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80p. tables graphs

Contract No. 88 139
UNIDO Project No. XR IRA 88 062

OPPORTUNITY STUDY IN THE ESTABLISHMENT OF AN INDUSTRIAL PRODUCTION OF SPECIAL ALUMINA FOR SPARK PLUG INSULATORS IN IRAN

Final report

NPO „VAMI"

VVO „TECHNOEXPORT"

ST.-PETERSBURG
1991

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1. GENERAL BACKGROUND INFORMATION

Presently there are over 5 mln cars. khundreds of thousands of motocycles and other vehicles equipped with internal combustion engines are running in the Islamic Republic of Iran (IRI). Annual demand on spark plugs is 20 mln pieces.

The production of spark plugs in IRI is organized at IAAI plant in Kazvin and turns annually '2 mln plugs. Ceramic part of plugs (insulators) is imported from abroad (Germany, Yugoslavia etc.).

As in known the ceramic insulators for spark plugs in the world practice are fabricated from special grades of alumina consisting 99.6% of Al2O3 with α-Al2O3 content as high as 95% obtained at alumina refeneries from aluminium hydroxide.

At present there is no special grade alumina production in Iran and in the whole neighbourhood while the demand in automative industry on special grade alumina is about 3000 tpy and is expected to grow.

Soviet Union has elaborated an industrial technology of special grade alumina production from standard cell-grade alumina containing 99-99.5% of Al2O3. The Soviet automative industry successfully utilizes the special grade alumina obtained from more cheap cell-grade alumina to produce high quality plugs.

Thus the technology of special grade alumina production from the standard cell-grade alumina, developped in the USSR can be transferred to the Islamic Repoublic of Iran thourgh UNIDO.

Considering big demand in the IRI on spark plugs the Government of IRI has passed a decision on establishing proper production of spark plugs. In order to investigate the issue of raw materials for ceramic insulators it was decided to undertable an opportunity study of the project. It was understood to investigate the adaptability of alumina imported by IRI for aluminium production to its conversion for production of special grade alumina, to fabricate the demonstration lot of spark plugs for testing in Iranian automotive industry and to assess approximately the cost of construction of plant for special grade alumina.

In this connection the IRI Government has contacted UNIDO with a request to assist in realization of the opportunity study.

This work was awarded to the All-Union Research and Design Institute of Aluminium, Magnesium and Electrode Industry (VAMI) of the Ministry of Metallurgy of the USSR, 199026, Leningrad, Sredni prospect, 86.

2. OBJECTIVES OF THE PROJECT AND FOUNDERS

2.1. Objectives of the project

To demonstrate at laboratory level the possibility to produce special grade alumina from imported cell-grade alumina and fabricate the demonstration lot of insulators and spark plugs.

Basing on results of laboratory and pilot testing to present technical data and data on necessary capital investments to give the Government the possibility to adopt qualified decision on establishment of special grade alumina production for fabrication of spark plugs on industrial scale.

On request of Iranian side to undertake additional investigations on the possibility to obtain other grades of alumina from imported cell-grade alumina to meet demands of other industries.

2.2. Founders of the project are the Iranian Development and Renovation Organization (IDRO) with participation of IAAI.

3. MARKET AND DEMAND ON SPECIAL GRADE ALUMINA

The demand on special grade alumina for fabrication of spark plugs in the Iranian automotive industry in 3000 tpy.

According to Iranian data there is a demand in IRI on special grade alumina for refractories, electrotechnical, ratiotechnical and electronical industries which is expected to increase as much as 20000 tpy.

Given the absense in the IRI of special grade alumina production the said needs are met through importation.

Thus the issue of special grade alumina production from the cell-grade alumina have to be envisaged in larger content to meet needs of other varions industries.

Presently the IRI imports about 150 thousand tons of cell-grade alumina for the only aluminium smelter in the country belonging to IRALCO in Arak. In the future the expansion of smelter's capacity will call for import of about 300 thousand tons of alumina per year.

Aside from that the long term plans of the Government the construction of a facilities in the IRI to produce alumina from the local raw materials (bauxites, nepheline, alunite) is planned which will make possible a large scale production of special grade alumina at one of the above facilities.

The optimum capacity of the planned facility has to be determined taking into consideration the demand on special grade alumina in- and outside of country.

The construction of facilities for special grade alumina for spark plugs will leave enough time to master its production and form corresponding engineering and operating personnel.

4. METHODOLOGY OF PROJECT IMPLEMENTATION

Starting from the objectives of the project the methodology of its implementation foreseen the following stages:

- investigation of physical and chemical properties of cell-grade alumina;
- production of special grade alumina at laboratory scale and investigation of its properties;
- production of ceramic spark plug insulators for

demonstration and assembly of spark plugs:

- operation testing of plugs in Iranian automative industry;
- study of the possibility of such project in the Islamic Republic of Iran basing on results of laboratory and pilot testing and on industrial experience of special grade alumina production in the Soviet Union.

The composition of opportunity study corresponds to UNIDO recomendations and to Annex to the Contract.

The presented information is sufficient for well founded decision of the Government of Islamic Republic of Iran and project founders about establishment of special grade alumina production for fabrication of plugs for Iranian automotive industry.

