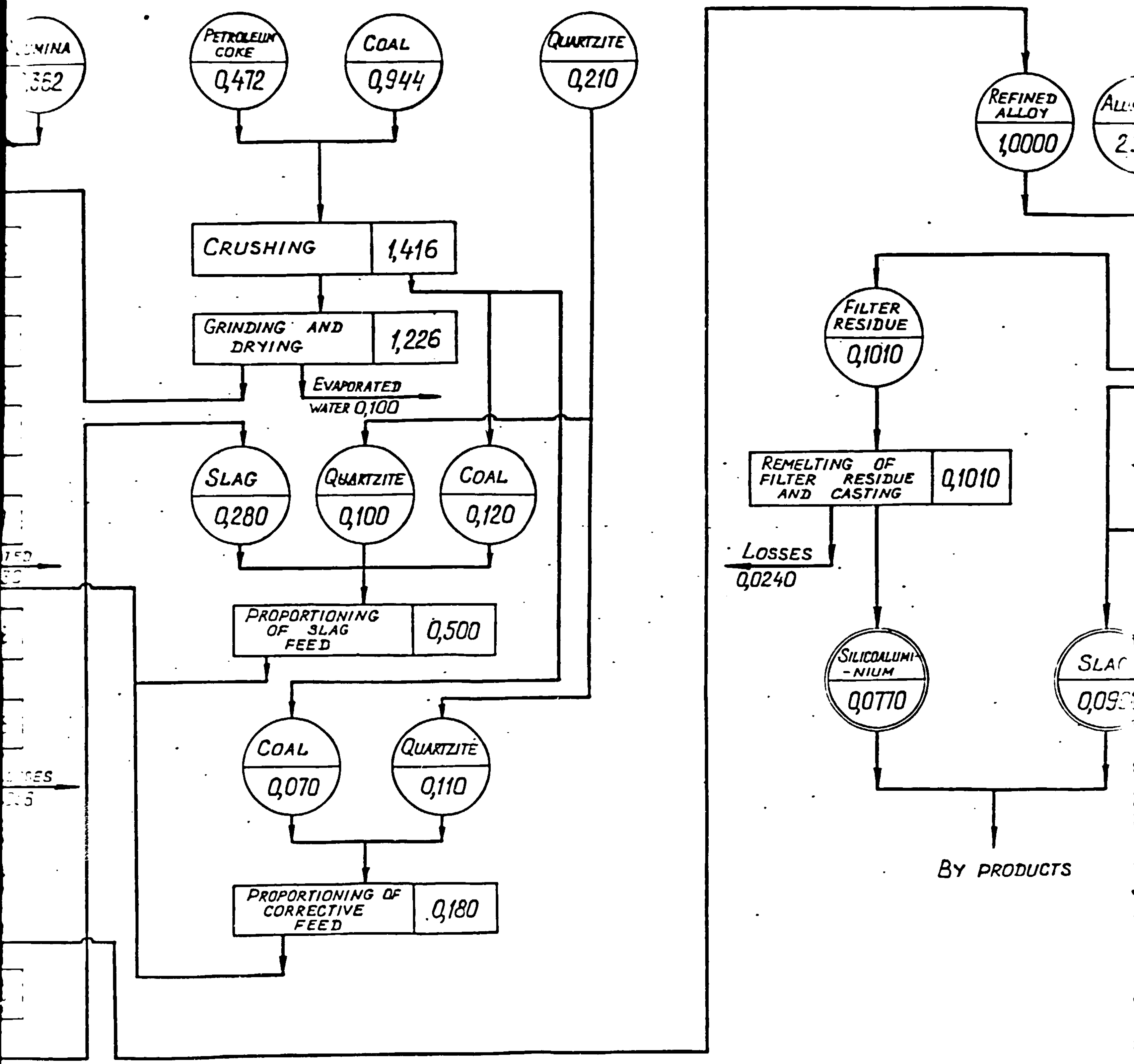
For the main production areas the following is prepared: equipment arrangement and process flowsheets, installation drawings, civil drawings, electrical diagrams and instrumentation, vicinity maps. The documentation above mentioned is collected in Volume II.

The principle process flowsheet with calculation of material flows per 1 tonne of primary (crude) refined Al-Si alloy is given below.

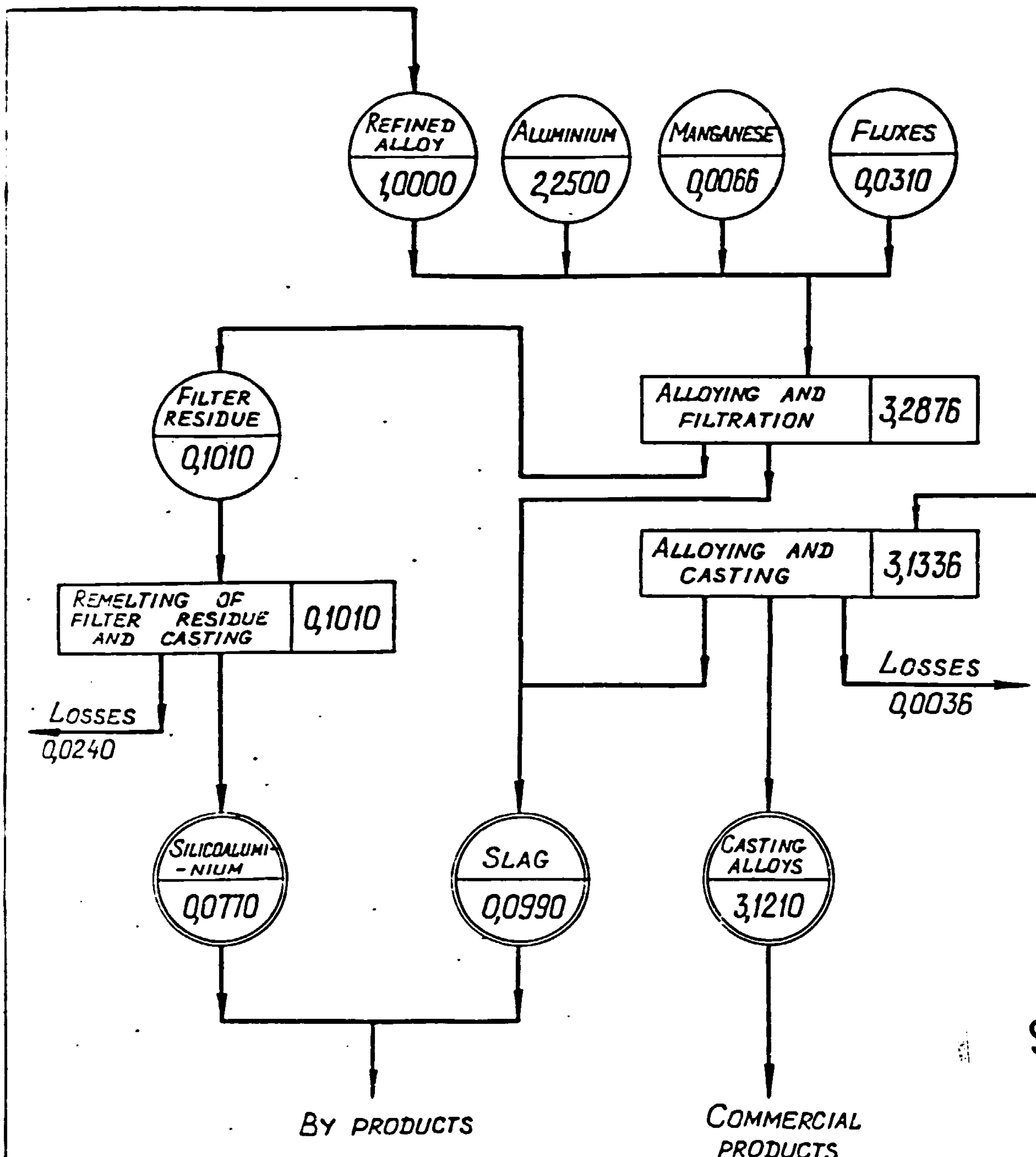


WATER
0,132
SELEX
0,220
SILLIMANITE CONCENTRATE
0,917
KAOLIN
0,611
ALUMINA
0,362
PETROLEUM COKE
0,472
DILUTION WITH WATER
0,352
PROPORTIONING
3,276
CRUSHING
MIXING
3,628
GRINDING AND DRYING
FLUXES
0,027
ELECTRODE PASTE
0,085
BRIQUETTING
3,628
BRIQUETTES DRYING
3,628
EVAPORATED WATER 0,330
SLAG
0,280
CLEANING OF FURNACE GASES
2,684
MELTING AND REDUCTION OF FEED
4,063
ALLOY REFINING
1,406
LOSSES
0,056
DUST
0,260
CLEANED GASES
2,424
TO AIR
COAL
0,070
SLAG
0,350
REFINED ALLOY
1,000
CRUSHING AND SCREENING
0,350
SLAG -5MM
0,070
TO DUMP

SECTION 1


PETROLEUM COKE 0,472
COAL 0,944
QUARTZITE 0,210
REFINED ALLOY 1,0000
CRUSHING 1,416
GRINDING AND DRYING 1,226
EVAPORATED WATER 0,100
FILTER RESIDUE 0,1010
SLAG 0,280
QUARTZITE 0,100
COAL 0,120
REMELTING OF FILTER RESIDUE AND CASTING 0,1010
LOSSES 0,0240
PROPORTIONING OF SLAG FEED 0,500
SILICOALUMI-NIUM 0,0770
COAL 0,070
QUARTZITE 0,110
PROPORTIONING OF CORRECTIVE FEED 0,180
BY PRODUCTS

SECTION 2



SECTION 3

PRINCIPAL PROCESS FLOWSHEET.
MATERIAL FLOWS PER 1T OF PRIMARY REFINED ALUMINIUM-SILICON ALLOY.

The specifications of equipment and materials are given in Volume 3.

For the Feasibility Report it is assumed that the equipment will be of Indian supply except for equipment of Alloy production (metallurgical) building and gamma-relay level meter, which are provided for .

6.3. Technology

6.3.1. Types of technologies for production of aluminium-silicon alloys

At present the casting Al-Si alloys are mainly produced by traditional synthetic method, consisting of melting primary aluminium with silicon metal.

The electrosmelting method for production of Al-Si alloys based on direct reduction of aluminium and silicon out of natural alumosilicates and other types of silica - alumina-containing raw materials in electric arc reduction furnaces is developed and successfully used on industrial scale in the Soviet Union.

The data related to consumptions of raw materials and electric power per 1t of refined and casting alloys at the Subcontractor's plant are given below.

While using the electrosmelting method, the powdered raw materials (sillimanite, kaolin, alumina, ground coal and petroleum coke) are proportioned, mixed with added binder, briquetted, dried and fed to arc reduction furnace for reduction smelting.

To produce the casting Al-Si alloys the primary (crude) alloy from arc reduction furnace after refining is diluted with corresponding quantity of primary aluminium and, depending on grades of produced casting alloys, it is master alloyed with copper, nickel or magnesium.

One of the main advantages of electrosmelting method of Al-Si alloys production is the utilization of low-modulus types of alumosilicate raw materials, like cyanite, sillimanite, kaolin, low-iron bauxite and others which cannot be processed to alumina and pripary aluminium efficiently.

Besides this the electrosmelting method of Al-Si alloys

APPROXIMATE CONSUMPTION OF RAW MATERIALS AND PROCESS POWER PER ONE TONNE OF REFINED ALLOY AT DNIEPR ALUMINIUM SMELTER (ZAPOROZHIE)

DESCRIPTION	UNIT OF MEASURE	W/o RECYCLE OF SLAG AND GAS CLEANING DUST	RECOVERING SLAG AND GAS CLEANING DUST
I. MAIN RAW MATERIALS			
-KAOLIN	KG	1340	1340
-SILLIMANITE	KG	450	370
-ALUMINA	KG	690	580
-QUARTZITE	KG	270	220
-COAL	KG	830	740
-PET. COKE	KG	550	490
-TECHN LYGNOSULPHONATE	KG	250	220
II. RECYCLED WASTES:			
-CRUSHED SLAGS	KG	-	280
-GAS CLEANING DUST	KG	-	260
TOTAL OF FEED:	KG	4380	4300
III. PROCESS POWER	MW HR	13.2	12.6
IV. ANALYSIS OF REFINED ALLOY			
Al	%	57.5	57.5
Si	%	39.3	39.3
Fe	%	1.8	1.8
Ti	%	0.7	0.7
Zr	%	0.3	0.3
Ca	%	0.4	0.4

(*) DATA RECEIVED IN INDUSTRIAL TESTING.

(Contd....2)

APPROXIMATE CONSUMPTION OF MATERIALS PER ONE TONNE OF CASTING ALLOY.

DESCRIPTION	ALLOY GRADE	RAW Al	KG/T REFINED ALLOY	COPPER	NICKEL	MAGNESIUM
ACCORDING TO CONTRACT 89/156	4652	715.3	299.3	11.1	11.1	12.1
DNIEPR ALUMINIUM SMELTER	AL 25**	695.0	300.0	21.0	11.0	12.0

(**) ANALYSIS OF ALLOY AL 25 AS PER SOVIET STANDARD, %

Cu - 1.5-3.0
Si 11--13
Mg 0.8-1.3
Fe 0.8
Mn 0.3-0.6
Ni 0.8-1.3
Ti 0.05-0.2
Al - BALANCE

production has another advantages as compared with the traditional synthetic method:

- reduction of capital costs;
- reduction of electric power consumption;
- no silicon metal is required;
- total consumption of primary aluminium is reduced by 20-25%;
- utilization of main process unit of significantly higher unit power rating (active rating of electric arc reduction furnaces used is 17,000 kW, and the power rating of 175 kA cells is about 750 kW, that is less by 22 times);
- reduction of electrode product consumption due to replacement of expensive anode paste by cheaper reducing materials- coal and petroleum coke (consumption of anode paste per tonne of primary aluminium - 565 kg, consumption of electrode paste per tonne of refined Al-Si alloy 85 kg, or recalculated per tonne of aluminium contained in alloy - 145 kg);
- reduction of cryolite consumption (8 kg instead electrolysis) and elimination of aluminium fluoride consumption;
- decrease of fluoride emissions to environment;
- utilization of cheaper AC instead of direct current for electrolysis of aluminium and, consequently, elimination of capital costs related to installation of rectifiers and operating costs for current rectiforming.

The calculations of capital costs and total power consumption for production of silumin and other casting Al-Si alloys revealed (based on data of some plants relating to the conditions of the USSR), that for the production of above alloys by electrosmelting as compared with their production by synthetic method, the capital investment costs are reduced by about 10%, and power consumption - by 4-8%.

6.3.2. Choise of technology

Sillimanite is a high-quality raw material (Al_2O_3 - 56 to 60%, SiO_2 - 37 to 39%) for production Al-Si alloys by electrosmelting method.

For the industrial processing of sillimanite concentrate only the electrosmelting technology of Al-Si alloys production may be use, consisting of feed reduction of crude Al-Si alloy.

For the production of casting alloys the crude alloy, after its refining, is diluted with respective quantity of primary aluminium and master alloys depending on alloy grade.

6.3.3. Main technological process parameters

6.3.3.1. Raw materials storage with crushing and reduct..nts grinding sections

Coal is crushed from 150-200 mm to 30 mm, petroleum coke - from 150-200 mm to 30 mm. Slag ingots with sizes 800x300x100 mm are crushed to size minus 40 mm.

Crushed slag is screened to two fractions;

fraction +5 -40 mm - recycled to smelting in form of slag, feed;

fraction -5 mm is rejected to dump.

Coal and petroleum coke are ground to size -1 mm, and fraction -0.5 mm should be contained in quantity of 80% min.

The ground materials are dryed:

coal - to 1.5-2.5% moisture content

pet.coke - to 0.5-1.5% moisture content.

The temperature of drying agent should be:

for coal grinding - 150°C max.;

for pet.coke grinding - 200°C max.

The temperature of dust laden gas at mill outlet -70°C max. Mill capacity - 7 t/hr.

6.3.3.2. Feed preparation building

The raw materials are proportioned with accuracy of ±2%. The estimated aluminium content in crude alloy - 55-60%.

The ratio of coal to pet coke in briquettes - 40:60% based on free carbon content in reducers.

The ratio of sillimanite concentrate to kaolin in feed - 60:40%.

The relative portion of carbon in feed 95-100% of stoichiometry

The tentative composition of briquetted feed for smelting of crude Al-Si alloy, %:

Sillimanite concentrate	- 24.2
Dry cleaned kaolin	- 16.1
Technical alumina	- 9.6
Coal	- 24.9
Petroleum coke	- 12.5
Gas-cleaning dust	- 6.9
Selex (binder)	- 5.8

Moisture content of briquettes after drying - 2% maximum.

Strength of dryed briquettes - 100 kg/briquette minimum.

6.3.3.3. Alloy production building (metallurgical)

The temperature of reaction zone of arc reduction furnace is more than 2000°C. The temperature of alloy produced from electric arc reduction furnace - 1700°C; the alloy passes through primary refining directly during tapping.

The average composition of crude refined alloy, %:

Al - 56.4; Si - 39.5; Fe - 1.8; Ti - 0.7; Zr - 1.5, Ca - 0.1.

For the production of casting alloys the crude refined alloy is diluted with aluminium to required silicon content in diluted alloy, then its is refined with fluxes and filtered at high temperature (T = 650-700°C) to remove the remained slag, further it is alloyed with required master alloys (copper, nickel, magnesium) depending on required alloy grade and cast into pigs of 10-15 kg.

For the production of alloy grade 4600 the diluted alloy is master alloyed with manganese to reduce the iron content and filtered at a temperature of 600-610°C.

6.3.3.4. Gas cleaning unit

The unit is designed to collect dust from gases from electric arc reduction furnace.

The specifications of gases supplied to gas cleaning and main process parameters of gas cleaning unit operation are shown below:

1. Gas flow at unit inlet, m^3/s	
maximum	163.29
minimum	112
2. Gas temperature at inlet, °C	
max.	300
min.	120
3. Gas analysis, vol.%	
carbon dioxide	1.9
carbon oxide	1.0
oxygen	18.5
nitrogen	75.8
steam	2.8
4. Sulphur dioxide content (at 0°C and 101.3 kPa), mg/m^3	65-100
5. Dust load of gas fed to gas cleaning (at 0°C and 101.3 kPa), g/m^3	1-3
6. Quantity of pollutants fed with gas, kg/hr (average value)	
dust	560
sulphur dioxide	23.1
7. Quantity of collected dust, kg/hr	551.6
8. Quantity of rejected pollutants, (average value), kg/hr	
dust	8.4
sulphur dioxide	8.0
9. Residual dust load at t = 0°C and P = 101.3 KPa, m^2/m^3	30

Average chemical analysis of dust, %
Al_2O_3 = 40.6; SiO_2 = 44.5; Fe_2O_3 = 0.46; TiO_2 = 0.18;
S = 0.4-0.7; L.O.I. = 10-12.

Dust particles size distribution, %

less then 0.5 mcm	- 50
0.5-1.0 mcm	- 15
1.0-10.0 mcm	- 25
more than 10 mcm	- 10

The gases from arc reduction furnace are fed to gas cleaning system, from which the cleaned gases are rejected to atmosphere, and collected dust is recycled to the process.

For the present project the gas cleaning system using bag filter is adopted, being the optimum system of those used for the production of Al-Si alloys and allowing to use the captured dust in the process.

The system consists of gas preparation stage, including radiation gas cooler and cyclone bank, and highly efficient bag filters.

Taking into account the experience of world practice not using for this type of systems the cleaning of sulphurous anhydrite, the proposed system also doesn't provide for SO_3 cleaning. The requirement of SO_3 cleaning is to be determined by NALCO depending on specific conditions.

The gas is cleaned in coolers down to 120°C, this temperature is determined by thermal resistance of bag filter cloth. The settling of dust largest particles is possible in coolers.

When the furnace gas is supplied at minimum temperature, the coolers are automatically switched off. The gas is supplied via by-pass gas duct to straight cyclone designed for capturing of hot coal particles.

Further gas is fed to bag filters and dedusted. Through the pipe located in top part of sheel the gas to be cleaned is supplied to dust laden gas chamber, where the bags are installed. The dust particles are settled on bags outside surface. The cleaned gas gets inside the bags from where it is fed to gas outlet pipe and rejected to atmosphere by fan through chimney stack 80 m high, diameter 3.4 m.

Dust deposited on bags is dislodged to bin by compressed air pulse, fed through headers inside a bag simultinuously from top and bottom.

The collected dust is recycled to main production.

6.3.4. Principal process flowsheet of Al-Si alloys production

The carbon materials used as reducing agents in process - lump hard coal and petroleum coke - are supplied to raw materials storage and crushed, as required, at jaw and roller crushers. The coal and pet coke crushed to -30 mm are fed to grinding in ball mill through a system of belt conveyor and elevator. Ground to -1 mm coal and pet coke are supplied to bins of feed preparation room by pneumatic transport.

At raw materials storage provision is made for unit processing slag production wastes, which are devided into two fractions: fine fraction (-5 mm) is dumped, coarse fraction (+5 -40 mm) mixed with lump coal and quartzite is recycled to smelting in arc reduction furnace.

Powder sillimanite, alumina and kaolin are also charged to bins of feed preparation room. All powdered feed components are metered by continuous proportioners and by screw conveyor are fed to blade mixer. The binder - aqueous solution of selex - is fed to mixer. Mixed raw feed is supplied to roller-press. Green briquettes from the press are fed to conveyor drying oven for drying. The finished briquettes from drying oven through a system of vibration feeders and belt conveyors are supplied to bins of arc reduction furnace, from where they are fed for smelting by valve feeders through chutes.

The crude (primary) Al-Si alloy produced in arc reduction furnace passes through high-temperature refining directly under tap-hole and is tapped to ladles, transported to low-temperature refining unit.

Refined alloy is poured to holding furnaces, where molten primary aluminium and manganese in form of aluminium-manganese master alloy, produced in induction furnace, are added. After the alloy reaches preset temperature, it is filtered with extraction of excess content of iron, titanium and zirconium.

Filtered alloy is fed to filtration furnaces, where it is alloyed with copper, nickel, magnesium and other components depending on grades of casting alloys to be produced.

Corresponding master alloys are prepared in ladles with agitating unit by melting of alloying components with primary aluminium, and they are fed to filtration furnaces.

After mixing, blending and obtaining the required chemical analysis the alloy from filtering furnaces is cast to ingots at casting conveyors.

The filter residue is extracted from funnels of filtering furnaces and supplied for remelting to induction furnaces to produce commercial alloy-silicoaluminium, having high content of iron, manganese, titanium, zirconium.

Tentative composition of silicoaluminium, %:

Si = 14-24; Fe = 4.5; Mn = 3.5; Ti = 2.0; Zr = 2.0;

Al - balance.

This alloy may be used in steel metallurgy as a complex deoxidizer of steel instead of individually used aluminium and ferrocilicium. Silicoaluminium may also be used as reducer in production of ferro-alloys and as complex inoculant of cast iron.

6.4. Equipment

6.4.1. Data for calculation and choise of equipment

The main process equipment is selected based on adopted technology of Al-Si alloys production from sillimanite concentrate.

The main process unit is an arc reduction furnace, where aluminium-containing briquetted feed is reduced for production of primary Al-Si alloy.

In Soviet Union the double and three-electrode arc reduction furnaces of 4.5 MW and 17.0 MW were industrially tested for electrosmelting of Al-Si alloys. At present the industrial production of these alloys is based on utilization of 14-17 MW electric aro reduction furnaces.

On the basis of mastering the similar production in the USSR, planned output of alloys and in order to get most advantageous techno-economic parameters an arc reduction furnace of 17 MW was adopted for the designed industrial demonstration unit.

The calculation of other types of equipment was based on ensuring the continuous operation of arc reduction furnace.

6.4.2. Raw materials storage with crushing area
(drg.Nº 1395273)

The storage is designed to receive, store and supply to production coal, petroleum coke, quartzite, sillimanite, kaolin, alumina, as well as to receive, store and screen slags of metallurgical production.

Provision is made to store at the storage the following materials:

- coal 900 t (in bulk)
- pet-coke - 600 t (bulk)
- quartzite - 650 t (bulk)
- kaolin - 270 t (in bags)
- alumina - 170 t (bags)
- sillimanite concentrate - 1700 t (bulk)

To crush coal and pet.coke it is provided to install one jaw and one roller crushers. The crushers capacity for crushing coal and coke to product size of 30 mm is 12-14 t/hr.

Slag is supplied to the storage from the metallurgical (alloy production) building in ingots of 800x300x100 mm.

The quantity of supplied slag is 10.88 t/day. To recycle the slag back to the process it is preliminary crushed by pneumatic hammer, and then - by jaw crusher, then screened into two fractions. The fraction +5 -40 mm (8.35 t/day) is recycled to smelting in form of lump feed, the fraction -5 mm (2.53 t/day) is rejected to dump.

The storage is equipped with one clamshell and one hook electric travelling cranes.

6.4.3. Reductants grinding area
(drg.1343508-TM)

The area is designed for grinding of coal and pet.coke used in preparation of briquetted feed.

Reductants (coal and pet.coke) are ground to -1 mm; content of fraction to 0.5 mm is to be not less than 80%.

To increase the explosion - proof conditions of grinding area a number of steps is provided:

- joint grinding of coal and pet.coke;
- installation of water-cooled coil pipe in furnace of drying agent, allowing to reduce quantity of air supplied to cool furnace gases;
- drying agent recirculating unit.

Two last measures ensure reduction of oxygen content in drying agent down to 18%. The ground materials are dryed to 1.5-2.5% of water content.

The following is installed in the area: hammer mill with portable separator; furnace for drying agent in set with blow fan and burner; mill fan, cyclone, electrostatic precipitator, bins of wet and ground dry reductents.

The process cycle of reductant grinding is open: air-gas mix after ESP is rejected to atmosphere. The ground reductant collected in cyclone and ESP is fed to the bin of finished product, from where it is fed to bins of feed preparation building by pneumatic unit.

The capacity of grinding area:

- coal - 28.1 t/day; 9010 tpy;
- pet.coke - 14.1 t/day; 4500 tpy.

6.4.4. Feed preparation room (drg.N° 1395274)

The feed preparation room is designed for production of briquetted feed and proportioning of lump slag feed supplied for smelting in arc reduction furnace.

The main process equipment includes continuous proportioners, blade mixers, roller press and conveyor dryer.

The make-up of process line for production of briquetted feed includes the following main equipment:

- two bins of coal, capacity 45 t each;
- two bins of petroleum coke, capacity 35 t each;
- two bins of sillimanite concentrate, capacity 150 t each;
- two bins of kaolin, capacity 25 t each;
- two bins of alumina, 65 t each;

- two bins of recycled materials (gas-cleaning dust, briquettes fines), useful capacity 70 m^3 each;
- twelve proportioners (for proportioning of each component of feed);
- two screw conveyors;
- two blade mixers;
- one roller press;
- one conveyor dryer.

The inventory of raw materials in bins of feed preparation building ensures operation of conveyor dryer during 4-5 days.

The transportation of finished briquettes to alloy production (metallurgical) room is by belt conveyors.

Based on properties of green briquettes (multicomponent composition, high moisture content, low mechanical strength) the conveyor type dryer is used for briquettes drying.

Use of drum dryers will result in breaking of green briquettes during drying.

On the basis of industrial experience of operation with kaolin and cyanite feeds, the capacity of installed blade mixers and roller press operating with sillimanite concentrate will be 6 t/hr of green briquettes (at moisture content of 10%), and the capacity of conveyor dryer - 5-5.5 t/hr of dry briquettes (at moisture content of 1-2%).

The output capacity of feed preparation room in production of dry briquettes is:

5.0 x 8760 x 0.88 = 38550 tpy,

where 5.0 - minimum hour capacity of conveyor dryer, t;
8760 - number of hours in year;
0.88 - availability factor of dryer.

The requirement in briquetted feed for arc reduction furnace is:

4.7 x 8760 x 0.88 = 36231 tpy,

where 4.7 - hourly requirement in briquetted feed for arc reduction furnace at maximum power, t;
8760 - number of hours in year;
0.88 - availability factor of arc reduction furnace.

The exceeding minimum production capacity of feed preparation room (briquetted feed) compared with the requirement of arc reduction furnace by 6% ensures its reliable continuous operation during routine and emergency repair works of feed preparation room equipment.

The following equipment is included into make-up of lump-feed proportioning unit:

- three bins (for slag, quartzite and coal), effective capacity 6 m^3 each;

- three continuous proportioners for metering in preset ratio of all lump feed components.

The inventory of lump feed materials in bins is as follows:

quartzite - 8.5 t
slag - 12.0 t
coal - 5.0 t

At consumption of lump feed in quantity of 0.68 t per 1 t of refined alloy, the above inventory ensures continuous operation of unit during 30 hours.

For receiving, storage and preparation of binder (selex) used for preparation of briquetted feed, the corresponding equipment, consisting of receiving lump with agitator of 45 m^3 holding capacity.

One tank of 7.5 m diameter and 6 m high and holding capacity of 250 m^3 is installed to store 350 t of selex - one month reserve.

To produce aqueous solution of selex of required concentration the agitator of 2 m diameter is used. The prepared binder solution is pumped to tank 2 m dia, from where it is supplied by gravity to two metering tanks, out of which it is supplied to mixers.

To pump selex from sump to tank, from tank to agitator unit and from agitator to binder solution tank two centrifugal pumps with capacity of abt.30 m^3/hr each are installed, one pump in operation and one - stand-by.

6.4.5. Alloys production room (drg.№ 1395275)

The alloy production(electrometallurgical) room is designed to produce primary refined Al-Si alloy and out of primary alloy-commercial casting Al-Si alloys.

The building consists of two main areas: electric furnace area and metallurgical area, and two support areas: electrode paste storage and finished product storage.

The arc reduction furnace is installed in electric furnace area. This furnace is equipped with feed charging system, furnace top and furnace tap-hole servicing pocker, gas exhaust system, haulage mechanism for ladles with crude alloy, etc.

In the metallurgical area all equipment required for production of commercial aluminium alloys is installed, including: unit for alloy refining, holding furnace for alloying, filtration furnaces, induction furnaces, casting conveyor, ingot stacker, crans.

The open three-phase, three-electrode electric furnace with power rating of 17 MW is installed for smelting of Al-Si alloys.

The output capacity of furnace (refined alloy) is estimated by formula:

$$B = \frac{P \times To \times 24 \times K}{q}$$

where: P - effective power rating of furnace, kW;

To- time of furnace operation during year, in days;

24 - number of hours in day;

K - factor acounting for utilisation of maximum furmece power rating;

q - specific power consumption per 1 t of refined Al-Si alloy.

$$B = \frac{17000 \times 320 \times 24 \times 0.95}{13000} = 9540 \text{ tpy}$$

The time of furnace operation in days per year is determined based on duration of overhauls, planned routine repairs and shut-down periods:

$$To = 365 - (T_{ov.} + T_{p.r.} + T_{s.d.}),$$

where: T_o - furnace time of operation during year, in days;

$T_{ov.}$- duration of overhauls (capital repair) in days per one year;

$T_{p.r.}$- duration of planned routine repair, in days;

$T_{s.d.}$ - furnace shut-down period, in days;

$T_0 = 365 - (20+10+15) = 320$ days.

The arc reduction furnace is fitted with a system of belt conveyors for handling and charging of briquetted feed to furnace bins. Totally there are 12 furnace bins out of which 10 bins are used for storage of briquetted feed, one bin for lump slag feed and one bin - for correcting additives.

The quantity of briquetted feed in furnace bins (120 t) ensures the operation of arc reduction furnace at full capacity for 25 hours.

To service the arc reduction furnace two charging stoking machines are used. Ladles of 2.3 t capacity are provided for tapping and handling of molten metal.

The alloys are refined of slag inclusions at special refining units.

Fuel oil fired holding furnaces of 15 t capacity are installed for alloying of primary refined alloy with aluminium. To reduce the iron content of alloy in production of commercial casting alloy grade 4600, the manganese master alloy is introduced to holding furnace.

The following is charged to holding furnace per one cycle:

- refined primary alloy - 4.5 t;
- primary aluminium - 10 t;
- aluminium-manganese master alloy - 0.5 t.

The duration of holding furnace process operations:

- accumulation of refined alloy

$$4.5 : 1.24 = 3.6 \text{ hours}$$

where: 1.24 - hourly output of refined alloy from arc reduction furnace;

- cooling of alloy to filtration temperature - 3.0 hours;
- slag skimming-0.5 hour;
- tapping and filtration of alloy - 2.0 hours;
- cleaning of holding furnace and preparation for next cycle - 2.0 hours.

Total duration of one cycle of holding furnace operation is:

$$3.6 + 3.0 + 0.5 + 2.0 + 2.0 = 11.1 \text{ hours.}$$

The required number of holding furnace operation per year is:

$$\frac{9540 + 21502 + 63}{15} \times 11.1 = 23017.7 \text{ hours}$$

where: 9540+21502+63 - annual quantities of processed refined alloy, aluminium and manganese.

The required number of holding furnaces to be installed:

23017.7 : 8760 = 2.6 - 3 holding furnaces.

The final processing of alloy (skimming of slags, removal of intermetallic compounds, alloying) is carried out in fuel oil fired filtration furnaces with capacity of 15 t.

The durations of process operations at filtration furnace are as follows:

- alloy filtration - 2.0 hrs.
- heating of alloy from filtration temperature to temperature of casting - 3.0 hrs.
- slag skimming - 0.5 hrs.
- metal casting: 15:7 = 2.1 hrs., where 7 - output capacity of casting conveyor, t/hr;
- cleaning of bath and preperation for next cycle - 2.0 hrs.

The total duration of one cycle of filtration furnace operation is:

$$2.0 + 3.0 + 0.5 + 2.1 + 2.0 = 9.6 \text{ hrs.}$$

The required number of filtration furnace hours of operation per year is:

$$\frac{9540+21502+415}{15} \times 9.6 = 20132.5 \text{ hrs., where}$$

415 - annual quantity of alloying components.

The required number of filtration furnaces:

20132.5 : 8760 = 2.3 3 filtration furnaces.

The induction crucible furnaces of 6 t capacity (by aluminium) are installed for secondary refining of primary crude alloy (if required), remelting of filter residue as well as for preparation of aluminium-manganese master alloy.

Based on practical data the capacity of induction furnace was estimated as follows:

- for secondary refining of Al-Si alloys - 3.0 t/hr;
- for remelting of filter residue - 1.7 t/hr;

- for preparation of master alloy - 1.7 t/hr.

The maximum availability of induction furnace per one year is:

- for secondary refining of crude alloy:

9540 : 3.0 = 3180 hrs;

- for remelting of filter residue:

736 : 1.7 = 433 hrs;

- for preparation of aluminium-magnesium master alloy:

$\frac{63}{0.1}$: 1.5 = 420 hrs, where:

63 - quantity of used manganese, t/year;

0.1 - manganese content in master alloy, (10%).

The total availability of induction furnaces (estimated) is:

(4033 : 8760) x 1.5 = 0.7 furnace, where

1.5 - factor accounting for furnace shut-down periods while switching over remelting of different materials.

To ensure the continuous operation of production cycle during emergency fault of inductor, as well as the possibility to use solid pig primary or scrap aluminium provision is made to install two crucibles of induction furnace with one set of equipment.

6.4.6. Brief description of main process equipment

The following is included to main process equipment for production of Al-Si alloys:

- conveyor dryer;
- electric arc reduction furnace;
- turning holding furnace;
- furnace for alloy filtration;
- crucible induction electric furnace.

6.4.6.1. Conveyor dryer (drg. No 1395279 BO)

The conveyor dryer is designed for drying of briquettes. It consists of heat-insulating body devided by 16 chambers, 12 chambers are filled with drying agent, steel chequered strip consisting of movable jointed chains of box shape, 15 fans ensuring circulation of air-gas media in dryer and one fan, ensuring gas exhaust.

The conveyor dryer belt width is 1.5 m. The dimensions of body: length - 31.2 m; width - 3.3 m; height - 3.9 m. Distance between centers of guide drive shafts is 37.4 m.

Dryer specifications

Srl No	Parameters	Unit of measure	Values
1	Capacity, dry briquettes	t/hr	5-5.5
2	Initial water content of briquettes	%	10
3	Residual water content of briquettes	"	1-2
4	Temperature in drying zone	^oC	200-250
5	Fuel oil consumption	kg/hr	130-150
6	Power rating of installed motors	kW	77.3

6.4.6.2. Electric Arc Reduction Furnace (drg. No 1395281 BO)

The electric arc reduction furnace is designed for smelting of primary crude Al-Si alloy from briquetted feed.

The electric furnace consists of refractory lined open round bath, three Soederberg electrodes with steel shell, exhaust hood with shutters, anode suspension and moving mechanism, current lead and electrical equipment including furnace transformers control boards and panels, automatic power regulator, equipment for water cooling of furnace elements and transformers, pump-and-cell station. The electric power for arc reduction furnace is supplied

from three single-phase furnace transformers
power rating 8333 kVA each, operating voltage 11000/140-230 V, with oil-water cooling, built-in switch control of secondary voltage on load. The furnace transformers are located in separate rooms close to the furnace. The busbars configuration of furnace is delta on electrodes.

To compensate for reactive power of furnace circuit and to increase power factor of the furnace transformers, provision is made for the booster transformer for connection of the power factor correction capacitors.

To increase power factor of the unit to 0.9 the correction capacitor bank is connected to the 11 kV busbars.

Electrical operating parameters regulation through electrode position adjustment is by the automatic power regulator of type APP-I.

To open the tap-hole for alloy tapping provision is made for the stinger electrode unit connected to the secondary winding taps of the transformer.

The current from furnace transformers is supplied to furnace electrodes through a pach of copper busbars, chain of flexible copper strips, movable current leads of electrode holders and contact clamps, pressed to electrodes.

The current density in busbars - 0.85 A/mm^2 at operating current intensity in electrodes of 85 kA.

6.4.6.3. Holding furnace (drg. No. 1395282 BO)

The holding furnace is designed for alloying of refined Al-Si alloy with primary aluminium and feeding of melt to filtration.

The holding furnace consists of weld cylindrical body lined with refractory bricks.

The furnace body is fitted with spout, through which the refined alloy, primary aluminium and aluminium-manganese master alloy are charged and melt is tapped to filtering funnel for filtration. Two ring rims are welded to furnace body, by which it is bearing against rollers, allowing to tilt it for better alloy mixing. To turn the holding furnace during melt tapping it is equipped with hydraulic hoist.

Specification of arc reduction furnace

Srl. No	Parameter description	Unit of measure	Value	Remark
1	Furnace power			
	- total	MVA	25.0	
	- active	MW	17.0	
2	Furnace type	-	three-phase, open	
3	Type of bath	-	roand, stationary	
4	Type of electrodes	-	Soederberg with sheel shell	
5	Number of electrodes	pc	3	
6	Electrode diameter	mm	1400	
7	Position of electrodes in bath	-	on vertex of equalateral triangle	
8	Electrode circle diameter	mm	3100-3300	May be modified at furnace shut-down
9	Number of tap-holes	pc	1	
10	Bath geometrical parameters:			
	- diameter	mm	6800	
	- depth	"	2450	
11	Number of furnace transformers	pc	3	
12	Idle voltage of transformer	V	140-230	

The holding furnace is fitted with mechanical unit for additional alloy mixing and with fuel oil burner for heating of working space during start-up of holding furnace after long-term shut down.

Specifications of holding furnace

Srl. No	Parameters	Unit of measure	Value
1	Holding capacity (Al-Si alloy)	t	15
2	Maximum alloy temperature	°C	850
3	Turning angle during tapping	degree	26
4	Fuel oil consumption for heating	kg/hr	70-90
5	Total power rating of installed electric motors	kW	10

6.4.6.4. Filtration furnace
(drg. No 1395283 BO)

The furnace is for filtration of alloy fed from holding furnace, alloying of filtered alloy with master alloys and supply of alloy to casting.

The furnace consists of lined welded body with a hole for installation of filtering funnel, opening for charging alloying additives, supply of fluxes and cleaning, with a removable cover, two tap-holes in opposite directions, two openings for installation of fuel oil burners and opening for outlet of furnace gas.

Filtration furnace specifications

Srl. No.	Parameters	Unit of measure	Value
1	Holding capacity (by Al-Si alloy)	t	15
2	Temperature of alloy	°C	650-700
3	Fuel oil consumption	kg/hr	80-100
4	Installed power rating of electric motor	kW	1.1

6.4.6.5. Induction furnace (drg. No 1395284 BO)

The induction furnace is designed for remelting of filter residue, preparation of aluminium-manganese master alloy, secondary refining of primary Al-Si alloy, melting of pig primary of scrap aluminium, if required. The induction electric furnace of crucible type, of industrial frequency, consists of framework, lined crucible, bottom, inductor, magnetic circuit, tilting mechanism and cover with lifting and turning mechanism. The inductor and bottom are removable. The crucible and bottom are rammed with special heat resistant concrete. The water-cooled cylindrical single-layer single phase inductor is manufactured of special section copper pipe.

The current is supplied to the electric furnace through flexible water-cooled cable.

The electric furnace is covered with welded cover lined with heat resistant concrete. The mechanism for lifting and turning of cover is of hydraulic type.

The metal is tapped through discharge spout by tilting of electric furnace to an angle to 100 degrees. Hydraulic tilting mechanism consists of two hydraulic rams, oil pressure unit and hydraulic drive equipment.

The furnace set includes: furnace transformer, control and signalling board, automatic controller of electrical conditions, capacitor bank, contactors panels, oil pressure unit, control panel, heater for drying of inductor with control board, indicator of inductor lining and insulation conditions.

The power is supplied to induction furnace from three-phase furnace transformer with ail-water cooling, power rating 2500 kVA with taping of secondary voltage on load. To compensate for reactive power the capacitor bank is provided.

The buswork of capacitor bank and current lead to furnace are made of flat aluminium busbars fixed on insulators. The busbars cross-section is selected based on requirement of current density of about 0.5 A/mm^2 at nominal conditions. The cables inside the electrical rooms are laid openly, if possible, and in furnace area-inside a pipe. The load on power and control cables is adopted at voltage to 1000 V.

The induction furnaces are installed at grade level in metallurgical area. The capacitor banks are located in vicinity of furnaces. Control and signalling board are built-in wall openings of electrical board rooms at a level of working platform; control desk of furnace tilting is to be installed close to the furnace taking into account requirement to monitore and control the process of metal tapping from the furnace. The oil pressure unit is located in a separate room, the furnace transformer - in separate chamber.

Specifications of induction furnace

Srl. No	Parameters	Unit of measure	Value	Remark
1	Furnace holding capacity (by aluminium)	t	6	
2	Furnace power rating (by transformer)	kW	2500	
3	Wattage	"	2430	
4	Rated voltage	V	1922	
5	Current frequency	Hertz	50	
6	Melt operating temperature	^{o}C	750	
7	Specific power-consumption	$\frac{kWh}{t}$	500-600	
8	Water consumption for furnace cooling	m^3/hr	36.3	
9	Total power of electric motors	kW	45	

6.4.7. Brief description of gas cleaning equipment

The gases are cleaned of dust in a unit including:

- coolers - 4 Nos.;
- cocurrent cyclones - 6 Nos. (2 - stand-by);
- bag filters - 14 Nos. (1 stand-by);
- fans - 3 Nos. (1 stand-by);
- air dryer - 1 No.

Specifications of gas cleaning equipment

Srl. No		Unit of measure	Value
1	**Cooler**		
	Cooling surface area	m^2	4.75
	Inlet gas flow	m^3/s	40.82
	Outlet gas flow	"	28
	Inlet gas temperature	^oC	300
	Outlet gas temperature	"	120
	Gas velocity in cooler	m/s	10
	Gas dedusting efficiency	%	3
	Quantity of collected dust (average)	kg/hr	4.2
	Unit hydraulic resistance	kPa	0.5
2	**Cocurrent cyclone**		
	Cyclone diameter	mm	3000
	Inlet gas flow	m^3/s	28
	Inlet gas temperature	^oC	120
	Gas velocity in cyclone	m/s	3.96
	Gas dedusting efficiency	%	7
	Quantity of collected dust	kg/hr	9.50
	Hydraulic resistance	kPa	0.7
3	**Bag filter** (framework type, with double side pulse blowing, filtering area of 1600 m2		
	Bag filter cloth - lavsan		
	Inlet gas flow	m^3/s	8.6
	Inlet gas temperature	^oC	120
	Specific gas load	m^3/m^2min	0.32
	Dust load in cleaned gas	mg/nm^3	30
	Quantity of collected gas	kg/h	38.2
	Unit hydraulic resistance	kPa	2.0
4	**Fan**		
	Flowrate, 10% reserve	m^3/s	61
	Electric motor power rating	kW	1250
	Head	kPa	10

6.5. Electric power supply, automatic control and signalling

6.5.1. Electric power supply

The main users of electric power are electric furnaces, A.C.motors and lighting. The total installed power rating of consumers is 32.1 MW. The maximum electric loads and power consumption by areas are shown in table below. The maximum consumption from power grid is 28.6 MW (31.2 MVA) at maximum annual power consumption of 189 x 10^6 kWh.

The main part of power consumers are the users of second category of electric power supply reliability; the shut-down of their supply will result in output defficiency, downtime of equipment and operating personnel.

The users of first category, interruption of power supply of which may result in equipment damage, danger of personnel safeness or mass spoilage of product include water recirculating unit, gas cleaning system and compressor station.

The estimated load of first category users is about 4,4 MW.

The power supply of transformer substations with users of first and second category is provided from two independent sources from different circuits of MSDS busbars.

The following voltages of electric circuits are adopted:

11 kV - for power supply of plant transformer substations;

6.6 kV - for power supply of gas cleaning system electric motors with power rating of 1250 kW;

0.415/0.24 kV - for electric motors with power rating to 320 kW and electric lighting.

The distribution circuit of 11 and 6.6 kV have an insulated neutral conductor, the circuit of 0.415/0.24 kW - solidly ground neutral.

6.5.1.1. Electrical loads and electric power consumptions

Srl. No	Description	Watt consumption P kW	Q kVAP	S KVA	Annual power consumption, mln.KWh
1	Raw materials storage with grinding area	296	243	329	0.92
22	Reductants grinding area	517	395	651	2.60
3	Feed preparation room	352	208	409	2.57
4	Alloy production room (electrometallurgical) with electrode paste and finished product storages	23030	8885	24685	150.85
5	Compressor station	744	652	990	6.25
6	Gas cleaning system	3030	1670	3460	21.15
7	Water recirculating system	593	424	729	4.5
8	Fuel oil storage	42	25	49	0.13
	Total:	28604	12402	31177	188.97

6.5.2. Arrangement of electric power supply

The power is supplied from captive Main Step Down Substation (MSDS), located outside the fence of NALCO opèrating smelter. At MSDS a transformer of 220/11 kV and power rating of 37.5 MVA is to be installed.

A stand-by transformer of similar capacity installed at aluminium smelter site will be used for emergency cases.

The transformer will be supplied at 220 kV through 220 kV power transmission line from the operating open distribution 220 kV switchgear unit of the smelter. From the Distribution Unit (DU) - 11 kV of MSDS the power is supplied to electric furnaces and integrated transformer substations, designed for consumers of 415/240 V, and transformers of 11/6.6 kV of gas cleaning system electric motors.

Taking into account the negative effect of electric furnaces operation on operation of power using equipment, provision is made for supply of all furnace units from captive section of DU-11 kV of MSDS. Two other sections of DU-11 kV supplied from released windings of 37.5 MVA transformer are designed for power supply of power consumers. Thus the collected busbars of MSDS consist of 3 sections.

The MSDS equipment is designed for cut-off power of 350 MVA. The diagram of MSDS is attached on drg.No 1388191- G.

6.5.3. Cable circuits

The cable circuits of the Unit are laid in ground trench (to 6 power cables) and overhead on process structures.

The armoured cables with lead sheathing and copper cores are adopted for laying. While chosing the cross-sections of cable lines based on admissible heating, the reducing factor of 0.85 is assumed for the highest daily air temperature.

In furnaces area the cables are laid in pipes, in electrical rooms-in open. The power and control cables to 1000 V are adopted of Indian manufacturing.

6.5.4. Safety earthing

The safety earthing units are common for all voltage systems. The earthing units are connected with grounding circuit of MSDS throught metal sheathing of cables, thus around all buildings equipped with electrical units, provision should be made for earthing circuit. This circuits are also used for potentials equalizing.

All metal not current leading parts of power units are to be grounded. The fourth cores of cables and steel strips of 25x4 mm are used as earthing conductors.

6.5.5. Lightning protection

In accordance with lighting protection norms effective in the USSR, the following is to be protected:

- main step-down substation (MSDS);
- cable racks;
- feed preparation room;
- raw materials storage with reductants grinding area;
- chimney stacks (lightning protectors are allowed jointly with stack structure).

The MSDS is protected by lightning rods installed on portal; the valve-type lightning arrestors are installed for protection from storm overloads.

The lightning protection of cable rack is by earthing of rack steel structures.

6.5.6. Power equipment

The power users of electrical equipment are supplied from low-voltage switchboards of transformer substations.

The start-up and protective equipment-control blocks of industrial series integrated in control station boards are installed in control station rooms. The electrical users of one process flow are supplied from one control station board, allowing to inspect the electrical equipment without disturbing the other process flow.

The control of mechanisms electric motors is local control cabinets. The mechanisms of crushing and raw materials handling are combined in flow-transport systems. The design provides for three modes of control for electric motors of flow-transport systems:

- centralized interlocked from operator board;
- local, for implementation of repair and maintenance works;
- local, interlocked for adjustment works and for the case of failure of centralized control. For the safety of maintenance and normal operation of flow-transport system mechanisms provision is made for the following types of alarm signalling;
- pre-start, warning about start-up of mechanisms;
- operator's response, indicating readiness of mechanisms for centralized start-up;
- indicating position of mechanisms;
- emergency alarm, warning about emergency shut-down of mechanism, with audible signalling to operator.

Supplying and distribution circuits in industrial buildings are made of cables with aluminium cores and PVC insulation and sheathing, tropicalized version. Control and signalling circuits are of cables with copper cores.

The cables in industrial building are lain in open on cable structures and troughs, as well as in ducts.

6.5.7. Electric lighting

The lighting intensity is assumed in accordance with norms effective in the USSR.

The following is adopted as light sources:

- mercury arc lamps - for main industrial buildings, the height of installation - more than 6 m, and for lighting of roads;
- luminiscent lamps for main industrial rooms of low height, as well as for administration building, laboratories and electrical rooms;
- incandescent lamps for auxiliary rooms, open process platforms and for guard lighting. The following types of electric lighting are provided:
- operating lighting - in all rooms;
- emergency lighting - for continuation of operation during shut-down of operating lighting and for emergency evacuation following the lines of main passage ways;
- repair lighting - for inspection of equipment and implementation of repair works.

The voltage of lighting circuits is adopted as follows:

- operating and emergency lighting 415/240 VAC (of lamps - 230-240 V)
- repair lighting - 24 V.

6.5.8. Control and automation

The control design of industrial demonstration unit for production of Al-Si alloys provides for automatic control system at following process areas of the plant:

- raw materials storage with crushing area;
- reductants grinding area;
- feed preparation room;
- alloy production room;
- gas cleaning unit;
- compressor station.

6.5.8.1. Raw materials storage with crushing area

In this process area the control is provided by measurement of level in bins for coal and petroleum coke.

6.5.8.2. Reductant grinding are

The remote control of following process parameters is provided for this area:

- temperature of furnace gas in drying agent furnace;
- temperature of drying agent at mill inlet;
- temperature of air-dust mix at mill outlet;
- temperature of air-dust mix before mill fan;
- fuel oil temperature at furnace inlet;
- coal dust temperature in dust bin;
- pressure of air and fuel oil at inlet of drying agent furnace;
- pressure of air-dust mix at outlet of mill fan;
- pressure of air-dust mix and air at outlet of pneumatic handling unit;
- depression of drying agent at mill inlet;
- depression of air-dust mix at mill outlet;
- depression of furnace gas in furnace;
- depression of air-dust mix at cyclone inlet, outlet and mill fan inlet;
- fuel oil consumption at furnace inlet;
- dust levels in dust bins in four points of bin height;
- dust level in ESP bin;
- termination of wet coal supply to feeder.

Also the local control of following process parameters is provided:

- pressure and temperature of aspiration air with dust in gas duct at ESP inlet and outlet;
- temperature of drying agent in riser.

6.5.8.3. Feed preparation room

The measurement of following parameters is provided of the feed preparation room:

- levels in bins for coal, petroleum coke, kaolin, alumina, sillimanite, gas cleaning dust, slag feed;
- temperature of coal and drying agent in bins;
- temperature of furnace gas;
- consumption of fuel for drying.

6.5.8.4 Alloy production room (electrometallurgical)

The control of following process parameters is provided for alloy production room.

- temperature of flue-gas in arc reduction electric furnace and of molten metal-Al-Si alloy in holding furnace, filtering furnace and induction furnace;
- fuel consumption in holding furnace, filtration furnace and stand for ladle drying;
- availability of water flow in outcoming pipelines of furnace elements cooling system;
- feed level in pockets above the furnace.

6.5.8.5. Gas cleaning unit

The following process parameters are controlled at gas cleaning unit:

- gas temperature at unit inlet;
- gas temperature at cooler outlet;
- gas temperature at bag filters inlet;
- gas temperature at bag filters outlet;
- depression of gas at unit inlet;
- gas depression at bag filters outlet;
- gas pressure at fan outlet;
- compressed air pressure at unit inlet;
- compressed air consumption supplied to unit;
- dust level in cyclon bins;
- dust level in bag filters bins;
- air temperature at inlet and outlet of drying block;
- air pressure at inlet of drying block;
- air pressure after control valve of compressed air pressure.

Provision is also made for signalling:

- temperature increase in fan bearings;
- increase of amplitude of vibration movement of fan bearings.

6.5.8.6. Compressor station

Reliable and safe operation of compressors and air drying units is ensured due to fitting of the above equipment with control units, automatic devices and electrical interlocking systems, supplied by manufacturing plants in set with this equipment.

Additionally the remote control of the following process parameters is provided:

- air temperature in pressure air ducts at coolers outlet;
- air temperature in pressure air duct at heat exchanger outlet;
- temperature of dried air supplied to users;
- air pressure in pressure air duct at heat exchanger outlet;
- pressure of dried air supplied to users;
- pressure of cooling water at inlet and outlet of water recirculating system;
- air pressure drop at filters;
- consumption of dried air to users;
- consumption of cooling water at inlet and outlet of water recirculating system.

Also the local control of following process parameters is provided:

- temperature of cooling water to compressors;
- temperature of cooling water at inlet and outlet of water recirculating system;
- air pressure in intermediate blow collector;
- oil pressure in oil pipeline to compressors.

6.6. Water supply and sewerage

The water consumption and flow of sewages evacuated from the industrial site as well as the length of pipelines are specified as follows:

Srl No.	Description	Water consumption and sewages thou.m^3/year	m^3/day	m^3/hr	Length of pipelines, m
1	2	3	4	5	6
1	Industrial fresh water	550.0	1720.0	71.7	500.0
2	Potable water	48.0	168.0	25.0	1200.0
3	Industrial recirculating water	5260.0	14400.0	750.0	2000.0
4	Domestic sewages	11.0	37.5	8.4	800.0
5	Rain water sewage	1j 1 m^3/sec			

The potable and fresh industrial waters are supplied from NALCO smelter, and recirculating water - from captive water recirculating unit.

At site provision is made for systems of industrial and potable water supply.

6.6.1. Industrial water supply

The industrial water supply system is designed based on recirculation cycle from the captive water recirculating unit. Fresh industrial water is used only for make-up of water recirculating system for cooling of a number of assemblies, parts and enclosure of arc reduction electric furnace, transformers, induction furnaces, compressors and other users. Water recirculating unit with the capacity of 750 m^3/hr consists of the recirculating water pump station, double-section forced-draft cooling tower with section area of 64 m^2, receiving chambers of water and cooled recirculated water. The pipelines of recirculating water are made of steel pipes laid on racks, the other pipelines of water supply are made of steel and RCC pipes laid underground.

6.6.2. Potable water supply

The potable water is used for needs of ventilation, air conditionning and for domestic and storm-water.

The domestic sewerage is designed to evacuate sewages from welfare and administrative buildings, domestic flow is 37.5 m^3/day. The sewages from the above buildings are fed to pump station, then pumped to domestic sewerage system of aluminium smelter. The domestic sewerage pipelines are laid underground of steel and cast iron pipes of 100-150 mm diameter.

The storm water sewerage system is provided to evacuate rain water. Rain water drainage is assumed in open concrete and R.C.C. troughs and through R.C.C. pipes.

The storm water from the site passes through mechanical cleaning in horizontal settlers, and after that - by gravity are fed to channel or pumped to storm- water system of aluminium smelter. The flowsheet provides for possibility to supply clarified rain water instead of fresh water for make-up of water recirculating system. Polluted rain water from fuel oil storage before feeding to storm-water sewerage system is to be cleaned of petroleum products at local water purification unit.

6.7. Fuel oil supply

Fuel oil is adopted as fuel for process units of the industrial demonstration unit.

In accordance with the customer's information, the fuel oil of grade HV will be used at side; this grade has the following specifications:

Ash content, maximum - 0.1%;
Flash temperature - 66°C;
Presipitate, max. - 0.25% of weight;
Kinematic viscosity at 50°C - 370 centistokes;
Sulphur content - 4,5%
Maximum water content - 1%

Fuel oil consumption

Srl. No.	User description	Fuel oil consumption minimum, kg/hr	maximum, kg/hr	Annual, t/year
1	Feed preparation room	180	270	1785
2	Alloy production room	310	603	2680
3	Reductant grinding area	30	60	315
	Total:	520	933	4780

The fuel oil is delivered in motor tank cars. The tank cars with fuel oil arrived to site are to be pre-heated with steam at heating unit available at aluminium smelter.

The fuel oil storage is provided for receiving, storage, preparation and feeding of fuel oil to users of industrial demonstration unit. The composition of fuel oil storage includes: fuel oil pump station, receiving tank with automatic discharge, two steel tanks of 100 m^3 capacity each.

To prevent cooling of fuel oil in fuel oil pipelines provision is made for electrical heating.

The selected fuel oil storage tanks ensures inventory for under request of the Customer the inventory and holding capacity of tanks may be decreased.

6.8. Compressed air supply

Compressor station (drg.1343511 TM)

Dried compressed air is used for process needs: for pneumatic transport, blowing-off of bag filters at gas cleaning, aeration of raw materials bins, for instrumentation and pneumatic instruments.

Consumption of compressed air:

Srl. No.	User	Flowrate, nm^3/min		
		Consumption conditions, hours		
		to 24 hrs	to 16 hrs	to 8 hrs
1	Reductant grinding area	-	-	35
2	Feed preparation room	2.4	-	0.4
3	Alloy production room	12	11	46
4	Gas cleaning system	38	-	2
	Total:	52.4	11	83.4

Taking into account daily consumption schedule and losses in networks (15%), the maximum compressed air consumption is 116 nm^3/min; the annual demand of compressed air is $10x10^6$ nm^3.

As a source of supply with compressed air for the unit the captive compressor station is used, including two piston compressors with capacity of 63 nm^3/min, pressure of compressed air of 0.8 MPa and electric motor of 400 kW power rating, voltage 10 kV.

The dryig unit of cooling-cycle type is used to dry compressed air. The temperature of dew point is plus 5°C.

6.9. Nitrogen supply

Nitrogen is used in feed preparation room and reductant grinding area in coal bins to prevent ignition.

Taking into account the periodic conditions of nitrogen consumption, the proper source of nitrogen generation is not included into the composition of the demonstration unit. Nitrogen is to be delivered in cylinders. In feed preparation room a nitrogen cylinder bank for 2x10 cylinders of 40 liters capacity each is provided. The similar cylinder bank is to be installed also in reductant grinding area.

6.10. Buildings and structures

6.10.1. List of buildings and structures

The following buildings and structures are considered in the Feasibility Report:

- raw materials storage with crushing area,
- reductant grinding area;
- feed preparation building;
- alloy production building with electrode paste and finished products storages and crucible lining area, ventilation chambers and substations;
- gas cleaning units,
- compressor station,
- main step-down substation,
- fuel oil storage,
- water recirculating facilities,
- administration-welfare building.

6.10.2. Main parameters of buildings

Srl. No	Description of buildings and structures	Built-up area, m2	Effective area, m2	Constructed volume, m3
1	2	3	4	5
1	Raw materials storage with crushing area	3040	3290	52845
2	Reductant grinding area	333	813	5230
3	Feed preparation room, including:	2370	3810	43470
	- support rooms	170	156	730
4	Alloy production room, including:	10184	15152	185535
	- furnace area	2000	7190	51740
	- metallurgical area	5970	5850	126350
	- electrode paste storage	301	288	3015
	- finished product storage	930	924	-
	- ventilation chambers, transformer substations	752	634	3390
	- crucible linig area	231	116	1040
5	Gas cleaning units, including:	3250	5630	55000

1	2	3	4	5
	- shed over fans	650	630	-
	- bag filters building	1500	4000	55000
	- foundations of coolers	1100	1000	-
6	Compressor station	862	1044	6013
7	Conveyor gallery	500	435	1630
8	Main step down substation including:	2736	2716	1015
	- MSDS	2500	2500	-
	- control systems point	236	216	1015
9	Water recirculating unit, including:	1599,6	1167.9	11407.9
	- pump station of recirculating water supply	660	740	6240
	- double-sections cooling tower with section area of 64 m2	178	128	1131
	- sewerage pump station, capacity 13-150 m3/hr	43.9	75.9	374.2
	- sewerage pump station, capacity 200-1200 m3/hr	159.5	224	1482
	- horizontal settler	558.2	-	2180.7
	- pipeline rack 600 m long	-	-	-
10	Fuel oil storage, including:	619.1	-	2459.3
	- fuel oil pump station,	175	-	886
	- overground steel tanks, 2 Nos., V = 100 m3	-	-	412
	- automatic discharge	133.6	-	38.3
	- control chambers of steel tanks, 2 Nos,	42	-	98
	- purification facilities for fuel-oil polluted rain water,	53.2	-	260
	- water reservoire for fire-fighting needs	215.3	-	765
11	Welfare and administrative building	640	2400	9520

6.10.3. Architectural and civil engineering concepts of buildings and structures

6.10.3.1. Main building elevation concepts

Architectural and civil engineering concepts are adopted based on the civil engineering norm of the USSR and local conditions specified by hot tropical climate with long monsoon periods, as well as taking into account the initial data for designing supplied by the Indian side.

The building elevation concepts of all buildings and structures accounting for maximum utilization of natural ventilation and protection of inside rooms from high insolation and monsoon rains.

All auxiliary and support rooms (electrical substations, ventilation chambers, etc.), as a rule, are located inside the main buildings and, in some cases, these rooms are located outside the buildings at a distance of 6 m.

The height of spans for all buildings is assumed multiple of 6 m. The column pitch along inside and outside rows of all building is adopted equal to 6 m.

The column grid of administrative building is assumed of 6 x 6 m.

The height of single-storey industrial buildings up to the bottom of bearing structure is adopted multiple of 200 mm, and the height of multi-storey industrial buildings from floor to floor-multiple of 600 mm, the storey height of welfare rooms is 3.6 m.

For all buildings the finished floor elevation of ground floor is adopted of 450 mm above the levelling ground elevation, and the pavement along external building periphery has width of 1-1.3 m.

The natural lighting of buildings is adopted through wall openings and openings filled with single-layer glazing or sun-protective grill, or sky-lights in roofing using the transparent corrugated plastic sheets.

6.10.3.2. Design concepts

The foundations of all main industrial buildings and structures and of support walls of over 1 m height are adopted of R.C. concrete of grades 150-200 on natural foundation, except for furnace area of alloy production building, where pile foundations are used with cast-in-place piles of 600 mm diameter and 16 m long with bearing capacity to 100 t.

The foundations are installed to the depth from 1 to 3 m into the soil.

The foundations of small pieces of equipment and strip foundations of administrative and welfare buildings, as well as of electrical rooms and ventilation chambers are assumed made of concrete.

Columns, girders, crane run-way girders, members of framework ties and window sashes of all industrial buildings are of steel.

In administrative-welfare building the columns and floors are adopted of R.C.C., concrete grade M-200.

The roofing for industrial buildings are of galvanised section steel sheets and aluminium shapes with slope 1:6, and for administrative building and separate ventilation chambers and electrical rooms - flat R.C.C. roofing with parapets.

For external walls in industrial buildings provision is made for shaped steel or aluminium sheets on steel framework with brick socle 800 mm high and 230 mm wide.

External and internal walls and partitions of administrative building as well as walls and partitions of rooms built in industrial shops are provided made of bricks. Also brickwork is designed for the walls of separate ventilation chambers, instrumentation rooms and distribution stations. The floors in industrial buildings are mainly of concrete on gravel-sand bedding, except for hot cast houses and furnace areas, where the floors are assumed of cast iron plates and fireclay bricks on sand-gravel bedding.

The floors of welfare buildings are of mosaics on concrete base and of ceramic tiles and linoleum.

6.10.3.3. Finishing works

All outside and inside surfaces of brick wells are plastered and painted in light colours.

The steel structures are painted with corrosion-proof compound in four layers with total thickness tc 140 mcm.

The external surface of walls and bottoms of underground structures with the depth of installation exceeding 1 m are to be with water proofing at a depth to 3 m - bitumen coating, and at a depth exceeding 3 meters - gluing water seal of rolled materials with installation of protective wall.

The flat roofings are insulated with rolled felt, consisting of seven layers of thin inpregnated with bitumen roofing felt glued to RCC cover with bituminous cement and coating of top layer with fine gravel.

6.10.4. Ventilation and air conditioning

The concepts of ventilation and air conditioning are assumed in accordance with Soviet design noms taking into account specific conditions of construction region.

The following parameter of environmental air are adopted for calculations:

- hot period for ventilation systems +35°C, for air conditioning +41°C; relative air humidity - 30-68%;
- cold period - for ventilation systems +20°C, relative air humidity 50-80%;
- monsoon period - for ventilation systems +29°C, for air conditioning +32°C; relative humidity - 80-90%.

The main harmful emissions from industrial buildings are excess heat emission and dust. The general exchange forced-exhaust natural ventilation - aeration using the aeration skylights for the exhaust is designed for assimilation of heat excess.

The intake of environmental air is ensured through bottom openings of windows.

The places of most intensive heat exposure of workers close to arc reduction and induction furnaces are ensured with air spraying and wetting.

The places of dust generation during crushing, screening, grinding and transfer of feed materials are fitted with air tight enclosures ensuring aspiration exhaust of dust laden air.

The dust laden air evacuated through aspiration systems is cleaned before being ejected to atmosphere in cyclones and bag filters.

Totally provision is made for three aspiration systems at raw materials storage and reductants grinding area, capacity of each system 12000 m^3/hr.

The forced ventilation with mechanical draft and adiabatic cooling of forced air (excluding for monsoon period) is designed:

- for centralized air supply for air spraying;
- for special process requirements to purity of supplied air and for positive pressure in control stations;
- for underground part of building having no natural ventilation.

In Compressor Station the secondary collection system is ensured by mechanical exhaust and natural inflow.

For the operators posts, instrumentation rooms and laboratories the self-contained air conditioners are provided.

The household air conditioners are provided for maintaining comfort conditions in auxiliary service premises.

The data on consumption of potable water and installed power ratings for systems of ventilation and air conditioning are given below:

Srl. No	Unit description	Water consumption, m3/hr	Installed power, kW
1	2	3	4
1	Raw materials storage with reductants grinding area	9.0	75.0
2	Feed preparation building	-	50.0
3	Alloy production building	13.0	25.0
4	Gas cleaning system	-	-
5	Electric power supply facilities	5.0	25.0
6	Auxiliary and support facilities	-	25.0
7	Administrative building	10.0	40.0
8	Compressor station	2.0	10.0
	Total	39.0	250.0

6.11. Cost Estimate

The present section estimates the required investment cost related to acquisition of technology, construction of buildings, structures, supply of equipment and its installation.

6.11.1. Cost of know-how

The know-how cost was estimated by the Supplier in amount of 250,000 US dollars (Rs. 6.5 mln.). The cost estimate for technology acquisition is given in Schedule 6-1.

6.11.2. Equipment cost

The investment cost of equipment includes: cost of equipment and materials as delivered to site, cost of installation works and initial stock of spare parts.

For the estimation it is assumed, that the main process equipment of the alloy production building composing an integrated set of the electric arc reduction furnace should be supplied from the USSR. It is assumed as well, that the gamma-relay instruments are to be delivered from the USSR.

For the estimation it is assumed that the main process equipment of the Alloy Production Building composing of an integrated set of electric arc reduction furnace will be imported. Also it is assumed that the import supply will include gamma-relay level meters intended for contactless position control of liquid, bulk and lump materials.

The scope of supply includes: detection block, data processing block and emmission sourse block.

Technical and operational specifications of instrument:

-Sensitivity - 2.5 x 10^{12} kg/kl,

-Electrical operational threshold - release - 20-2000 imp/s

-Operation time - release - 0.02 s.

-Voltage - 220 V (50 Hertz)

-Power consumption - 30 VA

- Admissible environmental temperature - from 10 to 50°C,

- Admissible moisture content at 35°C - to 98%.

The cost of imported equipment and materials are estimated by the Supplier on c.i.f. basis at prices updated for December 1991 price level. The itemwise costs of foreign equipment are given in the Specifications (Volume III). In accordance with the

Initial data the cost of imported equipment also includes custom duty at 80%, port charges and transportation costs from port to site at 5 and 3 % respectively from cost of imported equipment. All other types of process, auxiliary, sanitary, electrical and handling equipment and instruments and material are assumed to be of Indian supply. These costs in prices of December 1991 are assumed as per MECON data in accordance with the Protocol of discussions of Draft Feasibility Report.

The initial stock of spare parts and the cost of installation works is estimated in accordance with the initial data.

The estimates of investment cost of equipment are given in Schedule 6-2, the summary sheet of equipment cost - in Schedule 6-3.

6.11.3. Civil Engineering Works

The cost of construction is estimated based on tentative scopes of work for construction of buildings and structures and condensed unit costs of civil engineering works assumed in accordance with the initial data.

The following cost items were included into the scope of civil engineering works for estimation: earthwork, concrete laying and installation of R.C. concrete structures (girders, floorings, foundations, etc.), supply and installation of structural steel, brickwork, laying of pipelines, finishing works.

The estimates of investment costs of civil engineering works are given in Schedule 6.4. For the production personnel provision is made for construction of township. In conformity with the initial data 70% of total number of personnel is to be provided with living accomodations.

The estimates in Schedule 6-5 are based on data of Indian National Partner related to categories of living accomodations to be provided for different categories of personnel and its cost.

The estimate of construction works at December 1991 price level was updated in Schedule 6-6 based on utilization of escalation factor for structural steel and construction works 15 and 10% respectively in agreement with the Protocol of discussions of Draft Feasibility Report.

Schedule 6-1

Estimate of investment cost

Technology

No	Quantity	Unit	Item description	Unit cost, Rs. thous.	Cost, Rs.mln. Foreign	Local	Total
1			Know-how		6.50	-	6.50
2	35	%	Tax on know-how	6500	-	2.27	2.27
			Total:		6.50	2.27	8.77

Schedule 6-2

Estimate of investment cost

Equipment

Raw materials storage and crushing area

Srl.No	Quantity	Unit of measure	Project component and cost item	Unit cost Rs. thous.	Cost, Rs.mln Foreign	Local	Total
1	2	3	4	5	6	7	8
1			Raw materials storage and crushing area				
1.1			Main process equipment			4.11	4.11
1.2			Handling equipment			9.35	9.35
1.3			Sanitary equipment			4.16	4.16
1.4			Electrical equipment			4.33	4.33
1.5	10	%	Installation of mechanical equipment	17620	-	1.76	1.76
1.6	15	%	Installation of electrical equipment	4330	-	0.65	0.65
1.7	5	%	Spare parts	21950	-	1.10	1.10
			Total of 1:			25.46	25.46
2			Reductants grinding area				
2.1			Main process equipment		-	7.76	7.76
2.2			Handling equipment		-	1.10	1.10
2.3			Materials		-	0.81	0.81
2.4			Electrical equipment		-	1.08	1.08
2.5	10	%	Installation of mechanical equipment	8860	-	0.89	0.89
2.6	15	%	Installation of electrical equipment	1080	-	0.16	0.16
2.7	5	%	Spare parts	9940	-	0.50	0.50
			Total of 2:			12.30	12.30

Schedule 6-2/cont'd

1	2	3	4	5	6	7	8
3			Feed preparation rooms				
3.1			Main process equipment		-	14.80	14.80
3.2			Handling equipment		-	4.65	4.65
3.3			Sanitary equipment		-	2.48	2.48
3.4			Electrical equipment		-	13.73	13.73
3.5			Materials		-	3.47	3.47
3.6	10	%	Installation of mechanical equipment	21930	-	2.19	2.19
3.7	15	%	Installation of electrical equipment	13730	-	2.06	2.06
3.8	5	%	Spare parts	35660	-	1.78	1.78
			Total of 3:			45.16	45.16
4			Alloy production room				
4.1			Main process equipment		125.04	-	125.04
4.2			Auxiliary equipment		-	3.00	3.00
4.3			Handling equipment		-	43.13	43.13
4.4			Sanitary equipment		-	6.80	6.80
4.5			Electrical equipment		-	40.83	40.83
4.6			Materials		-	18.16	18.16
4.7	10	%	Installation of mechanic	177970	-	17.80	17.80
4.8	15	%	Installation of electrical equipment	40830	-	6.12	6.12
4.9	5	%	Spare parts	218800	6.25	4.69	10.94
4.10			Refractory lining and materials				
4.10.1	100	t	Carbon blocks	55.0	-	5.50	5.50
4.10.2	46	t	Fireclay bricks with high alumina content	7.7	-	0.35	0.35
4.10.3	537.8	t	Fireclay bricks with low alumina content	5.9	-	3.17	3.17
4.10.4	683.8	t	Refractory lining	3.3	-	2.26	2.26
			Sub-total		131.29	151.81	283.10

1	2	3	4	5	6	7	8
4.11	80	%	Custom duty	131290	-	105.03	105.03
4.12	5	%	Port charges	131290	-	6.56	6.56
4.13	3	%	Transportation to site	131290	-	3.94	3.94
			Total of 4:		131.29	267.34	398.63
5			Gas cleaning system				
5.1			Main process equipment		-	72.50	72.50
5.2			Handling equipment		-	3.67	3.67
5.3			Sanitary equipment		-	0.03	0.03
5.4			Electrical equipment		-	5.63	5.63
5.5			Materials		-	10.62	10.62
5.6	10	%	Installation of mechanical equipment	76200	-	7.62	7.62
5.7	15	%	Installation of electrical equipment	5630	-	0.84	0.84
5.8	5	%	Spare parts	81830	-	4.09	4.09
			Total of 5:			105.00	105.00
6			Compressor station				
6.1			Main process equipment		-	14.62	14.62
6.2			Handling equipment		-	0.38	0.38
6.3			Sanitary equipment		-	0.69	0.69
6.4	10	%	Electrical equipment		-	8.82	8.82
6.5			Materials		-	2.07	2.07
6.6	10	%	Installation of mechanical equipment	15690	-	1.57	1.57
6.7	15	%	Installation of electrical equipment	8820	-	1.32	1.32
6.8	5	%	Spare parts	24510	-	1.22	1.22
			Total of 6:			30.69	30.69

Schedule 6-2/cont'd

1	2	3	4	5	6	7	8
7			Electrical power supply				
7.1			Electrical equipment		-	71.80	71.80
7.2	15	%	Installation	71800	-	10.77	10.77
7.3			Materials		-	12.12	12.12
7.4	5	%	Spare parts	71800	-	3.59	3.59
			Total of 7:			98.28	98.28
8			Water supply and sewerage				
8.1			Main process equipment		-	5.42	5.41
8.2			Electrical equipment		-	7.55	7.55
8.3			Materials		-	17.01	17.01
8.4	10	%	Installation of mechanical equipment	5410	-	0.54	0.54
8.5	15	%	Installation of electrical equipment	7550	-	1.13	1.13
8.6	5	%	Spare parts	12960	-	0.65	0.65
			Total of 8:				
9			Fuel oil storage				
9.1			Process equipment		-	0.95	0.95
9.2			Handling equipment		-	0.04	0.04
9.3			Materials		-	3.53	3.53
9.4	10	%	Installation	990	-	0.10	0.10
9.5	5	%	Spare parts	990	-	0.05	0.05
			Total of 9:				
10			Administration building				
10.1			Sanitary equipment		-	1.85	1.85
10.2			Electrical equipment		-	2.70	2.70
10.3	10	%	Installation of mechanical equipment	1850	-	0.18	0.18
10.4	15	%	Installation of electrical equipment	2700	-	0.41	0.41
10.5	5	%	Spare parts	4550	-	0.23	0.23
			Total of 10:			5.37	5.37

Schedule 6-2/cont'd

1	2	3	4	5	6	7	8
11			Technological transport, communication, signalling, lighting				
11.1			Technological transport		-	1.70	1.70
11.2			Electrical equipment		-	2.24	2.24
11.3			Materials			1.57	1.57
11.4			Communication equipment		-	3.71	3.71
11.5			Instrumentation and control		0.24	50.29	50.53
11.6	15	%	Installation	2240	-	0.34	0.34
11.7	5	%	Spare parts	2240	-	0.11	0.11
			Sub-Total:		0.24	59.96	60.20
11.8	80	%	Custom duty	240	-	0.19	0.19
11.9	8	%	Port charges and transportation to site	240	-	0.02	0.02
			Total of 11:		0.24	60.17	60.41
			Grand total:		131.53	686.73	818.26

Schedule 6-3

Summary sheet Investment Cost				
Equipment				
Nº	Description	Investment cost, Rs.mln		
		foreign	local	total
1	Cost of supplies:			
1.1	Indian supply	-	485.25	485.25
1.2	Foriegn supply, including custom duty, port charges, transportation to site	125.28	115.74	241.02
	Total of item 1:	125.28	600.99	726.27
2	Installation and lining works	-	67.73	67.73
3	Spare parts	6.25	18.01	24.26
	Grand total at XII-1991 price level	131.53	686.73	818.26

Schedule 6-4

Estimate of investment cost

Civil engineering works

Srl. No	Quantity	Unit of measure	Project component and cost item	Unit cost, Rs. thous.	Cost, Rs.mln. foreign	local	total
1	2	3	4	5	6	7	8
1			Raw materials storage and crushing area				
1.1	6166	m^3	Earthwork	0.15	-	0.92	0.92
1.2	271.3	m^3	Concrete laying	1.4	-	0.38	0.38
1.3	1474	m^3	R.C. concrete laying	3.6	-	5.31	5.31
1.4			Structural steel				
1.4.1	420.2	t	- supply	17.0	-	7.14	7.14
1.4.2	420.2	t	- installation	2.5	-	1.05	1.05
1.5	35	m^3	Brickwork	1.2	-	0.04	0.04
1.6	10	%	Finishing works	6780	-	0.68	0.68
			TOTAL of 1			15.52	15.52
2			Reductants grinding area				
2.1	1057	m^3	Earthwork	0.15	-	0.16	0.16
2.2	104.3	m^3	Concrete laying	1.4	-	0.15	0.15
2.3	149	m^3	R.C. concrete laying	3.6	-	0.54	0.54
2.4			Structural steel				
2.4.1	74.6	t	- supply	17.0	-	1.27	1.27
2.4.2	74.6	t	- installation	2.5	-	0.19	0.19
2.5	155.1	m^3	Brickwork	1.2	-	0.19	0.19
2.6	10		Finishing works	1070	-	0.11	0.11
			TOTAL of 2			2.61	2.61

Schedule 6-4 (cont'd)

1	2	3	4	5	6	7	8
3			**Feed preparation room**				
3.1	6642	m^3	Earthwork	0.15	-	1.00	1.00
3.2	192	m^3	Concrete laying	1.4	-	0.27	0.27
3.3	1092.7	m^3	R.C. concrete laying	3.6	-	3.93	3.93
3.4			Structural steel				
3.4.1	611	t	- supply	17.0	-	10.39	10.39
3.4.2	611	t	- installation	2.5	-	1.53	1.53
3.5	241	t	Brickwork	1.2	-	0.29	0.29
3.6	10	%	Finishing works	6020	-	0.60	0.60
			TOTAL of 3			18.01	18.01
4			**Alloy production foom**				
4.1	21066	m^3	Earthwork	0.15	-	3.16	3.16
4.2	1413.6	m^3	Concrete laying	1.4	-	1.98	1.98
4.3	10451.3	m^3	R.C. concrete laying	3.6	-	37.62	37.62
4.4			Structural steel				
4.4.1	2361.7	t	- supply	17.0	-	40.15	40.15
4.4.2	2361.7	t	- installation	2.5	-	5.90	5.90
4.5	1122.2	m^3	Brickwork	1.2	-	1.35	1.35
4.6	1128	m^3	Fireclay brick lining	10.0	-	11.28	11.28
4.7	10	%	Finishing works	59030	-	5.90	5.90
			TOTAL of 4			107.34	107.34
5			Conveyor galleries				
5.1	107	m^3	Earthwork	0.15	-	0.02	0.02
5.2	153	m^3	R.c. concrete laying	3.6	-	0.55	0.55
5.3			Structural steel				
5.3.1	125	t	- supply	17.0	-	2.12	2.12

Schedule 6-4 (cont'd)

1	2	3	4	5	6	7	8
5.3.2	125	t	- installation	2.5	-	0.31	0.31
5.4	10	%	Finishing works	1170	-	0.12	0.12
			TOTAL of 5			3.12	3.12
6			Gas cleaning system				
6.1	249	m^3	Earthwork	0.15	-	0.04	0.04
6.2	418.3	m^3	R.C. concrete laying	3.6	-	1.51	1.51
6.3			Structural steel				
6.3.1	784.4	t	- supply	17.0	-	13.33	13.33
6.3.2	784.4	t	- installation	2.5	-	1.96	1.96
6.4	10	%	Finishing works	3470	-	0.35	0.35
			TOTAL of 6			17.19	17.19
7			Compressor station				
7.1	1155	m^3	Earthwork	0.15	-	0.17	0.17
7.2	64.2	m^3	Concrete laying	1.4	-	0.09	0.09
7.3	218.3	m^3	R.C.concrete laying	3.6	-	0.79	0.79
7.4			Structural steel				
7.4.1	25.0	t	- supply	17.0	-	0.42	0.42
7.4.2	25.0	t	- installation	2.5	-	0.06	0.06
7.5	35.8	m^3	Brickwork	1.2	-	0.04	0.04
7.6	10	%	Finishing works	980	-	0.10	0.10
			TOTAL of 7			1.67	1.67
8			Electric power supply				
8.1	600	m^3	Earthwork	0.15	-	0.09	0.09
8.2	104.9	m^3	Concrete laying	1.4	-	0.15	0.15
8.3	65.9	m^3	R.C. concrete laying	3.6	-	0.24	0.24

Schedule 6-4 (cont'd)

1	2	3	4	5	6	7	8
8.4			Structural steel				
8.4.1	27.3	t	- supply	17.0	-	0.46	0.46
8.4.2	27.3	t	- installation	2.5	-	0.07	0.07
8.5	10	%	Finishing works	460	-	0.05	0.05
			TOTAL of 8			1.06	1.06
9			Water supply and sewerage				
9.1	5248	m^3	Earthwork	0.15	-	0.79	0.79
9.2	95.4	m^3	Concrete laying	1.4	-	0.13	0.13
9.3	1590.1	m^3	R.C. concrete laying	3.6	-	5.72	5.72
9.4			Structural steel				
9.4.1	168.5	t	- supply	17.0	-	2.86	2.86
9.4.2	168.5	t	- installation	2.5	-	0.42	0.42
9.5	39.1	m^3	Grickwork	1.2	-	0.05	0.05
9.6			Pipeline laying of steel pipes				
9.6.1	95.5	t	- supply	15.0	-	1.43	1.43
9.6.2	40	%	- laying	1430	-	0.57	0.57
9.7	10	%	Finishing works	6890	-	0.69	0.69
			TOTAL of 9			12.66	12.66
10			Fuel oil storage				
10.1	1210	m^3	Earthwork	0.15	-	0.18	0.18
10.2	96.3	m^3	Concrete laying	1.4	-	0.13	0.13
10.3	241.4	m^3	R.C. concrete laying	3.6	-	0.87	0.87
10.4			Structural steel				
10.4.1	19.25	t	- supply	17.0	-	0.34	0.34
10.4.2	19.25	t	- installation	2.5	-	0.05	0.05

Schedule 6-4 (cont'd)

1	2	3	4	5	6	7	8
10.5	117.4	m^3	Brickwork	1.2	-	0.14	0.14
10.6			Iron pipeline				
10.6.1	12.91	t	- supply	12.0	-	0.15	0.15
10.6.2	40	%	- laying	150.0	-	0.06	0.06
10.7	10	%	Finishing works	1250	-	0.13	0.13
			TOTAL of 10			2.05	2.05
11			Administration building				
11.1	640	m^2	Building	3.0	-	1.92	1.92
11.2	15	%	Finishing works	1920	-	0.29	0.29
			TOTAL of 11			2.21	2.21
12			Site arrangement and motor road				
12.1			Access road	-	-	0.11	0.11
12.2			Motor road for transportation of molten aluminium	-	-	0.05	0.05
12.3	1500	r.m.	Fencing of area with brick wall	1.5	-	2.25	2.25
			TOTAL of 12			2.41	2.41
			GRAND TOTAL in price as of March 1991			185.85	185.85

Schedule 6-5

Estimate of investment cost							
Township							
No	Quan-tity	Unit	Cost kitem	Unit cost, Rs. thous.	Cost, Rs.mln		
					Foreign	Local	Total
1	484	m^2	Living houses, category A	2.97	-	1.44	1.44
2	10880	m^2	Same, category B	2.63	-	28.61	28.61
3	1581	m^2	Same, category C	2.60	-	4.11	4.11
4	2112	m^2	Same, category D	2.55	-	5.39	5.39
			Total in price of March 1991			39.55	39.55

Schedule 6-6

ESTIMATE OF INVESTMENT COSTS

CONSTRUCTION WORKS

No.	Description	Costs, Rs.mln.	
		In prices of III-1991	In prices of XII-1991
1.	Construction works	93.62	102.98
2.	Structural steel and pipelines	92.23	106.06
	TOTAL	185.85	209.04
3.	Township	39.55	43.51
	GRAND TOTAL	225.40	252.55

7. PLANT ORGANIZATION, OVERHEADS AND OTHER COSTS

7.1. Plant Organization

As the location of Al-Si alloys production is considered at the site adjacent to the aluminium smelter it is assumed that it would be a part of the aluminium plant from the organizational point of view. It is also assumed that within the framework of the aluminium smelter the arrangements will be made for manning, for routine and major repairs of the equipment, buildings and structures as well as for external transport services.

7.2. Overhead Operating Costs

According to initial data the overhead operating costs include the following:

- costs for maintenance, routine repair and servicing of buildings and structures at 1.0% of their cost, the same for the equipment - at 3.5% of the total equipment costs;
- the factory overhead costs at the rate of 5% of cost of materials (excluding molten aluminium).

For a summary estimate of the overhead operating costs see Schedule 7-1.

7.3. Depreciation

According to initial data revised in January 1992 the following depreciation rates are assumed for clculation:

- buildings and structures - 10%
- equipment - 25%
- gas cleaning equipment - 50%
- other costs - 25.%

7.4. Income Tax

In accordance with the protocol of discussions of Draft Feasibility Report the income tax including the surcharge is assumed at 51.75% of taxable profit.

The income tax is calculated using the method of Written Down Value (WDV). In this case according to the Indian Income Tax Act (section 801) during the first 8 years of operation the tax reduction for taxable profit at 25% is adopted.

If the first operating years give losses, the tax is to be paid after the losses are covered.

Schedule 7-1

Estimate of Production Costs

Overhead Costs

Sl. No.	Value	Unit of measure	Cost category	Amount, Rs.th	Costs, Rs,mln
1		Maintenance and current repair			
1.1	3.5	Percentage of equipment cost	Equipment	818260	28.64
1.2	1.0	Percentage of buildings and structures cost	Buildings and structures	209040	2.09
		Total of Item 1:			30.73
2	5	Percentage of material cost	Factory overhead costs	302030	15.10
		GRAND TOTAL:			45.83

8. MANPOWER

Basing on the operating conditions of main process equipment and composition of process units the tltel number of personnel is estimated at 300 persons, including:

- administration - 1 person
- senior management - 11 persons
- supervising personnel, foremen - 27 persons
- skilled workers - 202 persons
- semi-skilled workers - 42 persons
- unskilled workers - 17 persons.

The costs of salaries and wages are estimated on the basis of the above personnel make-up and initial data on average annual salaries and wages including 60% benefits.

The estimate of salaries and wages annual costs is given in Schedule 8-1.

Schedule 8-1

Estimate of production cost

Wages and salaries

No	Quantity	Unit	Categories of staff and labour	Annual salary wage, Rs. thous.	Cost, Rs.mln foreign	local	total
1	1	persons	Administration	124.0	-	0.12	0.12
2	11	"	Senior management	106.0	-	1.17	1.17
3	27	"	Supervisors, foremen	73.0	-	1.97	1.97
4			Workers				
4.1	202	"	Skilled	41.0	-	8.28	8.28
4.2	42	"	Semiskilled	33.0	-	1.39	1.39
4.3	17	"	Unskilled	31.0	-	0.53	0.53
			TOTAL			13.46	13.46

9. PROJECT IMPLEMENTATION

9.1. Project implementation programme and time scheduling

The following project implementation programme is assumed for calculations:

- before the beginning of construction within 15 months after the Contract award it is planned to prepare basic engineering for other units and to transfer design specifications;
- the construction of project components before geginning of production is planned for a period of 2 years;
- the equipment is to be supplied and installed within 1.5 years starting from the last quarter of the first year of construction;
- commissioning of production capacities and start-up of production is planned from the fourth year from the date of Contract award;
- reaching the design capacity - fourth year after start-up of capacities operation.

Total duration of project implementation period from the date of Contract award to the beginning of production is 39 months.

The project implementation programme for the establishment of industrial production of Al-Si alloys is shown on Diagram.

9.2. Cost Estimate

The investment costs for project implementation formed at pre-investment stage, in construction period, start-up and commissioning of production capacities are estimated in accordance with the initial data.

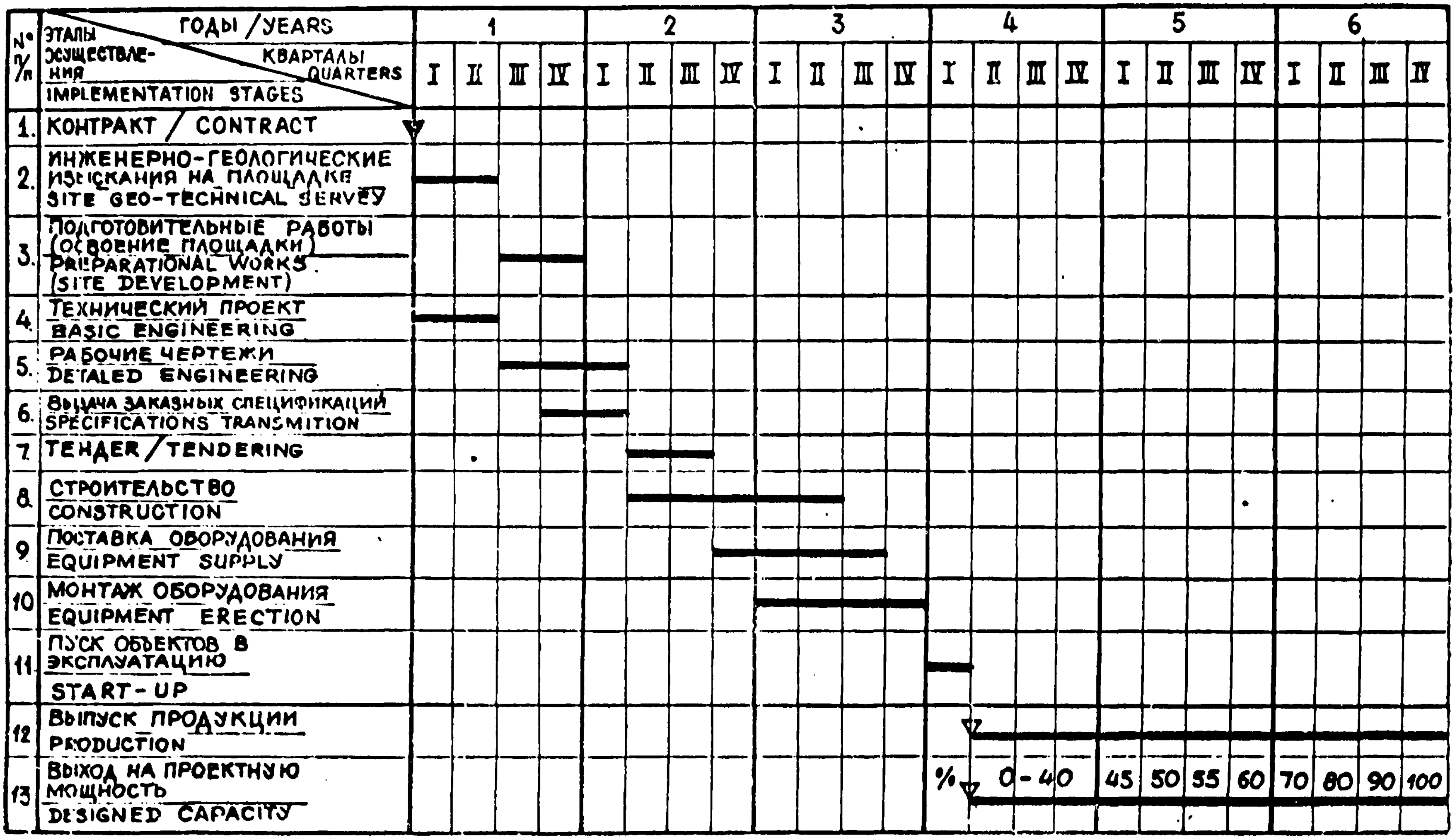
The costs include:

- insurance at 0.25% of project components cost;
- costs of management, control, coordination, start-up and commissioning, build-up of administration, recruitment and training of staff, and labour - at 5% of cost of works;

- survices of Subcontractor's specialists related to designer's supervision, supervision of erection, technical assistance - in amount of Rs. 3.16 mln. as per Supplier's estimate;
- tax on services of Subcontractor's specialists - at 35% of foreign exchange component of services cost;
- cost of training of Indian personnel at Subconractor's plant for 3 man-months.

The estimate of investment cost - Project Implementation is given in Schedule 9-1.

ГРАФИК ОСУЩЕСТВЛЕНИЯ ПРОЕКТА
DIAGRAM OF PROJECT IMPLEMENTATION PROGRAMME



Schedule 9-1

No	Quantity	Unit	Cost item	Unit cost, Rs. thou.	Costs, Rs. mln		
					foreign	local	total
Estimate of investment cost							
Project implementation							
1	0.25	%	Insurance of units	1027300	-	2.57	2.57
2			Services of Subcontractor's specialists				
2.1	25	man/m	Cost of services and supervision charges	92.0	1.20	1.10	2.30
2.2	15	pers.	Transport charges to fro Russia	57.2	0.86	-	0.86
2.3	35	%	Tax on services of Subcontractor's specialists	1200		0.42	0.42
			Total of 2		2.06	1.10	2.30
3			Training of Indian personnel at Subcontractor's plant				
3.1	3	man/m	Cost of training, lodging and boarding charges	124.4	0.37	-	0.37
3.2	3	pers	Transport charges to and fro journey	57.2	0.17	-	0.17
			Total of 3		0.54	-	0.54
4	5	%	Control, coordination, start-up and commissionning, build-up of administration, recruitment and training of personnel, arrangement of supplies	209040	-	10.45	10.45
			TOTAL		2.60	14.54	17.14

10. FINANCIAL AND ECONOMIC EVALUATION

10.1. General

The financial and economic evaluation presented in this chapter was prepared in accordance with methodology of UNIDO and using COMFAR 2.1 programme. It includes computer calculations, preparation and summarizing of results in form of corresponding Schedules and Charts.

The financial evaluation based on these results and presented on Charts also includes sensitivity analysis and analysis of project break-even point at different levels of capital investment, production costs and sales revenues.

The costs of construction and operation are estimated at price level of December, 1991 without taking into account its escalation.

The foreign exchange component of costs was estimated on US dollar basis with a conversion rate of 1 US dollar = Rs. 26.0 in conformity with the Protocol of discussions of Draft Feasibility Report.

It is to be noted that the present financial evaluation is not considering the other national economical and social benefits from the present project. These questions may be studied at follow-up stages of project implementation.

As the result of calculations carried out the following parameters were obtained, characterising the economic viability of Al-Si alloys production in the average annual parameters for total period of operation:

1. Sales revenue, Rs.mln	1353.6
2. Production cost, Rs.mln	1238.6
- operating expenses, Rs.mln	1122.4
- depreciation, Rs.mln	64.6
- interest, Rs.mln	51.6
3. Gross profit, Rs.mln	115.0
4. Tax, Rs.mln	68.0
5. Net profit after tax, Rs.mln	47.0
6. Cash balance, Rs.mln.	69.2

The project economic efficiency as a whole is specified by the following parameters:

1. Internal rate of return:
   - on total investment, % — 11.65
   - on equities, % — 7.80
2. Pay-back period, years — 6.0

1. Internal rate of return:	
- on total investment, %	11.65
- on equities, %	7.80
2. Pay-back period, years	6.0

10.2. Initial information and evaluation of calculation results

The results of calculations under COMFAR programme are summarized in following Schedules:

- "Summary Sheet"
- "Total Initial Investment"
- "Total Current Investment"
- "Total Production Costs"
- "Working Capital requirements"
- "Source of Finance"
- "Cashflow tables"
- "Net Income Statement"
- "Projected Balance Sheets"

The initial data are summarized in Schedules of Investment Costs, Production Costs and Sources of Finance.

The Schedules of Cashflow Tables, Net Income Statement and Project Balance Sheets include all absolute and relative parameters resulted from calculations and illustrating the financial state of project for a production period of 20 years.

COMFAR programme also presents the results of calculations in form of charts.

The Schedules and Charts prepared by COMFAR are given in the end of Chapter 10.

10.2.1. Total Initial Investment

The total initial investment is determined as a total of fixed assets (cost of site preparation, technology, equipment, buildings and structures, project implementation), and pre-production capital expenditures (interest during construction).

While determining the total initial investment the pre-operating costs and contingencies are added to the total investment costs at 3% of civil work and equipment costs including installation in agreement with the Protocol of discussions of Draft Feasibility Report.

The total initial investment amounts to Rs.1194.0 mln, including:

	Foreign	Local	Total
1. Fixed investment costs:			
1.1. Site preparation	-	22.40	22.40
1.2. Technology	6.50	2.27	8.77
1.3. Equipment	131.53	686.73	818.26
1.4. Building & structures	-	209.04	209.04
1.5. Project implementation	2.60	14.54	17.14
1.6. Township	-	43.51	43.51
Total fixed capital	140.63	978.49	1119.12
2. Pre-operation & contingency	3.94	28.18	32.12
3. Interest during construction	9.19	33.57	42.76
Total initial investment	153.76	1040.24	1194.00
including:			
1-st year of conctruction	0.60	29.40	30.00
2-nd - " -	0.80	353.30	354.10
3-rd - " -	152.36	657.54	809.90

The investment costs for replacement during production period are included at 20% of indegeneous equipment cost and complete replacement of lining for electric arc reduction furnace, holding and filtering furnaces.

10.2.2. Total Production Cost

The total production costs are calculated based on cost estimates of operation costs, depreciation and interest during operation as total annual costs for production of alloys during the whole estimated period.

The results of annual production costs for the 1-st year of operation (beginning of operation), and 4-th year (reaching 100% capacity) are given below (in Rs.mln):

	1-st year	4-th year
1. Operating cost		
1.1. Raw materials	19.42	89 26
1.2. Molten aluminium	181.05	832.13
1.3. Utilities & inputs	14.84	68.21
1.4. Energy	31.45	144.57
1.5. Labour	10.10	13.46
1.6. Repair & maintenance	11.53	30.73
1.7. Overheads	5.66	15.10
Total	274.05	1193.46
2. Depreciation	268.00	104.30
3. Interest	98.37	109.40
Grand total	640.42	1407.16

The ratio of the above cost items in total production costs is shown on Chart "Structure of Production Costs".

10.2.3. Working Capital

In accordance with the Protocol of discussions of Draft Feasibility Report the working capital is determined in amount equivalent to direct operating costs for 40 days.

The total working capital requirements amounts to Rs.132.5 mln In conformity with the Initial Data 35% of working capital (Rs.46.4 mln.) are capitalized in form of margin money and 65% (Rs. 86.1 mln.) are accounted in form of current assets.

10.2.4. Source of Finance

The Financing of total investment costs excluding the cost of Township are by equities and loans in ratio 1:1. The construction of Township is covered by equity capital.

The loan for supply of imported equipment is covered by

Supplier's credit at annual interest rate of 12% and debt repayment period of 10 years start-up and commissioning of production capacity.

A remainder part of loaned assets is to be covered through long-term local loan at annual interest rate of 16% and repayment period of 10 years with grace period of 2 years after start-up.

The capitalized part of working capital (35% of it) is financed at the same conditions as fixed investment. The current assets are covered by short-term loan at annual interest rate of 21.25%.

It is assumed that the financing starts from equity capital.

The total requirements in funds including working capital amounts to Rs.1326.5 mln., including:

1. Equity	- 621.23 mln.
2. Supplier's credit	- 153.22 -"-
3. Long-Term loan	- 465.95 -"-
4. Short-Term loan on working capital	- 86.10 -"-
Total	1326.50

10.3. Analysis of Profitability and Financial conditions

The conditions of project profitability and its financial feasibility are shown on Charts:

"Total Sales and Production Costs"
"Annual Net Cashflow"
"Accumulated Cashflow"
"Annual Financial Cashflow"
"Debt Service Ratio".

The Charts represent graphically, that:

- The products are sold inside the country, confirming the project orientation to domestic market. The sales are increasing from about Rs.0.31 mln. (1-st year of production) to Rs.1.44 mln. (4-th and following years).

- The assumed scheme of financing as a whole ensures the stable financial status of the project. The project has a positive cashflow balance starting from the first year of operation. The annual net cashflow increases from Rs.44.5 mln. at first year of operation to Rs.74.8 mln. after reaching the design capacity, and as an average annual for the estimated operation period amounts to Rs.69.2 mln.

- During the first three years of operation due to mastering of production capacities as well as to high interest rates of credit repayment and depreciation rates the project will have no net profit but starting from the third year the annual income is higher in 1.5-2.5 times than the debt service liabilities which also illustrate the high level of project financial stability.

10.4. Internal Rate of Return

The internal rate of return (IRR) is the discounting rate at which the total costs related to project construction and operation become equal to amount of future income after project implementation.

As it is shown in calculations, the IRR parameters are as follows:

- on total investment (IRRI) - 11.65%
- on equities (IRRE) - 7.80%

The values of IRRI are lower by 1.82% as compared with the level of this parameter determined in the Draft Feasibility Report (13.47%). The main reason for this is the increase of tax on taxable profit assumed for calculations in the Final Report from 44.8% to 51.75% in accordance with the Protocol of Discussions of Draft Feasibility Report.

10.5. Sensitivity Analysis

The sensitivity analysis carried out studies the effect of changing the main project variables (sales, production and investment costs) on project feasibility.

As the IRRI is the major summarizing parameter of feasibility, the sensitivity anlysis studies the values of this parameter at different points depending on the variation level of above variables.

The sensitivity analysis is presented in graphical form on

Chart "Sensitivity of IRR".

The calculation results show:

- The lowest impact on IRRI is effected by variantion of investment. At increase of 5% the IRRI reduces from 11.65% to about 11%. With the increase of investment of 10% the viability of project is still maintained (IRR is about 10.35%, or it is lower by 1.3% as compared with the base level). At decrease of investment of 5% the IRRI increases to 12.37%.

- The project is most sensitive to variation of sales and production costs. An increase of production cost or decrease of sales of 5% decreases IRRI to the level of 4.7-6.0% and the project becomes unfeasible at increase of production cost or decrease of sales by more than 8%. At decrease of costs or increase of sales of 5% the IRRI increases by about 1.4 times (from 11.65% to 16-16.7%).

The last point may be explained by the fact that the main component of Al-Si alloys as well as of alloys production costs is aluminium. The share of aluminium in finished product is 84-87%, and in framework of production cost structure the cost of aluminium consumed markets is about 60%. Thus the project is most sensitive to variation of aluminium price.

10.6. Break- Even Analysis

The Break-even analysis determines the minimum production capacity utilization level (break-even point) at which the sales equal the production costs or in other words when the project bears no profits no losses.

The break-even point is calculated for two statuses of the project:

- fixed assets don't include the financial costs for interest repayment on credit and loans;
- interest repayment is included.

Its value is as follows:

- excluding finance 53.3% (15870 tpy)
- including finance - 88.9% (26480 tpy)

10.7. Findings and Recommendations

1. The financical and economic evaluation carried out allows to draw a positive conclusion on viability of the project for establishment of electrosmelting production of Al-Si alloys in India. This statement is illustrated by the following:

- stable growth of demand for Al-Si alloys on the internal market of the country due to rather high rates of development of industries consuming these alloys (automobile, manufacturing of railway wagons, scooters, motorcycles, household appliances, ets.);

- practically unlimited reserves of natural aluminosilicate raw material - the shore sand of Orissa State and possibility to locate the production of Al-Si alloys in the area of sillimanite concentrate manufacturing and in direct vicenity of the source of molten aluminium;

- stable financial status of the project, which is specified by a positive net cashflow balance during the whole period of project operation, average for a year of Rs. 69.2 mln. and high debt service ratio (ratio of received cashflow to debt amounts to 2.0:1).

2. As aluminium is the most expensive component of production costs, the supply of molten aluminium directly from the Customer's Smelter determines the significant saving of production costs and due to this fact improvement of project techno-economic parameters.

3. The project is more stable to variation of investment costs and it is more sensitive to variation of sales revenue and production costs. This means that while taking the decision on project implementation one should be very careful in evaluation of demand of Al-Si alloys market, that of raw materials and utilites and input, first of all of aluminium, because the variation of its price affects mostly the economics of the project.