5. LABORATORY ANALYSIS AND INVESTIGATIONS FOR PRODUCTION OF SPECIAL GRADE ALUMINA FROM THE CELL-GRADE ALUMINA

Investigations of physical and chemical properties of Iranian alumina

To investigate the adaptability of Iranian alumina to production of special grade alumina the analyses were made to determine the content of chemical components, the phase and granulometric compositions of alumina were determined as well as a specific surface area. The results are given in the Table 5.1. The BET method was used for determination of the specific, surface area (Soviet made instrument), methods of laser-based determination of grain size distribution of powder materials in suspensions (Granulometer 715 of French company Cilas), X-ray spectral analyses were made with ARL quantometer, the petrographic method of phase composition determination was carried out with the help of metallographic microscope MIN-8 (Soviet made).

The conclusion of necessity to remove part of alkali contained in alumina was made.

As a rule the alkali content in special grade alumina

Characteristics of alumina recei

aluminas manufactured from

N	Name of sample	α-Al_2O_3 content, % and structure description	Specific area, m^2/g	Grane composition		
				0-3	3-6	6-12
1	Alumina, cell-grade	α = 25.3 Structure is tipical for cell-grade alumina	43.10	1.8	0.6	
2	Special-grade alumina, sintering temperature 1600°C, 15 min	α = 97.5 Aggregates of α-Al_2O_3 with dense structure	1.50	71.6	7.1	
3	Special-grade alumina, sintering temperature 1300°C, 30 min	α = 94.0 Aggregatos of α-Al_2O_3 of good recrystallization, deeply burned, of fine grane structure, uniform sample low-diffraction phase in the form of inclusion in aggregates, Aggregates woth needle - flake form were not observed	1.20	59.6	30.4	
4	Special-grade alumina, sintering t°=1300°C, 30 min	α = 87.5 Aggregates of α-Al_2O_3 of good recrystallization, fine grane structure, low diffraction phase in the form of inclusion in aggregates of α-Al_2O_3	1.15	75.3	19.6	
5	Special-grade alumina, sintering t°=1300°C, 30 min	α = 92.3 Structure is similar to sample N 4	1.1	-	-	

SECTION 1

of alumina received from Iran and special grade
nufactured from it

ane composition (by weight)							Chemical composition, %				
3-6	6-12	12-48	48-64	64-96	96	mean diam., microns	Na_2O	SiO_2	Fe_2O_3	CaO	TiO
0.6		29.5	20.3	30.0	16.6	61.3	0.45	0.03	0.019	0.024	0.0
7.1		10.5	0	0	0	1.8	<0.05	0.068	0.016	0.025	-
30.4		1.8	0	3.8	0	2.7	0.06	-	-	-	-
19.6		2.0	0	0	0	1.9	0.238	-	-	-	-
-		-	-	-	-	-	0.179	-	-	-	-

SECTION 2

Table 5.1

TiO_2	MgO	MnO	Cr_2O_3	V_2O_5	ZnO	Ga	Comments
0.0074	0.003	0.00033	0.0002	0.0037	0.004	0.008	Semple received from Iran
-	-	-	-	-	-	-	Sample manufactured in "Autoelectronics" research institute. Grane composition determined after grinding in vibrating mill for two minutes. Was used for spark plugs manufacturing
-	-	-	-	-	-	-	Sample washed by H_2SO_4 solution, mixed with AlF_3 (0.5%). Prepared at VAMI. Can be used for electronics chips manufacturing
-	-	-	-	-	-	-	Initial alumina mixed with complex mineralizer without washing. Special grade alumina of this type is used for electroceramics, radioceramics, special types of refractory
-	-	-	-	-	-	-	Initial alumina washed by hot water, mixed with complex mineralizer. Can be used for spark plugs manufacturing, electroceramics, radioceramics and special refractory

SECTION 3

for spark plug insulators is limited to 0.1% of Na_2O. In some cases 0.3% of Na_2O in admitted. In alumina imported by IRI from Turkey the alkali content is 0.45% which calls for its removal till the required level.

For this end the washing out of soluble alkalis by repulpation in thin solution of hydrochloric acid (concentration 5 g/l, S/L = 2:1, washing time 30 min). Also the alumina washing with hot water was used, but it proved to be less efficient in reducing alkali cintent in alumina.

The obtained results allow to draw a conclusion that the sample of alumina received from IRI is the typical cell-grade alumina. The α-Al_2O_3 content (25.3%) is good for its further processing to obtain special alumina. The impurities and microimpurities content is also within limits.

6. LABORATORY STUDY ON PRODUCTION OF SPECIAL GRADE ALUMINA FOR SPARK PLUG INSULATORS

During laboratory testing the full scope of investigations in conversion of cell-grade alumina into special grade alumina and determination of the latter's properties was undertken.

According VAMI's laboratory methods a portion of alumina weighing 100 g was acid washed, dried at 105°C and mixed with mineraliser. Commercial grade aluminium fluoride was used as a mineraliser. After mixing the sample was calcined in a laboratory furnace at 1300°C during 30 min. After calcination the sample was analysed for Fe_2O_3, Na_2O, SiO, specific surface area and grain size distribution of monocrystal sizes by fractions. Analytical results are given in Table 5.1.

The study of analytical results of low-soda highly calcined alumina under laboratory conditions has shown that by its main characteristics special alumina produced from Iranian alumina meets the requirements imposed on special grade alumina for production of spark plug insulators. Specially noted was good ability of alumina to recrystallisation under influence of mineraliser. Soda content was cut down to 0.06% which corresponds to the most stringent requirements of the alumina ceramics producers, including those of IC cases. Calcination degree as for α--Al203 content meets the requirements for spark plug insulator production.

The laboratory methods of production of special alumina and determination of its quality is used during 10 years at one of Soviet alumina refineries which produces and turnishes the special alumina for production of spark plugs.