Project Al-Si alloys, India
1992, February
UNIDO Contract No.89/156

3 year(s) of construction, 20 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: Rs. mln

Total initial investment during construction phase

fixed assets:	1194.00	12.878 % foreign
current assets:	0.00	0.000 % foreign
total assets:	1194.00	12.878 % foreign

Source of funds during construction phase

equity & grants:	621.23	0.000 % foreign
foreign loans :	153.22	
local loans :	419.55	
total funds :	1194.00	12.832 % foreign

Cashflow from operations

Year:	1	4	15-20
operating costs:	274.05	1193.46	7160.76
depreciation :	267.99	104.31	20.68
interest :	98.37	109.40	18.30
production costs	640.42	1407.16	7199.73
thereof foreign	8.51 %	2.26 %	-0.00 %
total sales :	313.55	1441.14	8646.84
gross income :	-326.87	33.98	1359.54
net income :	-326.87	33.98	655.98
cash balance :	44.52	66.49	678.12
net cashflow :	10.40	237.80	782.52

Net Present Value at: 12.00 % = -23.75
Internal Rate of Return: 11.65 %
Return on equity1: 2.14 %
Return on equity2: 7.80 %

Index of Schedules produced by COMFAR

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

Total Initial Investment in Rs. mln

Year	1992	1993	1994
Fixed investment costs			
Land, site preparation, development	22.40	0.00	0.00
Buildings and civil works	0.00	156.07	104.05
Auxiliary and service facilities	0.00	0.00	0.00
Incorporated fixed assets	7.60	4.77	13.54
Plant machinery and equipment	0.00	193.26	649.55
Total fixed investment costs	30.00	354.10	767.14
Pre-production capital expenditures.	0.00	0.00	42.76
Net working capital	0.00	0.00	0.00
Total initial investment costs	30.00	354.10	809.90
Of it foreign, in %	2.00	0.23	18.81

Total Current Investment in Rs. mln

Year	1995	1996	1997	1998	1999-2002	2003
Fixed investment costs						
Land. site preparation. development	0.00	0.00	0.00	0.00	0.00	0.00
Buildings and civil works	0.00	0.00	0.00	0.00	0.00	0.00
Auxiliary and service facilities	0.00	0.00	0.00	0.00	0.00	0.00
Incorporated fixed assets	0.00	0.00	0.00	0.00	0.00	0.00
Plant. machinery and equipment	0.00	0.00	0.00	0.00	0.00	70.00
Total fixed investment costs	0.00	0.00	0.00	0.00	0.00	70.00
Preproduction capitals expenditures.	0.00	0.00	0.00	0.00	0.00	0.00
Working capital	29.10	56.30	37.22	9.88	0.00	0.00
Total current investment costs	29.10	56.30	37.22	9.88	0.00	70.00
Of it foreign. %	0.00	0.00	0.00	0.00	0.00	0.00

COMFAR 2.1 - VAMI. LENINGRAD. U.S.S.R.

Total Current Investment in Rs. mln

Year	2004	2005- 14
Fixed investment costs		
Land. site preparation. development	0.00	0.00
Buildings and civil works	0.00	0.00
Auxiliary and service facilities	0.00	0.00
Incorporated fixed assets	0.00	0.00
Plant. machinery and equipment	71.47	0.00
Total fixed investment costs	71.47	0.00
Preproduction capitals expenditures.	0.00	0.00
Working capital	0.00	0.00
Total current investment costs	71.47	0.00
Of it foreign. %	0.00	0.00

Project Al-Si alloys. India --- 1992. February

Total Production Costs in Rs. mln

Year	1995	1996	1997	1998	1999	2000
% of nom. capacity (single product).	21.76	64.31	92.48	100.00	100.00	100.00
Raw material 1	19.42	57.41	82.55	89.26	89.26	89.26
Other raw materials	181.05	535.16	769.56	832.13	832.13	832.13
Utilities	14.84	43.87	63.08	68.21	68.21	68.21
Energy	31.45	92.98	133.70	144.57	144.57	144.57
Labour. direct	10.10	13.46	13.46	13.46	13.46	13.46
Repair. maintenance	11.53	23.05	30.73	30.73	30.73	30.73
Spares	0.00	0.00	0.00	0.00	0.00	0.00
Factory overheads	5.66	11.33	15.10	15.10	15.10	15.10
Factory costs	274.05	777.25	1108.18	1193.46	1193.46	1193.46
Administrative overheads	0.00	0.00	0.00	0.00	0.00	0.00
Indir. costs. sales and distribution	0.00	0.00	0.00	0.00	0.00	0.00
Direct costs. sales and distribution	0.00	0.00	0.00	0.00	0.00	0.00
Depreciation	267.99	191.04	139.73	104.31	81.17	60.51
Financial costs	98.37	111.23	111.23	109.40	100.10	90.81
Total production costs	640.42	1079.52	1359.14	1407.16	1374.73	1344.78
Costs per unit (single product)	2.04	1.16	1.02	0.98	0.95	0.93
Of it foreign. %	8.51	4.21	2.85	2.26	1.90	1.59
Of it variable.%	38.53	67.57	77.17	80.60	82.50	84.34
Total labour	10.10	13.46	13.46	13.46	13.46	13.46

Project Al-Si alloys. India --- 1992. February

COMFAR 2.1 - VAMI. LENINGRAD. U.S.S.R.

Total Production Costs in Rs mln

Year	2001	2002	2003	2004	2005	2006
% of nom. capacity (single product).	100.00	100.00	100.00	100.00	100.00	100.00
Raw material 1	89.26	89.26	89.26	89.26	89.26	89.26
Other raw materials	832.13	832.13	832.13	832.13	832.13	832.13
Utilities	68.21	68.21	68.21	68.21	68.21	68.21
Energy	144.57	144.57	144.57	144.57	144.57	144.57
Labour. direct	13.46	13.46	13.46	13.46	13.46	13.46
Repair. maintenance	30.73	30.73	30.73	30.73	30.73	30.73
Spares	0.00	0.00	0.00	0.00	0.00	0.00
Factory overheads	15.10	15.10	15.10	15.10	15.10	15.10
Factory costs	1193.46	1193.46	1193.46	1193.46	1193.46	1193.46
Administrative overheads	0.00	0.00	0.00	0.00	0.00	0.00
Indir. costs. sales and distribution	0.00	0.00	0.00	0.00	0.00	0.00
Direct costs. sales and distribution	0.00	0.00	0.00	0.00	0.00	0.00
Depreciation	50.66	49.91	49.91	56.07	44.23	34.79
Financial costs	81.51	72.22	62.93	53.63	44.34	35.05
Total production costs	1325.63	1315.59	1306.30	1303.17	1282.03	1263.30
Costs per unit (single product)	0.92	0.91	0.91	0.90	0.89	0.88
Of it foreign. %	1.38	1.25	1.12	0.73	0.29	0.15
Of it variable.%	85.56	86.21	86.82	87.03	88.47	89.78
Total labour	13.46	13.46	13.46	13.46	13.46	13.46

Total Production Costs in Rs. mln

Year	2007	2008	2009-14
% of nom. capacity (single product).	100.00	100.00	600.00
Raw material 1	89.26	89.26	535.56
Other raw materials	832.13	832.13	4992.78
Utilities	68.21	68.21	409.26
Energy	144.57	144.57	867.42
Labour, direct	13.46	13.46	80.76
Repair, maintenance	30.73	30.73	184.38
Spares	0.00	0.00	0.00
Factory overheads	15.10	15.10	90.60
Factory costs	1193.46	1193.46	7160.76
Administrative overheads	0.00	0.00	0.00
Indir. costs, sales and distribution	0.00	0.00	0.00
Direct costs, sales and distribution	0.00	0.00	0.00
Depreciation	28.39	24.33	20.68
Financial costs	25.75	18.30	18.30
Total production costs	1247.60	1236.09	7199.73
Costs per unit (single product)	0.87	0.86	0.83
Of it foreign, %	-0.00	-0.00	-0.00
Of it variable,%	90.91	91.75	94.52
Total labour	13.46	13.46	80.76

Net Working Capital in Rs. mln

Year	mdc	coto	1995	1996	1997	1998	1999-2003
Coverage	mdc	coto					
Current assets &							
Accounts receivable	0	---	0.00	0.00	0.00	0.00	0.00
Inventory and materials	40	9.0	23.92	70.71	101.89	109.96	109.96
Energy	0	---	0.00	0.00	0.00	0.00	0.00
Spares	0	---	0.00	0.00	0.00	0.00	0.00
Work in progress	7	52.9	5.18	14.68	20.93	22.54	22.54
Finished products	0	---	0.00	0.00	0.00	0.00	0.00
Cash in hand	0	---	0.00	0.00	0.00	0.00	0.00
Total current assets			29.10	85.40	122.62	132.50	132.50
Current liabilities and							
Accounts payable	0	---	0.00	0.00	0.00	0.00	0.00
Net working capital			29.10	85.40	122.62	132.50	132.50
Increase in working capital			29.10	56.30	37.22	9.88	0.00
Net working capital, local			29.10	85.40	122.62	132.50	132.50
Net working capital, foreign			0.00	0.00	0.00	0.00	0.00

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

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Net Working Capital in Rs. mln

Year	mdc	coto	2004
Coverage	mdc	coto	
Current assets &			
Accounts receivable	0	---	0.00
Inventory and materials	40	9.0	-2.76
Energy	0	---	0.00
Spares	0	---	0.00
Work in progress	7	52.9	135.26
Finished products	0	---	0.00
Cash in hand	0	---	0.00
Total current assets			132.50
Current liabilities and			
Accounts payable	0	---	0.00
Net working capital			132.50
Increase in working capital			0.00
Net working capital, local			132.50
Net working capital, foreign			0.00

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

Source of Finance, construction in Rs. mln

Year	1992	1993	1994
Equity, ordinary	30.00	354.10	237.13
Equity, preference	0.00	0.00	0.00
Subsidies, grants	0.00	0.00	0.00
Loan A, foreign	0.00	0.00	153.22
Loan B, foreign	0.00	0.00	0.00
Loan C, foreign	0.00	0.00	0.00
Loan A, local	0.00	0.00	419.55
Loan B, local	0.00	0.00	0.00
Loan C, local	0.00	0.00	0.00
Total loan	0.00	0.00	572.77
Current liabilities	0.00	0.00	0.00
Bank overdraft	0.00	0.00	0.00
Total funds	30.00	354.10	809.90

Source of Finance, production in Rs. mln

Year	1995	1996	1997	1998-2006	2007	2008-13	2014
Equity, ordinary	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equity, preference	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subsidies, grants	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loan A, foreign	0.00	0.00	-15.32	-15.32	0.00	0.00	0.00
Loan B, foreign	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loan C, foreign	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loan A, local	46.40	0.00	0.00	-46.59	-46.60	0.00	0.00
Loan B, local	86.10	0.00	0.00	0.00	0.00	0.00	-86.10
Loan C, local	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total loan	132.50	0.00	-15.32	-61.92	-46.60	0.00	-86.10
Current liabilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bank overdraft	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total funds	132.50	0.00	-15.32	-61.92	-46.60	0.00	-86.10

Cashflow Tables, construction in Rs. mln

Year	1992	1993	1994
Total cash inflow	30.00	354.10	809.90
Financial resources	30.00	354.10	809.90
Sales, net of tax	0.00	0.00	0.00
Total cash outflow	30.00	354.10	809.90
Total assets	30.00	354.10	767.14
Operating costs	0.00	0.00	0.00
Cost of finance	0.00	0.00	42.76
Repayment	0.00	0.00	0.00
Corporate tax	0.00	0.00	0.00
Dividends paid	0.00	0.00	0.00
Surplus (deficit)	0.00	0.00	0.00
Cumulated cash balance	0.00	0.00	0.00
Inflow, local	30.00	354.10	656.68
Outflow, local	29.40	353.30	657.53
Surplus (deficit)	0.60	0.80	-0.85
Inflow, foreign	0.00	0.00	153.22
Outflow, foreign	0.60	0.80	152.36
Surplus (deficit)	-0.60	-0.80	0.86
Net cashflow	-30.00	-354.10	-767.14
Cumulated net cashflow	-30.00	-384.10	-1151.24

Cashflow tables, production in Rs. mln

Year	1995	1996	1997	1998	1999	2000
Total cash inflow	446.05	926.83	1332.78	1441.14	1441.14	1441.14
Financial resources	132.50	0.00	0.00	0.00	0.00	0.00
Sales, net of tax	313.55	926.83	1332.78	1441.14	1441.14	1441.14
Total cash outflow	401.53	944.78	1271.96	1374.65	1366.33	1383.58
Total assets	29.10	56.30	37.22	9.88	0.00	0.00
Operating costs	274.05	777.25	1108.18	1193.46	1193.46	1193.46
Cost of finance	98.37	111.23	111.23	109.40	100.10	90.81
Repayment	0.00	0.00	15.32	61.92	61.92	61.92
Corporate tax	0.00	0.00	0.00	0.00	10.85	37.40
Dividends paid	0.00	0.00	0.00	0.00	0.00	0.00
Surplus (deficit)	44.52	-17.95	60.82	66.49	74.81	57.56
Cumulated cash balance	44.53	26.57	87.39	153.88	228.69	286.25
Inflow, local	446.05	926.83	1332.78	1441.14	1441.14	1441.14
Outflow, local	383.14	926.40	1238.25	1342.78	1336.30	1355.39
Surplus (deficit)	62.91	0.43	94.53	98.36	104.84	85.75
Inflow, foreign	0.00	0.00	0.00	0.00	0.00	0.00
Outflow, foreign	18.39	18.39	33.71	31.87	30.03	28.19
Surplus (deficit)	-18.39	-18.39	-33.71	-31.87	-30.03	-28.19
Net cashflow	10.40	93.28	187.37	237.80	236.83	210.28
Cumulated net cashflow	-1140.84	-1047.56	-860.18	-622.38	-385.55	-175.27

Cashflow tables, production in Rs. mln

Year	2001	2002	2003	2004	2005	2006
Total cash inflow	1441.14	1441.14	1441.14	1441.14	1441.14	1441.14
Financial resources	0.00	0.00	0.00	0.00	0.00	0.00
Sales, net of tax	1441.14	1441.14	1441.14	1441.14	1441.14	1441.14
Total cash outflow	1379.91	1374.22	1455.28	1451.88	1382.06	1382.46
Total assets	0.00	0.00	70.00	71.47	0.00	0.00
Operating costs	1193.46	1193.46	1193.46	1193.46	1193.46	1193.46
Cost of finance	81.51	72.22	62.93	53.63	44.34	35.05
Repayment	61.92	61.92	61.92	61.92	61.92	61.92
Corporate tax	43 02	46.62	66.98	71.40	82.34	92.03
Dividends paid	0.00	0.00	0.00	0.00	0.00	0.00
Surplus (deficit)	61.23	66.92	-14.14	-10.74	59.08	58.68
Cumulated cash balance	347.48	414.40	400.25	389.51	448.60	507.28
Inflow, local	1441.14	1441.14	1441.14	1441.14	1441.14	1441.14
Outflow, local	1353.55	1349.71	1432.61	1431.04	1363.06	1365.29
Surplus (deficit)	87.59	91.43	8.53	10.10	78.08	75.85
Inflow, foreign	0.00	0.00	0.00	0.00	0.00	0.00
Outflow, foreign	26.35	24.52	22.68	20.84	19.00	17.16
Surplus (deficit)	-26.35	-24.52	-22.68	-20.84	-19.00	-17.16

Net cashflow	204.66	201.06	110.70	104.81	165.34	155.65
Cumulated net cashflow	29.39	230.45	341.15	445.96	611.30	766.94

Cashflow tables, production in Rs. mln

Year	2007	2008	2009 -14
Total cash inflow . .	1441.14	1441.14	8646.84
Financial resources .	0.00	0.00	0.00
Sales, net of tax . .	1441.14	1441.14	8646.84
Total cash outflow . .	1365.96	1317.87	7968.72
Total assets	0.00	0.00	0.00
Operating costs . . .	1193.46	1193.46	7160.76
Cost of finance . . .	25.75	18.30	18.30
Repayment	46.60	0.00	86.10
Corporate tax . . .	100.16	106.11	703.56
Dividends paid . . .	0.00	0.00	0.00
Surplus (deficit) .	75.18	123.27	678.12
Cumulated cash balance	582.46	705.73	1383.85
Inflow, local	1441.14	1441.14	8646.84
Outflow, local	1365.96	1317.87	7968.72
Surplus (deficit) .	75.18	123.27	678.12
Inflow, foreign . . .	0.00	0.00	0.00
Outflow, foreign . . .	-0.00	-0.00	-0.00
Surplus (deficit) .	0.00	0.00	0.00
Net cashflow	147.52	141.57	782.52
Cumulated net cashflow	914.47	1056.03	1838.55

Cashflow Discounting:

a) Equity paid versus Net income flow:
Net present value .... -561.66 at [illegible] %
Internal Rate of Return (IRRE) .. [illegible] %
b) Net Worth versus Net cash return:
Net present value .... [illegible] at [illegible] %
Internal Rate of Return (IRRC) .. [illegible] %
c) Internal Rate of Return on total investment:
Net present value .... -23.75 at 12.00 %
Internal Rate of Return (IRR) .. 11.65 %
Net Worth = Equity paid plus reserves

Net Income Statement in Rs. mln

Year	1995	1996	1997	1998	1999
Total sales, incl. sales tax	313.55	926.83	1332.78	1441.14	1441.14
Less: variable costs, incl. sales tax.	246.76	729.41	1048.89	1134.17	1134.17
Variable margin	66.79	197.42	283.89	306.97	306.97
As % of total sales	21.30	21.30	21.30	21.30	21.30
Non-variable costs, incl. depreciation	295.28	238.88	199.02	163.59	140.46
Operational margin	-228.49	-41.46	84.87	143.38	166.51
As % of total sales	-72.87	-4.47	6.37	9.95	11.55
Cost of finance	98.37	111.23	111.23	109.40	100.10
Gross profit	-326.87	-152.69	-26.36	33.98	66.41
Allowances	0.00	0.00	0.00	33.98	38.45
Taxable profit	-326.87	-152.69	-26.36	-0.00	27.96
Tax	0.00	0.00	0.00	0.00	10.85
Net profit	-326.87	-152.69	-26.36	33.98	55.56
Dividends paid	0.00	0.00	0.00	0.00	0.00
Undistributed profit	-326.87	-152.69	-26.36	33.98	55.56
Accumulated undistributed profit	-326.87	-479.56	-505.92	-471.95	-416.39
Gross profit, % of total sales	-104.25	-16.47	-1.98	2.36	4.61
Net profit, % of total sales	-104.25	-16.47	-1.98	2.36	3.86
ROE, Net profit, % of equity	-52.62	-24.58	-4.24	5.47	8.94
ROI, Net profit+interest, % of invest.	-19.36	-3.35	6.66	11.17	12.13

Net Income Statement in Rs. mln

Year	2000	2001	2002	2003	2004
Total sales, incl. sales tax	1441.14	1441.14	1441.14	1441.14	1441.14
Less: variable costs, incl. sales tax.	1134.17	1134.17	1134.17	1134.17	1134.17
Variable margin	306.97	306.97	306.97	306.97	306.97
As % of total sales	21.30	21.30	21.30	21.30	21.30
Non-variable costs, incl. depreciation	119.80	109.95	109.20	109.20	115.36
Operational margin	187.17	197.02	197.77	197.77	191.61
As % of total sales	12.99	13.67	13.72	13.72	13.30
Cost of finance	90.81	81.51	72.22	62.93	53.63
Gross profit	96.36	115.51	125.55	134.84	137.97
Allowances	0.00	4.67	5.41	5.41	0.00
Taxable profit	96.36	110.84	120.14	129.43	137.97
Tax	37.40	43.02	46.62	66.98	71.40
Net profit	58.96	72.49	78.92	67.86	66.57
Dividends paid	0.00	0.00	0.00	0.00	0.00
Undistributed profit	58.96	72.49	78.92	67.86	66.57
Accumulated undistributed profit	-357.42	-284.93	-206.01	-138.15	-71.58
Gross profit, % of total sales	6.69	8.01	8.71	9.36	9.57
Net profit, % of total sales	4.09	5.03	5.48	4.71	4.62
ROI, Net profit, % of equity	9.49	11.67	12.70	10.92	10.72
ROI, Net profit+interest, % of invest.	11.67	12.00	11.77	9.66	8.43

Net Income Statement in Rs. mln

Year	2005	2006	2007	2008	2009-[illegible]
Total sales, incl. sales tax	1441.14	1441.14	1441.14	1441.14	8646.84
Less: variable costs, incl. sales tax.	1134.17	1134.17	1134.17	1134.17	6805.02
Variable margin	306.97	306.97	306.97	306.97	1841.82
As % of total sales	21.30	21.30	21.30	21.30	21.30
Non-variable costs, incl. depreciation	103.52	94.08	87.68	83.62	463.99
Operational margin	203.45	212.89	219.29	223.35	1377.83
As % of total sales	14.12	14.77	15.22	15.50	15.93
Cost of finance	44.34	35.05	25.75	18.30	18.30
Gross profit	159.11	177.84	193.54	205.05	1359.54
Allowances	0.00	0.00	0.00	0.00	0.00
Taxable profit	159.11	177.84	193.54	205.05	1359.54
Tax	82.34	92.03	100.16	106.11	703.56
Net profit	76.77	85.81	93.38	98.94	655.98
Dividends paid	0.00	0.00	0.00	0.00	0.00
Undistributed profit	76.77	85.81	93.38	98.94	655.98
Accumulated undistributed profit	5.19	91.00	184.38	283.32	939.30
Gross profit, % of total sales	11.04	12.34	13.43	14.23	15.72
Net profit, % of total sales	5.33	5.95	6.48	6.87	7.59
ROE, Net profit, % of equity	12.36	13.81	15.03	15.93	105.59
ROI, Net profit+interest, % of invest.	8.50	8.48	8.36	8.23	47.31

Projected Balance Sheets, construction in Rs. mln

Year	1992	1993	1994
Total assets	30.00	384.10	1194.00
Fixed assets, net of depreciation	0.00	30.00	384.10
Construction in progress	30.00	354.10	809.90
Current assets	0.00	0.00	0.00
Cash, bank	0.00	0.00	0.00
Cash surplus, finance available	0.00	0.00	0.00
Loss carried forward	0.00	0.00	0.00
Loss	0.00	0.00	0.00
Total liabilities	30.00	384.10	1194.00
Equity capital	30.00	384.10	621.23
Reserves, retained profit	0.00	0.00	0.00
Profit	0.00	0.00	0.00
Long and medium term debt	0.00	0.00	572.77
Current liabilities	0.00	0.00	0.00
Bank overdraft, finance required.	0.00	0.00	0.00
Total debt	0.00	0.00	572.77
Equity, % of liabilities	100.00	100.00	52.03

Projected Balance Sheets, Production in Rs. mln

Year	1995	1996	1997	1998	1999	2000
Total assets	1326.50	1326.50	1311.18	1283.24	1242.90	1184.39
Fixed assets, net of depreciation	926.01	734.97	595.24	490.94	409.77	349.26
Construction in progress	0.00	0.00	0.00	0.00	0.00	0.00
Current assets	29.10	85.40	122.62	132.50	132.50	132.50
Cash, bank	0.00	0.00	0.00	0.00	0.00	0.00
Cash surplus, finance available	44.53	26.57	87.39	153.88	228.69	286.25
Loss carried forward	0.00	326.87	479.56	505.92	471.95	416.39
Loss	326.87	152.69	26.36	0.00	0.00	0.00
Total liabilities	1326.50	1326.50	1311.18	1283.24	1242.90	1184.39
Equity capital	621.23	621.23	621.23	621.23	621.23	621.23
Reserves, retained profit	0.00	0.00	0.00	0.00	0.00	0.00
Profit	0.00	0.00	0.00	33.98	55.56	58.96
Long and medium term debt	705.27	705.27	689.95	628.03	566.11	504.20
Current liabilities	0.00	0.00	0.00	0.00	0.00	0.00
Bank overdraft, finance required.	0.00	0.00	0.00	0.00	0.00	0.00
Total debt	705.27	705.27	689.95	628.03	566.11	504.20
Equity, % of liabilities	46.83	46.83	47.38	48.41	49.98	52.45

COMFAR 2.1 - VAMI, LENINGRAD, U.S.S.R.

Projected Balance Sheets, Production in Rs. mln

Year	2001	2002	2003	2004	2005	2006
Total assets	1136.00	1080.51	1007.54	944.33	892.61	844.93
Fixed assets, net of depreciation	298.60	248.68	198.77	212.70	239.94	205.15
Construction in progress	0.00	0.00	70.00	71.47	0.00	0.00
Current assets	132.50	132.50	132.50	132.50	132.50	132.50
Cash, bank	0.00	0.00	0.00	0.00	0.00	0.00
Cash surplus, finance available	347.48	414.40	400.25	389.51	448.60	507.28
Loss carried forward	357.42	284.93	206.01	138.15	71.58	0.00
Loss	0.00	0.00	0.00	0.00	0.00	0.00
Total liabilities	1136.00	1080.51	1007.54	944.33	892.61	844.93
Equity capital	621.23	621.23	621.23	621.23	621.23	621.23
Reserves, retained profit	0.00	0.00	0.00	0.00	0.00	5.19
Profit	72.49	78.92	67.86	66.57	76.77	85.81
Long and medium term debt	442.28	380.36	318.45	256.53	194.61	132.69
Current liabilities	0.00	0.00	0.00	0.00	0.00	0.00
Bank overdraft, finance required.	0.00	0.00	0.00	0.00	0.00	0.00
Total debt	442.28	380.36	318.45	256.53	194.61	32.69
Equity, % of liabilities	54.69	57.49	61.66	65.79	69.60	73.52

Projected Balance Sheets, Production in Rs. mln

Year	2007	2008	2009-14
Total assets	891.71	990.65	1560.53
Fixed assets, net of depreciation	176.76	152.43	44.18
Construction in progress	0.00	0.00	0.00
Current assets	132.50	132.50	132.50
Cash, bank	0.00	0.00	0.00
Cash surplus, finance available	582.46	705.73	1383.85
Loss carried forward	0.00	0.00	0.00
Loss	0.00	0.00	0.00
Total liabilities	891.71	990.65	1560.53
Equity capital	621.23	621.23	621.23
Reserves, retained profit	91.00	184.38	283.32
Profit	93.38	98.94	655.98
Long and medium term debt	86.10	86.10	-0.00
Current liabilities	0.00	0.00	0.00
Bank overdraft, finance required.	0.00	0.00	0.00
Total debt	86.10	86.10	-0.00
Equity, % of liabilities	69.67	62.71	39.81

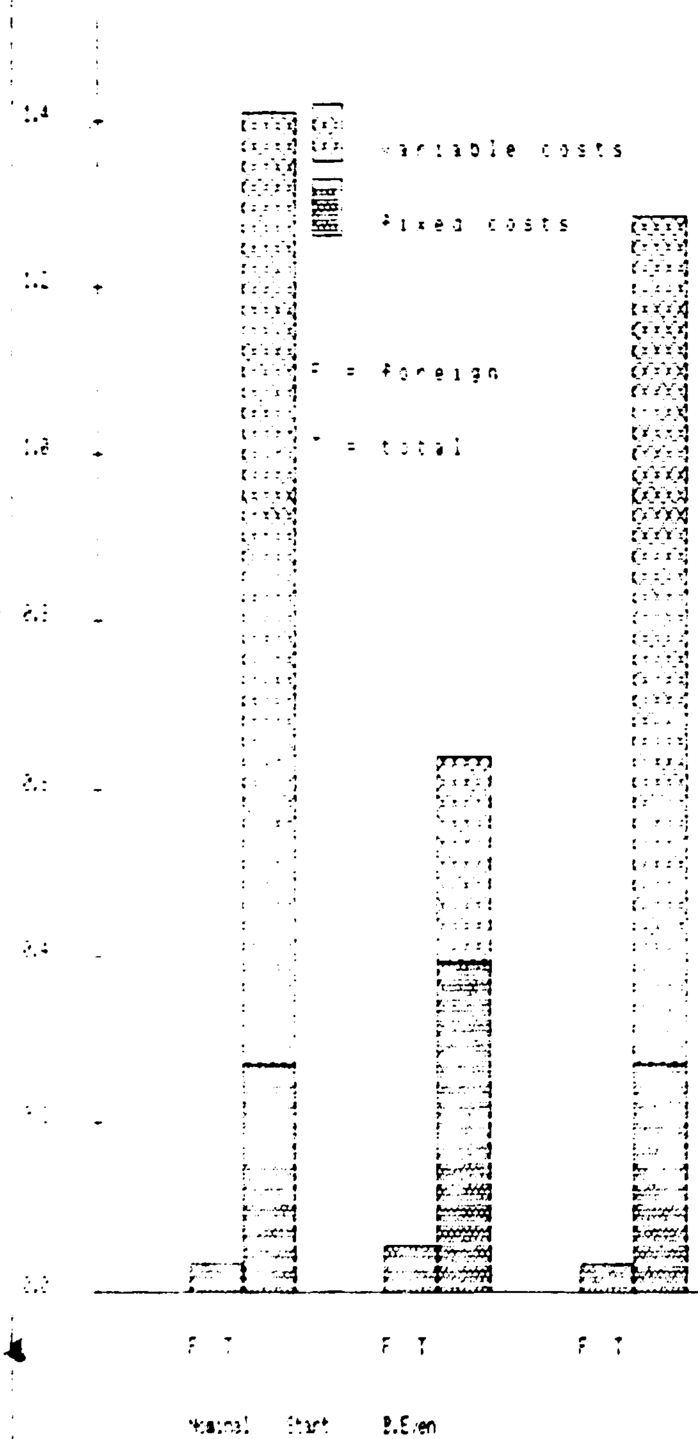
COMFAR 2.1 - UNI. LENINGRAD, U.S.S.R.

Structure of Production Costs

Project Al-Si alloys

10^6 ? Rs. mln

for 4th production year



Nominal	Start up	
[illegible].34	1.0[illegible]	raw material
5[illegible].14	28.27	other RM
4.85	2.32	utilities
10.27	4.91	energy
[illegible]	1.52	labour
2.15	1.30	maintenance
0.00	0.00	spares
1.07	0.38	overheads
[illegible].41	41.25	depreciation
[illegible]	15.7[illegible]	interest
100.00	100.00	Total P[illegible]

VALUES chart description [STANDARD]

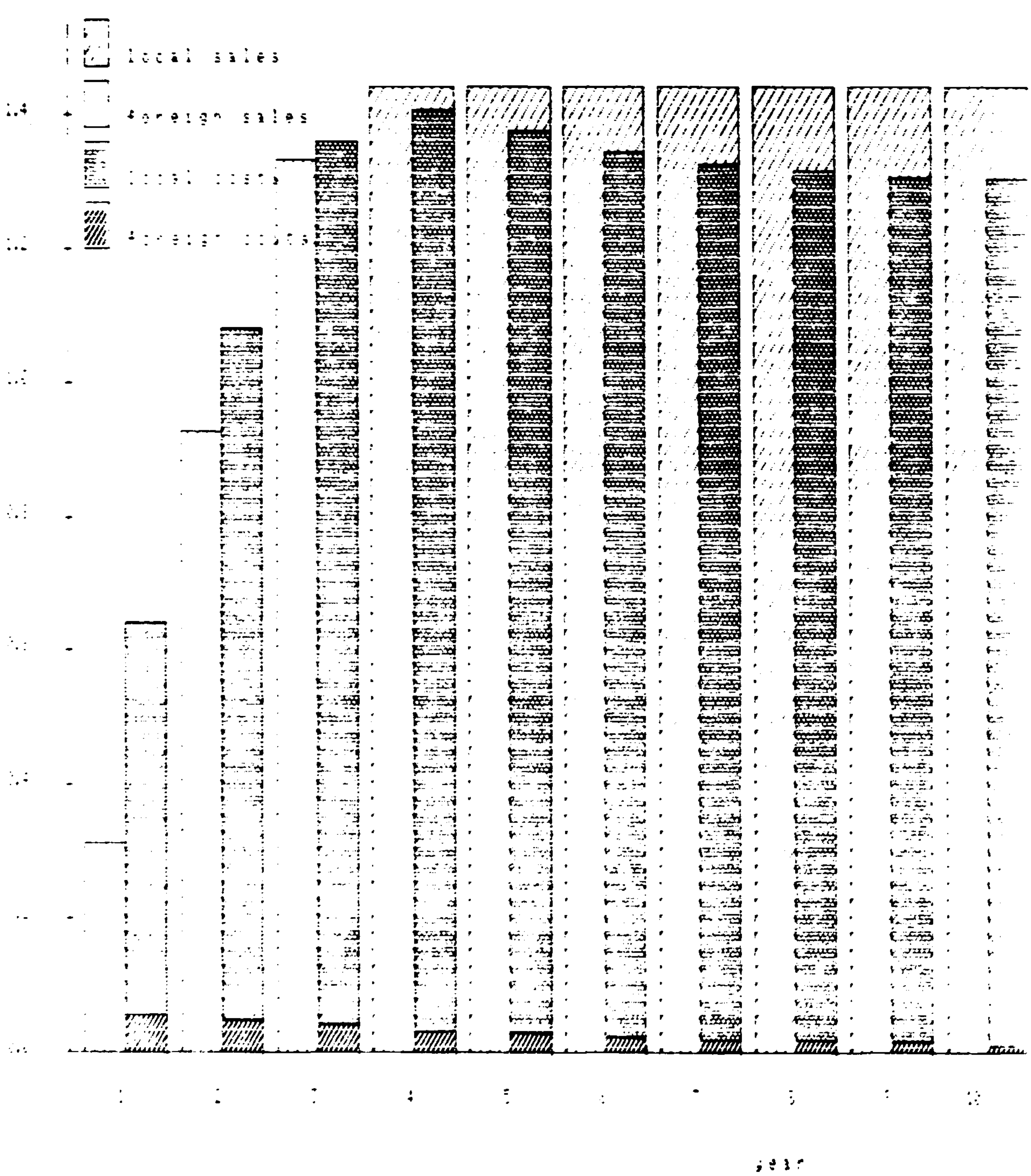
Structure of Production Costs
Rs. mln

Project Al-Si alloys
for 4th production year

	variable c	fixed cost		F = foreign	T = total
nominal F	0.00	31.80	3.03	6.34	31.80
nominal T	1134.17	272.99	28.27	59.14	1407.16
start F	0.00	54.53	2.32	4.85	54.53
start T	246.76	393.65	4.91	10.27	640.42
break F	0.00	31.80	1.58	0.96	31.80
break T	1008.63	272.99	1.80	2.18	1281.62
7			0.00	0.00	
8			0.88	1.07	
9			41.85	7.41	

** production level

Total Sales & Production Costs	Project Al-Si alloys
Rs. mln	

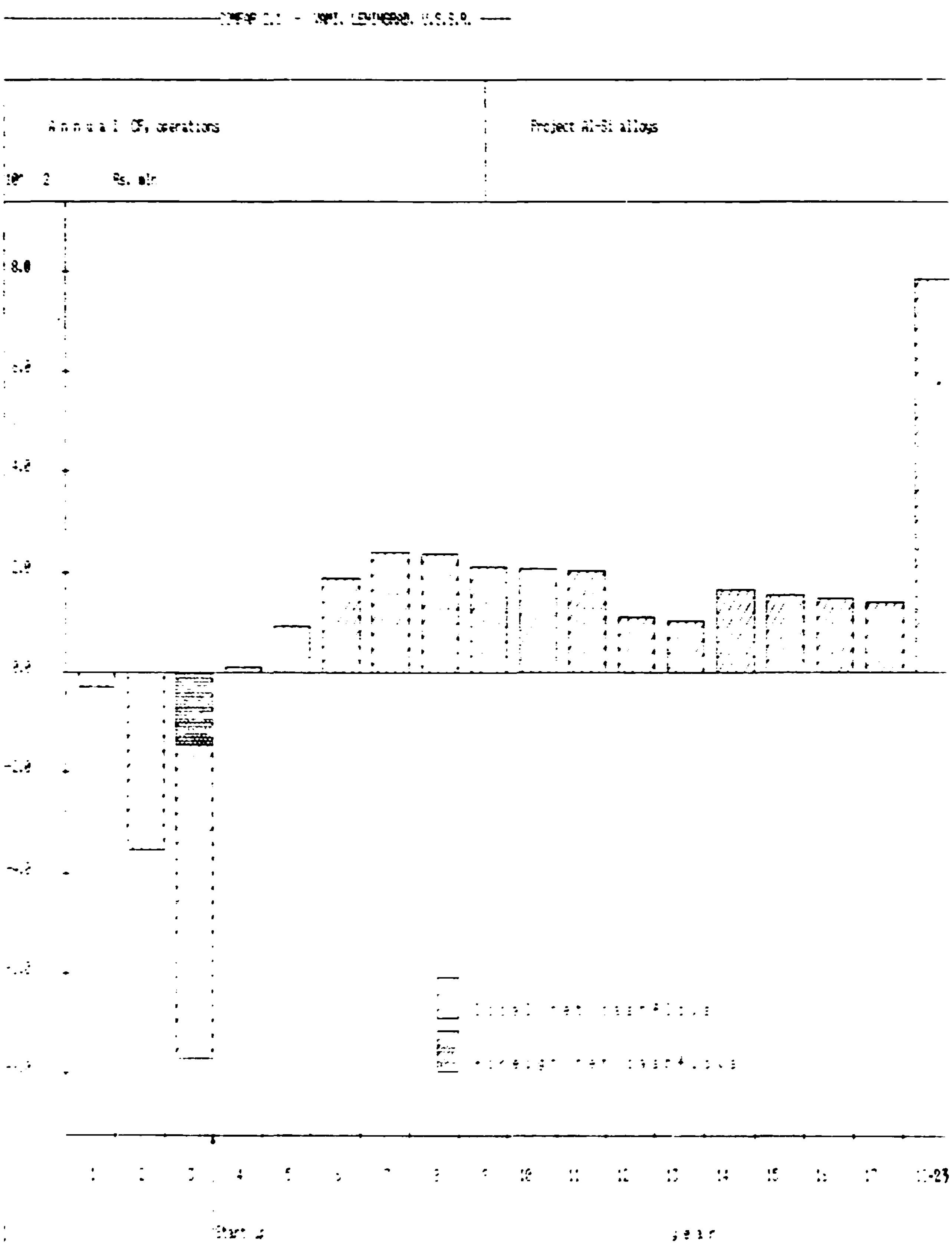


VALUES chart description [STANDARD]

Total Sales & Production Costs Project Al-Si alloys
Rs. mln

	local sales	foreign sal	local costs	foreign cos	
1	313.55	0.00	585.89	54.53	313.55
2	926.83	0.00	1034.03	45.49	926.83
3	1332.78	0.00	1320.43	38.72	1332.78
4	1441.14	0.00	1375.37	31.80	1441.14
5	1441.14	0.00	1348.58	26.15	1441.14
6	1441.14	0.00	1323.33	21.45	1441.14
7	1441.14	0.00	1307.37	18.26	1441.14
8	1441.14	0.00	1299.17	16.42	1441.14
9	1441.14	0.00	1291.72	14.58	1441.14
10	1441.14	0.00	1293.60	9.56	1441.14
11	1441.14	0.00	1278.35	3.68	1441.14
12	1441.14	0.00	1261.46	1.84	1441.14
13	1441.14	0.00	1247.60	-0.00	1441.14
14	1441.14	0.00	1236.09	-0.00	1441.14
15-20	8646.84	0.00	7199.73	-0.00	8646.84

-- year

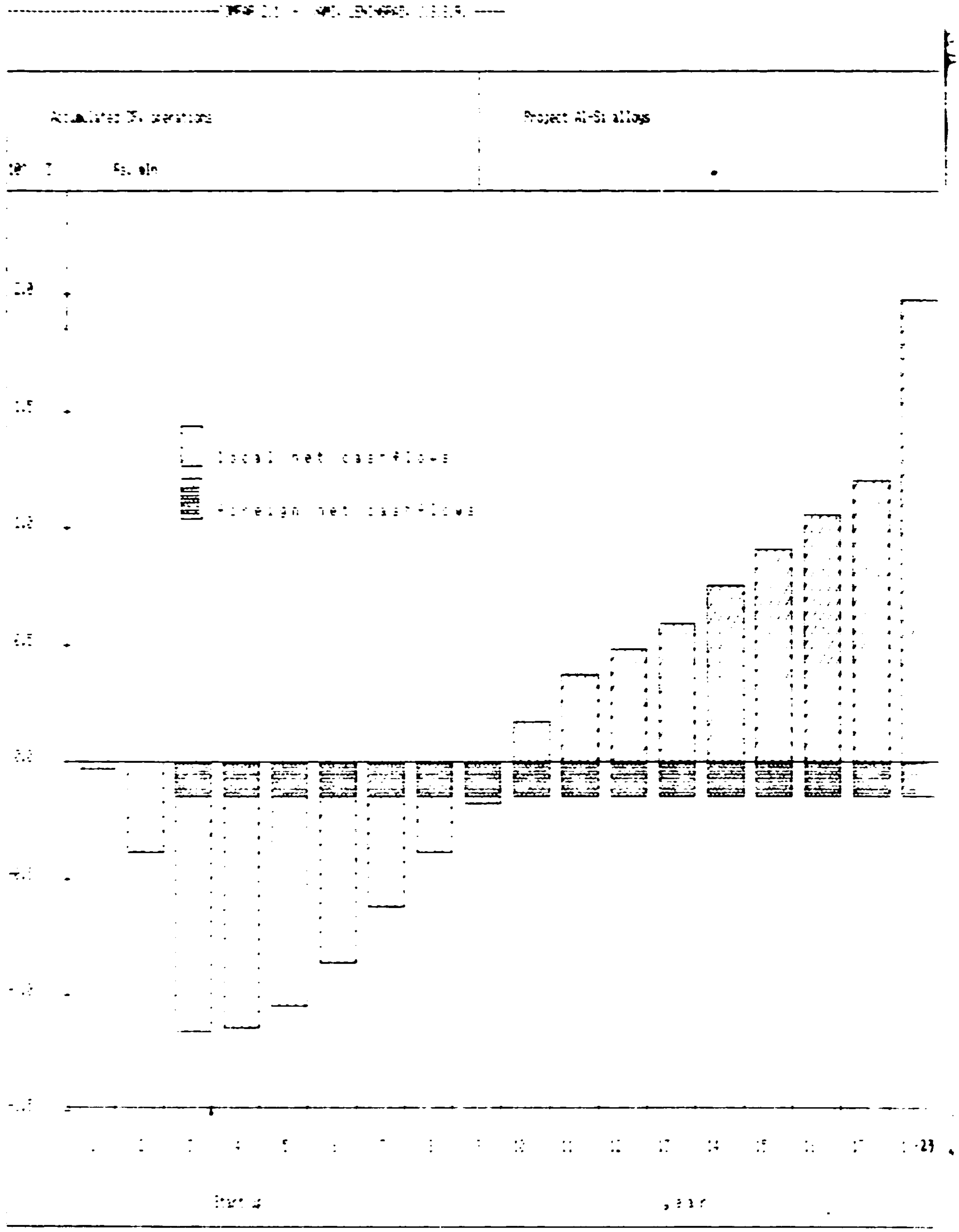

Annual CF, operations
Project Al-Si alloys
8.0
2.0
18-23
year

VALUES chart description (STANDARD)

Annual CF. operations Rs. mln   Project Al-Si alloys

*:Start up	local net c	foreign net	
1	-29.40	-0.60	-30.00
2	-353.30	-0.80	-354.10
3	-623.97	-143.17	-767.14
* 4	10.40	0.00	10.40
5	93.28	0.00	93.28
6	187.38	0.00	187.38
7	237.80	0.00	237.80
8	236.83	0.00	236.83
9	210.28	0.00	210.28
10	204.66	0.00	204.66
11	201.06	0.00	201.06
12	110.70	0.00	110.70
13	104.81	0.00	104.81
14	165.34	0.00	165.34
15	155.65	0.00	155.65
17	141.57	0.00	141.57
18-23	782.52	0.00	782.52

year


Project Al-Si alloys
Local net cashflows
Foreign net cashflows

VALUES chart description [STANDARD]

Accumulated CF, operations Project Al-Si alloys
Rs. mln

$:Start up	local net c	foreign net	
1	-29.40	-0.60	-30.00
2	-392.70	-1.40	-384.10
3	-1006.67	-144.57	-1151.24
4	-996.27	-144.57	-1140.84
5	-902.99	-144.57	-1047.56
6	-715.61	-144.57	-860.18
7	-477.81	-144.57	-622.38
8	-240.98	-144.57	-385.55
9	-30.70	-144.57	-175.27
10	173.96	-144.57	29.39
11	375.02	-144.57	230.45
12	485.72	-144.57	341.15
13	590.53	-144.57	445.96
14	755.87	-144.57	611.30
15	911.51	-144.57	766.94
17	1200.60	-144.57	1056.03
18-23	1983.12	-144.57	1838.55

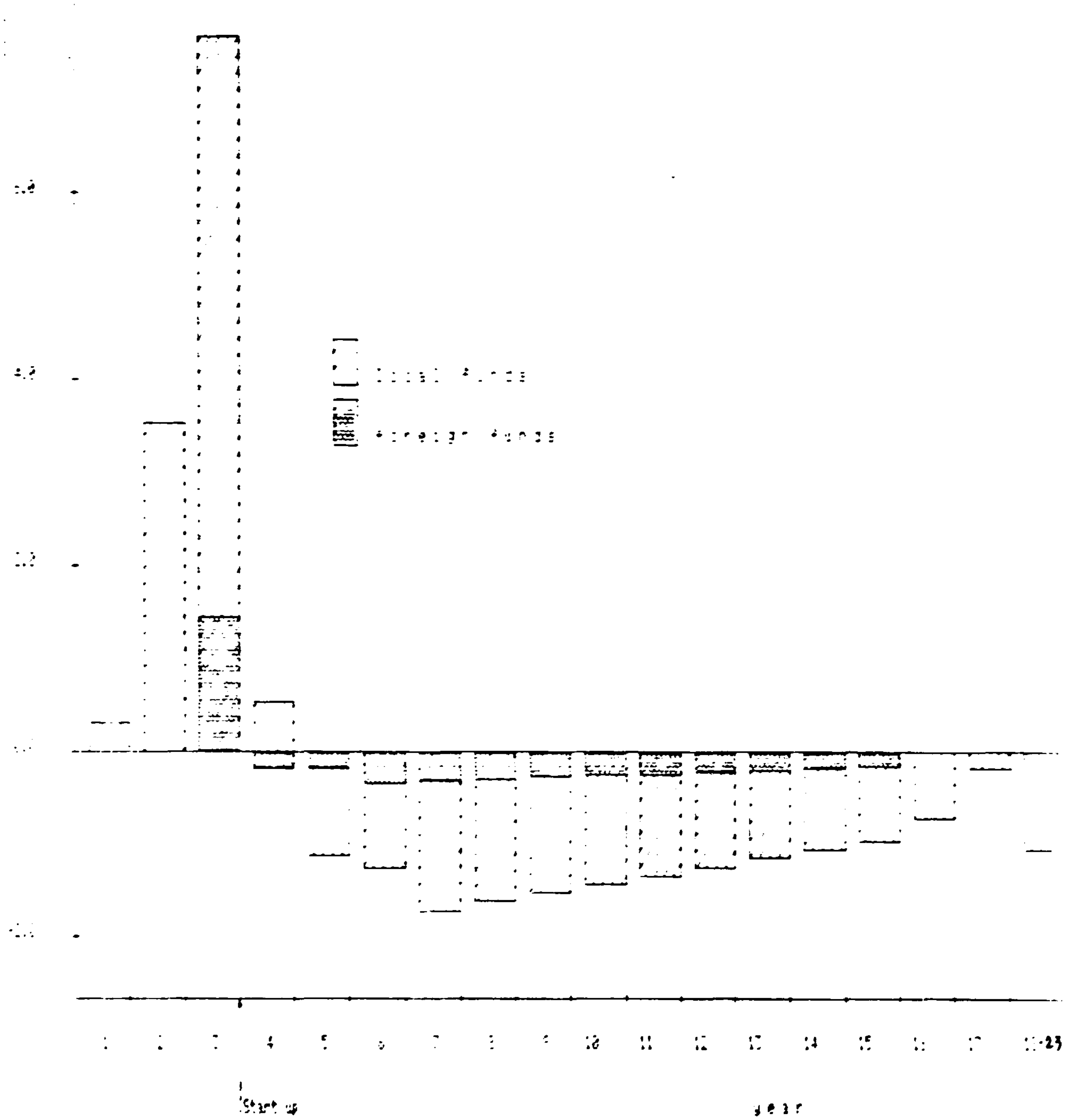
year

COMFAR 2.1 - UNIDO, LENINGRAD, U.S.S.R.

Annual Flow of Funds (Finance)

Project Al-Si alloys

Rs. mln



VALUES chart description [STANDARD]

Annual flow of funds (finance) Project Al-Si alloys
Rs. mln

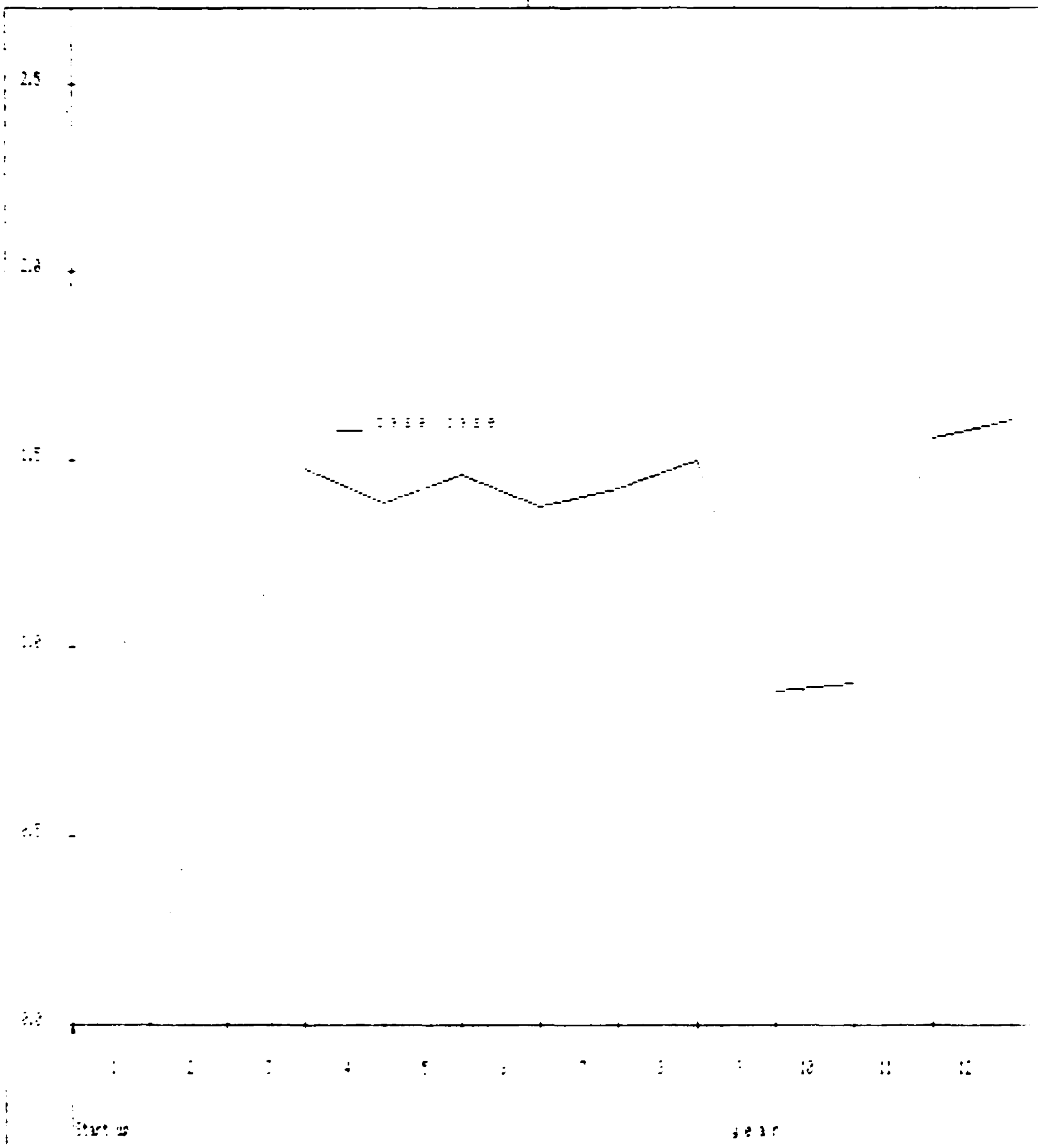
*:Start up	local funds	foreign fun	
1	30.00	0.00	30.00
2	354.10	0.00	354.10
3	623.12	144.03	767.14
* 4	52.51	-18.39	34.13
5	-92.85	-18.39	-111.23
6	-92.85	-33.71	-126.56
7	-139.44	-31.87	-171.31
8	-131.99	-30.03	-162.02
9	-124.53	-28.19	-152.73
10	-117.08	-26.35	-143.43
11	-109.62	-24.52	-134.14
12	-102.17	-22.68	-124.84
13	-94.71	-20.84	-115.55
14	-87.26	-19.00	-106.26
15	-79.80	-17.16	-96.96
17	-18.30	0.00	-18.30
18-23	-104.40	0.00	-104.40

year

Debt Service Ratio, by year

net cashflow/debt service

Project Al-Si alloys



VALUES chart description [STANDARD]

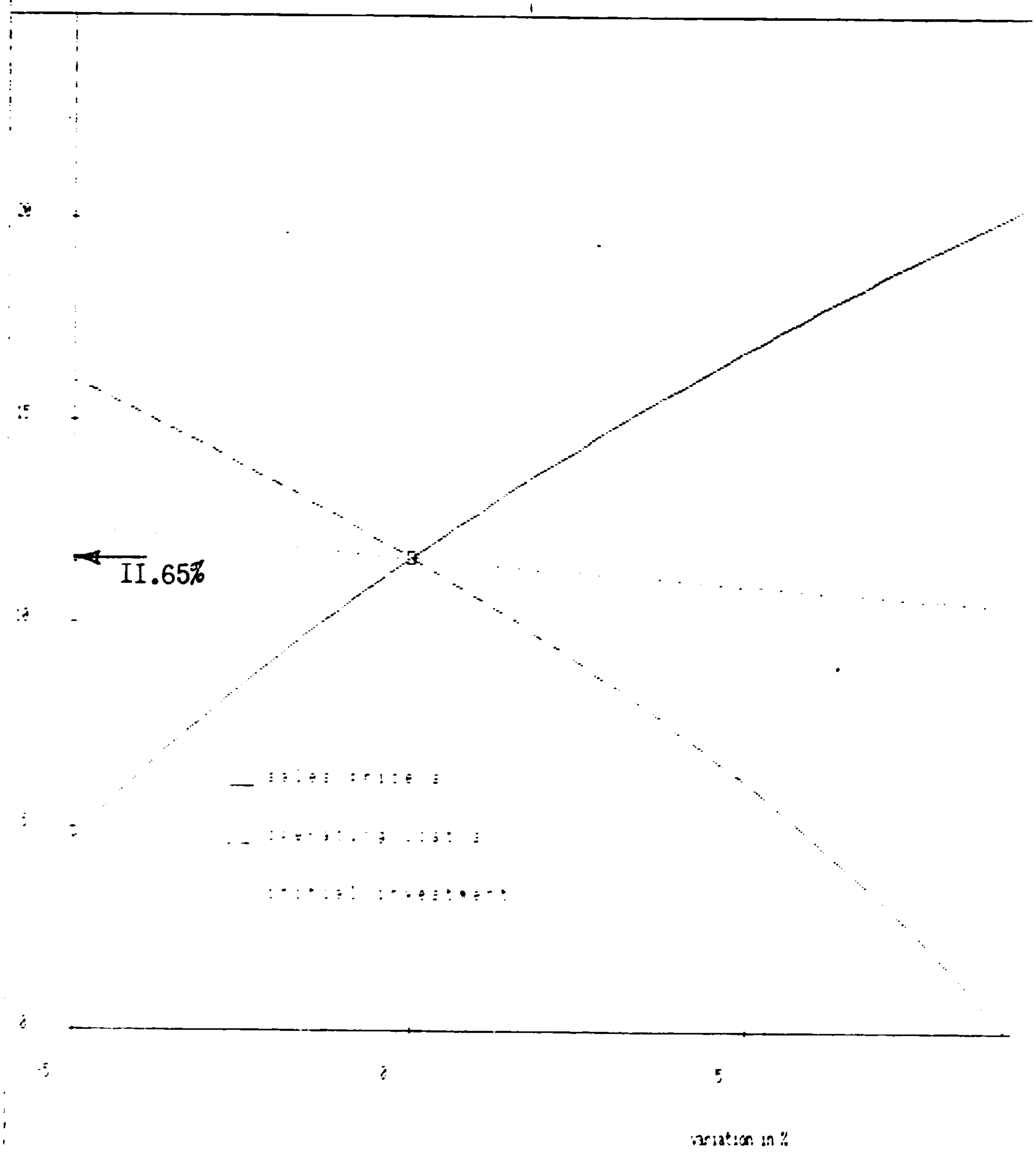
Debt Service Ratio, by year
net cashflow/debt service

Project Al-Si alloys

year	base case
1	0.11
2	0.84
3	1.48
4	1.39
5	1.46
6	1.38
7	1.43
8	1.50
9	0.89
10	0.91
11	1.56
12	1.61
13	2.04

COMFAR 2.1 - VAMI, LENINGRAD, U.S.S.R.

Sensitivity of IRR internal rate of return	Project Al-Si alloys



VALUES chart description (STANDARD)

Sensitivity of IRR
internal rate of return

Project Al-Si alloys

	sales price	operating c	initial inv	
-5.0	4.70	15.98	12.37	11.65
-4.7	5.21	15.74	12.33	
-4.4	5.71	15.50	12.28	
-4.1	6.19	15.26	12.24	
-3.8	6.65	15.01	12.19	
-3.5	7.10	14.77	12.15	
-3.2	7.54	14.51	12.11	
-2.9	7.97	14.26	12.06	
-2.6	8.39	14.00	12.02	
-2.3	8.79	13.74	11.97	
-2.0	9.19	13.48	11.93	
-1.7	9.58	13.22	11.89	
-1.4	9.96	12.95	11.84	
-1.1	10.34	12.68	11.80	
-0.8	10.70	12.40	11.76	
-0.2	11.41	11.84	11.67	
0.1	11.76	11.55	11.63	
0.4	12.10	11.26	11.59	
0.7	12.44	10.96	11.55	
1.0	12.77	10.66	11.51	
1.3	13.10	10.36	11.47	
1.6	13.42	10.05	11.43	
1.9	13.73	9.74	11.38	
2.2	14.04	9.42	11.34	
2.5	14.35	9.09	11.30	
2.8	14.66	8.76	11.26	
3.1	14.96	8.42	11.22	
3.4	15.25	8.08	11.18	
3.7	15.55	7.73	11.14	
4.0	15.83	7.37	11.10	
4.6	16.40	6.63	11.02	
4.9	16.68	6.24	10.98	
5.2	16.96	5.85	10.94	
5.5	17.24	5.44	10.90	
5.8	17.51	5.03	10.87	
6.1	17.78	4.60	10.83	
6.4	18.04	4.16	10.79	
6.7	18.31	3.70	10.75	
7.0	18.57	3.23	10.71	
7.3	18.83	2.74	10.67	
7.6	19.08	2.23	10.64	
7.9	19.34	1.71	10.60	
8.2	19.59	1.16	10.56	
8.5	19.84	0.58	10.52	
8.8	20.09	-0.03	10.49	
9.4	20.58	-1.34	10.41	
9.7	20.82	-2.07	10.37	

'' variation in %

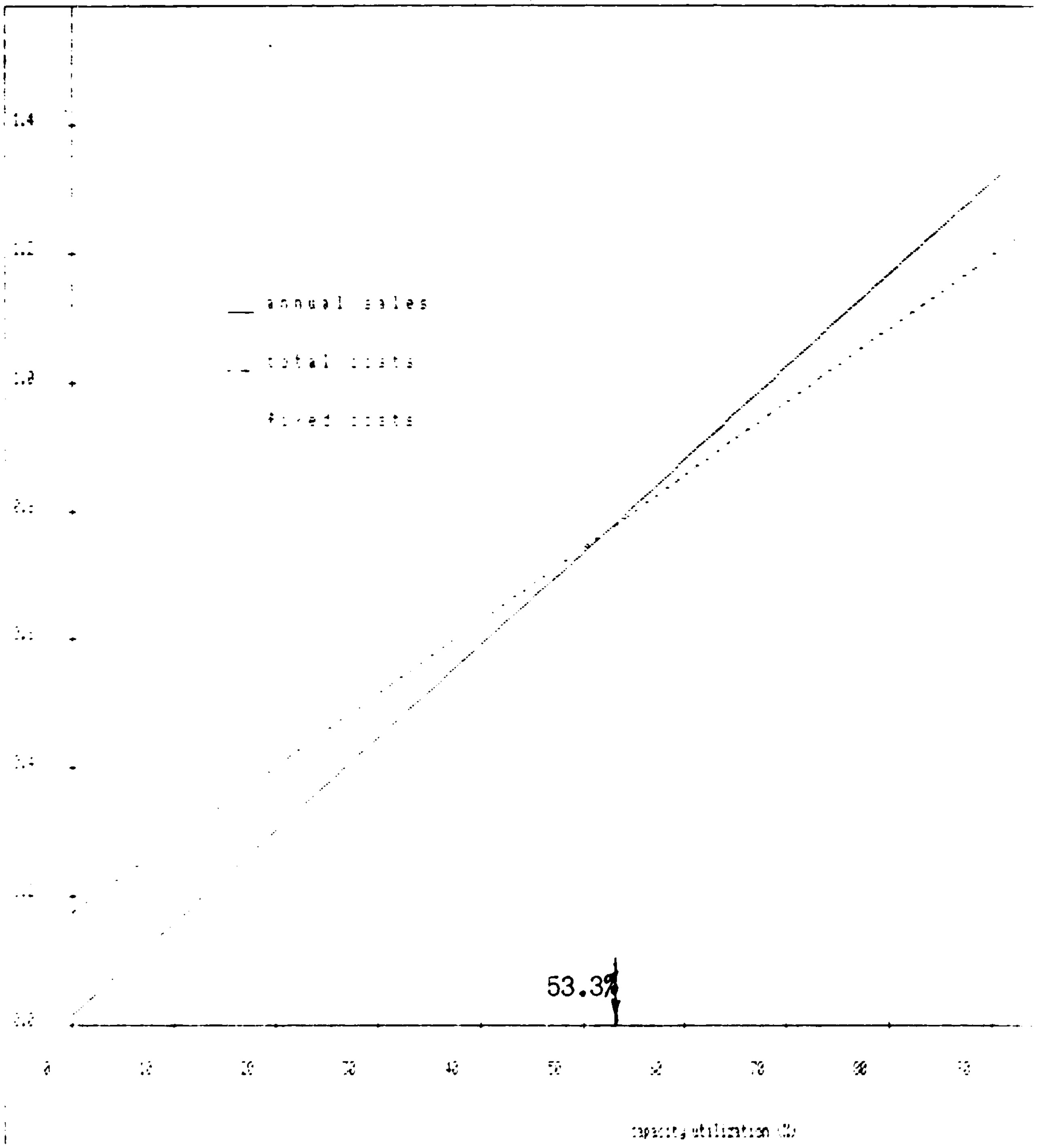
COMFAR 2.1 - VAMI, LENINGRAD, U.S.S.R.

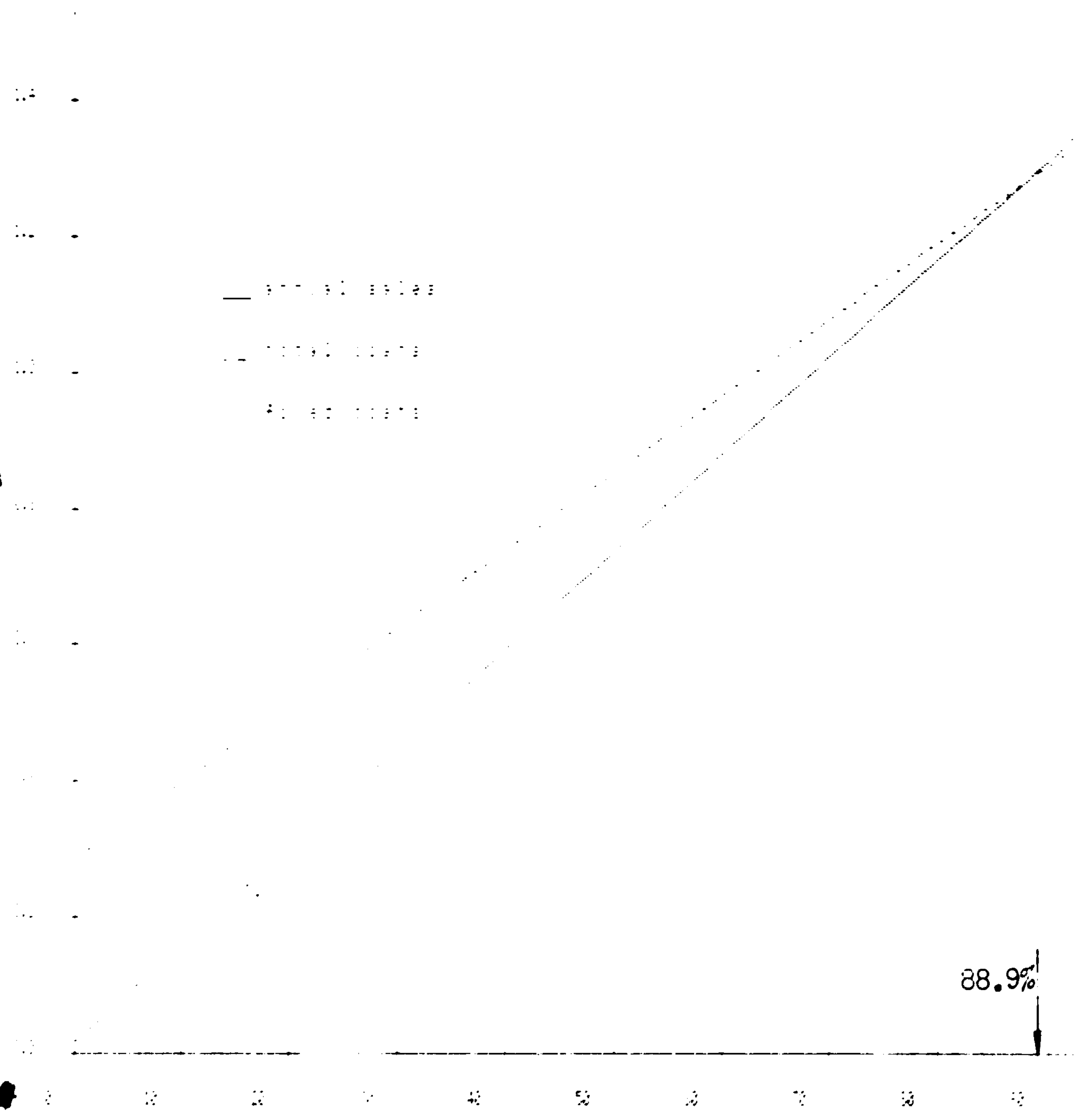
Break Even Chart excl. finance

Project Al-Si alloys

10^6 I Rs. mln

For 4th production year




88.9%

VALUES chart description [STANDARD]

Break Even Chart excl. finance
Rs. mln

Project Al-Si alloys
for 4th production year

	annual sale	total costs	fixed costs
100%	1441.14	1297.77	163.59

-- capacity utilization (%)

COMFAR 2.1 - VAMI. LENINGRAD. U.S.S.R.

VALUES chart description [STANDARD]

Break even chart incl. finance
Rs. mln

Project Al-Si alloys
for 4th production year

	annual sale	total costs	fixed costs
100%	1441.14	1407.16	272.99

-- capacity utilization (%)

Contract № 89 156
UNIDO PROJECT № DP/IND/88/063

TECHNO-ECONOMIC FEASIBILITY STUDY OF INDUSTRIAL SCALE ELECTRO-SMELTING OF AL-SI ALLOYS BASED ON PILOT TECHNOLOGICAL TESTING OF INDIAN RAW MATERIALS IN INDIA

Final report

VOLUME II

DRAWINGS

NPO „VAMI"

VVO „TECHNOEXPORT"

ST.-PETERSBURG

1992

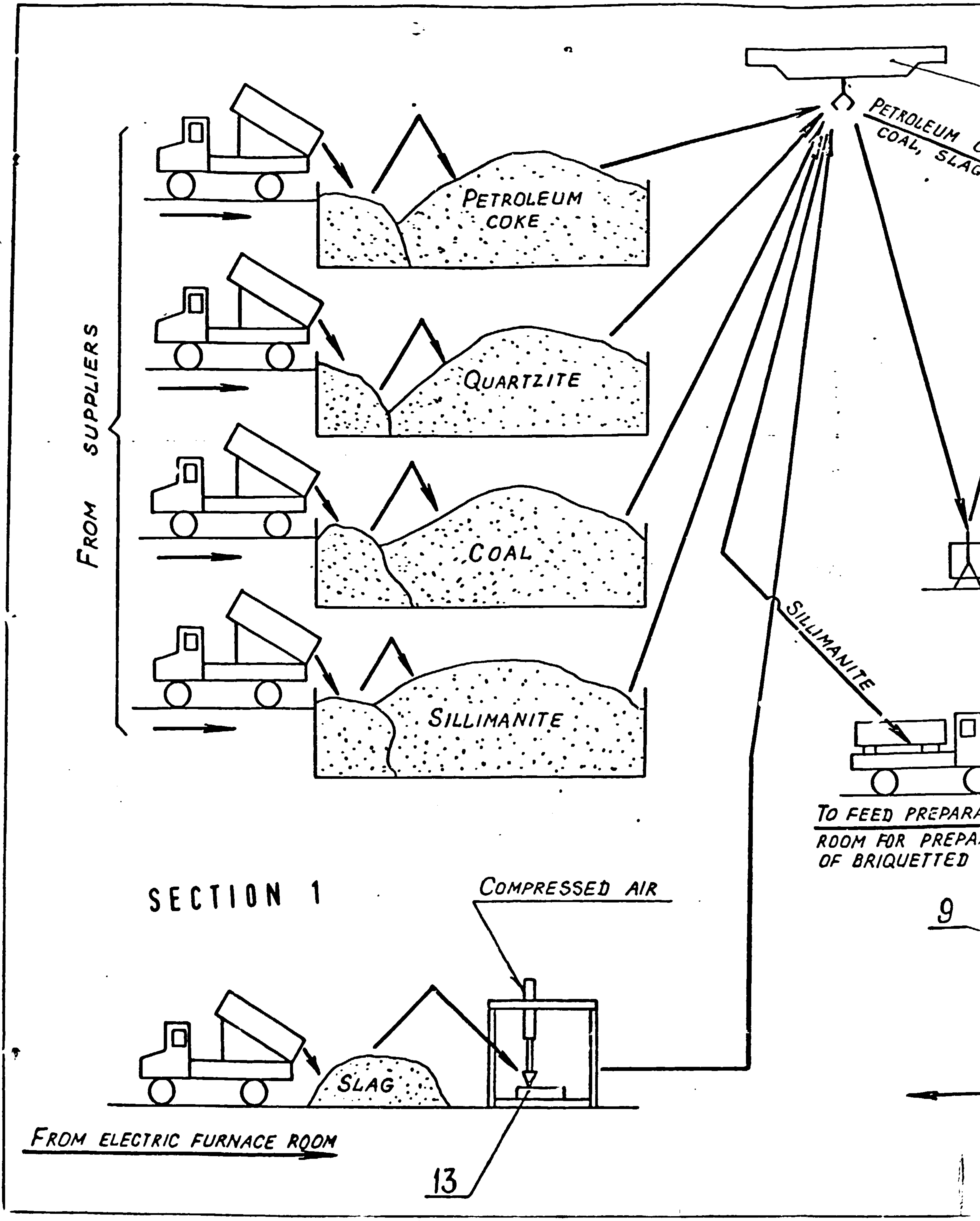
CONTENT
of techno-economic feasibility study

LIST OF DRAWINGS

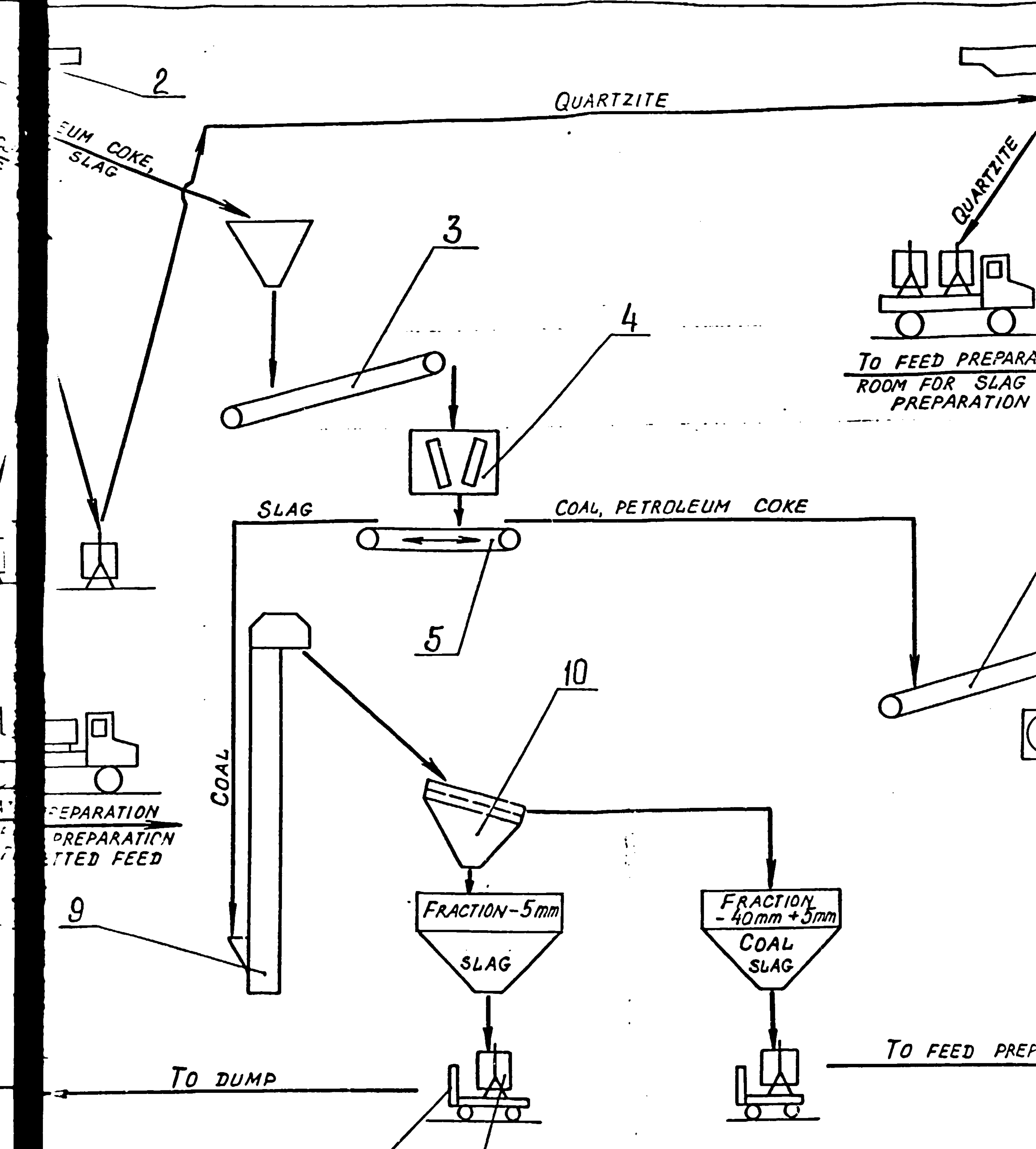
NN	Name of drawing	NN drg
	I. Process drawings	1395273-TM
1.1	Raw materials storage (4 sheets)	
	Sheet 1. Equipment arrangement and process flowsheet	
	Sheet 2. Plan at el.0.000	
	Sheet 3. Section A-A	
	Sheet 4. Sections	
1.2	Feed preparation room (5 sheets)	1395274-TM
	Sheet 1. Equipment arrangement and process flowsheet	
	Sheet 2. Plan at el.0.000	
	Sheet 3. Plans	
	Sheet 4. Section A-A	
	Sheet 5. Sections	
1.3	Alloy preparation (metallurgical) room (5 sheets)	1395275-TM
	Sheet 1. Equipment arrangement and process flowsheet	
	Sheet 2. Specifications	
	Sheet 3. Plan at el.0.000	
	Sheet 4. Plans	
	Sheet 5. Sections	
1.4	Reduction agent grinding area	1343508-TM
	Sheet 1. Plan at el.0.000; 7.200; 15.000; 23.300	
	Sheet 2. Sections 1-1; 2-2; 3-3	
	Sheet 3. Pipeline diagram	

NN	Name of drawings	NN drg
1.5	General view drawings of main process equipment	
1.5.1	Proportioner	1395276.B.0
1.5.2.	Blade mixer	1395277.B.0
1.5.3.	Roller press	1395278.B.0
1.5.4	Continuous drying stove	1395279.B.0
1.5.5	Fuel oil furnace	1395280.B.0
1.5.6	25 MVA electric arc reduction furnace (3 sheets)	1395281.B.0
1.5.7	Turning tilting holding furnace	1395282.B.0
1.5.8	Filtration furnace	1395283.B.0
1.5.9	Crucible induction furnace	1395284.B.0
2	Gas cleaning drawings (3 sheets)	1409691-TM
	Sheet 1. Equipment and process flowsheet	
	Sheet 2. Plan	
	Sheet 3. Section A-A	
3	Electrical drawing	1388191-ЭC
	Sheet 1. Power supply diagram	
4	Civil engineering drawings (11 sheets)	1500723-AC
4.1	Raw material storage and reductant grinding	
	Sheet 1. Plans at el.0.000; 7.200; 15.000	
	Sheet 2. Section 1-1	
	Sheet 3. Sections 2-2; 3-3; 4-4	
4.2	Charge shop	
	Sheet 4. Plans at el.0.000; 7.800; 18.000	
	Sheet 5. Section 1-1	
	Sheet 6. Sections 2-2 + 4-4	

NN	Name of drawings	NN drg
4.3	Electrometalurgical shop	
	Sheet 7. Plan at el.0.000	
	Sheet 8. Plans at el.6.600; 13.800; 21.000; 27.000; 30.000; 34.200	
	Sheet 9. Section 1-1	
	Sheet 10. Sections 2-2; 3-3	
4.4	Compressor station	
	Sheet 11. Plans at el.0.000; 3.000 Sections 1-1; 2-2; 3-3; 4-4	
5	General layout drawings	
5.1	Location plan scale 1:50000	1408013-ГП
5.2	General layout scale 1:2000	1408014-ГП

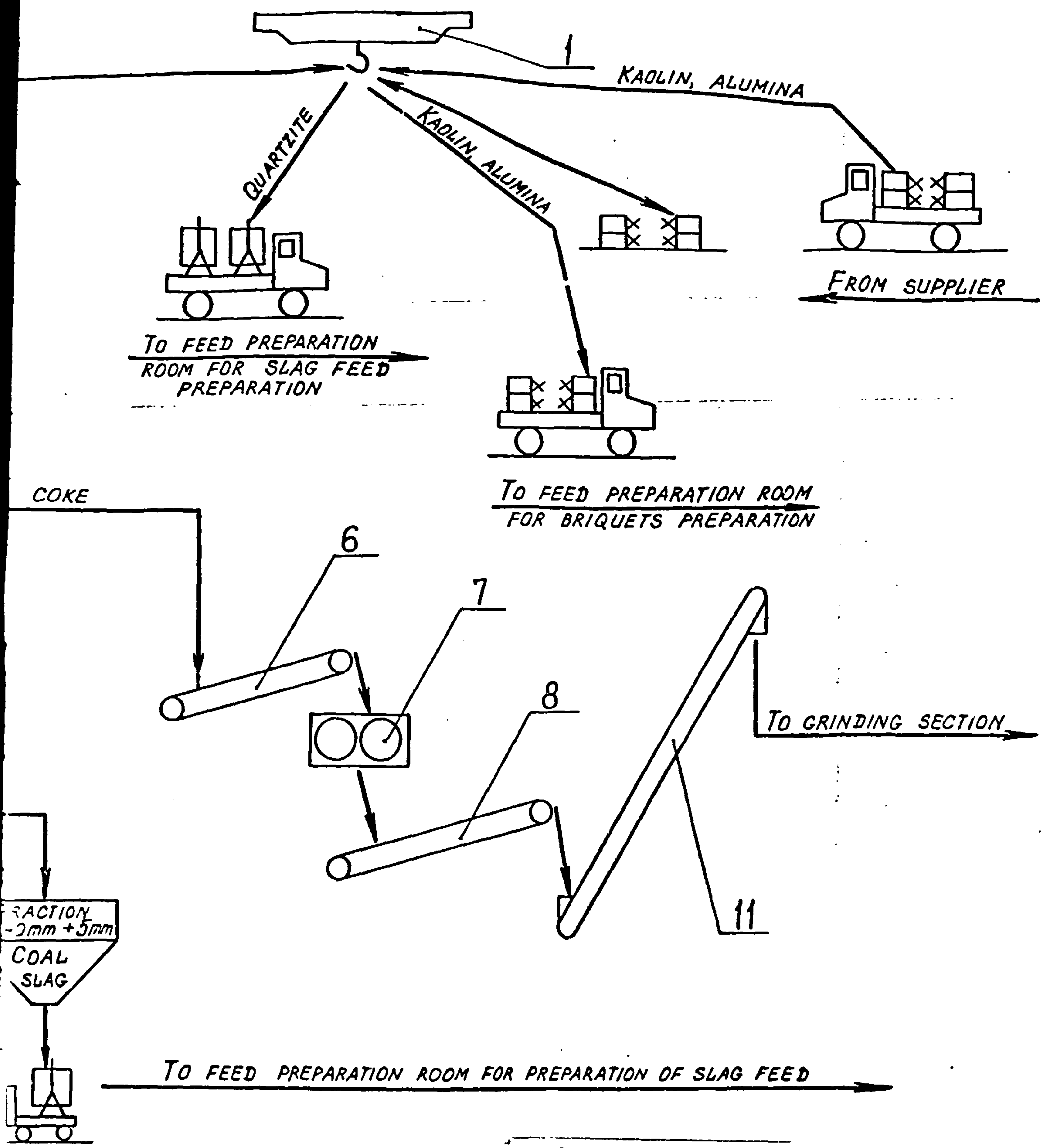


PETROLEUM COKE
QUARTZITE
COAL
SILLIMANITE
FROM SUPPLIERS
PETROLEUM C
COAL, SLAG
SILLIMANITE
TO FEED PREPARA
ROOM FOR PREPA
OF BRIQUETTED
9
SECTION 1
COMPRESSED AIR
SLAG
FROM ELECTRIC FURNACE ROOM
13

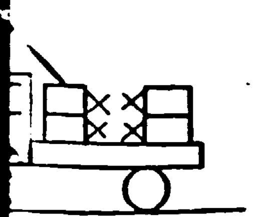


2
QUARTZITE
QUARTZITE
EUM COKE, SLAG
3
4
To FEED PREPARA
ROOM FOR SLAG
PREPARATION
SLAG
COAL, PETROLEUM COKE
5
10
COAL
EPARATION
PREPARATION
TTED FEED
9
FRACTION -5mm
SLAG
FRACTION -40mm +5mm
COAL
SLAG
To FEED PREP
To DUMP
14
12

SECTION 2


1
KAOLIN, ALUMINA
QUARTZITE
KAOLIN, ALUMINA
FROM SUPPLIER
TO FEED PREPARATION ROOM FOR SLAG FEED PREPARATION
TO FEED PREPARATION ROOM FOR BRIQUETS PREPARATION
COKE
6
7
8
11
TO GRINDING SECTION
COAL SLAG
TO FEED PREPARATION ROOM FOR PREPARATION OF SLAG FEED

SECTION 3



M SUPPLIER

ING SECTION

ITEM	DESCRIPTION	SPECIFICATION	QTY	REMARK
1	E.O.T. CRANE	$Q = 5T$; $L = 22{,}5m$ $H = 16m$	1	
2	CLAMSHEL E.O.T. CRANE	$Q = 5T$; $L = 22{,}5m$; $H = 16m$; $V = 2{,}5\,m^3$	1	
3	TROUGH INCLINED BELT CONVEYOR	$B = 650mm$; $L = 8m$	1	
4	JAW CRUSHER	$Q = 12 \ldots 18\ m^3/ч$	1	
5	REVERSIBLE BBLT CONVEYOR	$B = 800mm$; $L = 7m$	1	
6	TROUGH INCLINED BELT CONVEYOR	$B = 650mm$; $L = 21m$	1	
7	ROLLER CRUSHER	$Q = 12 \ldots 20\ m^3/HR$	1	
8	TROUGH INCLINED BELT CONVEYOR	$B = 650mm$; $L = 32m$	1	
9	CHAIN ELEVATOR	$B = 400mm$; $H = 11m$	1	
10	INERTIA GRIZZLY	$F = 3{,}7\,m^2$	1	
11	INCLINED BUCKET ELEVATOR	$H = 22m$	1	
12	BUCKET	$U = 1m^3$	20	
13	SLAG CRUSHER	—	1	
14	ELECTRIC TRUCK	$Q = 2T$	2	

SECTION 4

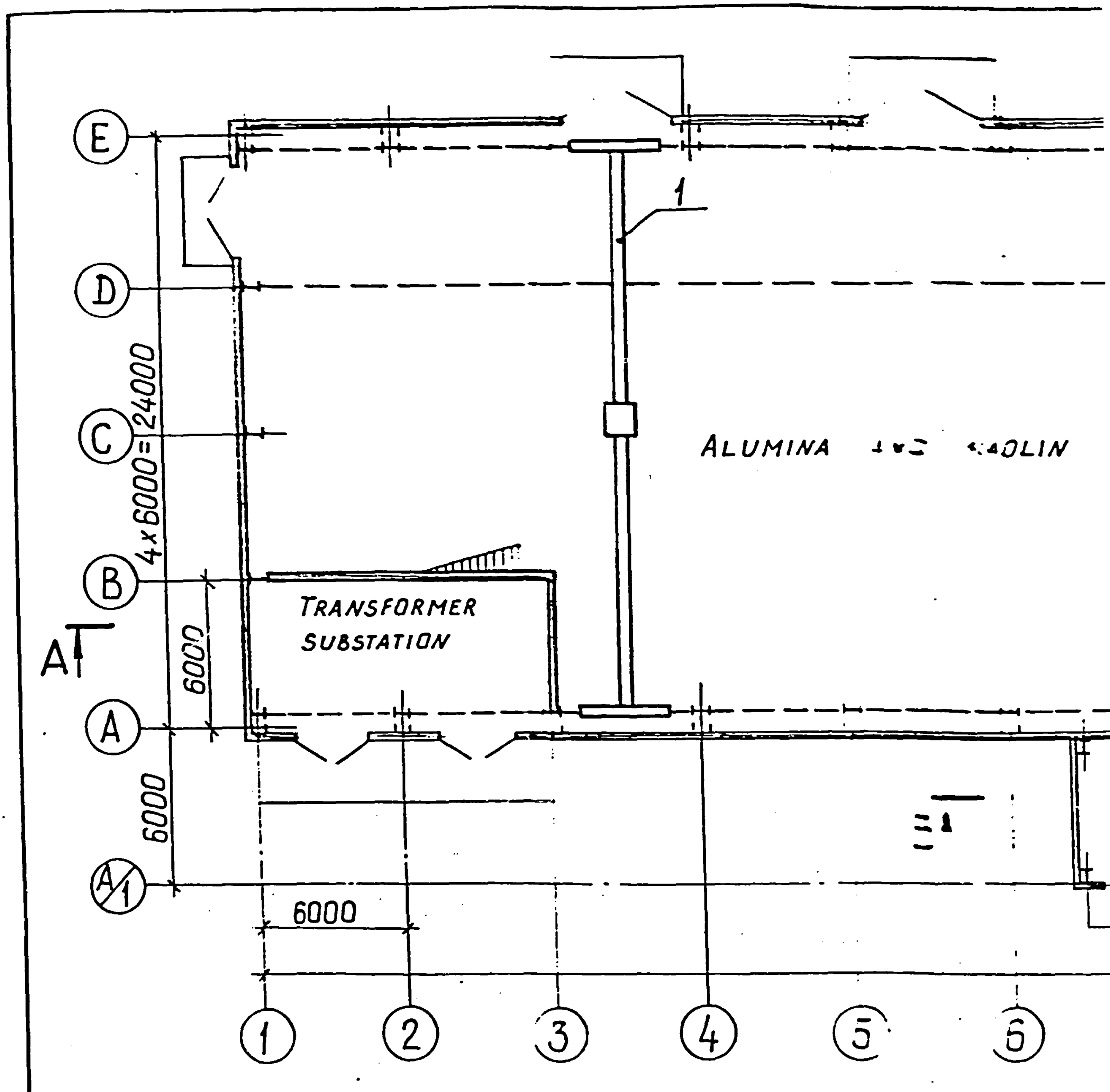
1395273-TM

ANGUL ALUMINIUM SMELTER (INDIA)

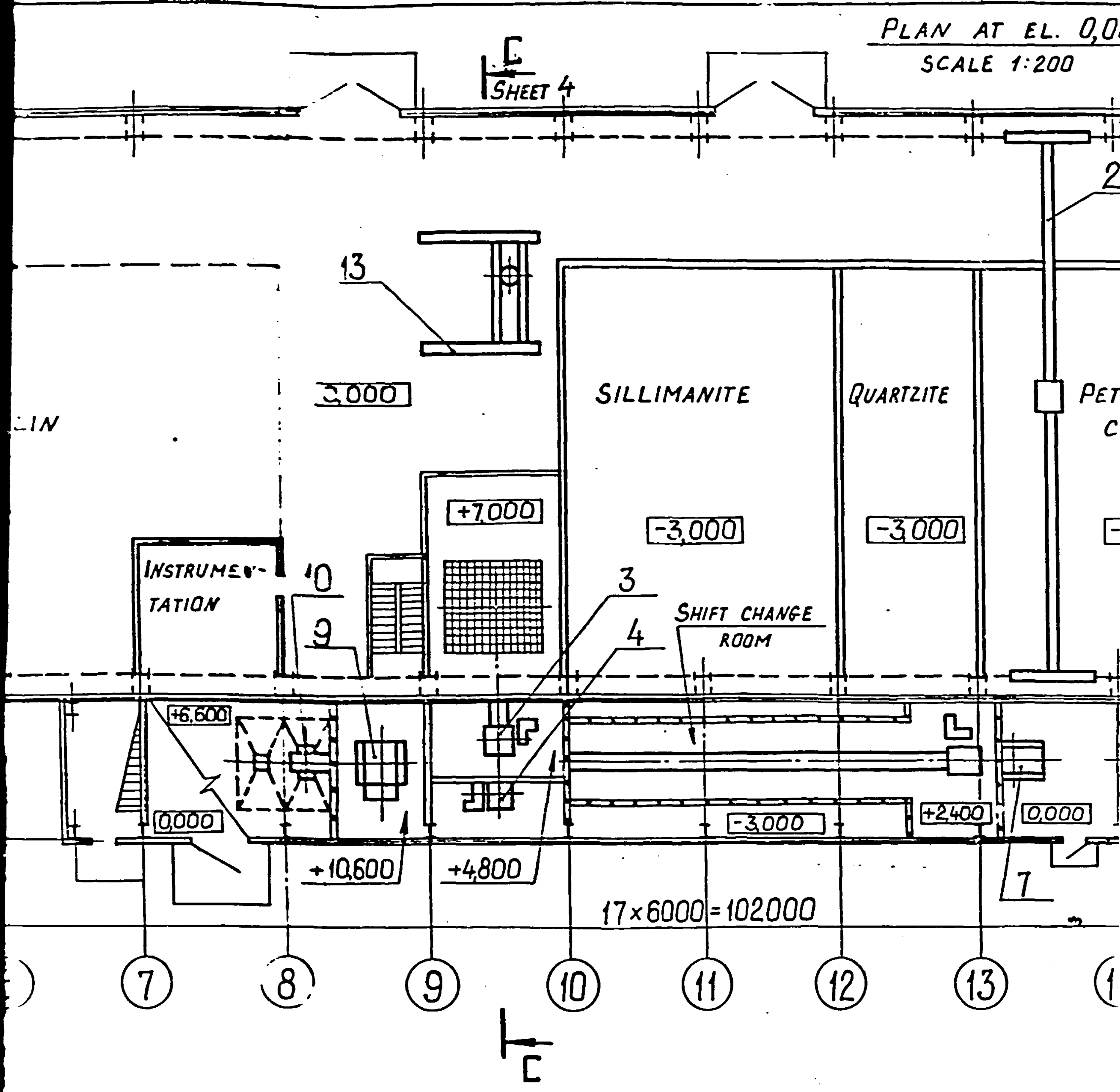
	PHASE	SHEET	SHEETS
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION RAW MATERIALS STORAGE	FS	1	4

EQUIPMENT ARRANGEMENT AND PROCESS FLOWSHEET

VAMI
LENINGRAD


E
D
C
B
A
A/1
4x6000=24000
6000
6000
6000
1
TRANSFORMER SUBSTATION
ALUMINA
A
1
2
3
4
5
6

SECTION 1



SECTION 2

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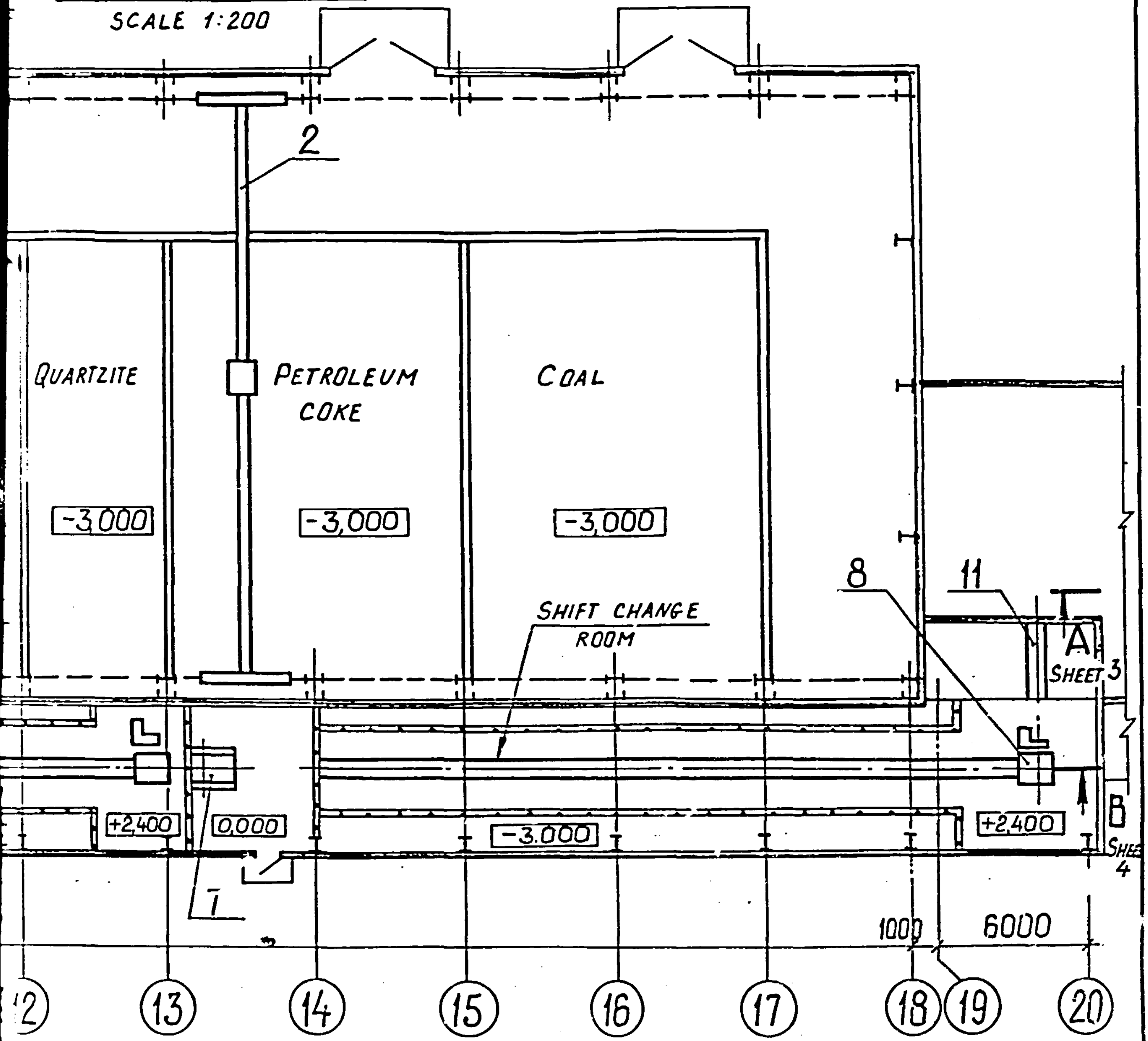
RED T
OR PE
MENT

PLAN AT EL. 0,000

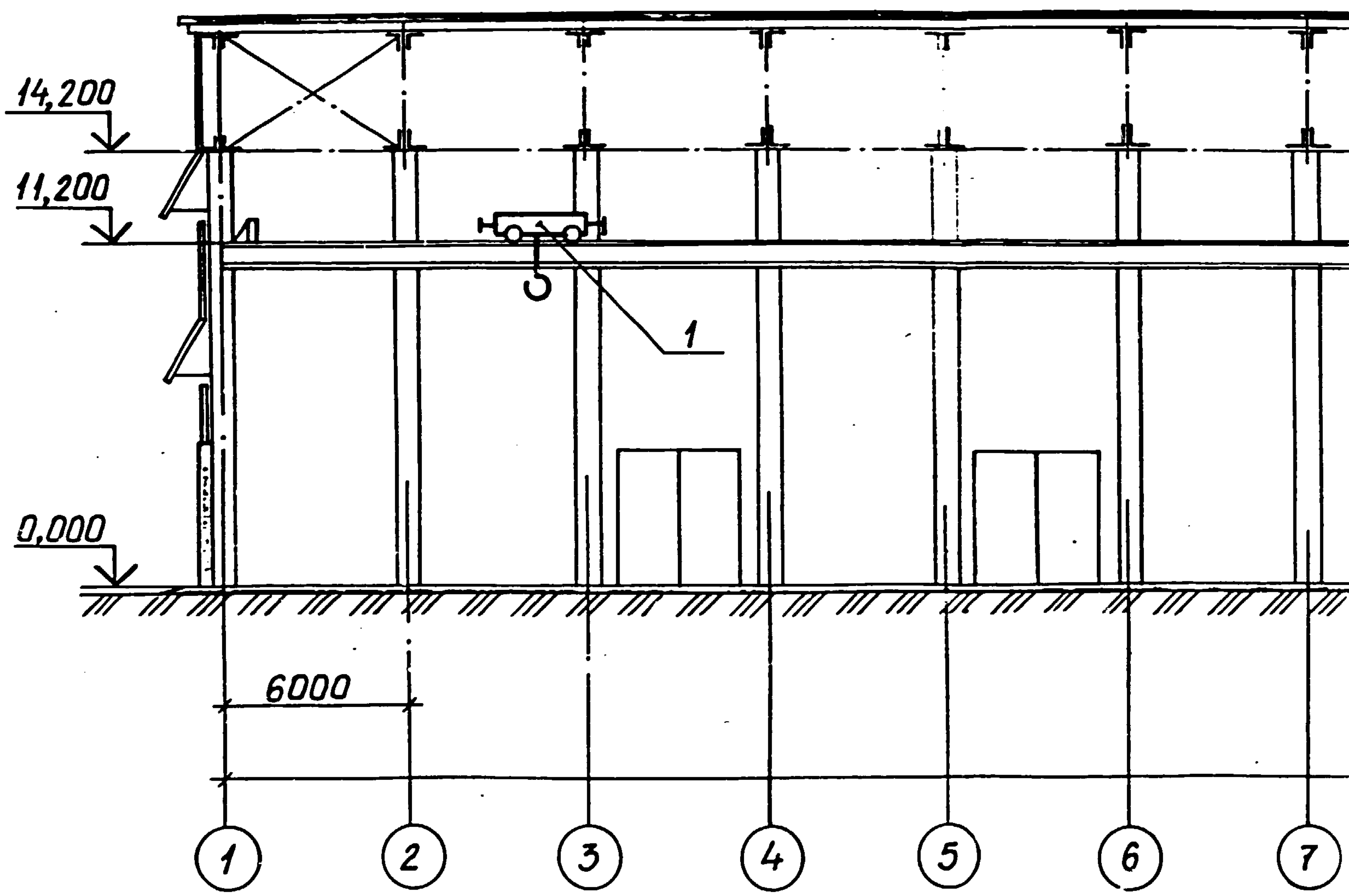
SCALE 1:200



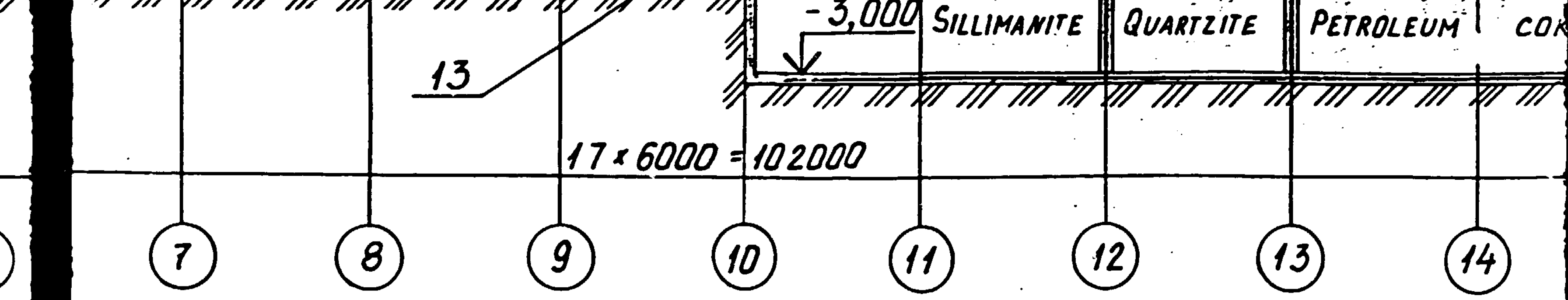
SECTION 3

THIS DRAWING IS NOT TO BE REPRODUCED OR TRANSFERRED TO OTHER ORGANIZATIONS OR PERSONS WITHOUT AGREEMENT WITH VAMI	13...73-TM		
	ANGUL ALUMIN... SMELTER (INDIA)		
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION RAW MATERIALS STORAGE-	PHASE: FS	SHEET: 2 / SHEETS:
	PLAN AT EL. 0,000	VAMI LENINGRAD	

SIZE A4×3



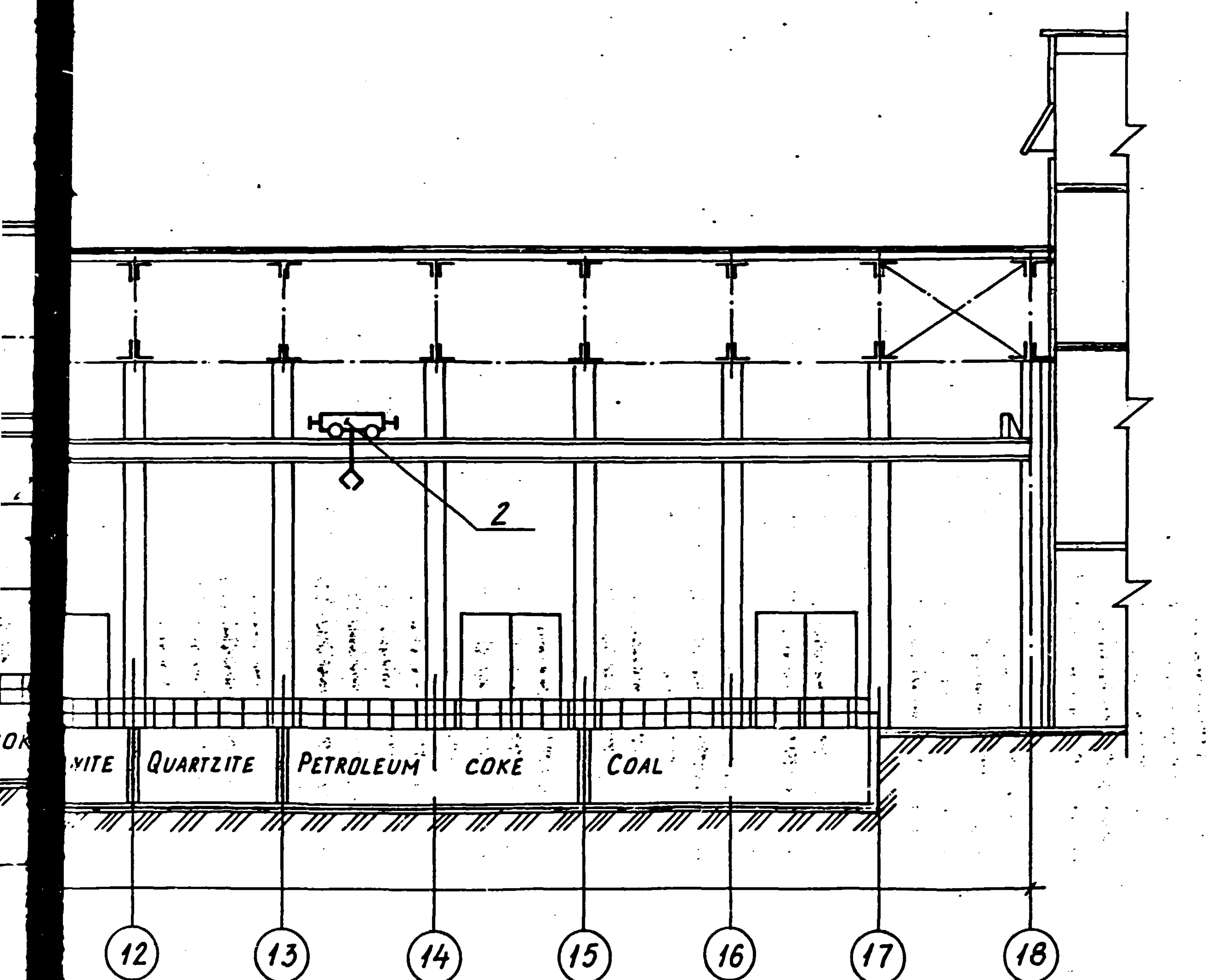
SECTION 1



SECTION 2

THIS DRAWING IS
REPRODUCED OR T
RED TO OTHER OR
OR PERSONS WITH
MENT WITH V.