An industrial process in rotary kilns was elaborated basing on the laboratory data obtained at electric furnaces, i.e. the corresponding temperature conditions are maintained and the metering of mineralizers is undertaken. The elaborated method allows to determine the suitability of initial alumina for fabrication of special alumina. The similar method was used to determine the process parameters for fabrication of special alumina for two Indian companies - BALCO and INDAL with the use of rotary kilns for calcination.

The next stage was the preparation of a lot of special alumina fir spark plugs fabrication.

According to Soviet practice the semi-industrial testing is undertaken after laboratory testing to prove the suitability of cell grade alumina for fabrication of special alumina. This method was proved during the start-up of a spark plug plant using the method of isostatic pressure, built by the design of British company Smits. In spite of difference in the methods of special alumina production in pilot electric furnace and the casting method there is a stable correlation between the properties of initial alumina and the quality of the ceramics. The multiple tests made by the VAMI, Saint-Petersburg, and NPO "Avtoelectronika", Moscow, allow to determine the suitability of the initial alumina for the production of special grade alumina.

Calcination process was run in the ammonia furnaces of the Avtoelectronika Institute (ceramics laboratory). Alumina was placed in ceramic capsulas without mineralising additives and pushed through the tunnel furnace at a rate of 1 capsule per 15 min. Maximum furnace temperature was 1600 C.

At this temperature alumina was held for about 35 min. Total retention time of a capsule in the furnace was 5 hrs.

Calcination under the said conditions resulted in alumina with α -Al_2O_3 content of 97.5% with average monocrystal size being 1.8 micron. Na_2O content lowered up to 0.05% (see Table 5.1).

Petrographic investigation of special grade alumina produced in VAMI and Avtoelectronica laboratories revealed a significant difference in structure of both products. This is attributed to addition of mineraliser in the first case. Calcination of alumina without mineraliser at higher temperature ensures a sufficiently complete phase transition, however there are practically no structural change in alumina. Table 5-1 demonstrates petrographic characteristics of all produced special grade alumina. Table also shows the results of laboratory seale calcination of the Iranian alumina according to special grade alumina process for production of electrical and ratio ceramics. The results prove the possibility to produce special grade alumina for electrical and radio engineering.

7. FABRICATION OF DEMONSTRATION SPARK PLUG INSULATORS AND ASSEMBLY OF DEMONSTRATION SPARK PLUG INSULATORS

Since only a reduced lot of Iranian alumina (~30 kg) was received for production of ceramics and insulators for spark plugs the laboratory technology of ceramics production by using the hot casting method of thermoplastic slips in the metallic moulds which allows operation with limited quantity of raw materials.

The similar process is used together with others under industrial conditions for production of spark plug insulators and ceramic parts of sophisticated configuration.

As a feedstock for ceramics the charge mix with special grade alumina with 96% of α- Al_2O_3 and monocrystal size in the range of 3.5-4.0 micron and demestic mineralisers (helping to reduce the sintering temperature): quarty sand, calcium carbonate and magnesium hydroxide.

Charge was dry ground in a vibromil BM-50 (Soviet made) using metallic balls with the grinding bodies to material ratio being 10 to 1 by weight. Optimum grinding time was found. Specific surface area of the resulting powder was 17500 cm^2/g.

In the process of charge grinding the specific surface area of the powder, pressed product density, sintering degree of pressed products after each grinding according to the method elaborated in the sintering laboratory of ceramics.

A casting slip was prepared out of ground powder, parrafine, petrolatum, max and oleinic acid after having optimum conditions of grinding. The ratio of binding components was selected on the basis of size distribution of the ground charge. Components ratio of the binder was selected on the basis of dispersion degree in vibrovacuum mixer at 90-95°C during 1.5 hr (mixer in based on vibromill of domestic production BM-8).

Moulded insulators and ceramic specimens were treated to remove the technological bond by packing with commercial (metal-grade) alumina. Boxes with semifabricated products and alumina were placed in the chamber furnaces with sellite heaters and the calcination was performed according to special conditions. The final temperature of the technological bond removal was 950-1000°C and retention time at this temperature was 5 hrs.

Then insulator moulds and ceramic specimens were treated to remove technological bond by packing with commercial grade (cell-grade) alumina. Boxes with semi-fabricated and alumina were placed in the chamber furnaces jwith sellite heaters and calcination was performed according to special regime. The final temperature of technological bond removal was 950-1000°C and retention time in it 5 hrs.

Then semi-fabricated products deprived of the bond were subjected to high temperature calcination in tunnel furnaces in protective atmosphere. Special heat treatment conditions were selected for ceramics to obtain necessary physical and thermal conditions of materials. The calcination temperature was 1680°C, interval between the capsules with insulators being 15 min. Retention time at final temperature was 25 min.

Physical and technical characteristics of the produced ceramics and insulators were:

mechanical strength, kgf/cm2	3200
electrical strength of insulators, kV	38
apparent density, g/cm3	3.76
average crystal size, micron	7
amount of glass phase, %	12

As a result of the final stage we prepared the cores and assembled spark plugs of two types W67D and W7D according to Besch classification which were submitted to the Iranian side for common testing.

8. RUNNING TESTS OF SPARK PLUG INSULATORS IN IRANIAN AUTOMOTIVE INDUSTRY

According to the Contract on fabrication from Iranian alumina of spark plug insulators the spark plug insulators have to undergo testing in the Iranian automotive industry.

During dispatching of Soviet experts to IRI it became clear that Iranian side does not possess the equipment for plugs testing. The Customer have put forward the request to perform the testing of the demostration spark plugs according to Soviet methods. Laboratory and operation testing of demonstration spark plugs with insulators made of ceramic consisting of special alumina made of cell-grade alumina received from Iranian side were carried out using equipent and methods of Ceramics Labratory.

8.1. Testing program

50 demonstration spark plugs of four types: A14DB. A17DB. A14DBP and A17DBP fabricated in plug department of NIIAE.

Spark plug A14DB - based on ceramics from Iranian alumina - 20 pieces.

Spark plug A17DB - based on ceramics from Iranian alumina - 20 pieces.

Spark plug A14DBP - based on ceramics from Iranian alumina with incorporated interference suppressing resistor - 5 pieces.

Spark plug A17DBP - based on ceramics from Iranian alumina with incorporated interference suppressing resistor - 5 pieces.

The testing of demonstration spark plugs was made to prove their correspondence to requirements of standards OST 37.003.081-87 for spark plugs. Besides, 100 evaluate lifetime and stability of incorporated interference suppressing resistor.

Here the following scope of work was done:

- testing of continuity of spark generation, verification of gas leahages, verification of and heating verification;
- testing of electrical resistivity value of the interference suppressing resistor incorporated into the core

of spark plug, the value which has to be within 4.0-12.0 k Ohm;

- determination of lifetime - 100 hr of operation testing in the motor VAZ-21011 with measurement of gap between electrodes and resistor values every 33.66 and 100 hrs.

8.2. Method of testing

Laboratory testing of spark plugs as for item 1 was performed according to method as in standard OST 37.003.081-87 "Spark plugs", as for item 2 according to specification TU [illegible].101.0074083 "Spark plug FE65P and FE65 PR", as for iter 3 according to method of selection of spark plugs for 4 tact carburattor engines" elaborated by N11A.

8.3. Testing results

8.3.1. Testing of continuity of spark generation by spark plugs as for item 1 has shown that spark plugs have performed well, the spark generation was continuous at the pressure of gas surrounding plugs electrodes being 8.5 + 0.5 kg/cm2, the gap being 0.60 + 0.1 mm.

8.3.2. Checking of gas leakage through the joints of spark plug parts as for item 1 has shown that the spark plugs have withstood the testing, the gas leakage was not observed with pressure drop 200 + 0.5.

8.3.3. Checking of burn-off number as for item 1 was performed at four A14DB plugs, numbers 21, 22, 23, 24; four A17DB plugs, number 25, 26, 27, 28 and one spark plug of the types A14DBP and A17DBP, correspondingly numbers 29 and 30.

Burn-off numbers of the proved plugs gives the following values - N 21 - 15,6; N 22 - 14,7; N 23 - 14,7; N 24 - 14,2; N 25 - 16,1; N 26 - 16,7; N 27 - 18,0; N 28 - 17.9; N 29 - 15,1; N 30 - 17,3.

The obtained results allow to draw conclusion that plugs with serial numbers 21, 22, 23, 24, 29 correspond to the spark plugs W8D (R), plugs with serial numbers 25, 26, 27, 28, 30 correspond to plugs W7D (R) according to Bosch companies classification.

8.3.4. Checking of the heating of the screwed in part as per item 1 was performed on three spark plugs from each lot. The results showed that spark plugs correspond to technical requirement, i.e. have remained tight and assure a uninterrupted spark generation.

8.3.5. Spark plugs of A14DBP and A17DBP types numbers 29, 31, 32, 33, 34 and 30, 35, 36, 37 and 38.

N of spark plug	Initial resistance	Resistance after sparking
29	9,2	8,1
31	8,8	7,0
32	7,2	6,2
33	8,4	7,7
34	6,0	5,2
30	5,7	5,0
35	6,1	5,2
36	7,5	6,2
37	8,0	7,2
38	7,5	6,9

The sparking was performed at a stand with pulse voltage amplitude 20 kV and 50 Hz during 1 min.

8.3.6. Lifetime testing was performed at VAZ 21011 engine during 100 hours.

Two types of spark plugs were tested: A17DB and A17DBP, four pieces of each type. The results are given in Table.

N of spark plug	Initial resistance k Ohm/ gap mm	Resistance after 33hrs k Ohm/gap mm	Resistance after 66 hrs k Ohm/gap mm	Resistance after 100 hrs k Ohm/gap mm
25	/0,65	/0,66	/0,66	/0,67
26	/0,62	/0,62	/0,63	/0,64
27	/0,62	/0,63	/0,63	/0,64
28	/0,60	/0,61	/0,62	/0,63

30	5,0/0,59	4,6/0,59	4,6/0,60	4,6/0,60
35	5,2/0,62	4,1/0,62	5,0/0,62	5,1/0,63
36	6,2/0,63	5,6/0,63	5,8/0,63	5,7/0,64
37	7,2/0,61	6,0/0,61	5,4/0,61	5,2/0,62

The testing have shown that the trial spark plugs with ceramic insulator from Iranian alumina correspond to technical requirements of the standard OST 37.003.081-87" Spark plugs", of the specification TU 37.101.0074-83". Spark plugs FE 65P and Fe 65PR.

By thermal characteristics the spark plug A14DP corresponds to the spark plug W8D, and the spark plug A17DB to the spark plug W7D according to Bosch classification.

The electrode wear in lifetime testing meets the requirements for spark plug valid in the USSR.