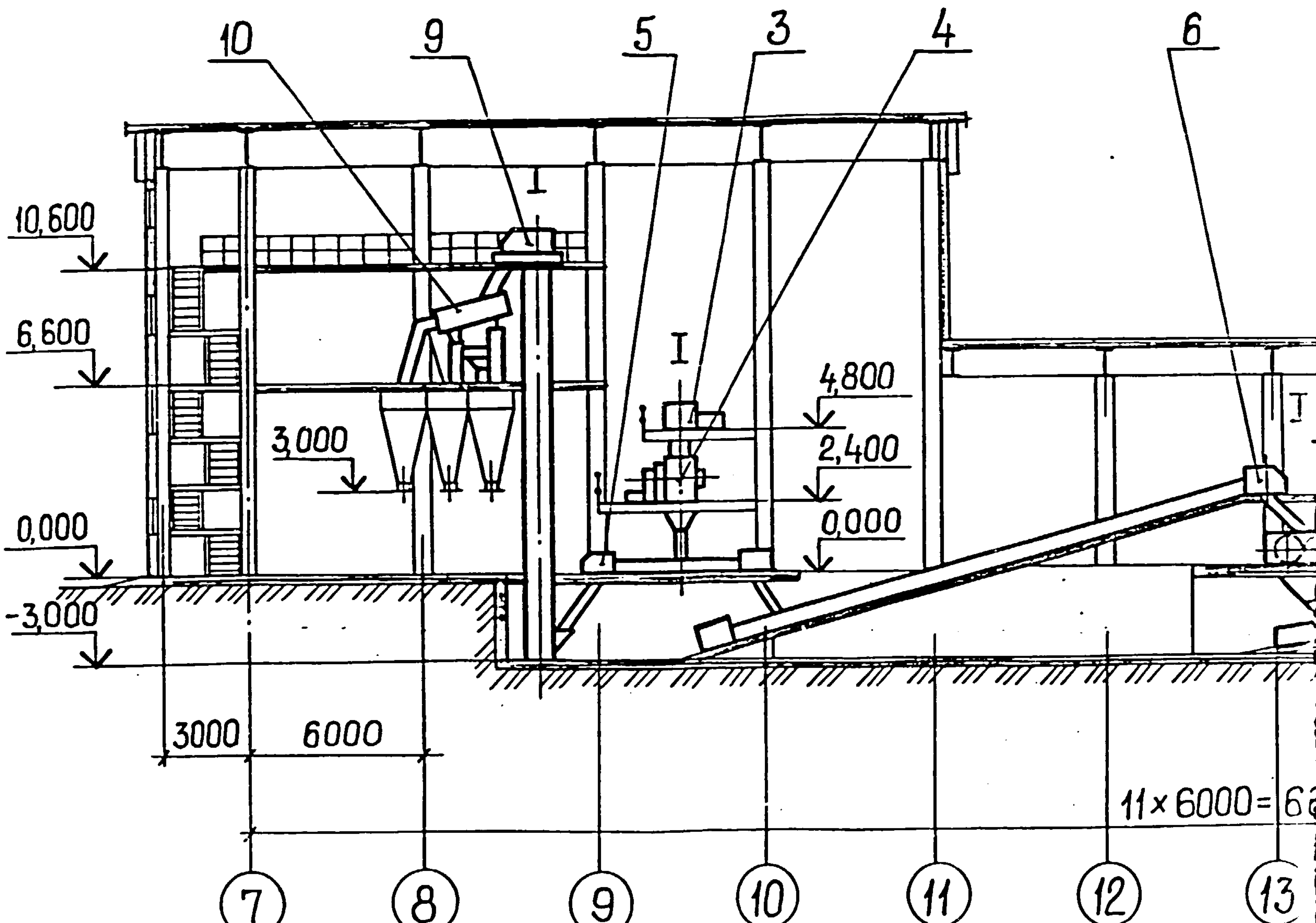
A – A SHEET 2
SCALE 1:200



SECTION 3

THIS DRAWING IS NOT TO BE REPRODUCED OR TRANSFERRED TO OTHER ORGANIZATIONS OR PERSONS WITHOUT AGREEMENT WITH VAMI

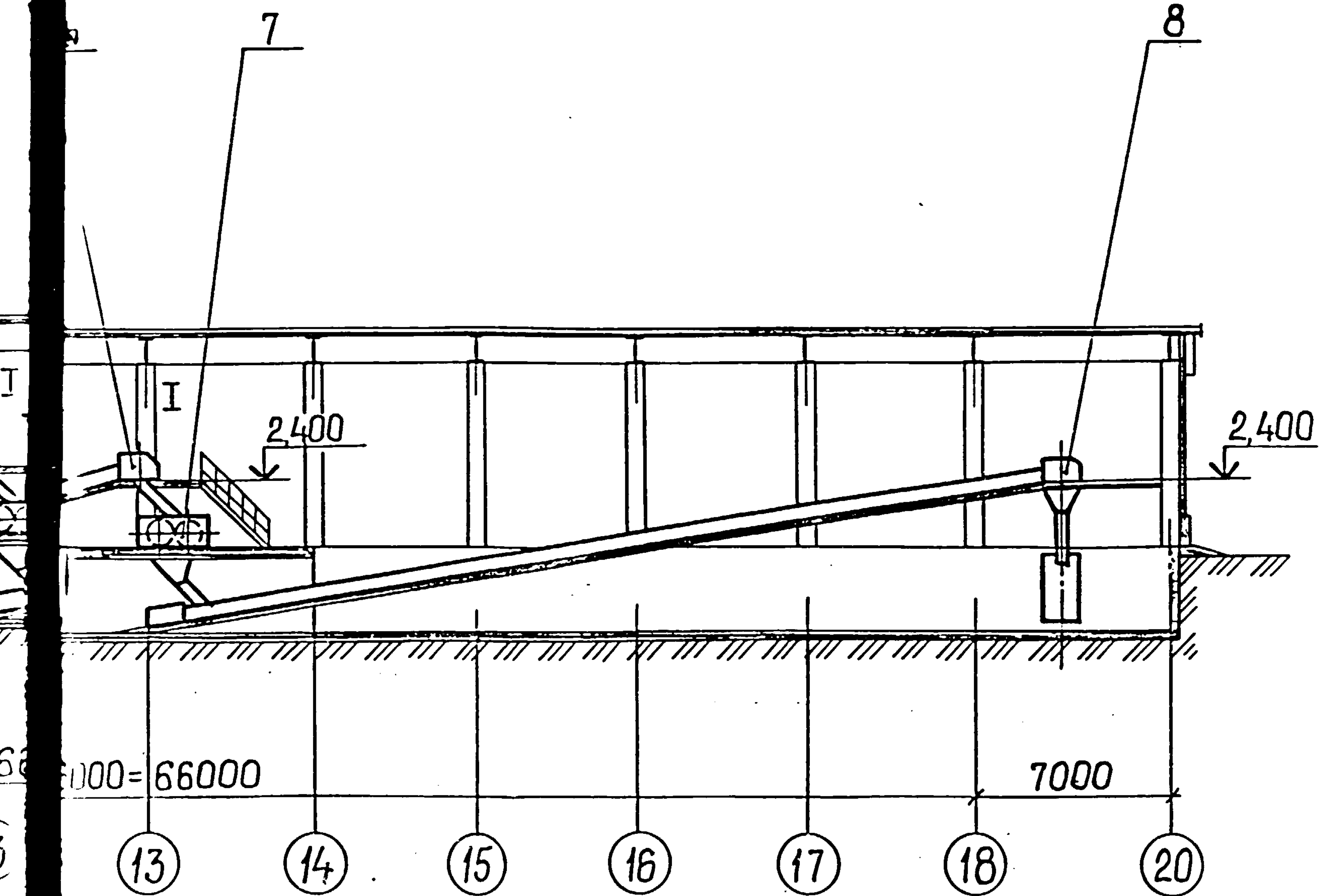
1395273-TM			
ANGUL ALUMINIUM SMELTER (INDIA)			
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION RAW MATERIALS STORAGE	PHASE	SHEET	SHEET
	FS	3	
SECTION A-A	VAMI LENINGRAD		


10
9
5
3
4
6
10,600
6,600
3,000
0,000
-3,000
4,800
2,400
0,000
I
3000
6000
11×6000=
7
8
9
10
11
12
13

SECTION 1

B - B SHEET 2

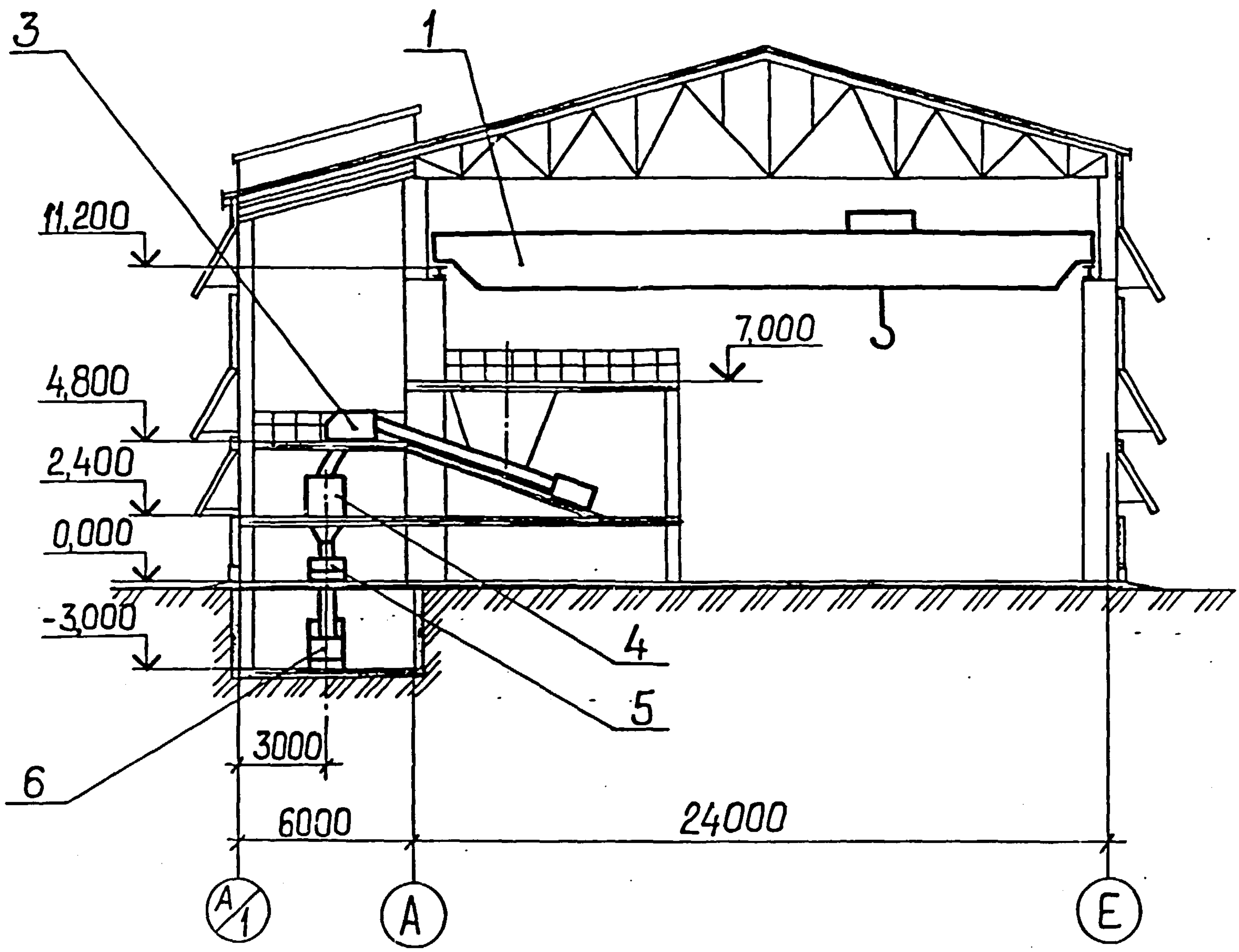
SCALE 1:200



SECTION 2

C-C SHEET 2

SCALE 1:200



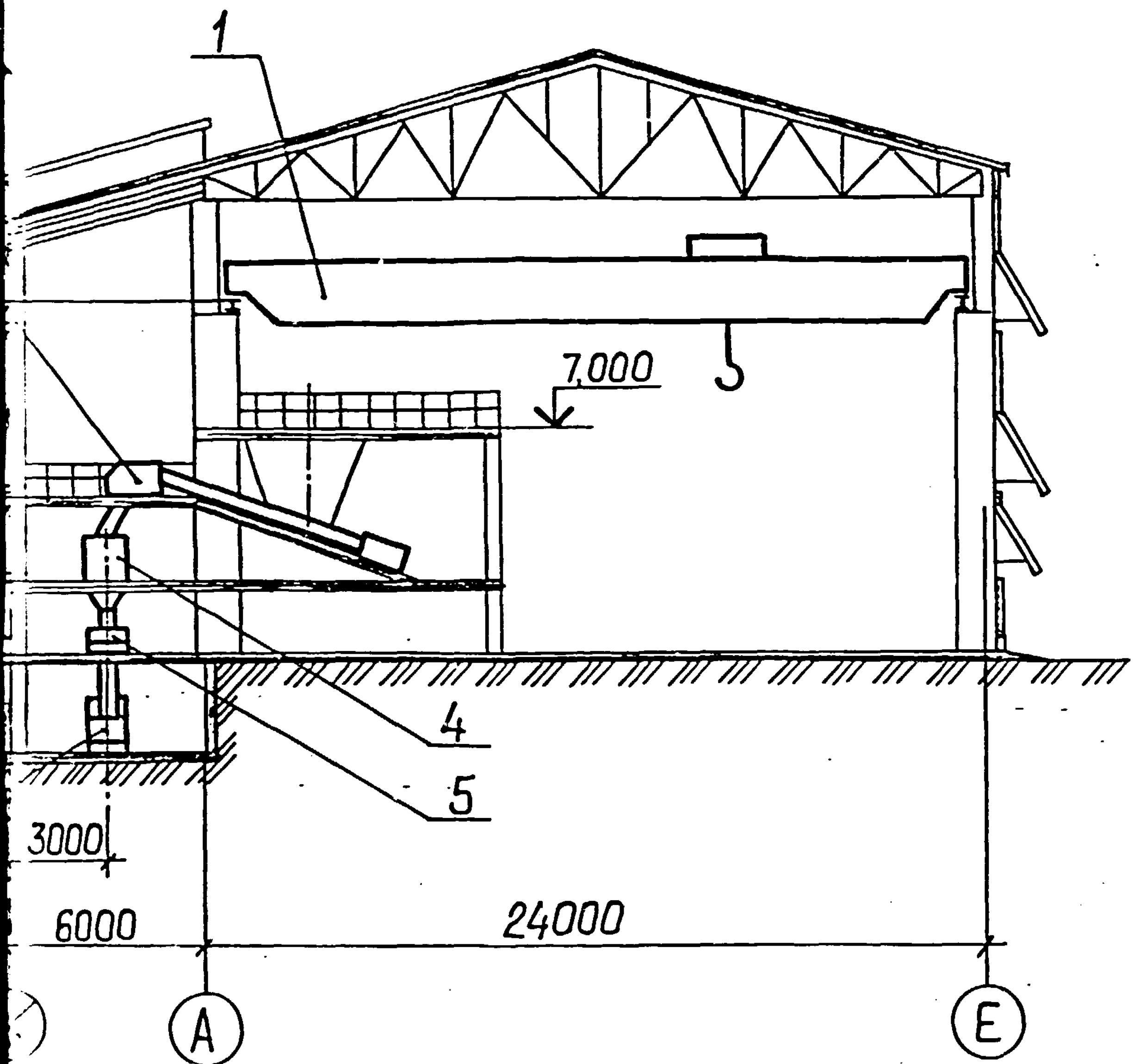
SECTION 3

THIS DRAWING IS NOT TO BE REPRODUCED OR TRANSFERRED TO OTHER ORGANIZATIONS OR PERSONS WITHOUT AGREEMENT WITH VAMI

13952	
ANGUL ALUMINIUM SMEL	
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION RAW MATERIALS STORAGE	PH
	F
SECTIONS	

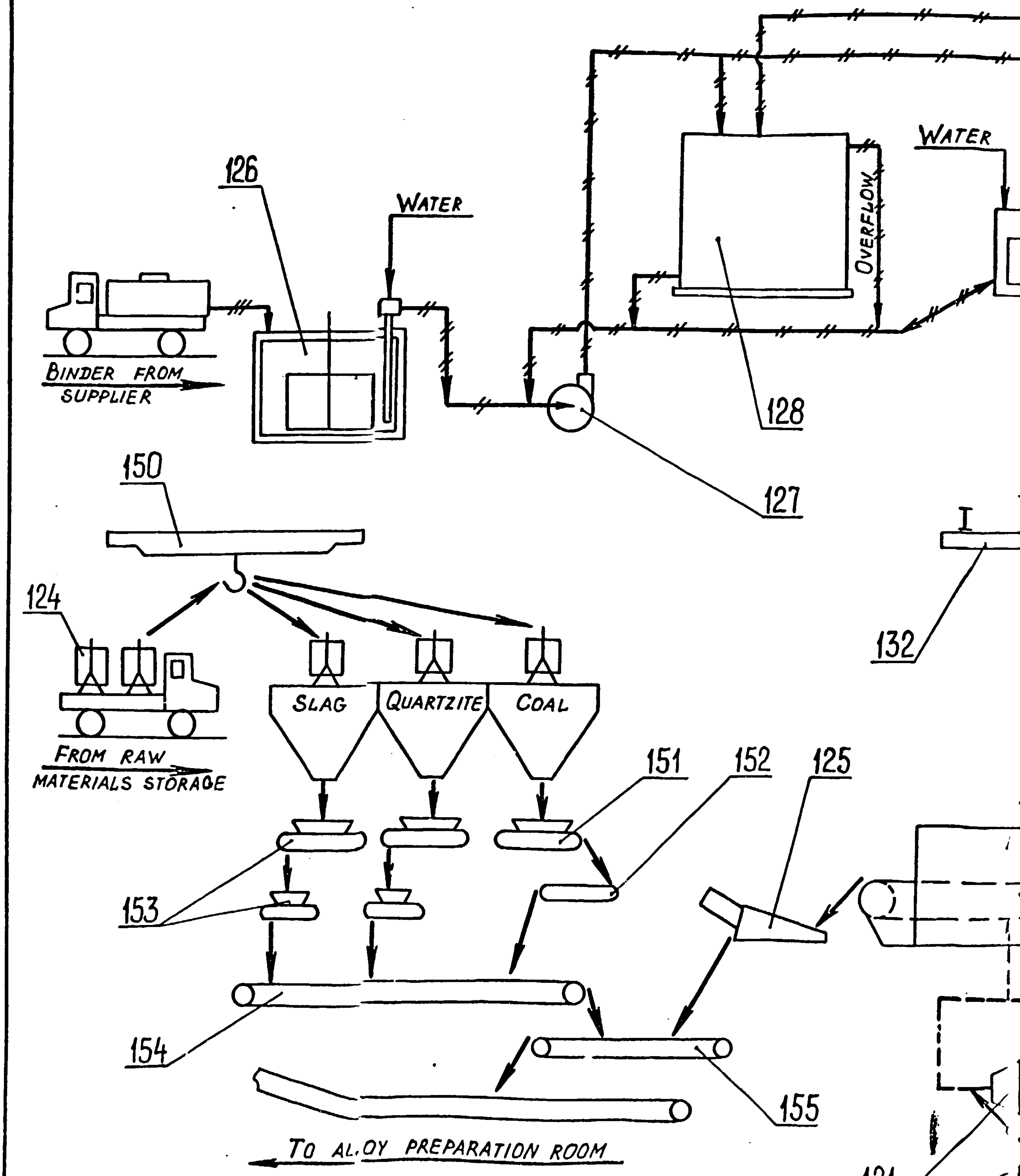
C - C Sheet 2

SCALE 1:200



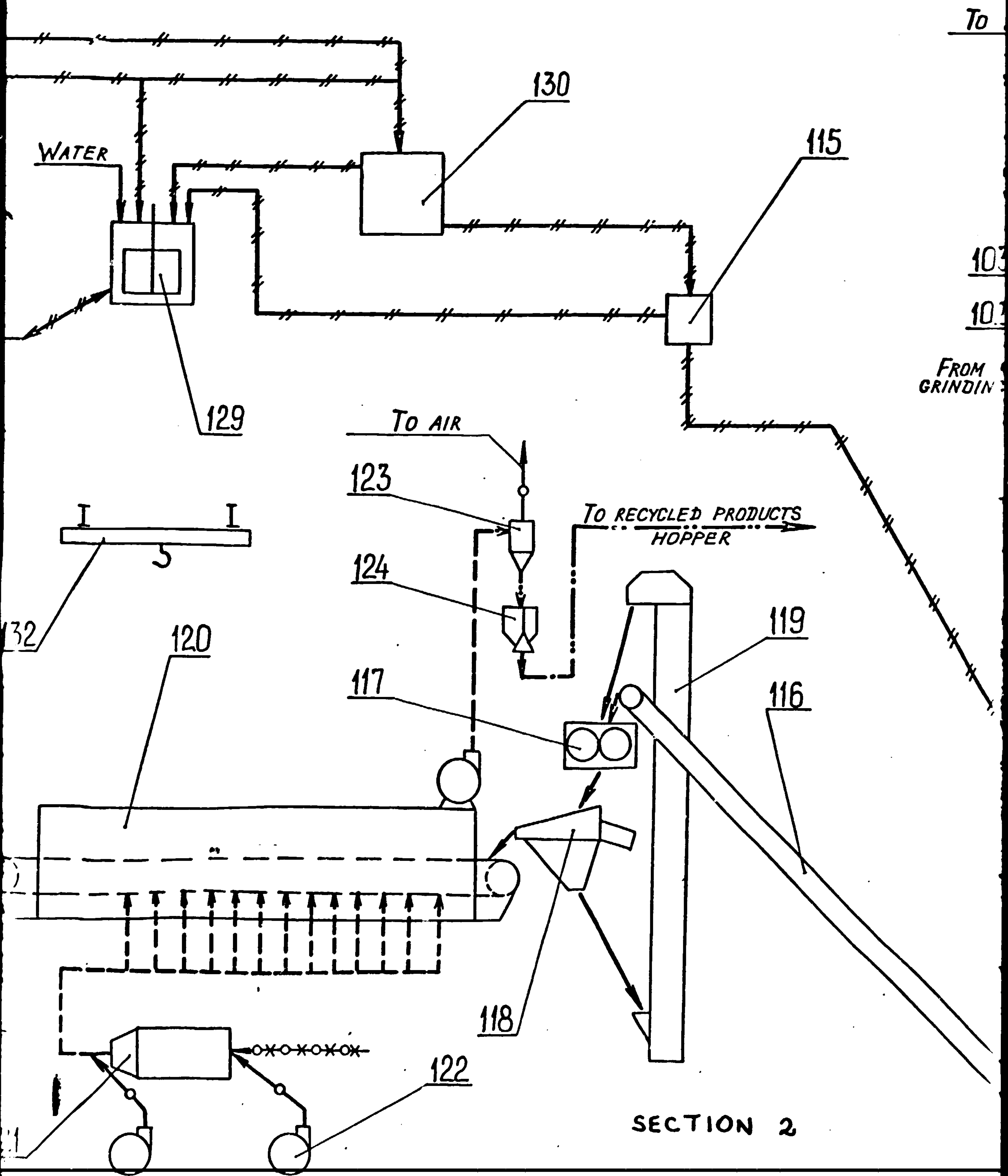
SECTION 4

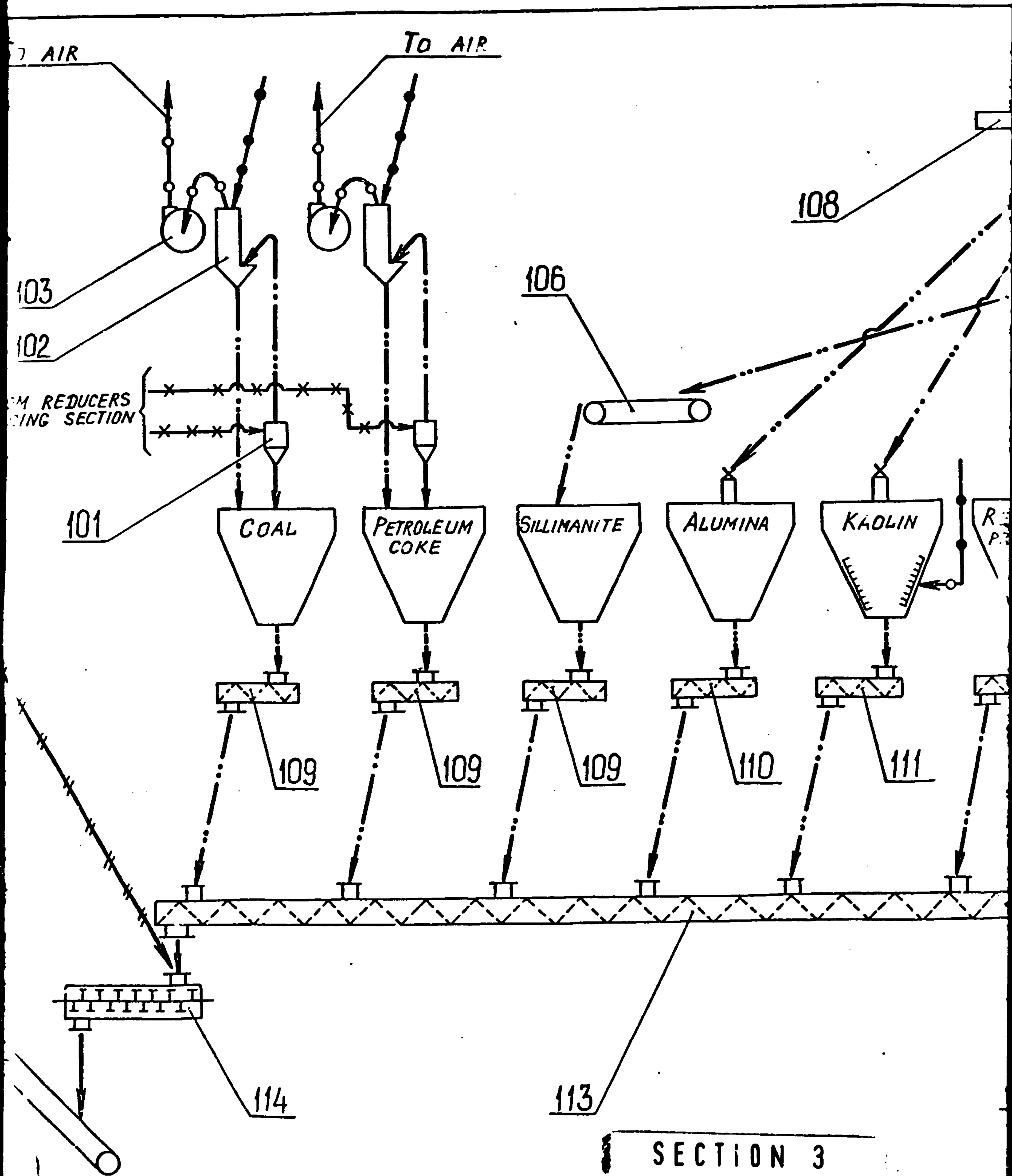
THIS DRAWING IS NOT TO BE REPRODUCED OR TRANSFERRED TO OTHER ORGANIZATIONS OR PERSONS WITHOUT AGREEMENT WITH VAMI	1395273-TM			
	ANGUL ALUMINIUM SMELTER (INDIA)			
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION RAW MATERIALS STORAGE	PHASE	SHEET	SHEETS
		FS	4	
	SECTIONS	VAMI LENINGRAD		



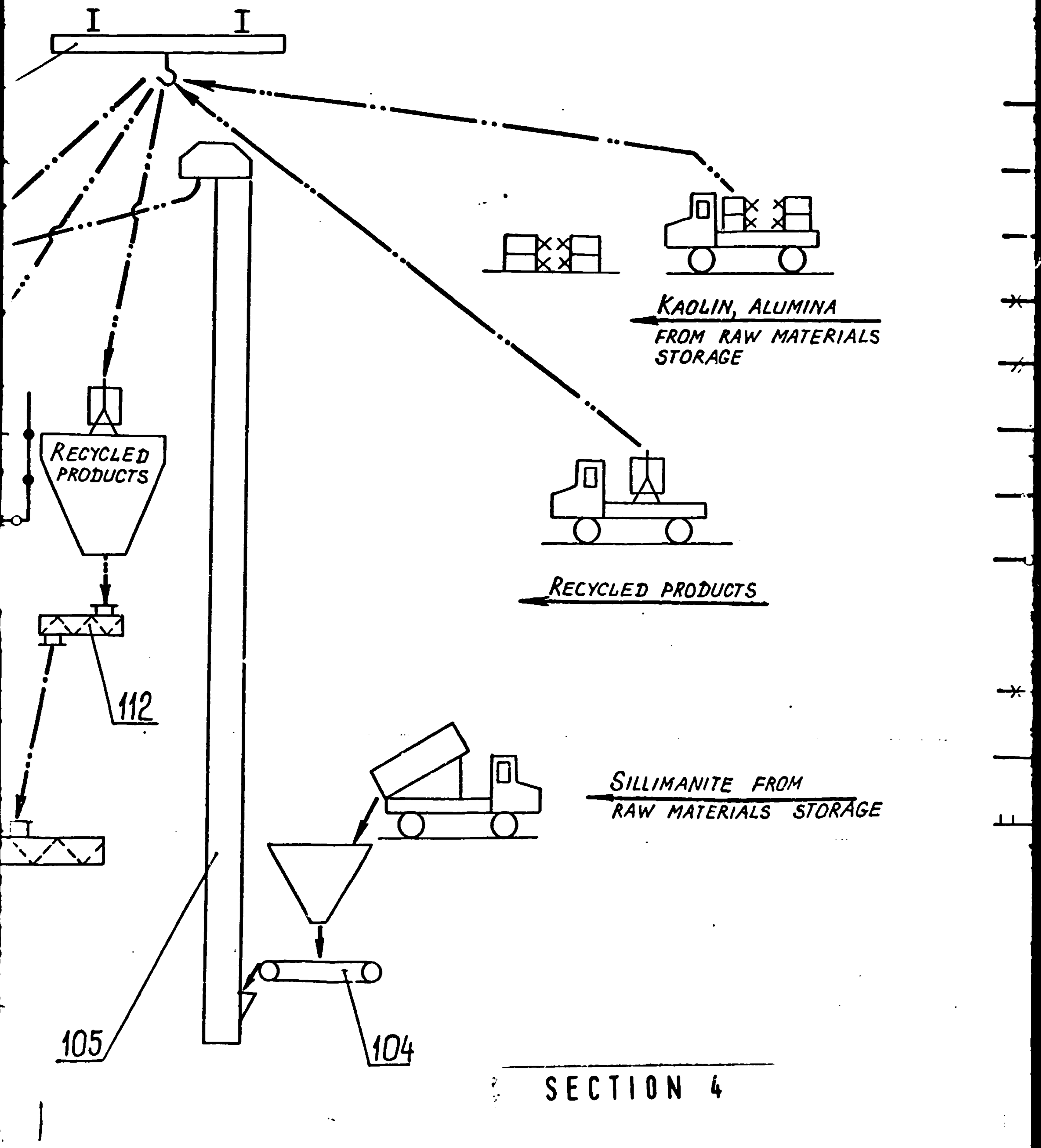
126
WATER
BINDER FROM SUPPLIER
128
OVERFLOW
WATER
127
150
124
132
SLAG
QUARTZITE
COAL
FROM RAW MATERIALS STORAGE
151
152
125
153
154
155
TO ALLOY PREPARATION ROOM
121

SECTION 1


To
130
115
WATER
129
103
10
FROM
GRINDIN
To AIR
123
To RECYCLED PRODUCTS
HOPPER
124
132
120
119
117
116
118
122
SECTION 2


TO AIR
TO AIR
103
102
101
108
106
REDUCERS
SECTION
COAL
PETROLEUM COKE
SILLIMANITE
ALUMINA
KAOLIN
109
109
109
110
111
113
114

SECTION 3


KAOLIN, ALUMINA
FROM RAW MATERIALS STORAGE
RECYCLED PRODUCTS
RECYCLED PRODUCTS
112
SILLIMANITE FROM RAW MATERIALS STORAGE
105
104

SECTION 4

LEGEND

SOLID PRODUCTS

GASEOUS PRODUCTS

DUST MATERIALS

PNEUMATIC TRANSPORT

SELEX SOLUTION

SELEX

COMPRESSED AIR

AIR

FUEL OIL

WATER

AERATION SYSTEM

ITEM	DESCRIPTI
118	ELECTRIC VIB FEEDER
119	BELT ELEV
120	CONVEYOR D
121	FURNACE
122	FAN
123	CYCLONE
124	BUCKET
125	ELECTRIC VIB FEEDER
126	SUMP WITH
127	CENTRIFUGAL
128	TANK
129	AGITATOR
130	TANK
131	PASSENGER E
132	ELECTRIC MO HOIST
150	E.O.T. CRANE
151	SINGLE-UNIT
152	BELT FEEDE
153	DOUBLE-UNIT V
154	BELT CONVE
155	BELT CONVEY

SECTION 5

ITEM	DESCRIPTION	SPECIFICATION	QTY	REMARK
118	ELECTRIC VIBRATION FEEDER	$Q=25\ m/HR$	1	
119	BELT ELEVATOR	$B=250mm$; $H=10{,}6\ m$	1	
120	CONVEYOR DRYER	$Q=5...6\ T/HR$	1	
121	FURNACE	$Q=1{,}0...1{,}5$ ГКАЛ/HR	1	
122	FAN	$Q=4000\ m^3/ч$; $H=0{,}15m$	2	
123	CYCLONE	Ф700	1	
124	BUCKET	$U=1\ m^3$	15	
125	ELECTRIC VIBRATION FEEDER	$Q=25\ m^3/HR$	1	
126	SUMP WITH AGITATOR	Ф4500; $H=3000$	1	
127	CENTRIFUGAL PUMP	$Q=30...50\ m^3/HR$	2	
128	TANK	Ф7500; $H=6000$	1	
129	AGITATOR	Ф2000; $H=1900$	1	
130	TANK	Ф2000; $H=2000$	1	
131	PASSENGER ELEVATOR	$Q=0{,}32\ T/HR$; $H=18m$	1	
132	ELECTRIC MONORAIL HOIST	$Q=2\ T$; $L=10{,}8m$; $H=12m$	1	
150	E.O.T. CRANE	$Q=3{,}2\ T$; $L=10{,}2m$; $H=12m$	1	
151	SINGLE-UNIT WEIGHER	$Q=2\ T/HR$	1	
152	BELT FEEDER	$Q=2\ T/HR$	1	
153	DOUBLE-UNIT WEIGHER	$Q=2\ T/HR$	2	
154	BELT CONVEYOR	$B=650mm$; $L=21m$	1	
155	BELT CONVEYOR	$B=650mm$; $L=20m$	1	

SECTION 6

108	ELECTRIC HOIST
109	EXPLOSION WEIGHER
110	WEIGHER
111	WEIGHER
112	WEIGHER
113	SCREW CL
114	MIXER
115	PROPORTIO
116	BELT CONVEYOR
117	ROLLER

15m	2	
	1	
	15	
	1	
00	1	
	2	
00	1	
	1	
0	1	
	1	
=12m	1	
=12m	1	
	1	
	1	
	2	
m	1	
m	1	

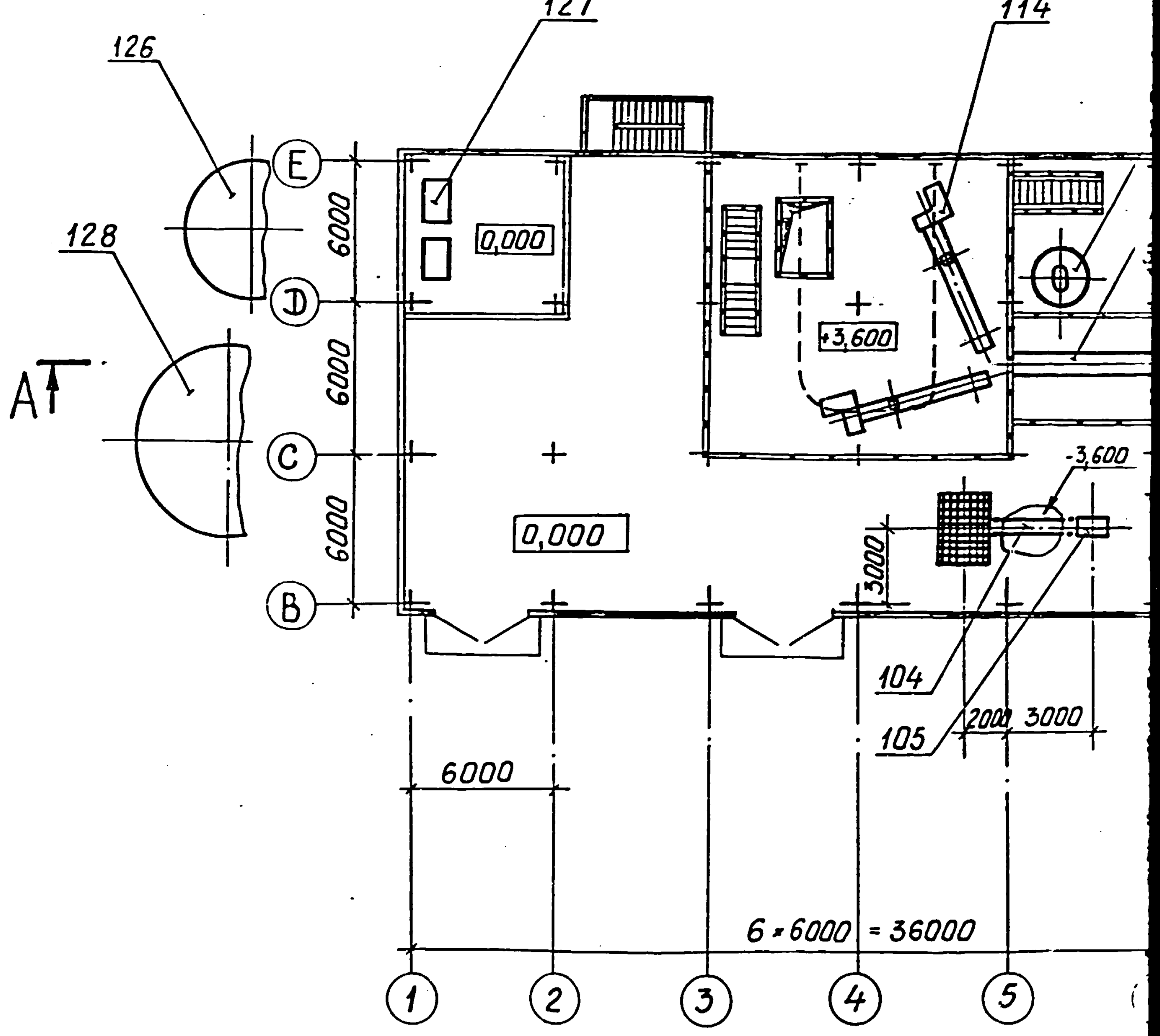
ITEM	DESCRIPTION	SPECIFICATION	QTY	REMARK
101	SETTLER	Φ1200	4	
102	EXPLOSION-PROOF BAG-FILTER	$F = 60 m^2$	2	
103	EXPLOSION-PROOF FAN	$Q = 4000 m^3/HR; H = 0{,}15 m$	2	
104	BELT FEEDER	B=400 mm; L=2m	1	
105	BELT BUCKET ELEVATOR	B=250 mm; H=22 m	1	
106	BELT CONVEYOR	B=650mm; L=15m	1	
107	BELT TILTER		1	
108	ELECTRIC MONORAIL HOIST	Q=2T; L=17,4m; H=24m	1	
109	EXPLOSION-PROOF WEIGHER	$Q = 0{,}61 \ldots 3{,}65\ m^3/HR$	6	
110	WEIGHER	$Q = 0{,}61 \ldots 3{,}65\ m^3/HR$	2	
111	WEIGHER	$Q = 2{,}4 \ldots 14{,}3\ m^3/HR$	2	
112	WEIGHER	$Q = 0{,}13 \ldots 0{,}76\ m^3/HR$	2	
113	SCREW CONVEYOR	B=400mm; L=34m	2	
114	MIXER	Q = 6 T/HR	2	
115	PROPORTIONER	$V = 1 m^3$	2	
116	BELT CONVEYOR	B=650mm; L=38m	1	
117	ROLLER PRESS	Q=6 T/HR	1	

SECTION 7

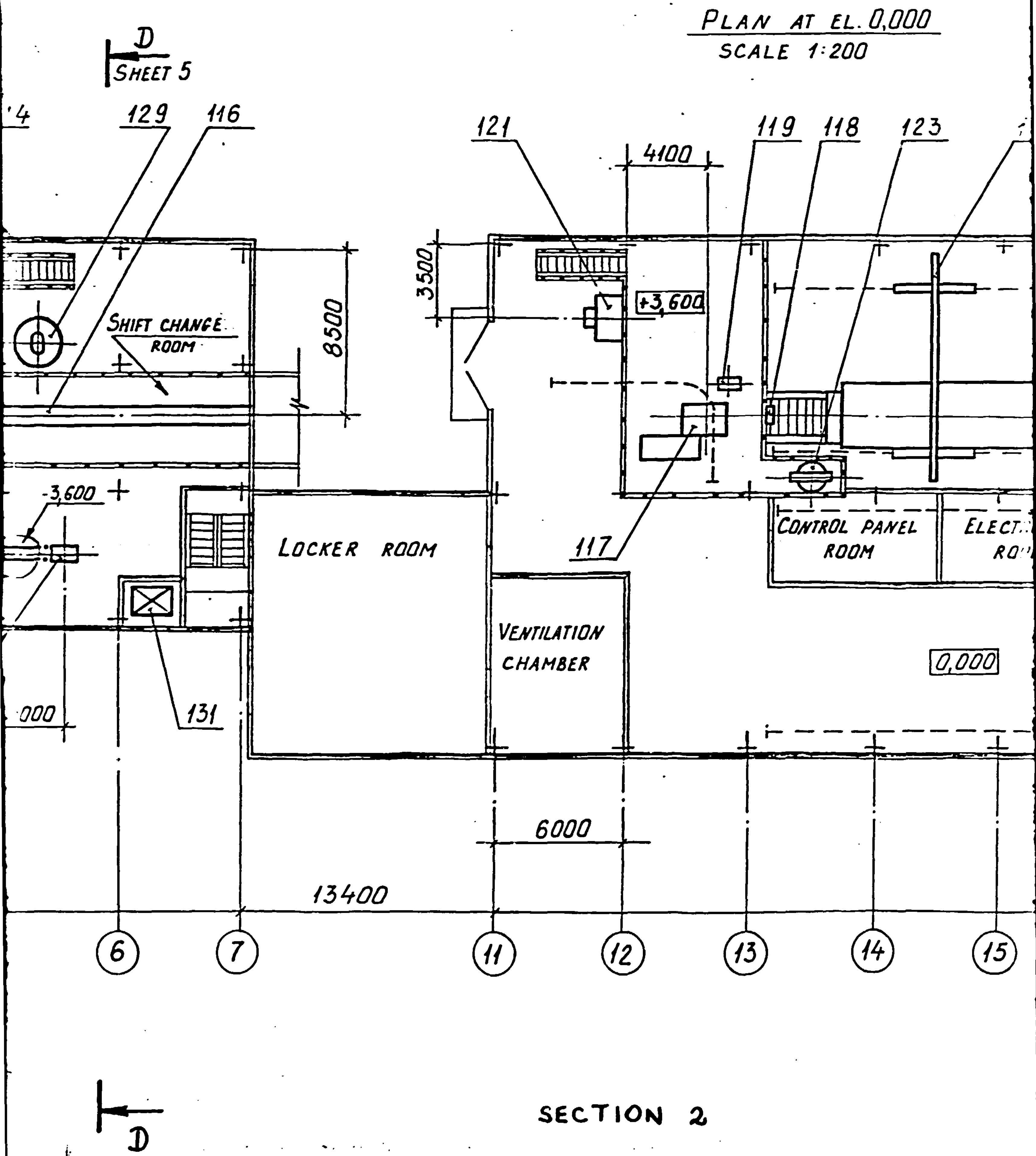
1395274-TM

ANGUL ALUMINIUM SMELTER (INDIA)

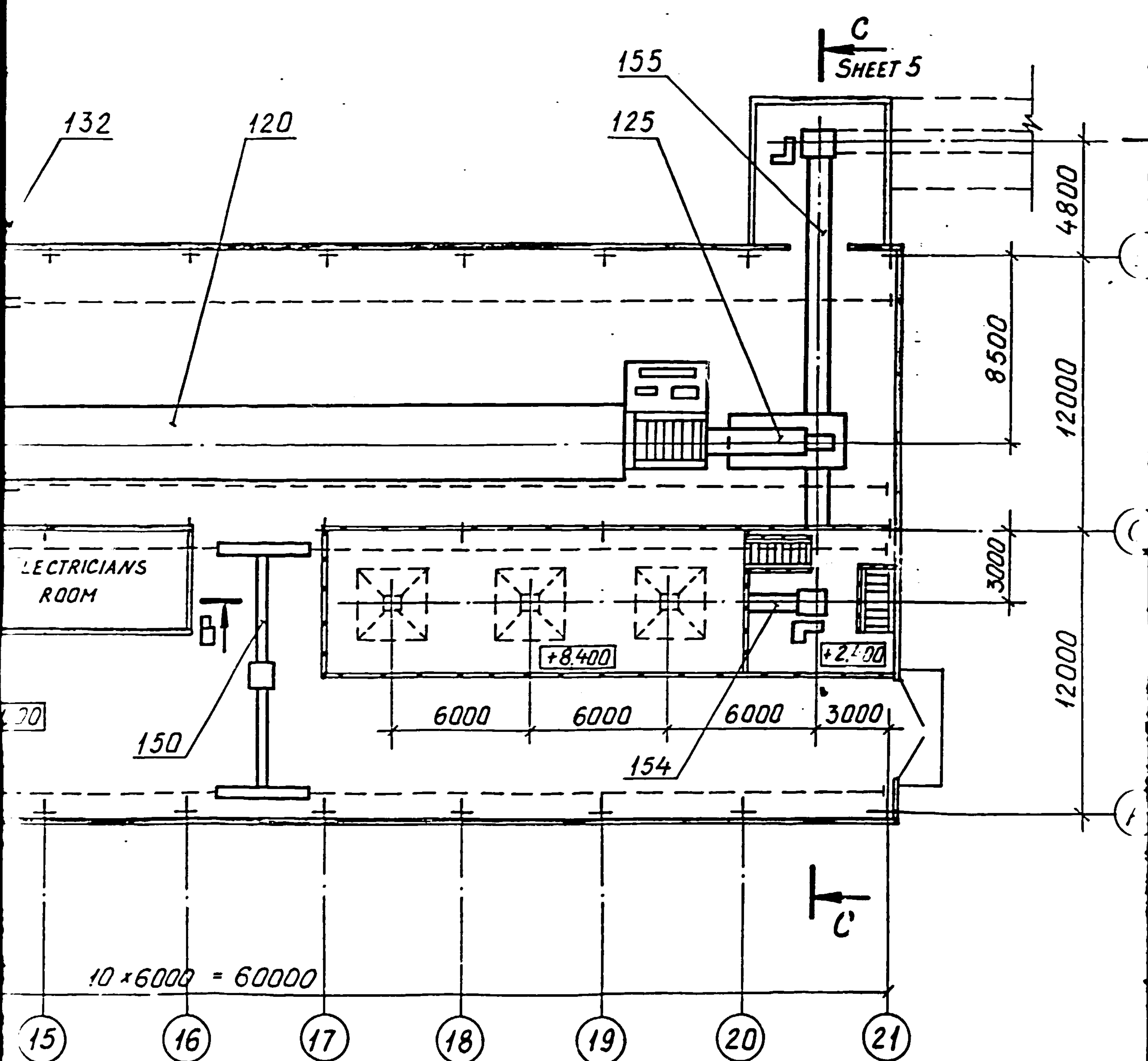
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION FEED PREPARATION ROOM	PHASE	SHEET	SHEETS
	FS	1	5
EQUIPMENT ARRANGEMENT AND PROCESS FLOWSHEET	VAMI LENINGRAD		


127
126
114
128
E
D
C
B
A
6000
6000
6000
0,000
+3,600
0,000
-3,600
3000
104
105
2000
3000
6000
6 × 6000 = 36000
1
2
3
4
5

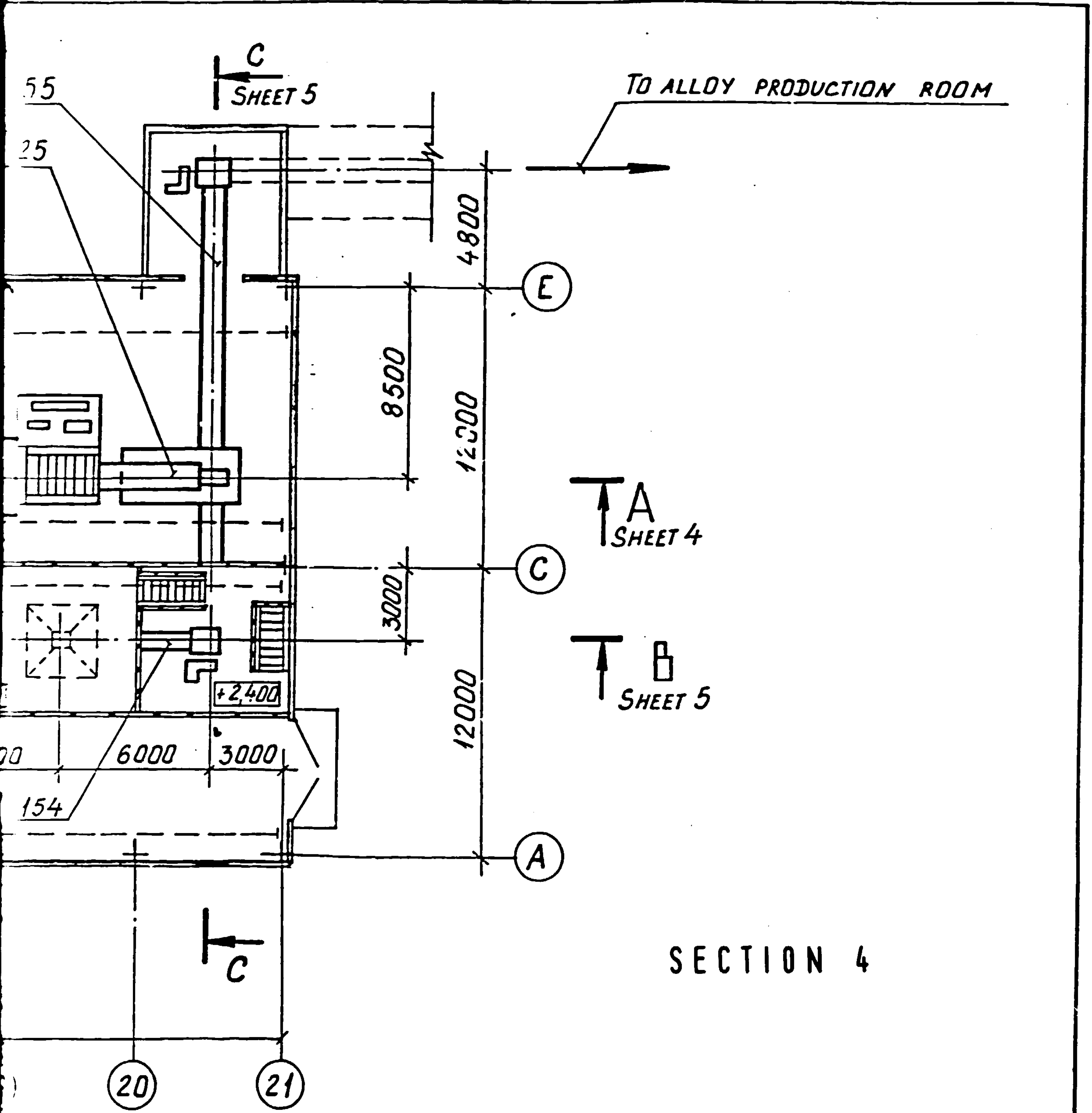
SECTION 1


PLAN AT EL. 0,000
SCALE 1:200
D
SHEET 5
129
116
121
119
118
123
4100
3500
8500
+3,600
SHIFT CHANGE ROOM
-3,600
LOCKER ROOM
117
CONTROL PANEL ROOM
VENTILATION CHAMBER
0,000
131
6000
13400
6
7
11
12
13
14
15
D

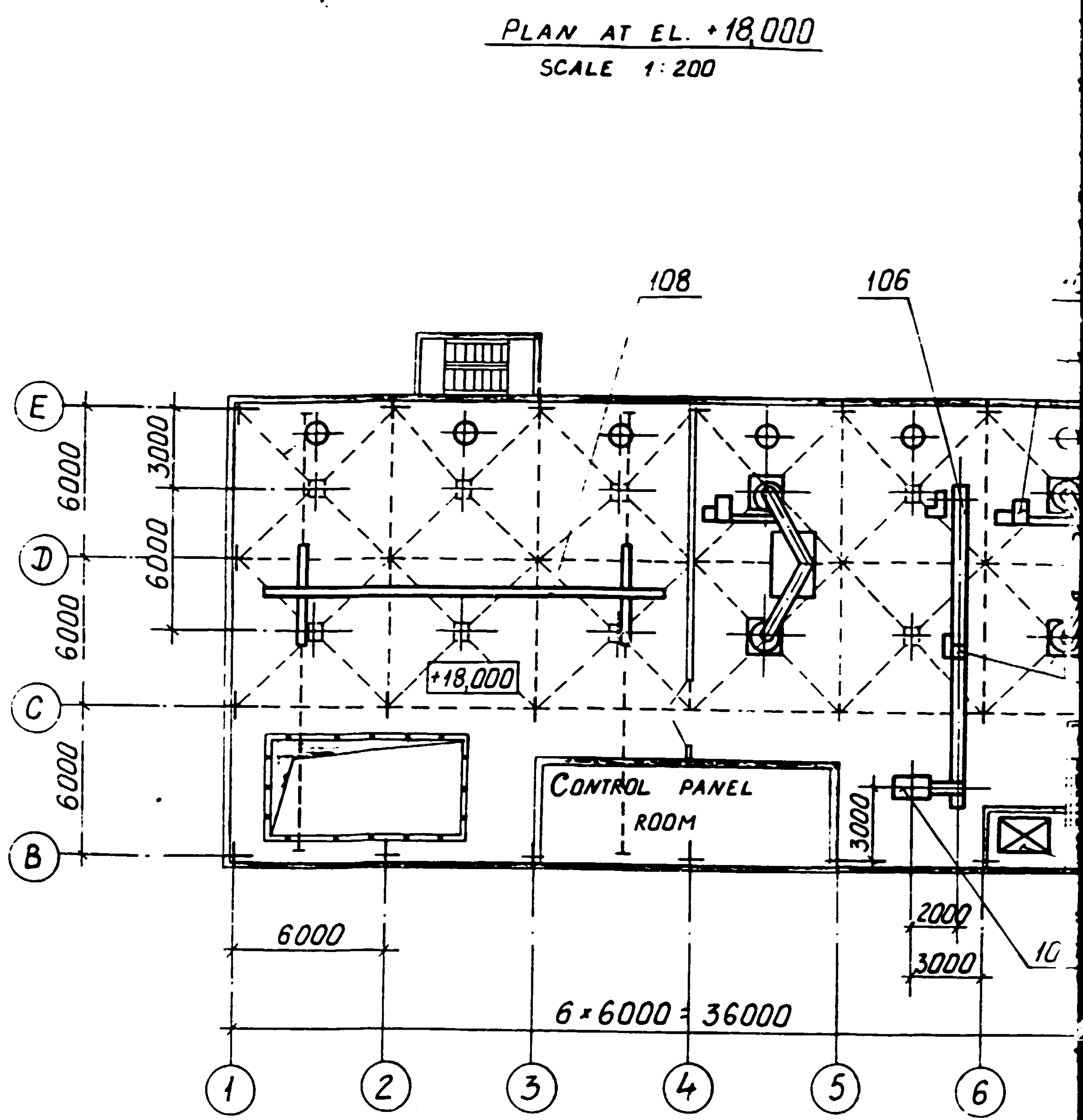
SECTION 2


C
SHEET 5
155
132
120
125
4800
8500
12000
3000
12000
ECTRICIANS
ROOM
B
+8.400
+2.400
6000
6000
6000
3000
150
154
C
10 × 6000 = 60000
15
16
17
18
19
20
21

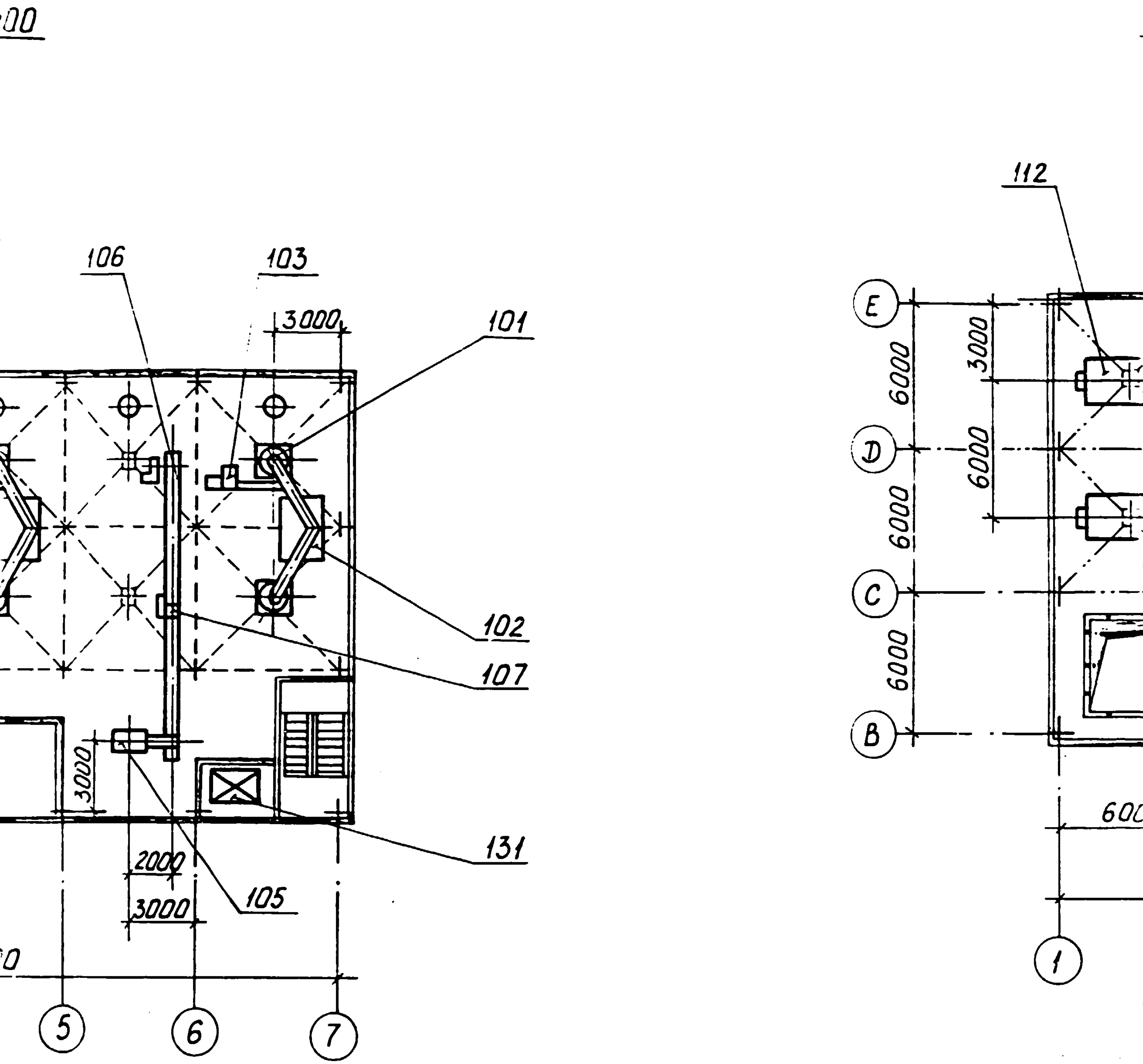
SECTION 3



1395274-TM			
ANGUL ALUMINIUM SMELTER (INDIA)			
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION FEED PREPARATION ROOM	PHASE	SHEET	SHEET
	FS	2	
PLAN AT EL. 0,000	VAMI LENINGRAD		


PLAN AT EL. +18,000
SCALE 1:200
108
106
3000
6000
6000
6000
6000
+18,000
CONTROL PANEL
ROOM
3000
2000
3000
6000
6 × 6000 = 36000
E
D
C
B
1
2
3
4
5
6

SECTION 1


00
106
103
3000
101
102
107
3000
131
2000
105
3000
5
6
7
112
E
D
C
B
6000
3000
6000
6000
6000
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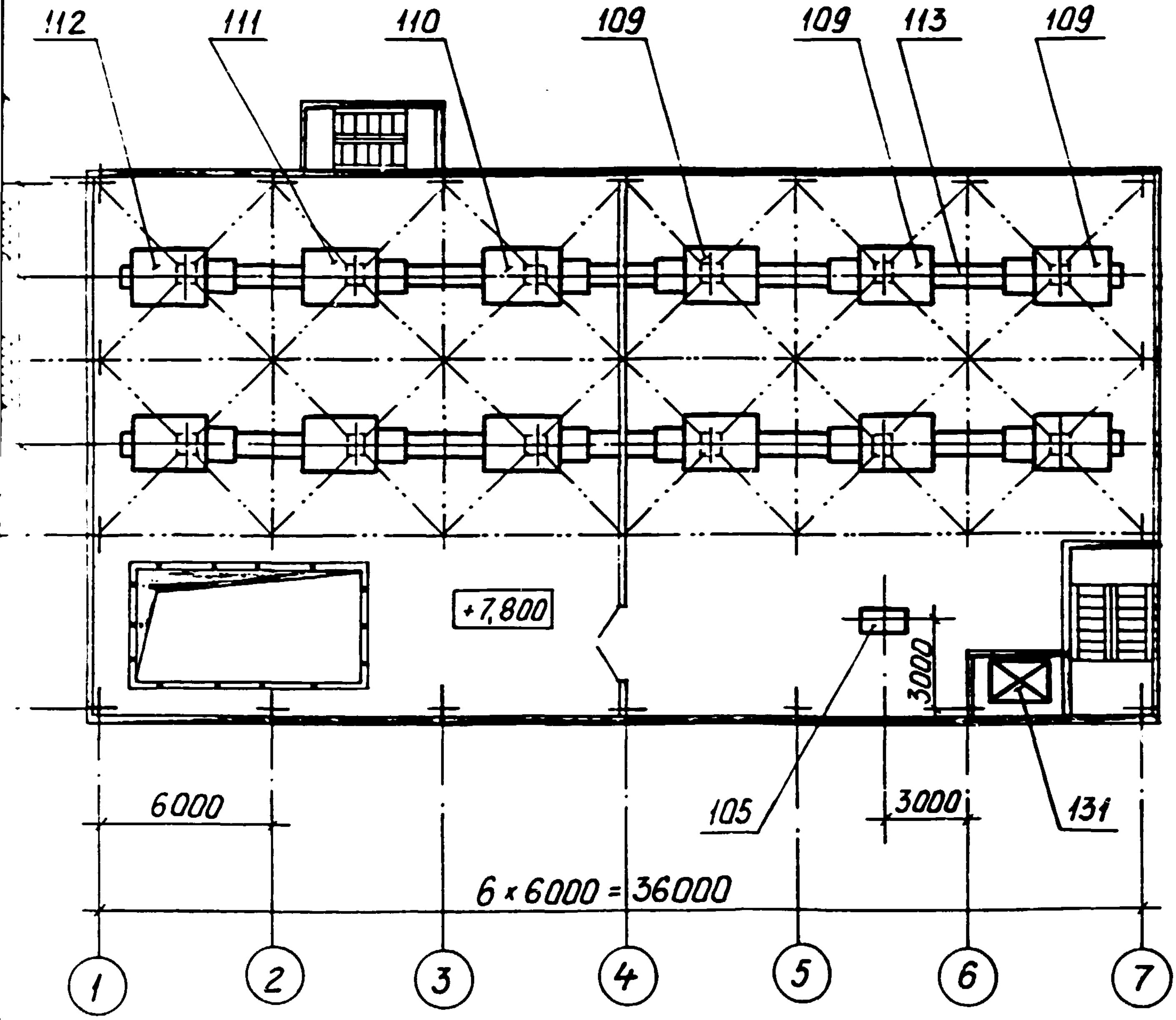
1

SECTION 2

PLAN AT EL. + 7,800
SCALE 1:200



SECTION 3

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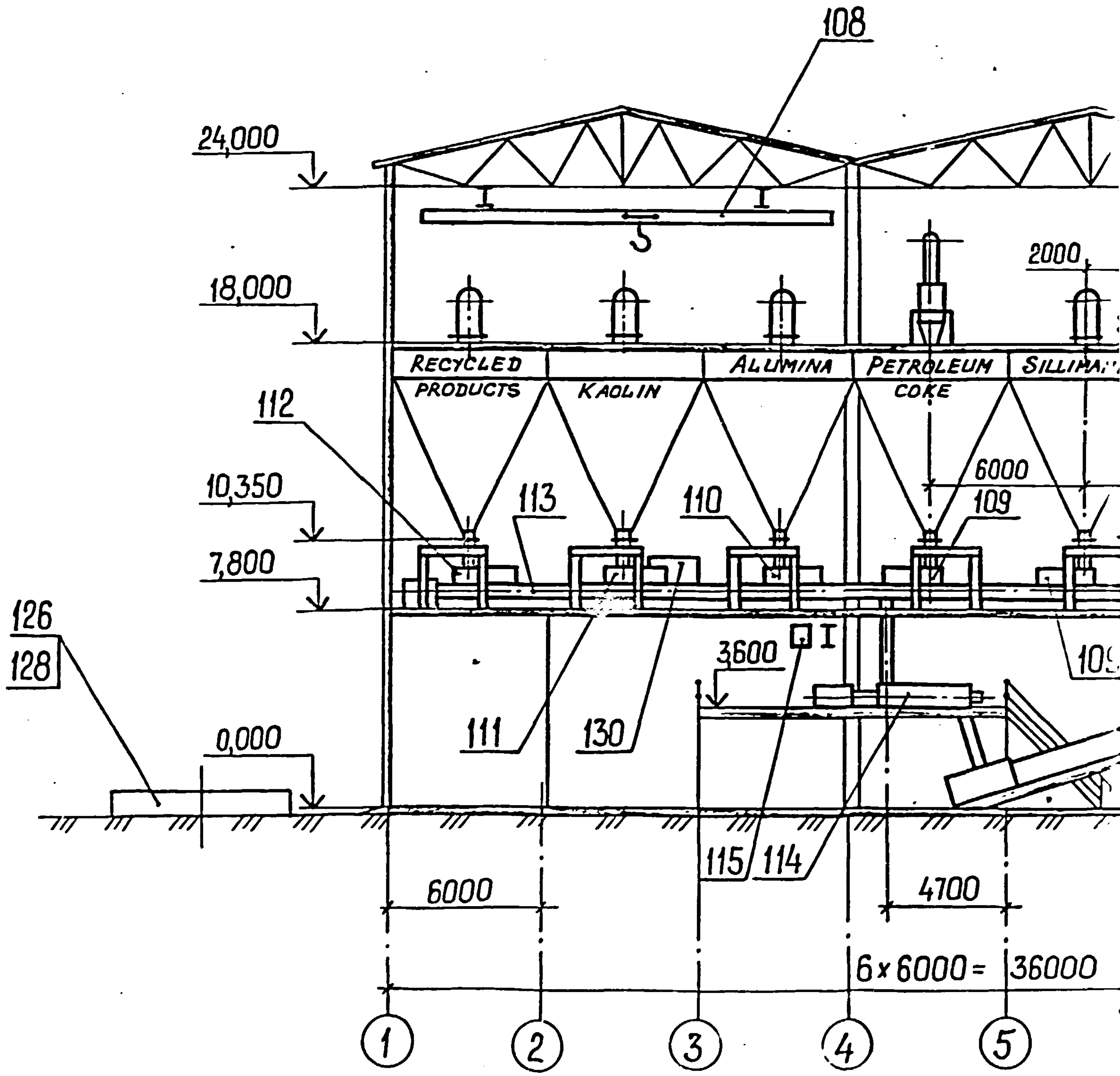
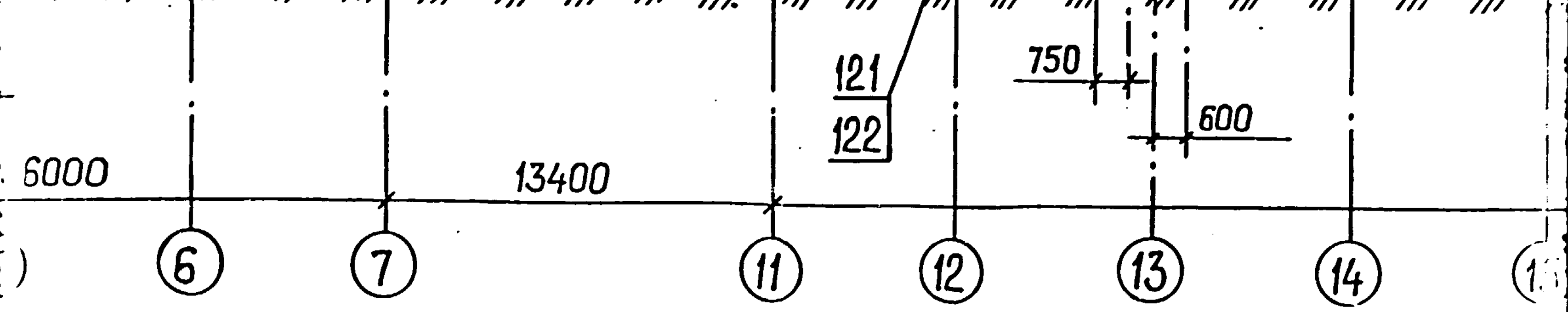
1395274-TM

ANGUL ALUMINIUM SMELTER (INDIA)

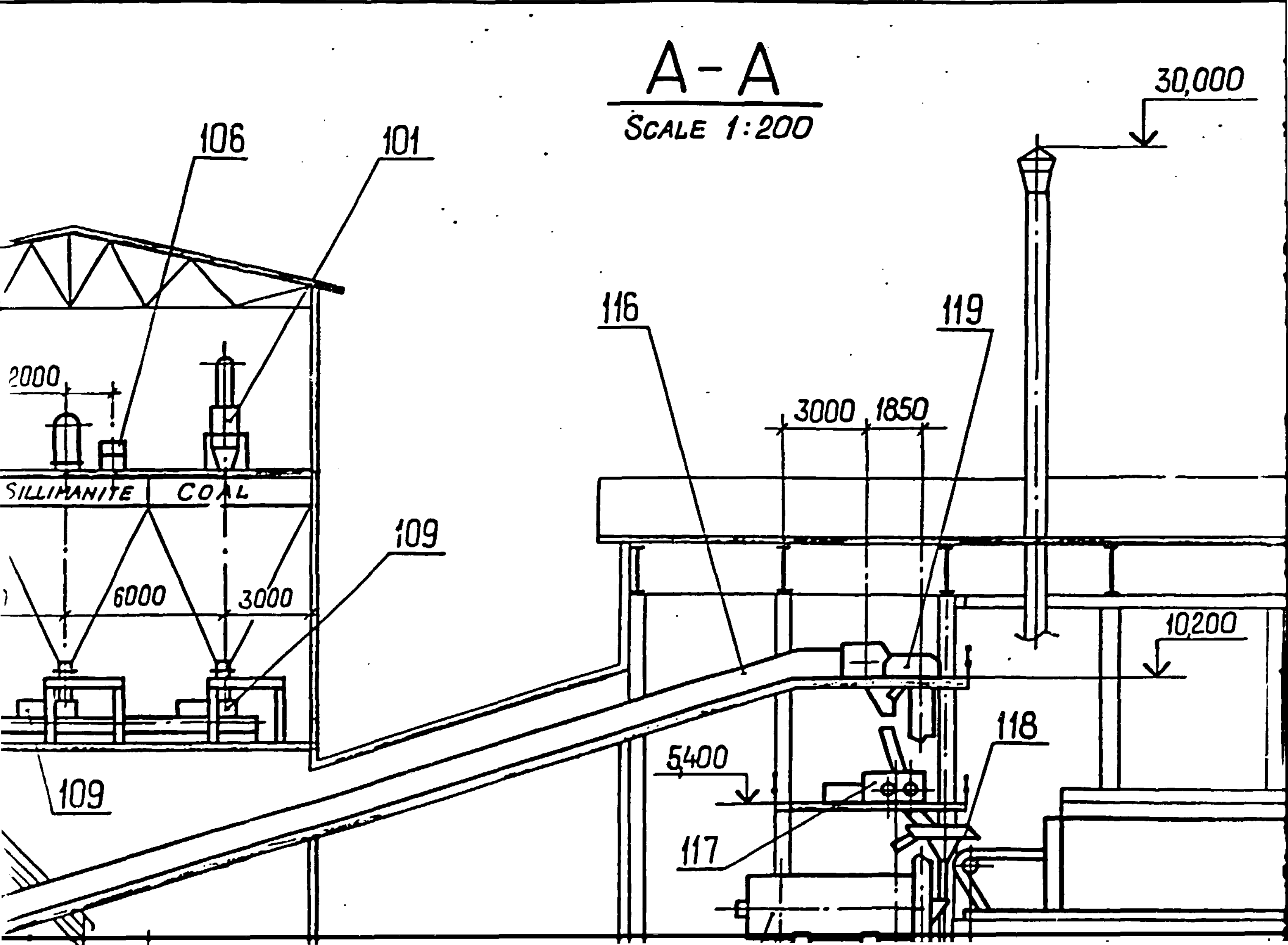
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION FEED PREPARATION ROOM	PHASE	SHEET	SHEETS
	FS	3	
PLANS	VAMI LENINGRAD		

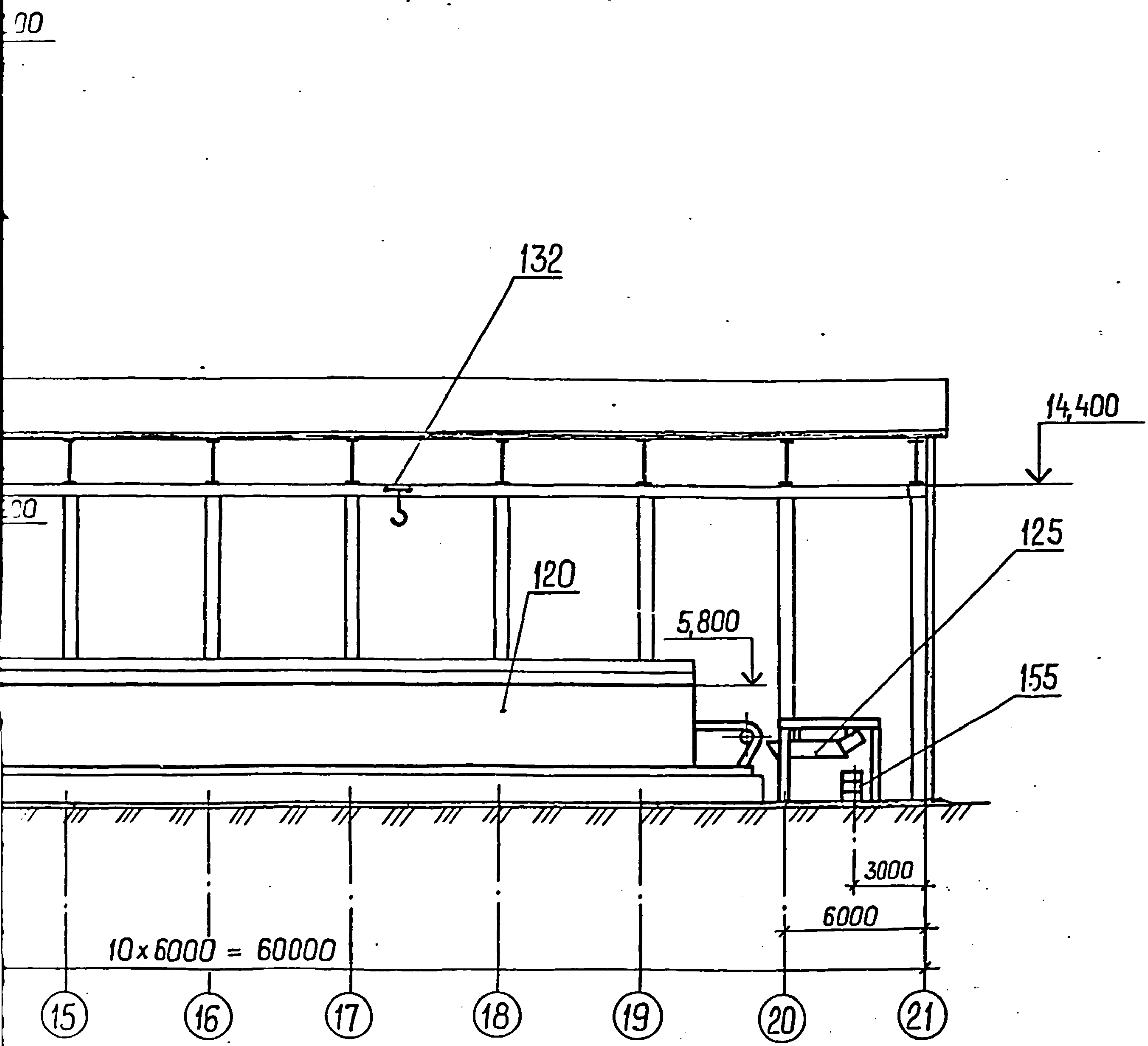

108
24,000
18,000
2000
RECYCLED PRODUCTS
KAOLIN
ALUMINA
PETROLEUM COKE
112
10,350
113
110
109
6000
7,800
126
128
3600
111
130
0,000
115
114
6000
4700
6 x 6000 = 36000
1
2
3
4
5

SECTION 1



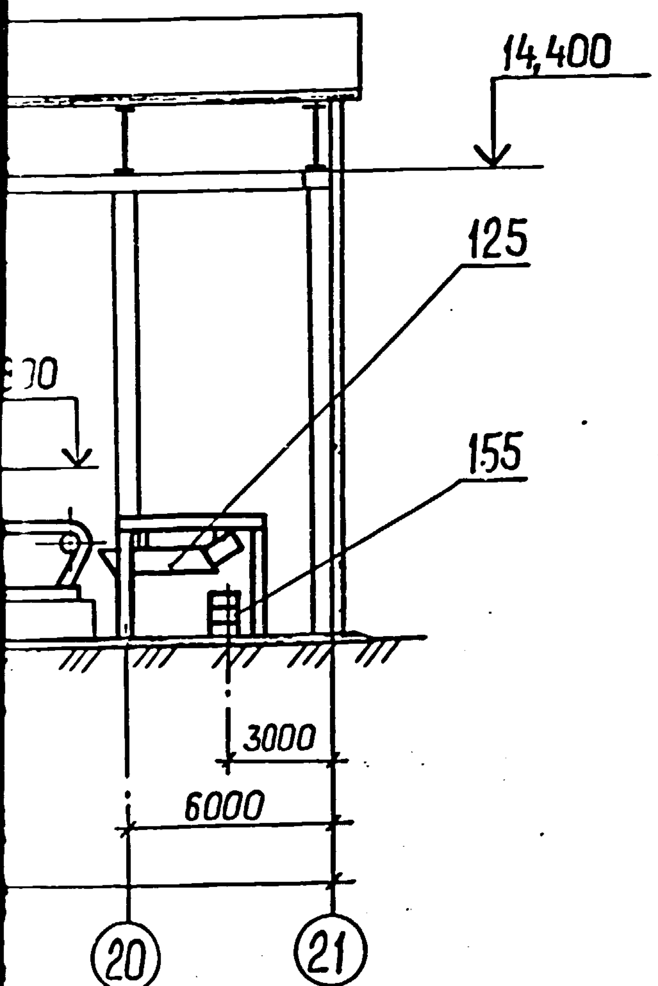
SECTION 2


A-A
SCALE 1:200
30,000
106
101
116
119
2000
3000
1850
SILLIMANITE
COAL
109
6000
3000
10,200
118
5400
109
117



00
132
14,400
00
125
120
5,800
155
3000
6000
10 × 6000 = 60000
15
16
17
18
19
20
21

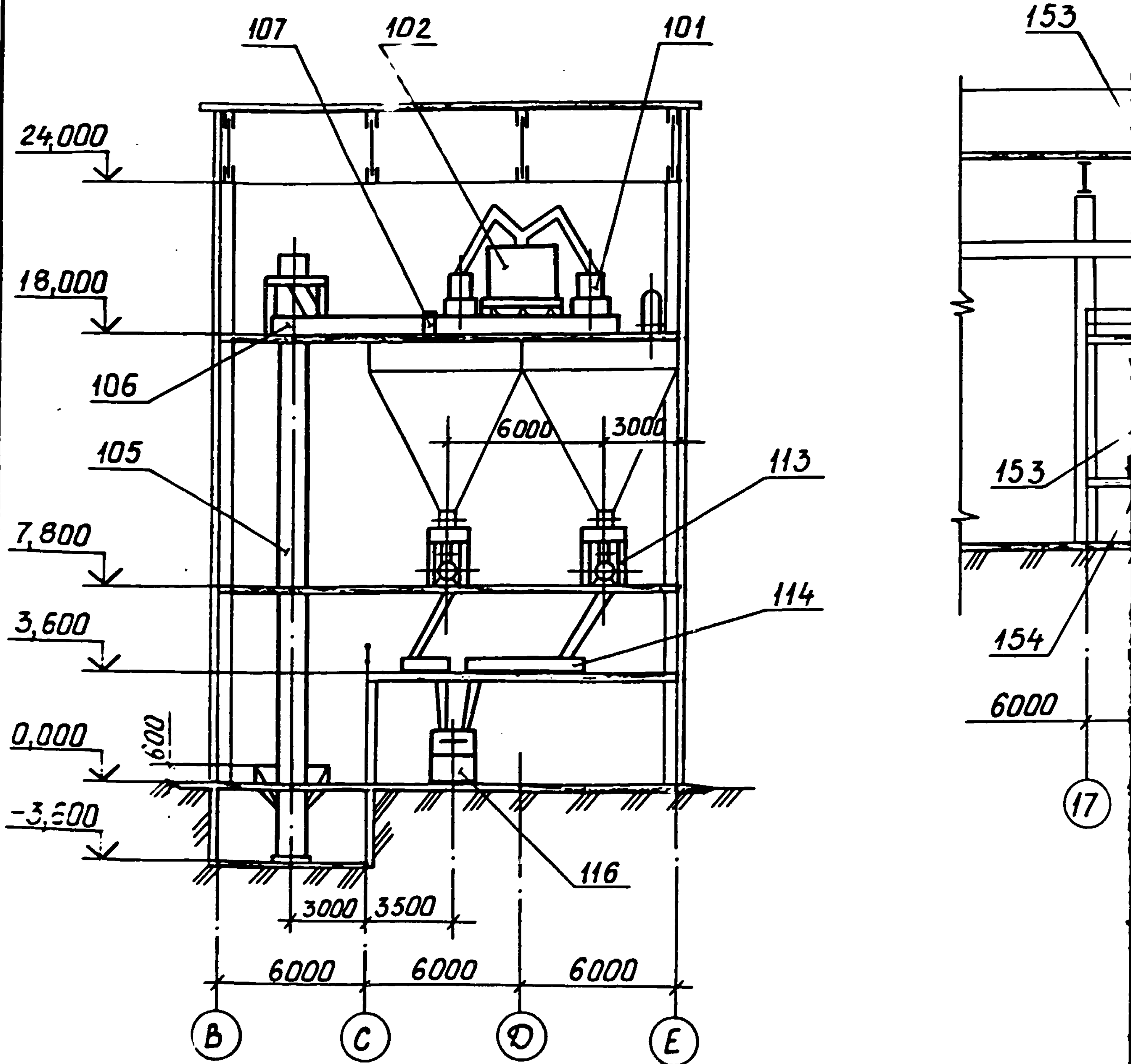
SECTION 3



SECTION 4

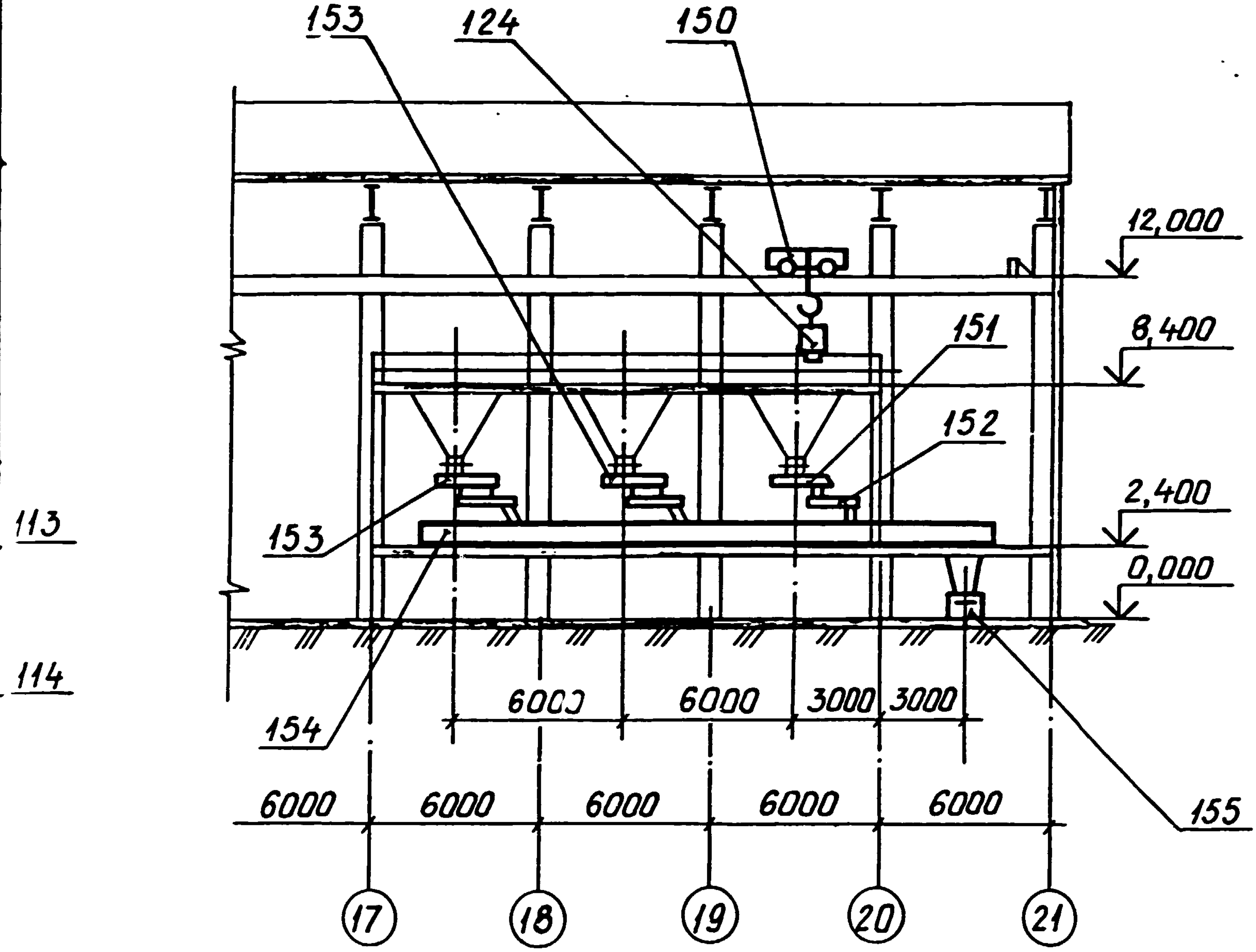
1395274-TM			
ANGUL ALUMINIUM SMELTER (INDIA)			
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION FEED PREPARATION ROOM	PHASE	SHEET	SHEETS
SECTION A-A	VAMI LENINGRAD		

D - D SHEET 2



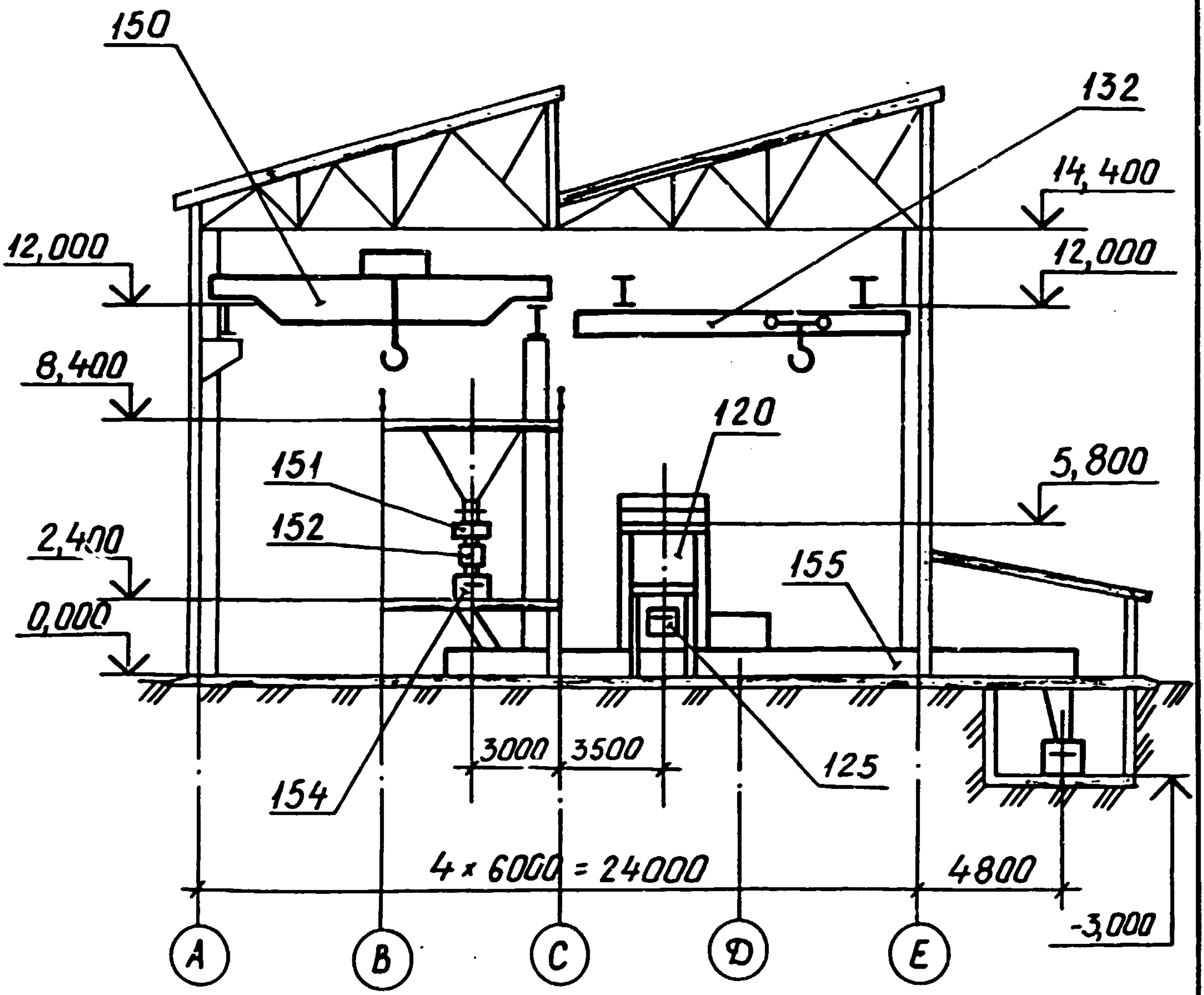
SECTION 1

Б – Б SHEET 2



SECTION 2

C–C SHEET 2



SECTION 3

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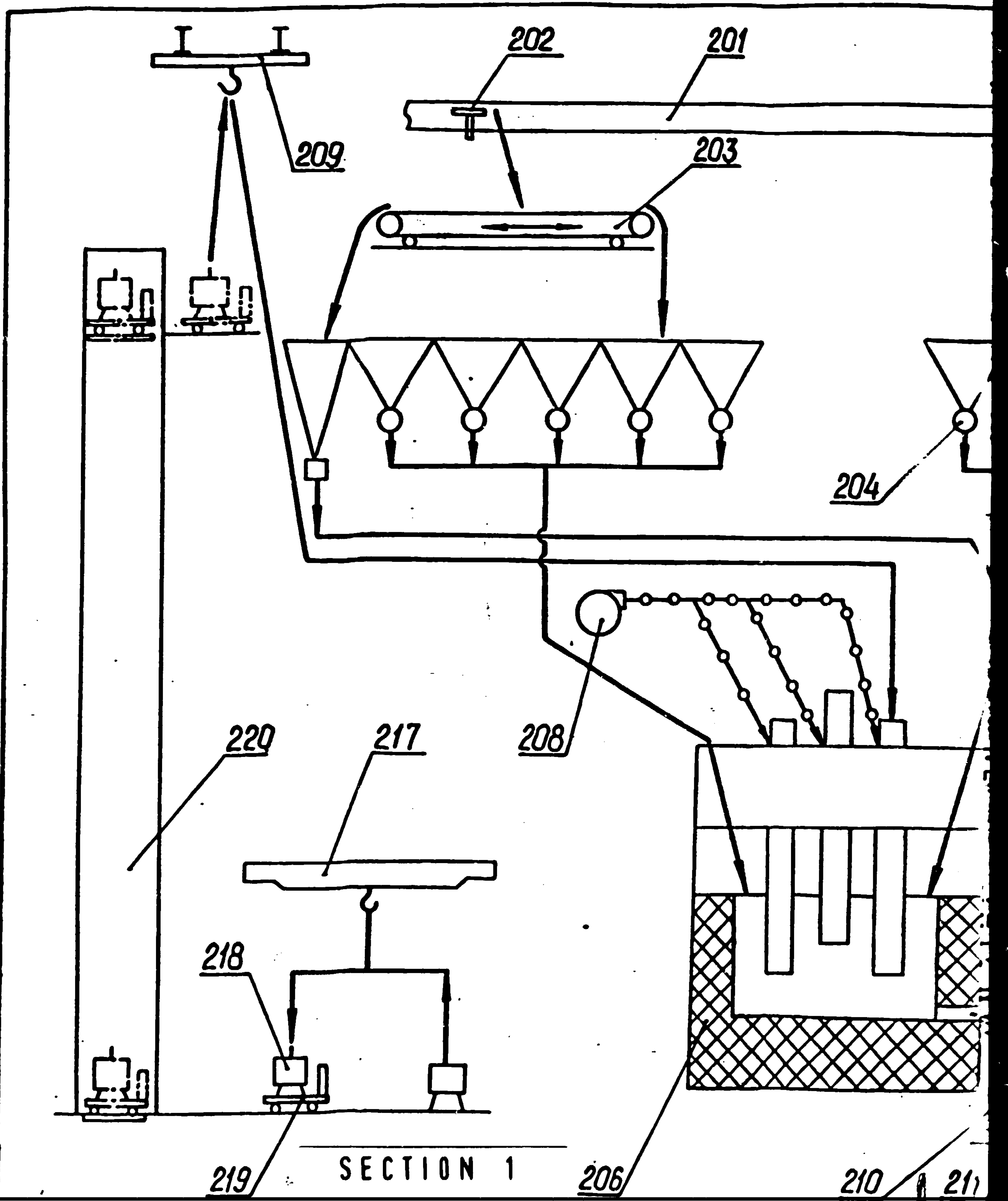
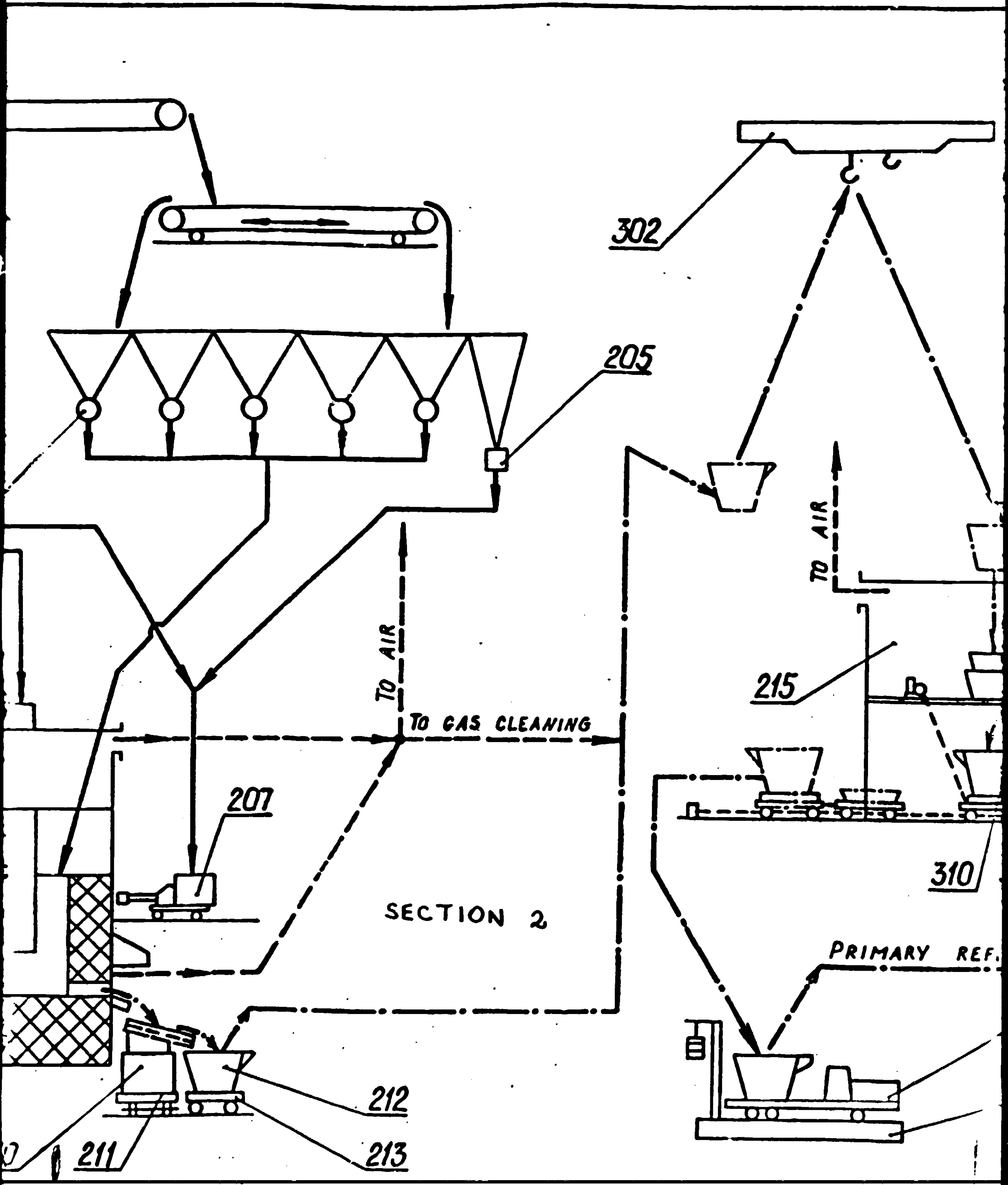
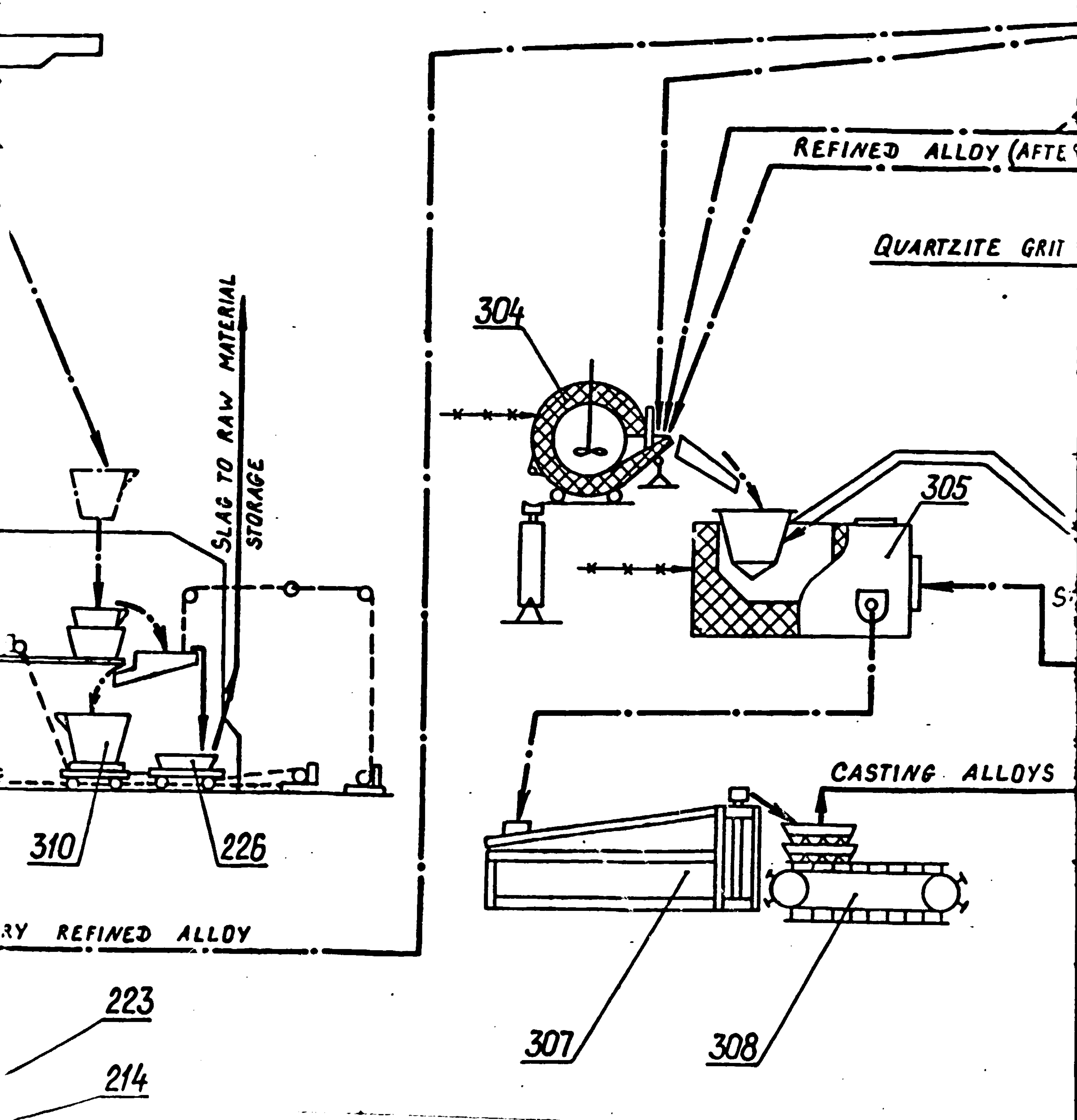
	ANGUL ALUMINIUM SMELTER (INDIA)		
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION FEED PREPARATION ROOM	PHASE: FS	SHEET: 5
	SECTIONS	VAMI LENINGRAD	



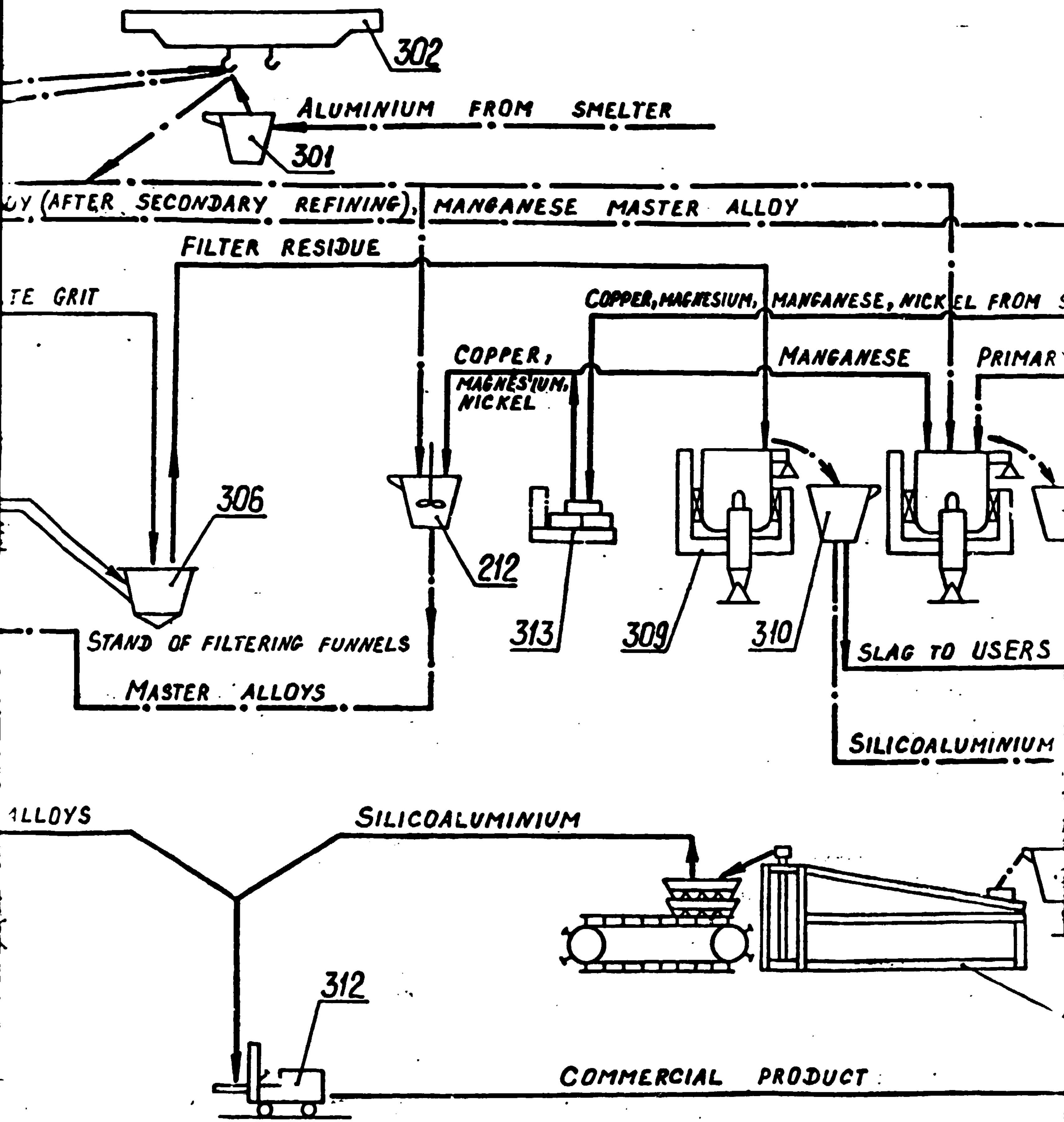
SECTION 1



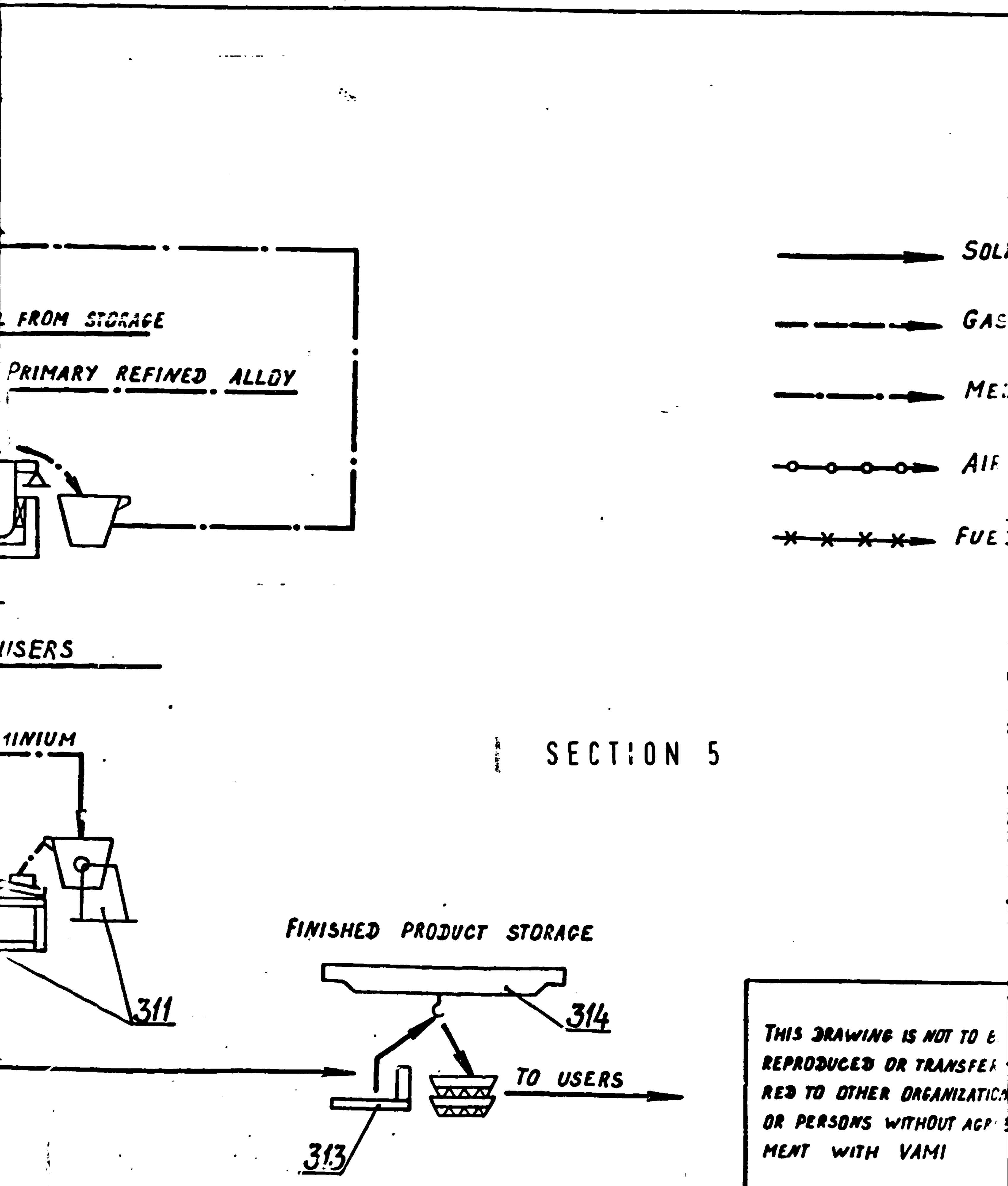
302
205
TO AIR
TO GAS CLEANING
TO AIR
215
207
310
SECTION 2
PRIMARY REF.
212
211
213


REFINED ALLOY (AFTE
QUARTZITE GRIT
304
SLAG TO RAW MATERIAL STORAGE
305
310
226
CASTING ALLOYS
RY REFINED ALLOY
223
214
307
308

SECTION 3


302
ALUMINIUM FROM SMELTER
301
OY (AFTER SECONDARY REFINING), MANGANESE MASTER ALLOY
FILTER RESIDUE
TE GRIT
COPPER, MAGNESIUM, MANGANESE, NICKEL FROM
COPPER, MAGNESIUM, NICKEL
MANGANESE
PRIMAR
306
212
313
309
310
STAND OF FILTERING FUNNELS
MASTER ALLOYS
SLAG TO USERS
SILICOALUMINIUM
ALLOYS
SILICOALUMINIUM
312
COMMERCIAL PRODUCT

SECTION 4



FROM STORAGE
PRIMARY REFINED ALLOY
USERS
INIUM
SECTION 5
FINISHED PRODUCT STORAGE
311
314
313
TO USERS
SOL
GAS
ME
AIR
FUE
THIS DRAWING IS NOT TO BE
REPRODUCED OR TRANSFER-
RED TO OTHER ORGANIZATIONS
OR PERSONS WITHOUT AGREE-
MENT WITH VAMI

LEGEND

SOLID PRODUCTS

GASEOUS PRODUCTS

MELT

AIR

FUEL OIL

SECTION 6

E

/14

SERS

THIS DRAWING IS NOT TO BE REPRODUCED OR TRANSFERRED TO OTHER ORGANIZATIONS OR PERSONS WITHOUT AGREEMENT WITH VAMI	1395275 - TM		
	ANGUL ALUMINIUM SMELTER (INDIA)		
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION ALLOY PREPARATION (METALURGICAL) ROOM	PHASE	SHEET	SHEETS
		FS	1	5
	EQUIPMENT ARRANGEMENT AND PROCESS FLOWSHEET	VAMI LENINGRAD		

ITEM	DESCRIPTION	SPECIFICATION	QTY	REMARK
310	LADLE	CAPACITY 3T	5	
311	CASTINS CONVEYOR WITH LADLE TILTER	L = 12 m	1	
312	ELECTRIC LOADER	Q = 2T	1	
313	BEAM BALANCE	Q = 3T	1	
314	E.O.T. CRANE	Q=3,2T; L=16.5m; H=6 m	1	
315	TRAILER	Q = 20T	1	
316	TRACTOR	N = 220 HP	1	

ITEM	DESC
215	REFINING
216	STAND FOR DRYING A
217	E.O.T. CR
218	BUCKET
219	ELECTRIC
220	FREIGHT
221	AUXILIARY
222	E.O.T. CR
223	ELECTRIC
224	LADLE CLE
225	AIR DRY
226	SLAG PC
301	LADLE
302	E.O.T. CR
304	TURNITG HOLDING
305	FILTRATIO
306	FILTERING
307	CASTING
308	AUTOMATI STACKER
309	INDUCTIO FURNACE

SECTION 1

ITEM	DESCRIPTION	SPECIFICATION	QTY	REMARK
215	REFINING UNIT	——	1	
216	STAND FOR LADLES DRYING AND HEATING	——	2	NOT SHOWN ON FLOW-SHEET
217	E.O.T. CRANE	$Q=5T; L=10m; H=16m$	1	
218	BUCKET	$V=1m^3$	7	
219	ELECTRIC TRUCK	$Q=5T$	1	
220	FREIGHT ELEVATOR	$Q=5T; H=27m$	1	
221	AUXILIARY WINCH	$Q=12T$	1	NOT SHOWN ON FLOW-SHEET
222	E.O.T. CRANE	$Q=80/20T; L=10m; H=25/27m$	1	
223	ELECTRIC TRUCK	$Q=10T$	1	
224	LADLE CLEANING MACHINE	——	1	NOT SHOWN ON FLOW-SHEET
225	AIR DRYER	CAPACITY $100\ m^3/HR$	1	NOT SHOWN ON FLOW-SHEET
226	SLAG POT	$V=1m^3$	3	
301	LADLE	CAPACITY 10T	2	
302	E.O.T. CRANE	$Q=32/5T; L=28,5m; H=16m$	2	
304	TURNITG TILTNG HOLDING FURNACE	CAPACITY 15T	3	
305	FILTRATION FURNACE	CAPACITY 15T	3	
306	FILTERING FUNNEL	——	6	
307	CASTING CONVEYOR	$L=12m$	3	
308	AUTOMATIC INGOT STACKER	——	4	
303	INDUCTION CRUCIBLE FURNACE	POWER RATING 2500 KVA	2	

ITEM	DESC
201	BELT CON
202	BELT INC MECHANIS
203	PORTABLE BELT CONV
204	CONTROL GA
205	JAW GATE PNEUMATIC
205	THREE-PHA REDUCTION
207	ARC REDUC. SERVICING DANGO DI
208	FAN
209	ELECTRIC M
210	CHUTES S
211	TRUCK
212	LADLE
213	TRUCK
214	.RUCK SC

SECTION 2

QTY	REMARK
1	
2	NOT SHOWN ON FLOW-SHEET
1	
7	
1	
1	
1	NOT SHOWN ON FLOW-SHEET
1	
1	
1	NOT SHOWN ON FLOW-SHEET
1	NOT SHOWN ON FLOW-SHEET
3	
2	
2	
3	
3	
6	
3	
4	
2	

ITEM	DESCRIPTION	SPECIFICATION	QTY	REMARK
201	BELT CONVEYOR	B = 650mm; L = 158 m	1	
202	BELT INCLINATION MECHANISM	———	1	
203	PORTABLE REVERSIBLE BELT CONVEYOR	B = 800mm; L = 8,5 m	2	
204	CONTROL GATE FEEDER	$V = 0{,}04\ m^3$	10	
205	JAW GATE WITH PNEUMATIC DRIVE	———	2	
206	THREE-PHASE ARC REDUCTION FURNACE	POWER RATING 25000 KVA	1	
207	ARC REDUCTION FURNACE SERVICING MACHINE, DANGO DINENTAL	———	2	
208	FAN	$Q = 1600\ m^3/HR$; H = 0,29 m	1	
209	ELECTRIC MONORAIL HOIST	Q = 5T; L = 18m; H = 36 m	1	
210	CHUTES SECTION	———	6	
211	TRUCK	Q = 3T	2	
212	LADLE	CAPACITY 2,3T	5	
213	TRUCK	Q = 10T	1	
214	TRUCK SCALES	Q = 30T	1	

SECTION 3

1395275-TM

ANGUL ALUMINIUM SMELTER (INDIA)

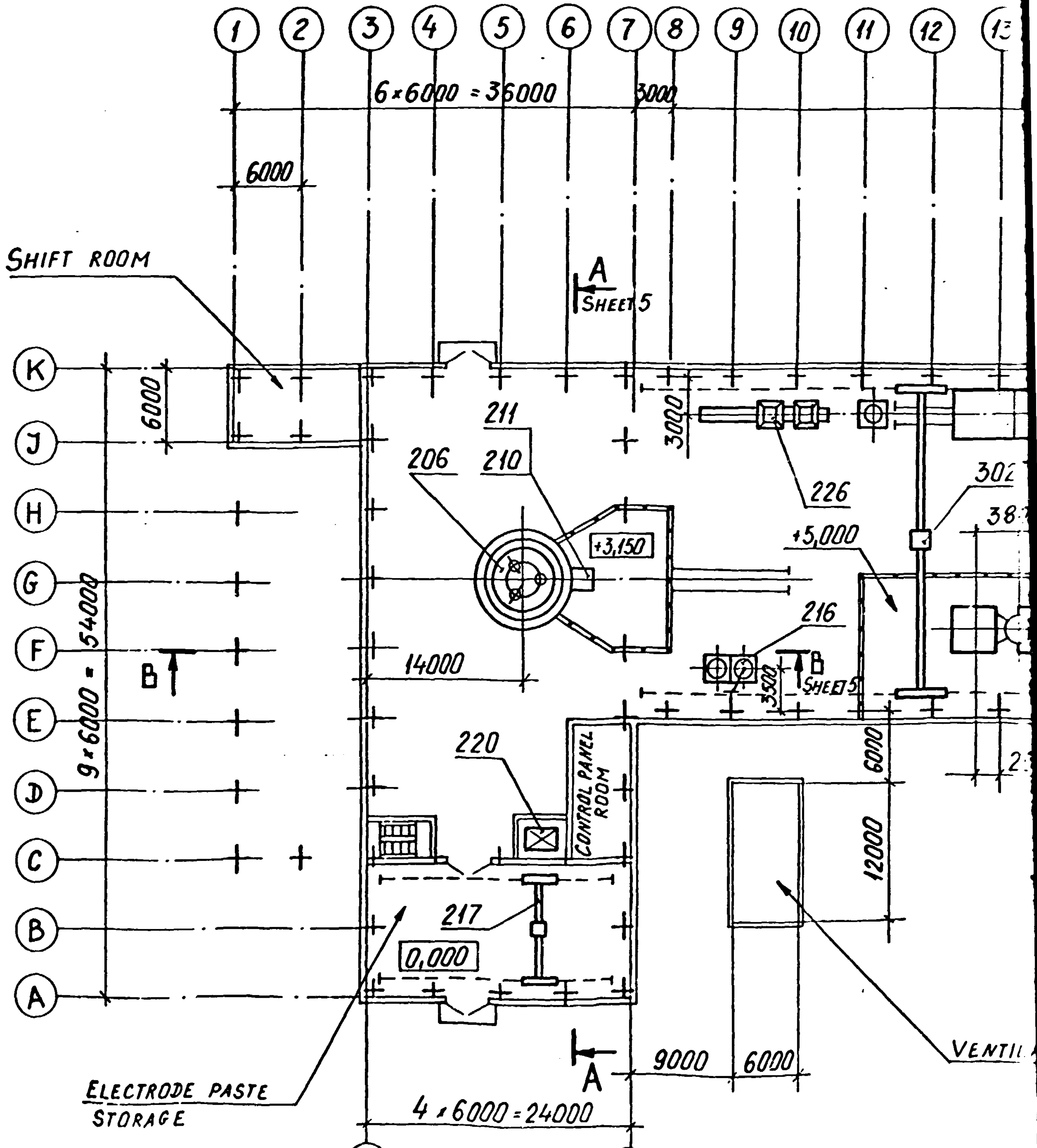
INDUSTRIAL DEMONSTRATION UNIT FOR Al-Si ALLOYS PRODUCTION
ALLOY PREPARATION (METALLURGICAL) ROOM

PHASE	SHEET	SHEETS
FS	2	

SPECIFICATIONS

VAMI LENINGRAD

SIZE A4×3

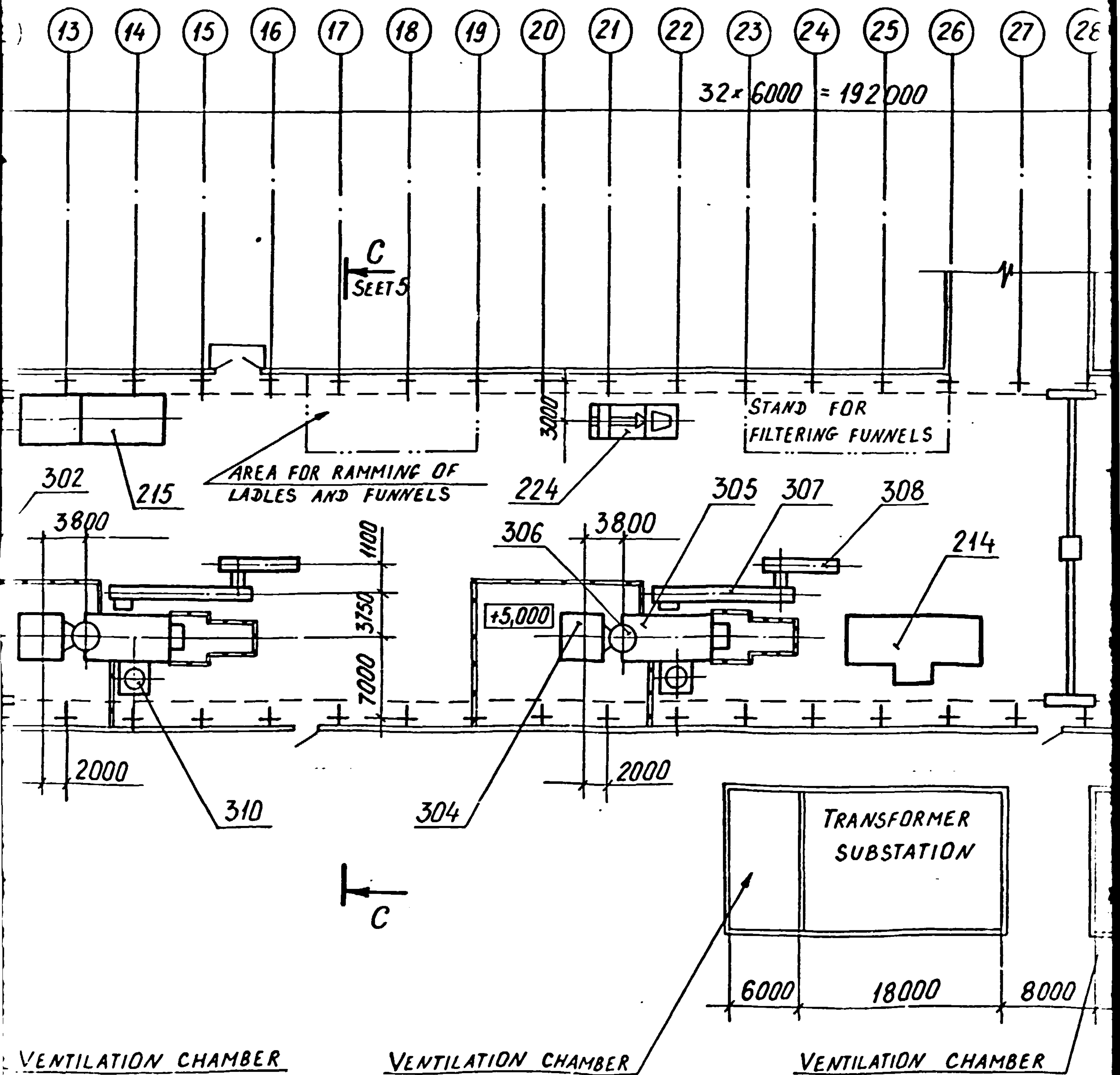


6×6000 = 36000
3000
6000
SHIFT ROOM
A
SHEET 5
211
206
210
+3,150
226
302
+5,000
216
B
SHEET 5
3500
14000
9×6000 = 54000
220
CONTROL PANEL ROOM
6000
12000
217
0,000
9000
6000
4×6000 = 24000
ELECTRODE PASTE STORAGE
VENTIL

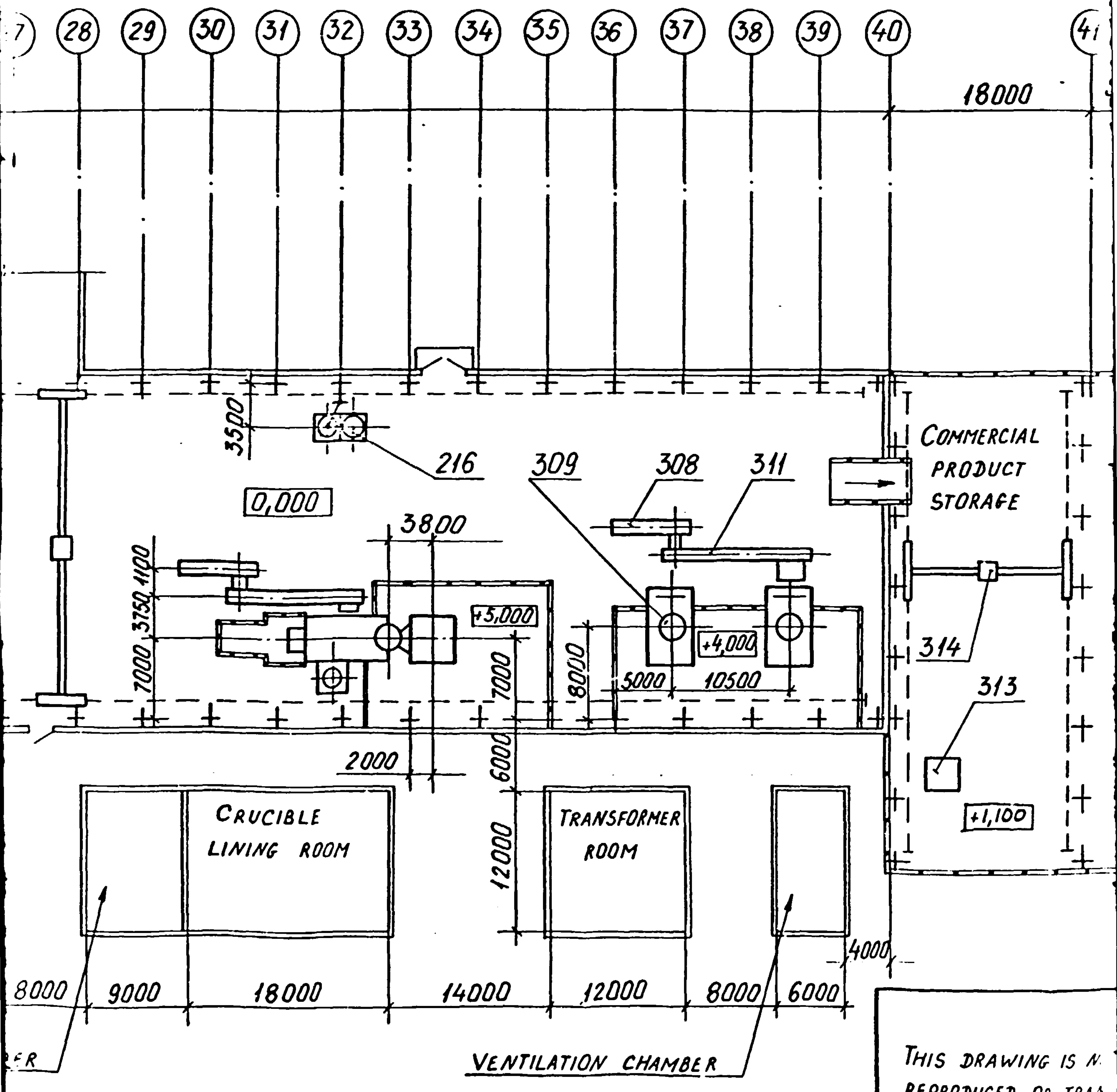
SECTION 1

PLAN AT EL. 0,000

SCALE 1:400



SECTION 2



SECTION 3

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OR PERSONS WITHOUT
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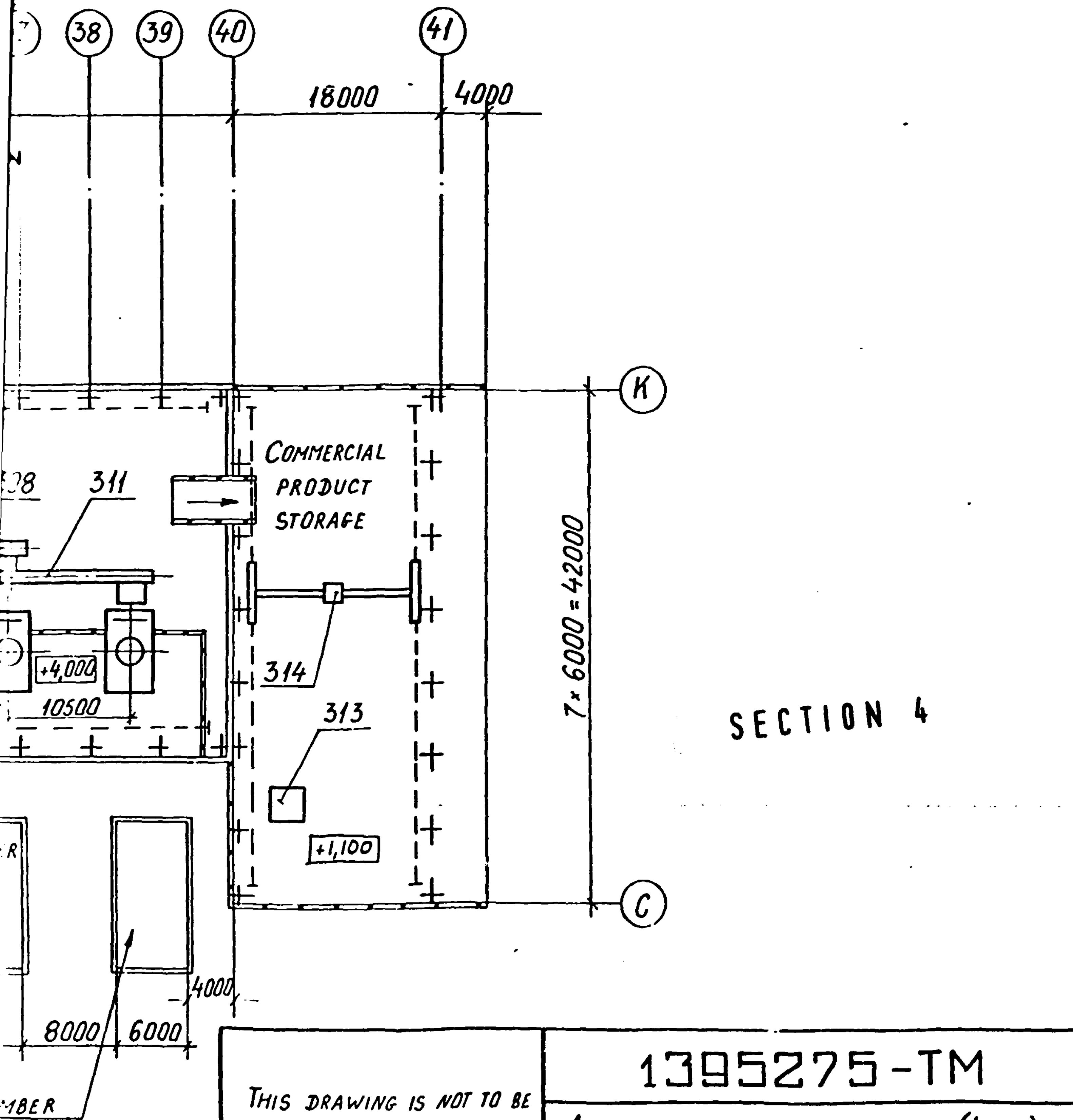
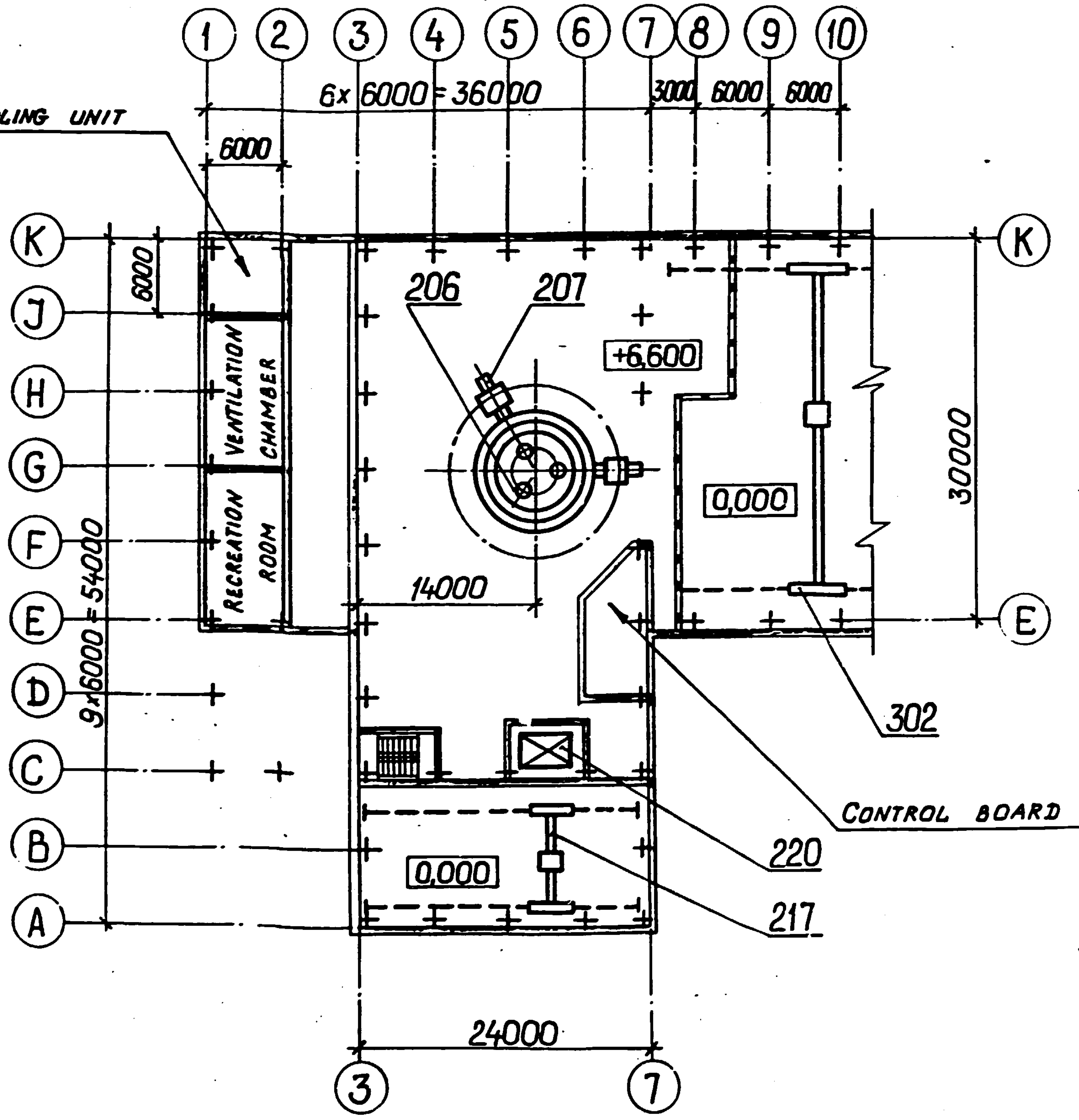


1395275-TM

ANGUL ALUMINIUM SMELTER (INDIA)

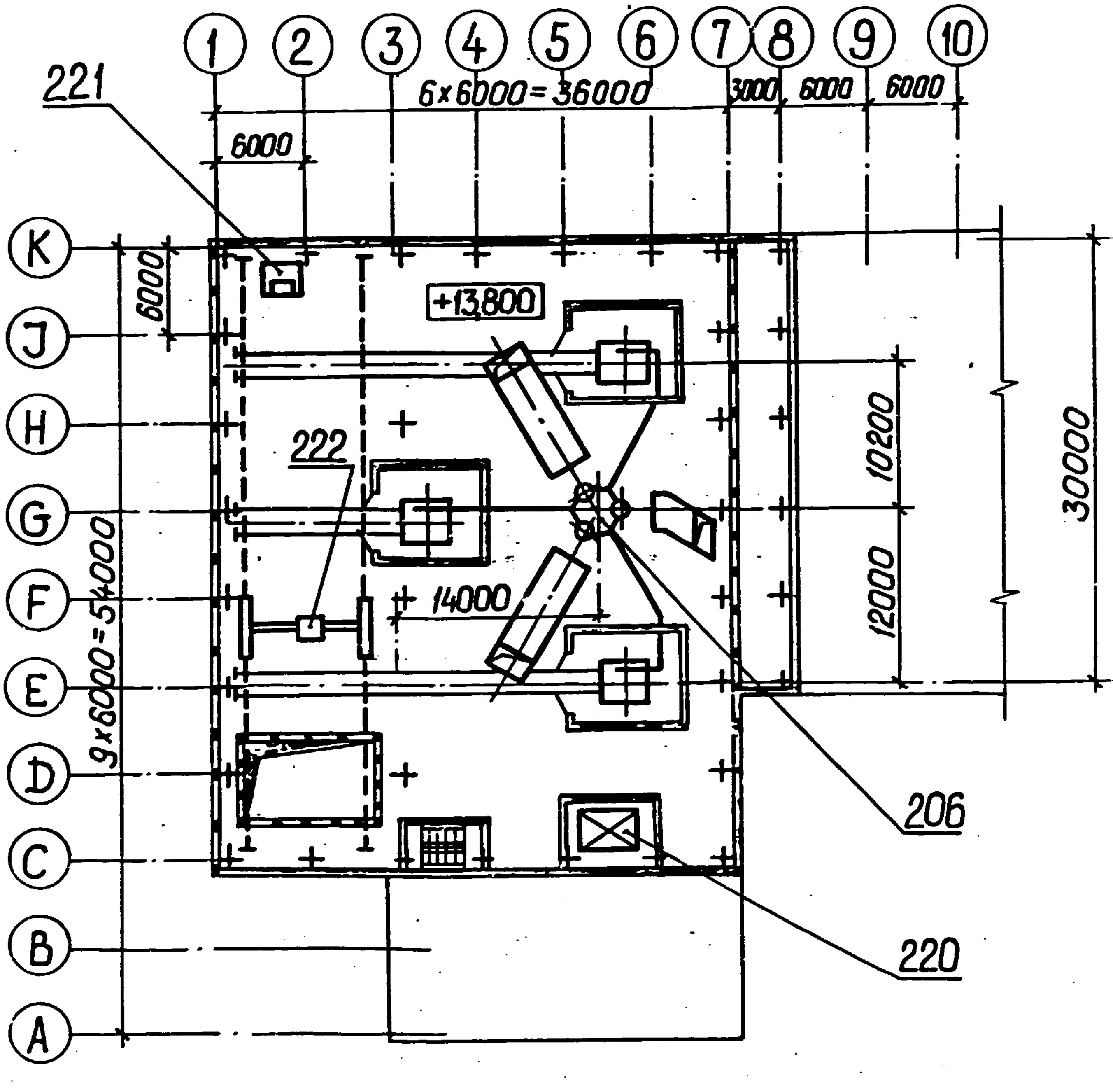
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION ALLOY PREPARATION (METALLURGICAL) ROOM	PHASE	SEET	SHEETS
	FS	3	
PLAN AT EL. 0,000	VAMI LENINGRAD		

PLAN AT EL.+6,600



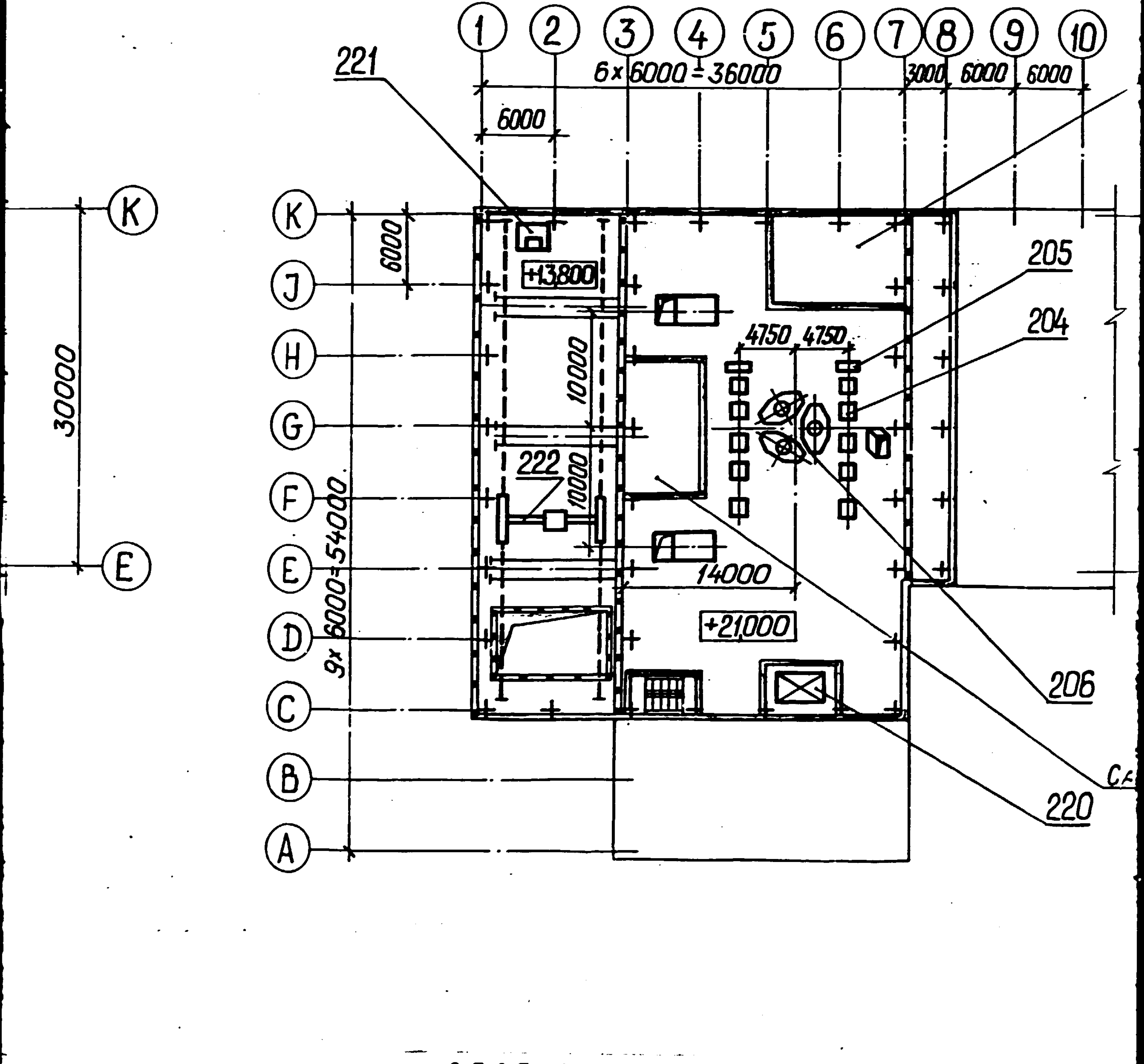
SECTION 1

PLAN AT EL. +13,800

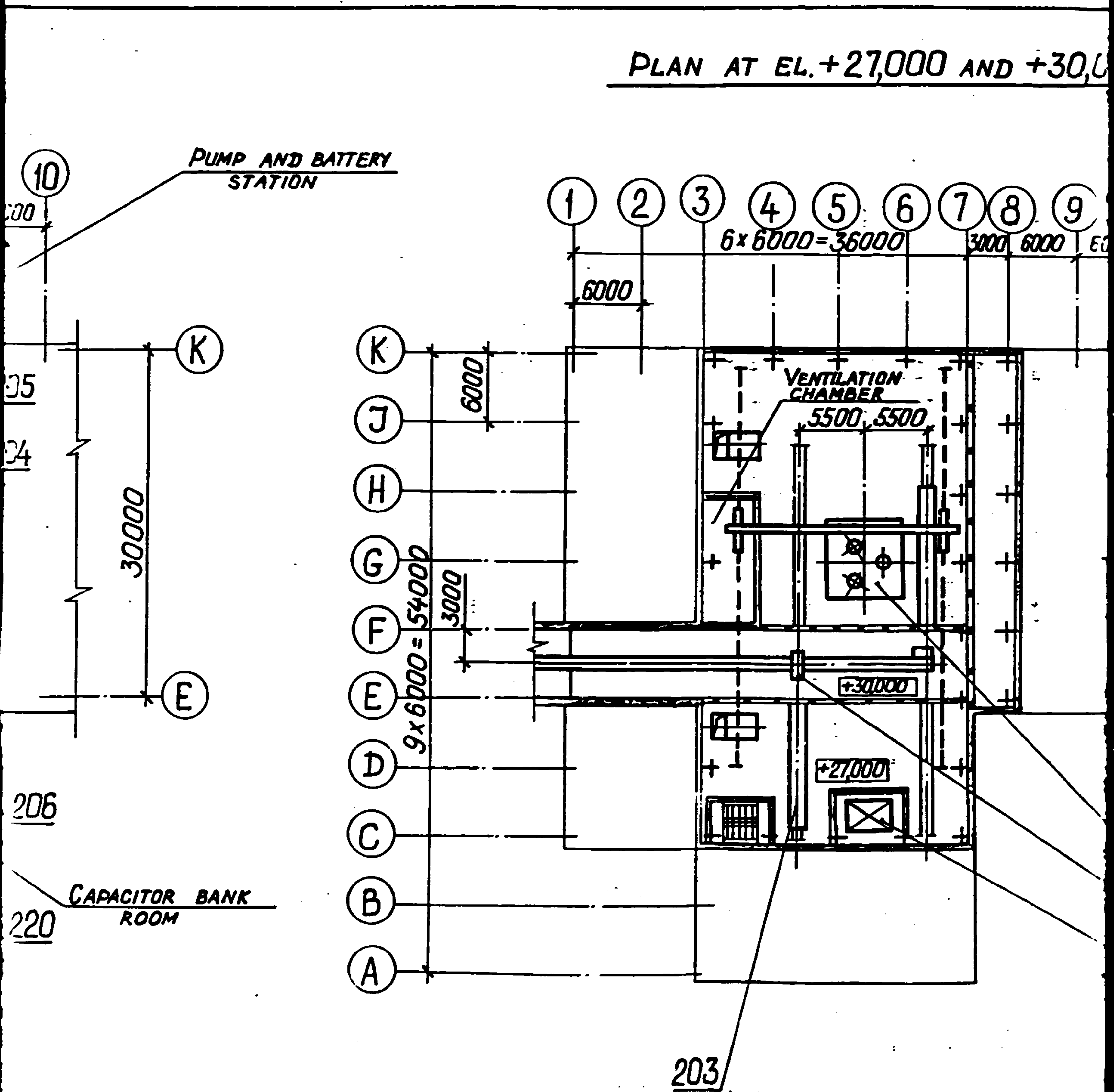


SECTION 2

PLAN AT. EL. +21,000



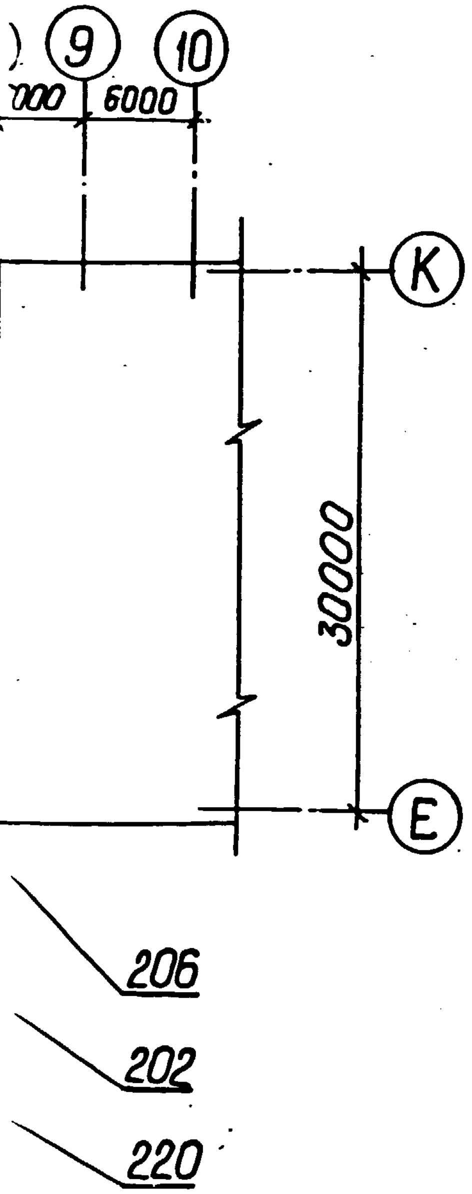
SECTION 3



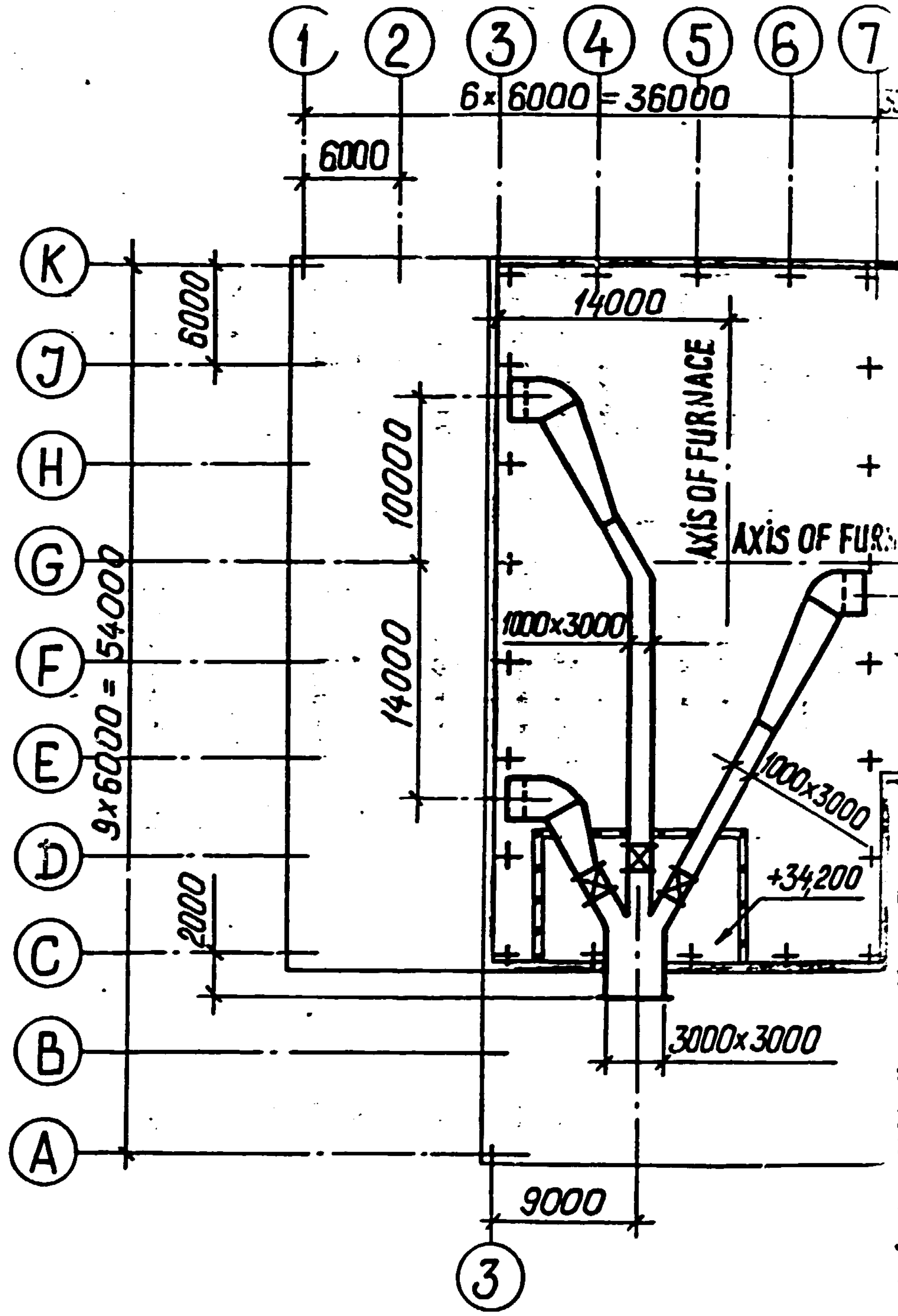
PLAN AT EL. +27,000 AND +30,0
PUMP AND BATTERY STATION
10
K
E
30000
05
04
206
220
CAPACITOR BANK ROOM
1
2
3
4
5
6
7
8
9
6×6000=36000
3000
6000
6000
K
J
H
G
F
E
D
C
B
A
6000
9×6000=54000
3000
VENTILATION CHAMBER
5500
5500
+30,000
+27,000
203

SECTION 4

+30,000



PLAN AT EL. +34,2



SECTION 5

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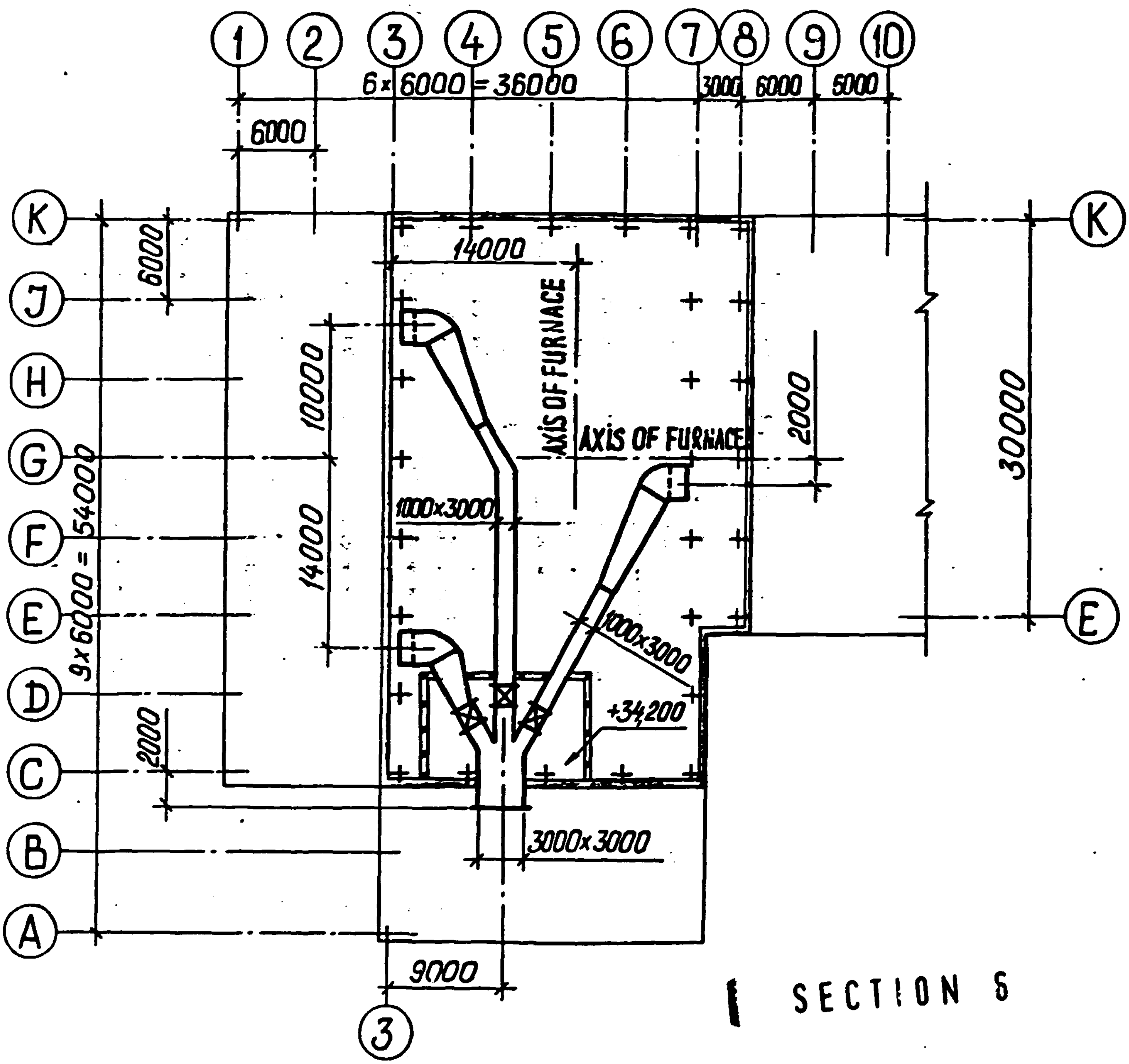
PLAN AT EL. +34,200



SECTION 6

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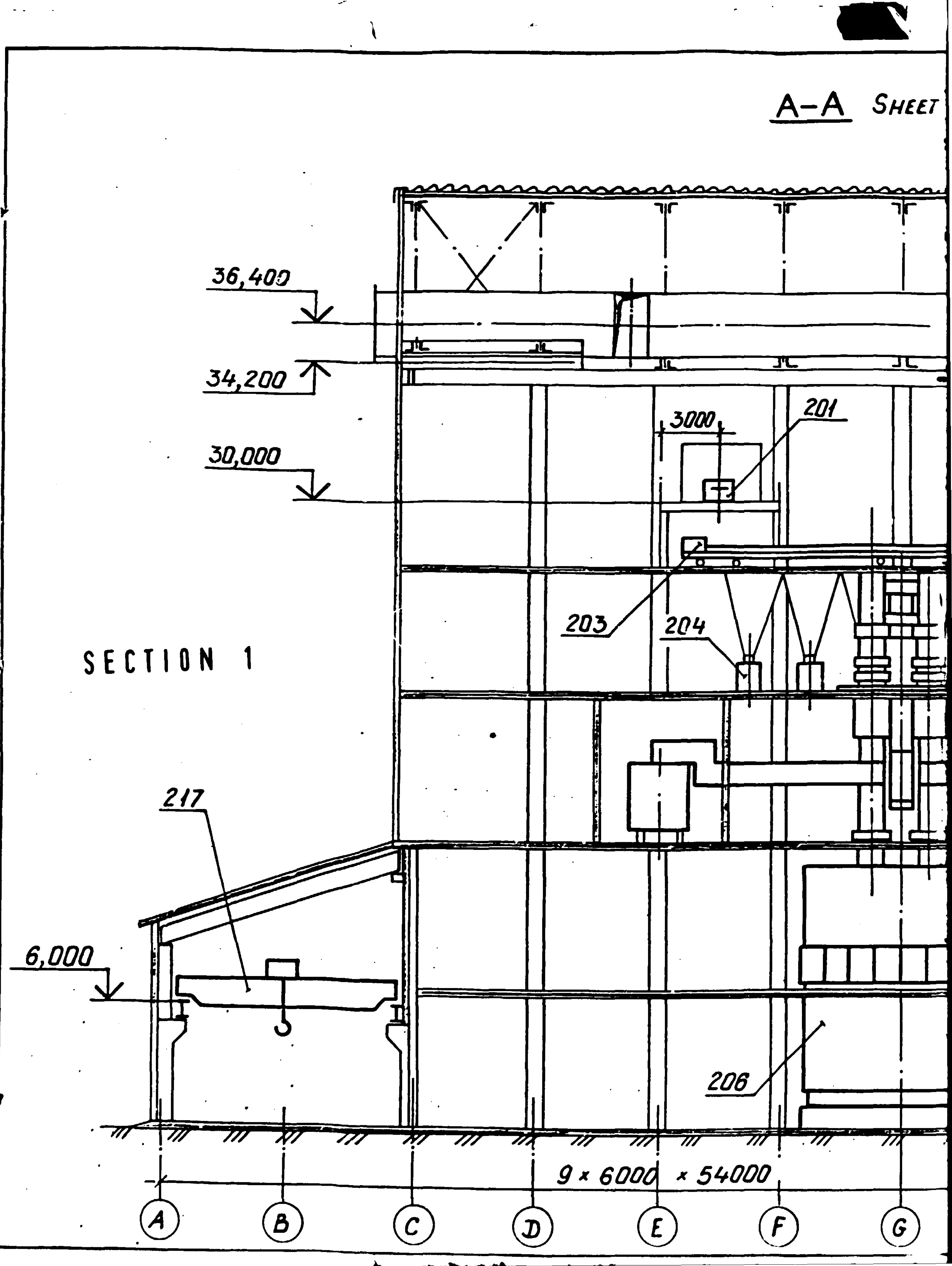
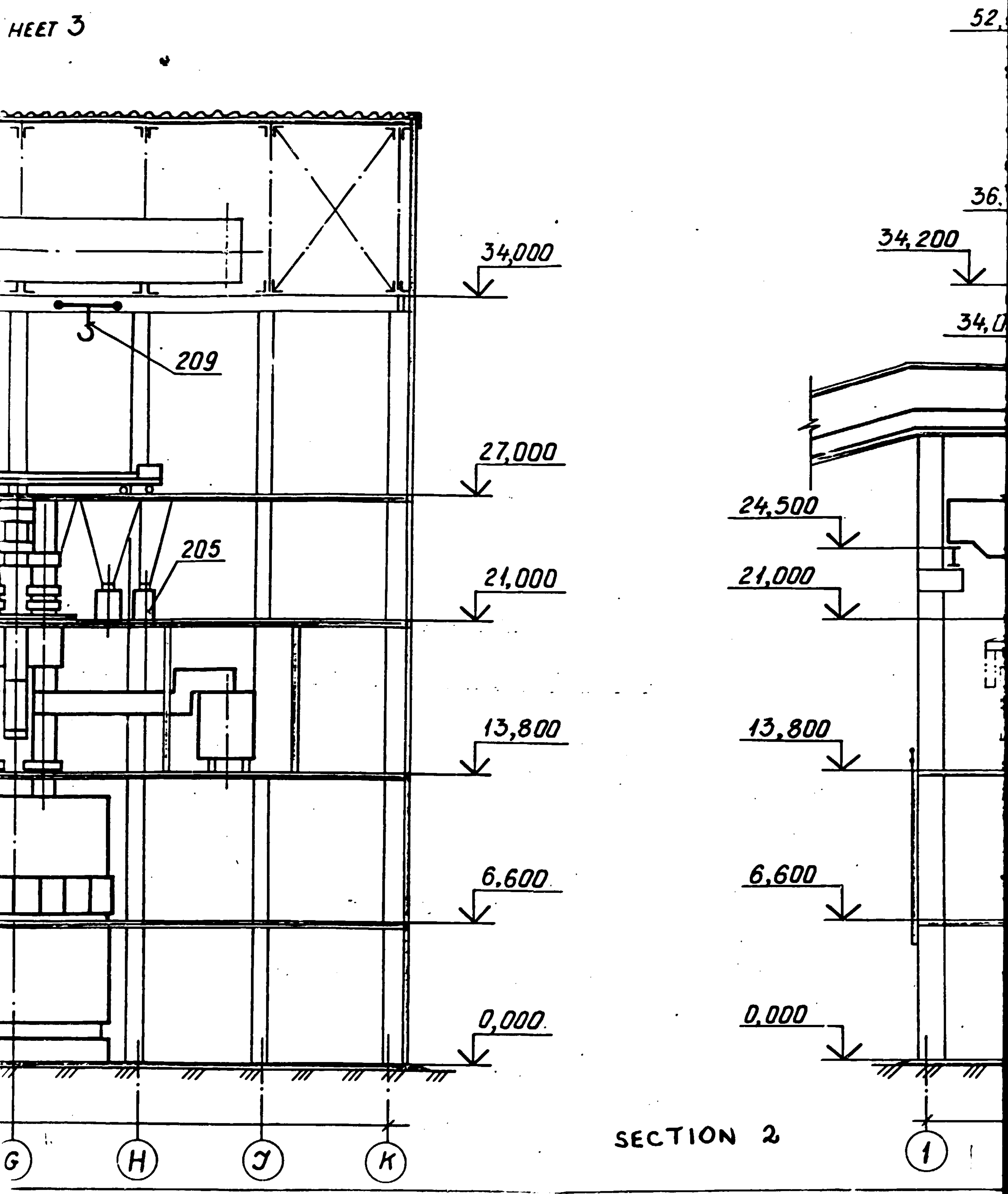
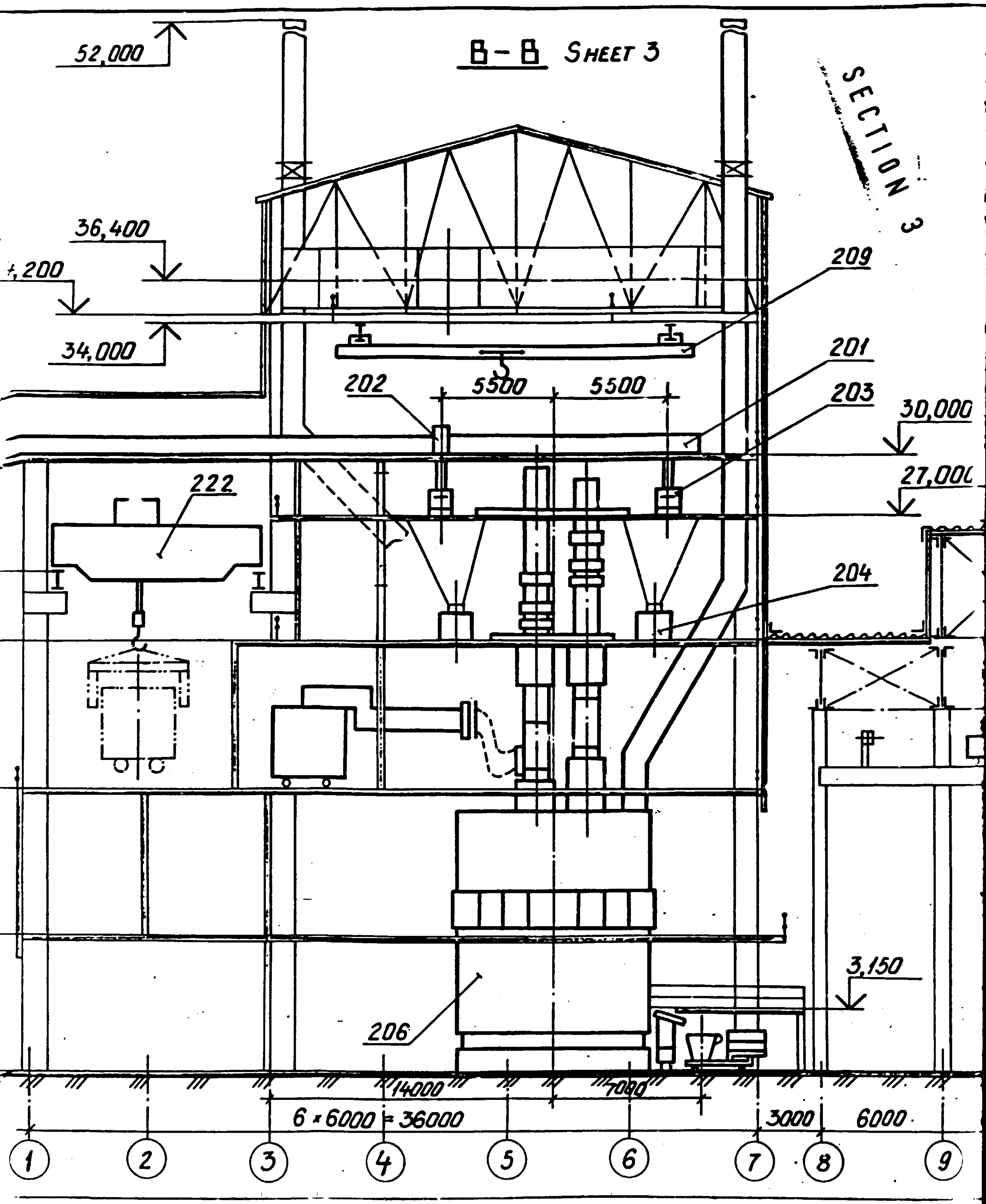
1395275-TM		
ANGUL ALUMINIUM SMELTER (INDIA)		
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION ALLOY PREPARATION (METALLURGICAL) ROOM	PHASE: FS	SHEET: 4 / SHEETS:
PLANS	VAMI LENINGRAD	


A–A SHEET
SECTION 1
36,400
34,200
30,000
6,000
3000
201
203
204
217
206
9 × 6000 × 54000
A
B
C
D
E
F
G

HEET 3

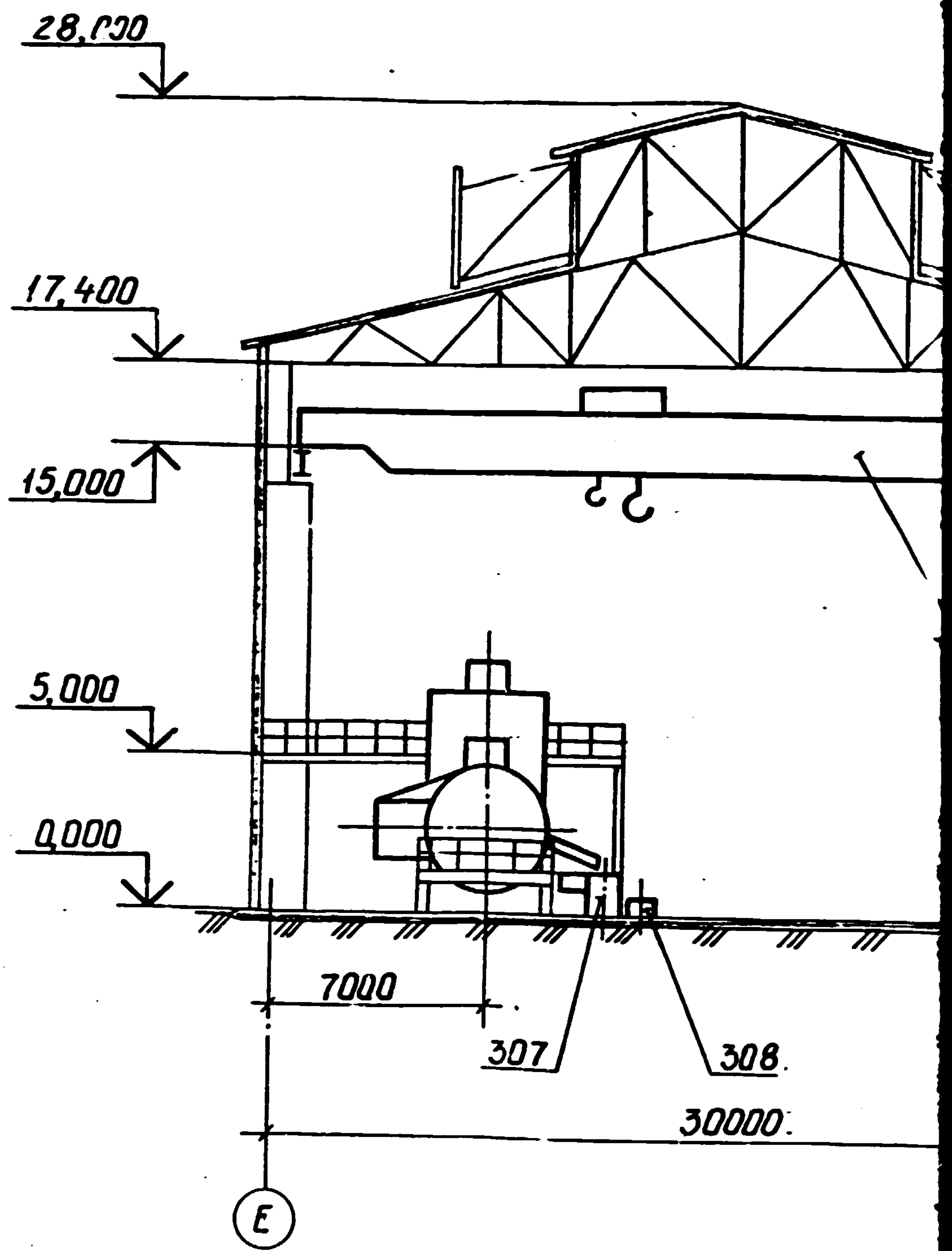


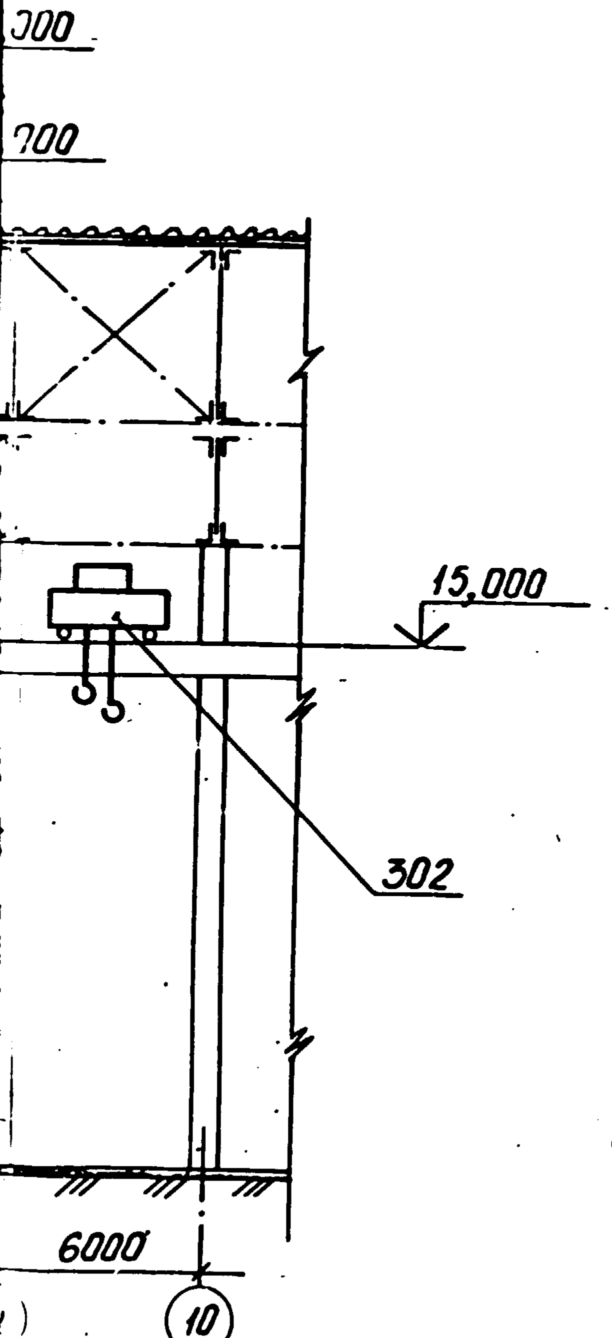
SECTION 2



B - B Sheet 3
SECTION 3
52,000
36,400
+,200
34,000
30,000
27,000
3,150
209
201
202
203
204
222
206
5500
5500
14000
7000
6 × 6000 = 36000
3000
6000
1
2
3
4
5
6
7
8
9

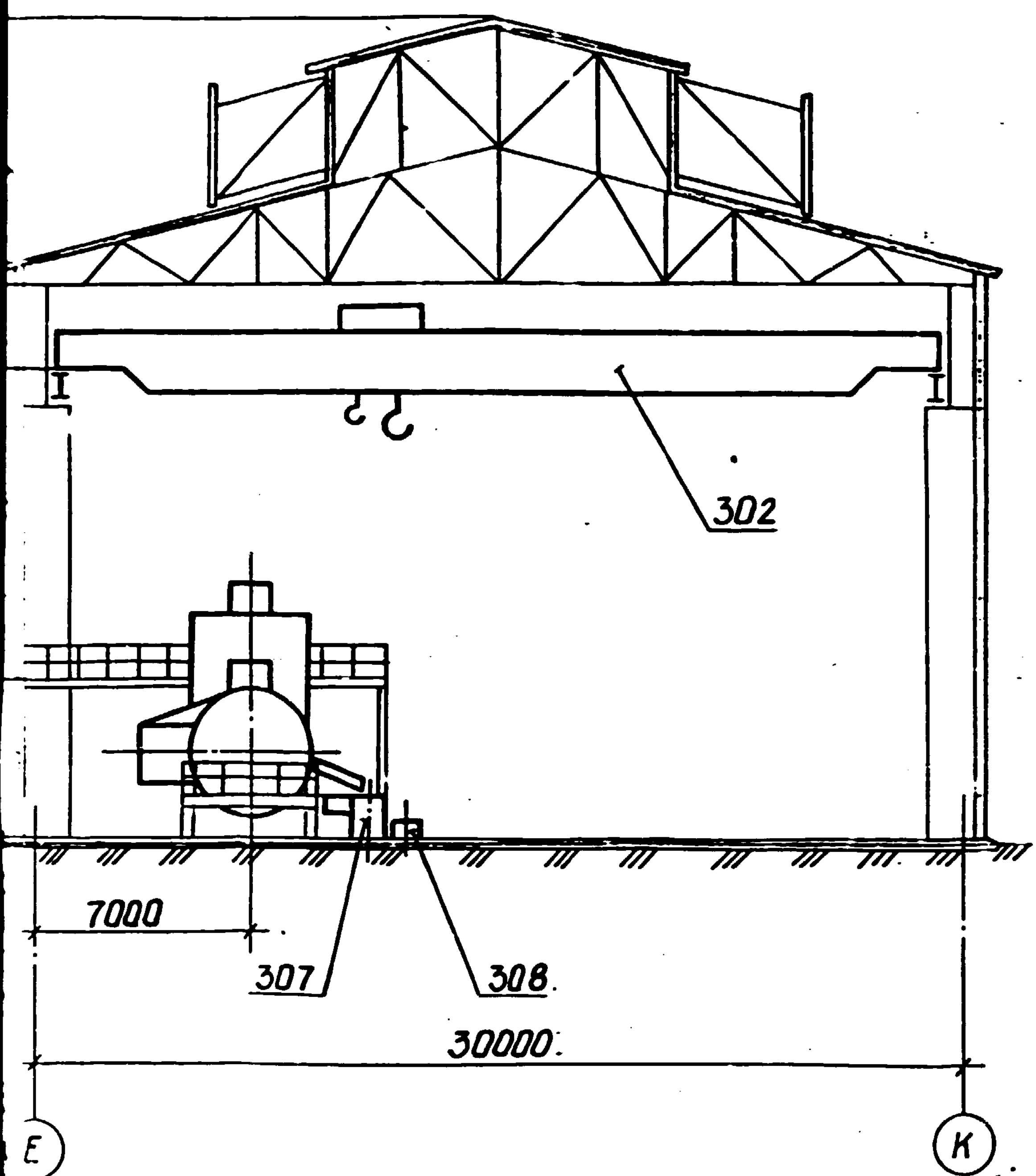
C-C SHEET 3





SECTION 4

C-C SHEET 3



SECTION 5

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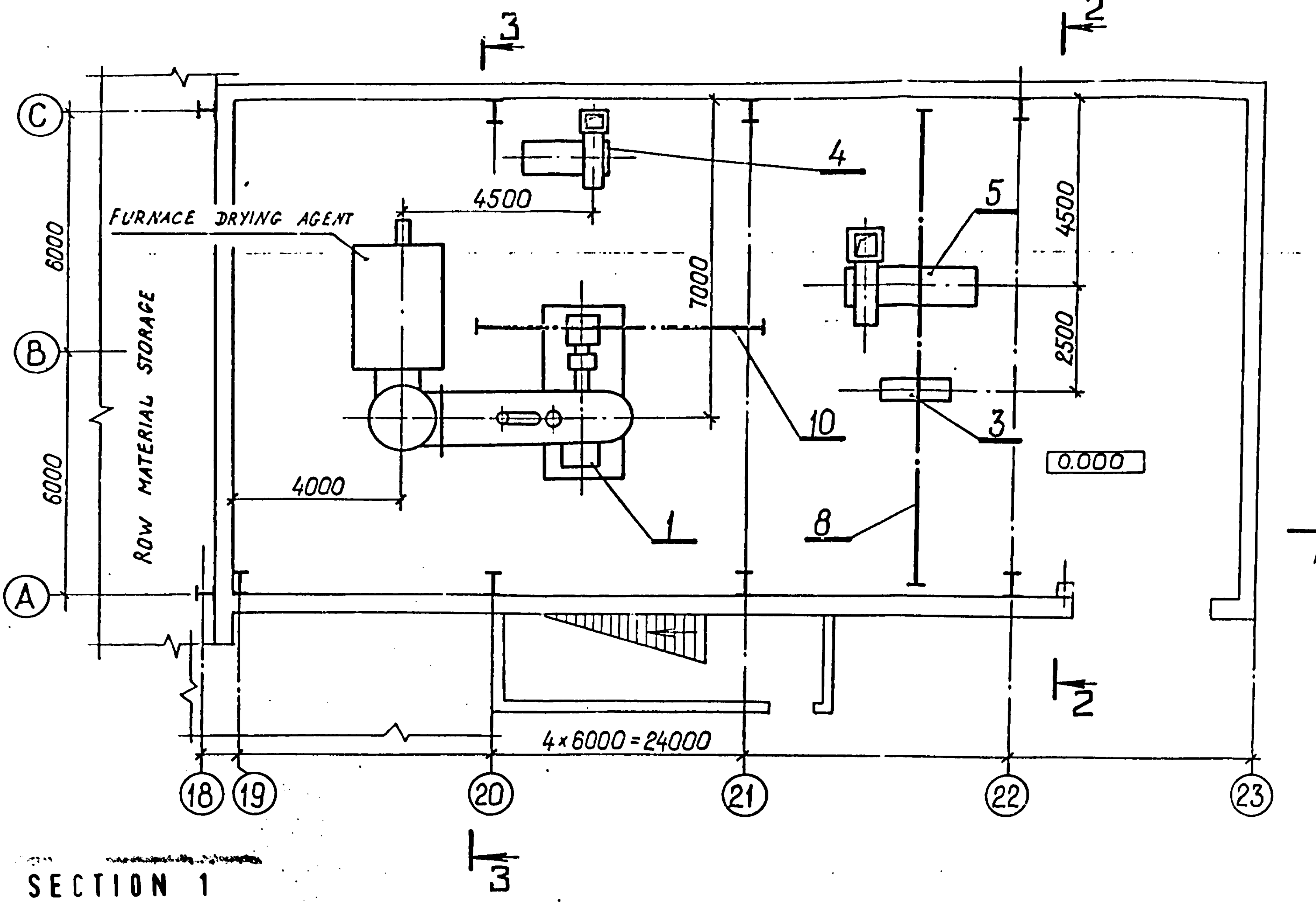
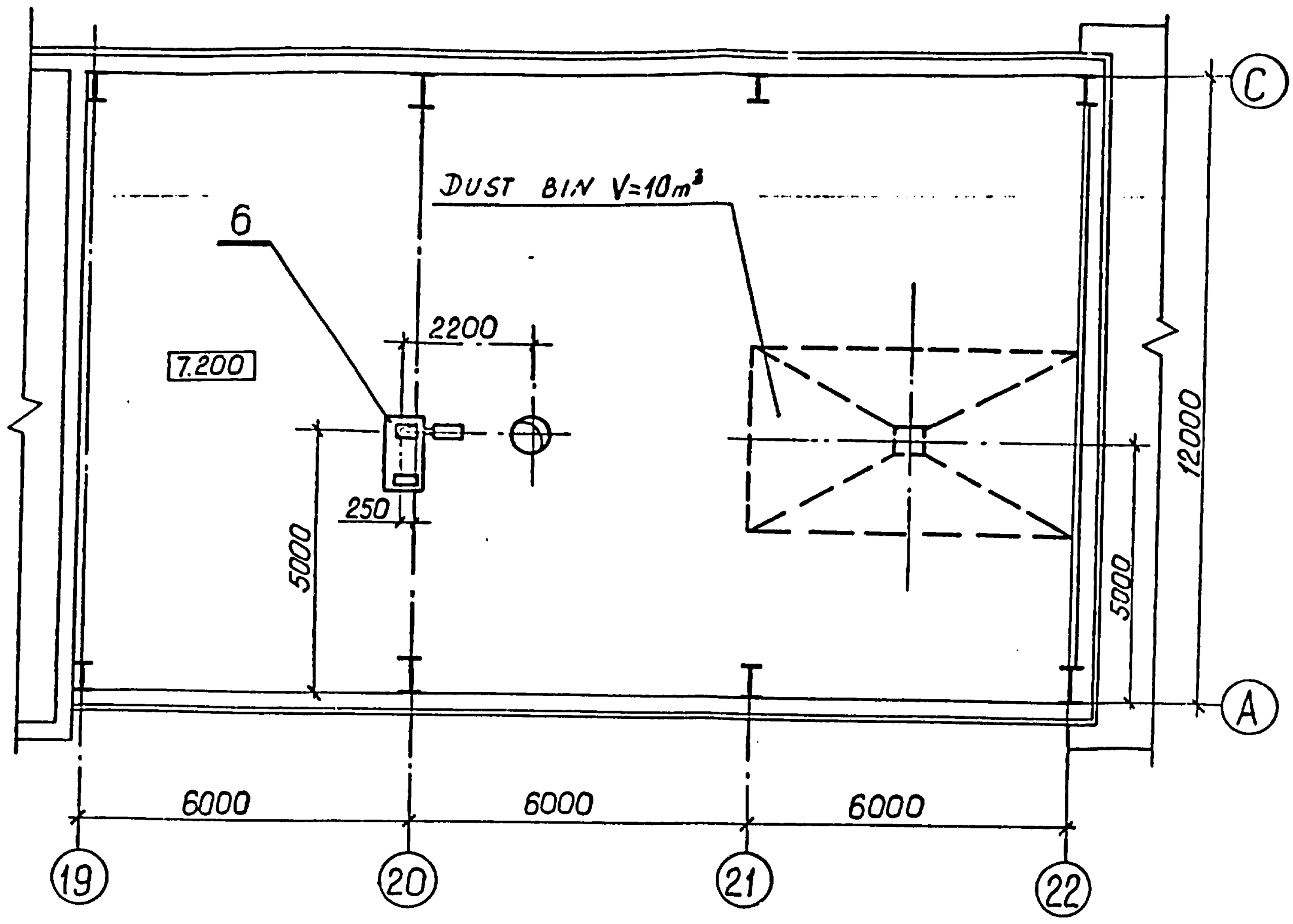
	ANGUL ALUMINIUM SMELTER (INDIA)			
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION ALLOY PREPARATION	PHASE	SHEET	SHEETS
		FS	5	
	SECTIONS	VAMI LENINGRAD		

PLAN AT EL. 0.000



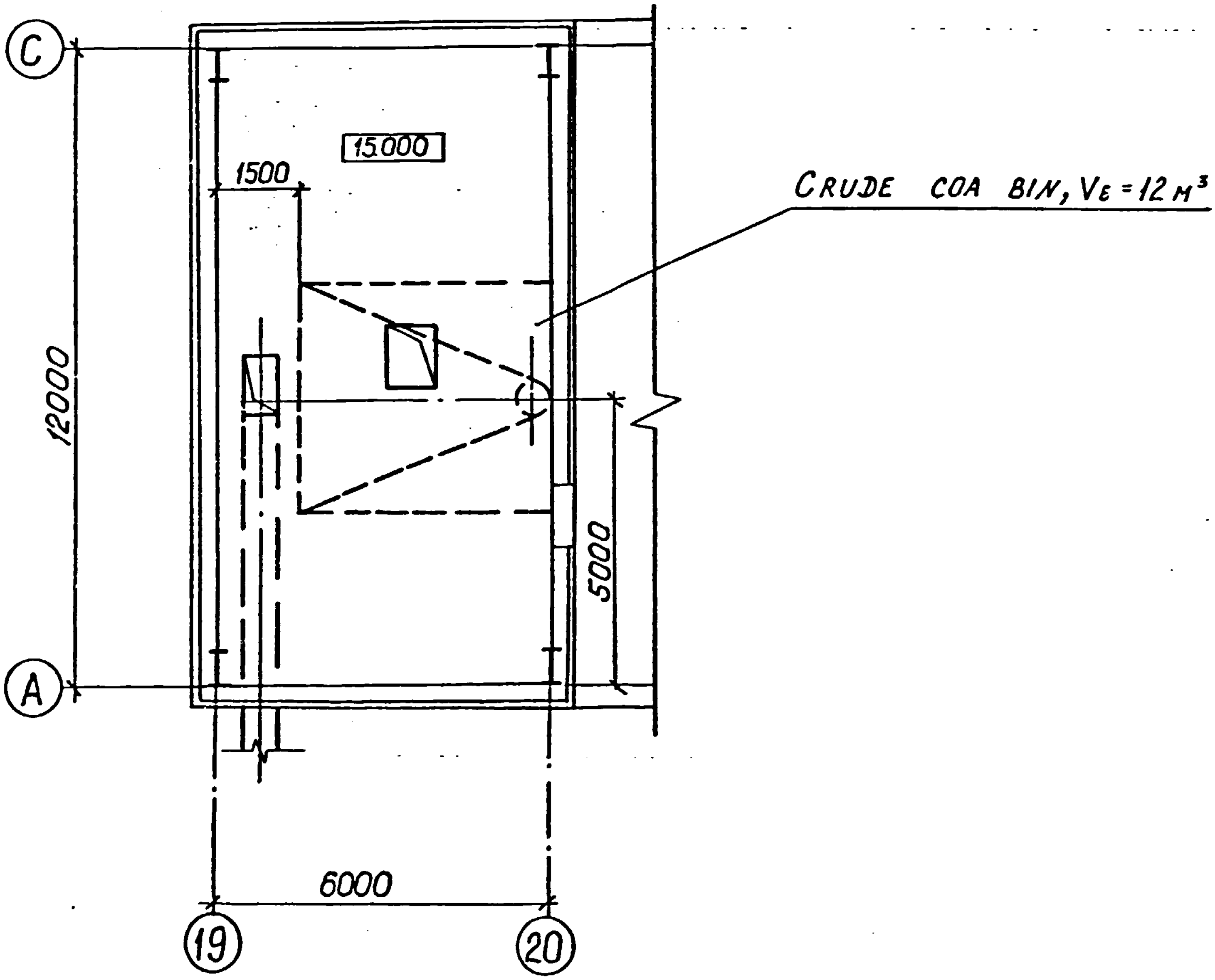
SECTION 1

PLAN AT EL. 7.200



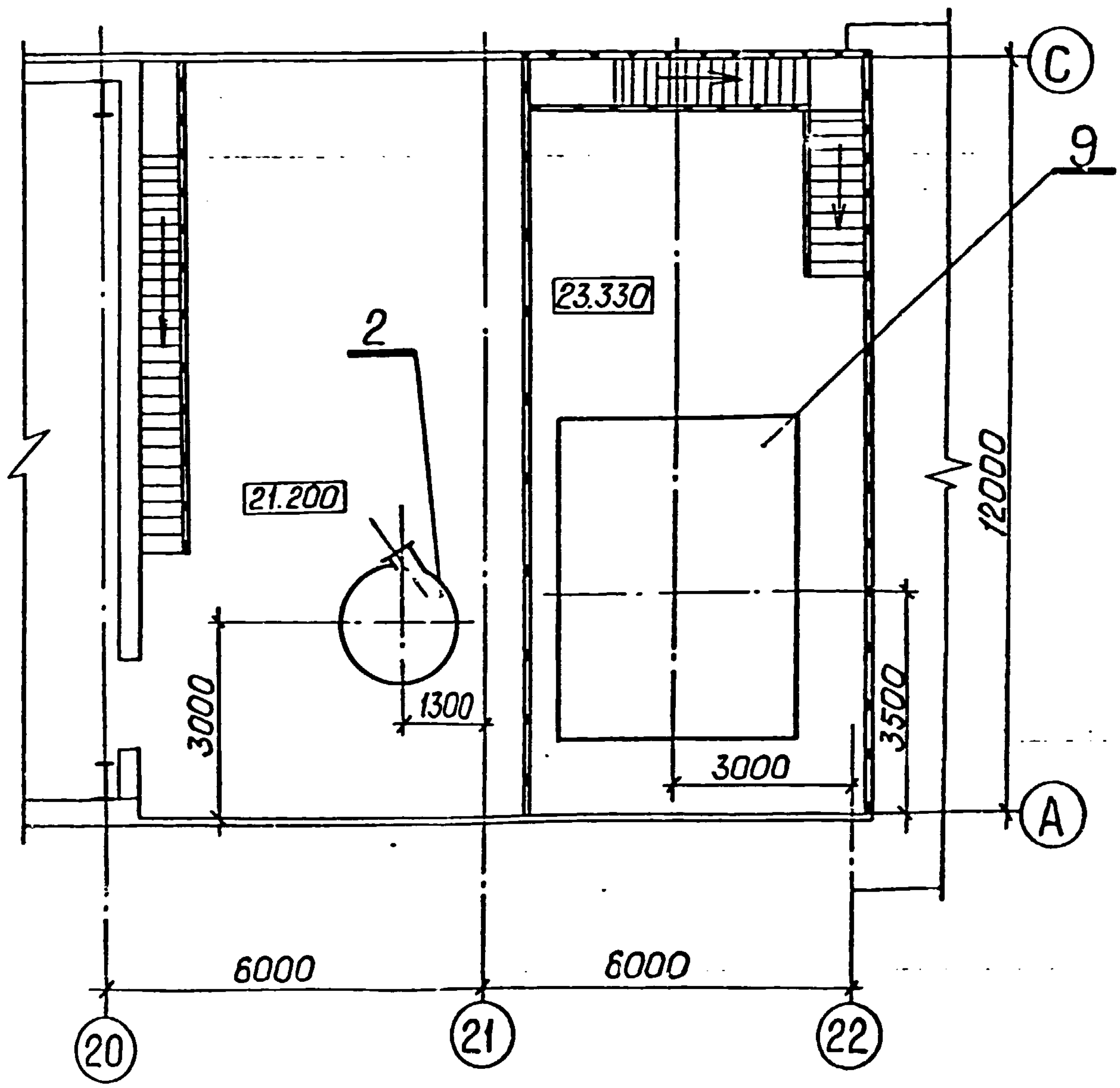
SECTION 2

PLAN AT EL.15.000



SECTION 3

PLAN AT EL.23.330



SECTION 4

SECTION 5

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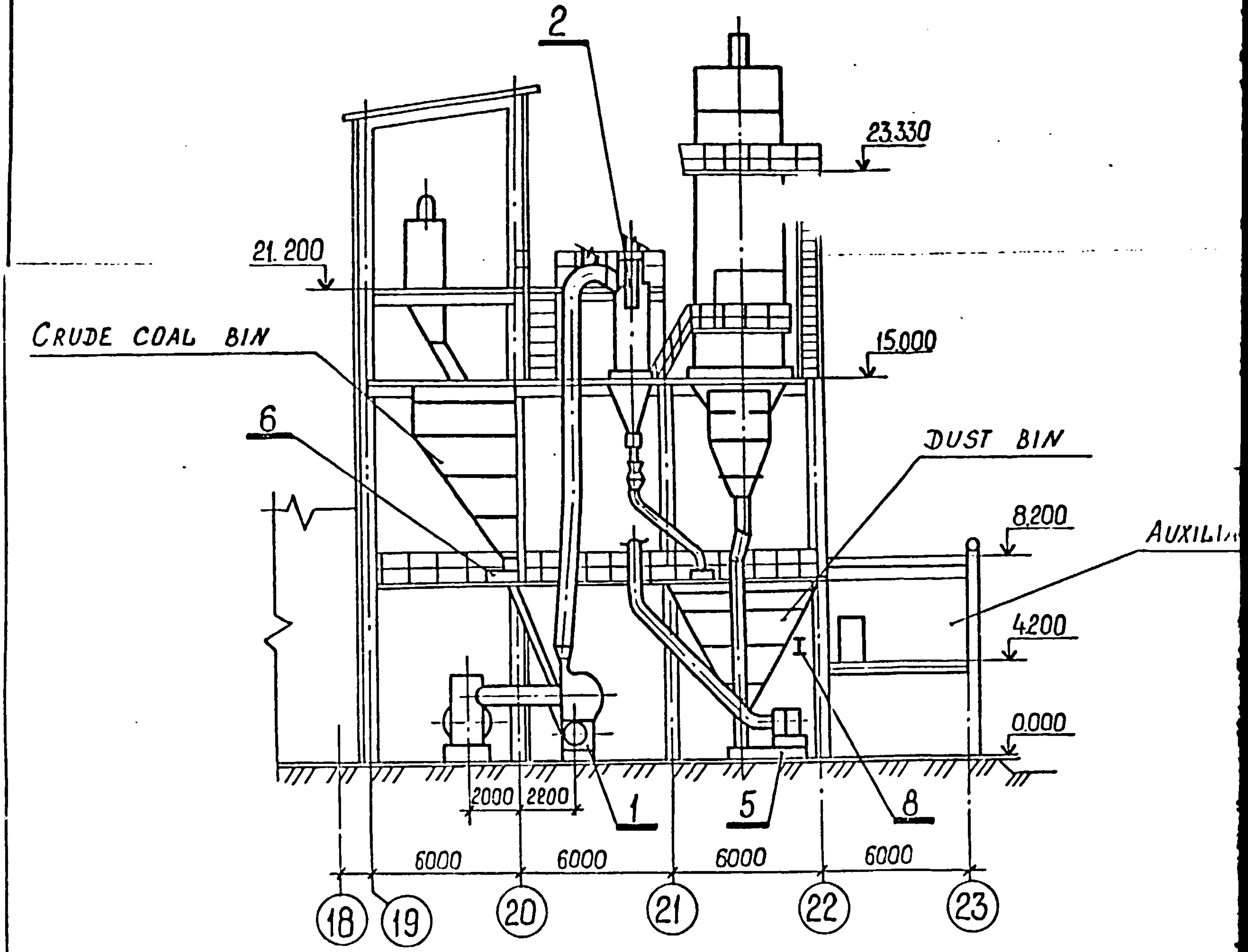
	ANGUL ALUMINIUM SMELTER (INDIA)			
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION	PHASE	SHEET	SHEETS
	REDUCTION AGENT GRINDING AREA	FS	1	3
	PLAN AT EL. 0.000, 7.200, 15.000, 23.330	VAMI LENINGRAD		

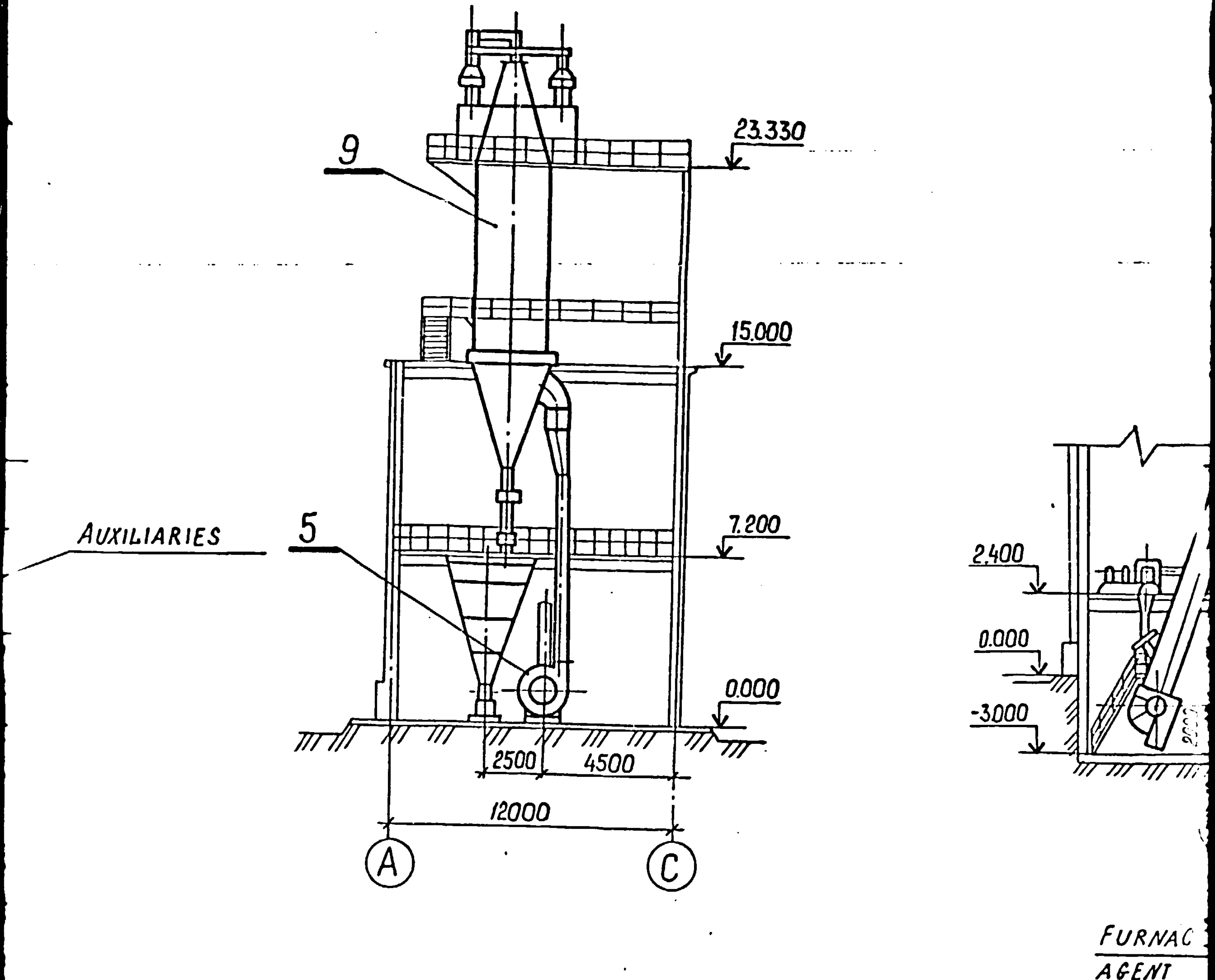
SIZE A

1 - 1

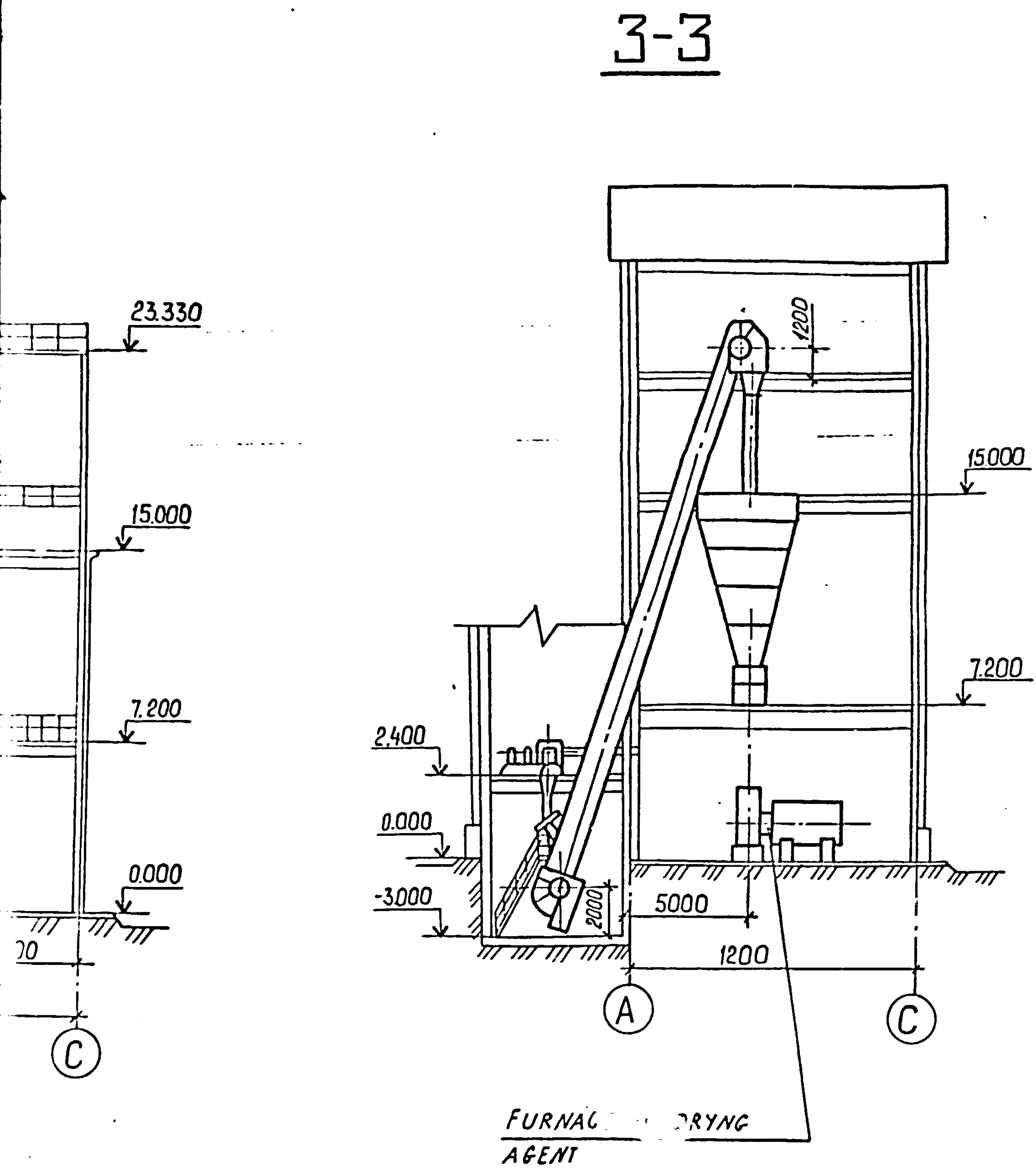

2
23.330
21.200
CRUDE COAL BIN
15.000
6
DUST BIN
8.200
AUXILIA
4200
0.000
2000
2200
1
5
8
6000
6000
6000
6000
18
19
20
21
22
23