9. TECHNOLOGICAL PROCESS OF SPECIAL GRADE ALUMINA PRODUCTION

9.1. Raw materials

9.1.1. Cell-grade alumina (imported from Turkey)

α-Al2O3 content	25%
Na2O	0.45%
Specific surface area	43.1 m2/g
Average particle diameter	61.3 μ

9.1.2. Aluminium fluoride. Supplied from aluminium smelter in Arak.

9.1.3. Sulphuric acid (imported) H2SO4 content 98%

9.1.4. Natural gas

High heating value 10370 kcal/m3

composition: CH4 - 84%

C2H6 - 16%

specific weight 0.65 kg/m3

9.1.5. Water (from existing system)

Temperature 15°C

Pressure 4 kg/cm2

9.1.6. Power (from existing network)

Voltage 380 V

Frequency 50 Hz

3 phase

9.1.7. Water steam (from existing boiler)

Pressure 10 kg/cm2

Temperature 250°C

9.2. General flowsheet (drawing N 1398860,p.1,appendix 5)

The deeply calcined alumina (special alumina) is produced at 1250-1300° C in rotary kiln by calcination of cell grade alumina washed with the solution of sulphuric acid to remove alkali in the presence of the mineralizer.

The initial cell grade alumina is fed from the receiving bin by screw feeder 2 into the mixer where it is mixed with the sulphuric acid and arrives into the tank 3 equipped with the mixer.

The sulphuric acid is pumped through the receiver 14 by the centrifugal pump 16 into the receiving tank 17, from where it is pumped by necessity by the pump 18 into the tank 19 with the mixer where the solution of sulphuric acid is prepared. The diluted sulphuric acid is pumped by the pump 20 through the measuring tank 21 into the tank 3.

The ready slurry is pumped by the pump 4 to the filtration for separation and washing of the sediment on the band filter 5.

The used acid is collected in the mixer where the burned limestone is fed (not shown in the diagram). After mixing the reaction products are flown into the second mixer the overflow of which is disposed of into the drain, and the hard product (gypsum) is discharged and brought to disposal.

The alumina washed from the alkali in the form of wet cake arrives into the receiving bin of the rotary kiln from where it is sent by the feeder 44 into day bin where is fed at the same time by the feeder 33 the mineralizer. The ready mixture is conveyed by the feeder 32 into U-shaped ascending branch of the gas duct. Here takes place the drying of initial materials in suspended state and the reduction of the flue gas temperature.

The dried material is separated from gases in the cyclone 28 and arrives by gravity into rotary kiln 25 where the the heating, calcination and recrystallization takes place.

The calcined special alumina is cooled in the drum cooler 26 with water sprayed case. The cooled product alumina is fed by pneumatic devices 35 into the silo for ready product, from where by loading machines 42 it is packed into bags and shipped.

For rejected alumina the separate silo is provided which is also equipped with loading machines.

Waste gases from the kiln after cyclone 28 are dedusted in ESP 30 and sent to air by fan 31. The collected dust is returned to the process.

Fuel is burned in discharge part of the kiln in air stream supplied by fan 27. Supply of mineralizer to discharge part of the kiln has been provided for in the project.

Alumina dust has adsorbtion ability to fluor, which gives opportunity to practically fully adsorb fluor from waste gases by circulation. Experience of special alumina production in kilns shows that waste gases sent to air contains fluor within permissible limits.

Finished product is sent to receiving bin by pneumatic transportation, then loaded in sacks and shipped to consumer.

9.3. Major process equipment

The major process equipment is:

- for washing of alkali:
  belt conveyor

- for calcination:
  rotary kiln
  drum cooler
  electrostatic precipitator
  induced draft fan

Item	Description	Qty	Unit weight	Total
1	Conveyor B=400 mm	1	-	-
2	Screw feeder 160 mm dia	1	620	620
3	Mixer V=1 m^3, N=1.5 kW	2	630	1260
4,9,11, 13,18,20	Acid-proof pump Q=8 m^3/h H=30 m (centrifugal)	10	165	1650
5	Belt filter, F=1.8 m^2	1	1930	1930
6	Receiver, V=1 m^3	1	344	344
7	Trap V=0.4 m^3	1	200	200
8	Vacuum pump Q=12 Nm^3/min, H=30 kPa	1	1000	1000
10,12,19	Mixer V=2 m^3, N=3 kW	3	1340	4020
14	Receiver, 500 dia x 6 m	1	540	540
15	Vacuum pump Q=12 Nm^3/min, H=30 kPa	1	1000	1000
16	Acidproof centrifugal pump Q=40 m^3/h H=12 m	1	630	630
17	Tank, 4.5 m dia x 4.5 m	1	4920	4920
21	Measuring tank V=0.1 m^2/h	1	165	165
25	Rotary kiln 1600 mm dia, L=20 m	1	20045	20045
26	Drum cooler 1200 mm dia, L=16 m	1	14850	14850
27	Fan Q=1000 m^3/h H=5-6 kPa	1	200	200
28	Cyclone TsN-15, 600 mm dia	1	500	500
29	Cyclone TsN-15, 400 mm dia	1	260	260
30	Electrostatic precipitator Q=10000 m^3/h, t=350 deg.C	1	13900	13900
31	Fume exhaust fan Q=10000 m^3/h, H=3-3.5 kPa	1	800	800
32	Screw conveyor, 200 mm dia,	1	400	400
33	Weightometer, Q=0.4-2 kg/h	2	400	800
34	Air lift 100 mm dia, Q=3 t/h	2	150	300
35	Jet pump 100 mm dia	2	250	500
36	Electric hoist, Q=1 t	1	250	250
37	Screw conveyor, 200 mm dia,	1	1200	1200