SECTION 1

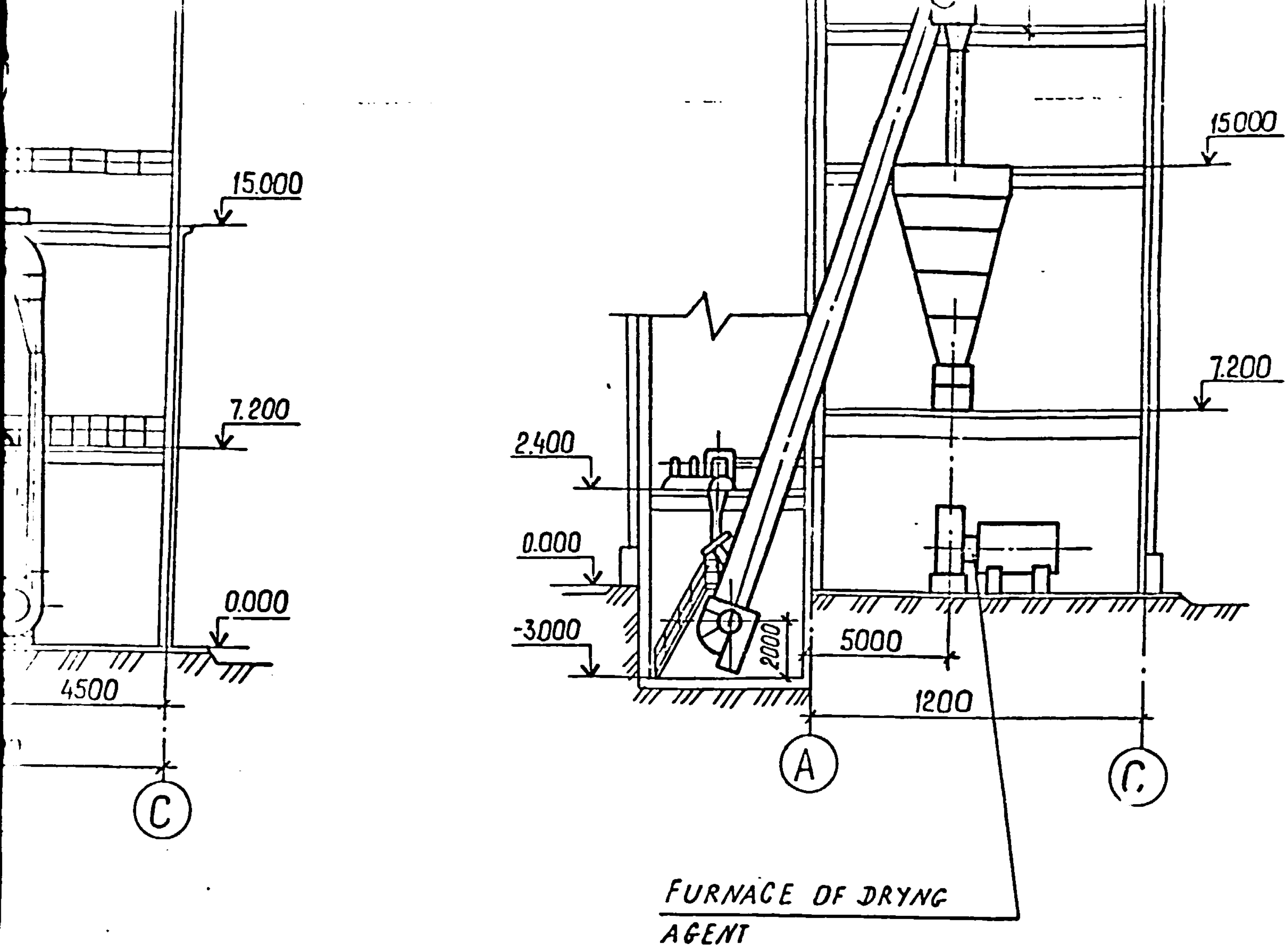
2-2


23.330
9
15.000
AUXILIARIES
5
7.200
0.000
2500
4500
12000
A
C
2.400
0.000
-3.000
FURNAC
AGENT

SECTION 2

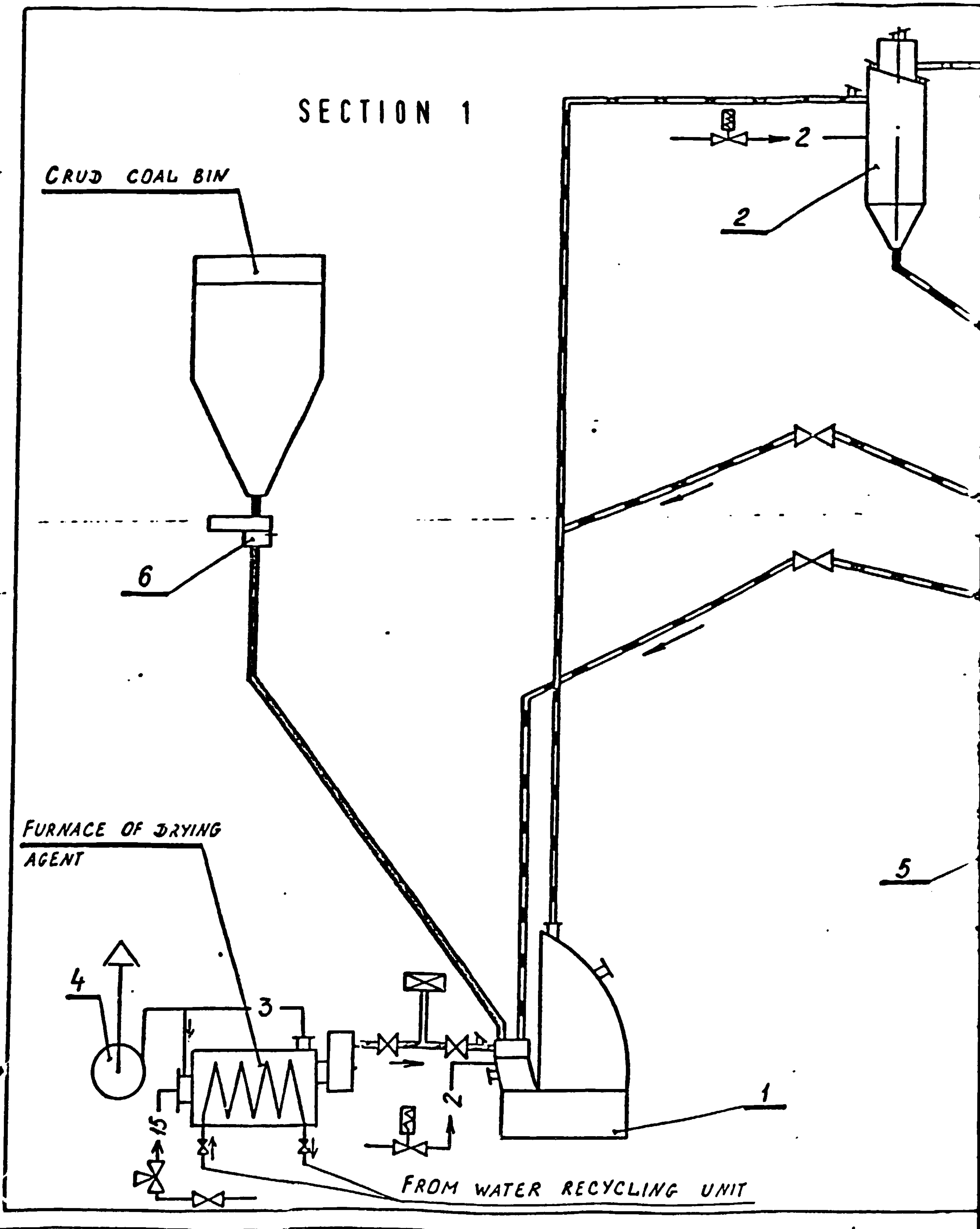

3-3
23.330
15.000
7.200
0.000
1200
15.000
7.200
2,400
0.000
-3.000
2000
5000
1200
A
C
C
FURNAC
DRYNG
AGENT

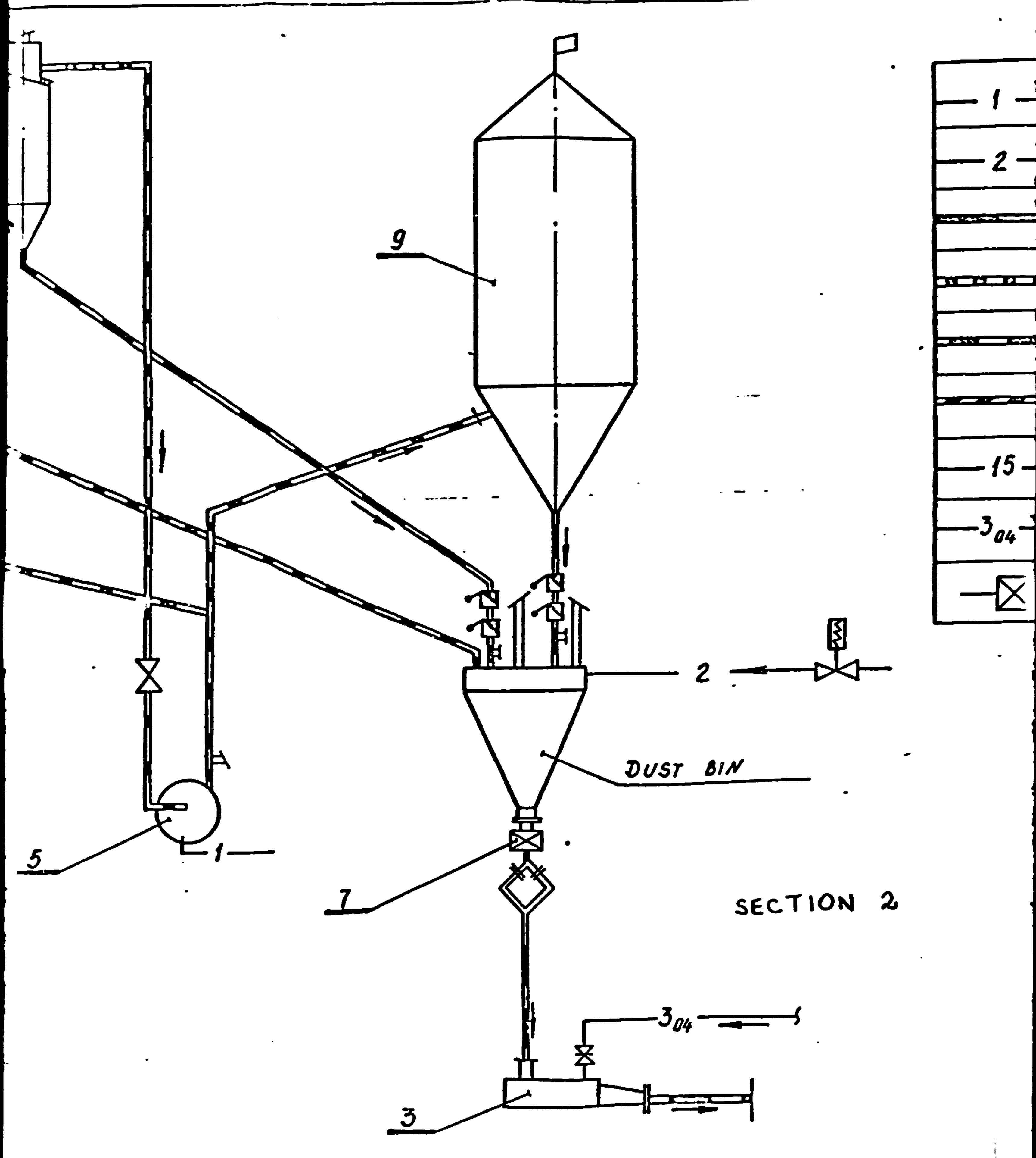
SECTION 3



SECTION 4

1343508-TM			
ANGUL ALUMINIUM SMELTER (INDIA)			
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION REDUCTION AGENT GRINDING AREA	PHASE	SHEET	SHEETS
	FS	2	
SECTIONS 1-1, 2-2, 3-3	VAMI LENINGRAD		

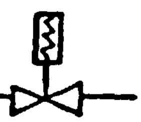

SECTION 1
CRUD COAL BIN
2
2
2
6
FURNACE OF DRYING AGENT
4
3
2
15
1
5
FROM WATER RECYCLING UNIT



SECTION 2

SYMBOLS

1	WATER		DUST SAMPLING HOLE
2	STEAM FOR FIRE FIGHTING		SWING-CHECK VALVE
	CRUDE COAL		BLINKER
	DUST-GAS-AIR MIXTURE		SAFETY VALVE
	COAL DUST		FLOW DIRECTION
	DRYING AGENT	3	AIR
15	MAZOUT		VALVE WITH EL. DRIVE
3_{04}	AIR P=0,4 MПa		SHUT-OFF WALVE
	COOL AIR VALUE		GATE



ITEM N	
1	HAM
	MMT
	ELEC
2	DUS
3	AIR
4	CENT
	WITH
5	MILL
	ELEC
6	SCRA
7	BLA
8	HAN
9	ELE
10	HAN

SECTION 3

THIS D
REPROD
RED T
OR PE
MENT

SAMPLING HOLE
-CHECK VALVE
KER
TY VALVE
V DIRECTION
WITH EL. DRIVE
OFF WALVE
E

ITEM. N	NAME	DATA	QUANTITY	NOTA
1	HAMMER TANGENTIAL MILL	CAPACITY	1	
	MMT 1300/2030/750K WITH	6T/h		
	ELECTROMOTOR	N=250KW, n=750RPM		
		VOLTAGE 415B		
2	DUST CYCLON ЦП2-1400	Φ 1400	1	
3	AIR SLIDE	CAPACITY 2,5T/h	1	VAMI DWG 1317008C6
4	CENTRIFUGAL FAN Ц14-46-6,3	$Q=3\cdot10^3$ M³/h		
	WITH ELECTROMOTOR 4A200M6	H=180 WG	1	
		N=22 KW		
		n=1000 RPM		
5	MILL FAN BM-15 WITH	$Q=18\cdot10^3$ M³/h	1	
	ELECTROMOTOR 4A315S4Y3	H=500 WG		
		N=160KW, n=1500RPM		
6	SCRAPER FEEDER	CAPACITY	1	
	ПС-700/1500	6T/h		
7	BLADE FEEDER ППЛ-5	CAPACITY 1,4-7T/h	1	
8	HAND HOIST MOBILE	г/п 1T	1	
9	ELECTROFILTER UVP-12CK	CAPACITY $18\cdot10^3$ M³/h	1	
10	HAND HOIST, MOBILE	г/п 5T	1	

SECTION 4

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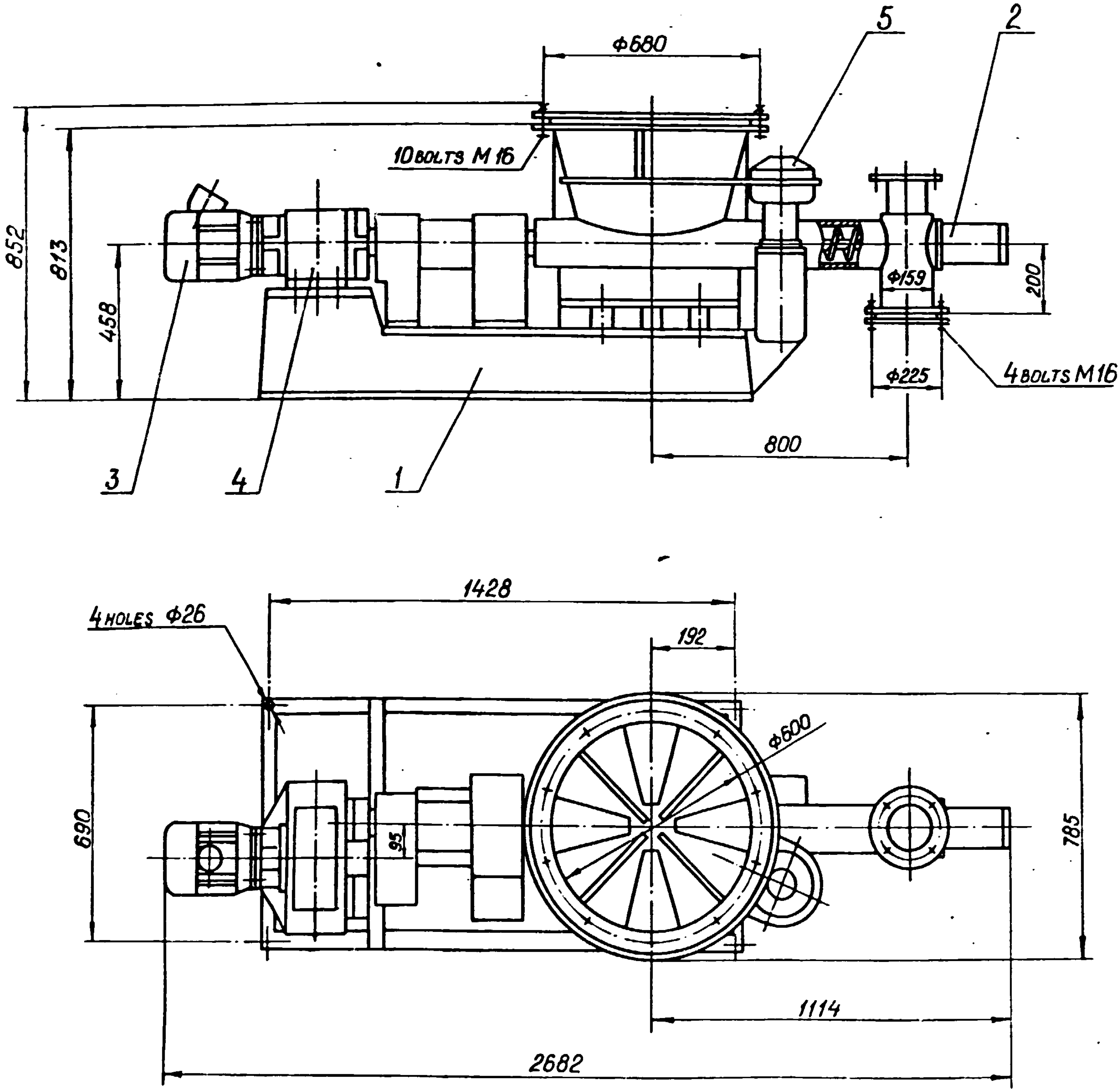
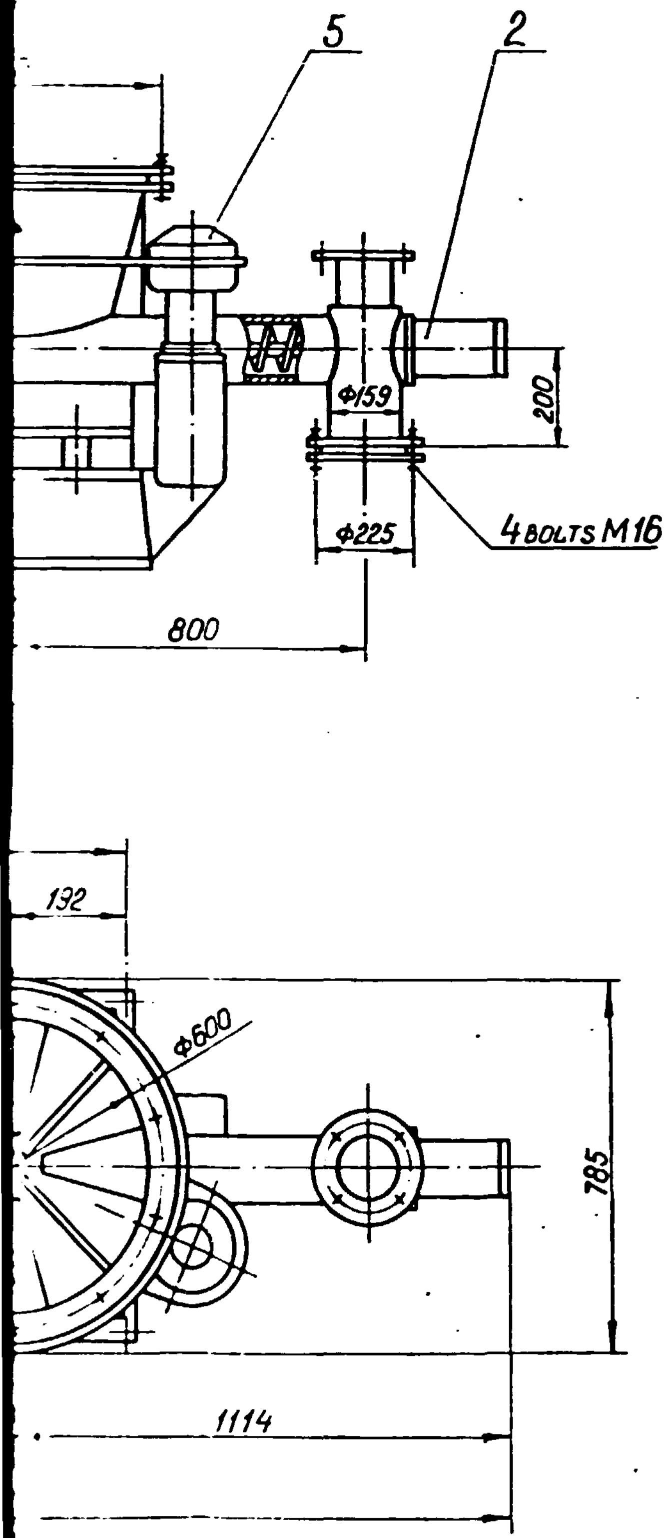
	ANGUL ALUMINIUM SMELTER (INDIA)			
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION REDUCTION AGENT GRINDING AREA	PHASE	SHEET	SHEETS
		FS	3	
	PIPELINE DIAGRAM	VAMI LENINGRAD		

SIZE A 4×4



Φ680
10 BOLTS M16
5
2
852
813
458
Φ159
200
4 BOLTS M16
Φ225
800
3
4
1
1428
4 HOLES Φ26
192
Φ600
690
95
785
1114
2682

SECTION 1



SPECIFICATIONS

1. PRODUCTION RATE, M^3/HR – 0.61...3.65
2. PROPORTIONING ACCURACY, % – ±2
3. SCREW DIAMETER, MM – 100
4. SCREW PITCH, MM – 100
5. SCREW REVOLUTION FREQUENCY, MIN^{-1} – 30...174
6. POWER RATING OF FEEDER DRIVE MOTOR, KW – 2.2
7. SHAFT REVOLUTION FREQUENCY, MIN^{-1} – 1430
8. POWER RATING OF VIBRATOR MOTOR, KW – 1.1

ITEM	CODE	DESCRIPTION	QTY	REMARK
1		FRAME	1	
2		BODY	1	
3		ELECTRIC MOTOR	1	
4		SPEED REGULATOR	1	
5		VIBRATOR	1	

SECTION 2

1395276 BO

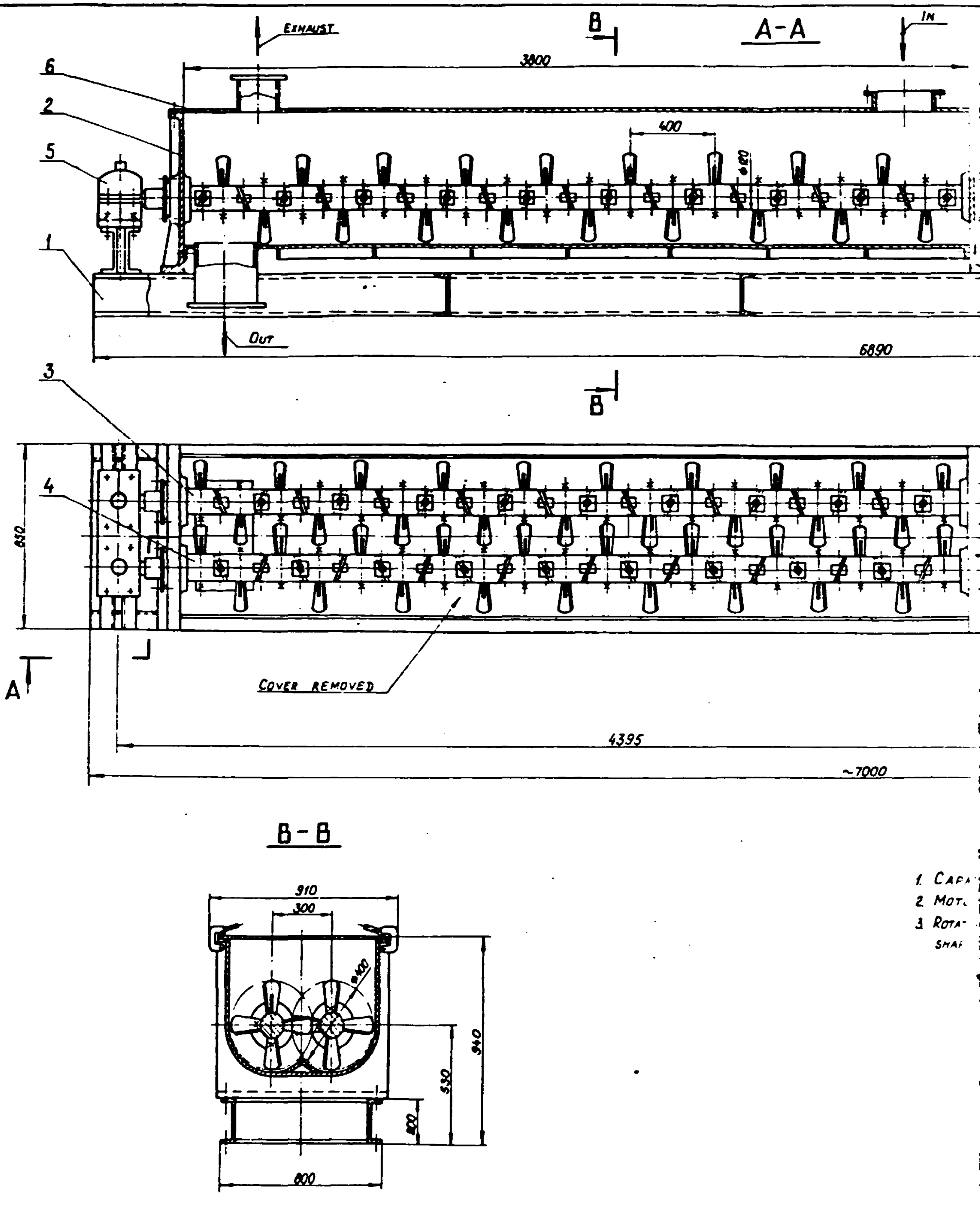
PROPORTIONER

GENERAL VIEW DRAWING

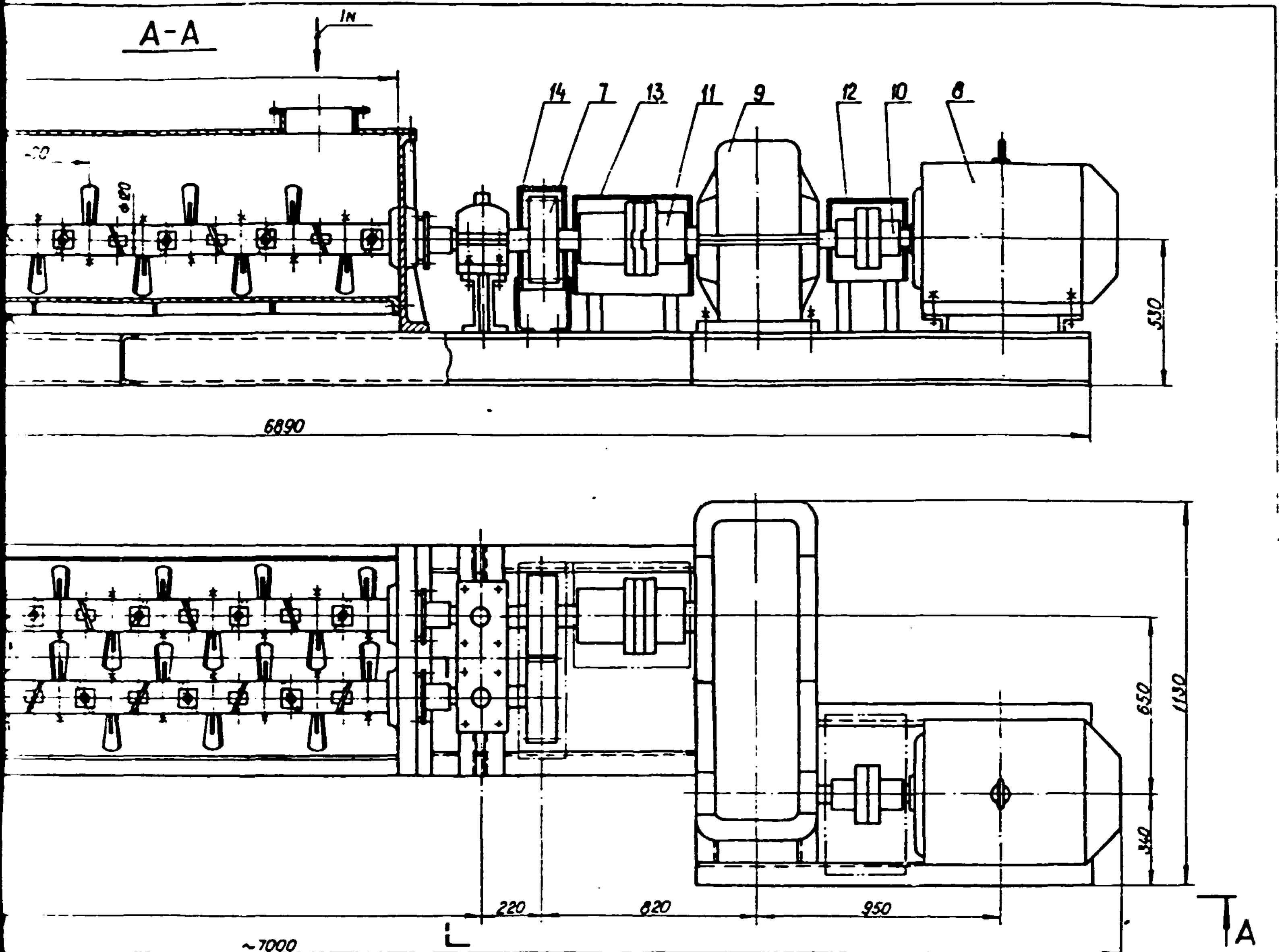
PHASE	MASS	SCALE
FS	754	1:10
SHEET	SHEETS 1	

VAMI
LENINGRAD

SIZE A2


EXHAUST
B
A-A
IN
3800
6
2
5
1
400
OUT
6890
3
B
4
850
A
COVER REMOVED
4395
~7000
B-B
910
300
940
530
800
1. CAPA
2. MOT
3. ROTA
SHAF

SECTION 1



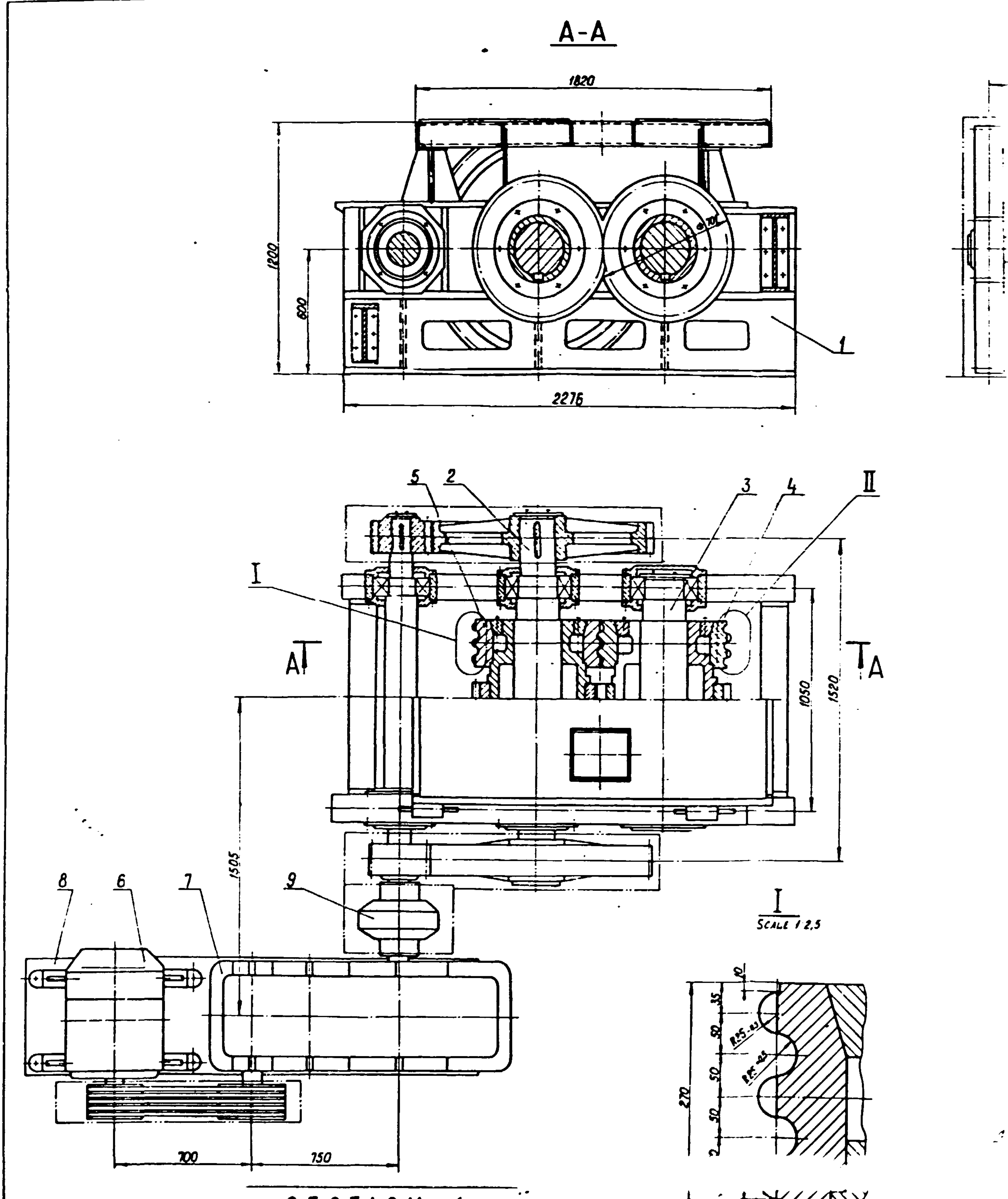
ITEM	CODE	DESCRIPTION	QTY	REMARK
1		FRAME	1	
2		BODY	1	
3		DRIVING SHAFT	1	
4		DRIVEN SHAFT	1	
5		BEARING	2	
6		COVER	1	
7		GEAR WHEEL	2	
8		ELECTRIC MOTOR	1	
9		REDUCTION GEAR	1	
10		COUPLING	1	
11		COUPLING	1	
12		CASING	1	
13		CASING	1	
14		CASING	1	

SPECIFICATIONS

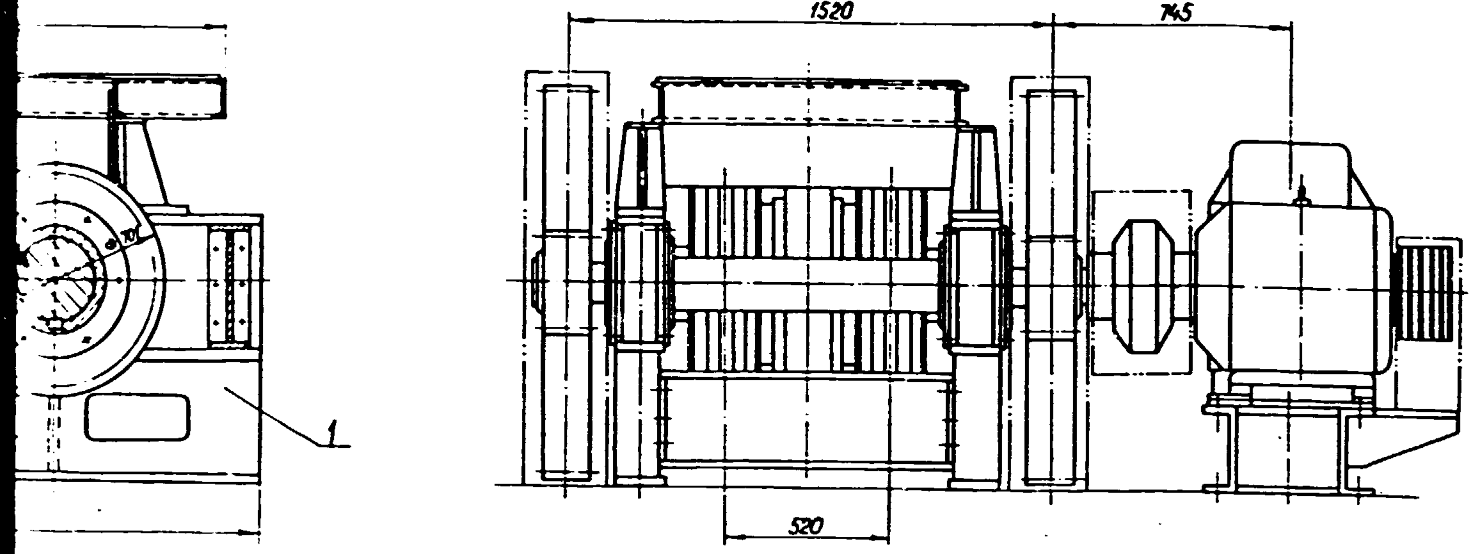
1. CAPACITY, T/HR — 6
2. MOTOR POWER RATING, KW — 30
3. ROTATION FREQUENCY OF MIXER SHAFTS, MIN^{-1} — ~90

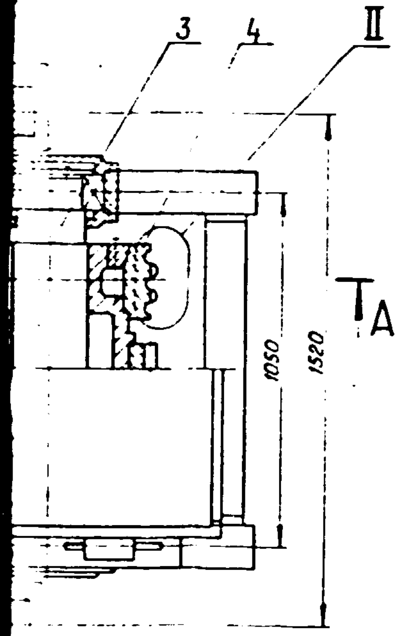
SECTION 2

1395277 BO			
BLADE MIXER GENERAL VIEW DRAWING	PHASE	MASS	SCALE
	FS	4800	1:10
	SHEET	SHEETS 1	
	VAMI LENINGRAD		
	SIZE A1		

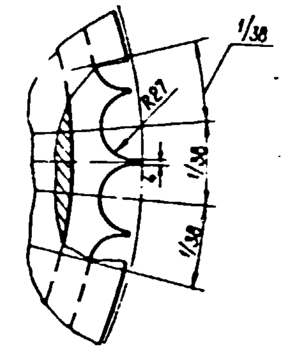

A-A
1820
1200
600
2276
1
5
2
3
4
II
I
A
A
1050
1520
1505
8
6
7
9
I
SCALE 1:2,5
10
35
50
50
50
270
700
750
2

SECTION 1





B-B
SCALE 1:2.5

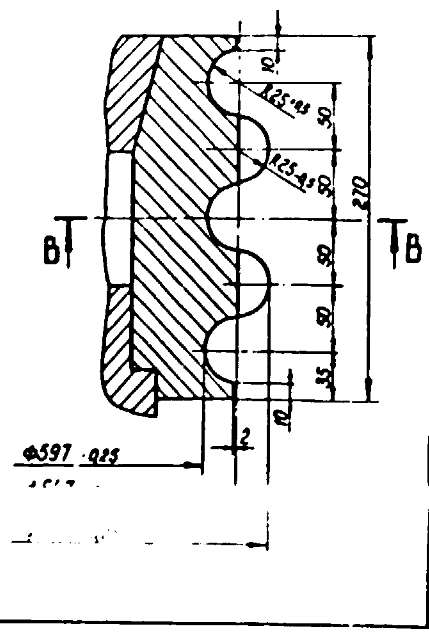


SPECIFICATIONS

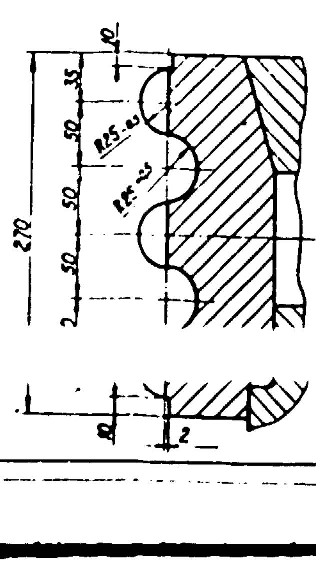
1 Capacity,	T/hr - 6
2 Working pressure, min,	MPa - 20
3 Electric motor power rating,	kW - 30
4 Shafts rotation frequency,	min^{-1} - 4 6
5 Sleeve	
- number of rows,	pcs - 5
- number of cells in row,	pcs - 38
- total number of cells,	pcs - 190

Item	Code	Description	Qty	Remark
1		Frame	1	
2		Driving shaft	1	
3		Driven shaft	1	
4		Right sleeve	2	
5		Left sleeve	2	
6		Electric motor	1	
7		Reducer	1	
8		Drive frame	1	
9		Coupling	1	

II
SCALE 1:2.5



I
SCALE 1:2.5



SECTION 2

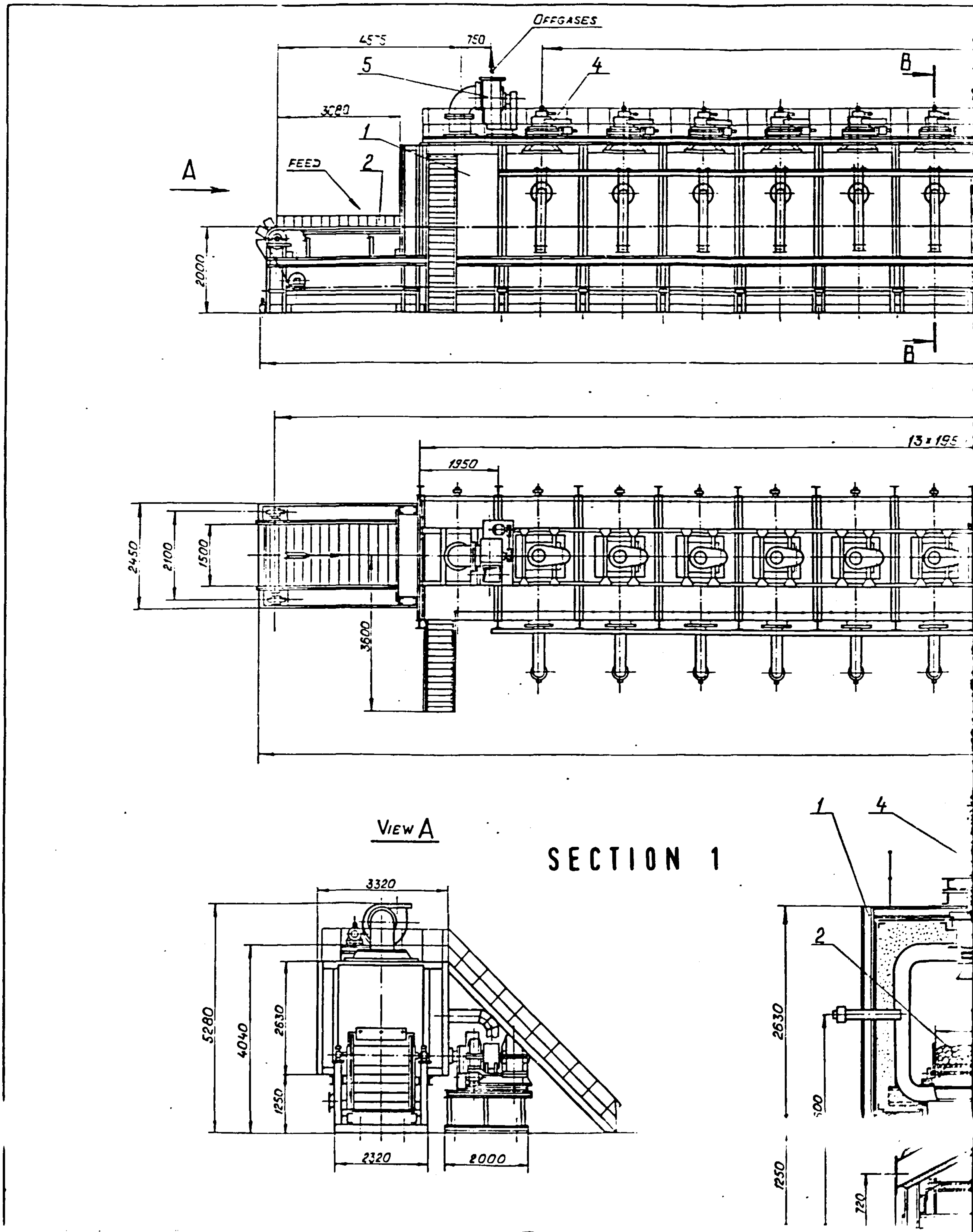
1395278 BO

... OR PERSONS WITHOUT AGREEMENT WITH VAMI

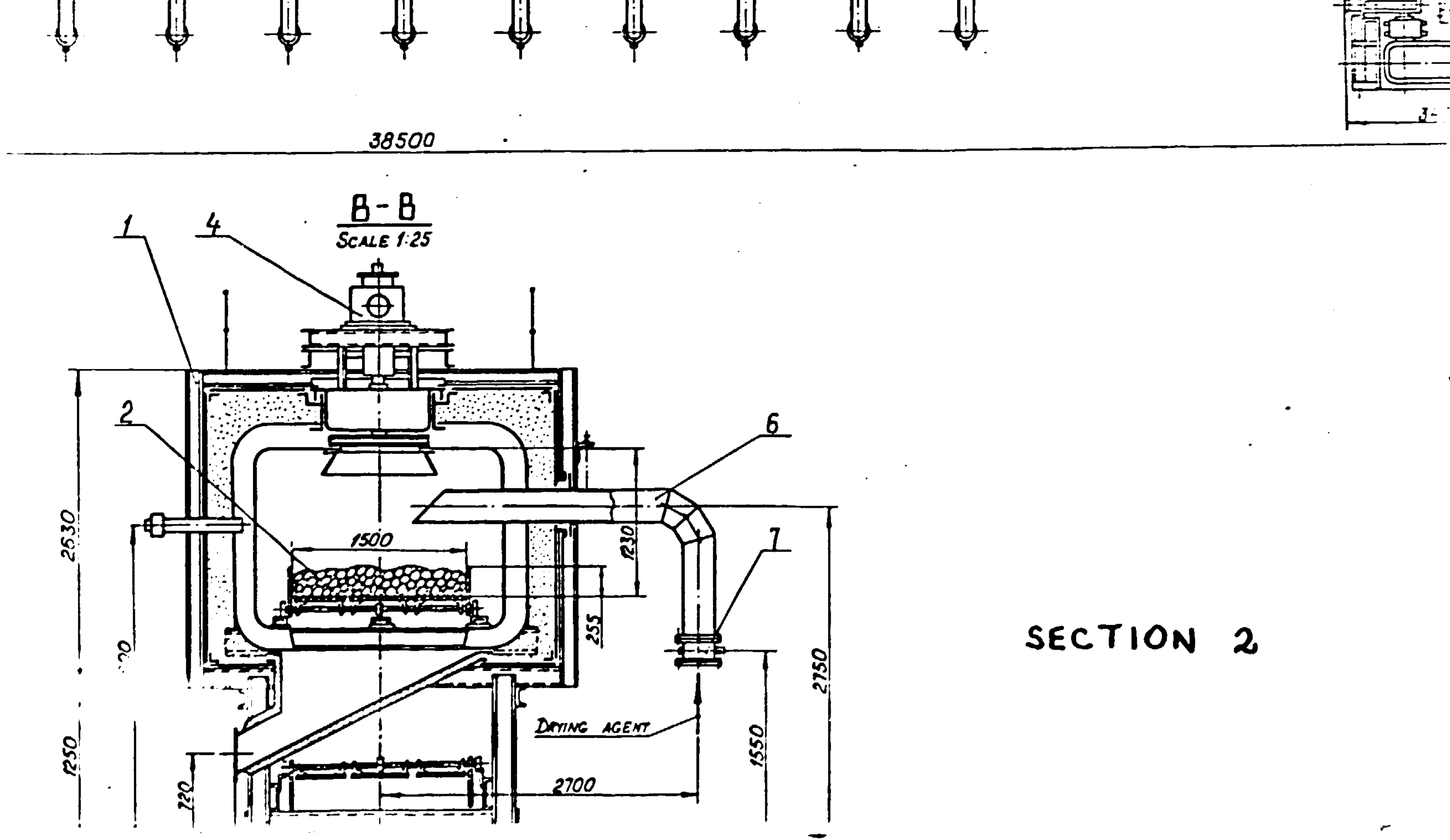
GENERAL VIEW DRAWING

Sheet	Sheets 1

VAMI
LENINGRAD
Size A1

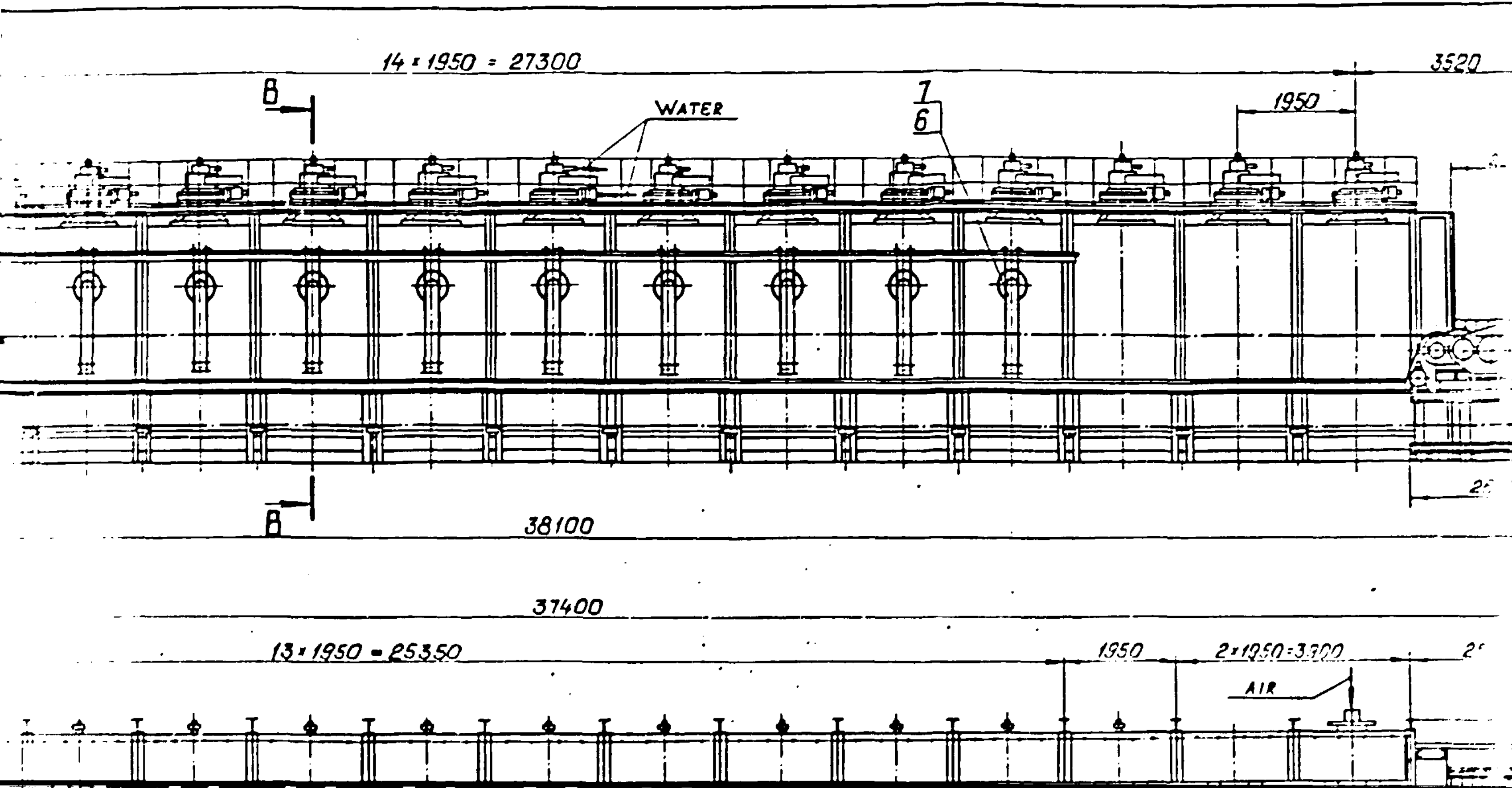


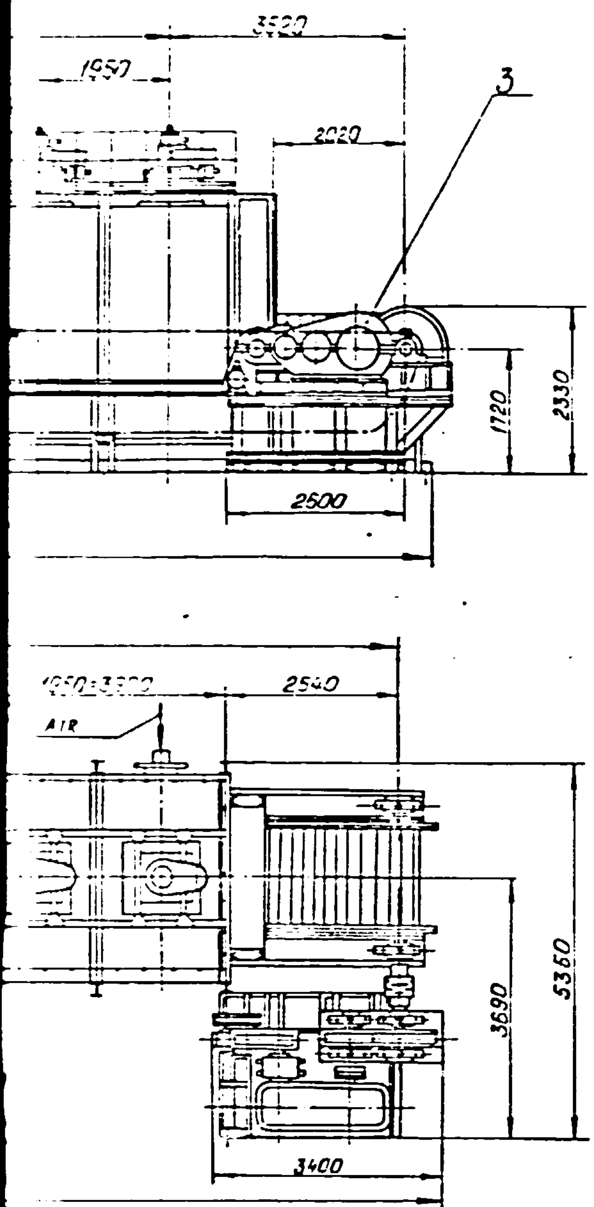
OFFGASES
750
5
4
B
1
FEED
2
A
2000
B
1950
2450
2100
1500
3600
VIEW A
SECTION 1
3320
5280
4040
2630
1250
2320
2000
1
4
2
2630
1250
720



38500
B - B
SCALE 1:25
1
4
2
6
7
1500
1230
255
2630
1250
720
2750
1550
2700
DRYING AGENT

SECTION 2


14 × 1950 = 27300
3520
B
WATER
7
6
1950
B
38100
37400
13 × 1950 = 25350
1950
AIR



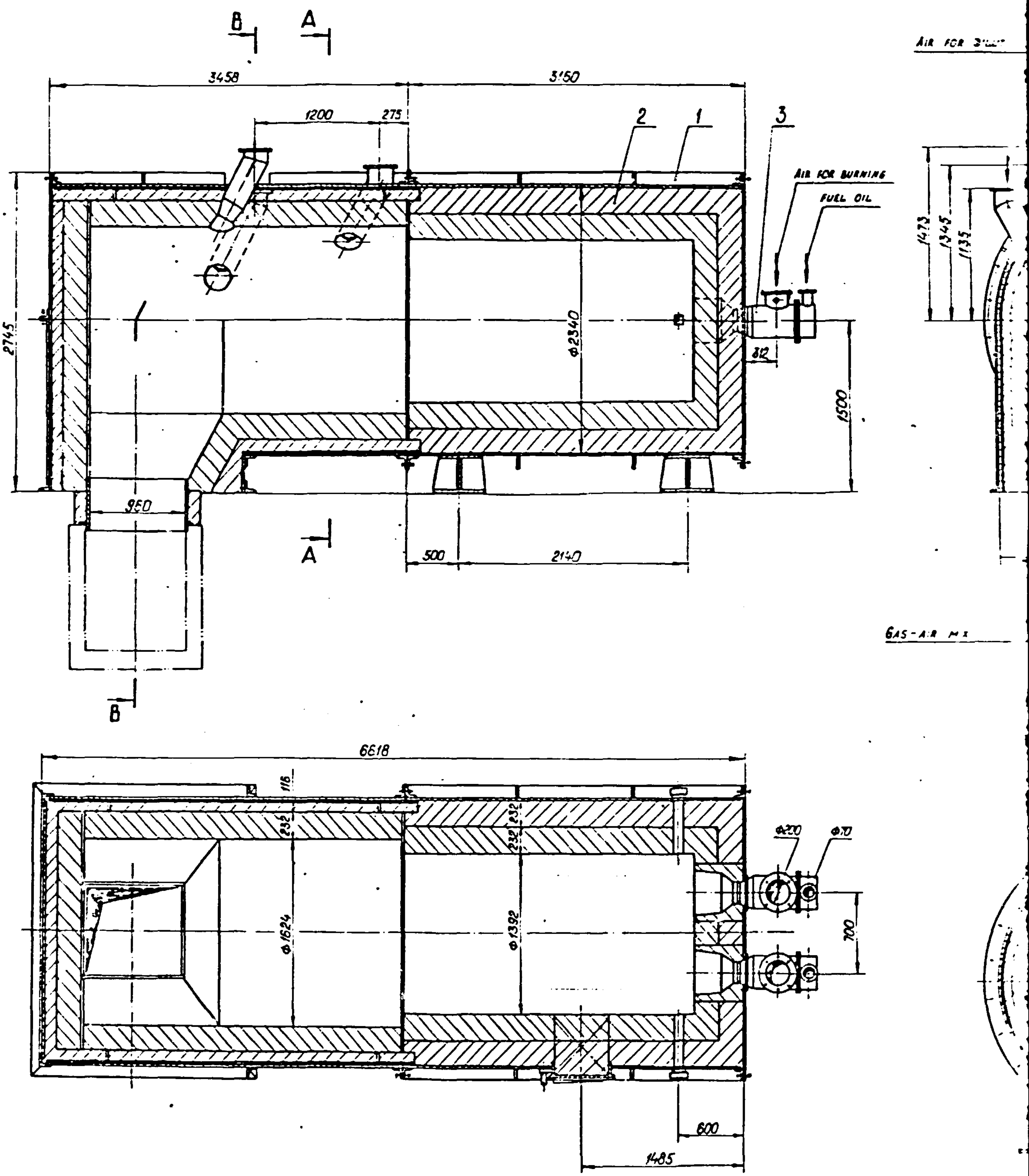
SPECIFICATIONS

1. CAPACITY, DRY BRIQUETTES, T/HR — 6
2. WATER CONTENT:
   - WET BRIQUETTES, % — TO 10
   - DRY BRIQUETTES, % — TO 2
3. TEMPERATURE IN DRYING ZONE, °C — 200...400
4. DRYING AGENT - GAS-AIR MIX AT TEMPERATURE, °C — 500...700
5. CONSUMPTION OF DRYING AGENT M^3/HR — 7000...6500
6. CONEYOR MOVEMENT SPEED, M/MIN — 0,6; 0,45/0,3
7. CONVEYOR DRIVE MOTOR POWER ATING, KW — 2,8
8. EXHAUST FAN MOTOR POWER RATING, KW — 7
9. CIRCULAT FANS MOTOR POWER, KW — 15×4,5=67,5

ITEM	CODE	DESCRIPTION	QTY	REMARK
1		BODY	1	
2		CONVEYOR	1	
3		CONVEYOR DRIVE	1	
4		CIRCULATION FAN	15	
5		EXHAUST FAN	1	
6		ELBOW	12	
7		VALVE	12	

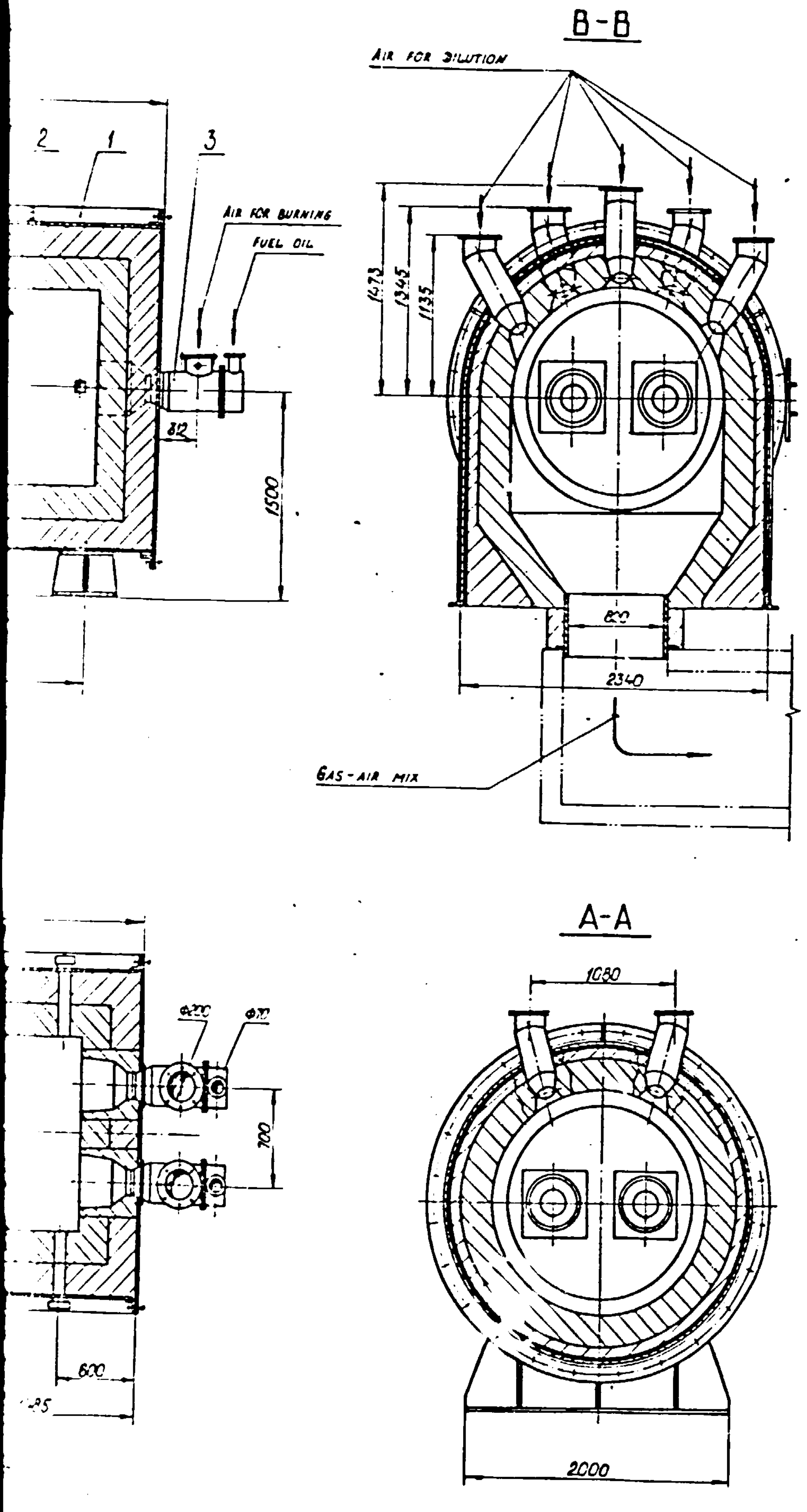
SECTION 3

1395279 80			
CONTINUOUS DRYING STOVE	PHASE	MASS	SCALE
	FS	36100	1:50
GENERAL VIEW DRAWING	SHEET	SHEETS 1	



B
A
3458
3150
1200
275
2
1
3
AIR FOR BURNING
FUEL OIL
2745
Φ2340
812
1500
950
500
2140
A
B
6618
116
232
232
232
Φ1624
Φ1392
Φ200
Φ70
700
600
1485
1473
1345
1135
GAS-AIR MIX

SECTION 1



SPECIFICATIONS

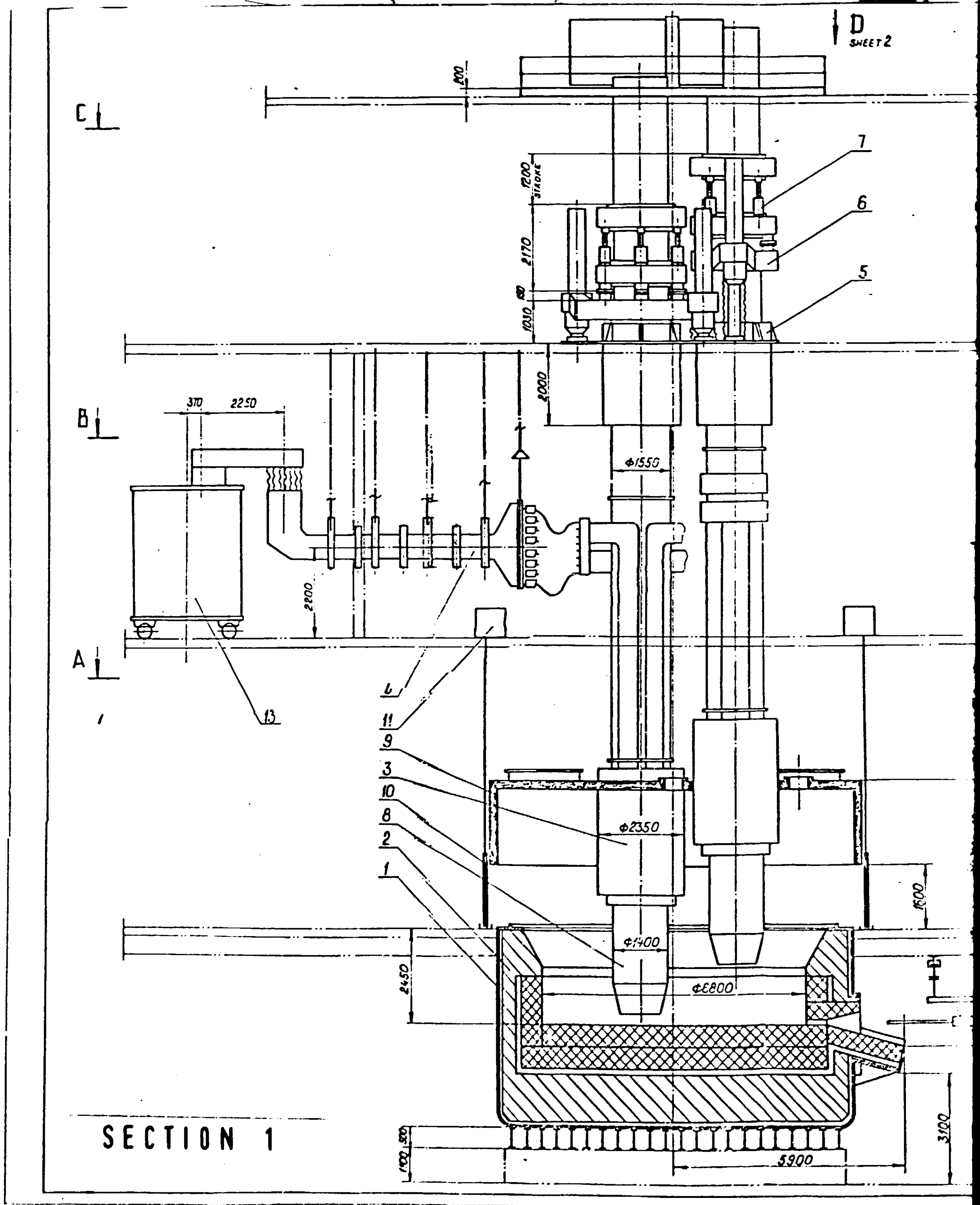
1 FUEL CALORIFIC VALUE (FUEL OIL),	KJ/KG - 418
2 FUEL OIL CONSUMPTION,	KG/HR - 130-150
3 MAXIMUM TEMPERATURE OF GAS-AIR MIX AT FURNACE OUTLET,	°C - 750

ITEM	CODE	DESCRIPTION	QTY	REMARK
1		BODY	1	
2		LINING	1	
3		BURNER	2	

SECTION 2

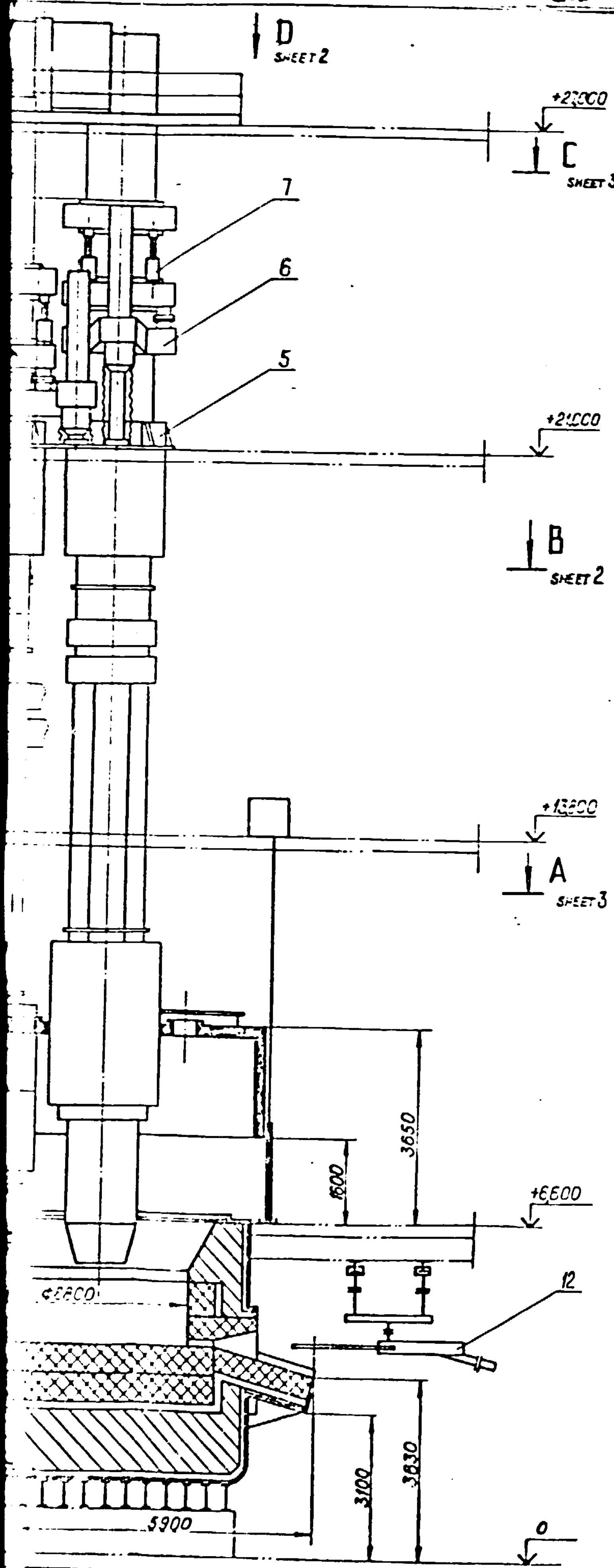
THIS DRAWING IS NOT TO BE REPRODUCED OR TRANSFERRED TO OTHER ORGANIZATIONS OR PERSONS WITHOUT AGREEMENT WITH VAMI	1395280 80			
	FUEL OIL FURNACE GENERAL VIEW DRAWING	PHASE	MASS	SCALE
		FS	27000	1:20
		SHEET	SHEETS 1	
		VAMI LENINGRAD		

SIZE A1



D
SHEET 2
C
B
A
200
1200
STROKE
2170
180
1030
2000
370
2250
2200
Φ1550
Φ2350
Φ1400
ΦE800
1600
2450
3100
500
1100
5900
7
6
5
4
11
13
9
3
10
8
2
1

SECTION 1



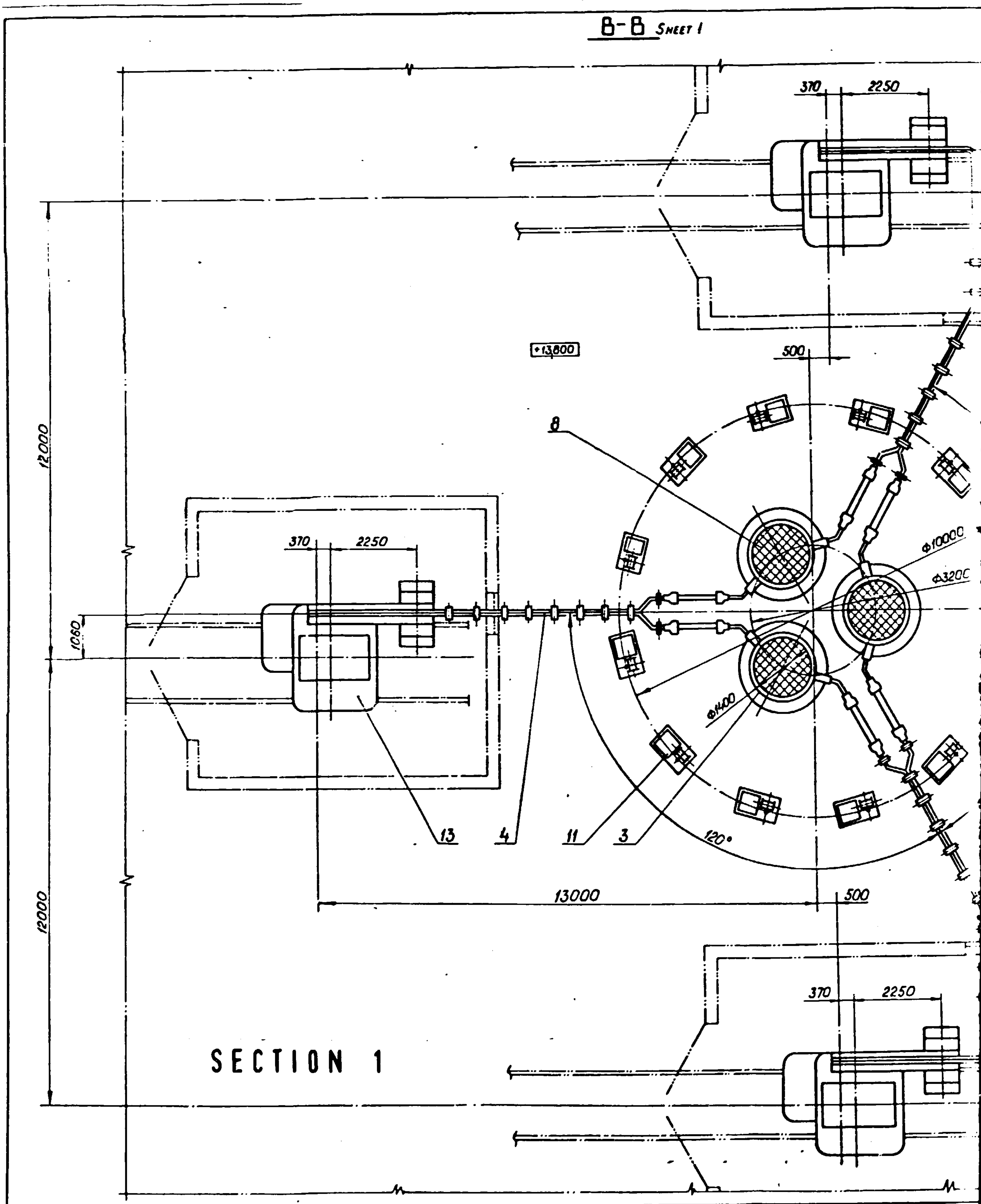
SECTION 2

SPECIFICATIONS

1. FURNACE RATED POWER, MVA —25
2. REAL POWER, MW —17
3. TYPE OF FURNACE, — OPEN STATIONARY THREE-PHASE FURNACE
4. TYPE OF ELECTRODES, — SELF-BAKING (SOEDERBERG) WITH STEEL SHELL
5. NUMBER OF ELECTRODES, PCS —3
6. ELECTRODE DIAMETER, MM —1400
7. ELECTRODE PITCH CIRCLE (MAY BE CHANGED AT FURNACE SHUT-DOWN) MM —3100...3300
8. STROKE OF ELECTRODE, MM —1200
9. NUMBER OF TAPHOLES, PC. — 1
10. GEOMETRIC DIMENSIONS OF CAVITY:
    - —DEPTH, MM —2450
    - —DIAMETER, MM —6800
11. NUMBER OF PHASES, PCS — 3
12. VOLTAGE OF TRANSFORMERS IDLE RUNNING, V —140 230
13. MINIMUM CURRENT IN ELECTRODE, A —85000
14. NUMBER OF FURNACE TRANSFORMERS, PCS — 3
15. TYPE OF FURNACE TRANSFORMERS, — SINGLE-PHASE
16. INSTALLED POWER OF ONE TRANSFORMER, MVA — 8,33
17. FURNACE POWER FACTOR, $\cos\varphi$:
    - —NATURAL, WITHOUT COMPENSATION, — 0,68
    - —WITH COMPENSATION DUE TO LONGITUDINAL COMPENSATION UNIT, — 0,80
    - —WITH COMPLETE COMPENSATION ON HV SIDE, — 0,92
18. SPECIFIC POWER CONSUMPTION PER 1T OF REFINED ALLOY, KWHR/T —13000±5%

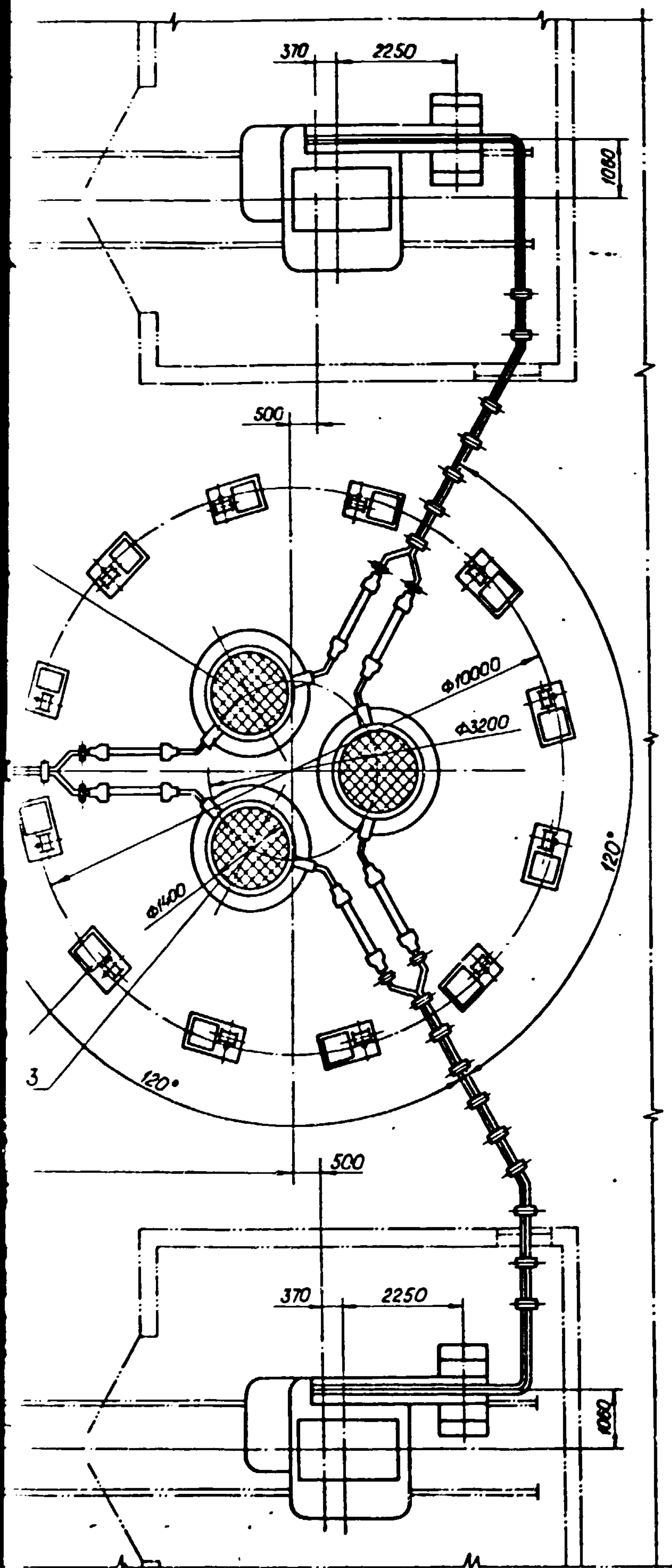
ITEM	CODE	DESCRIPTION	QTY	REMARK
1		SHELL	1	
2		LINING	1	
3		CURRENT LEAD	3	
4		SHORT CIRCUIT	1	
5		CENTRING SLEEVE	3	
6		HYDRAULIC JACK	3	
7		BY PASS MECHANISM	3	
8		ELECTRODE	3	
9		EXHAUST HOOD	1	
10		CURTAIN COVER	1	
11		WINCH	12	
12		POKER	1	
13		TRANSFORMER	3	

1395281 BO			
25 MVA ELECTRIC ARC REDUCTION FURNACE	PHASE	MASS	SCALE
	FS	[illegible]	1:50
GENERAL VIEW DRAWING	SHEET 1	SHEETS 3	
	VAMI LENINGRAD		

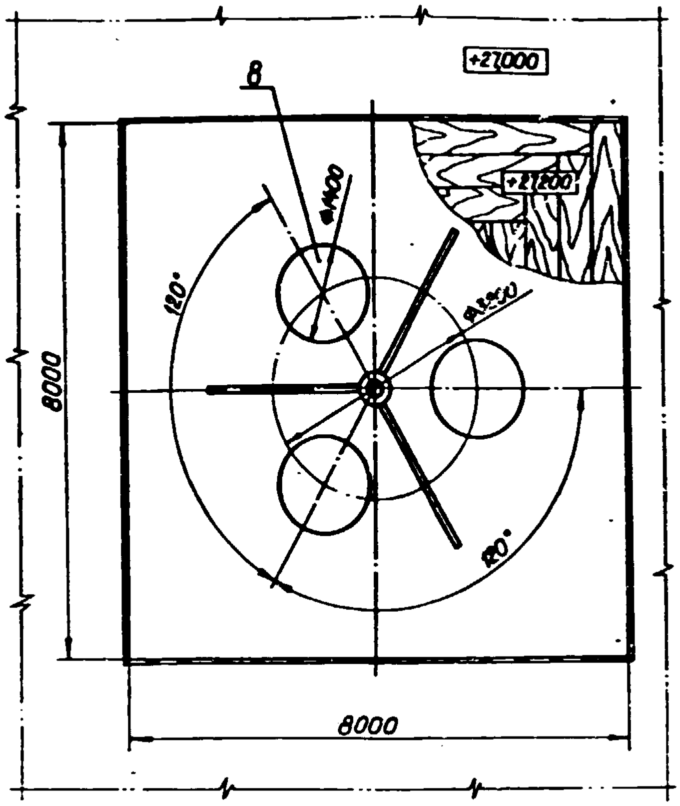


B-B Sheet 1
370
2250
+13800
500
8
12000
370
2250
1060
Φ10000
Φ3200
Φ1400
120°
13
4
11
3
13000
500
12000
370
2250
SECTION 1

-B Sheet 1



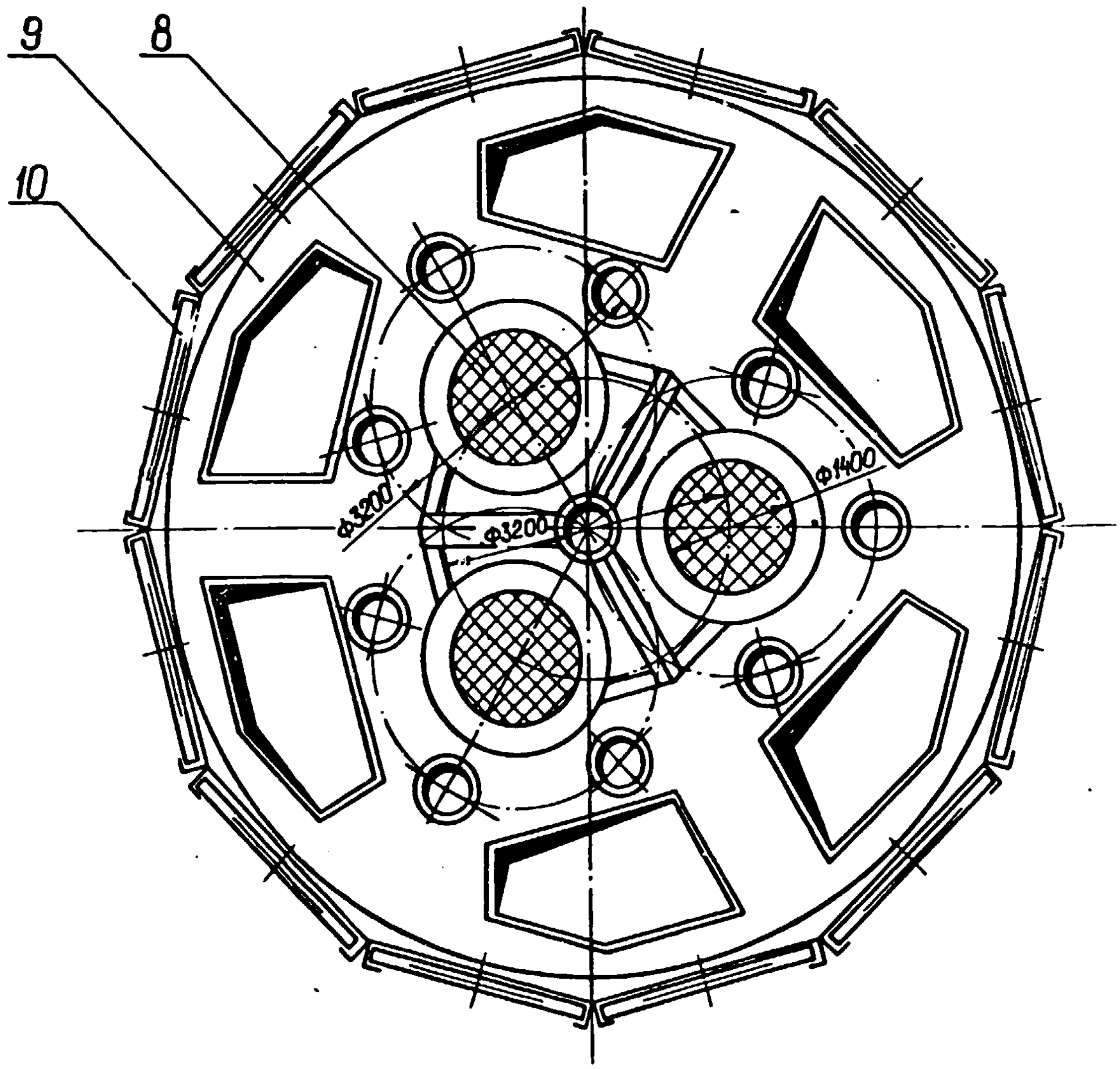
View D Sheet 1



SECTION 2

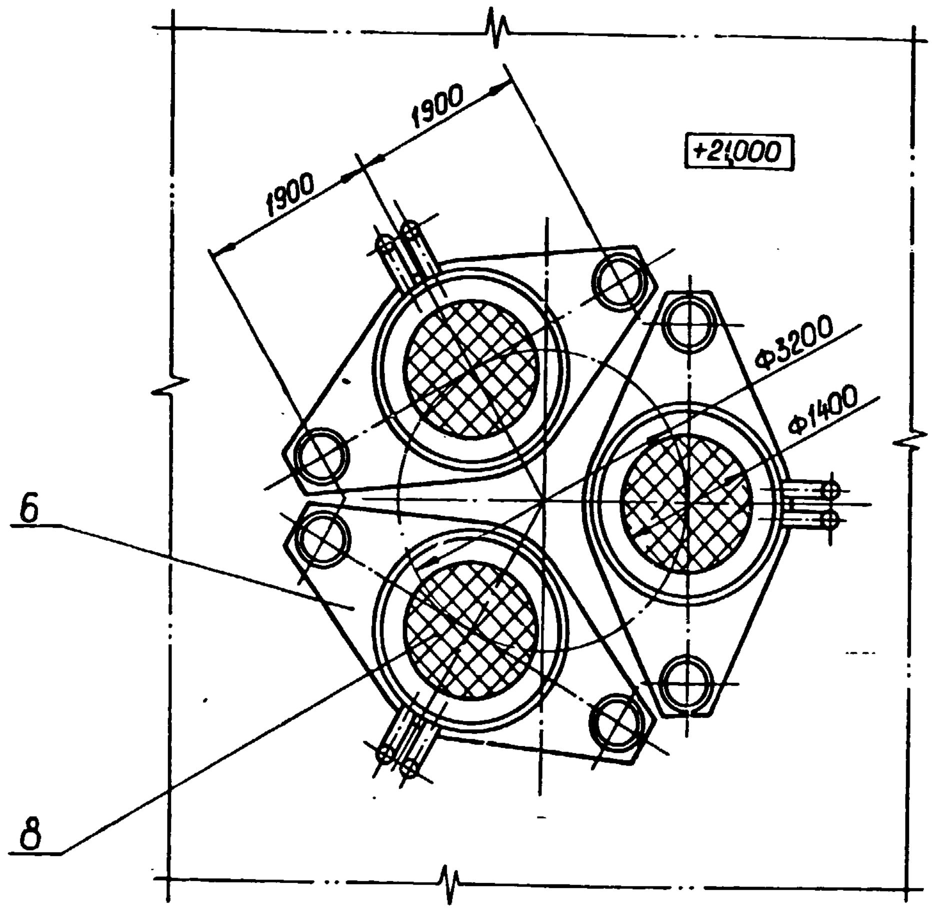
This drawing is not to be reproduced or transferred to other organizations or persons without agreement with VAMI	1395281 80			
	25 MVA ELECTRIC ARC REDUCTION FURNACE GENERAL VIEW DRAWING	Phase	Mass	Scale
		FS	—	1 50
		Sheet 2		Sheets
		VAMI Leningrad		
		Size A1		

A-A SHEET 1



SECTION 1

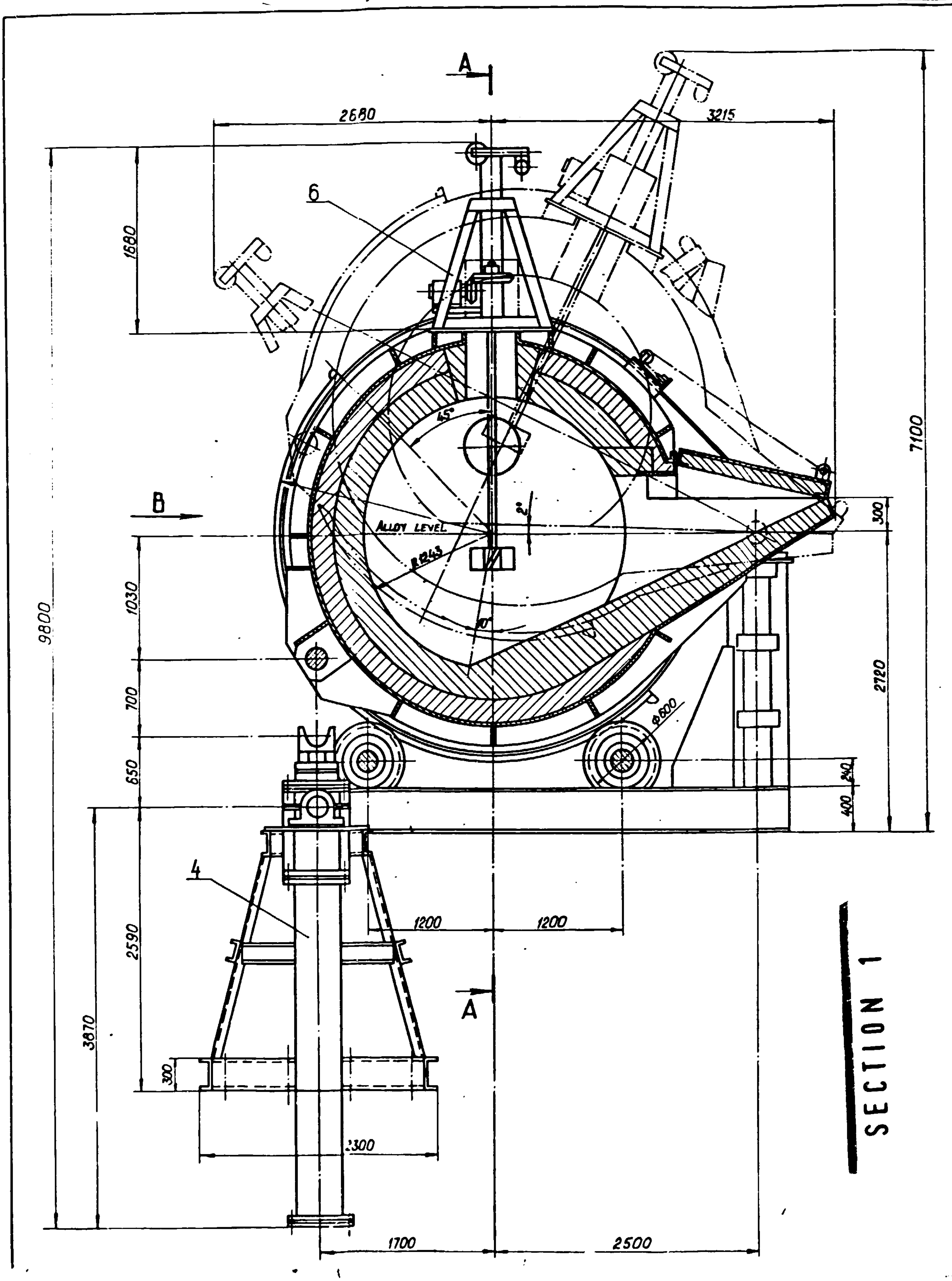
C - C Sheet 1



SECTION 2

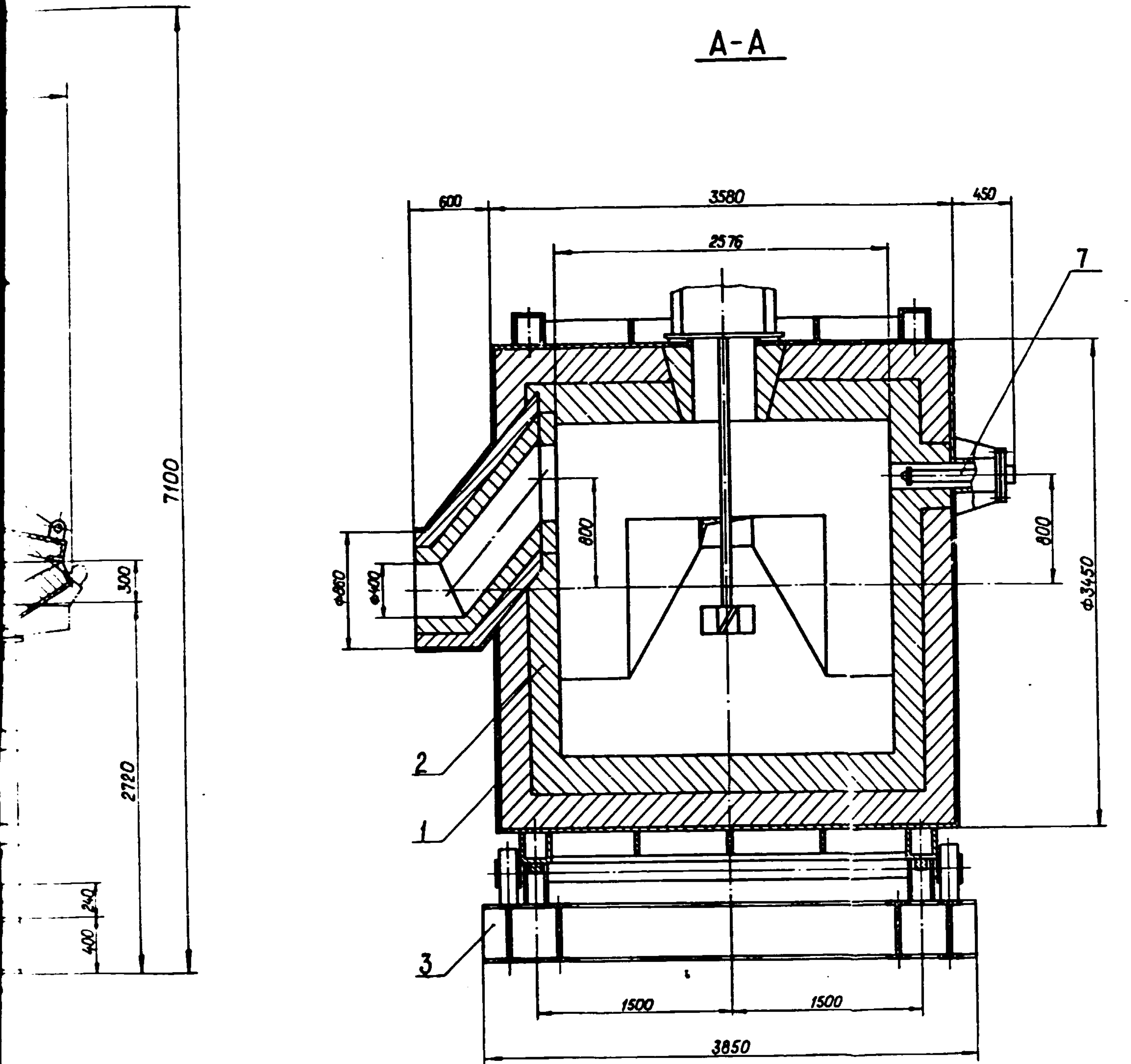
THIS DRAWING IS NOT TO BE REPRODUCED OR TRANSFERRED TO OTHER ORGANIZATIONS OR PERSONS WITHOUT AGREEMENT WITH VAMI	1395281 80			
	25 MVA ELECTRIC ARC REDUCTION FURNACE GENERAL VIEW DRAWING	PHASE	MASS	SCALE
		FS	—	1:50
		SHEET 3	SHEETS	
		VAMI LENINGRAD		

SIZE A2


A
2680
3215
6
1680
45°
2°
B
ALLOY LEVEL
ø1243
10°
9800
1030
700
650
2720
7100
300
Φ600
240
400
4
1200
1200
2590
3870
300
2300
1700
2500
A

SECTION 1

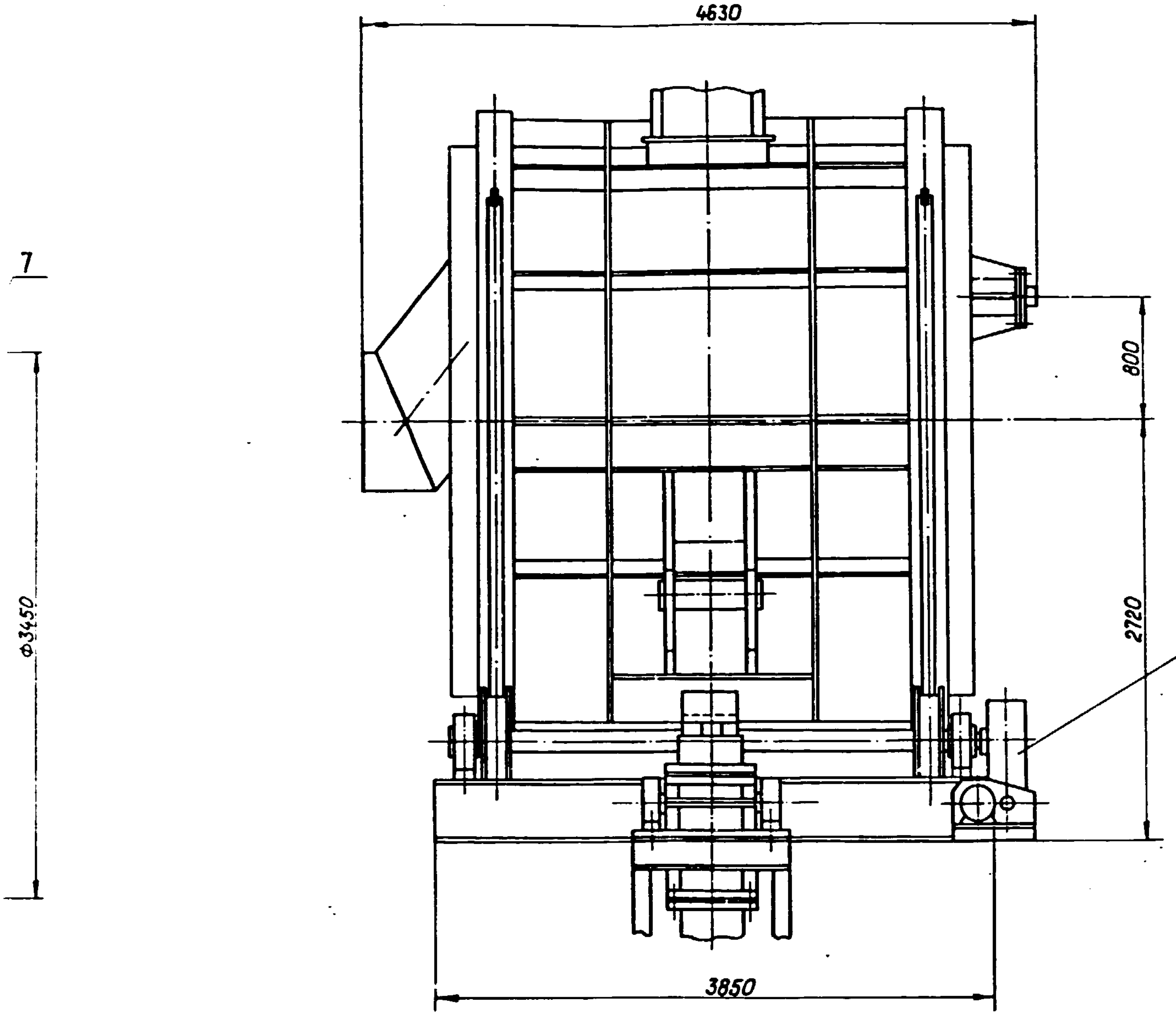
A-A



600
3580
450
2576
7
7100
300
2720
240
400
800
800
Φ800
Φ400
Φ3450
2
1
3
1500
1500
3850

SECTION 2

VIEW B



SPECIFICATIONS

1. HOLDING FURNACE CAVITY CAPACITY, M^3 — 6
2. WEIGHT OF ALLOY (BY ALUMINIUM), T — 15
3. MAXIMUM ALLOY TEMPERATURE, °C — 850
4. FUEL CALORIFIC VALUE (FUEL OIL), KJ/KG — 41870
5. FUEL OIL CONSUMPTION, KG/HR — 70...90
6. HOLDING FURNACE TURNING, DRIVE — HYDRAULIC
7. NUMBER OF HYDRAULIC CYLINDERS, PC — 1
8. MAXIMUM TURNING ANGLE OF HOLDING FURNACE DURING TAPPING, DEGREE — 26
9. TOTAL POWER OF INSTALLED ELECTRIC MOTORS, KW — 10

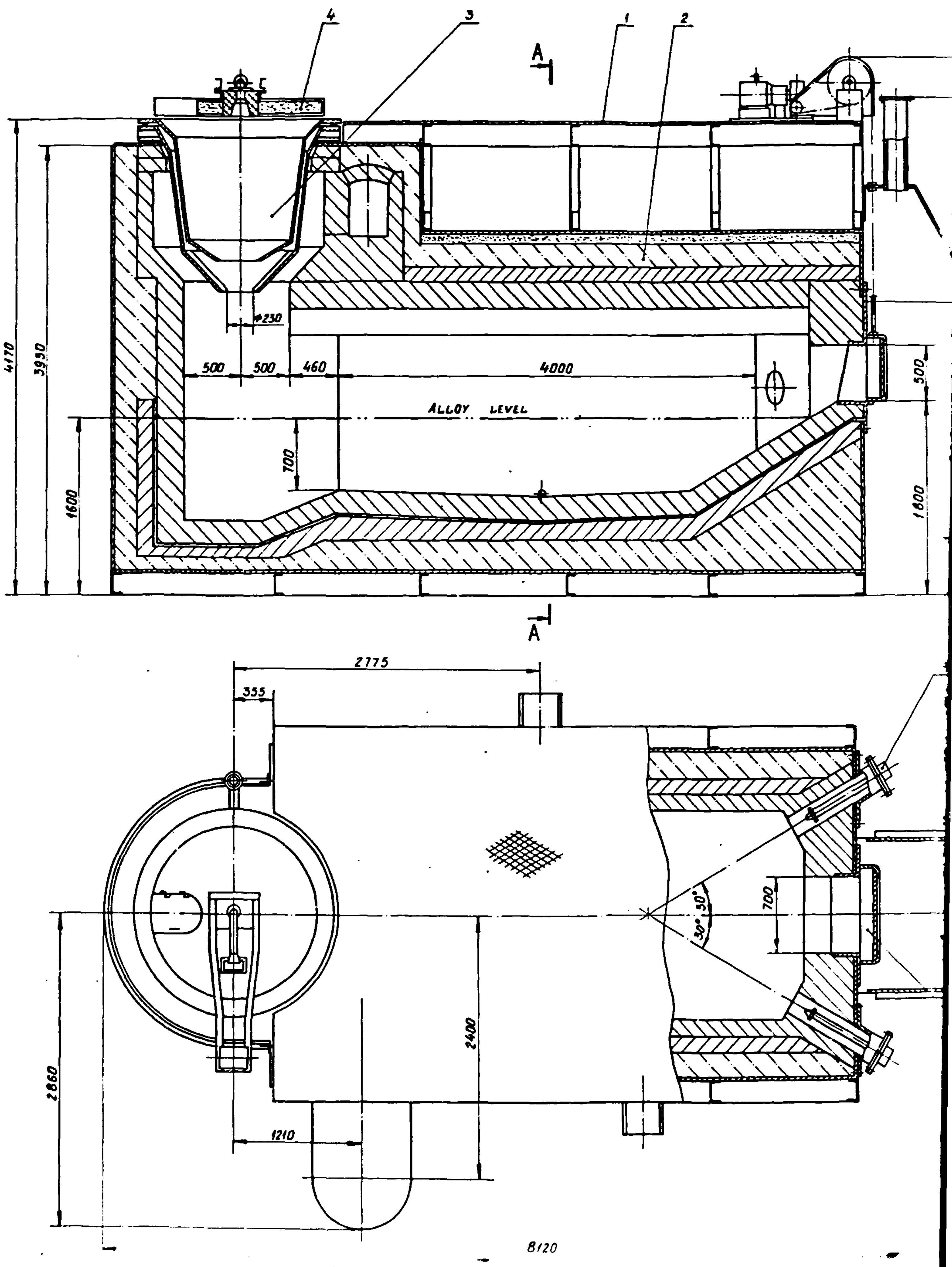
ITEM	DESIGNATION	DESCRIPTION	QTY	REMARK
1		CASING	1	
2		LINING	1	
3		FRAME	1	
4		HYDRAULIC CYLINDER	1	
5		DRIVE	1	
6		AGITATOR UNIT	1	
7		BURNER	1	

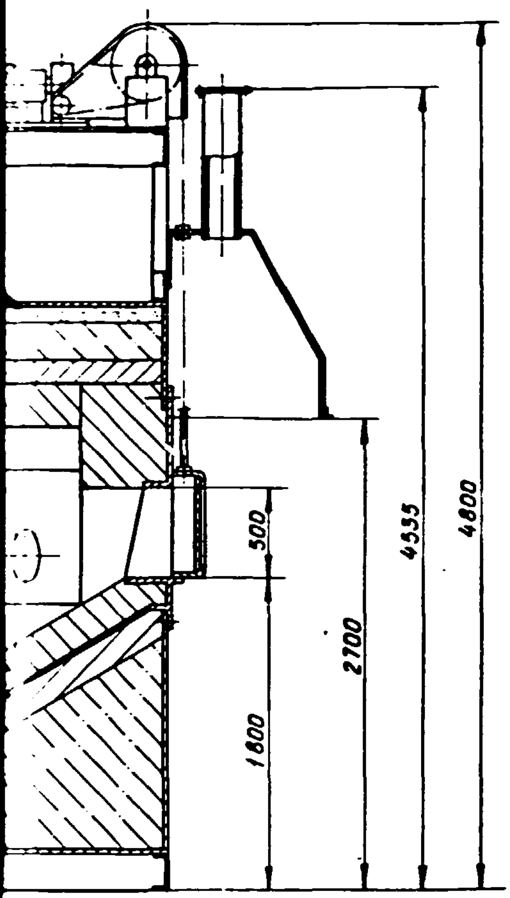
SECTION 3

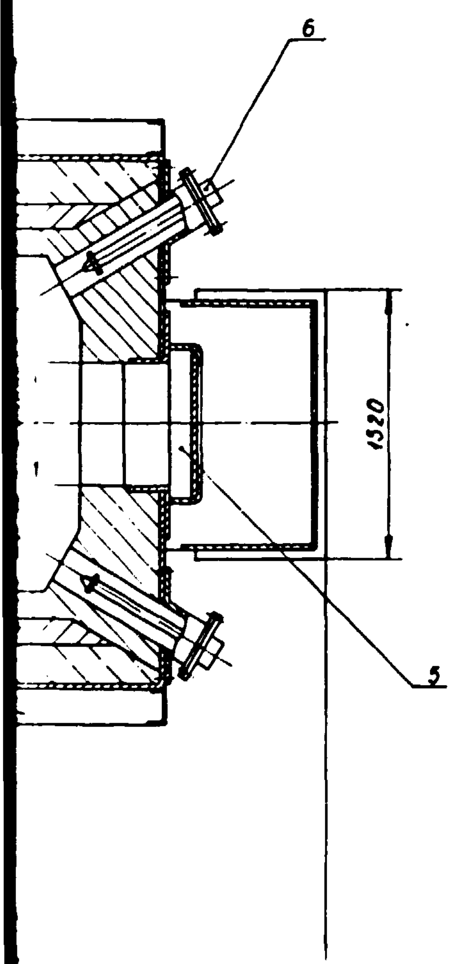
1395282 BO

	PHASE	MASS	SCALE
TURNING TILTING HOLDING FURNACE	FS	61000	1:20
GENERAL VIEW DRAWING	SHEET	SHEETS 1	

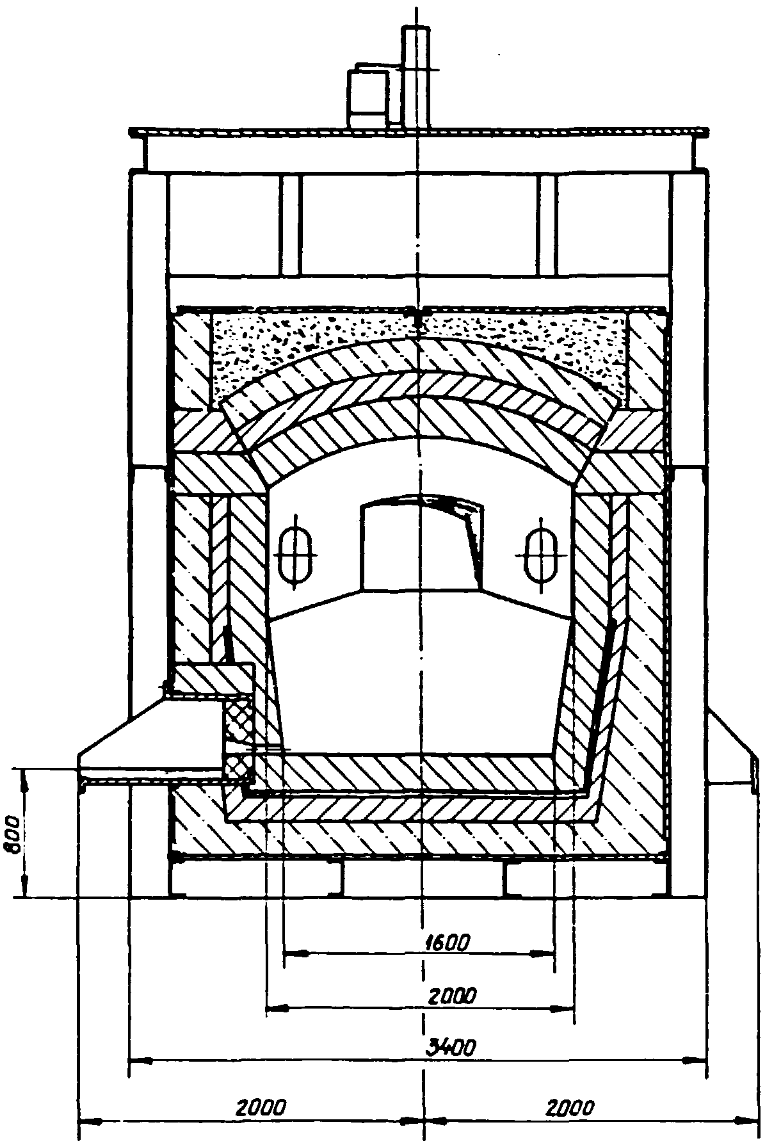
SECTION 1


4
3
1
2
A
ø230
500
500
460
4000
ALLOY LEVEL
700
1600
3930
4170
500
1800
A
2775
355
700
30°
30°
2400
2860
1210
8120



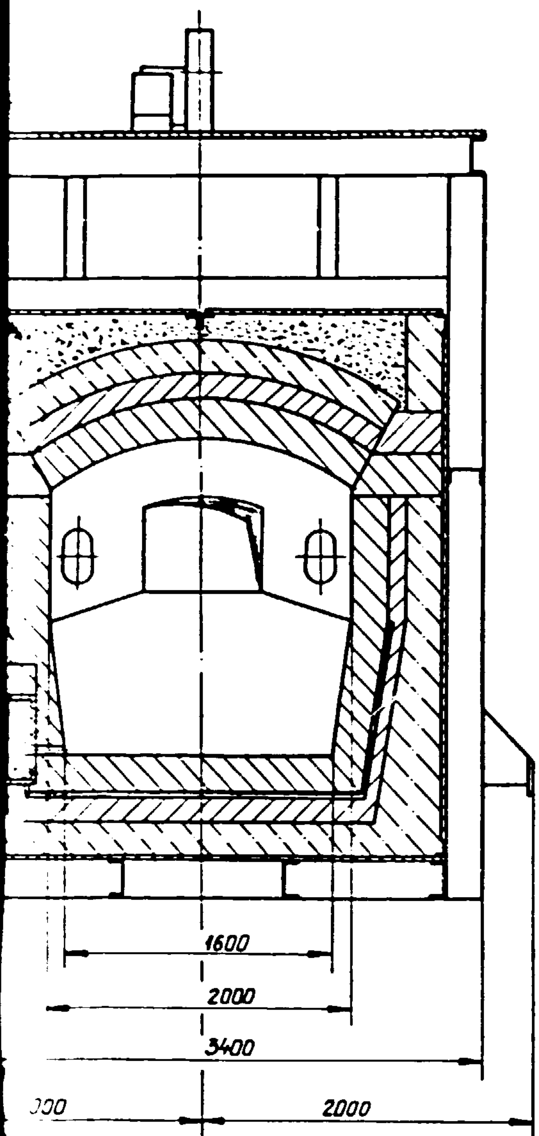


A-A



SECTION 2

A-A



SPECIFICATION

1 CAPACITY OF FURNACE CAVITY	m^3	6
2 ALLOY WEIGHT (ALLUMINIUM)	T	15
3 ALLOY TEMPERATURE	°C	650-700
4 FILTERING AREA OF FUNNEL	m^2	0,75
5 FUEL CALORIFIC VALUE (FUEL OIL)	KJ/KG	41870
6 FUEL OIL CONSUMPTION	KG/HR	80-100
7 INSTALLED CAPACITY OF ELECTRIC MOTOR	KW.	1,1