Item	Description	Qty	Unit weight	Total
38	Rotary feeder, 150 mm dia,	4	200	800
39	Bag filter S=60 m^2	2	2060	4120
40	Fan Q=3500-4800 m^3/h, H=2.2 kPa	2	500	1000
41	Electric hoist, Q= 3.2 t	2	650	1300
42	Bagging machine Q= 200 bags/h	4	800	3200
44	Bulk material meter Q= 0.2-2 t/h	1	400	400
47	Belt conveyor B=650 mm	1	1600	1600

9.4. Process parameters

Productivity of the unit in special grade alumina	400 kg/h
Filter productivity in alumina	0,5 kg/h
Duration of acid treatment	40-60 min
Water content in filter cake	25-30%
Temperature of alumina discharge	1250-1300°C
Stack gases	250-300°C
cooled special grade alumina	80-100°C

9.5. Product quality

In the process of high temperature processing of cell-grade alumina the special grade alumina with the following characteristics is obtained:

α-Al2O3 content	95%
Na2O content	0,1%
Specific surface area	1,0-1,5 m2/g
Average particles diameter	1,5-2,0 μ

9.6. Main operating performances

Unit's performances	3000 tpy
Consumption of	
cell-grade alumina	3600 tpy
fuel	697000 m3/year
aluminium fluoride	18 tpy
sulphuric acid	36 tpy
compressed air	4500000 m3/year
hot water	5400 m3/year
fresh water	20000 m3/year
power	1000000 kWh/year

9.7. Capacity and location

The initial capacity of the unit according to the

Contract was 1000 tpy of special grade alumina. On request of Iranian side the capacity was to be expanded to 3000 tpy.

Two areas were considered for the location of unit:

- Qazvin in the industrial region of Albar (150 km to the west of Tehran) at site of existing spark plug production of IAAI;

- Arak, at site of existing aluminium smelter of IRALCO.

Taking into consideration that the special grade alumina production is organized for fabrication of ceramic insulators for spark plugs it was decided jointly with Iranian side to locate the production unit in Qazvin at the site of IIAI spark plug production plant.

Climatic conditions at the site are:

maximum temperature	+40°C
minimum temperature	-25°C
precipitations	300 mm/year
duration of heating season	4 month

The location of the unit at plant site is shown on the drawing N 1398860, p.3 (appendix 7).

The equipment flowsheet is exposed on drawings N 1398860 pp.1-3 (appendixes 5-7).

9.8. Recommendations for grinding and separation of final product

According to the world practice production of special alumina can be added with grinding equipment and equipment for pneumatic separation of special alumina, which can improve its properties.

Vibration or jet mills can be used for the purpose . USSR has experience to use jet mills for grinding of special aluminas. Using the method special quality alumina with more suitable grain size can be produced and shipped. In Germany vibration mills are used which gives opportunity to supply to customers the product with more stable grain size. Besides, preliminary ground special quality alumina is more expensive in case of its selling in world market.

10. FINANCIAL AND ECONOMIC EVALUATION

10.1 General

The estimates based on the major criteria assumptions submitted by Customer (IAAI company) in January 1991 (Appendix 2) are prepared by application of the COMFAR program.

The estimation results contain:

- initial and working capital requirements;
- project financing sources;
- production costs;
- cash flow tables;
- loss and profit account;
- discounted cash flow;
- project balance sheets.

10.2. Capital requirements

10.2.1 Initial capital

For preliminary estimate of the capital investment at this project stage in accordance with the Memorandum of January 17, 1991 (Appendix 1) it was assumed that the major process equipment for production of special grade alumina will be imported from the USSR, and construction will be carried out by Iranian organisations. The initial capital includes pre-operational expenses (project development).

The cost of the major process equipment is estimated on the basis of the weight and world market prices of certain items of the equipment and machinery available in VAMI and experience in implementation of foreign projects.

Equipment installation cost was estimated at 15% of the equipment costs.

Civil construction cost estimate is based on the quantities of works, type and unit rates submitted by Iranian counterpart (Appendix 2, para 13.1).

Project implementation costs includes estimated costs of the engineering, know-how fee, technical assistance, design supervision and miscellaneous work.

Contingency at 15% of the estimated costs was added in evaluation of capital requirements.

Summary estimate of the initial capital investment is shown in Table 10.1.

Table 10.1

Estimate of Initial Investment Cost

Item	Description	Capital requirements, US $ 000		
		Local	Foreign	Total
1	Major production facilities			
1.1	Equipment and materials	-	1760	1760
	with: transport	-	175	175
1.2	Equipment installation	260	-	260
	with: transport	25	-	25
1.3	Civil works	380	-	380
	Total of 1	640	1760	2400
2	Support and auxiliary facilities			
2.1	Equipment and materials	300	-	300
	with: transport	35	-	35
2.2	Equipment installation	30	-	30
	with: transport	5	-	5
2.3	Civil works	270	-	270
	Total of 2	600	-	600
3	Whole plant complex			
3.1	Equipment and materials	300	1760	2060
	with: transport	35	175	210
3.2	Equipment installation	290	-	290
	with: transport	30	-	30
3.3	Civil works	650	-	650
	Total of 3	1240	1760	3000
4	Pre-operational expenses	900	-	900
	Total of 3+4	2140	1760	3900
5	Contingency	320	265	585
	Overall	2460	2025	4485

10.2.2. Working capital

Capital requirements for the plant startup and establishment of required stocks are estimated from experience on the basis of production quanitities and costs of products at $360,000.

10.2.3. Total investment

Total capital requirement for construction of the special grade alumina plant in Iran is estimated at $4,845,000 (including contingency), with:

- equipment and material - $2,370,000;
- civil works and equipment installation - $1,080,000;
- pre-operational expenses - $1,035,000.

10.3. Project financing

In accordance with the major criteria assumptions (Appendix 2, para 12.10 - 12.11) the capital investment will be financed as follows:

30% - local funds;

70% - long-term credit (foreign - for major process equipment and materials purchase; local - for civil works and equipment installation, etc.)

Working capital will be funded from local funds (25%) and long-term credit (75%) (Appendix 2, para 14.9).

Distribution of investments by financing sources is as follows ($ 000):

a) initial capital:
- equity - 1345
- long-term foreign credit - 2025
- long-term local credit - 1115

b) working capital:
- equity - 90
- short-term local credit - 270

It was assumed that:
- dividends on equity are ignored;

- foreign credit will be granted for 5 years at 10% interest, repayment to start from the first operating year in equal installments;
- long-term local credit will be granted at 14% interest, repayment to start in 12 months after start of the plant in equal installments for 5 years (Appendix 2, para 12.10-12.11);
- short-term local credit will be granted for 1 year at 14% interest (Appendix 2, para 14.9).

10.4. Labour

In accordance with para 8.1, 8.2, 10.2, 12.4 of the major criteria assumptions (Appendix 2) estimate is made of labour requirements for production of the planned quantity of special grade alumina in this Section.

Number of the main production workers (22 persons) is calculated on the basis of the scope of the proposed equipment and operation of the plant (continuous, three 8-h shift operation).

For maintenance and small repairs of the equipment a repair crew of 7 persons is provided. It is assumed that scheduled repairs and fabrication of spare parts will be effected by special services of the plant or subcontractors.

Operating personnel of the special grade alumina plant will include an express laboratory staff (14 people) for raw material and finished product quality control.

Engineering support of the special grade alumina production technology will be provided by the plant personnel.

Management of the operating personnel for production of special grade alumina is by shift superintendent (foreman).

Thus total labour requirements are 44 persons, with 43 workers. For the manning table refer to Table 10.2.

Table 10.2

Manning Table of Special Grade Alumina Plant

Item	Profession, position	Work day	Cat.	Shift I	Shift II	Shift III	Total	Conver. factor	Man on roll
1	Foreman	8	s	-	1	-	1		1
	a) raw material preparation								
2	Filter operator	8	m.w	1	1	1	3	1.6	5
3	Pump operator	8	m.w	1	1	1	3	1.6	5
	b) calcination								
4	Calcination operator	8	m.w	1	1	1	3	1.6	5
5	Gas filter operator	8	m.w	1	1	1	3	1.6	5
6	Pneumatic system operator	8	m.w	-	1	1	2	1.17	2
	Total of main production workers			4	5	5	14	-	22
	c) maintenance								
7	Fitter	8	r.w	1	1	1	3	1.6	5
8	Electrician	8	r.w	-	1	1	2	1.19	2
	d) express laboratory								
9	Chemist	8	a.w	1	1	1	3	1.6	5
10	Crystal optic analyst	8	a.w	1	1	1	3	1.6	5
11	Lab assistant	8	a.w	-	2	-	2	1.19	2
12	Quality inspector	8	a.w	-	1	1	2	1.19	2
	Total of auxiliary workers			3	7	5	15	-	21
	Total of plant			7	13	10	30	-	44

Note: s - supervisor

m.w - main production worker

r.w - repair worker

a.w - auxiliary worker

10.5. Production costs

Production costs include the following cost items:

a) raw and other materials;

b) fuel and utilities;

c) labour cost;

d) maintenance and repair materials;

e) plant overheads;

f) administrative overheads;

g) financing costs;

h) depreciation.

10.5.1. Costs of raw materials, materials, fuel and utilities

These costs have been estimated on the basis of consumption figures shown in section 9.6 and prices of these items.

Cost of cell-grade alumina may be assumed by the average world market prices including transport charges for delivery to the plant at \$300/t, and cost of aluminium fluoride - at \$1260/t. Filter cloth cost is included in the expenses at \$2.5/m^2, compressed air - at \$0.86/1000 Nm^3 (based on power costs, power demand for production of compressed air and percentage of power cost in the total production cost of compressed air).

Costs of sulfuric acid (\$93.75/t), natural gas (\$12.5/1000 Nm^3), electric power (\$6.25/1000 kWh) and water (\$12.5/1000 m^3) were assumed in accordance with para 12.1 and 12.2 of the major criteria assumptions.

Annual costs of raw material and materials amount to \$1,102,800, fuel and utilities - \$17,200.

10.5.2. Labour costs

Average annual salary and wages of the personnel of the plant including all benefits and additives are assumed in accordance with para 12.5 of the major criteria assumptions at 2 million Reals (\$2500) for workers and 4 million Reals (\$5000) for the foreman.

The annual salary fund of the personnel is \$112,500.

10.5.3. Maintenance and repair materials

The costs in accordance with para 12.8 of the major criteria assumptions were assumed at 3% of the plant investment to amount to $134,600 per annum.

10.5.4. Overheads

In accordance with para 12.9 of the major criteria assumptions the plant overheads are assumed at 15% of the costs listed in para 5.1-5.3, which amounts to $205,100 per year, and administrative overheads (10% of the above costs including plant overheads) - $157,200 per annum.

10.5.5. Financing costs and depreciation

Costs listed in para 10.5.1-10.5.4 are the operating costs of the plant amounting to $1,729,400 per annum.

Besides, they include financing costs (interest payment on loaned capital) and depreciation.

Financing expenses were determined on the basis of the credit terms (see para 10.11, 10.12, 14.8 and 14.9 of the major criteria assumptions).