ITEM	DESIGNATION	DESCRIPTION	QTY	REMARK
1		BODY	1	
2		LINING	1	
3		FILTERING FUNNEL	1	
4		COVER	1	
5		GATE	1	
6		BURNER	2	

SECTION 3

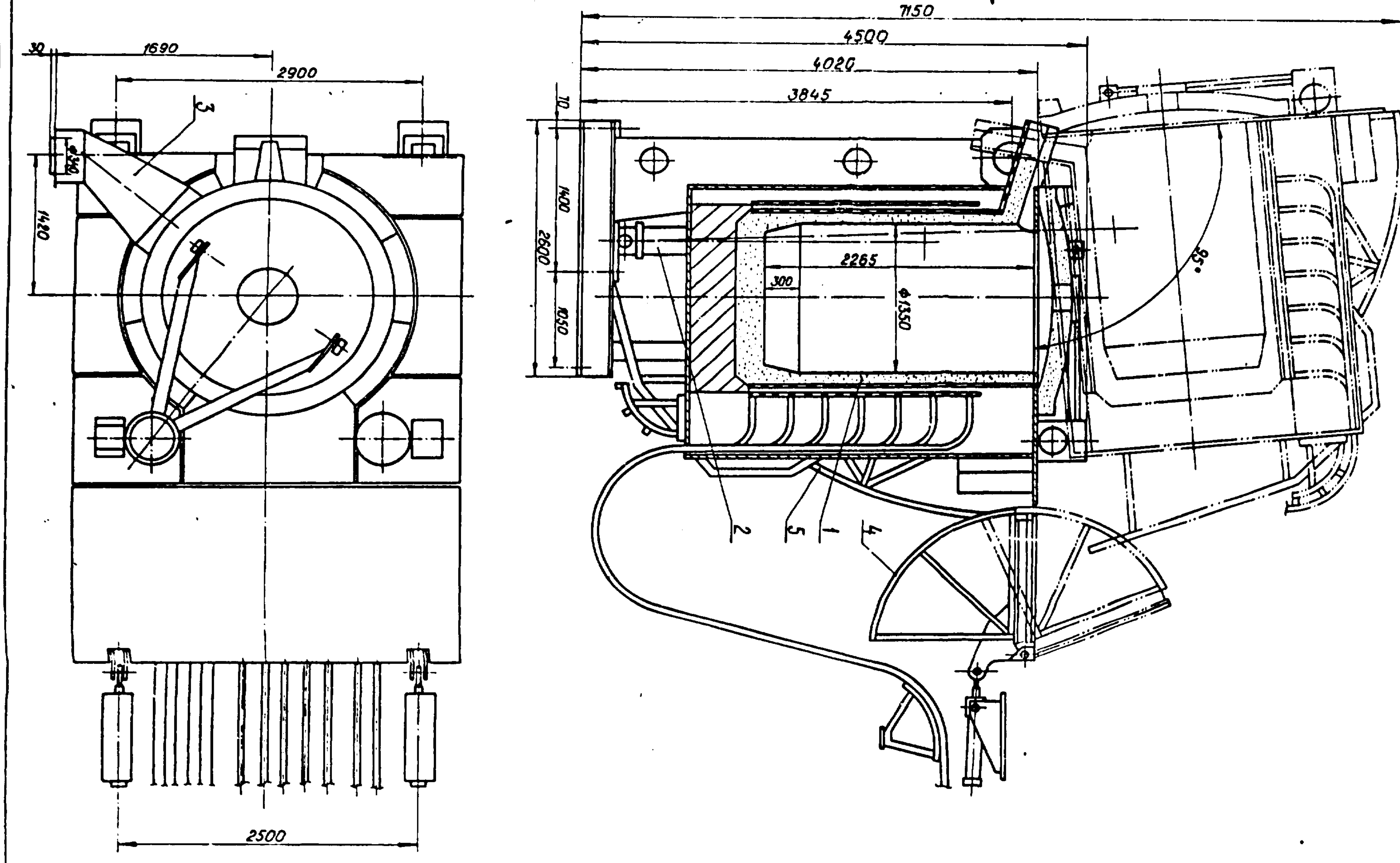
1395283 BO

FILTRATION FURNACE GENERAL VIEW DRAWING

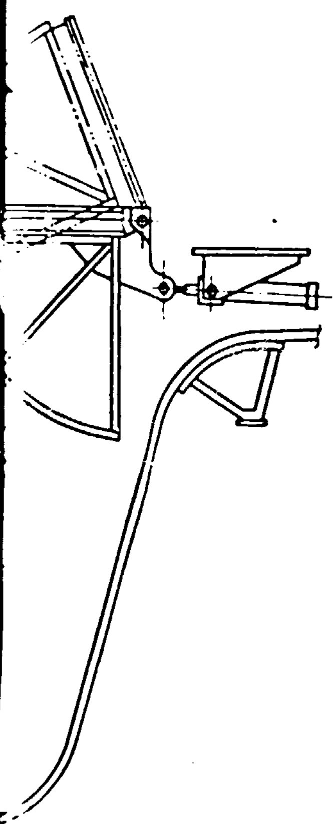
PHASE	MASS	SCALE
FS	64000	1:20
SHEET	SHEETS 1	

VAMI

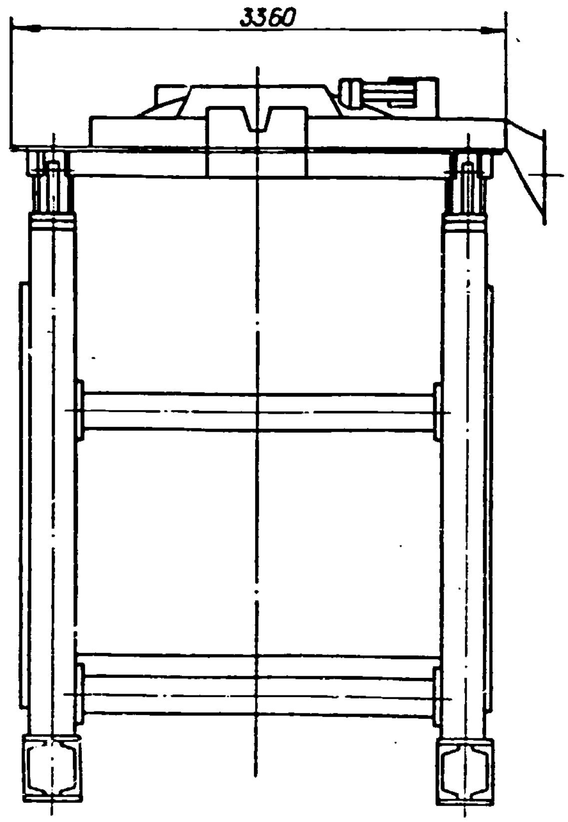
SECTION 1

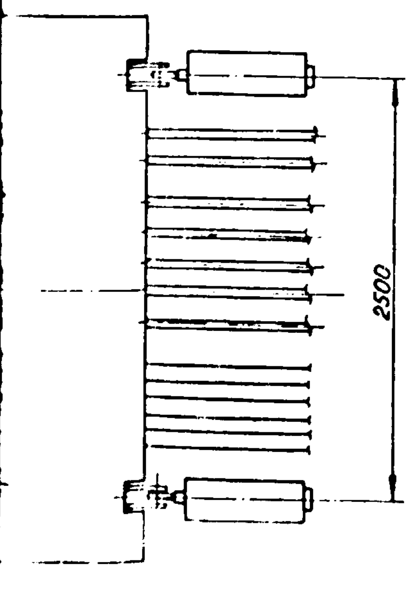


30
1690
2900
3
Φ340
1420
2500
A
7150
4500
4020
3845
70
1400
2600
1050
2265
300
Φ1350
95°
2
5
1
4



VIEW A





SECTION 2

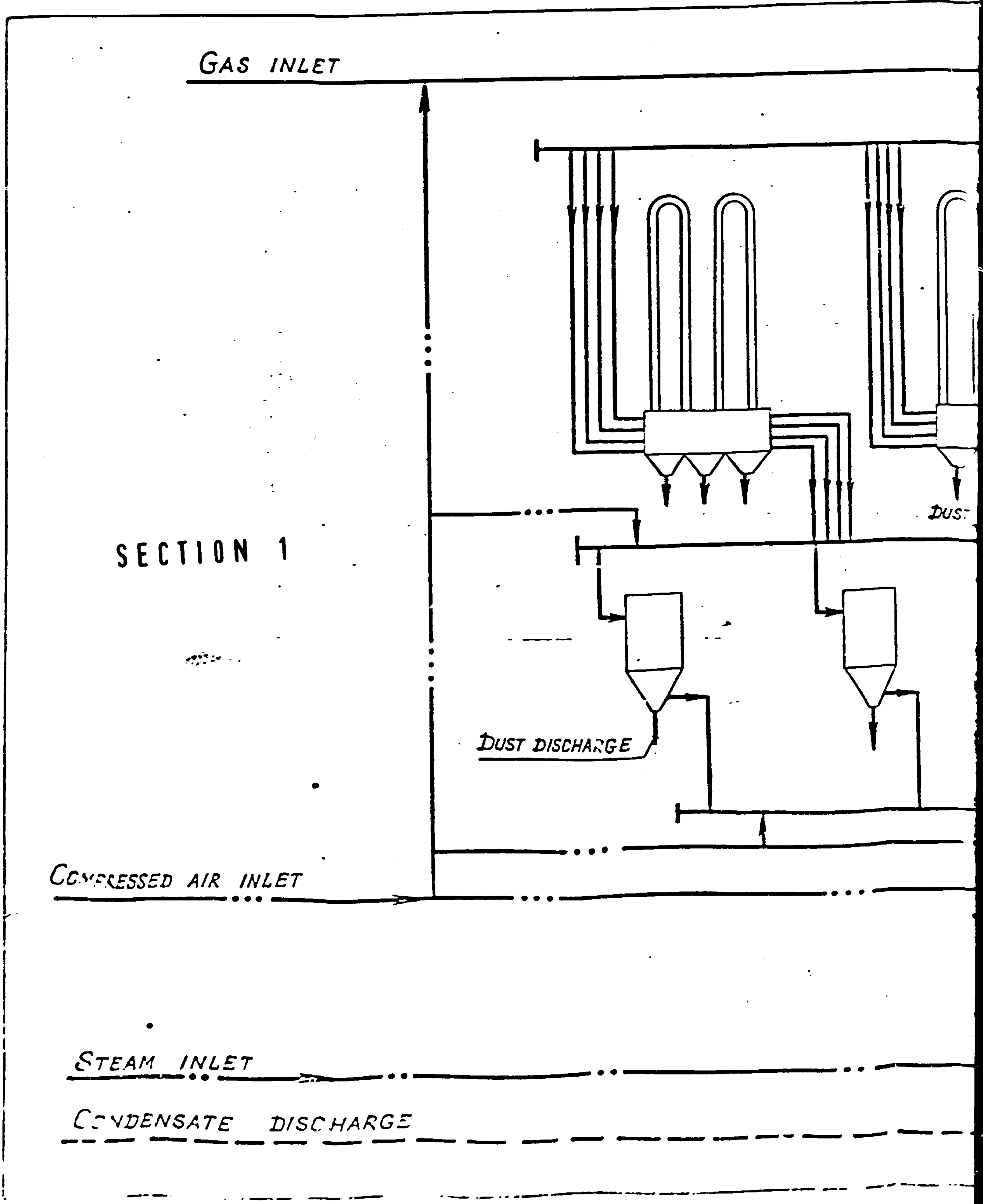
SPECIFICATIONS

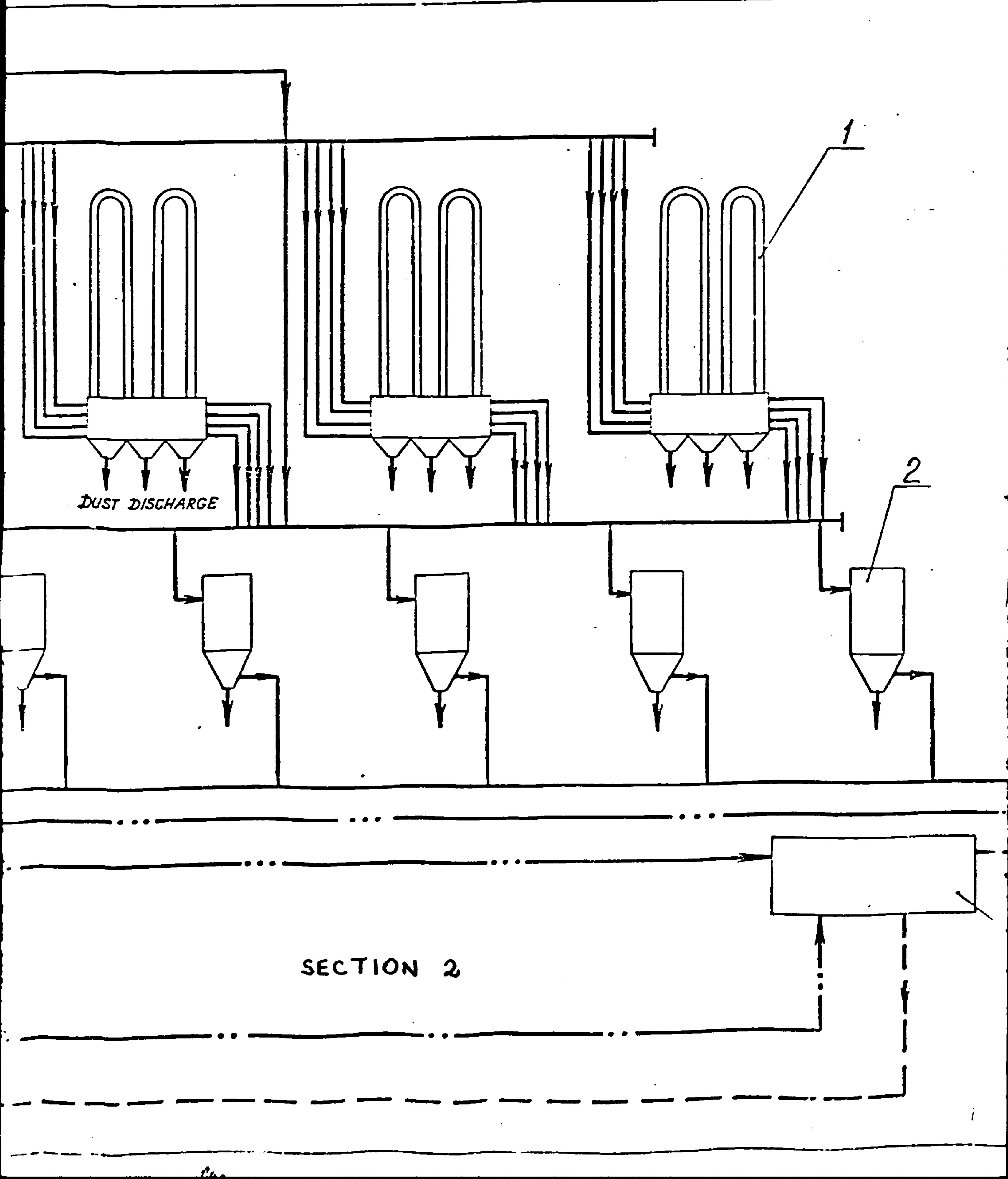
1 FURNACE CAPACITY (ALUMINIUM),	T - 6
2 FURNACE TRANSFORMER POWER,	KVA - 2500
3 FURNACE POWER RATING,	KW - 2430
4 RATED VOLTAGE,	V - 1922
5 CURRENT FREQUENCY,	HERTZ - 50
6 MELT OPERATING TEMPERATURE,	°C
7 SMELTING PERIOD DURATION,	HR - 4.83
8 SPECIFIC POWER CONSUMPTION,	$\frac{KW\ HR}{T}$ 503
9 WATER CONSUMPTION FOR FURNACE COOLING,	M^3/HR - 36 3
10 TOTAL POWER OF ELECTRIC MOTORS,	KW - 45

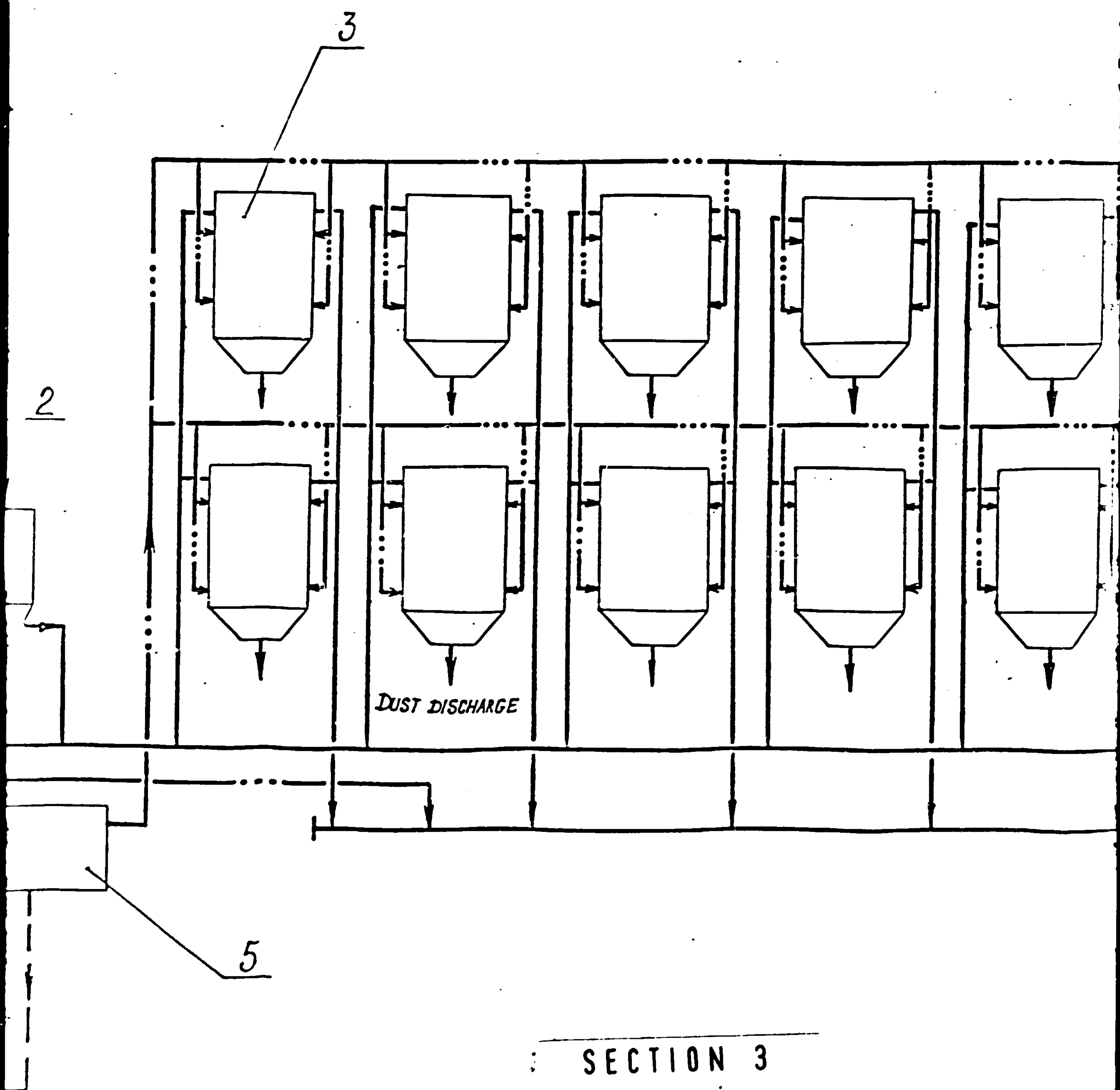
ITEM	CODE	DESCRIPTION	QTY	REMARK
1		CRUCIBLE		
2		TILTING UNIT		
3		GAS EXHAUST		
4		[illegible] PLATFORM		
5				

1395284 BO			
CRUCIBLE INDUCTION FURNACE GENERAL VIEW DRAWING	PHASE	MASS	SCALE
	FS	23000	1 20
	SHEET	SHEETS 1	
	VAMI LENINGRAD		

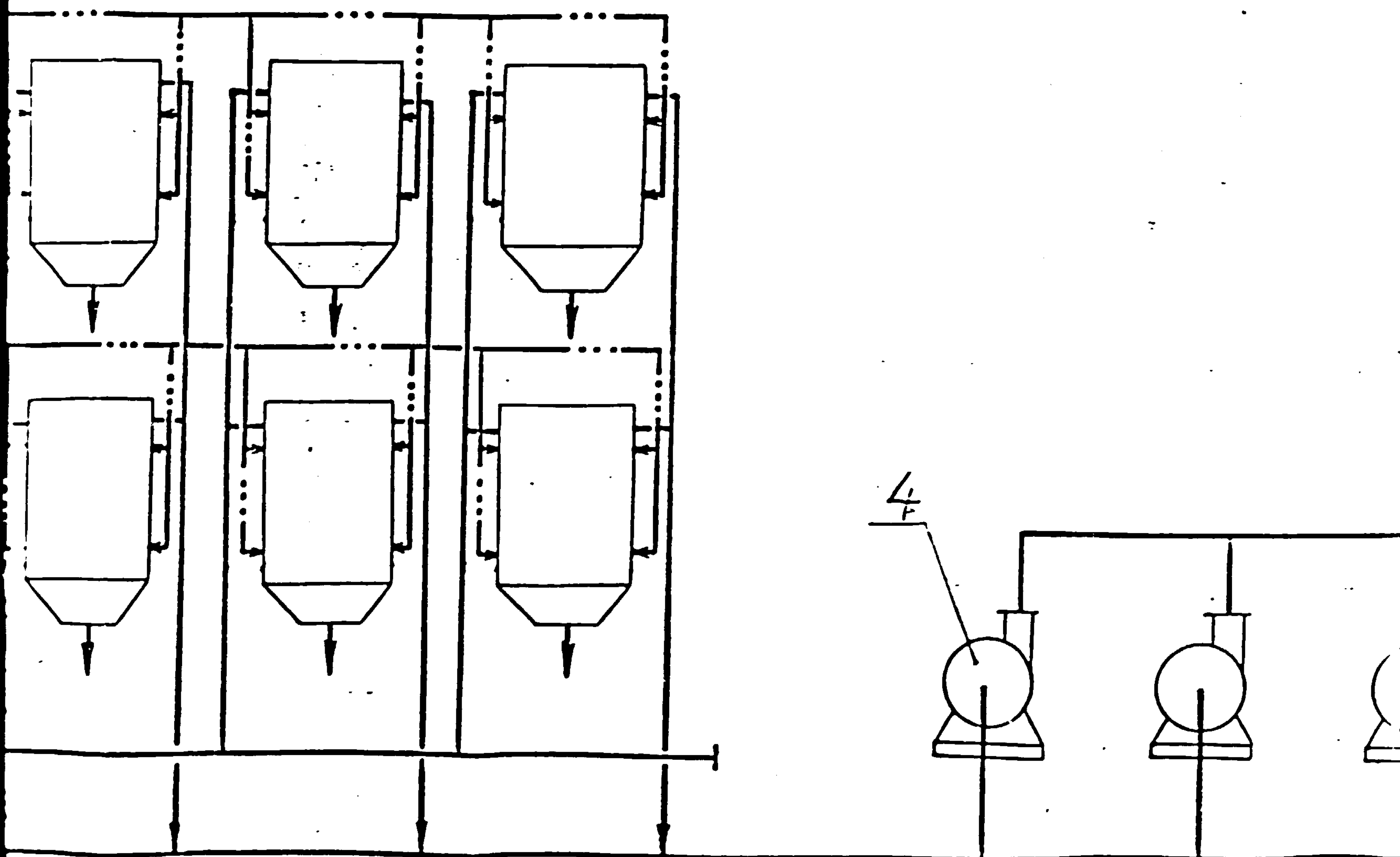
SIZE A1


GAS INLET
SECTION 1
DUST DISCHARGE
COMPRESSED AIR INLET
STEAM INLET
CONDENSATE DISCHARGE

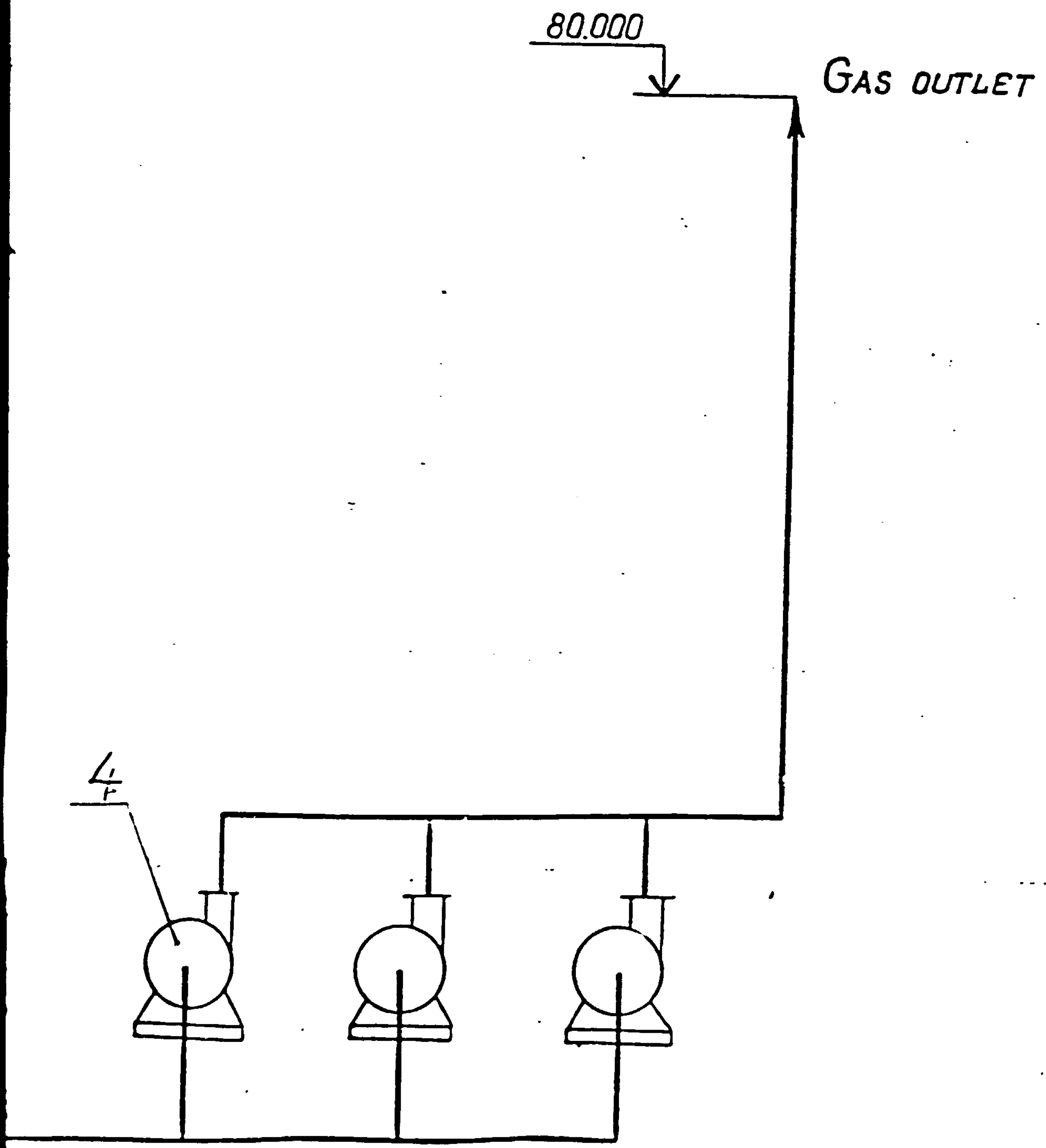

1
2
DUST DISCHARGE
SECTION 2



SECTION 3



SECTION 4



SECTION 5

MAIN DESIGN PARAMETERS

(AT TEMPERATURE OF 0°C AND PRESSURE OF 101.3 KPa)

1. VOLUME OF GASES FED TO UNIT

	FROM FURNACE HOOD	230000 m^3/h
	FROM TAPHOLE	50 000 m^3/h

2. TEMPERATURE OF GASES FED TO UNIT

	FROM FURNACE HOOD	120...300 °C
	FROM TAPHOLE	80...90 °C

3. GAS VACUUM AT UNIT INLET — 0,5 KPa

4. COMPOSITION OF GASES FED TO UNIT, VOL % : CO_2 - 1.9; CO - 1.0; O_2 - 18.5; N_2 - 75.8; H_2O - 2.8

   SO_2 CONTENT — 65...100 mg/m^3

5. GASES DUST CONTENT AT UNIT INLET — 2 G/m^3

   AT UNIT OUTLET — 30 mg/m^3

LEGEND

——— GAS

—··— STEAM

—···— COMPRESSED AIR

— — — CONDENSATE

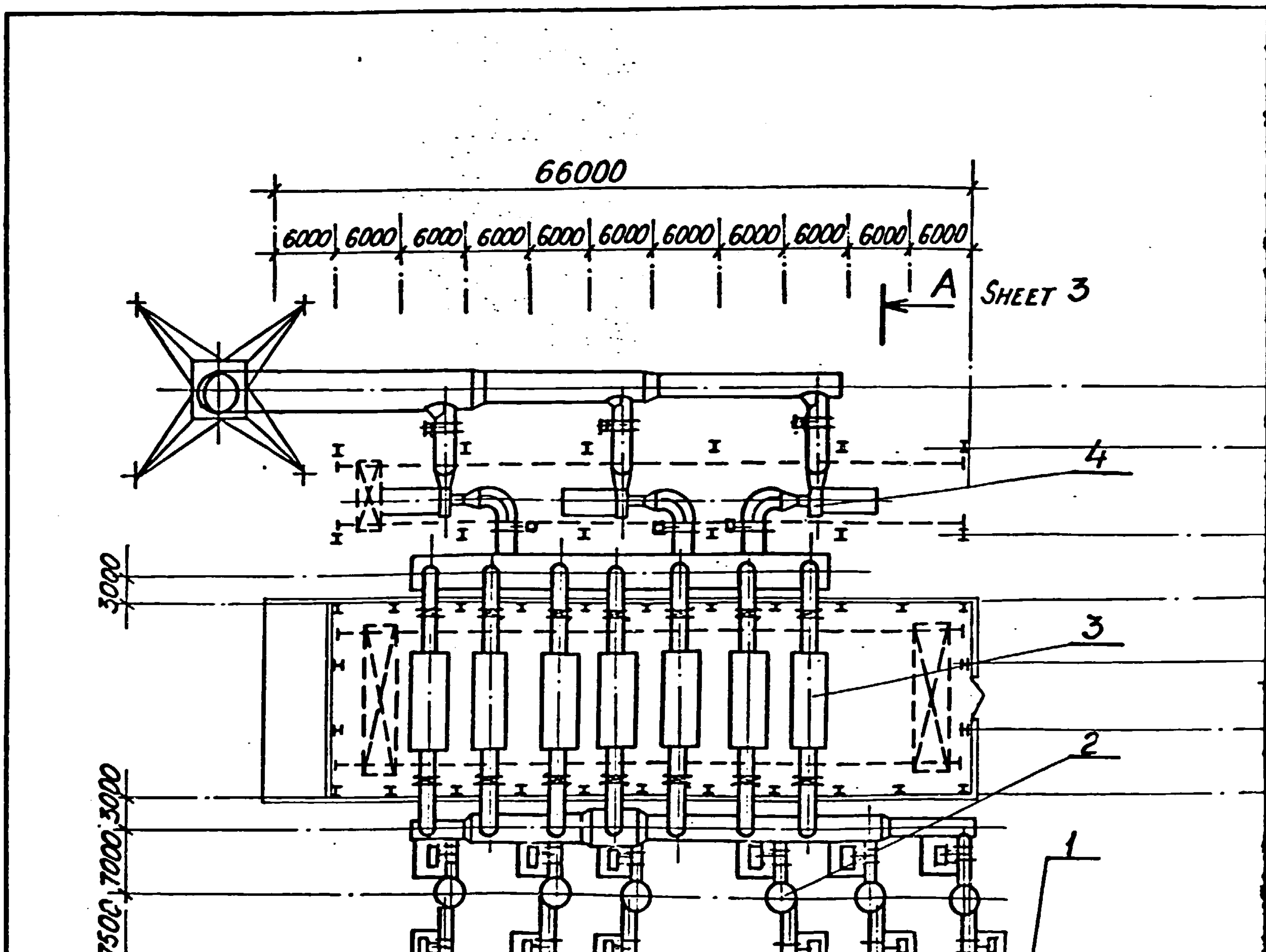
SECTION 6

EQUIPMENT SPECIFICATION

ITEM	DESCRIPTION	SPECIFICATION	QTY	REMARK
1	COOLING UNIT $1900 m^2$		4	
2	STRAIGHT FLOW CYCLONE		6	
3	BAG FILTER		14	
4	FAN		3	
5	AIR DRYING UNIT		1	

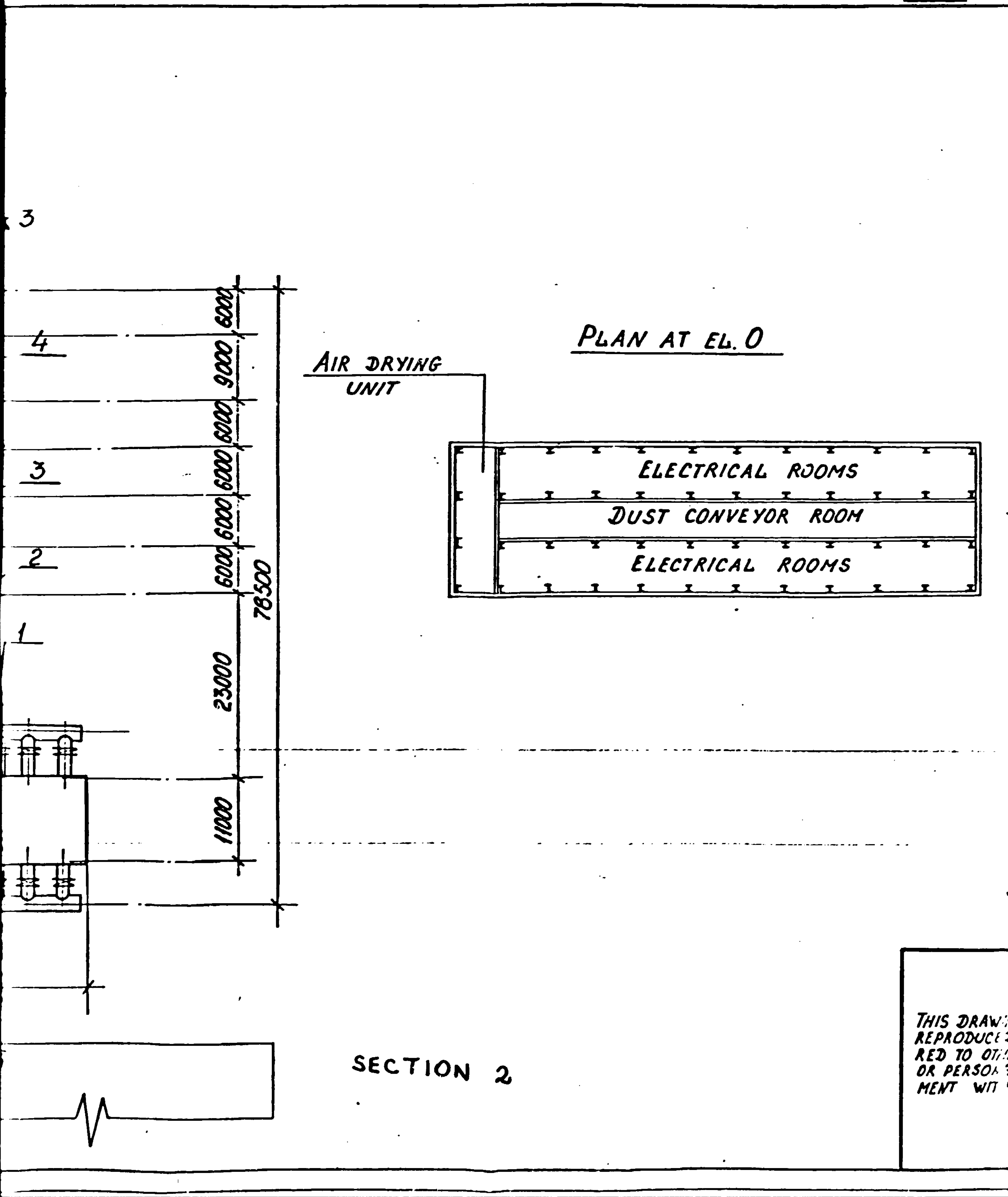
SECTION 7

	1409691-TM		
	ANGUL ALUMINIUM SMELTER (INDIA)		
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION GAS CLEANING SYSTEM	PHASE / SHEET / SHEETS	FS / 1 / 3
	EQUIPMENT AND PROCESS FLOWSHEET	VAMI LENINGRAD	

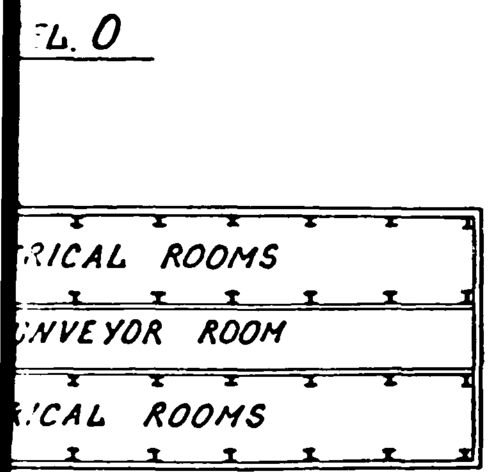


66000
6000
6000
6000
6000
6000
6000
6000
6000
6000
6000
6000
A
SHEET 3
4
3
2
1
3000
3000
7000
7500
5500
5500
38500
80000
A
SHEET 3

SECTION 1



PLAN AT EL. 0
AIR DRYING UNIT
ELECTRICAL ROOMS
DUST CONVEYOR ROOM
ELECTRICAL ROOMS
3
4
3
2
1
6000
9000
6000
6000
6000
6000
23000
11000
78500
SECTION 2
THIS DRAW
REPRODUCE
RED TO OT
OR PERSON
MENT WIT



SECTION 3

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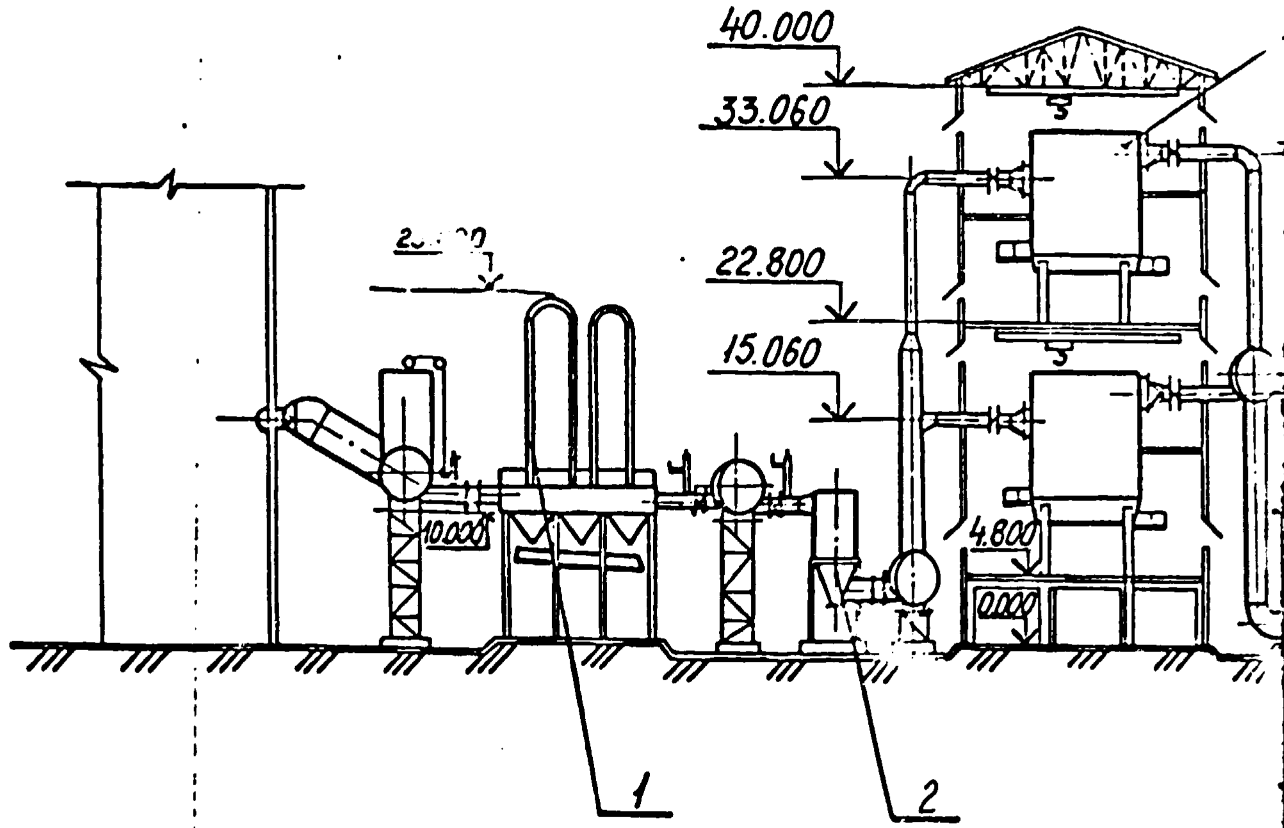
	ANGUL ALUMINIUM SMELTER (INDIA)			
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION GAS CLEANING SYSTEM	PHASE	SHEET	SHEETS
		FS	2	
	PLAN	VAMI LENINGRAD		

SIZE A4 x 3

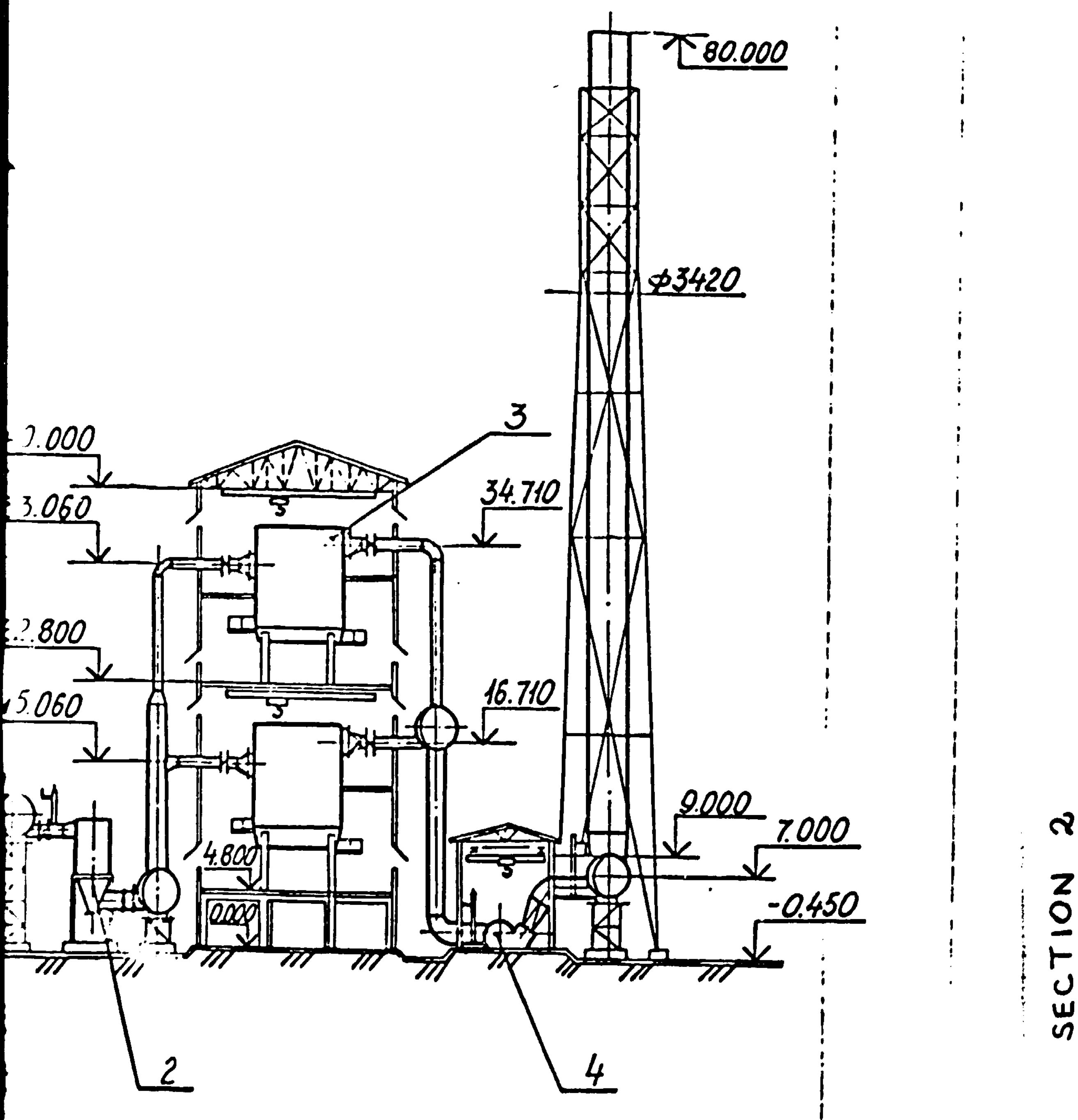
A—A SHEET 2



THIS DRAWI[illegible]
REPRODUCE[illegible]
RED TO OTH[illegible]
OR PERSON[illegible]
MENT [illegible]

SECTION 1

A – A *SHEET 2*



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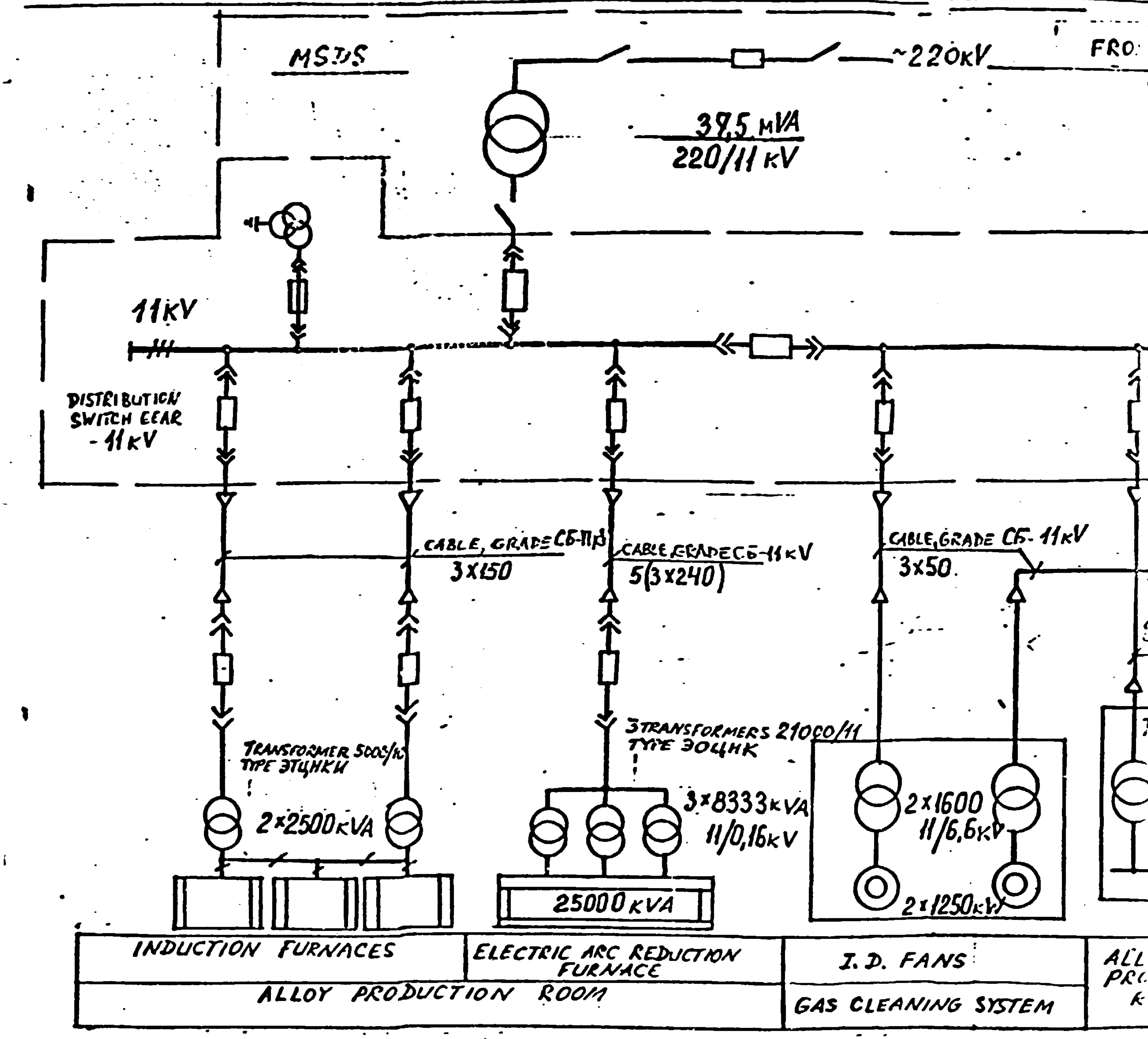
1409691-TM

ANGUL ALUMINIUM SMELTER (INDIA)

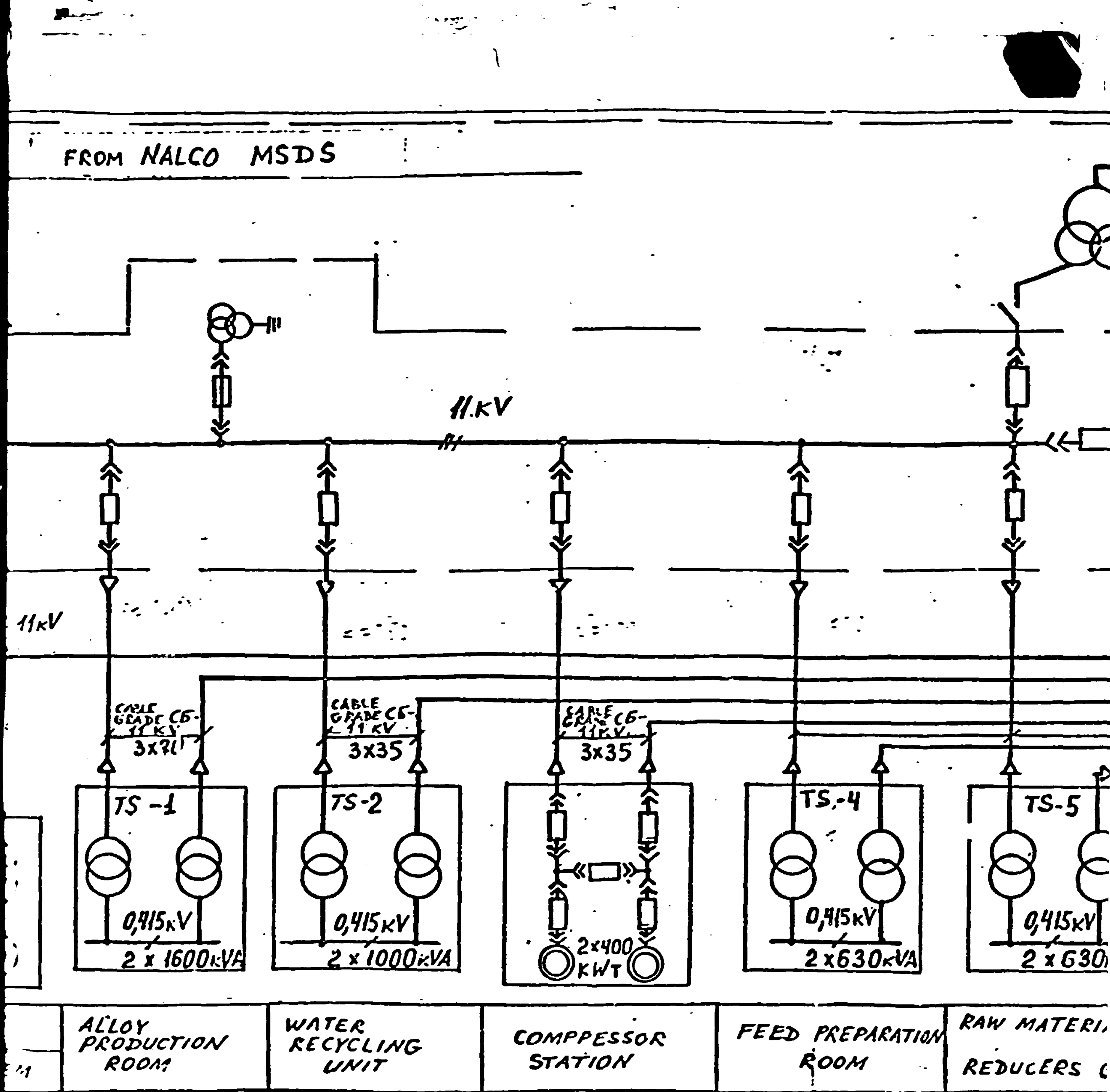
	PHASE	SHEET	SHEETS
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION GAS CLEANING SYSTEM	FS	3	

SECTION A-A	VAMI LENINGRAD

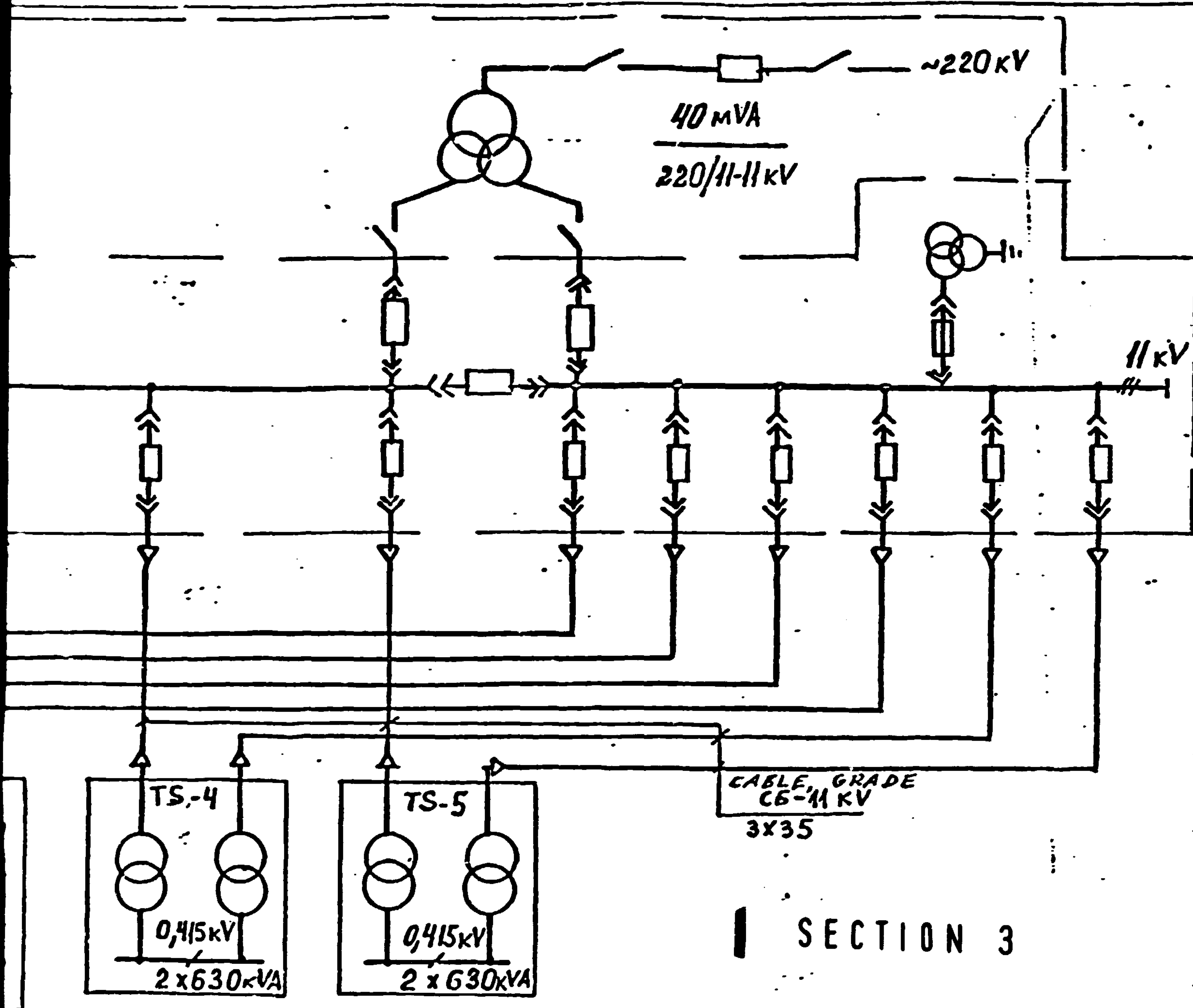


MSDS
~220kV
FRO
37,5 MVA
220/11 kV
11kV
DISTRIBUTION SWITCH GEAR - 11kV
CABLE, GRADE СБ-11кВ
3X150
CABLE GRADE СБ-11kV
5(3x240)
CABLE, GRADE СБ-11kV
3x50
TRANSFORMER 5000/11 TYPE ЭТЦНКИ
2x2500kVA
3 TRANSFORMERS 21000/11 TYPE ЭОЦНК
3x8333kVA
11/0,16kV
25000 kVA
2x1600
11/6,6kV
2x1250kW
INDUCTION FURNACES
ELECTRIC ARC REDUCTION FURNACE
ALLOY PRODUCTION ROOM
I. D. FANS
GAS CLEANING SYSTEM

SECTION 1


FROM NALCO MSDS
11 kV
11kV
CABLE GRADE CБ-11 KV
3x70
CABLE GRADE CБ-11 KV
3x35
CABLE GRADE CБ-11 KV
3x35
TS-1
0,415kV
2 x 1600kVA
TS-2
0,415kV
2 x 1000kVA
2x400 KWT
TS-4
0,415kV
2x630kVA
TS-5
0,415kV
ALLOY PRODUCTION ROOM
WATER RECYCLING UNIT
COMPPESSOR STATION
FEED PREPARATION ROOM
RAW MATERI
REDUCERS

SECTION 2



FEED PREPARATION ROOM	RAW MATERIALS STORAGE REDUCERS GRINDING SECTION

1388191-3C

ANGUL ALUMINIUM SMELTER (INDIA)

INDUSTRIAL DEMONSTRATION UNIT FOR ALUMINIUM-SILICON ALLOYS PRODUCTION

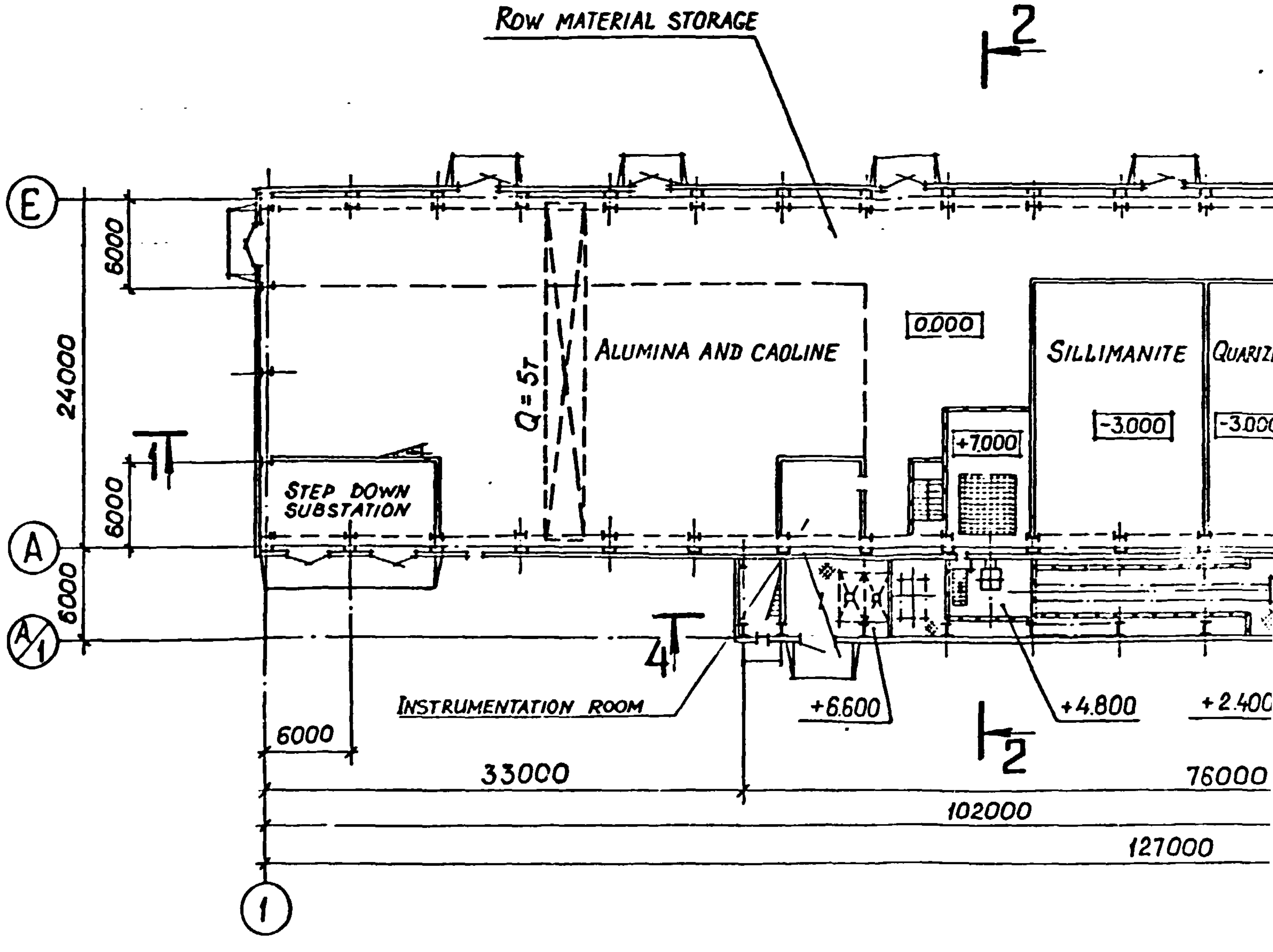
PHASE	SHEET	SHEETS
FS	1	1

POWER SUPPLY DIAGRAM

VAMI
LENINGRAD

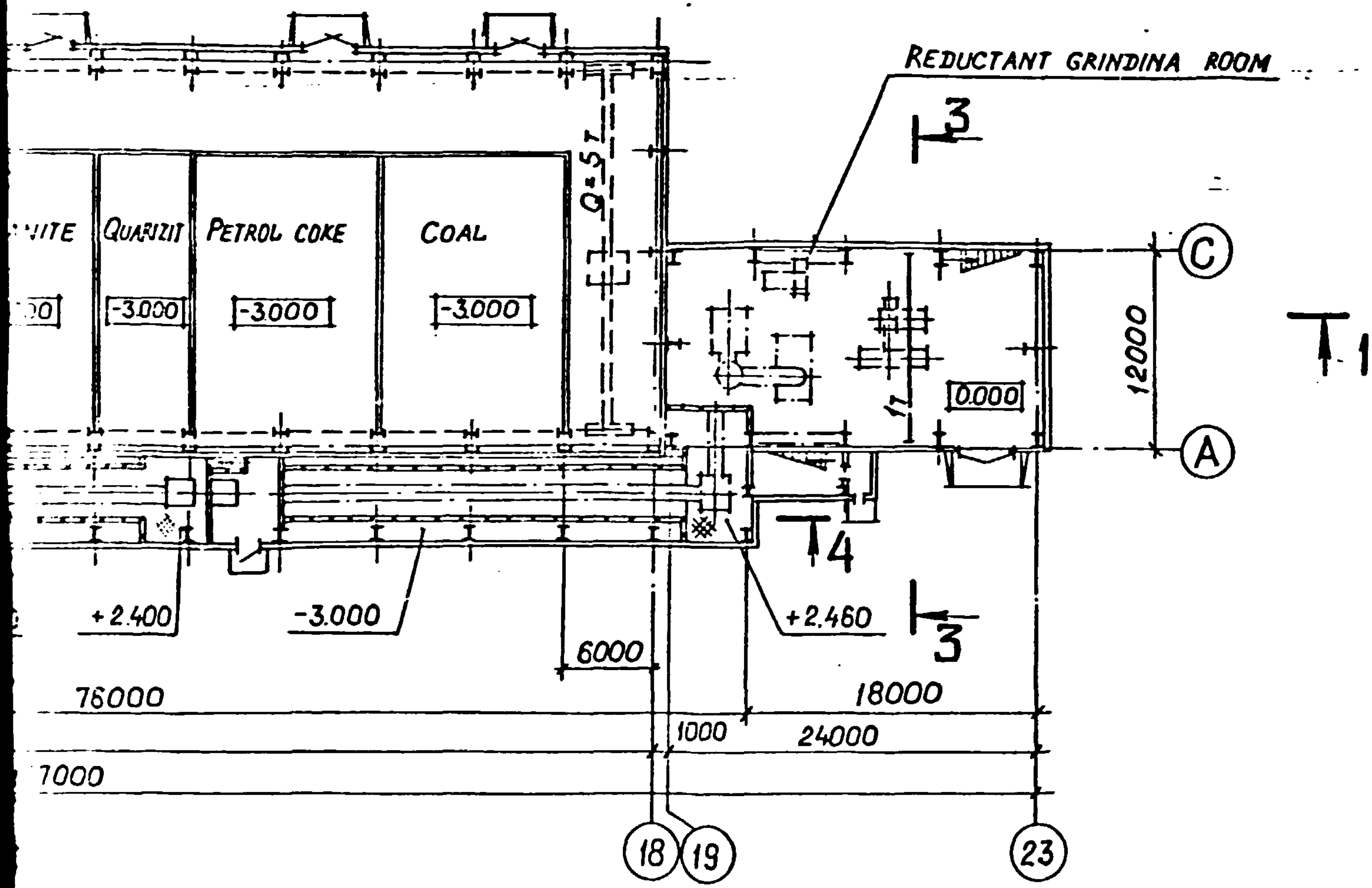
Size A

PLAN



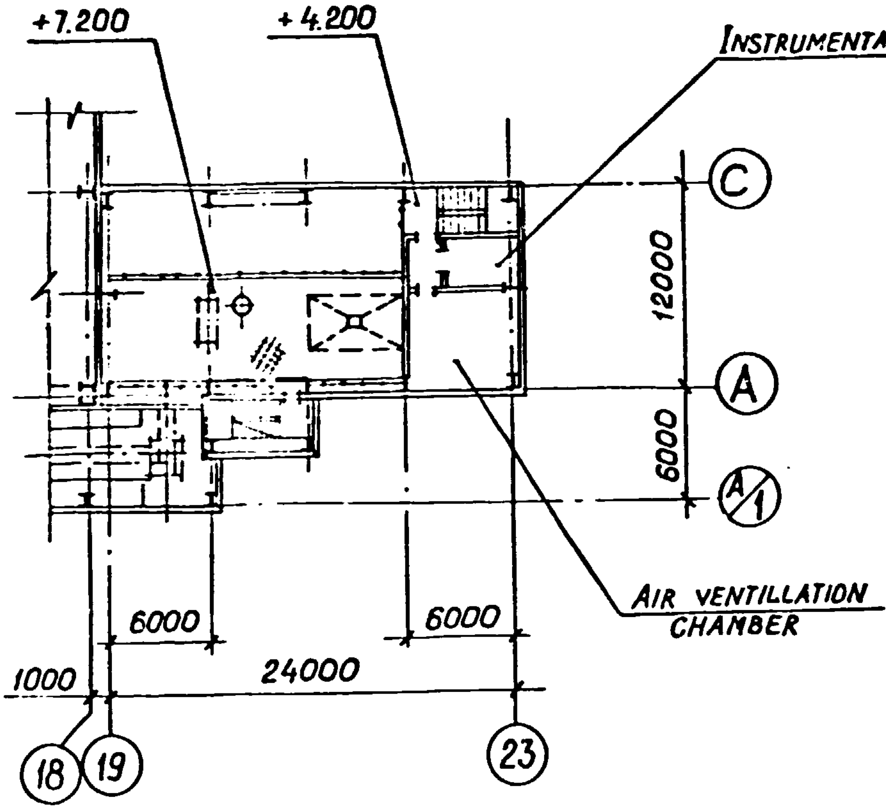
SECTION 1

PLAN AT EL. 0.000

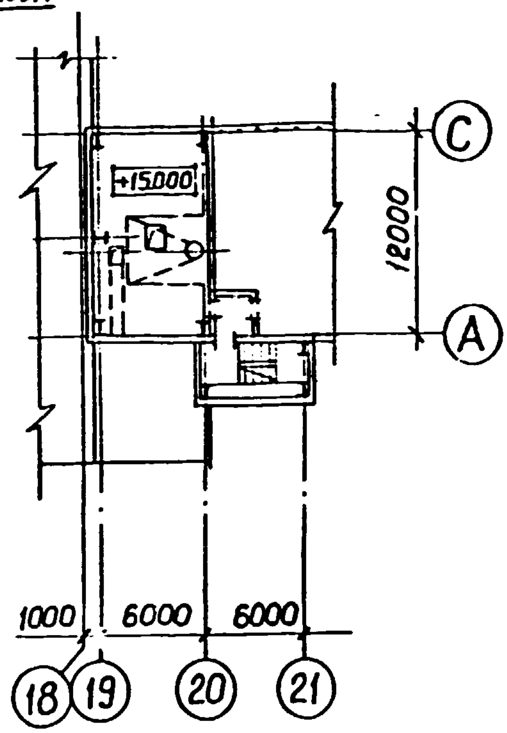


SECTION 2

PLAN AT EL. 7.200

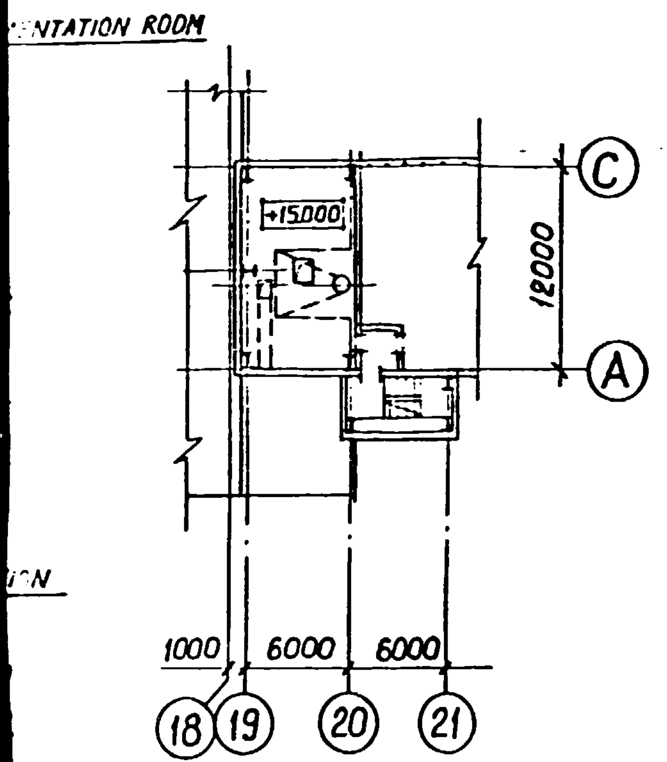


PLAN AT EL. 15.000



SECTION 3

PLAN AT EL. 15.000



SECTION 4

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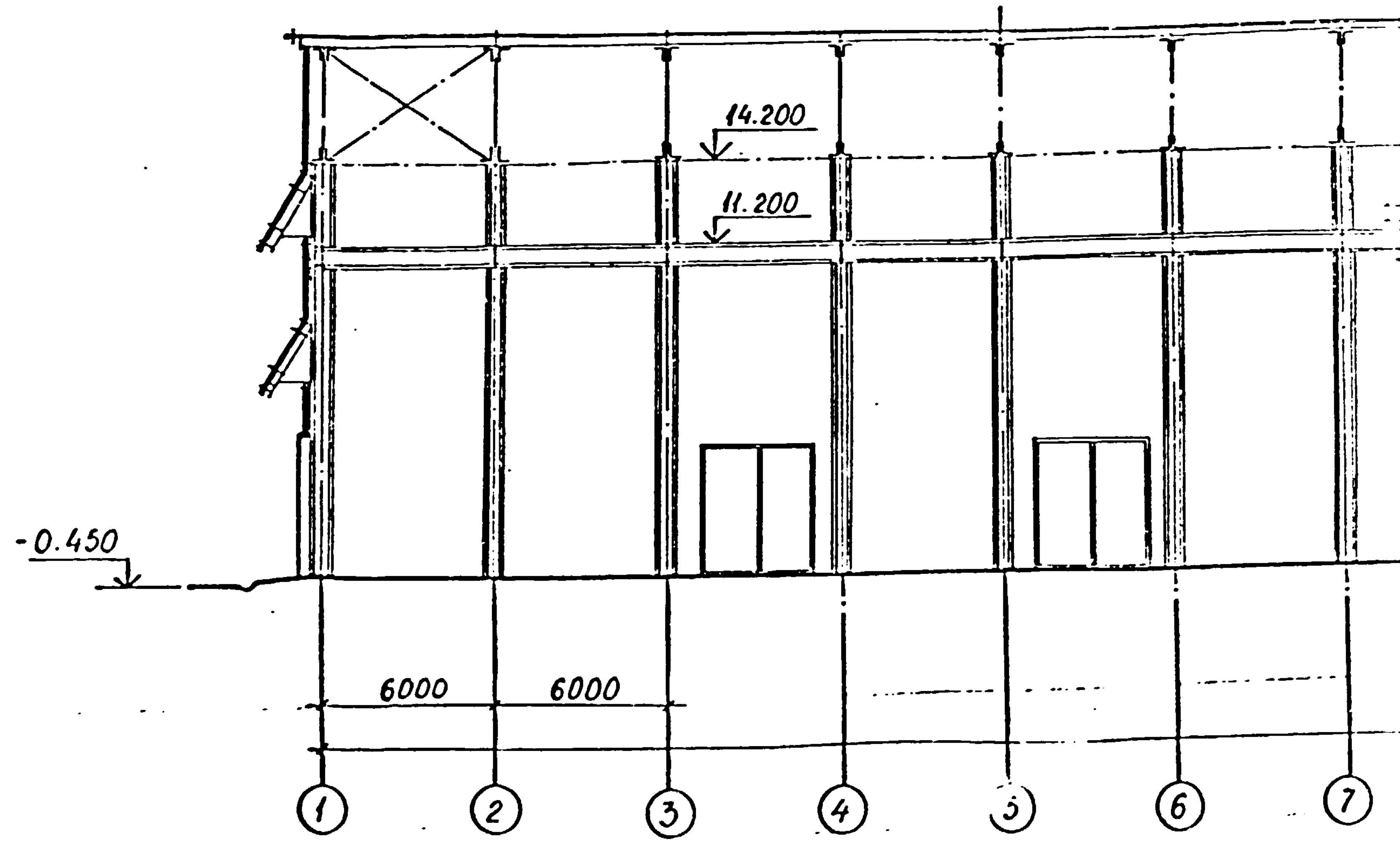
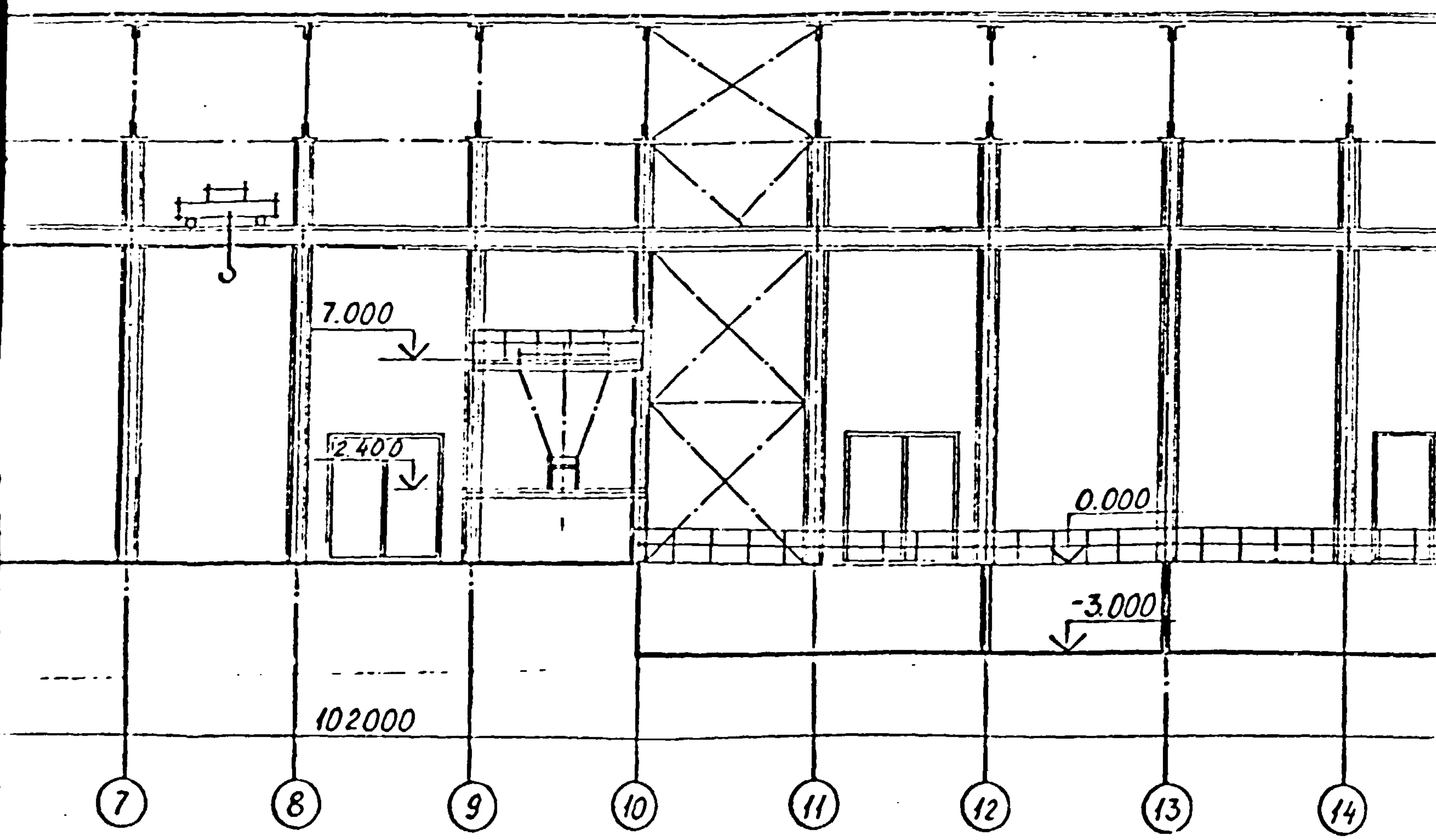
	ANGUL ALUMINIUM SMELTER (INDIA)			
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION	PHASE	SHEET	SHEET…
	REDUCTANT GRINDING ROOM	FS	1	11
	PLANS AT EL. 0.000; 7.200; 15.000	VAMI LENINGRAD		



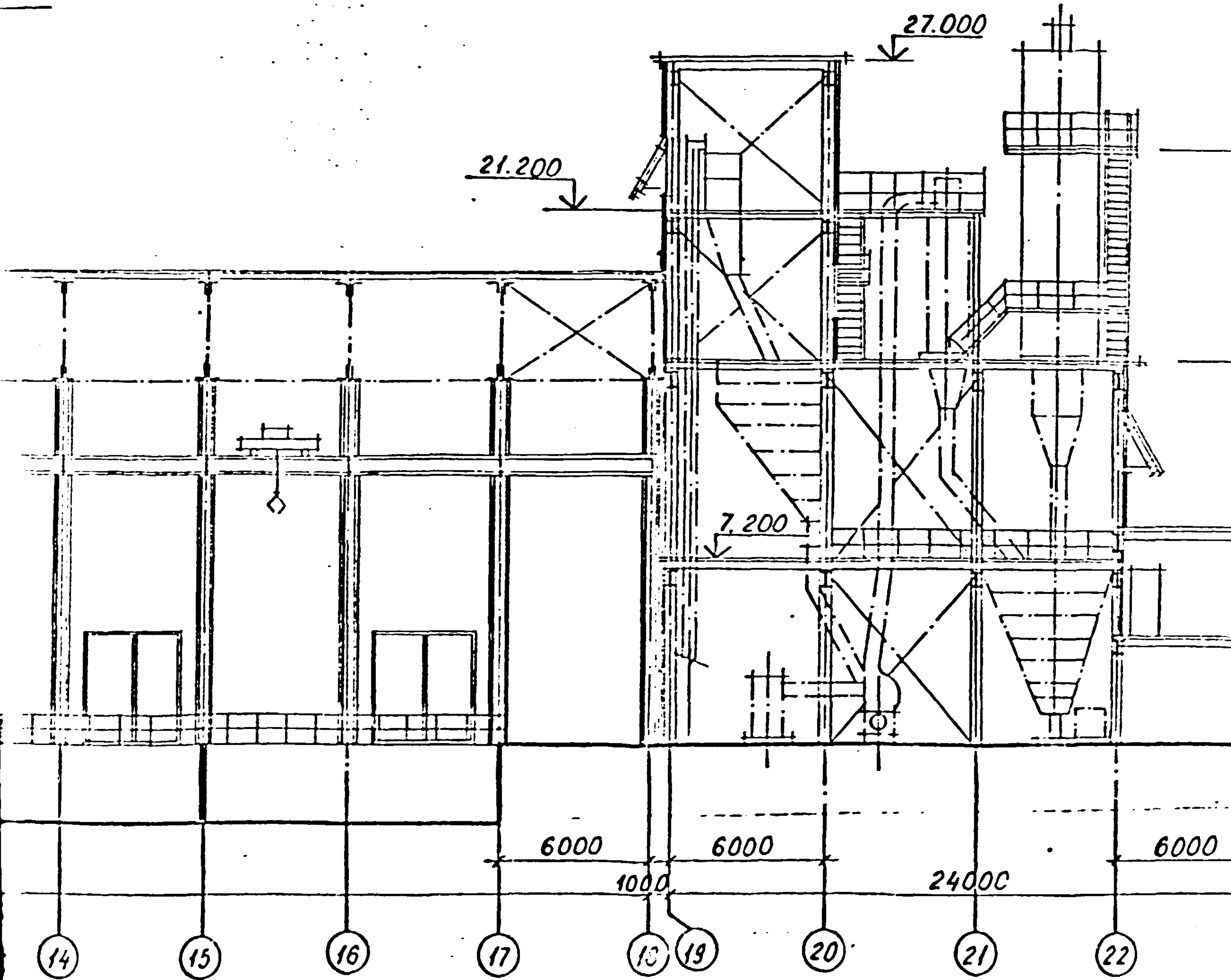
SECTION 1

SECTION 1-1



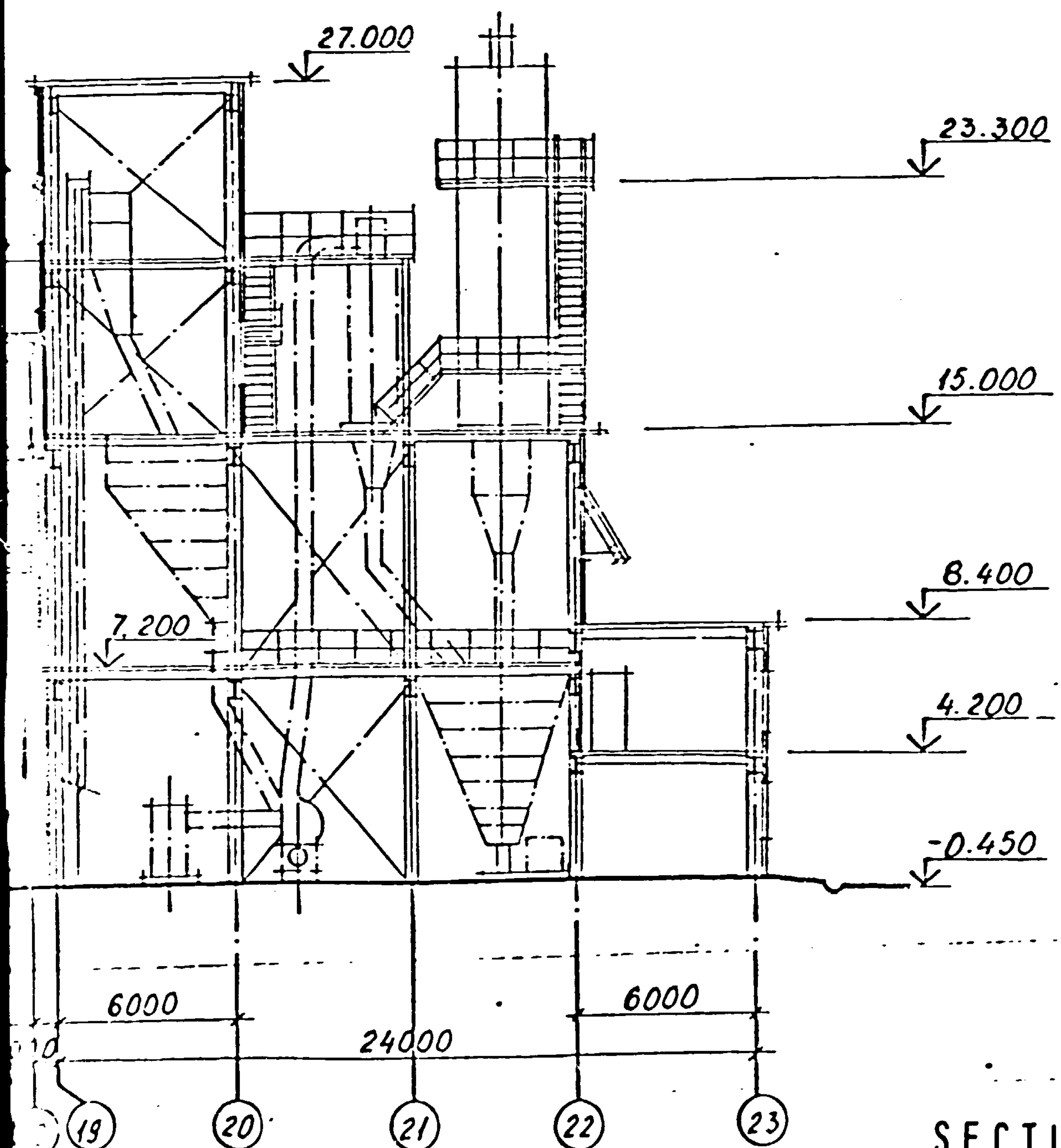
SECTION 2

1



27.000
21.200
7.200
6000
6000
1000
24000
6000
14
15
16
17
19
20
21
22

SECTION 3



SECTION 4

1500723 - AC

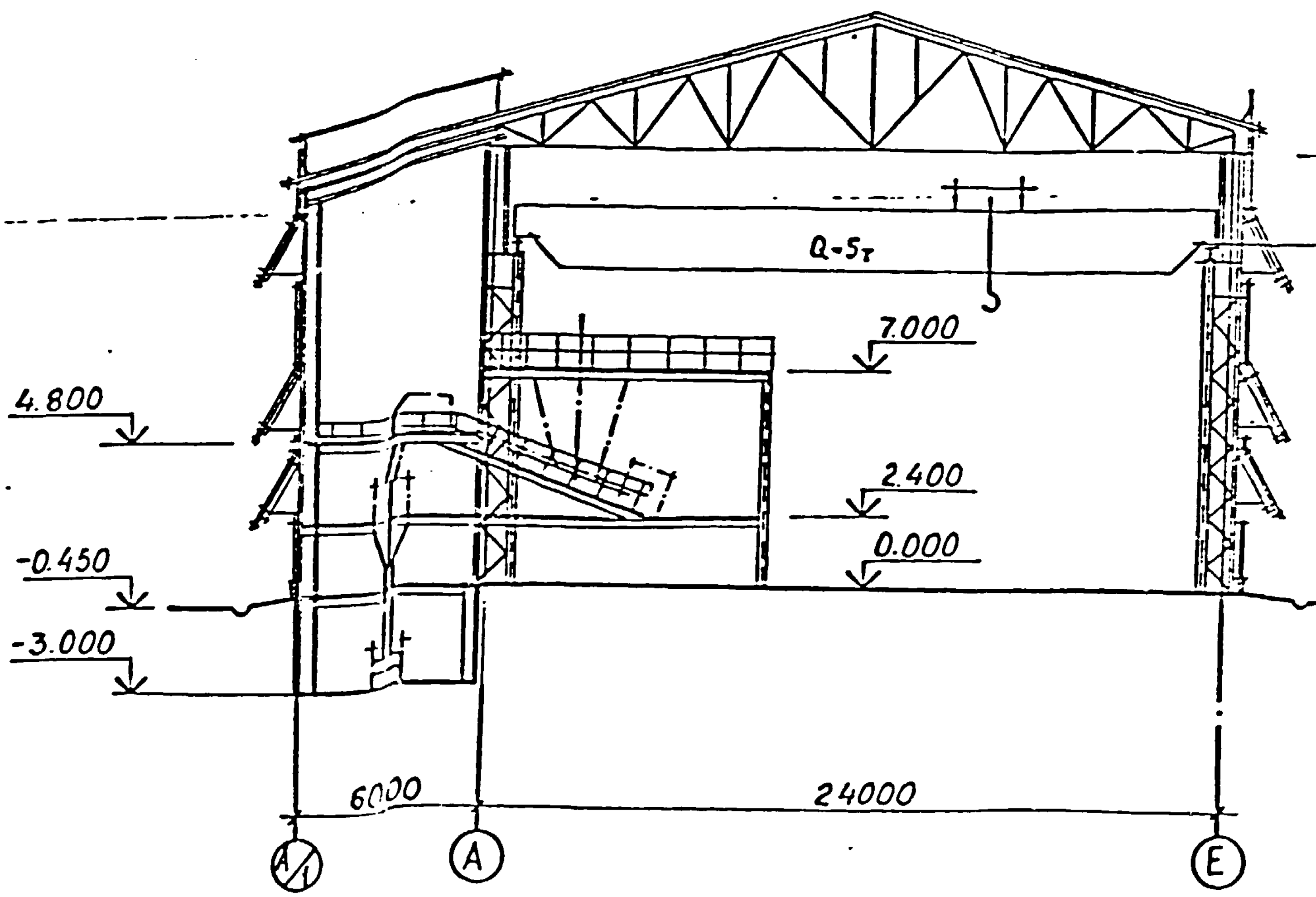
ANGUL ALUMINIUM SMELTER (INDIA)

	Phase	Sheet	Sheets
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION ROW MATERIAL STORAGE AND REDUCTANT GRINDING	FS	2	

SECTION 1-1

VAMI LENINGRAD

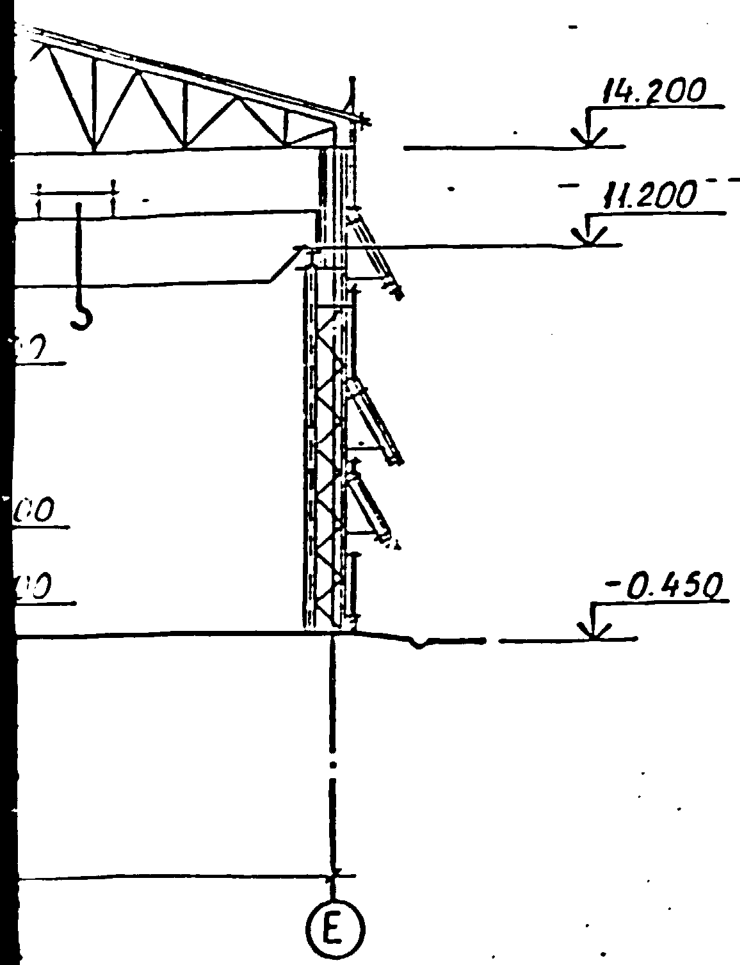
SECTION 2-2

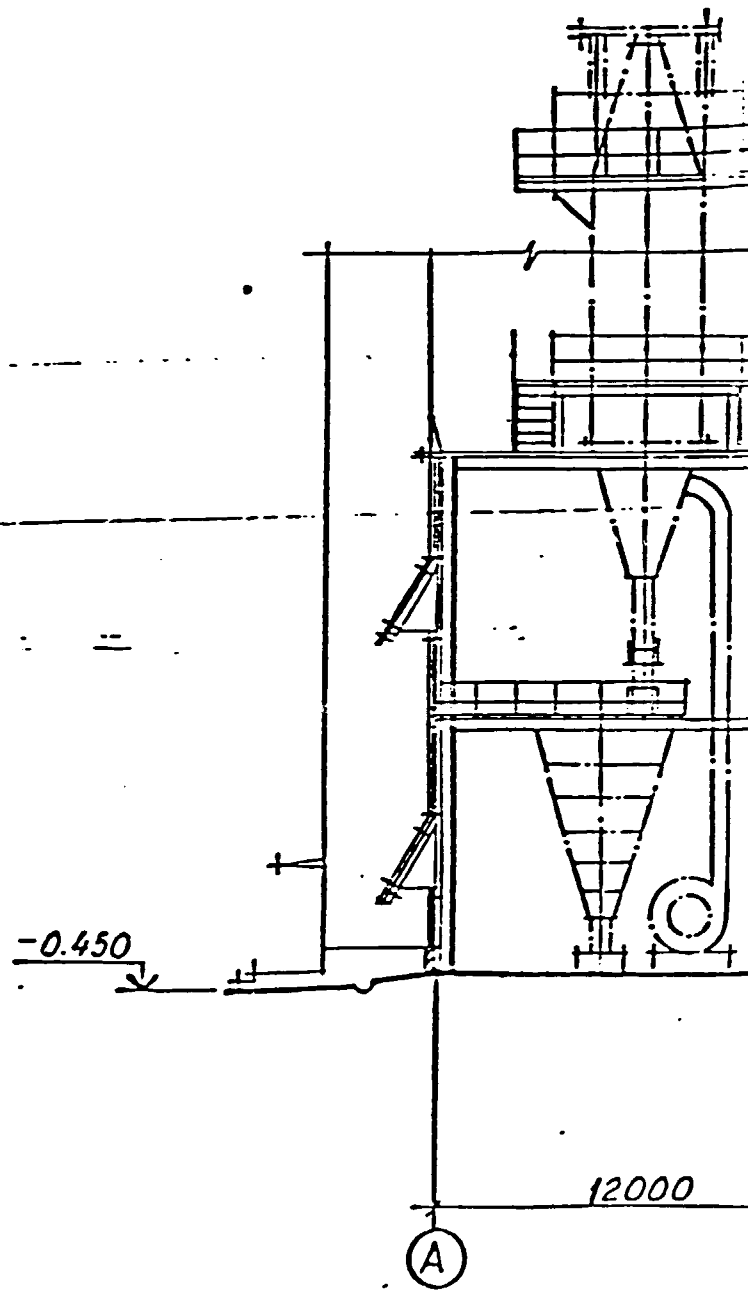


SECTION 1

-2

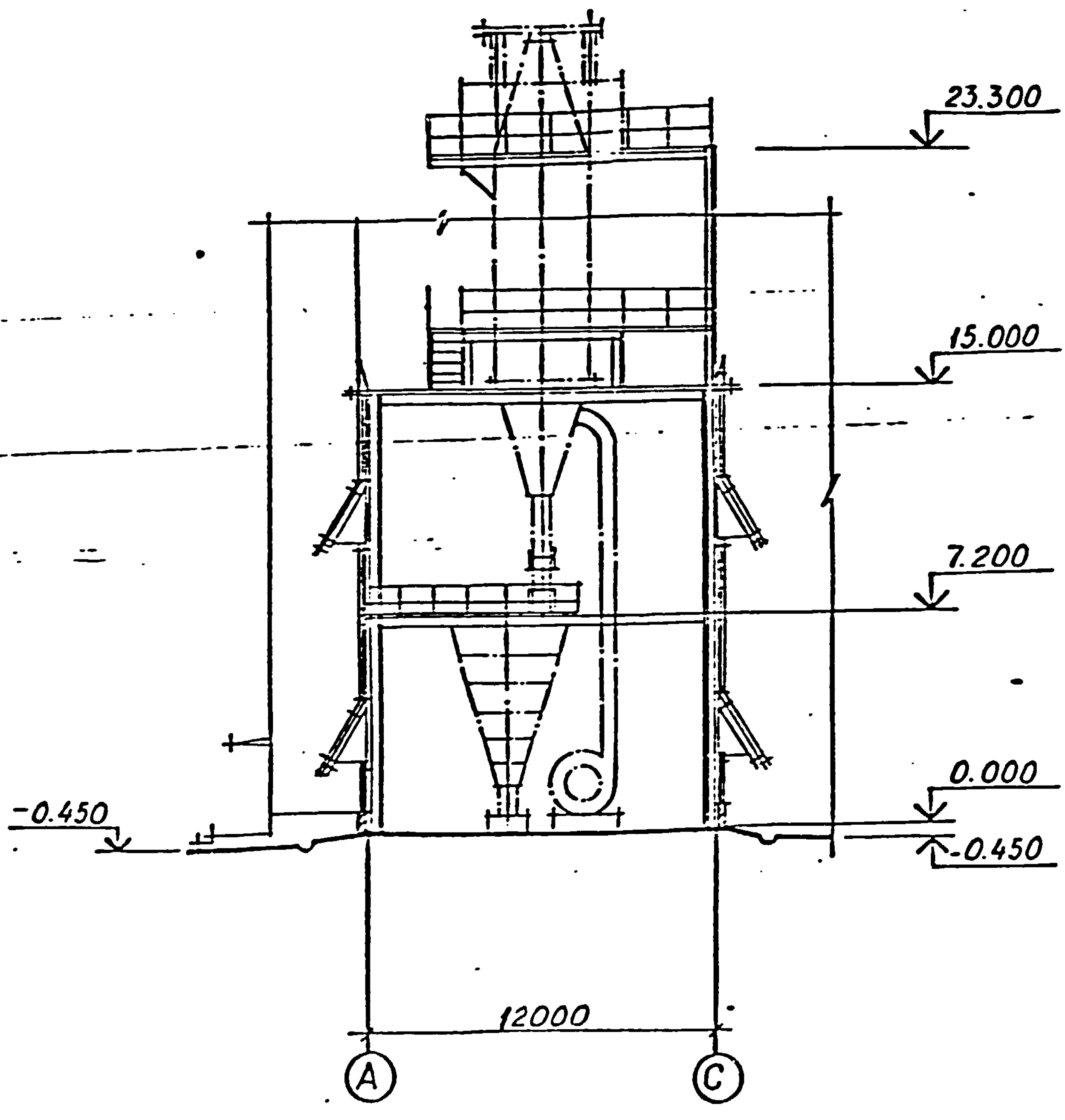
SECTION 3



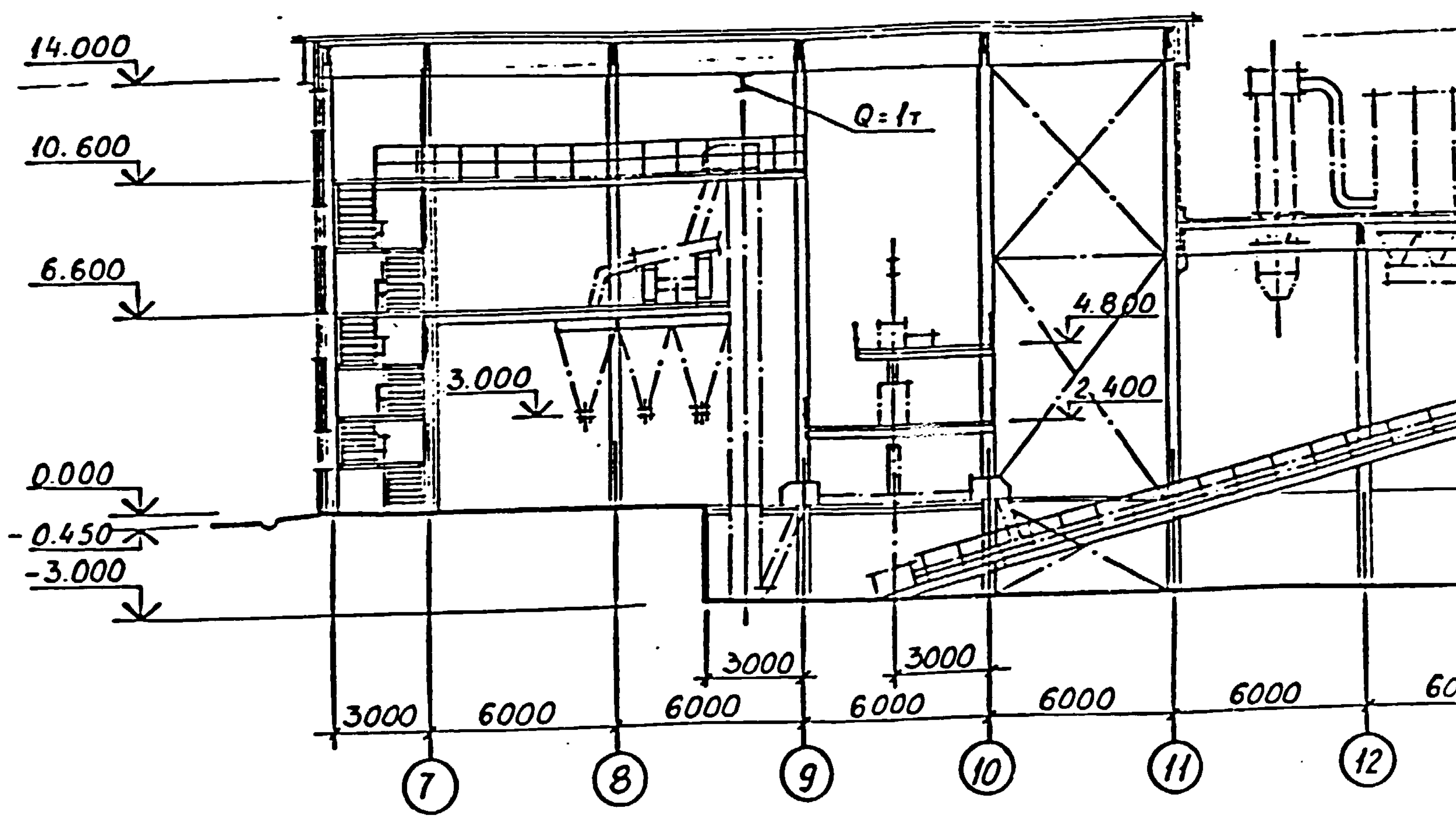


SECTION 2

SECTION 3-3



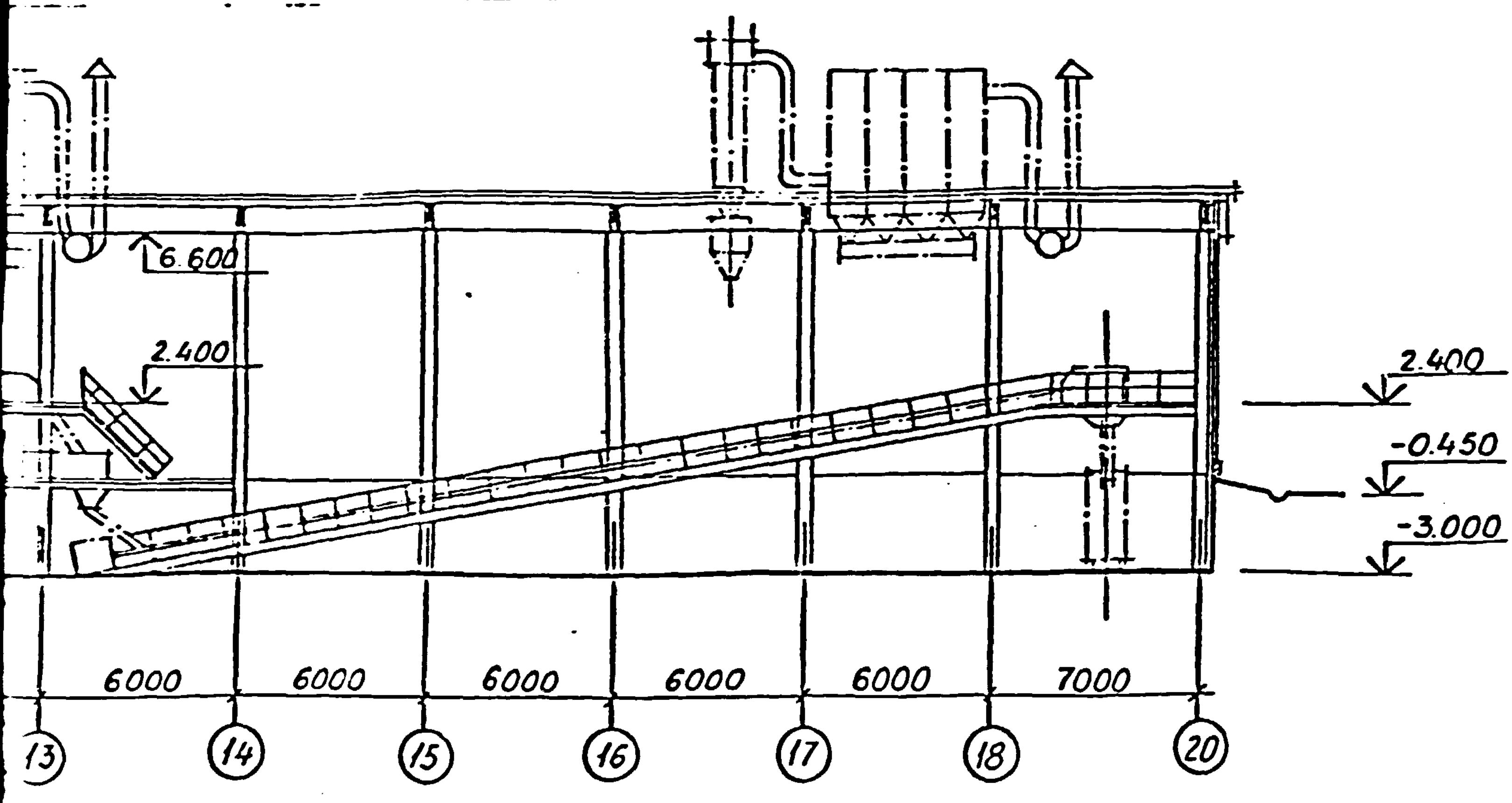
SECTION 3


14.000
10.600
6.600
3.000
0.000
-0.450
-3.000
Q=1т
4.800
2.400
3000
3000
3000
6000
6000
6000
6000
6000
7
8
9
10
11
12

SECTION 4

SECTION 4-4

SECTION 5



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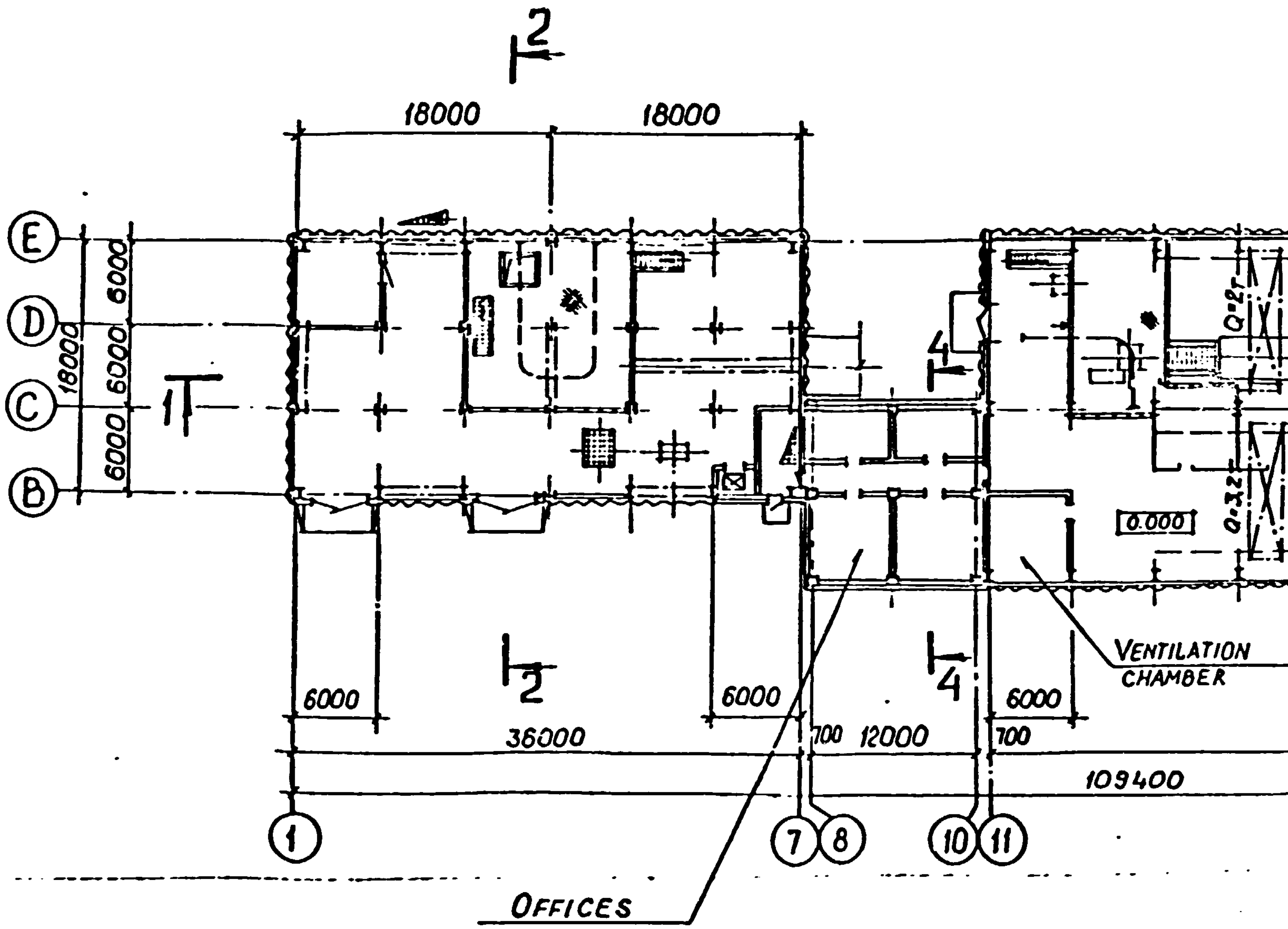
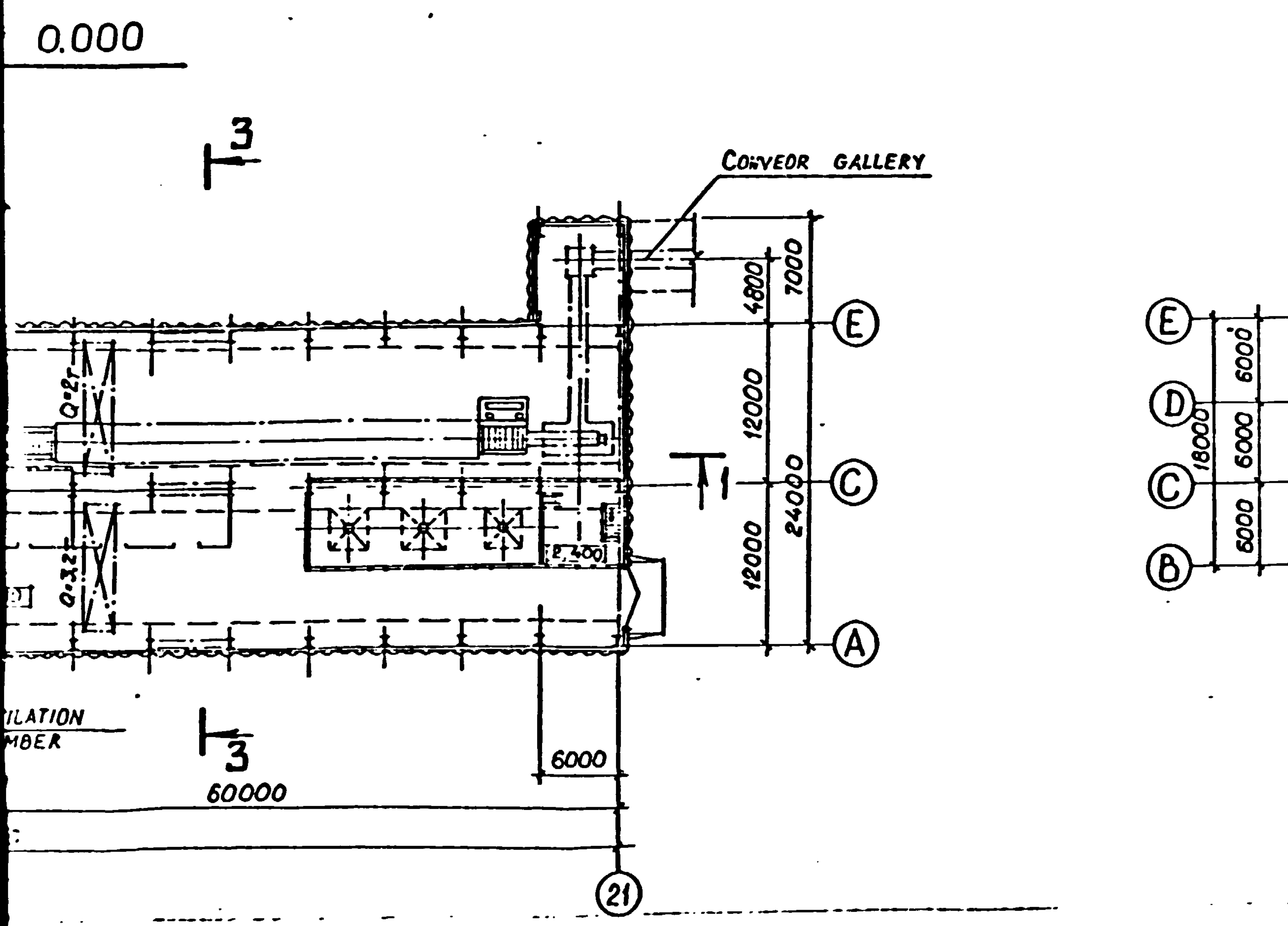
1500723-AC			
ANGUL ALUMINIUM SMELTER (INDIA)			
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION ROW MATERIALS STORAGE AND REDUCTANT GRINDING	PHASE	SHEET	SHEETS
	FS	3	
SECTIONS 2-2; 3-3; 4-4.	VAMI LENINGRAD		

SIZE A 4x5

PLAN AT EL. 0.00

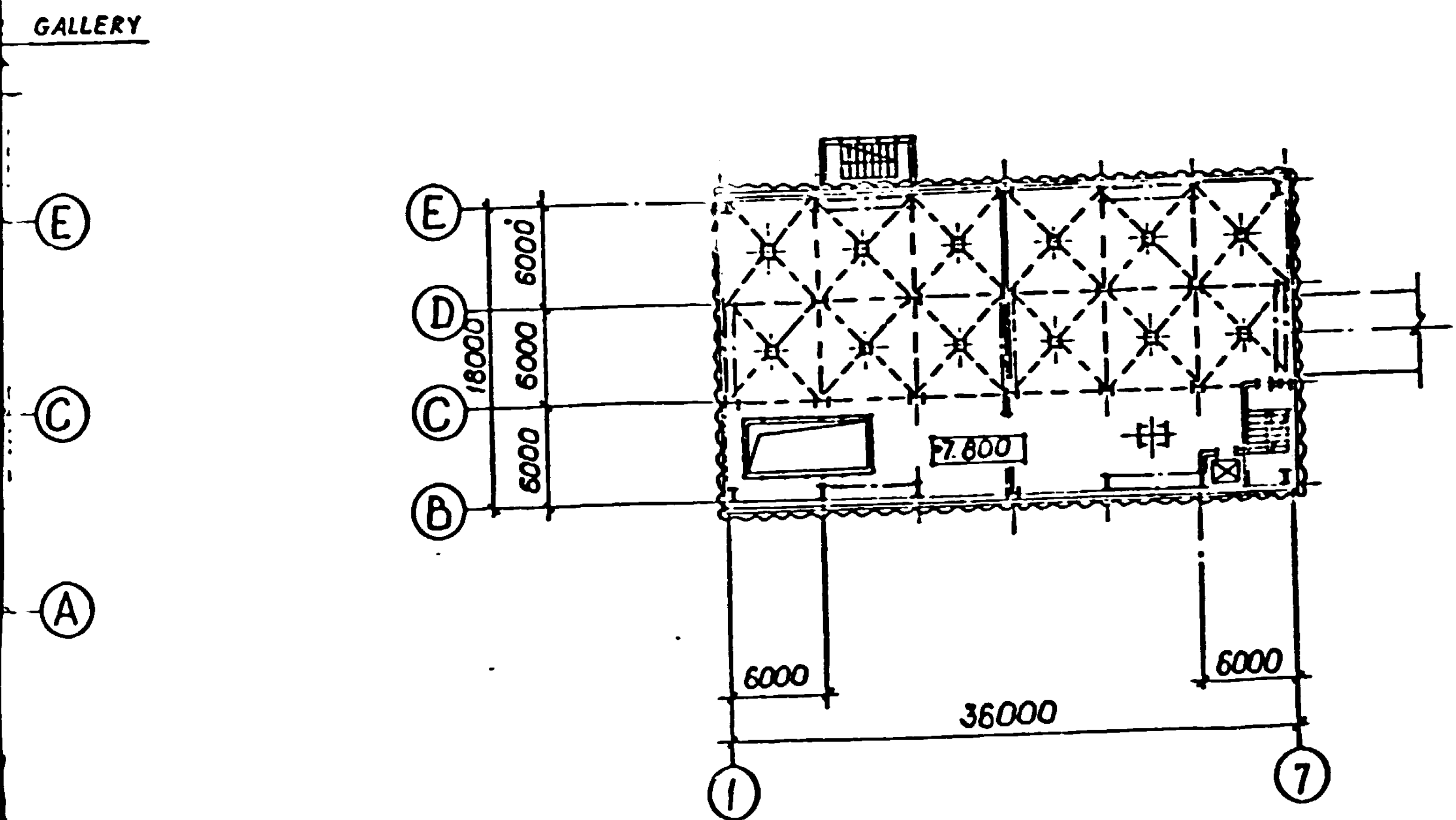


SECTION 1


0.000
3
CONVEOR GALLERY
7000
4800
E
12000
24000
C
12000
A
1
Q=2T
Q=3.2
2.400
ILATION
MBER
3
6000
60000
21
E
D
C
B
6000
6000
6000
18000

SECTION 2

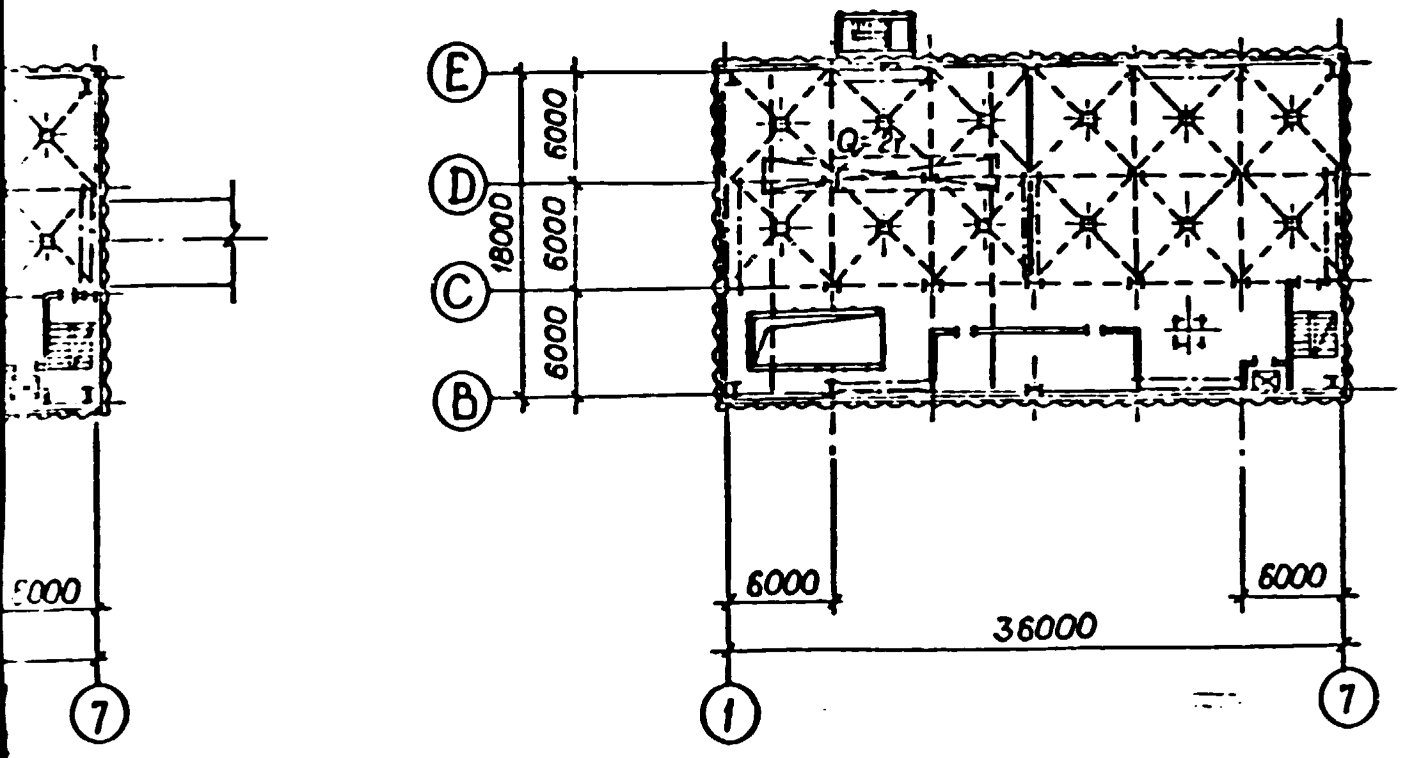
PLAN AT. EL. 7.800



SECTION 3

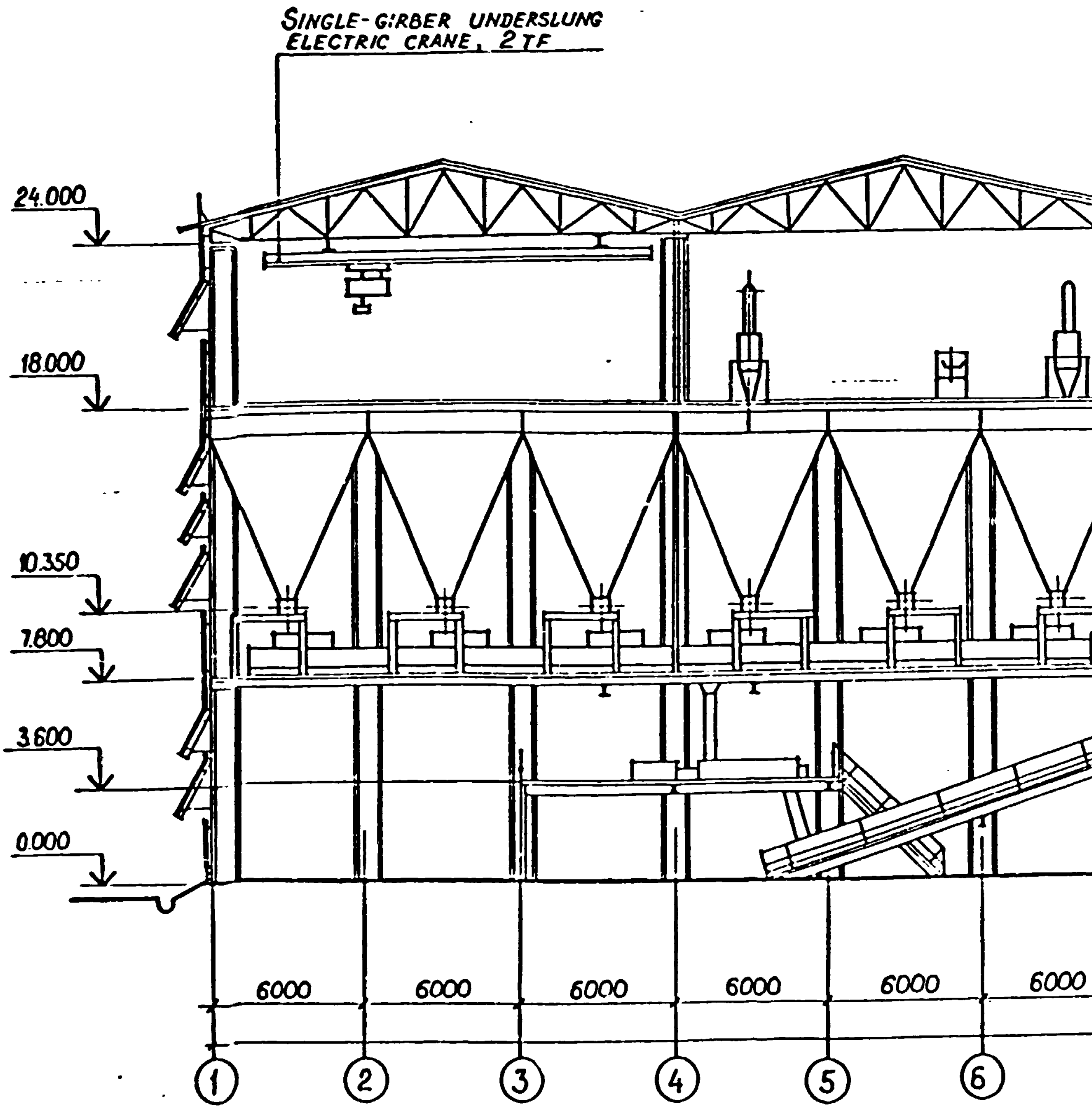
300

PLAN AT. EL. 18.000



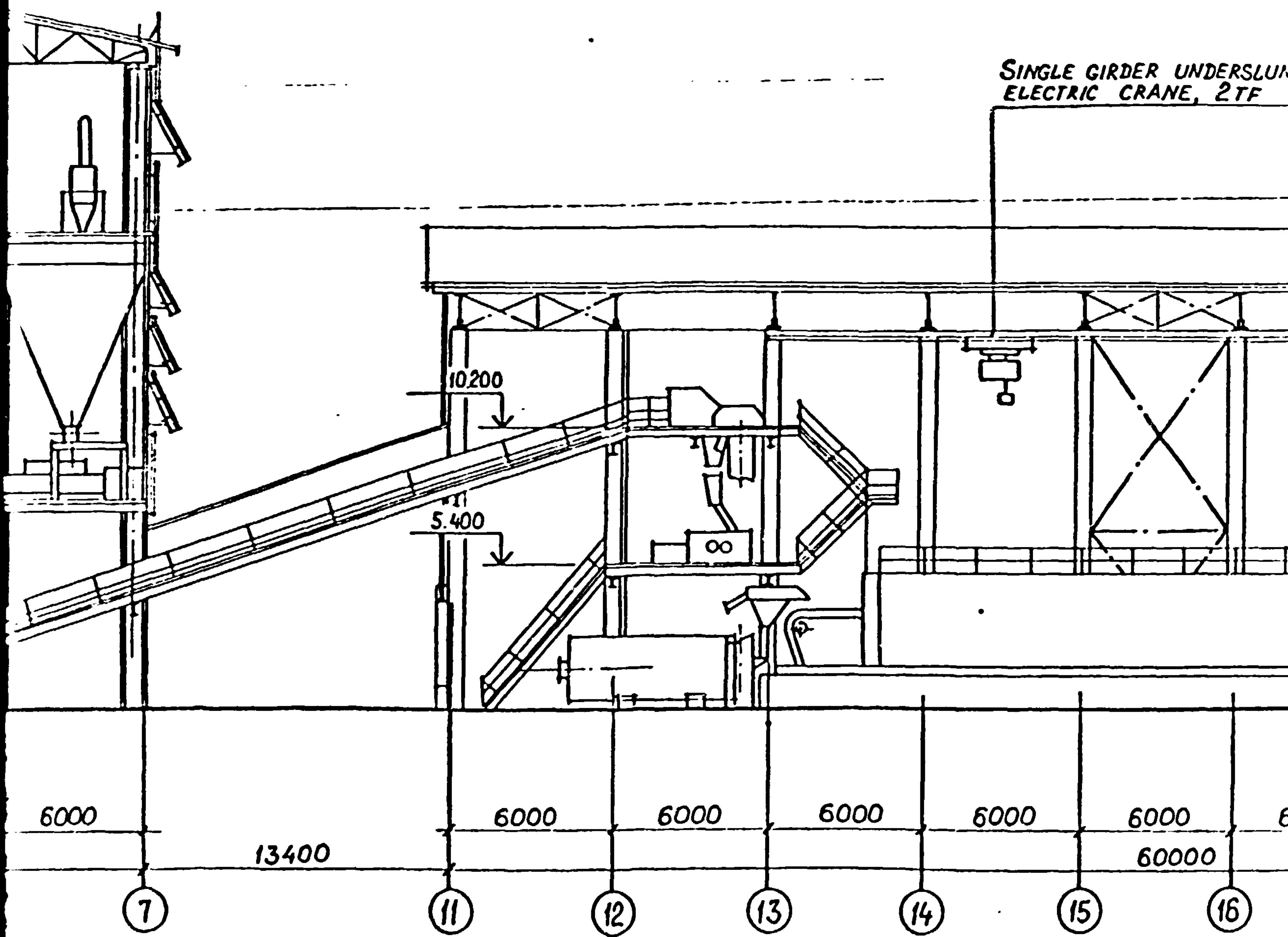
SECTION 4

	1500723-AC		
	ANGUL ALUMINIUM SMELTER (INDIA)		
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION CHARGE SHOP	PHASE FS	SHEET 4	SHEETS
	PLANS AT EL. 0.000; 7.800; 18.000	VAMI LENINGRAD		

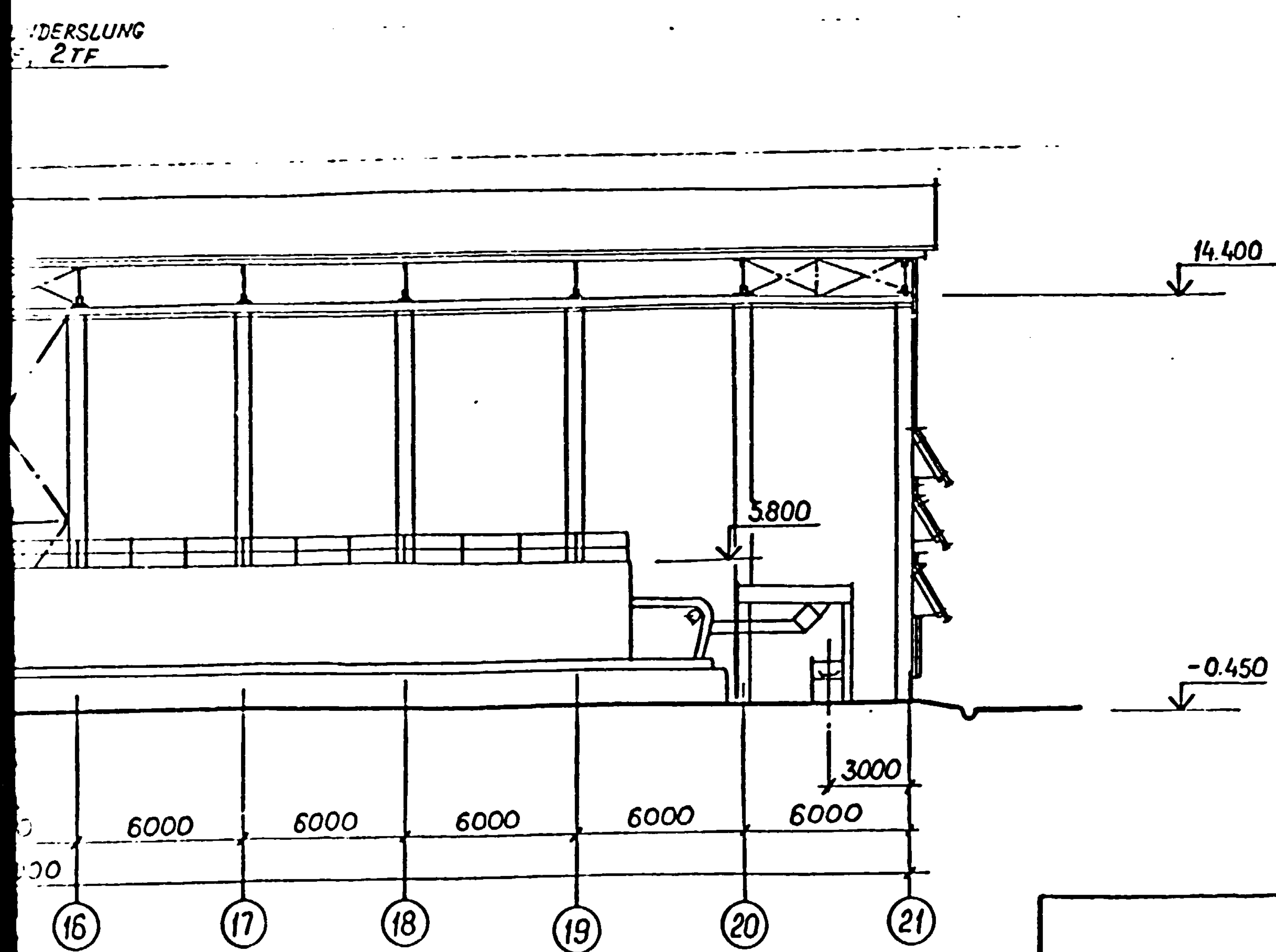

SINGLE-GIRBER UNDERSLUNG
ELECTRIC CRANE, 2 TF
24.000
18.000
10.350
7.800
3.600
0.000
6000
6000
6000
6000
6000
6000
1
2
3
4
5
6

SECTION 1

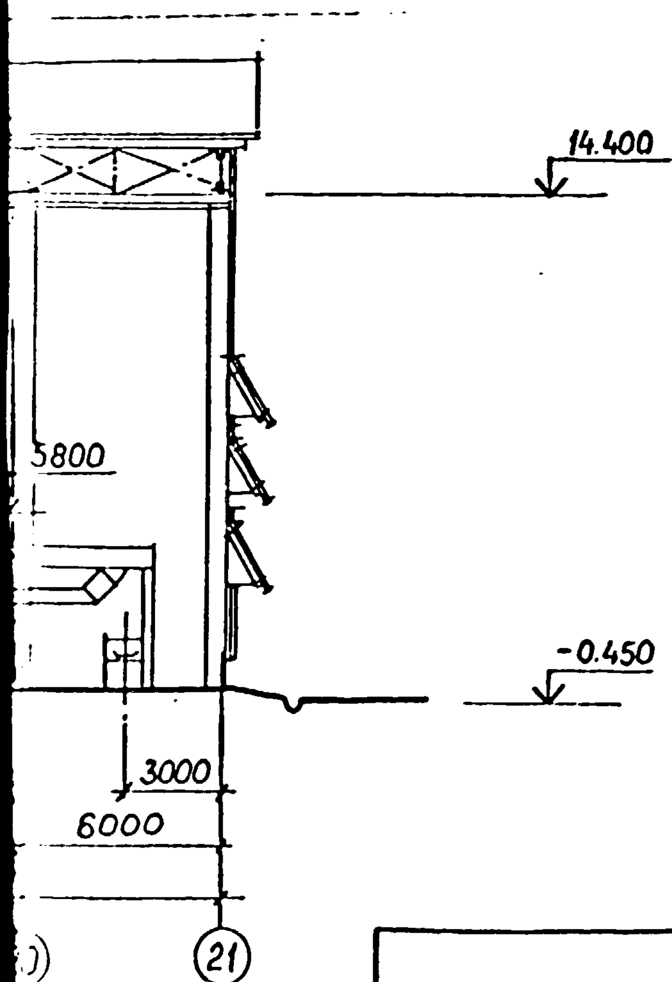
SECTION 1-1



SECTION 2



SECTION 3

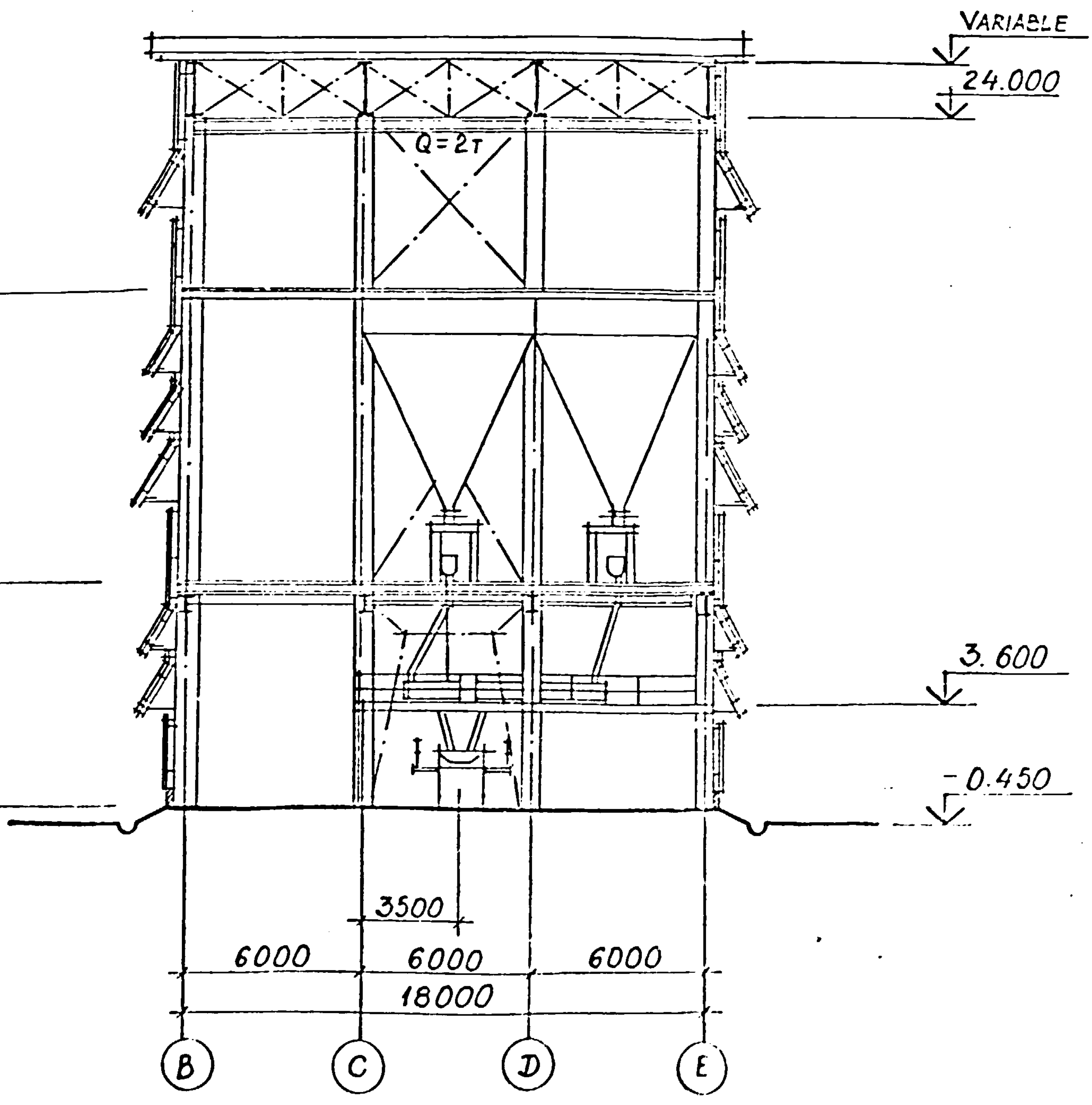


SECTION 4

1500723-AC			
ANGUL ALUMINIUM SMELTER (INDIA)			
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION CHARGE SHOP	PHASE	SHEET	SHEETS
	FS	5	
SECTION 1-1	VAMI LENINGRAD		

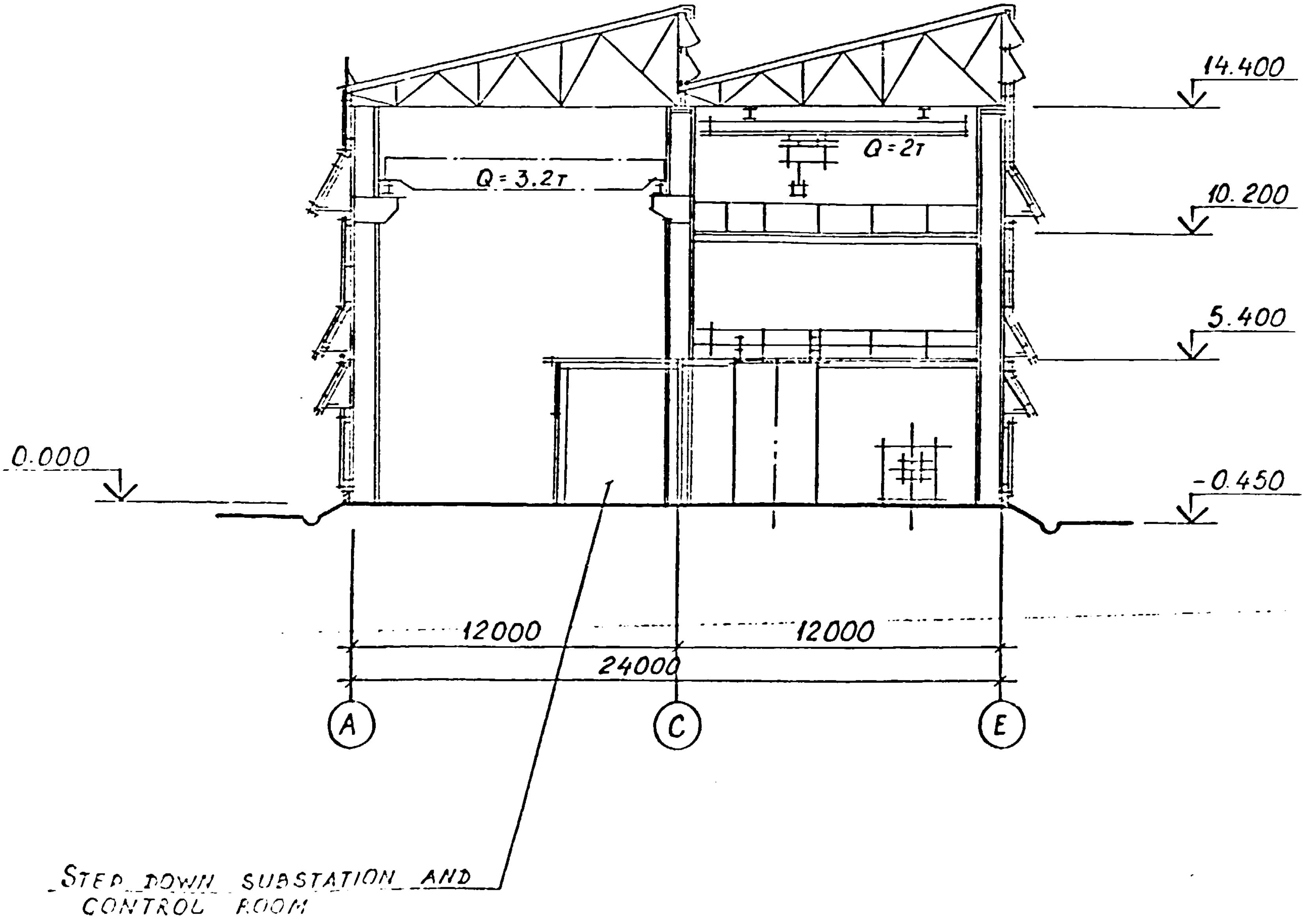
SIZE A 4×4

SECTION 2-2



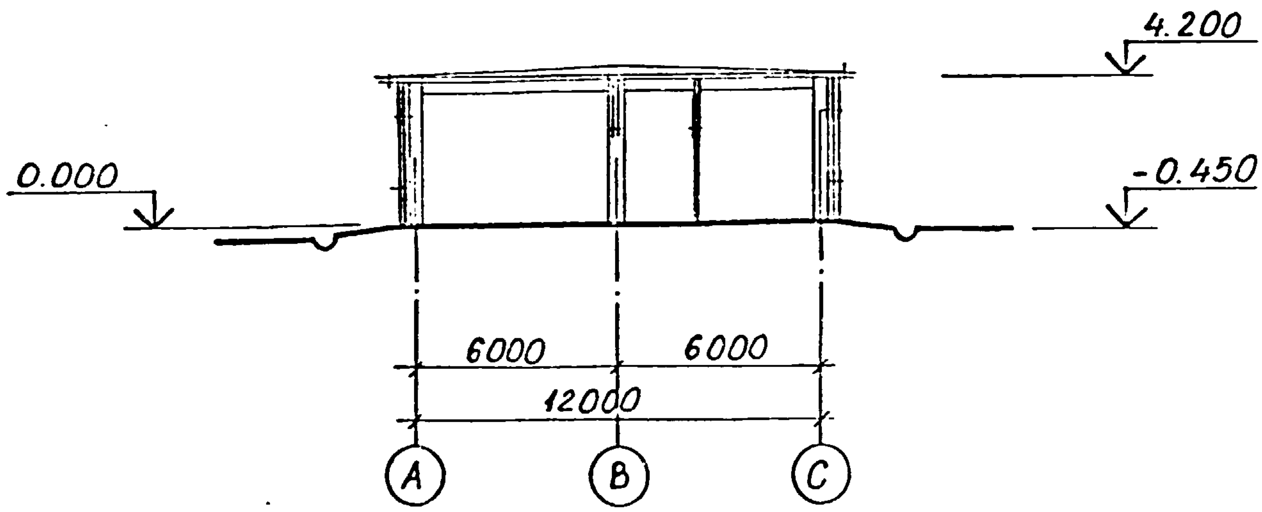
SECTION 1

SECTION 3-3



SECTION 2

SECTION 4-4



SECTION 3

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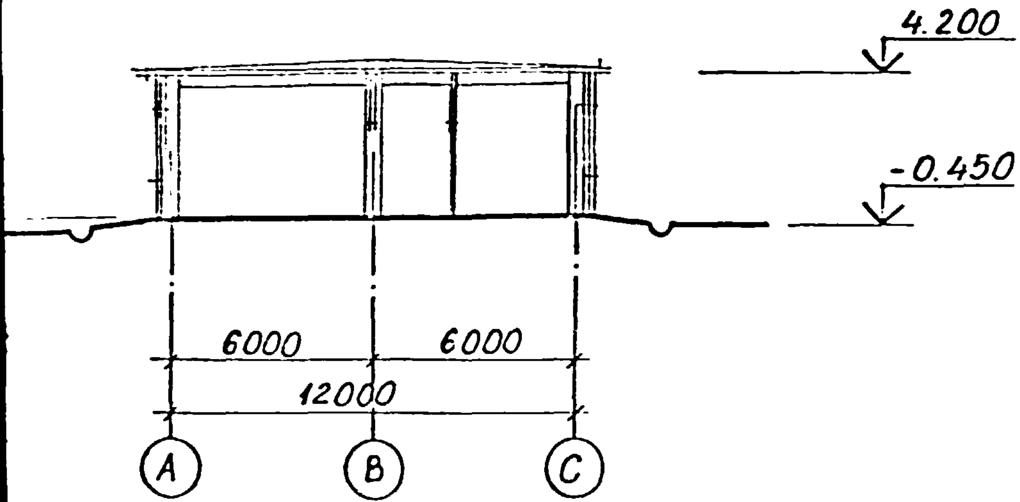
15007

ANGUL ALUMINIU

INDUSTRIAL DEMONSTRAT
FOR AL-SI ALLOYS PROD
CHARGE SHO

SECTIONS 2-2 ÷

SECTION 4 - 4



SECTION 4

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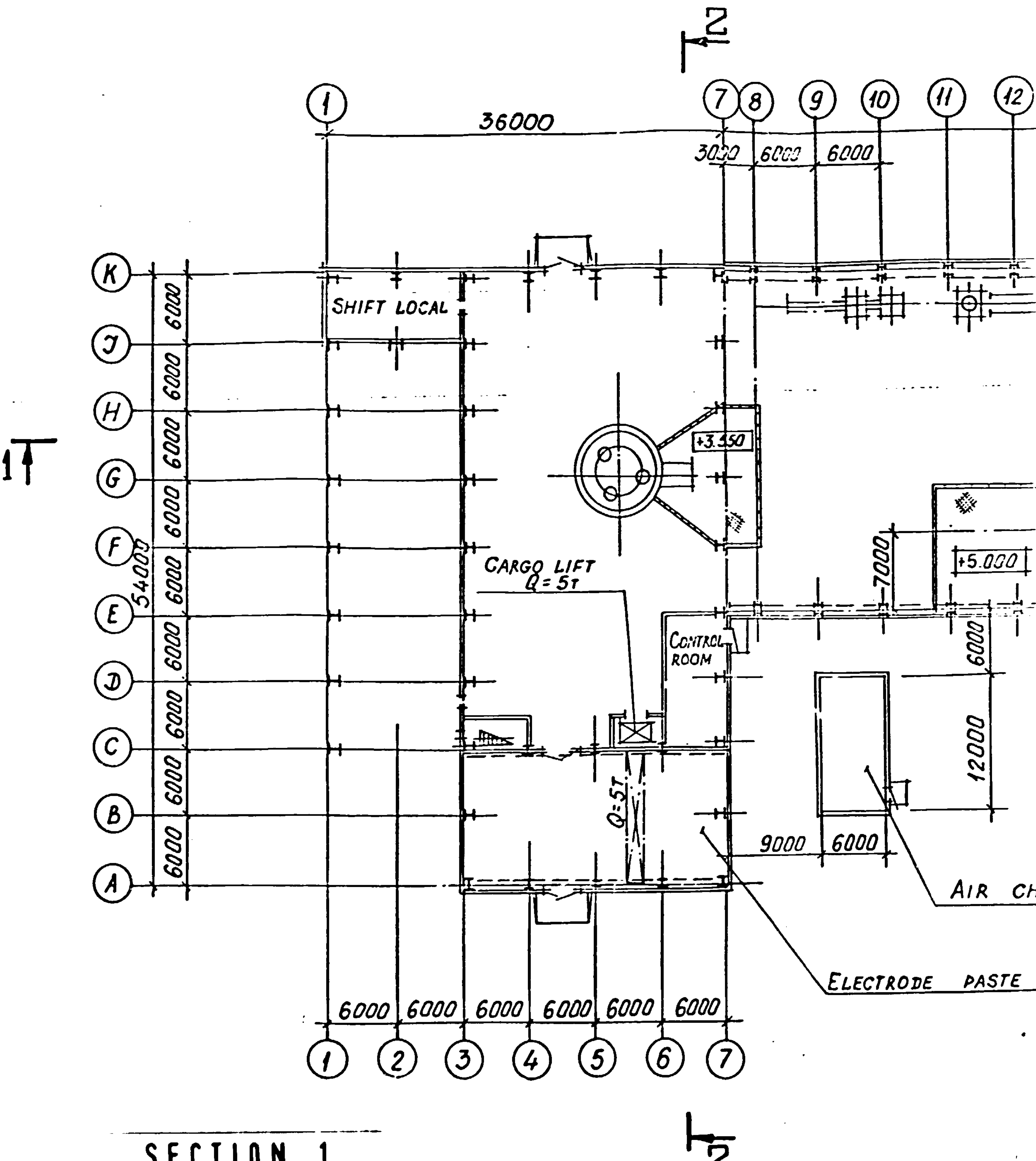
1500723-AC			
ANGUL ALUMINIUM SMELTER (INDIA)			
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION CHARGE SHOP	PHASE	SHEET	SHEETS
	FS	6	
SECTIONS 2-2 ÷ 4-4.	VAMI LENINGRAD		

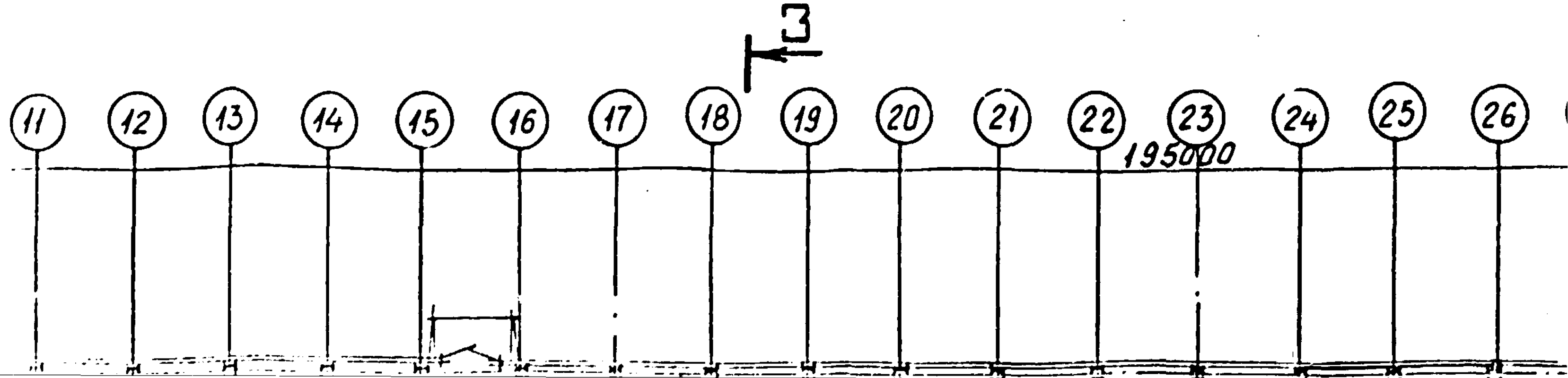
SIZE A 4 × 4

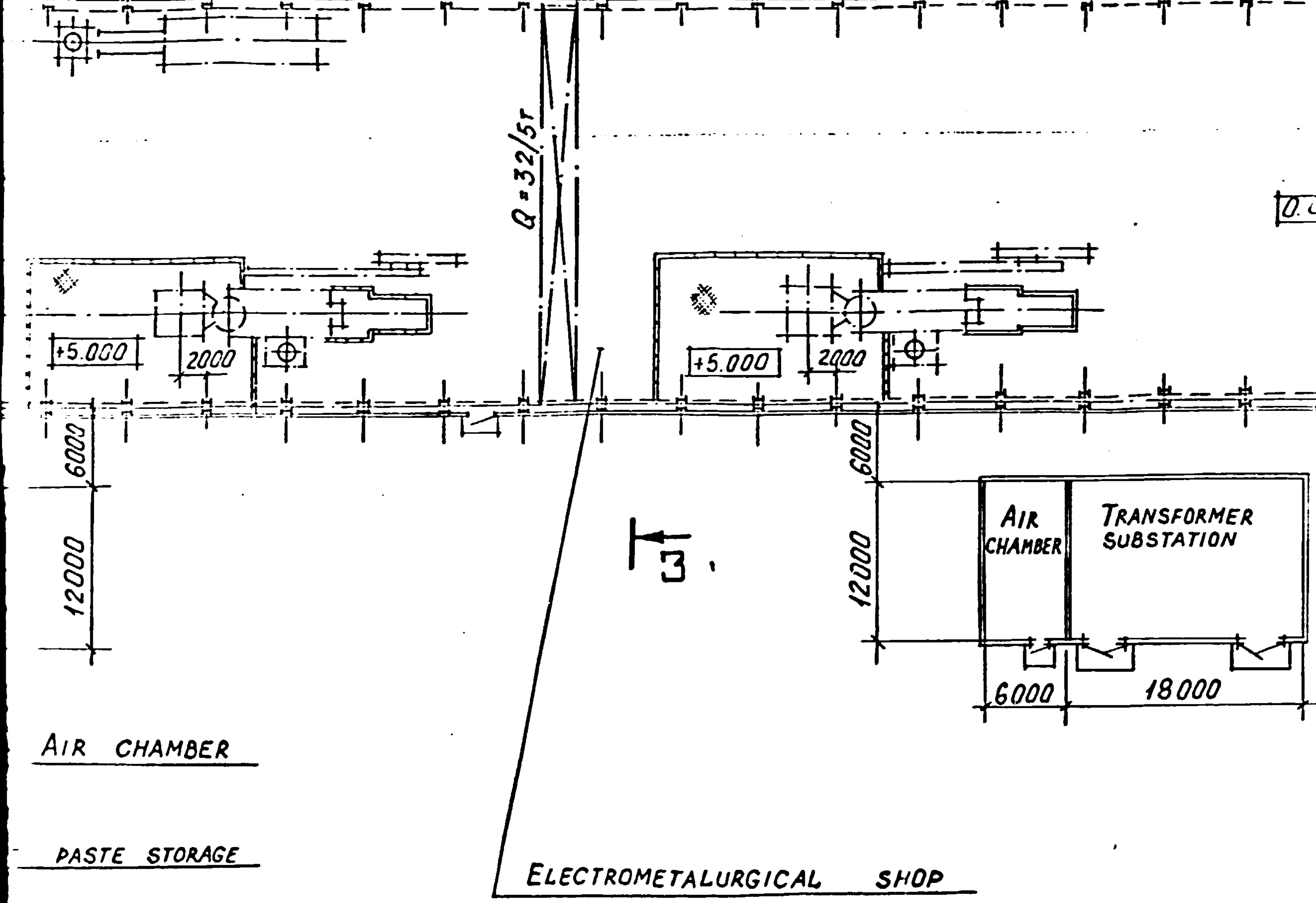


2
36000
3000 6000 6000
1 7 8 9 10 11 12
K J H G F E D C B A
6000
54000
SHIFT LOCAL
+3.550
+5.000
7000
CARGO LIFT
Q = 5T
CONTROL ROOM
Q=5T
12000
9000 6000
AIR CH
ELECTRODE PASTE
6000 6000 6000 6000 6000 6000
1 2 3 4 5 6 7

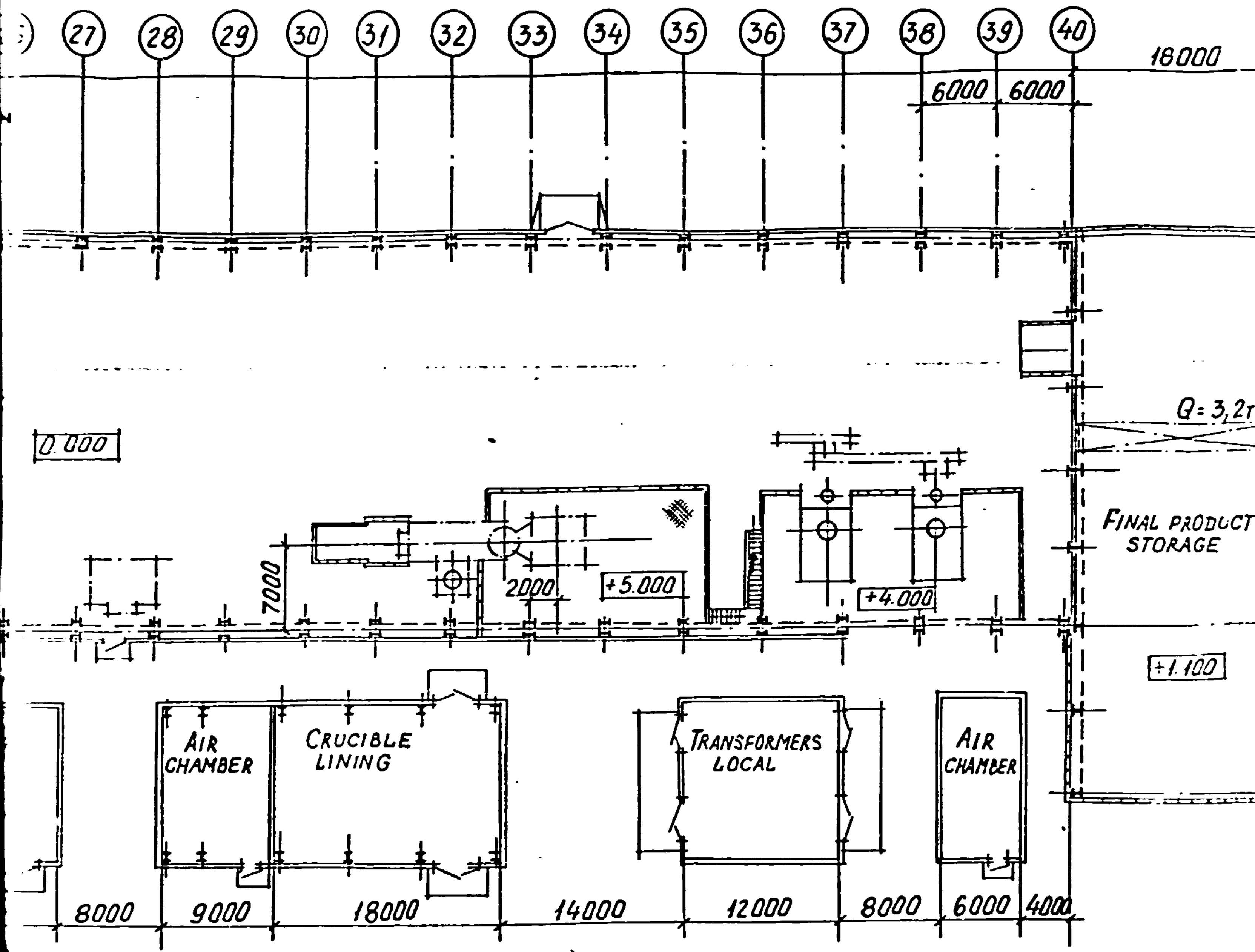
SECTION 1

PLAN AT. EL. 0.000

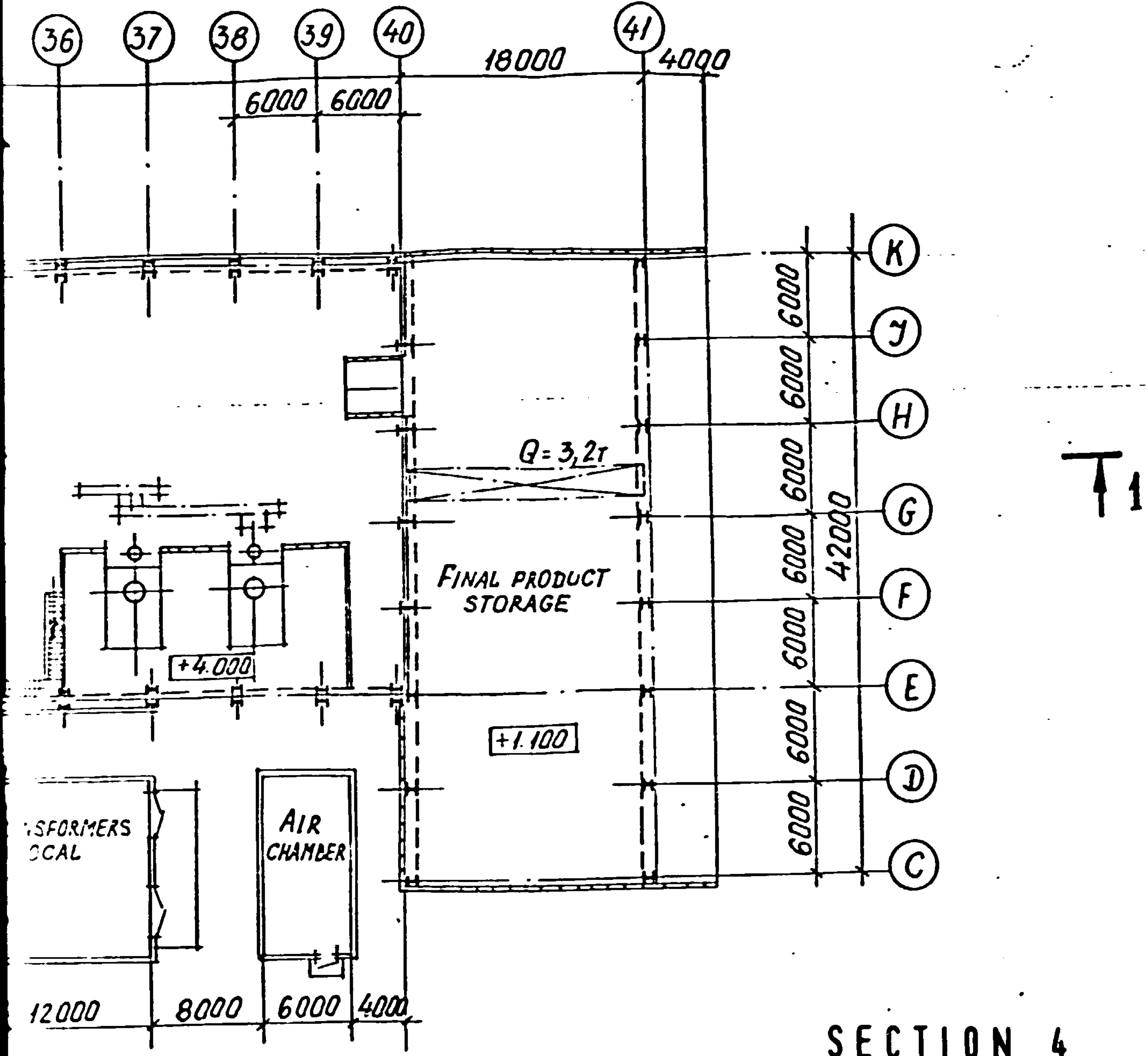



Q = 32/5T
+5.000
2000
+5.000
2000
6000
12000
6000
12000
AIR CHAMBER
TRANSFORMER SUBSTATION
6000
18000
3
AIR CHAMBER
PASTE STORAGE
ELECTROMETALURGICAL SHOP

SECTION 2


27
28
29
30
31
32
33
34
35
36
37
38
39
40
18000
6000
6000
Q=3,2т
0.000
FINAL PRODUCT
STORAGE
7000
2000
+5.000
+4.000
+1.100
AIR CHAMBER
CRUCIBLE LINING
TRANSFORMERS LOCAL
AIR CHAMBER
8000
9000
18000
14000
12000
8000
6000
4000

SECTION 3



SECTION 4

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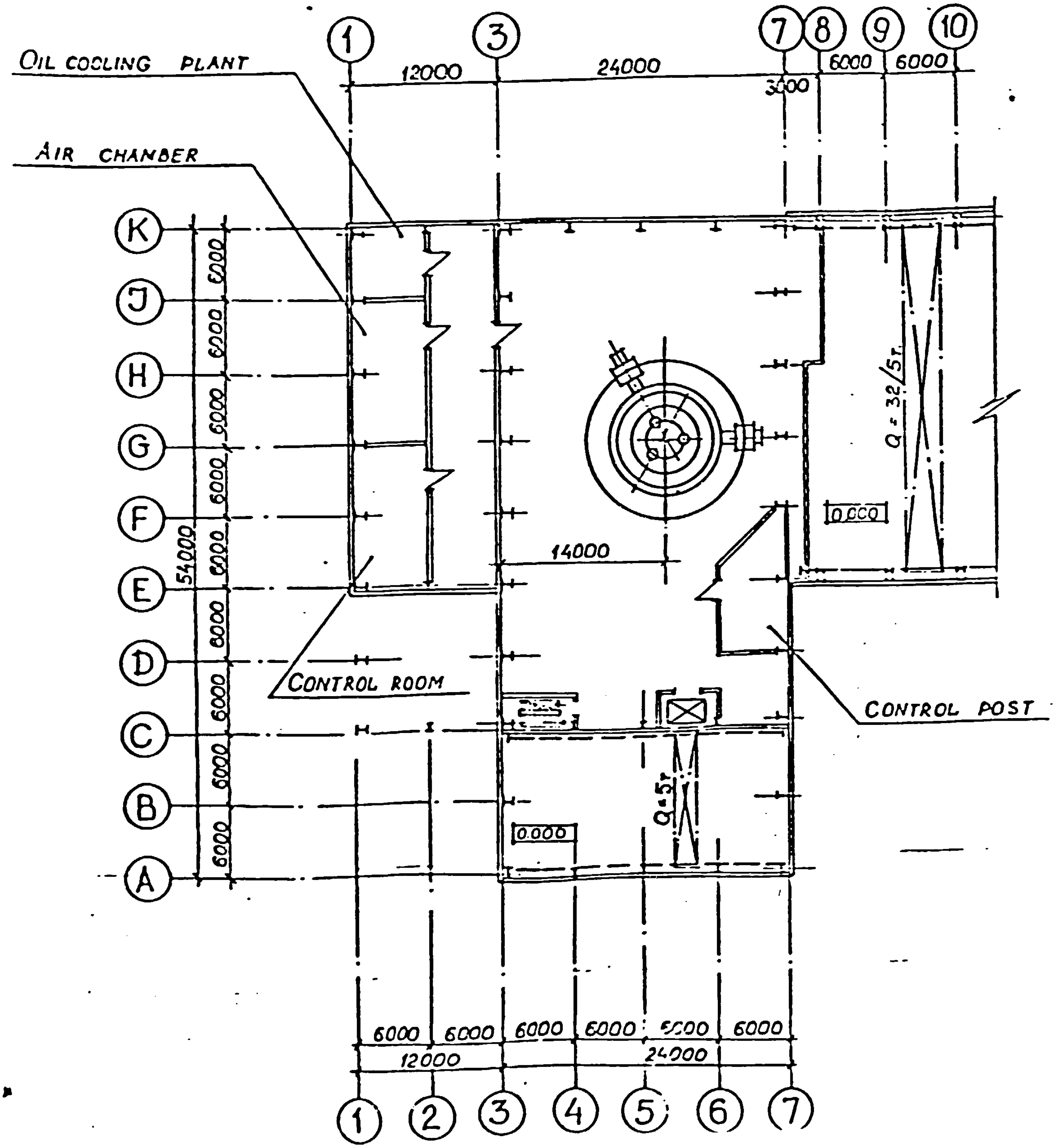
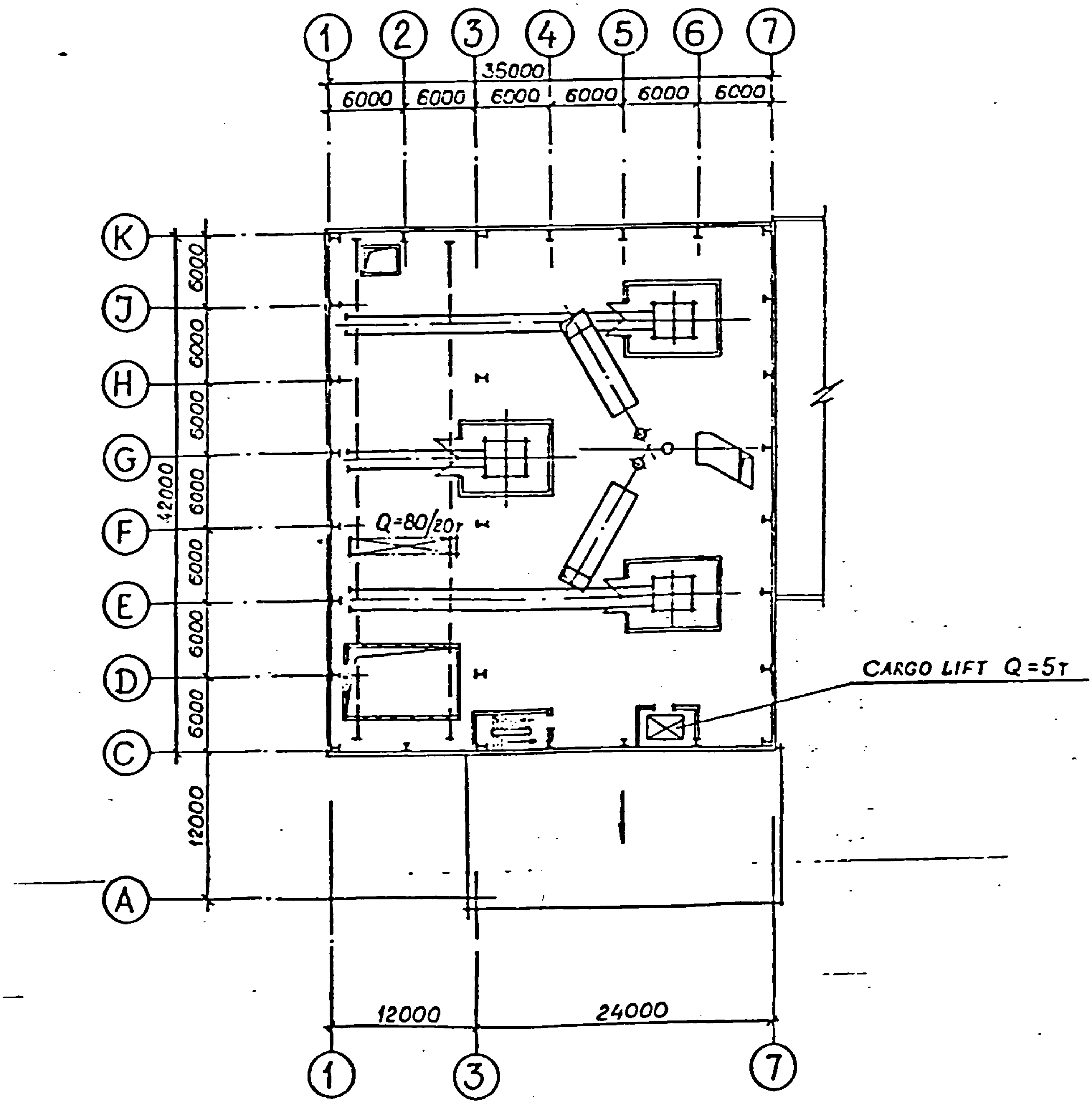
1500723-AC			
ANGUL ALUMINIUM SMELTER (INDIA)			
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION ELECTROMETALURGICAL SHOP	PHASE	SHEET	SHEETS
	FS	7	
PLAN AT EL. 0.000	VAMI LENINGRAD		
	SIZE A 4x4		

PLAN AT EL 6.600



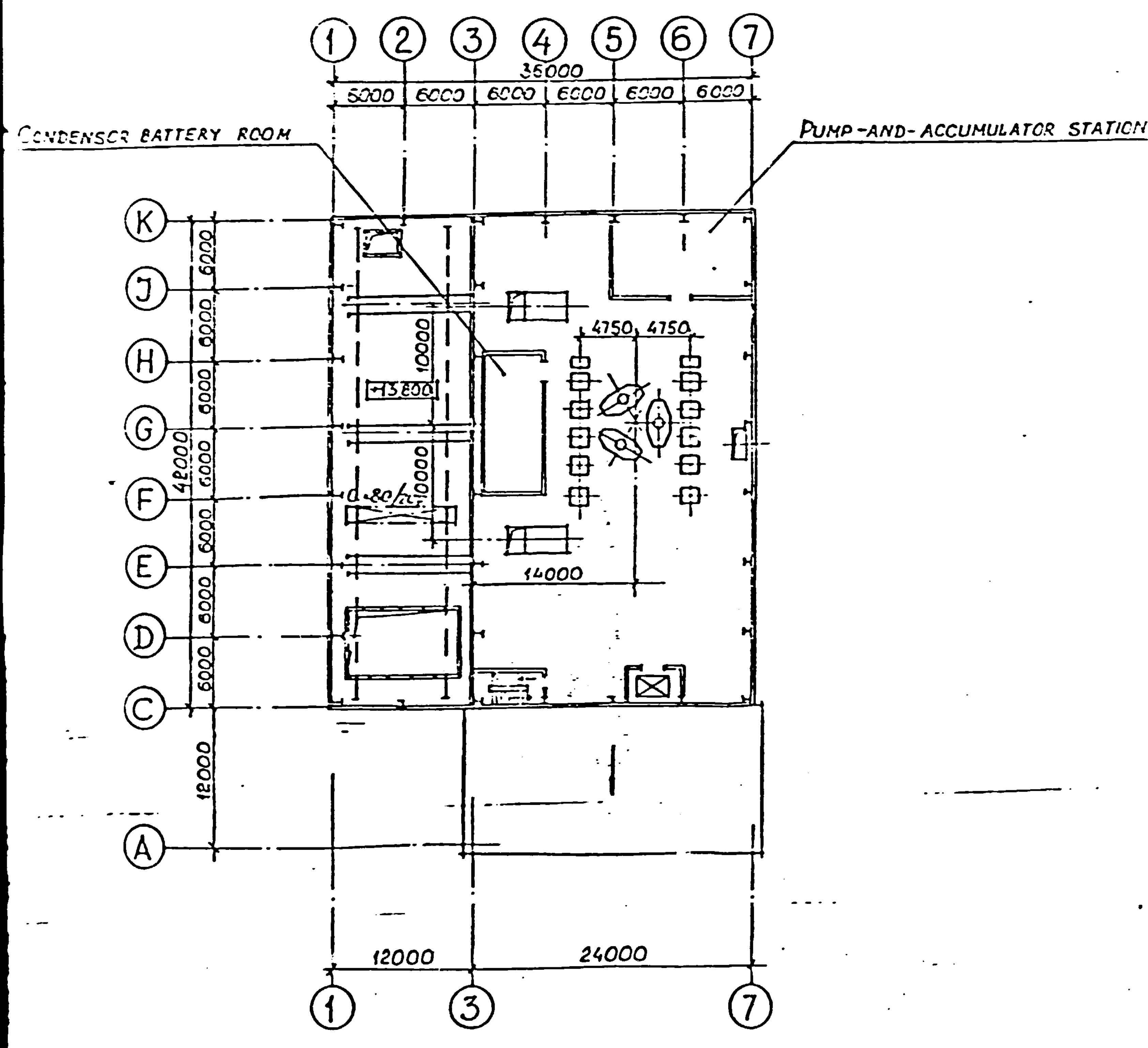
SECTION 1

PLAN AT EL. 13.800



SECTION

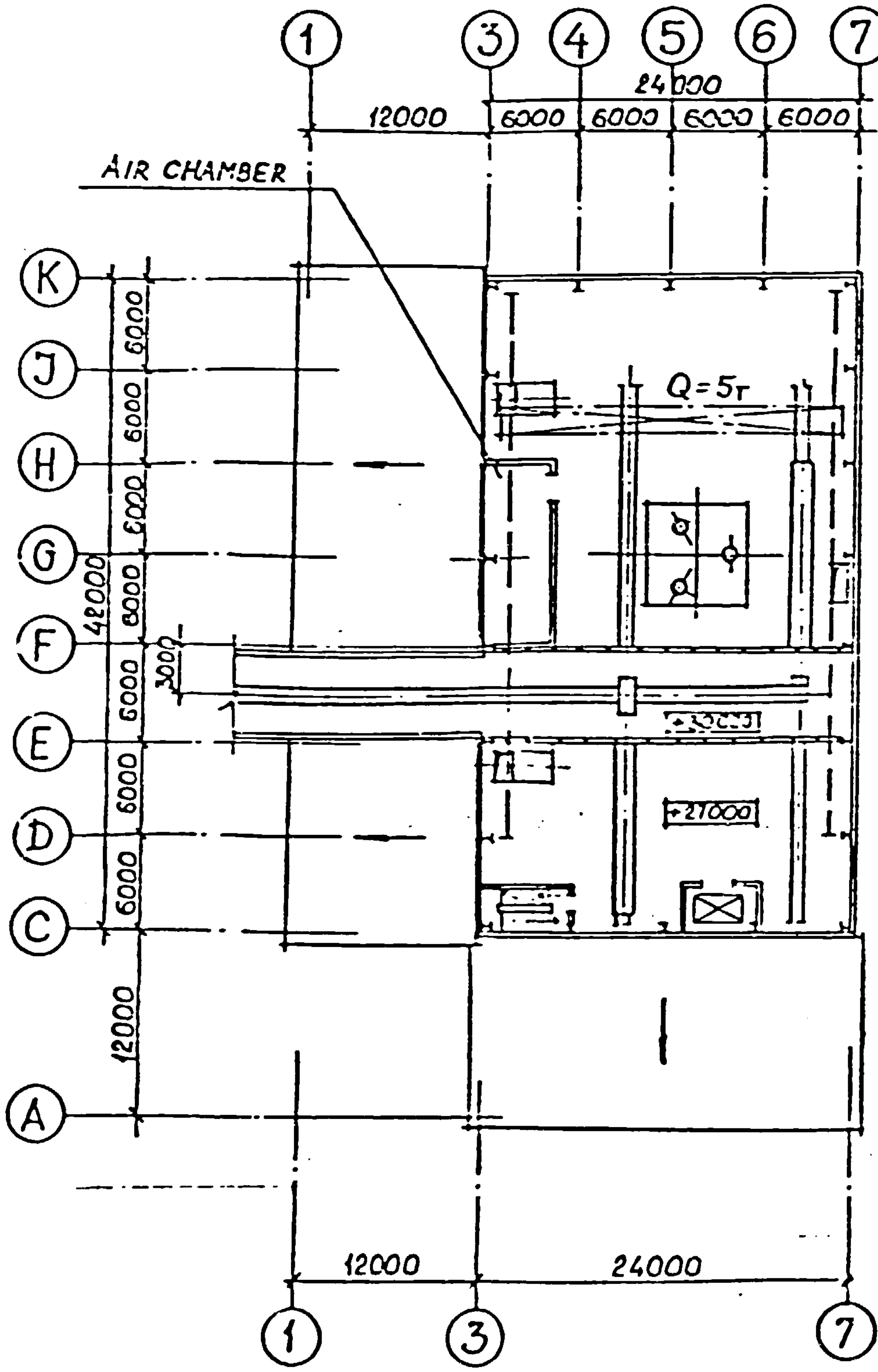
PLAN AT EL. 21.000



SECTION 3

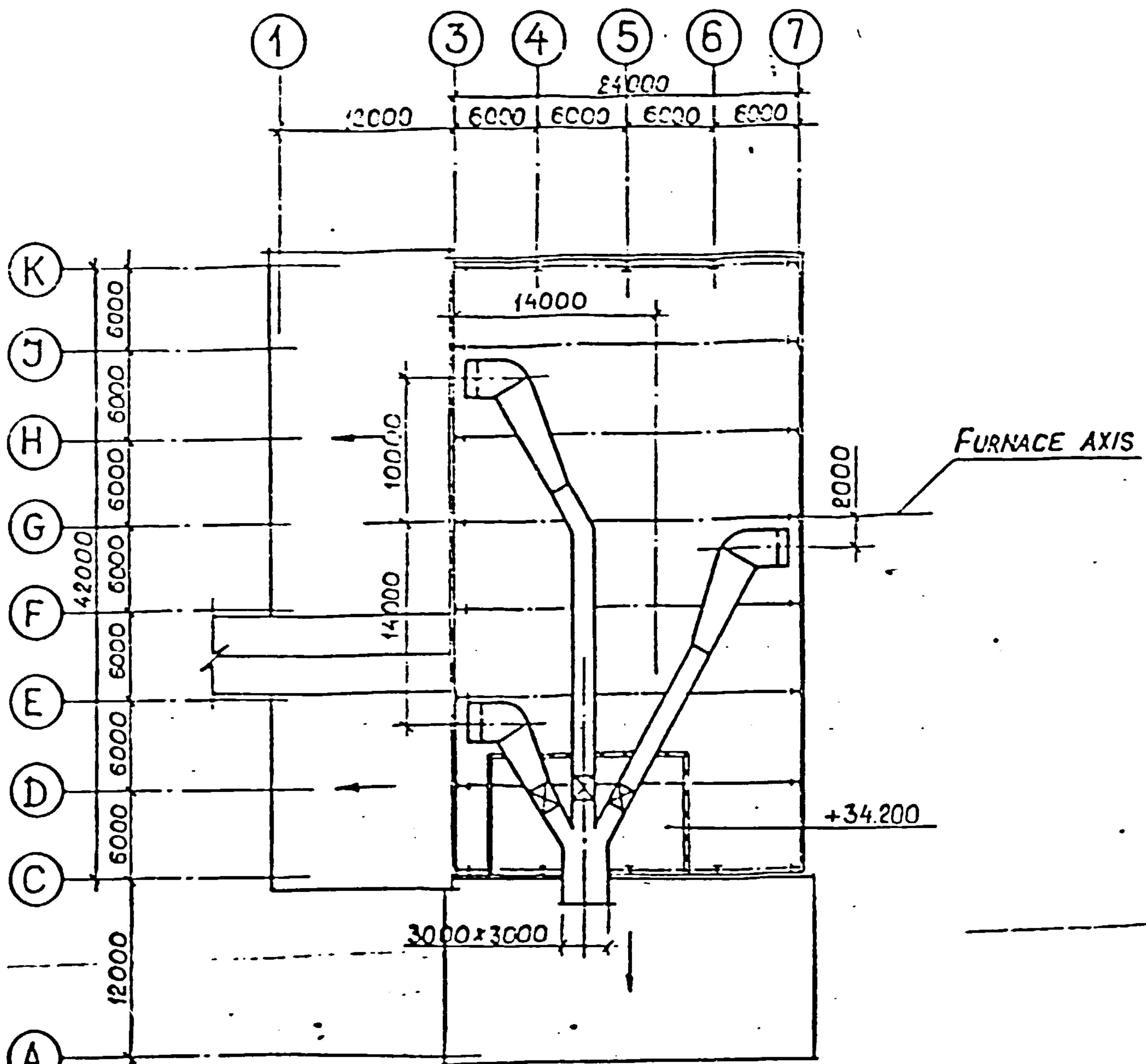
PLAN AT EL. 27.000 AND 30.000

STATION



SECTION 4

PLAN AT EL. 34.200



SECTION 5

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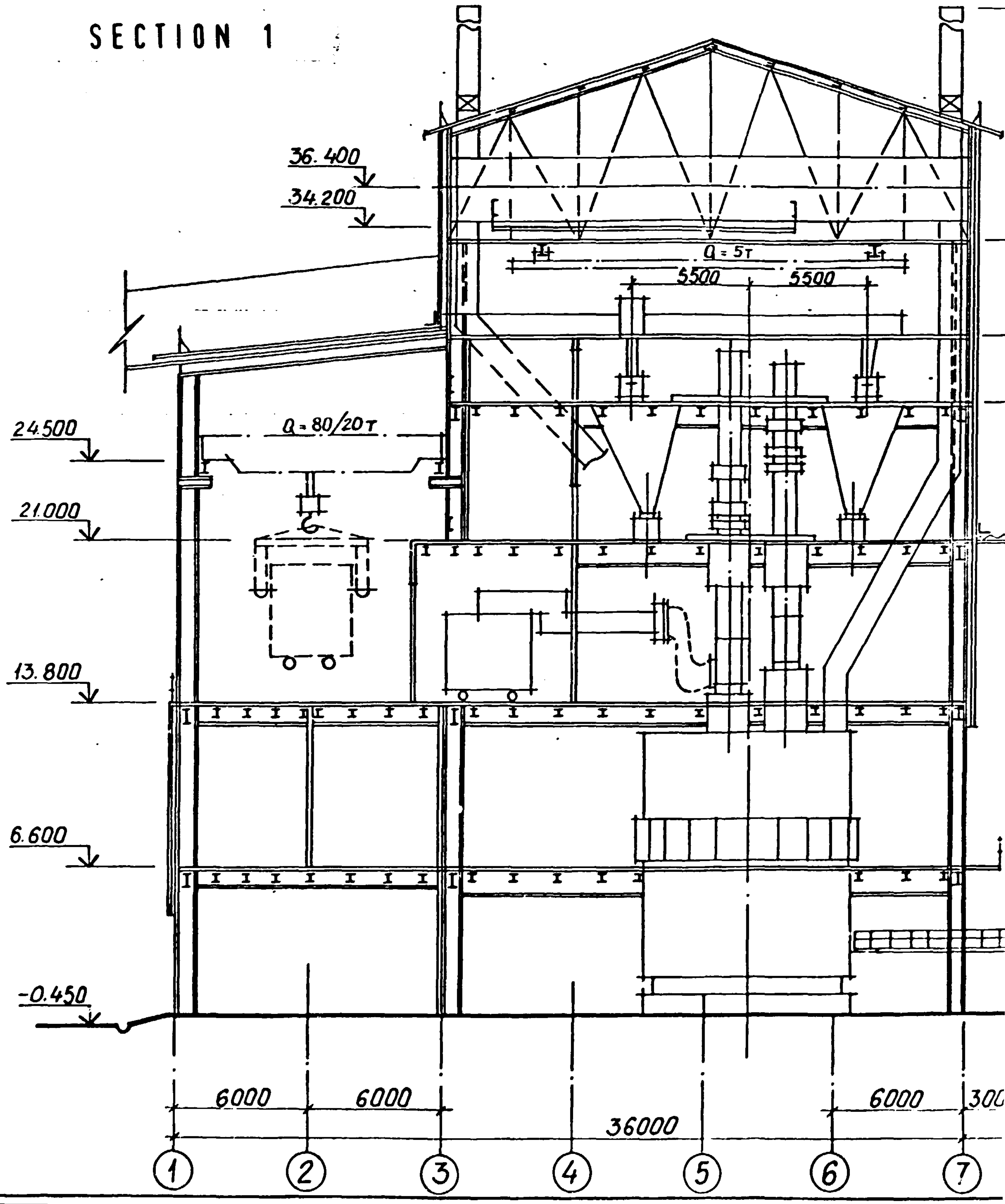
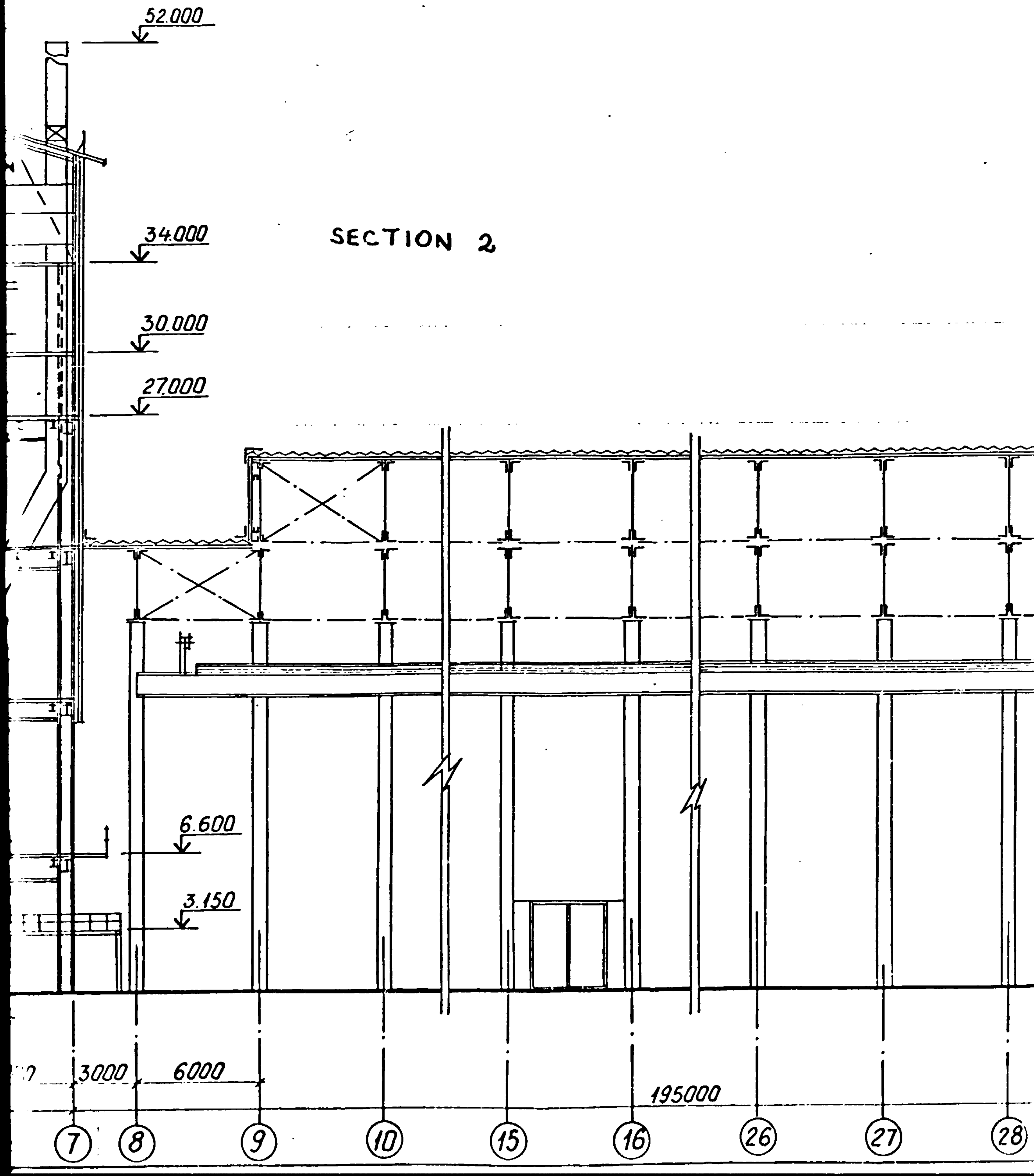
	ANGUL ALUMINIUM SMELTER (INDIA)			
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION ELECTROMETALURGICAL SHOP	PHASE	SHEET	SHEET
		FS	8	
	PLANS AT EL.6.600; 13.800; 21000; 27.000; 30.000; 34.200	VAMI LENINGRAD		

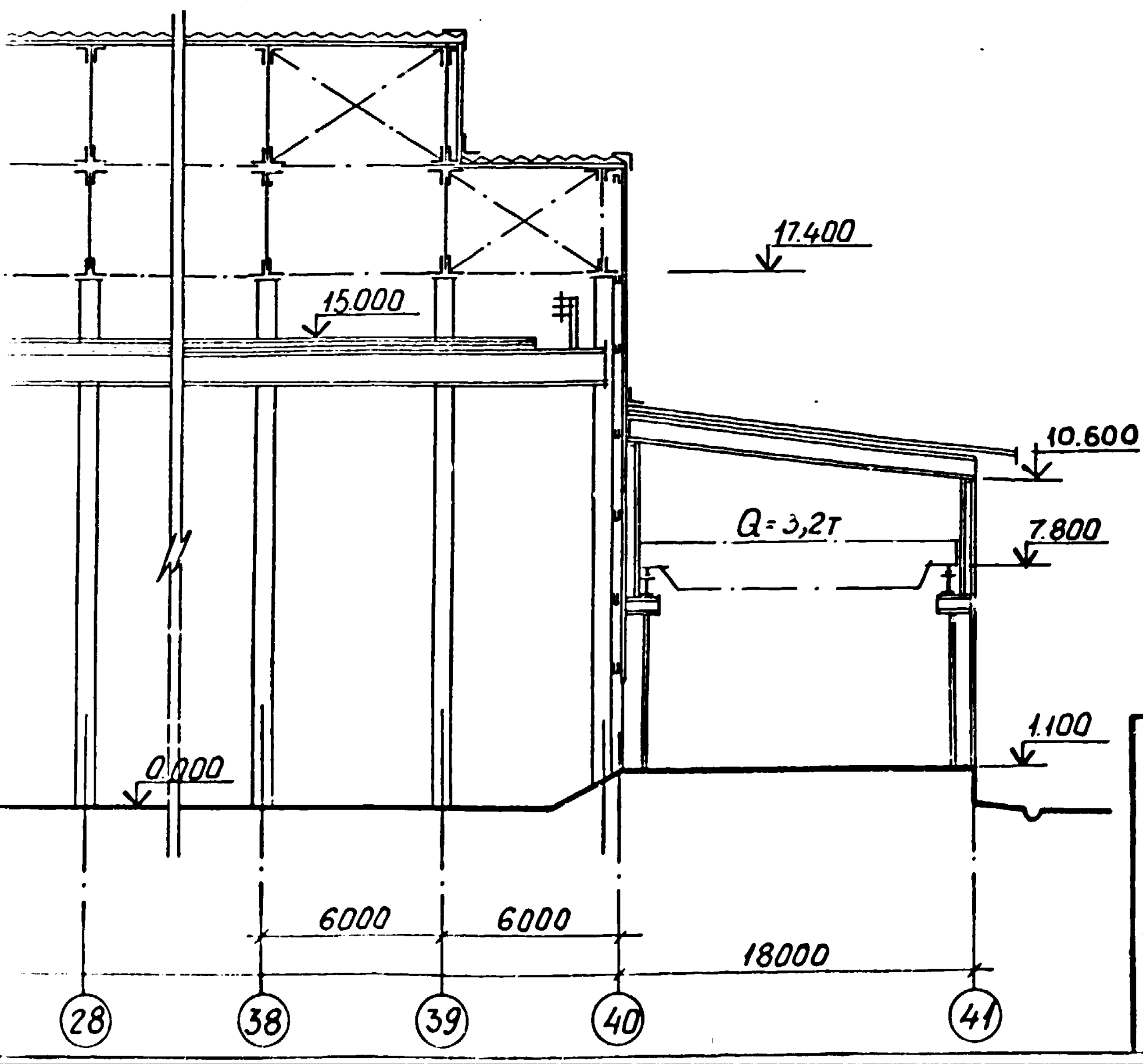
SECTION 1-1



SECTION 1
36.400
34.200
Q = 5T
5500
5500
24.500
Q = 80/20T
21.000
13.800
6.600
-0.450
6000
6000
6000
300
36000
1
2
3
4
5
6
7


SECTION 2
52.000
34.000
30.000
27.000
6.600
3.150
3000
6000
195000
7
8
9
10
15
16
26
27
28

SECTION 3



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OR PERSONS WITHOUT AG
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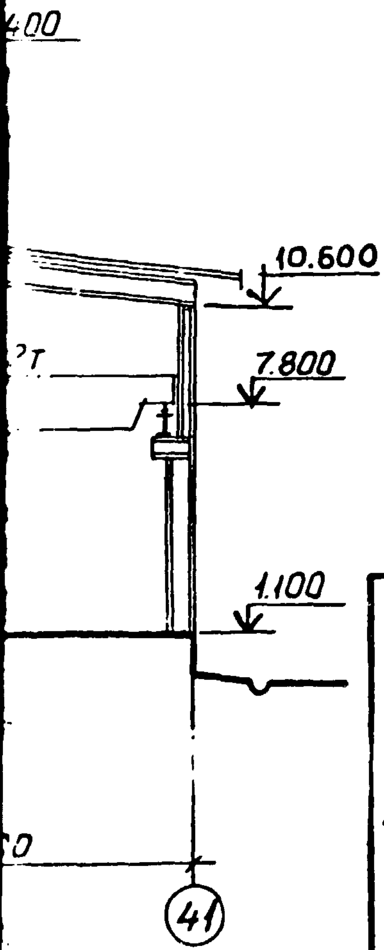
SECTION 4



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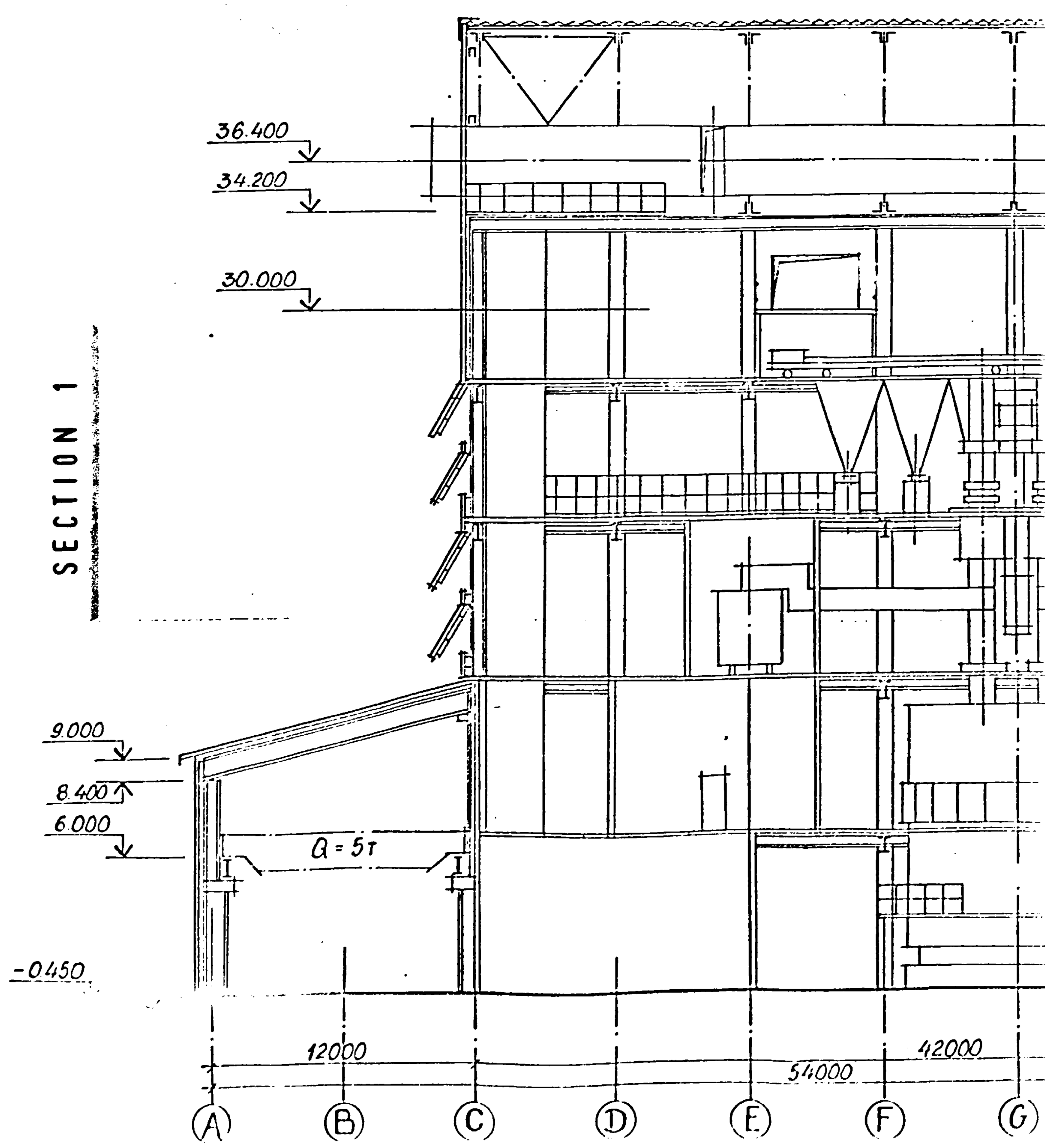
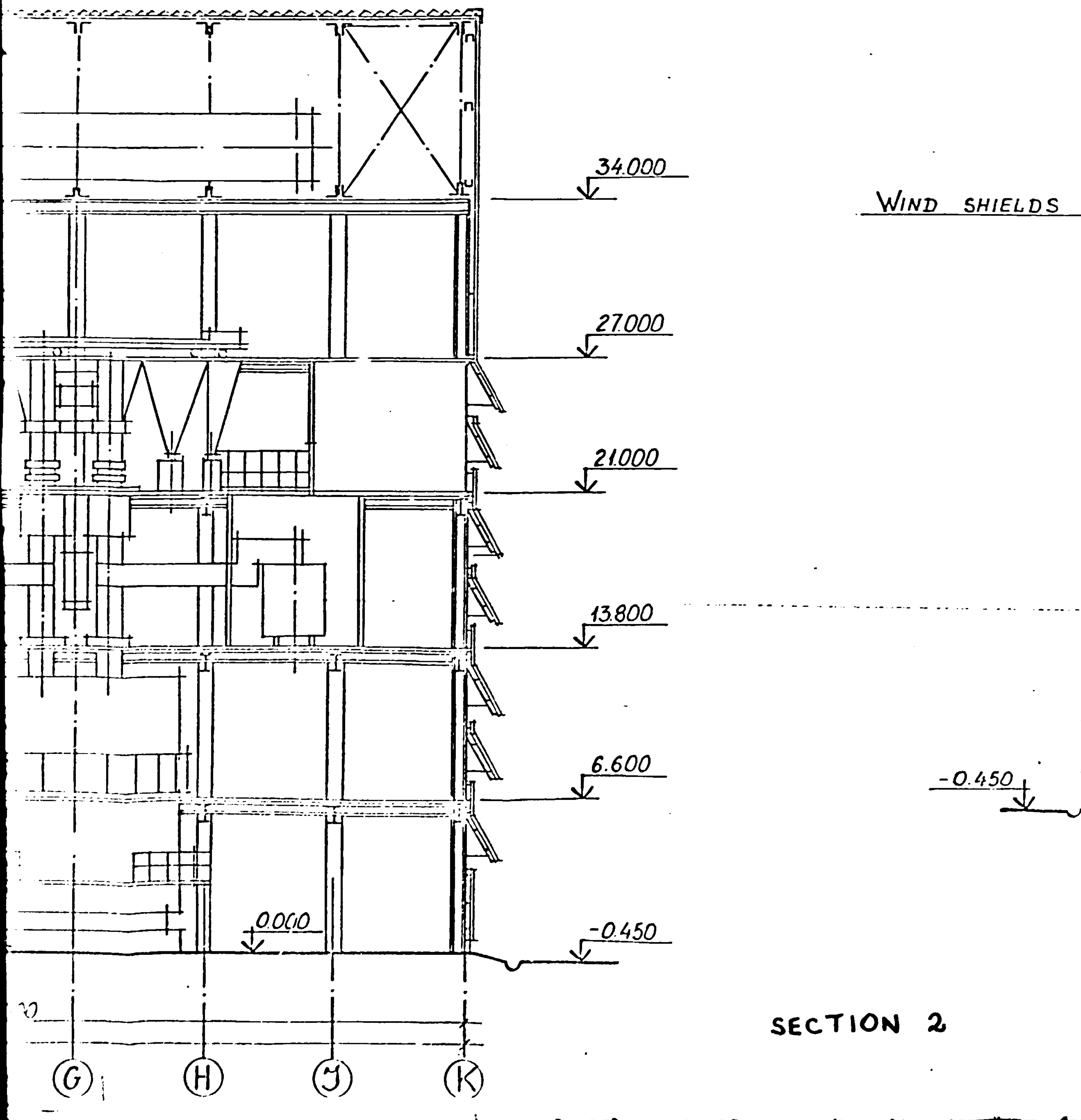
1500723-AC			
ANGUL ALUMINIUM SMELTER (INDIA)			
INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION ELECTOMETHLURGICAL SHOP	PHASE	SHEET	SHEETS
	FS	9	
SECTION 1-1	VAMI LENINGRAD		

SECTION 2-2

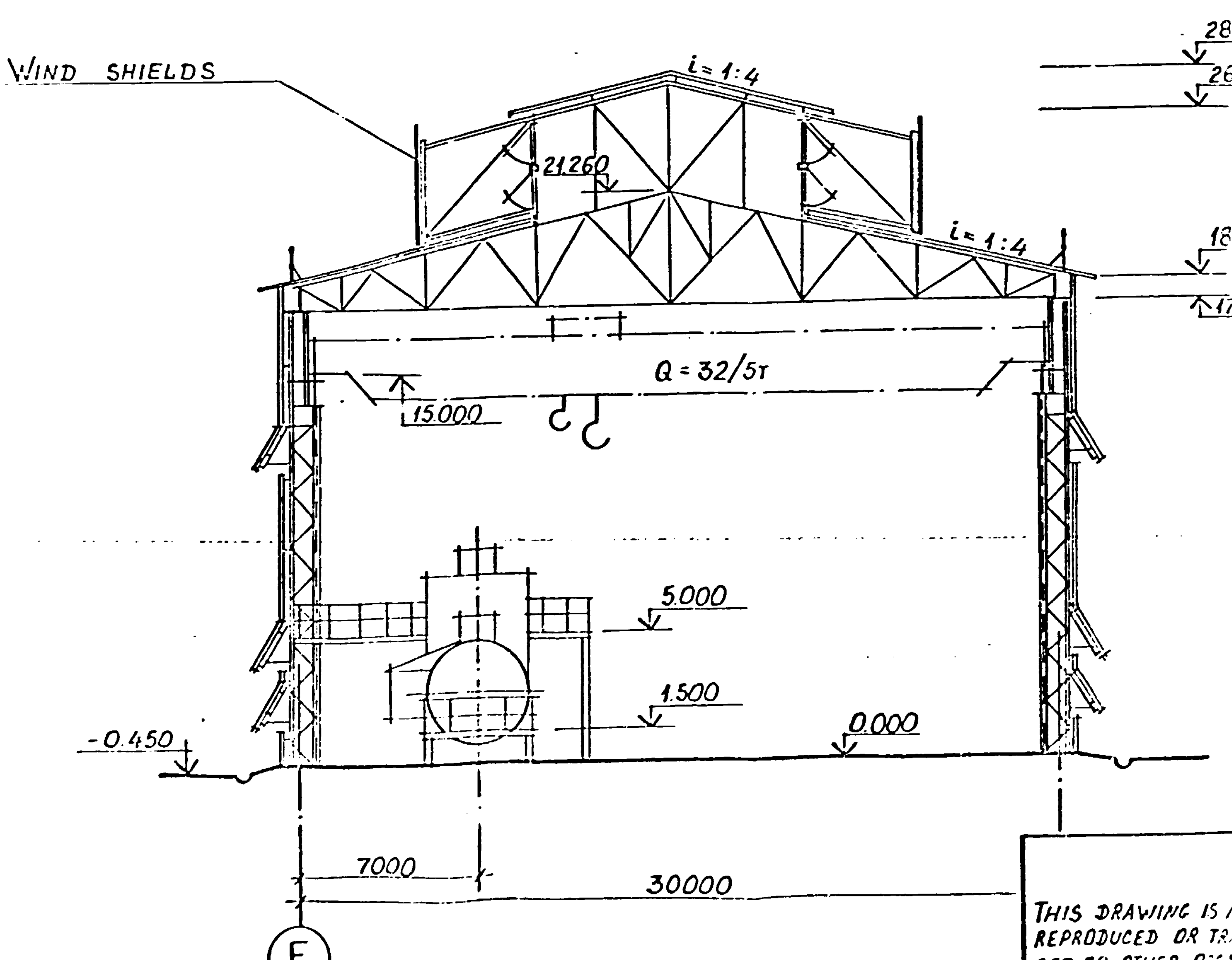


SECTION 1
36.400
34.200
30.000
9.000
8.400
6.000
-0.450
Q = 5T
12000
42000
54000
A
B
C
D
E
F
G


34.000
WIND SHIELDS
27.000
21.000
13.800
6.600
-0.450
0.000
-0.450
G
H
J
K

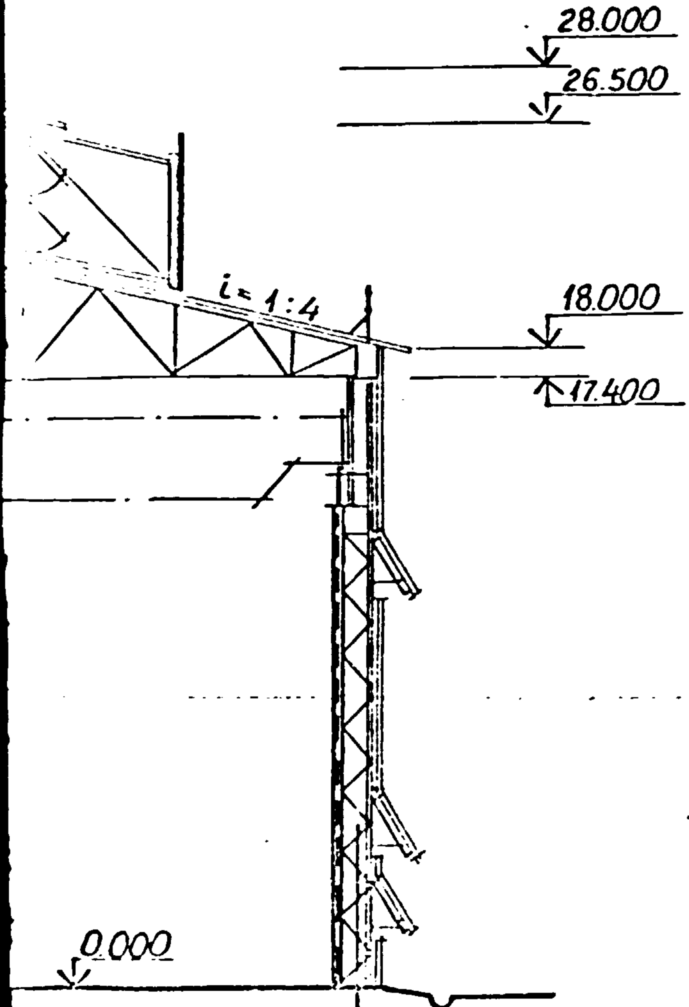
SECTION 2

SECTION 3-3



SECTION 3

3



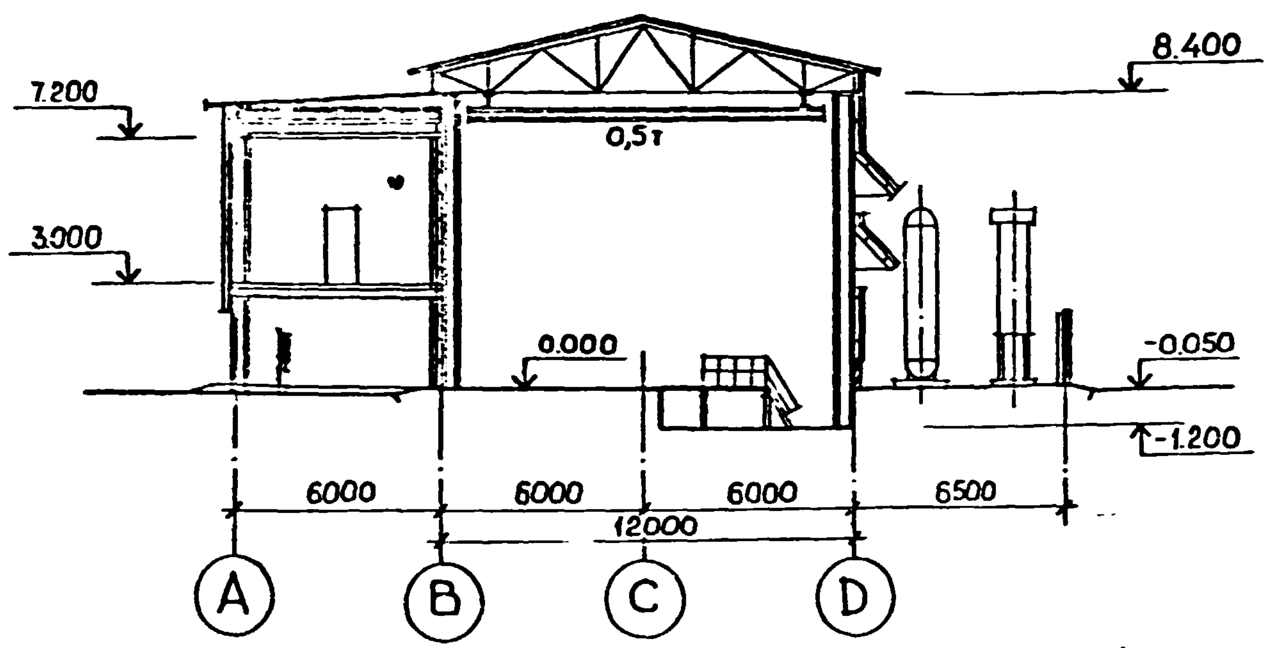
SECTION 4

1500723-AC

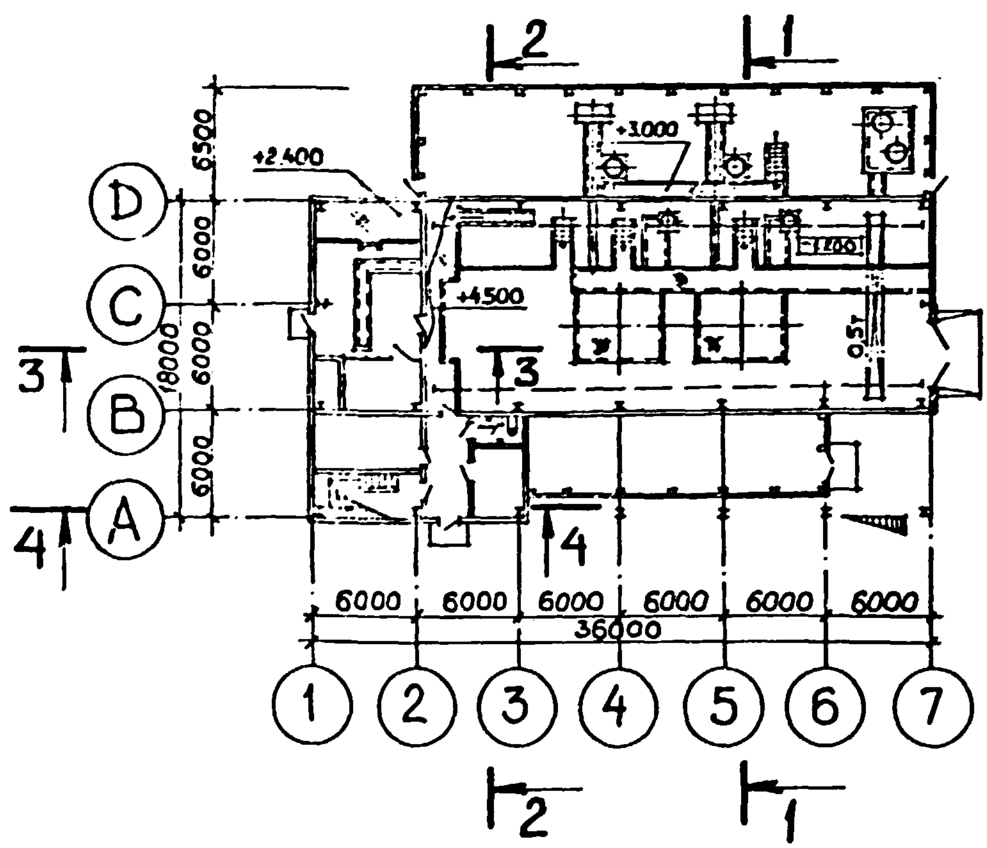
ANGUL ALUMINIUM SMELTER (INDIA)

INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION ELECTROMETALURGICAL SHOP	PHASE	SHEET	SHEETS
	FS	10	
SECTIONS 2-2; 3-3	VAMI LENINGRAD		

SECTION 1-1

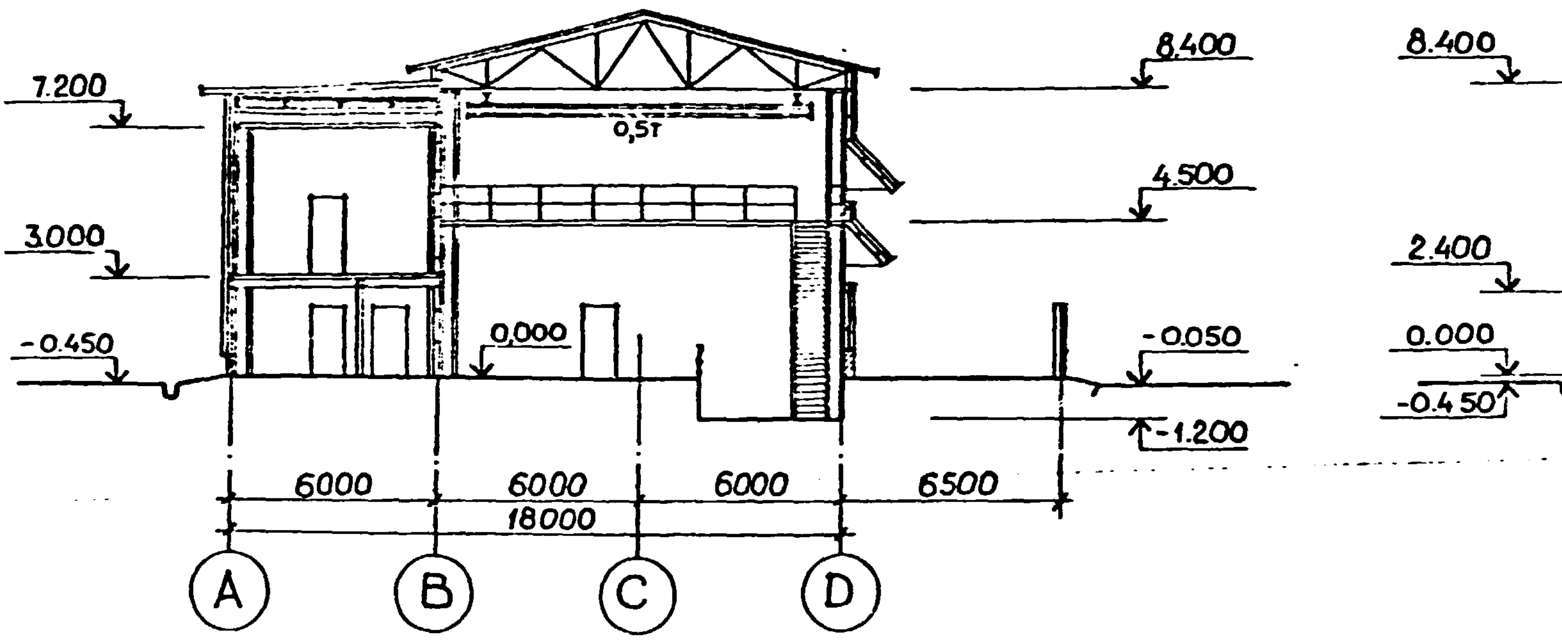


PLAN AT EL. 0.000

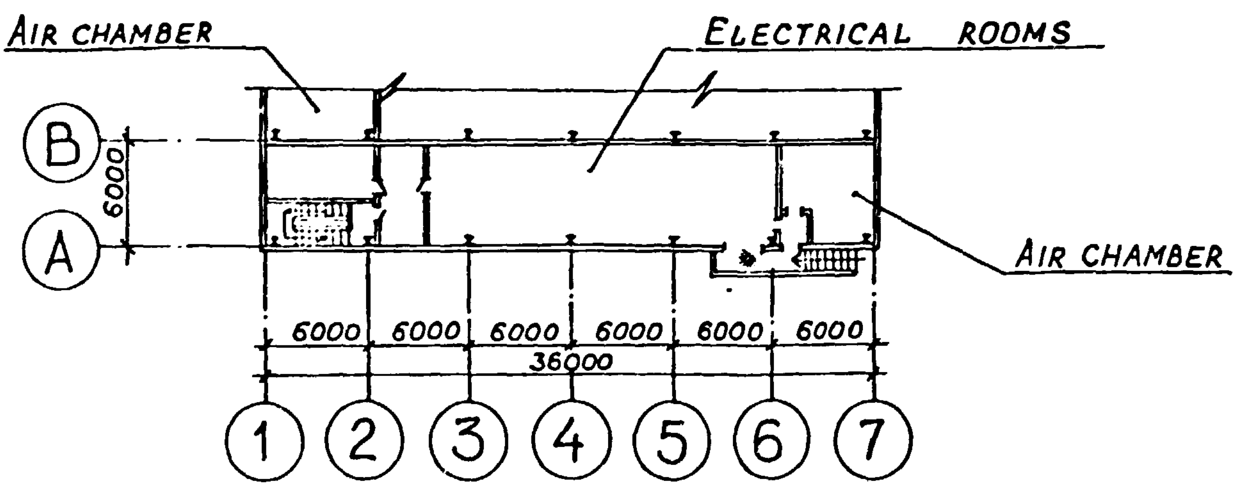


SECTION 1

SECTION 2-2

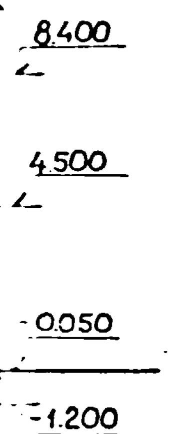


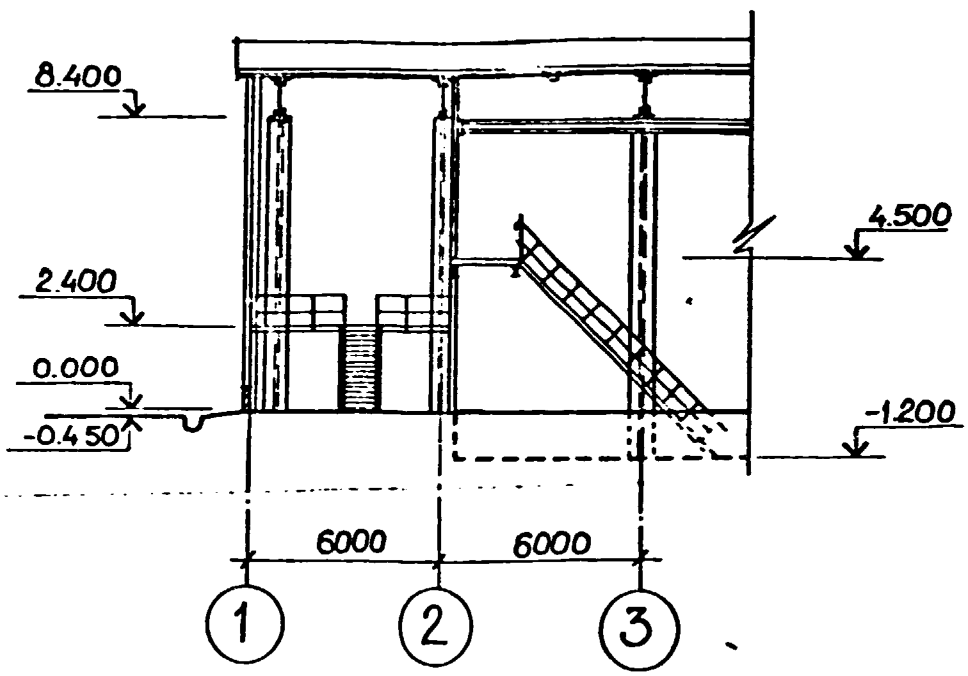
PLAN AT EL. 3.000

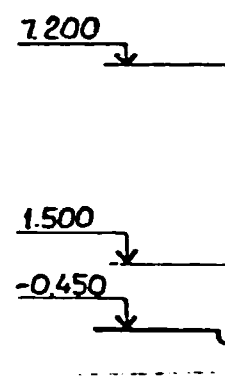


SECTION 2

SECTION 3-3

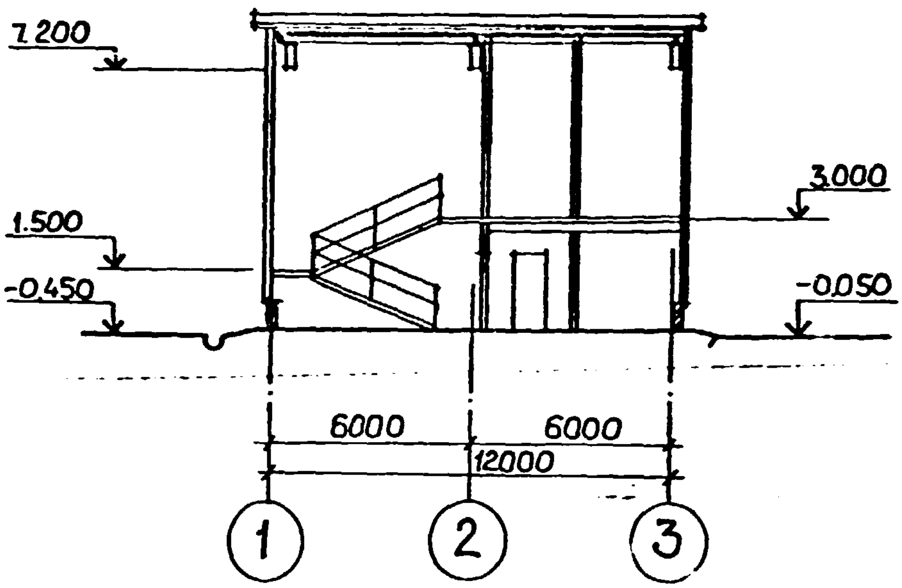






SECTION 3

SECTION 4-4



SECTION 4

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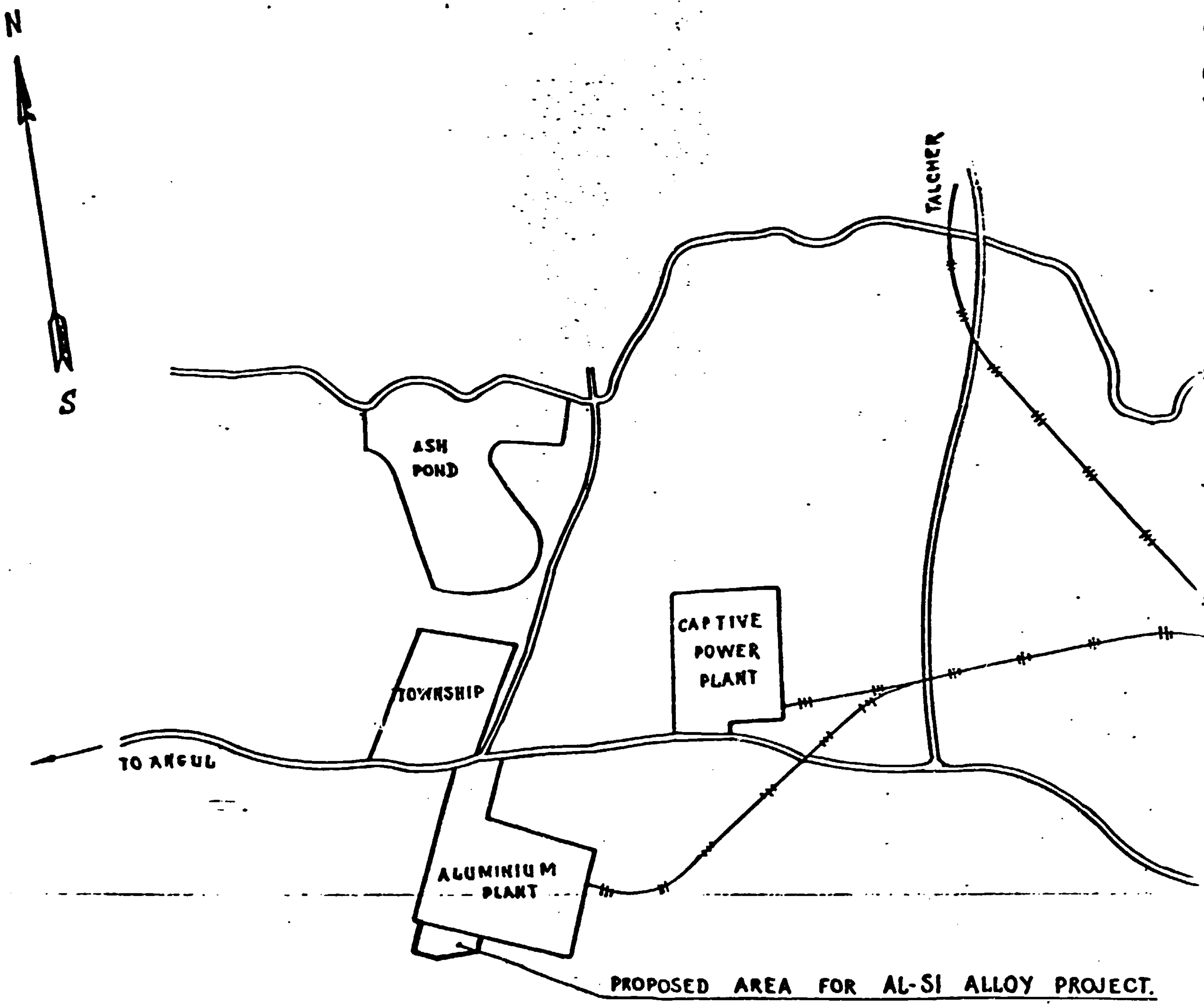
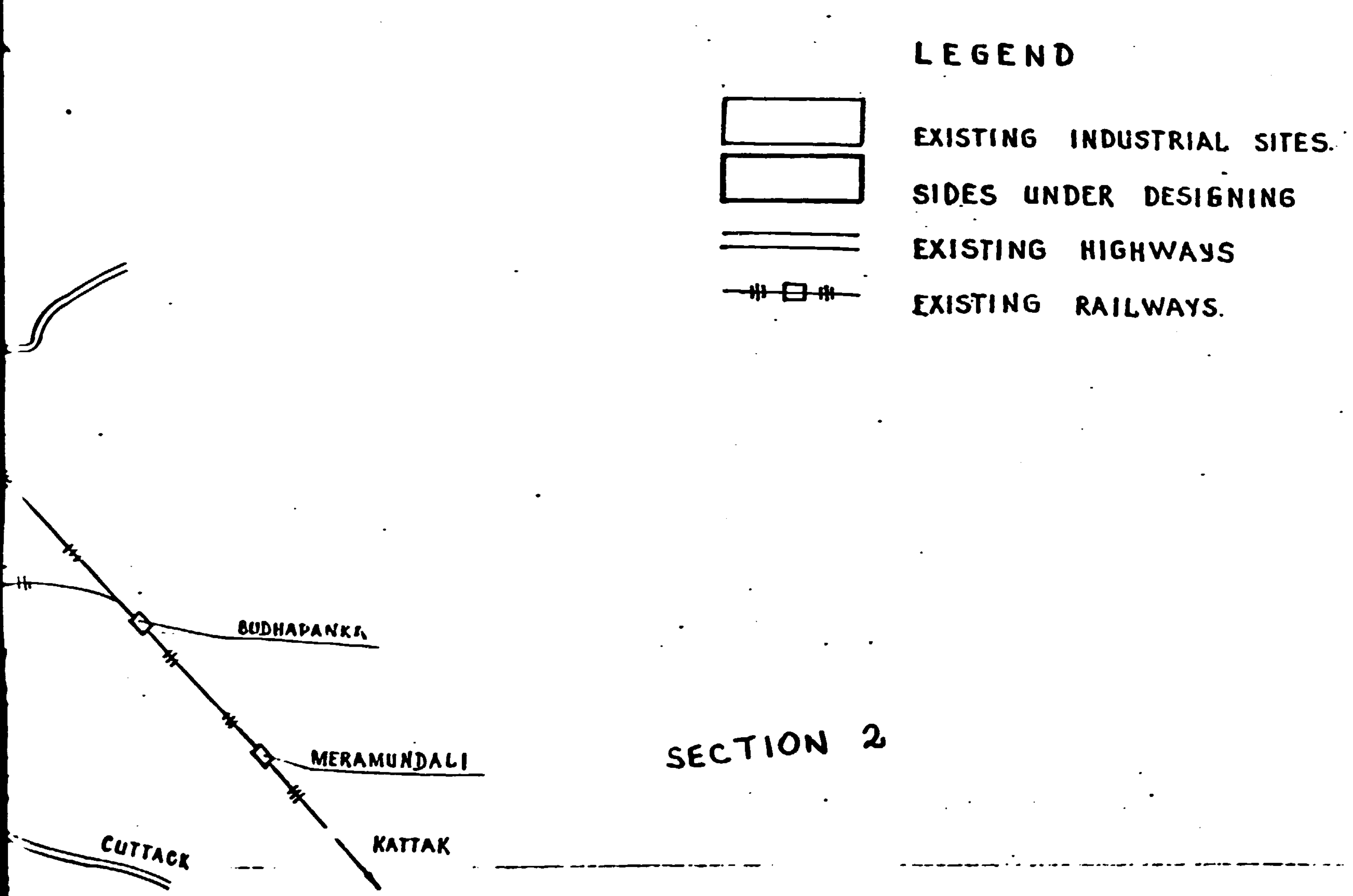
	ANGUL ALUMINIUM SMELTER (INDIA)			
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION COMPRESSOR STATION	PHASE	SHEET	SHEETS
		FS	11	
	PLANS AT EL 0.000; 3.000 SECTIONS 1-1; 2-2; 3-3; 4-4.	VAMI LENINGRAD		

SIZE A 4x4


N
S
TALCHER
ASH
POND
TOWNSHIP
CAPTIVE
POWER
PLANT
TO ANGUL
ALUMINIUM
PLANT
PROPOSED AREA FOR AL-SI ALLOY PROJECT.

SECTION 1



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14080

ANGUL ALUMINIUM

INDUSTRIAL DEMONSTRAT
FOR AL-Si ALLOYS PRODU

LOCATION PLAN.
SCALE 1:50000

LEGEND

EXISTING INDUSTRIAL SITES.

SIDES UNDER DESIGNING

EXISTING HIGHWAYS

EXISTING RAILWAYS.

ALI

K

SECTION 3

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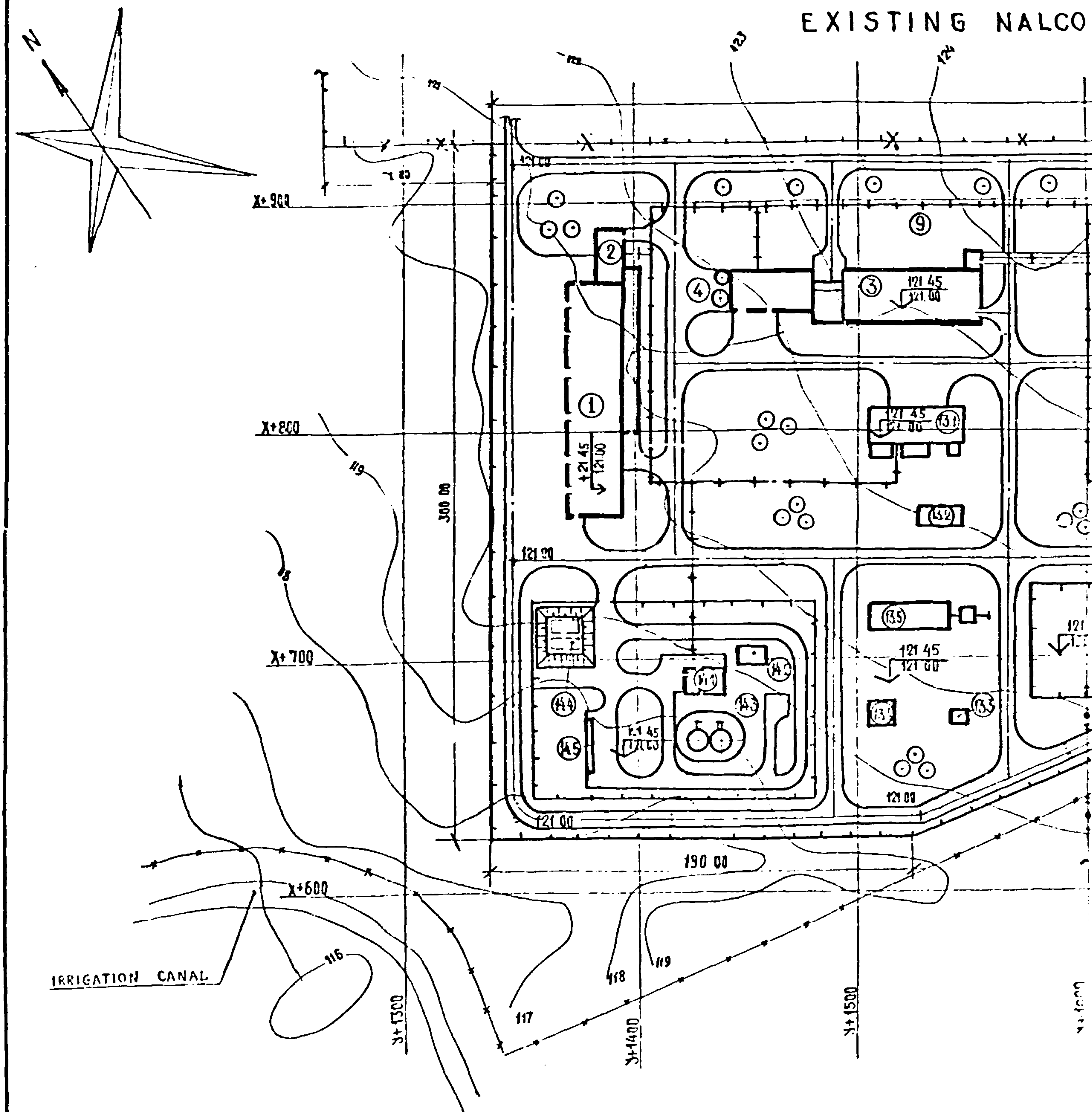
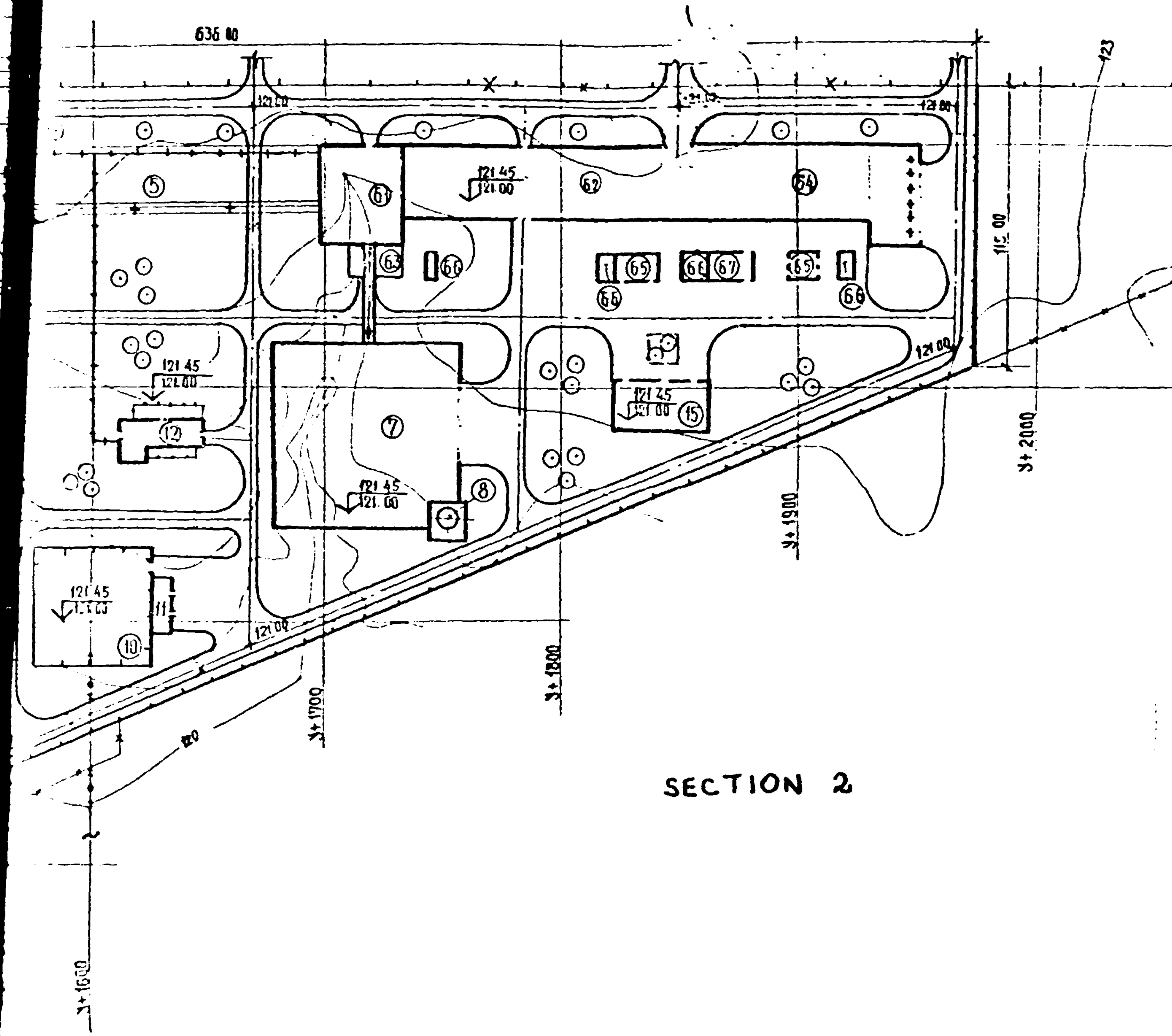
	ANGUL ALUMINIUM SMELTER (INDIA)			
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-Si ALLOYS PRODUCTION	PHASE	SHEET	SHEETS
		FS		1
	LOCATION PLAN. SCALE 1:50000	VAMI LENINGRAD		

SIZE A 4 x 3

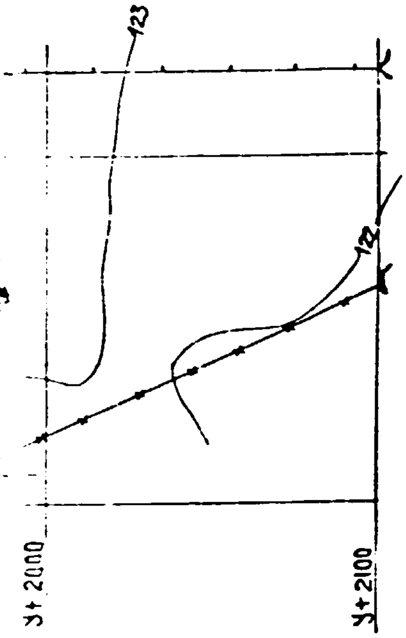

EXISTING NALCO
N
X+900
X+800
X+700
X+600
300 00
190 00
121 00
121 45
IRRIGATION CANAL
Y+1300
Y+1400
Y+1500
116
117
118
119

SECTION 1

..CO ALUMINIUM SMELTER



SECTION 2



SYMBOLS.

- BUILDINS AND STRUCTURES.
- MOTOR ROADS.
- FENCING.
- RACKS.
- CONVEYOR GALLERY.
- HV POWER TRANSMISSION LINE.

} DESIGNING

- EXISTING FENCING.
- BIREBED WIRE-NALCO-OWNED LANDLIMIT
- FENCING TO BE DISMANTLED.
- 121.45 / 121.00 — FLOOR ELEVATION / GRADE LEVEL.
- GREENERY.

SECTION 3

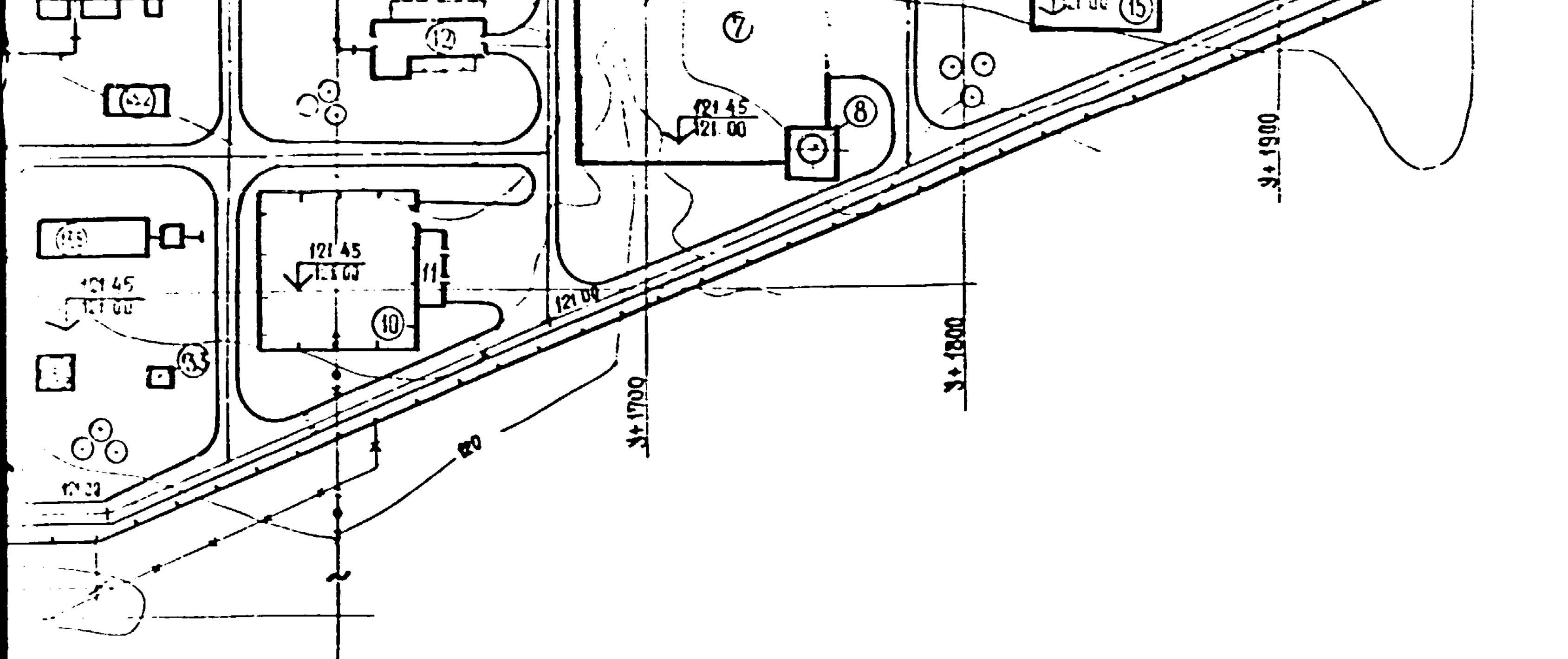
:ING

.IMIT

MAIN PARAMETERS AS PER GEHERAL LAYOUT.

SRL NO	DESCRIPTION	UNIT OF MEASURE	QUANTITY.
1.	TOTAL UNIT AREA INSIDE FENCING	HECTARES.	15.0
2.	AREA BUILT-UP WITH BUILDINGS AND STRUCTURES	HECTARES.	4.5
3.	BUILDING DENSITY	%	30
4.	LENGTH OF MOTOR ROADS AND TOTAL AREA OF ROADS PAVEMENT.	KM/HECTARE.	4.5/3.3
5.	GREENERY AND SITE DEVELOPMENT AREA.	HECTARES.	3.0

SECTION 4



L E G E

I ALUMINIUM - SILICON ALLOYS PRODUCTION.

1. RAW MATERIALS STORAGE.
2. REDUCERS GRINDING DPT.
3. FEED PREPARATION DPT.
4. BINDER STORAGE.
5. GALLERY
6. METALLURGICAL BUILDING.
6.1 FURNACE DPT.
6.2 ALLOY PREPARATION DPT.
6.3 ELECTRODE PASTE STORAGE.
6.4. COMMERCIAL PRODUCT STORACE.
6.5 ELECTRICAL SUBSTATIONS.
6.6 VENTILATION CHAMBERS.
6.7 CRUCIBLE LINING ROOM.
7. GAS CLEANING SYSTEM.
8. CHIMNEY STACK.
9. RACKS FOR CABLES, PNEUMATIC CONVEYORS, WATER, FUEL OIL AND COMPRESSED AIR PIPELINES.

SECTION 5

3+2000

3+2100

HV POWER TRANSMISSION LINE.

EXISTING FENCING.

BIREBED WIRE-NALCO-OWNED LANDLIMIT

FENCING TO BE DISMANTLED.

121.45 / 121.00 FLOOR ELEVATION / GRADE LEVEL.

GREENERY.

END

II POWER AND UTILITIES FACILITIES.

10. MAIN STEP-DOWN SUBSTATION.
11. CONTROL SYSTEM STATION
12. COMPRESSOR STATION.

III WATER SUPPLY FACILITIES

13. RECYCLE WATER SUPPLY UNIT.
13.1 RECYCLE WATER SUPPLY PUMP STATION.
13.2 DOUBLE-SECTION VENTILATION COOLING TOWER.
13.3 SEWERAGE SYSTEM PUMP STATION.
13.4. SEWERAGE SYSTEM PUMP STATION FOR STORM WATER.
13.5. HORISONTAL SETTLER.

IV SUPPORT AND SERVICE FACILITIES.

14. FUEL OIL SUPPLY UNIT.
14.1. FUEL OIL PUMP STATION
14.2. RECEIVER TANK.
14.3 TANKS.
14.4. FIRE-FIGHTING WATER RESERVOIR.
14.5. PURIFICATION UNITS FOR RAINWATER POLLUTED WITH FUEL OIL.
15. ADMINISTRATION-WELFARE BUILDING.

SECTION 6

.DLIMIT

3.	BUILDING DENSITY	%	30
4.	LENGTH OF MOTOR ROADS AND TOTAL AREA OF ROADS PAVEMENT.	KM/HECTARE	4.5/3.3
5.	GREENERY AND SITE DEVELOPMENT AREA.	HECTARES.	3.0

SECTION 7

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	ANGUL ALUMINIUM SMELTER (INDIA)			
	INDUSTRIAL DEMONSTRATION UNIT FOR AL-SI ALLOYS PRODUCTION	PHASE	SHEET	SHEETS.
		FS		1
	GENERAL LAYOUT SCALE 1:2000.	VAMI LENINGRAD		

Contract № 89/156
UNIDO PROJECT № DP/IND/88/063

TECHNO-ECONOMIC FEASIBILITY STUDY OF INDUSTRIAL SCALE ELECTRO-SMELTING OF AL-SI ALLOYS BASED ON PILOT TECHNOLOGICAL TESTING OF INDIAN RAW MATERIALS IN INDIA

Final report

VOLUME III
EQUIPMENT SPECIFICATIONS

NPO „VAMI"

VVO „TECHNOEXPORT"

ST.-PETERSBURG
1992

CONTENT

of techno-economic feasibility study

CONTENTS

I. EXPLANATORY NOTE

This equipment list of the basic items included in the industrial demonstration unit for electrothermal production of aluminium silicon alloys from sillimanite has been prepared in conformity with the Protocol of negotiations for collection of basic data (para.10.1) with NALCO and MECON during the visit of the Soviet experts to India from February 1 to 21, 1990, and Memorandum of discussions of Interim Report based on the results of Pilot amenability testing of Indian raw materials at VAMI Pilot Plant during the visit of Soviet experts to India from March 2 to 12, 1991.

The present equipment list in accordance with para.9.3 of Memorandum, shows the specifications of equipment and instruments, study of this list will allow Indian partner to select equipment and instruments to be manufactured in India or to ensure its supply from the third countries.

The list of major equipment has been prepared with breakdown by the process areas.

II. MAIN PRODUCTION AREAS

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
		1. Raw material storage with crushing Process design Major process equipment						
1 4		Jaw crusher, capacity 12-18 m^3/hr. Motor rating 45 kW. Input opening - 250 mm, length - 900 mm. Maximum lump size 210 mm. Width of output opening 40±20 mm		pc	1	-	8500	
2 7		Roll crusher. Motor rating 45 kW. Roll dia. 1000 mm, length 550 mm. Max.lump feed size - 50 mm. Adjustment limits for lump feed - 4-18 mm. Rolls rotation, r.p.m. - 63, 89, 112		pc	1	-	13400	
3 10		Inertia screening.area 1250x3000mm, 3.7 m2, input lump size - 50 mm. Box vibration amplitude, at: 16 s^{-1} - 1.6-3.7 mm 24 s^{-1} - 1.6-2.06 mm vibration frequency s^{-1}-16.0,24.2, screening holes size - 5x5 mm		pc	1	-	2000	
4 13		Pneumatic breaker for slag. Hammer force 480 kg, striker rate 50-100 strikes/min		pc	1	-	4000	
		Total:					27900	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		Handling Equipment						
5/1		EOT crane, capacity 5 t, span 22.5 m, lifting height 16 m. Cabin control. Overall motor rating 31.7 kW		pc	1	-	15110	
6/2		EOT grab-type crane, capacity 5 t, span 22.5 m, lifting height 22 m. Bucket capacity 2.5 m3 . Overall motor rating 61.2 kW. Maximum single motor rating 22 kW, total number of motors 5. Duty cycle 40%.		pc	1	-	18400	
7/4		Electric car, capacity 2 t. Motor rating 5.5 kW (travel motion)		pc	2	1900	3800	
8/3		Troughed belt conveyor, belt width 650 mm, length 8 m, motor rating 3 kW, including:		pc	1	-	2000	
		a) structural steel					1600	
		b) belt		m	21		45	
		c) drive					255	
9/5		Reversible belt conveyor, belt width 800 mm, length 7 m, motor rating 3 kW, including:		pc	1	-	2100	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg: of one piece	Net weight, kg: total	Whom to be supplied by
		a) structural steel					1700	
		b) belt		m	19	-	190	
		c) drive					210	
10/6		Inclined troughed belt conveyor, belt width 650 mm, length 21 m, motor rating 7.5 kW, including:		pc	1	-	3000	
		a) structural steel					2190	
		b) belt		m	47	-	360	
		c) drive					450	
11/8		Inclined troughed belt conveyor, belt width 650 mm, length 32 m, motor rating 7.5 kW, including:		pc	1	-	4280	
		a) structural steel					3300	
		b) belt		m	70	-	530	
		c) drive					450	
12/9		Chain elevator, bucket width 400 mm, bucket capacity - 6.3 l, pitch - 515 mm. Chain velocity - 1.47 m/s. Max. lump size - 50 mm. Elevator height - 11 m, motor rating - 11 kW		pc	1	-	3000	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
13/11		Inclined bucket elevator, bucket width - 650 mm, bucket capacity - 65 l, bucket pitch - 400 mm, chain velocity - 0.45 m/s. Max. lump size - 150 mm. Inclination angle - 60-82°. Length - 22 m. Motor drive rating - 30 kW		pc	1	-	26390	
		Total:					78080	
		Sanitary-engineering design						
		Fans						
1		Dust I.D. fan with motor 4A180S, Motor rating 22 kW, capacity 12000 m3/hr, head 300 kg/m2		pc	2	550	1100	
		Total:					1100	
		Sanitary-engineering Equipment						
2		Cyclone capacity 12000 m3/hr Dust cleaning efficiency - 65%		pc	2	1700	3400	
3		Bag filter, capacity 19400 m3/hr, efficiency - 99%		pc	2	4580	9160	
		Total:					12560	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		Section II. MATERIALS						
4		Structural steel	st.3				1500	
5		C.I.. valves	∅100mm				500	
6		Malleable C.I. valves	∅100mm				50	
7		Electrowelded steel pipes	dia. 150-100mm				1000	
8		Water and gas supply pipes	dia. 150-100mm				500	
		INSTRUMENTATION DESIGN						
		Instruments and Controls						
1		Gamma-relay level metor, sensitivity - 2.5×10^{12} kg/kl		pc	6	4.5	27.0	$692.3
2		Relay~220 VAC, 4 N.O.+4 N.C. contacts		pc	10	3.0	30.0	
3		Circuit breaker, I NOM.TRIP = 0.6 A I CUT OFF = 1.5 I NOM.TRIP		pc	10	3.5	35.0	
4		Electric bell~200 VAC		pc	1	-	0.5	
5		Stepdown transformer~220/36 VAC		pc	1	-	3.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
6		Cabinet w/rear door, 2200x800x600 mm		pc	1	-	350.0	
		Total:					445.5	
		Cables						
7		Copper cable, shielded, 4x1 mm2					59.76	
		ELECTRICAL DESIGN						
		Electrical equipment						
1		Packaged transformer substation with transformers 11/0.415 kV, capacity 630 kVA each		set	1	-	7500	
2		A.C. control station boards, open type, large size, 2200x3200x600 mm		standard	4	300	1200	
3		Control cabinets and panels, floor and wall mounted, 2000x800x600 mm		panel	3	80	240	
4		Distribution points w/circuit breakers rated 63 to 250 A		pc	3	170	510	
5		Distribution boxes w/knife switches or plug connectors, 600x300x300 mm		pc	3	25	75	
6		Reversible and non-reversible magnetic starters current 10 to 80 A		pc	5	9	45	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
7		Miscellaneous control and signalling equipment		pc	10	2	20	
		Total:					9590	
		Electric lighting						
8		Electric lighting fixtures and light sources					150	
		Total of electrical equipment:					9740	
		Materials						
9		Cables, cross-section 2.5÷240 mm^2					2300	
10		Steel water and gas supply pipes, dia.50-80 mm					8450	
11		Electrical installation and fixing materials					2420	
12		Structural steel					1790	
13		Insulation materials					900	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
		2. REDUCTANT GRINDING AREA PROCESS DESIGN						
		Major Process Equipment						
1		Tangential hammer mill, motor diameter 1300 mm, coal capacity 9.0 t/hr		pc	1	-	17800	
2		Dust cyclone for explosive fuels, diameter 1400 mm, capacity 15000 m3/h		pc	1	-	2100	
3		Flap valve with cone valve, Dnom 150		pc	6	54	324	
4		Electrostatic precipitator, gas flowrate 43200 m3/hr, cross-section area 12 m2, hydraulic resistance 50(5) Pa (mm H_2O gauge) Sizes 7800x4900H = 19635 mm		pc	1	-	33500	
5		Oven of drying agent with water-cooled coil pipe, volume of furnace chamber - 3.6 m3	VAMI drg.	pc	1	-	50000, including steel - 15000 bricks - 35000	
6		Pneumatic transport vessel, capacity 2.5 t/hr	VAMI drg.	pc	1	-	500	
		Total:					104224	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		Fans, Pumps						
7		LH mill fan, w/motor 4A315S4Y3, rating 160 kW, 1500 rpm, capacity 17000 m3/hr, pressure 7500 Pa		pc	1	-	3675	
8		Radial fan (centrifugal) W/motor 4A200M6, rating 22 kW, 975 rpm, capacity -30000 m^3/hr, head-1600 Pa		pc	1	-	411	
		Total:					4086	
		Handling Equipment						
9		Scraper feeder (stationary), capacity 10 t/hr		pc	2	5460	10920	
10		Paddle feeder, capacity 1.4 t/hr		pc	2	840	1680	
11		Manual travelling worm blocks, capacity 1 t, lifting height 3 m		pc	1	-	23	
		Total:					12623	
		Materials						
12		Gas and water ducts dia.100-400mm, welded of steel sheets 4 mm thick					25000	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
		INSTRUMENTATION DESIGN						
		Instruments and Controls						
1		Gamma relay level meter, sensitivity - 2.5×10^{12} kg/kl		pc	14	4.5	63.0	$1615,4
2		Chromel-copel thermoelectric transducer, measuring range - 50°C ... +600°C		pc	28	1.0	28.0	
3		Platinum resistance thermal transducer. Measuring range 0°C...+1000°C		pc	28	1.0	28.0	
4		Measuring transducer, 0-5 mA		pc	28	3.0	84.0	
5		Pressure transducer, 0-1 MPa		pc	16	12.0	192.0	
6		Flowrate transducer, 0-5 mA		pc	10	14.0	140.0	
7		Chamber-type orifice plate, Pnom = 0.6 MPa, Dnom = 100 mm		pc	10	0.5	5.0	
8		Indicating manometer, measuring range 0-1 MPa		pc	30	2.0	60.0	
9		Automatic recorder, scale 0-100%		pc	50	12.0	600.0	
10		Regulator, ~220 VAC, input signal-0.5 mA		pc	10	5.0	50.0	
11		Contactless starter, reversive ~220VAC		pc	10	4.0	40.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
12		Electric actuating mechanism~220 V		pc	10	12.0	120.0	
13		O_2 analyser, measuring range 0-10%		pc	2	17.0	34.0	
14		Relay~220 VAC, 4 N.O.+4 N.C. contacts		pc	50	3.0	15.0	
15		Circuit breaker I NOM.TRIP = 0.6 A I CUT OFF = 1.5 I NOM. TRIP		pc	200	3.5	700.0	
16		Stepdown transformer~220/36 VAC		pc	6	3.0	18.0	
17		Voltage stabiliser~220 V		pc	10	3.5	35.0	
18		Cabinet w/rear door, 2200x1000x600 mm		pc	10	400	4000	
19		Instrumentation cabinet with rear door, ЩШ -3D-I-1000x600 УХЛ 4 УР30 ОСТ 36.13-76		set	5	158.0	790.0	
20		Platinum resistance thermal transducer, measuring range 0°C... +1000°C		pc	1	-	1.0	
21		Copper resistance thermal transducer, range 0°C...+200°C		pc	5	1.5	7.5	
22		Measuring pressure transducer: 0...1 MPa 0...6 MPa		pc	12	13.0	156.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg		Whom to be supplied by
						of one piece	total	
23		Fuel oil quantity indicator Scale 0...100 dm3/hr		pc	1	-	3.5	
24		Indicating pressure gauge. Scale 0.06... 6 MPa		pc	5	0.5	2.5	
25		Straight technical thermometer Scale 0°C ... +350°C		pc	3	0.01	0.03	
26		Radioisotope relay instrument for level measurement		pc	5	4.5	22.5	
27		Indicating and recording instrument, scale 0...100%		pc	20	12.0	240.0	
28		Double-channel power supply unit, ~220/36 VAC		pc	2	4.0	8.0	
29		Regulator, ~220 VAC, input signal 0.5 mA		pc	1	-	5.0	
30		Set-point device, for manual input signal - from 0 to 5 mA to functional unit		pc	1	-	2.5	
31		Control block, ~24 VAC		pc	1	-	3.0	
32		Contactless starter, reversive, ~220 VAC		pc	1	-	4.5	
33		Electrical actuator, ~220 VAC		pc	1	-	12.0	
		ELECTRICAL HARDWARE						
34		Distrubition switch gear with one input and 24 feeder switches		pc	2	85.0	170.0	
		Total:					7775.03	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
		PIPELINE VALVES						
35		Globe coupled valve, D_n25-50, P_{nom} -to 1.6 MPa		pc	50	6.0	300.0	
36		Three way gauge cock, D_n- 15 mm		pc	10	3.0	30.0	
		Total:					330.0	
		MATERIALS						
		CABLES AND WIRES						
37		Control cables with copper conductors, cross sections						
		4 x 1.00 mm^2		km	0.9	99.6	89.64	
38		5 x 1.00 mm^2		km	0.6	129.6	77.76	
		Control cables with aluminium conductors, cross sections:						
39		4 x 2.5 mm^2		km	0.4	124.0	49.6	
40		10 x 2.5 mm^2		km	0.3	256.0	76.8	
41		Flexible wire with copper core, cross section 1 x 1 mm2		km	0.3	14.0	4.2	
		Total:					298.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
		INSTALLATION MATERIALS AND PRODUCTS						
42		Seamless steel pipe GOST 8734-75 14 x 2		m	400	0.82	328.0	
43		Electrically welded steel pipe, GOST 10704-76 20 x 1.6		m	50	0.89	44.5	
44		Flexible metal conduit, dia 15 mm		m	60	0.5	30.0	
45		Connection box, 230x100 mm		pc	20	0.3	6.0	
		Total:					408.5	
		ELECTRICAL DESIGN						
		Electrical equipment						
1		Control station boards, open type, large size, 2200x1600x600 mm		pannel	2	300	600	
2		Control cabinets and panels, floor and wall mounted, 2000x800x600 mm		pannel	2	80	160	
3		Distribution boxes w/knife switches and fuses, or w/plug connectors, 600x300x300 mm		pc	1	-	25	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
4		A.C. circuit breakers, current up to 400 A		pc	4	3.5	14	
5		Miscellaneous control and signalling equipment		pc	10	2	20	
		Total:					819	
		Electric Lighting						
6		Electric lighting fixtures and light sources					100	
		Materials						
7		Cables, cross-section 2.5÷240 mm^2					1390	
8		Steel water pipes, D_n- 25-100 mm					1920	
9		Structural steel					500	
10		Insulation materials					290	
		3. MIX PREPARATION AREA						
		PROCESS DESIGN						
		Major Process Equipment						
$\frac{1}{101}$		Settler, diameter 1200 mm		pc	4	375	1500	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
2/102		Bag filter, filtration surface 60 m2, explosion-proof version		pc	2	2500	5000	
3/109		Explosion-proof metering device, capacity 0.61-3.65 m3/hr, screw diameter 100 mm, pitch 100 mm, feeder drive motor rating 2.2 kW, vibrator motor rating 1.1 kW, metering accuracy - 1÷2%		pc	6	790	4740	
4/110		Non-explosion-proof metering device capacity 0.61-3.65 m3/hr, screw diameter 100 mm, pitch 100 mm, feeder drive motor rating 2.2 kW, vibrator motor rating 1.1 kW, metering accuracy 1÷2%		pc	2	759	1518	
5/111		Non-explosion-proof metering device capacity 2.4-14.3 m3/hr, screw diameter 160 mm, pitch 160 mm, feeder drive motor rating 4 kW, vibrator motor rating 1.1 kW, metering accuracy 1÷2%		pc	2	1220	2440	
6/112		Non-explosion-proof metering device capacity 0.13-0.76 m3/hr, screw diameter 63 mm, pitch 64mm, feeder drive motor rating 1.1 kW, vibrator motor rating 1.1 kW, accuracy 1÷2%		pc	2	460	920	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
7/114		Paddle mixer, capacity 6 t/hr Motor rating 30 kW, mixer shaft rotation cycle - 90 min	VAMI drg	pc	2	4800	9600	
8/117		Roll press, capacity 6 t/hr, Motor rating 30 kW, Moulding pressure 50÷70 MPa, shaft rotation cycle - 4-6 min	VAMI drg	pc	1	-	11000	
9/120		Conveyor drier, capacity 6 t/hr, overall motors rating 77.3 kW, number of motor 17, conveyor speed 0 -.6/0.45/0.3 m/min	VAMI drg	pc	1	-	96700	
10/115		Metering device, V = 1 m3	VAMI drg	pc	2	40	80	
11/130		Tank, capacity 6 m3, dia 2 m, Height - 2 m		pc	1	-	900	
12/121		Fuel oil fire box, capacity 1.0-1.5 Gcal/hr	VAMI drg	pc	1	-	27000 including lining 21640	
13/123		Cyclone, diameter 700 mm	VAMI drg	pc	1	-	250	
14/126		Sump with mixer, diameter 4.5 m, height 3.0 m, motor rating 5.5 kW	VAMI drg	pc	1	-	steel-2600 concrete-35000	

NOS	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg		Whom to be supplied by
No according to technological flowsheet						of one piece	total	
15/129		Mixer, diameter 2 m, height 1.9 m, motor rating 3 kW	VAMI drg	pc	1	-	2700	
16/151		Continuous weightometer, single unit type, capacity 2 t/hr, motor drive rating 1.6 kW. Belt width - 1200 mm. Max. lump size - 130 mm, Accuracy of metering - 1÷2%		pc	1	-	1900	
17/153		Continuous weightometer, double unit type, capacity 2 t/hr, motor rating 2.3 kW. Belt width - 1200 mm, max.lump size - 130 mm. Metering accuracy - 1÷2%		pc	2	3400	6800	
18/124		Bucket with opening bottom, holding capacity 1 m3	VAMI drg	pc	15	460	6900	
		Total:					160908 excluding concrete -35000 kg and lining -21640 kg	
		Handling Equipment						
19/108		ES single-girder crane, capacity 2 t, span 17.4 , lifting height 24 m, overall motor rating 3.61kW, number of motors 4, maximum single motor rating 2.8 kW, duty cycle 25%		pc	1	-	2455	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg		Whom to be supplied by
						of one piece	total	
20/132		ES single-girder crane, capacity 2 t, span 10.8, lifting height 12 m, overall motor rating 3.6 kW, number of motors 4, maximum single motor rating 2.8 kW, duty cycle 25%		pc	1	-	1045	
21/150		EOT top-running crane, version Б (cabin control) capacity 3.2 t, span 10.2, lifting height 12 m, overall motor rating 6 kW, number of motors 3, maximum single motor rating 4.5 kW, duty cycle 25%		pc	1	-	2950	
22/131		Passengers lift, capacity 320 kg, motor rating 7 kW, lifting height 18 m	-	pc	1	-	3000	
23/106		Troughed belt conveyor, length 15 m, belt width 650 mm, motor rating 5.5 kW, including:		pc	1	-	2500	
		a) structural steel					1850	
		b) belt		m		35	250	
		c) drive					400	
24/113		Screw conveyor, diameter 400 mm, length 34 m, motor rating 22 kW		pc	2	3587	7174	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
25/116		Inclinded troughed belt conveyor, length 38 m, belt width 650 mm, motor rating 5.5 kW, including:		pc	1	-	5225	
		a) structural steel					4375	
		b) belt		m	82		450	
		c) drive					400	
26/154		Belt conveyor, length 21 m, belt width 650 mm, motor rating 5.5 kW, including:		pc	1	-	3300	
		a) structural steel					2540	
		b) belt		m	48		360	
		c) drive					400	
27/155		Belt conveyor, length 20 m, belt width 650 mm, motor rating 5.5kW, including:		pc	1	-	3000	
		a) structural steel					2290	
		b) belt		m	45		310	
		c) drive					400	
28/104		Belt feeder 400x2000 mm. Motor drive rating 0.75 kW. Lump size 50 mm max. Inclination angle - 0-15 deg.		pc	1	-	424	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
29 / 118		Electric vibrating feeder, trough length 2500 mm, capacity to 25 m3/hr, motor rating 0.5kW	VAMI drg	pc	1	-	900	
30 / 125		Electric vibrating feeder, capacity 25 m3/hr, motor rating 2 kW, trough length - 3600 mm	do	pc	1	-	2600	
31 / 152		Belt feeder. Distance between drums axes - 3000 mm. Belt width -400 mm. Capacity 2 t/hr. Motor rating 1.1 kW. Lump size - 50 mm max. Inclination angle - 0-15°		pc	1	-	510	
32 / 105		Belt bucket elevator, bucket capacity - 2 l, width - 250 mm, lifting height - 22 m, drive motor rating 11 kW, pitch - 400 mm, belt width - 300 mm, belt speed - 1.6 m/s, lump size - 70 mm, max.		pc	1	-	2120	
33 / 119		Belt bucket elevator, bucket width 250 mm, lifting height - 10 m drive motor rating 11 kW, bucket capacity - 2 l, pitch - 400 mm, belt width - 300 mm, belt speed - 1.6 m/s, lump size - 20 mm max.		pc	1	-	1900	
34 / 107		Belt trippler		pc	1	-	180	
		Total: including					39283	
		structural steel					11055	
		belt					1370	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		Fans, Pumps						
35 / 127		Centrifugal pump, capacity 30-50 m3/hr, drive motor rating 5.5 kW		pc	2	210	420	
36 / 103		Centrifugal dust fan, explosion-proof, capacity 4000 m3/hr, head 150 mm H_2O, motor rating 5.5 kW		pc	2	325	650	
37 / 122		Centrifugal dust fan, capacity 4000 m3/hr, head 150 mm H_2O motor rating 5.5 kW		pc	2	325	650	
		Total:					1720	
		SANITARY ENGINEERING DESIGN						
		Sanitary-engineering Equipment						
1		Cyclone, capacity 12000 m3/hr dust collecting efficiency 65%		pc	1	-	1700	
2		Bag filter, capacity 19400 m3/hr dust collecting efficiency 99%		pc	1	-	4580	
3		Dust fan, capacity 12000 m3/hr, head 300 kg/m2, motor 4A180S4 rating 22 kW		pc	1	-	550	
		Total:					6830	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		SECTION II. MATERUALS						
4		Structural steel	st.3	kg			2000	
5		C.I. valves	dia 100mm	kg			500	
6		C.I. valves	dia 50-15 mm	kg			50	
7		Electrically welded steel pipes	dia 100mm	kg			1000	
8		Water and gas supply pipes	dia 50--15 mm	kg			500	
		INSTRUMENTATION DESIGN						
		Instruments and Controls						
1		Gamma relay level meter, sensitivity 2.5×10^{-2} kg/kl		pc	38	4.5	171.0	$4384,6
2		Radio isotope density meter, measuring range 1.5-1.8 t/m3		pc	3	200	600.0	
3		Chromel-alumel transducer, measuring range 0°C - 900°C		pc	50	1.0	50.0	
4		Measuring transducer, 0-5 mA		pc	50	3.0	150.0	
5		Automatic recorder, scale 0-5 mA		pc	11	12.0	132.0	
6		Regulator, ~220 VAC, input signal 0.5 mA		pc	3	5.0	15.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
7		Contactless starter, reversible, ~220 VAC		pc	3	4.0	12.0	
8		Electric actuating mechanism~220 V a.c.		pc	3	10.0	30.0	
9		Electromagnetic relay~220 V a.c. 4 N.O. + 4 N.C. contacts		pc	100	3.0	300.0	
10		Circuit breaker, I NOM.TRIP. = = 0.6 A I cut -off = 1.5 I NOM.TRIP		pc	115	3.5	402.5	
11		Cabinet w/rear door, 2200x1000x600 mm		pc	11	400.0	4400.0	
		TOTAL:					6262.5	
		ELECTRICAL DESIGN						
		Electrical equipment						
1		Packaged transformer substation consisting of: two transformers 630 kVA each, voltage 11/0.415 kV, 5 low-voltage cabinets, tropicalised version		set	1	-	7500	
2		A.C. control station boards, open type, large size, 2200x24000x600 mm		pannel	30	300	9000	
3		Single control cabinets, 2000x800x600 mm		pannel	5	400	2000	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
4		Control cabinets and panels, floor and wall mounted, 2000x800x600 mm		Panel	30	80	2400	
5		Distribution points w/circuit breakers rated 16 to 250 A		pc	3	170	510	
6		Distribution boxes w/knife awitches or plug connectors, 600x300x300 mm		pc	11	25	275	
7		Distribution boxes w/knife switches, 2I0xI90xI00 mm		pc	5	16	80	
8		Reversible and non-reversible magnetic starters, current 10 to 80 A		pc	20	9	180	
9		A.C. circuit breakers, current up to 250 A		pc	8	3.5	28	
10		Miscellaneous control and signalling equipment		pc	200	1.7	340	
		Total:					22313	
		Electric Lighting						
11		Electric lighting fixtures and light sources					1450	
		Total of electrical equipment:					23763	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		SECTION II. MATERIALS.						
I2		Cables, cross-section 2.5 + 240mm^2					11780	
I3		Steel water and gas pipes, dia.25-80 mm					31000	
I4		Electrical installation materials and fixtures					14450	
I5		Structural steel					11950	
I6		Insulating materials					3800	
		4. ELECTRIC ARC FURNACE AREA						Equipment cost without lining $ x10^3
		PROCESS DESIGN						
		Major Process Equipment						
1/206		Electric arc, three electrode furnace, rating 25000 kVA, open type bath, round, stationary, Soederberg electrodes diameter 1400 mm, w/set of electrical equipment of overall rating 186 kW, number of motors 18		pc	1	-	810000 incl.lining 400000	4600
2/207		Stoking machine for electric arc furnace servicing, motors rating 30 kW		pc	2	700	1400	1.96

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
3 / 305		Metal filter-furnace, fuel fired, capacity 15 t, door operating motor 1.1 kW	VAMI drg	pc	3	64000 incl.lining 52000	192000 156000	50.4
4 / 309		Induction crucible furnace, capacity 6 t, rating 2500 kVA, overall motor rating 45 kW	IAT-6/ 2.5-I1	pc	2	27240 incl.lining 9110	54480 18220	50.764
5 / 304		Swinging holding furnace, fuel fired, capacity 15 t. Overall motor rating 14 kW, number of motors 2, maximum single motor rating 11 kW	VAMI	pc	3	44000 incl.lining 32000	132000 96000	50.4
6 / 215		Refining unit. Overall motor rating 65.8 kW, number of motors 6, maximum single motor rating 11 kW	VAMI	pc	1	-	51838 incl.lining 13670	53.435
7 / 225		Air drier, capacity 100 m3/hr, power demand 05 kW		pc	1	-	1700	2.38
		Total equipment :					1243418	4809.34 (Rs.125.04 ml
		Lining					683890	

NOS	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg		Whom to be supplied b
No according to process flowsheet						of one piece	total	
		Auxiliary Equipment						
8/210		Section of 5 troughs for crude alloy refining. Maximum section dimensions 2250x1450 mm. Trough frame made of steel, on which asbestos board 10 mm thick is installed from inside. Grafite plate 50x250x1450 mm is on bottom of trough, then lined (rammed) with forming ground, rammed ground layer 25-30 mm.		pc	6	1640	9840	
9/216		Stand for ladle drying and preheating by oil, drive motor rating 1.1 kW	VAMI drg	pc	2	1090	2180	
10/306		Filtering funnel	-"-	pc	6	2500	15000	
11/226		Slag ladle, capacity 1 m^3	-"-	pc	3	3370	10110	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	total	Whom to be supplied by
12/224		Ladle cleaning machine, drive pneumatic, compressed air pressure 4-5 kg/cm2	VAMI drg	pc	1	-	1300	
13/301		Ladle 10 t capacity		pc	2	7500 incl.lining 3450	15000 6900	
14/310		Ladle 3 t capacity, motor rating 1.1 kW	VAMI drg.	pc	5	3500 incl.lining 1835	17500 9175	
15/212		Ladle 2.3 t capacity	VAMI	pc	5	3350 incl.lining 1930	16750 9650	
		Total: equipment					87680	
		lining					25725	
		Handling Equipment						
16/209		ES single-girder crane, capacity 5 t, span 18, lifting height 36m, overall motor rating 9 kW, number of motors 5, maximum single motor rating 7 kW		pc	1	-	3985	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	total	Whom to be supplied by
17 / 217		EOT top-running crane, cabin control, capacity 5 t, span 10.5, lifting height 16 m, overall motor rating 18.1 kW, number of motors 4, maximum single motor rating 13 kW, duty cycle 25%		pc	1	-	11030	
18 / 222		EOT capacity 80/20 t, span 10, lifting height 25/27 m, overall motor rating 181 kW, number of motors 5, maximum single motor rating 90 kW, duty cycle 25%		pc	1	-	85000	
19 / 302		EOT cabin control, capacity 32/5.0 t, span 28.5, lifting height 16 m, overall motor rating 127.5 kW, number of motors 5, maximum single motor rating 75 kW, duty cycle 40%		pc	2	44500	89000	
20 / 314		EOT top-running crane, version 5, (cabin control), capacity 3.2 t, span 16.5, lifting height 6 m, overall motor rating 8.1 kW, number of motors 4, maximum single motor rating 5 kW		pc	1	-	3950	
21 / 211		Truck, capacity 3 t	VAMI drg	pc	2	1250	2500	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
22/213		Truck, capacity 10 t	VAMI drg	pc	1	-	1500	
23/219		Electric car, capacity 5 t		pc	1	-	3000	
24/223		Electric car, capacity 10 t		pc	1	-	4670	
25/312		Fork truck, capacity 2 t		pc	1	-	3600	
26/201		Belt conveyor, length 158 m, belt width 650 mm, motor rating 30 kW, including		pc	1	-	21725	
		structural steel					18600	
		belt		m	320		2300	
		drive					825	
27/202		Belt inclinating mechanism	VAMI drg	pc	1	-	20	
28/203		Travelling reversible belt conveyor, length 8.5 m, belt width 800 mm, overall motor rating 9.6 kW, number of motors 2, maximum single motor rating 7.5 kW		pc	2	6450	12900	
29/307		Casting conveyor, capacity 6.75-7.7 t/hr, length 12 m, width 1260 mm (ingots 15 kg), drive motor rating 4 kW		pc	3	20000	60000	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
30 / 311		Casting conveyor w/ladle tippler, length 12 m, width 1260 mm, overall drive motor rating 17 kW, number of motors 2	VAMI drg	pc	1	-	25600	
31 / 218		Bucket, capacity 1 m3	do	pc	7	250	1750	
32 / 204		Rotary feeder, capacity 40 l (0,04 m3), drive motor rating 1.1 kW, number of revolutions - 6.6^{-1}min	do	pc	10	470	4700	
33 / 205		Camshell gate with pneumatic drive	do	pc	2	130	260	
34 / 214		Truck scale, capacity 30 t		pc	1	-	4560	
35 / 313		Platform scale, portable, fulcrum type. Weighing range 50 to 3000 kg		pc	1	-	750	
36 / 220		Cargo lift, capacity 5 t, lifting height 27 m, motor rating 28 kW		pc	1	-	12000	
37 / 221		Winch. Traction 12 t. Motor rating 22 kW, vehicle motor 5 kW		pc	1	-	7400	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
38 308		Ingot stacker, capacity 7 t/hr, capacity of conveyor 3 stacks. Total rating of installed motors 7 kW, stack weight 900 kg		pc	4	6400	25600	
39 315		Trailer for transport of aluminium ladles, capacity 20 t		pc	1	-	5000	
40 316		Truck tractor for trailer with ladle, motor rating 220 h.p.		pc	1	-	7500	
		Total:					398000	
		including:						
		structural steel					18600	
		belt					2300	
		drive					825	
		Fans						
41 208		Centrifugal fan, capacity 1600 m3/hr, head 290 mm H_2O, motors rating 4 kW		pc	1	-	92	
		Total:					92	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		SANITARY ENGINEERING DESIGN						
		Sanitary-engineering Equipment						
1		Axial fan, capacity 5000 m3/hr, head 10 kg/m2, motor 4A63B4		pc	3	40	120	
2		Air conditioner with sprayer section, capacity 35000 m3/hr,		pc	2	6350	12700	
3		Household air conditioner, capacity 600 m3/hr, cooler Q = 1.5 kW		pd	2	60	120	
		Total:					12940	
		structural steel	st.3				1000	
		INSTRUMENTATION DESIGN						
		Instruments and Controls						
1		Gamma relay level meter, sensitivity $2.5x10^{5}$ kg/kl		pc	24	4.5	108.0	$27692
2		Platinum-rhodium thermoelectrical transducer, measuring range 300-1500°C		pc	44	1.5	66.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
3		Copper thermal resistance transducer. Measuring range - 50°C + 200°C		pc	61	1.5	91.5	
4		Flow relay, Dnom 20 mm, Pnom 0.6 MPa		pc	56	5.0	280.0	
5		Measuring transducer, 0-5 mA		pc	105	3.0	315.0	
6		Flowrate measuring transducer, 0-5 mA		pc	5	13.0	65.0	
7		Automatic recorder, scale 0-100%		pc	100	12.0	1200.0	
8		Electromagnetic relay~220 VAC, 4 N.O. + 4 N.C. contacts		pc	120	3.0	360.0	
9		Stepdown transformer~220/36 V		pc	4	3.0	12.0	
10		Cabinet w/rear door, 2200x1000x600 mm		pc	20	400.0	8000.0	
11		Circuit breaker, three-pole, I NOM.TRIP = 4A I cut-off = 3.5 I nom.trip		pc	10	2.0	20.0	
12		Switch, I nom.trip = 0.6 A		pc	120	3.5	420.0	
		Total:					10937.5	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	total	Whom to be supplied by
		SECTION II. MATERIALS. CABLES						
13		Control shielded cable, copper, cross-section 4x1 mm2		km	2.4	-	367.2	
14		Control copper cable, section 5x1 mm2		km	5.25	-	670.4	
15		Control aluminium cable, section 4x2.5 mm2		km	0.5	-	62.0	
		Installation Materials						
16		Steel seemless pipes	GOST 8734-75	m	20	-	164.0	
		ELECTRICAL DESIGN						
		Electrical equipment						
1		Packaged transformer substation consisting of: two transformers 1600 kVA each, voltage 11/0.415kV, two high-voltage feeder cabinets, 5 low-voltage cabinets, tropicalised version		set	1	-	18900	
2		A.C. control station boards, open type, large size, 2200x40000x600 mm		panel	50	300	15000	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
3		Single control cabinets, 2000x800x600 mm		panel	6	400	2400	
4		Control cabinets and panels, floor and wall mounted, 2000x800x600 mm		panel	40	80	3200	
5		Distribution points w/circuit breakers rated 16 to 250 A		pc	10	170	1700	
6		Distribution boxes w/knife switches or plug connectors, 600x300x300 mm		pc	50	25	1250	
7		Distribution boxes w/knife switches, 210x190x100 mm		pc	30	16	480	
8		Reversible and non-reversible magnetic starters, current 10 to 100 A		pc	50	9	450	
9		A.C. circuit breakers, current up to 250 A		pc	30	3.5	105	
10		Miscellaneous control and signalling equipment		pc	100	1.7	170	
11		Single-phase transformer, voltage 10 kV, power rating 1000 kVA		pc	10	8	80	
12		Electric lighting fixtures and light sources					6000	
13		Correction capacitors, voltage 10 kV, rating 1125 kVAR		set	12	1400	16800	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
14		Set of equipment for electric arc furnace:						
		1. Electric furnace singel-phase on-load voltage regulation transformer, oil-water cooling, forced oil circulation, rating 833 kVA, voltage 11000/140÷150V, indoor type		pc	3	40000	120000	
		2. Automatic power regulator with pump station and cylinder bank		pc	1	-	9680	
		3. Control board		pc	2	350	700	
		4. Control cabinet		pc	1	-	250	
		5. Control station		pc	1	-	445	
15		Set of equipment for induction melting furnaces IAT-6/2.5-I1:						
		1. Electric furnace three-phase on-load voltage regulation transformer, forced oil circulation, rating 2500 kVA, voltage 10000/423+2113 V, indoor type		pc	1	-	23400	
		2. Reactance coil, rating 1900 kVA, voltage 2100 V		pc	2	1900	3800	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		3. Capacitor bank		pc	14	1200	16800	
		4. Control cabinet		pc	9	300	2700	
		5. Control panel		pc	1	—	250	
		6. Control panel		pc	1	—	150	
		7. Panel with control equipment		pc	1	—	350	
16		Packaged distribution unit, rating 11 kV, consisting of 6 cabinets		set	2	15000	30000	
17		Packaged unit for feeding electromagnets operating high-voltage breakers		set	2	300	600	
18		Single-pole trip, voltage 11 kV, current 2500 A, motorised main knife switch, work drive on grounding knife switch		set	3	50	150	
19		Current transformer 11 kV, 1500/5 A		pc	3	I6	48	
20		Voltage transformer 6000/100 V		pc	3	24	72	
21		Current transformer 11 kV, 1000/5 A		pc	I2	16	I92	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
22		Bushing and post insulators		pc	2000	5	10000	
		Total:					286122	
		SECTION II. MATERIALS.						
23		Cables , section 2.5÷240 mm^2					38600	
24		Busbars of aluminium alloy, section 6x60-10x120 mm					2700	
25		Steel water and gas pipes, dia 25-80 mm					47700	
26		Electrical installation materials and fixtures					34300	
27		Structural steel					45000	
28		Insulation materials					9400	
		FINISHED PRODUCT STORAGE						
		SANITARY-ENGINEERING DESIGN						
		Sanitary-engineering Equipment						
1		Household air conditioner, capacity 600 m3/hr, cooling capacity 1.5 kW		pc	1	-	56.6	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	total	Whom to be supplied by
		Valves						
2		C.I. Valves	dia.400--300mm	kg			2300	
3		C.I.valves	dia 100mm	kg			80	
4		Valves of malleable C.I.	dia.70--15 mm	kg			30	
		SECTION II. MATERIALS						
5		Electrically welded steel pipes	dia.400--300mm	kg			30000	
6		-Same-	dia.80--100mm	kg			1500	
7		Water and gas supply pipes	dia.50--15 mm	kg			1000	
		5. GAS CLEANING SYSTEM						
		PROCESS DESIGN						
		Major Process Equipment						
1		Bag filter with pulse compressed air cleaning, filtering surface 1600 m2, gas flowrate 14 m3/hr at system inlet, dust load of polluted gas - 20 g/m3 maximum,		pc	14	33140	463960	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		dust load of cleaned gas - 0.02 g/m3 max, hydraulic resistance - 2 kPa (max)						
2		Air drier, capacity - 200 m3/h of dry air		pc	1	-	1955	
3		Straight-through cyclone, dia.3 m, inlet gas flow - 27.98 m3/s, hydraulic resistance - 0.7 kPa, cleaning efficiency - 7%		pc	6	10000	60000	
4		Cooler, cooling surface - 475 m2, initial gas temperature - 300°C, final t°-120°C, hydraulic resistance - 0.5 kPa		pc	4	79000	316000	
5		Vortex oil-moisture separator, capacity 20-70 m3/min		pc	2	190	380	
6		Flap valve with cone valve Dnom 200		pc	78	40	3120	
		Total:					845015	
		Pumps and fans						
7		Fan, capacity 275 000 m3/hr, head 12.5 MPa with electric motor 1250 kW ;-fan weight		pc	3	5883	17649	
		-electric motor weight		pc	3	4840	14520	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
8		Single-chamber pneumatic vessel capacity 20 t/hr, length 400 m, pressure 600 kPa, consumption of compressed air - 15 m3/min		pc	6	1578	9468	
9		Jet pump with intensifier chamber, capacity 16.5 t/hr, pressure 200 kPa, supply distance - 150 m, consumption of compressed air - 15 m3/min	-	pc	6	80	480	
		Total:					42117	
		Handling Equipment						
10		Screw conveyor, length 8 m, diameter 320, capacity 16 t/hr, motor rating - 5.5 kW		pc	4	874	3496	
11		Screw conveyor, length 15 m, diameter 320, capacity 16 t/hr motor rating - 11.0 kW		pc	2	1467	2934	
12		Screw conveyor, length 18 m, diameter 320, capacity 16 t/hr, motor rating - 15 kW		pc	4	1708	6832	
13		Screw conveyor, length 20 m, diameter 320, capacity 16 t/hr, motor rating - 15 kW		pc	14	1854	25956	
		Total:					39218	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		SANITARY ENGINEERING DESIGN						
		Sanitary-engineering Equipment						
		Household air conditioner, capacity 600 m3/hr, cooling capacity 1.5 kW		pc	1	-	56.6	
		Total:					56.6	
		ELECTRICAL DESIGN						
		Electrical equipment						
1		Power oil transformer, rating 1600 kVA, voltage 11/6.6 kV		set	2	6000	12000	
2		Control stations board, outdoor type, consisting of 10 panels, 600x2500x600		pc	2	2000	4000	
3		I.D. fan control cabinet, wall mounted, 600x800x350		pc	2	60	120	
4		Floor mounted, power distribution point, with feeder breaker rated up to 630 A and 8 line breakers rated from 16 to 250 A		pc	1	-	300	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	total	Whom to be supplied by
5		Electric lighting fixtures and light sources				—	350	
		Total:					16770	
		MATERIALS						
6		Cables, section 2.5 ÷240 mm^2					1800	
7		Steel pipes, D_n 25÷100 mm					4710	
8		Electrical installation materials and fixtures					2510	
9		Structural steel					80400	
10		Auxiliary, installation and other materials					66100	
		INSTRUMENTS AND CONTROLS						
1		Copper resistance thermal transducer, measuring range 0-150°C		pc	12	1.5	18.0	
2		Copper resistance thermal transducer. Meas.range 0-100°C. Protecting reinforcement material Л 96. Installation length - 20 mm		pc	4	1.5	6.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
3		Temperature-sensitive element. Control range 0-30°C. At low temp. is closing		pc	4	0.3	1.2	
4		Contact electrical manometer Scale 0-10 kg/cm2		pc	18	2.2	39.6	
5		Interchangeable differential diaphragm manometers						
		1. Measuring range 0-630 kgf/ m2		pc	2	12.0	24.0	
		2. 0-0.4 kgf/cm2		pc	1	12.0	12.0	
		3. 0-4 kgf/cm2		pc	1	12.0	12.0	
6		Interchangeable differential bell manometer with output signal 10..0.1 m Henry						
		1. Measuring range 0-100 kgf/ m2		pc	4	24.0	96.0	
		2. 0-0.4 kPa		pc	2	24.0	48.0	
7		Diaphragm separator. Range 0-4 kgf/cm2		pc	20	0.5	10	
8		Differential liquid draught and head meter. Range 0-630 kgf/m2		pc	6	2.7	16.20	
9a		Twelve-channel controller and recorder. Scale 0-150°C. One measuring range. Four-wire connection		pc	2	13.5	27.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg		Whom to be supplied by
						of one piece	total	
9b		Same. Three measuring ranges. Transducer type ПНТ (0-5 mA) Scales: 0-6.3 kPa, 0-1 kPa, 0-5x10^5 m3/h		pc	2	13.5	27.0	
9c		Same. Three measuring ranges. Three scales: 0-100%. Transducer type ПНТ (0-5 mA)		pc	4	13.5	54.0	
10		Normalizing transducer, input signal 0-10 mGn, output signal 0-5mA		pc	10	4.5	45.0	
11		Induction flow-meter, trasducer covered with fluoroplastic						
11a		Dnom.=50 mm, scale 0-31.5x10^{-4}m3/s		pc	5	4.0	20.0	
11b		Dnom.=300mm, scale 0-1250x10^{-4}m3/s		pc	6	4.0	24.0	
11c		Dnom.=80 mm, scale 0-80x10^{-4} m3/s		pc	1	4.0	4.0	
12		Relay-level gauge						
12a		1. Media - bulk, electrically conductive		pc	24	14.0	336.0	
		2. Media - liquid, conductive		pc	8	14.0	112.0	
13		Relay level gauge, version 1, ~220VAC, measuring limits 0-2 m		pc	2	4.0	8.0	
14		Multi-channel signalling unit. Measuring range 0-100°C with three-position signalling		pc	1	-	8.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	total	Whom to be supplied by
15		Sensitive element of major-type pH-meter, scale 0-10 units pH		pc	2	8.0	16.0	
16		Industrial transducer. Output 0-5 mA. Meas. range 1-14 pH units		pc	2	7.5	15.0	
17		Secondary recorder. Input 0-5 mA. Range 0-100%		pc	2	15.5	31.0	
18		General purpose monitoring and signalling equipment with recording block. Relocation amplitude 10-1000 mcm. Frequency range 12.5-500 Hertz		pc	1	-	2.5	
19		Electrical actuator, ~220 VAC		pc	4	12.0	48.0	
		Total:					1060.5	
		ELECTRICAL HARDWARE						
20		Distribution switch-gear with one input and 30 feeder switches		pc	3	100.0	300.0	
21		Distribution switch-gear without input switch, 6 feeder switches		pc	1	-	80.0	
		Total:					380.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
		PIPELINE VALVES						
22		Globe coupled valve $D_n = 15$ mm		pc	50	2.3	115.0	
23		Three-way gauge cock $D_n = 15$ mm		pc	20	3.0	60.0	
		Total:					175.0	
		PANELS						
24		Cabinet panel w/rear door. ЩШ-ЗД-I-1000x600, УХЛ 4, OST 36, 13-76		pc	7	158.0	1106.0	
25		Small-size cabinet panel. ЩШМ-1000x600-П УХЛ 4-УР30 OST 36.13-76		pc	2	48.8	97.6	
		Total:					1203.6	
		SECTION II. MATERIALS						
		Control cable with copper cores GOST 1508-78, cross-section						
26		4 x 1 mm^2		km	4.0	99.6	398.4	
27		14 x 1 mm^2		km	0.3	286.0	85.8	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
28		37 x 1 mm^2		km	0.4	665.0	266.0	
		Control cable with copper cores GOST 1508-78 and braided, section						
29		4 x 1 mm^2		km	0.7	153.0	107,1	
30		14 x 0.75 mm^2		km	0.2	296.0	59.2	
31		Coaxial cable, section 2x0.35 mm^2		km	0.2	16.4	3.3	
32		Flexible wire with copper core, section 1.0 mm2 GOST 6323-79		km	0.4	14.0	5.6	
		Total:					925.4	
		INSTALLATION MATERIALS AND PRODUCTS						
33		Seamless steel pipe GOST 8734-75, 14 x 2 mm^2		m	500	0.82	410.0	
34		Flexible metal conduit, D_N 15 mm		m	100	0.5	50.0	
35		Connection box, 230x100 mm		pc	12	0.3	3.6	
36		Connection box, 280x110 mm		pc	1	-	0.7	
		Total:					464.3	

III. AUXILIARY AND SUPPORT AREAS

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
		1. ADMINISTRATIVE BUILDING						
		SANITARY ENGINEERING DESIGN						
		Sanitary-engineering Equipment						
1		Self-contained air conditioner, capacity 7000 m3/hr, cooling capacity 32 kW		pc	5	1200	6000	
2		Household air conditioner, capacity 600 m3/hr, cooling capacity 1.5 kW		pc	10	56.6	566	
		Total:					6566	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		ELECTRICAL ENGINEERING						
		Electrical equipment						
1		Distribution points w/circuit breakers rated 16 to 250 A		pc	3	170	510	
2		Single-phase transformer, voltage 10 kV, power rating 1000 kVA		pc	3	8	24	
3		Electric lighting fixtures and light sources					2300	
		Total:					2834	
		SECTION II. MATERIALS						
4		Cables, section 2.5÷ 240 mm²					390	
5		Electrical installation materials and fixtures					620	
6		Structural steel					130	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	total	Whom to be supplied by
		2. WATER RECIRCULATING SYSTEM						
		PROCESS DESIGN						
		Pumps, fans						
1		Electric pumpset, motor 4AM250M2T2, capacity 300 m3/hr, head 63 m H_2O, motor rating 90 kW, 2900 rmp		pc	3	887	2661	
2		Electric pumpset, motor 4AM225M2T2, capacity 300 m3/hr, head 42 m H_2O, motor rating 55 kW, 2900 rmp		pc	3	662	1986	
3		Axial fan, motor BACO 14-16-32, capacity 500000 m3/hr, head 15 kg/m2, motor rating 30 kW, 178 rpm		pc	2	4960	9920	
		Total:					14567	
		Pipeline valves						
4		Gate, D_{nom} 300		pc	26	253	6578	
5		Same, D_{nom} 200		pc	10	125	1250	
6		Same, D_{nom} 150		pc	6	73.5	441	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
7		Same, D_{nom} 50		pc	8	18.4	147.2	
8		Clapper swing-check valve D_{nom} 200		pc	12	41.4	496.8	
9		Fire hydrant H-1750		pc	13	142	1846	
		Total:					10759.0	
		SECTION II. MATERIALS						
10		Steel pipe dia 325x4		m	2000	31.66	63320	
11		Same, dia 108x3		m	750	7.77	5827.5	
12		C.I. pipe dia 600		m	2000	222.9	445800	
13		Same, dia 500		m	700	167.5	117250	
14		Same, dia 200		m	300	44.6	13380	
15		Same, dia 150		m	2000	30.5	61000	
16		Same, dia 100		m	900	18.9	17010	
17		Ceramic pipe, dia 150		m	1000			

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		ELECTRICAL DESIGN						
		Electrical equipment						
1		Packaged transformer substation consisting of: two transformers 1000 kVA each, voltage 11/0.415 kV, two high-voltage feeder cabinets, 5 low-voltage cabinets, tropicallised version		set	1	-	16650	
2		A.C. control-station boards, open type, large size 2200x9600x600 mm		panel	12	300	3600	
3		Single control cabinets 2000x800x600 mm		panel	4	400	1600	
4		Control cabinets and panels, floor and wall mounted 2000x800x600 mm		panel	8	80	640	
5		Distribution points w/circuit creakers rated 63 to 250 A		pc	2	170	340	
6		Distribution boxes w/knife switches or plug connectors 600x300x300 mm		pc	6	25	150	
7		Distribution boxes w/knife switches 210x190x100 mm		pc	3	16	48	
8		Boards with circuit breakers, number of groups up to 12		pc	2	70	140	

NOS: No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg: of one piece	Net weight, kg: total	Whom to be supplied by
9		Single-phase transformer, voltage 10 kV, power rating 1000 kVA		pc	2	8	16	
10		Reversible and non-reversible magnetic starters, current 10 to 80 A		pc	5	9	45	
11		A.C. circuit breakers, current up to 250 A		pc	6	3.5	21	
12		Miscellaneous control and signalling equipment		pc	20	1.7	34	
13		Electric lighting fixtures and light sources					220	
		Total:					23504	
		SECTION II. MATERIALS						
14		Cables, section 2.5 ÷240 mm^2					5100	
15		Steel water and gas pipes, dia 25–80 mm					7200	
16		Electrical installation and fixturing materials					2750	
17		Structural steel					1780	
18		Insulation materials					1100	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measu- rement	Quan- tity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		3. COMPRESSOR STATION						
		PROCESS DESIGN						
		Major Process Equipment						
1		Piston-type air compressor, capacity 62.2 m3/min, absolute pressure 0.9 MPa complete with motor CDK2 16-24-10, rating 400 kW, voltage 10000 V, automatic control, intermediate and termination equipment, w/optional equipment (at extra cost):		set	2	11450	22900	
		End cooler (version 1)		pc	2	880	1760	
		Air accumulator, capacity 6.3 m3		pc	2	1425	2950	
2		Air drier with cooling cycle, capacity 125 m3/min, dew point of dried air +50°C (similar to air drier OBM-15)		pc	1	-	5500	
3		Heat exchanger, absolute pressure 1.0 MPa, surface area 150 m2		pc	1	-	4200	
		Total:					37310	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg		Whom to be supplied by
						of one piece	total	
		Pumps						
4		Manual pump, delivery 0.74 l per double stroke, pressure 0.3 MPa		pc	2	13.6	27.2	
5		Electric piston pump, capacity 1 m3/hr, pressure 1.6 MPa, motor AMP80A4, rating 1.1 kW		pc	1	-	130	
		Total:					157.2	
		Handling Equipment						
6		ES crane, single girder, capacity 5 t, span 9 m, length 10.2 m		pc	1	-	2430	
		Total:					2430	
		Auxiliary Equipment						
7		Bleeder silencer, diameter 1020, height 5350	VAMI drg	pc	1	-	1806	
8		Filter with silencer, flowrate 63 m3/min, height 4780, width 2095, depth 1520		pc	2	1945	3890	
9		Devices for cleaning compressed air lines		pc	1	-	366	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	 total	Whom to be supplied by
		SANITARY ENGINEERING DESIGN						
		Sanitary-engineering Equipment						
1		Household air conditioner, capacity 600 m3/hr, cooling capacity 1.5 kW		pc	1	-	56.6	
		Total:					56.6	
		VALVES						
2		C.I. valves Dnom 15-50 mm		pc	30		100	
3		Steel valves Dnom 15-200 mm		pc	60		2000	
		SECTION II. MATERIALS						
4		Steel pipes , dia. 50 mm		m	1900		8000	
5		Structural steel					800	
6		Structural steel for fabrication of non-standard equipment					2200	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		ELECTRICAL ENGINEERING DESIGN						
		Electrical equipment						
1		Packaged distribution gear rated at 11 kV, consisting of 8 cells, w/all necessary connections between devices and instruments		set	1	-	20100	
2		Packaged power source for electromagnets operating high-voltage circuit breakers		pc	1	-	300	
3		Packaged transformer substation consisting of: two transformers 630 kVA each, voltage 11/0.415 kV, two high-voltage feeder cabinets, 5 low-voltage cabinets, tropicallised version		set	1	-	7500	
4		Distribution points w/circuit breakers rated 16 to 250 A		pc	3	170	510	
5		Distribution boxes w/knife switches of plug connectors, 600x300x300 mm		pc	2	25	50	
6		Distribution boxes w/knife switches , 210x190x100 mm		pc	2	16	32	
7		Reversible and non-reversible magnetic starters, current 10 to 100A		pc	4	9	36	
		Total:					28528	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	total	Whom to be supplied by
		SECTION II. MATERIALS						
8		Cables, section 2.5 ÷240 mm^2					3900	
9		Steel pipes for water and gas supply, dia 25-80 mm					9400	
10		Electrical installation materials and fixtures					2000	
11		Structural steel					8000	
12		Insulating materials					760	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		INSTRUMENTS AND CONTROLS						
1		Chamber diaphragm P_N = 10 MPa, D_N = 200 mm		pc	1	-	0.5	
2		Chamber diaphragm P_N = 0.6 MPa, D_N = 150 mm		pc	2	0.3	0.6	
3		Measuring flowrate transducer 0-5 mA		pc	4	14.0	56.0	
4		Measuring pressure transducer 0-1 MPa		pc	4	13.0	52.0	
5		Copper resistance thermal transducer 0-100°C		pc	4	1.5	6.0	
6		Liquid draught and head meter. Scale 0-0.63 kPa		pc	2	2.7	5.4	
7		Indicating manometer. Scale 0-0.63 MPa		pc	2	0.5	1.0	
8		Electrical contact manovacuum meter. Scale 0-1.0 kPa		pc	2	0.5	1.0	
9		Straight technical thermometer Scale 0-100°C		pc	6	0.01	0.06	
10		Indicating and recording unit. Scale 0-100°C		pc	13	12.0	156.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
11		Root extracting block		pc	3	3.5	10.5	
12		Single-channel power supply unit		pc	2	4.0	8.0	
		Total:					297.0	
		Electrical hardware						
13		Distribution switchgear with one input and 18 feeder switches		pc	1	-	90.0	
		Total:					90.0	
14		Instrumentation panel with rear door. Panel-3D-I-1000x600 YX/I4 YP30 OCT 36.13-76		set	4	158.0	632.0	
		Total:					632.0	
		Pipeline valves						
15		Globe couples valve D_N = 15 mm		pc	30	2.3	69.0	
16		Three-way gauge cock D_N = 15 mm		pc	10	0.3	3.0	
		Total:					72.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	total	Whom to be supplied by
		SECTION II. MATERIALS						
		Cables and wires						
		Control cables with copper cores GOST 1508-78, cross-section:						
17		4 x 1 mm2	КВВГ	km	0.5	99.6	49.8	
18		5 x 1 mm2	"	km	0.2	129.6	26.0	
		Control cable with aluminium cores GOST 1508-78, cross-section:						
19		4 x 2.5 mm2	АКВВГ	km	0.2	124.0	24.8	
20		5 x 2.5 mm2	"	km	0.1	136.0	13.6	
21		14 x 2.5 mm2	"	km	0.2	326.0	65.2	
22		Flexible wire with copper core 1 x 10 mm2 GOST 6323-79	ПВЗ	km	0.3	14.0	4.2	
		Total:					183.6	
		Installation Materials and Products						
23		Seamless steel pipe GOST 8734-75 14 x 2		m	200	0.82	164.0	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
24		Electrically welded steel pipe GOST 10704-76 20 x 1.6		m	50	0.89	44.5	
25		Flexible metal conduit, D_N=15 mm		m	100	0.5	50.0	
26		Connection box, 230x100 mm		pc	20	0.3	6.0	
		TOTAL:					264.5	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		4. MAIN STEPDOWN SUBSTATION						
		Electrical equipment						
1		Power oil transformer, three-phase, double winding, split low-voltage winding, rating 37500 kVA, voltage 220/11-11kV, on-load voltage regulation, tropicallised version		set	1	-	187500	
2		Air circuit breaker, rating~220kV		set	4	15600	62400	
3		Three-pole trip, outdoor installation,~220 kV, 1000 A, earthing knife switch		set	8	775	6200	
4		Valve discharger,~220 kV		pc	4	405	1620	
5		Current transformer,~220 kV, 1000/5 A		pc	8	2600	20800	
6		Packaged distribution gear rated at 11 kV, consisting of 30 cells, w/all necessary connections between devices and instruments		set	1	-	75500	
7		Packaged power source for electromagnets operating high-voltage circuit breakers		pc	3	300	900	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
8		Control, protection and regulation boards		panel	12	500	6000	
9		Distribution points w/circuit breakers rated 16 to 250 A		pc	3	260	780	
10		Bushing and post insulators		pc	60	38	2280	
11		Electric lighting fixtures and light sources					600	
		Total:					364580	
		SECTION II. MATERIALS						
12		Cables, section 2.5 -240 mm^2					61450	
13		Steel water and gas supply pipes, dia 25-80 mm					1150	
14		Electrical installation structures					2200	
15		Structural steel					1100	

NOS	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg		Whom to be supplied by
No according to technological flowsheet						of one piece	total	
		5. FUEL OIL STORAGE						
		PROCESS DESIGN						
		Major Process Equipment						
1		Coarse oil filter, diameter 150, capacity 3 m3/hr		pc	2	125.4	250.8	
2		Coarse oil filter, diameter 100,		pc	2	94.1	188.2	
3		Fine oil filter, capacity 8.3 l/s (30 m3/hr), pressure 2.5 MPa (25 kg/cm2)		pc	2	220	440	
4		Oil heater, capacity 1.7 l/s (6 m3/hr), pressure 2.5 MPa (25 kg/cm2)		pc	3	616	1848	
5		Horizontal steel vessel, capacity 75 m3		pc	2	4400	8800	
		Total:					11527	
		Pumps						
6		Pump, impeller diameter 180 mm, capacity 12.5 l/s (45 m3/hr), pressure 0.37 MPa (3.8 kg/cm2), motor BAOMH62-2, rating 17 kW, 2950 rpm		pc	2	315	630	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
7		Pump, capacity 0.83 l/s (3 m3/hr), pressure 2.5 MPa (25 kg/cm2), motor 4AM112M2OM2, rating 5.5 kW, 1450 rpm		pc	2	120	240	
8		Drainage pump, capacity 1.6 l/s (5.8 m3/hr), pressure 0.25 MPa (2.5 kg/cm2), motor AИP90L4, rating 2.2 kW, 1450 rpm		pc	1	-	53.2	
		Total:					923.2	
		Handling Equipment						
9		ES manual single girder crane, capacity 0.5 t, span 6 m, total length 7.2 m		pc	1	-	383	
		Total:					383	
		Valves						
10		C.I. valves D_N 15-50 mm		pc	75		360	
11		Steel valves D_N 20-300 mm		pc	75		2500	
		SECTION II. MATERIALS						
12		Pipelines D_N 15- 300 mm					108000	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		6. TRANSPORT						
1		Truck, capacity 7÷8 t		pc	1	-	6700	
2		Dump truck, capacity 7÷8 t		pc	1	-	7200	
		Total:					13900	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		7. ELECTRIC LIGHTING OF TERRITORY						
		Electrical equipment						
1		Control cabinet, 2000x800x600 mm		pc	3	300	900	
2		Distribution points w/circuit breakers, number of groups up to 12		pc	3	70	210	
3		Single-feeder box, 1200x600x400 mm		pc	6	25	150	
4		Electric lighting fixtures and light sources					1500	
		Total:					2760	
		SECTION II. MATERIALS						
5		Cables, section 2.5 ÷240 mm^2					4150	
6		Steel water and gas supply pipes, dia.25–80 mm					22500	
7		Electrical installation materials					220	
8		Structural steel					430	

NOS No according to technological flowsheet	Trans. No	Name and technical characteristics	Type, brand, model, cipher	Unit of measurement	Quantity	Net weight, kg of one piece	Net weight, kg total	Whom to be supplied by
		8. COMMUNICATION AND SIGNALLING						
1		Exchange telephone handset АТС		pc	40	0.6	24.0	
2		Interoom telephone handset ЦБ		pc	27	0.6	16.2	
3		Secondary single-face electric clock		pc	27	2.0	54.0	
4		PAS loudspeaker, voltage 30 V, rating 0.15 W, "Taiga-304"		pc	20	0.6	12.0	
5		PAS handset		set	18	12.0	216.0	
6		Magnetic thermal anunciator		pc	30	0.05	1.5	
7		Magnetic contact alarm		pc	50	0.05	2.5	
8		Magnetic contact inertia sensor		pc	50	0.05	2.5	
9		Fire alarm		pc	10	0.1	1.0	
10		Burgler telecommunication alarm		set	2	10.0	20.0	
		Total:					349.7	