Depreciation is calculated in accordance with para 12.7 of the major criteria assumptions.

Distribution of the costs by operating years is shown in following Tables (Appendix 3).

10.6. Financial and economic figures

For calculation of the financing and economic figures to estimate the profitability of the establishment of the special grade alumina plant in the Islamic Republic of Iran the following data was assumed:

a) cost of special grade alumina for production of spark plug insulators - $1200/t;

b) construction time of the plant - 1 year;

c) operating life of the plant - 15 years;

d) plant profit tax was calculated in accordance with para 14.1 of the major criteria assumptions starting from the 5th operating year.

Tables calculated with application of COMFAR program and showing the main financial and economic figures are given in Appendix 3.

Table 10.3 shows summary of the base case estimates.

For demonstration purposes Figure 1 shows the structure of production costs of the plant, Figure 2 - breakeven point with minimal level of the capacity utilisation while maintaning profitable operation of the plant.

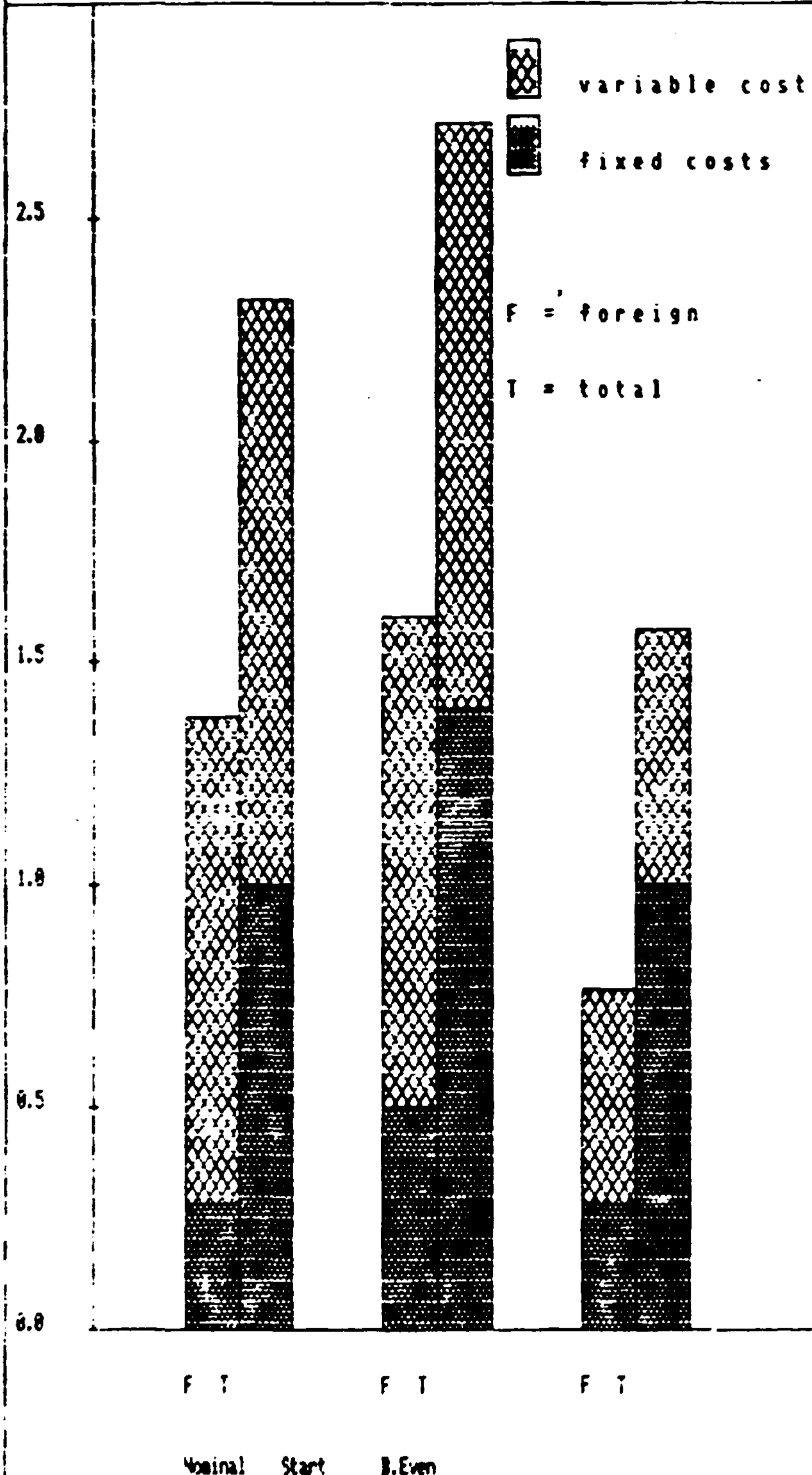
Thus, the above results indicate the high viability of the establishment of the special grade production facility in Iran for fabrication of spark plug insulators.

Structure of Production Costs

Spec.Grade Alumina Plant in Iran

10^ 3 US $ '000

for 5th production year



Nominal	Start up	
46.65	39.65	raw ma[illegible]
0.98	0.94	other [illegible]
0.00	0.00	utilit[illegible]
0.74	0.63	energy
4.86	4.15	labour
5.61	[illegible]	mainten[illegible]
0.00	0.00	spares
13.65	[illegible]	overhea[illegible]
20.85	22.80	deprec[illegible]
4.45	14.19	interes[illegible]
100.00	100.00	Total [illegible]

Fig.1. Production costs structure for special grade alumina production (5th operating year)

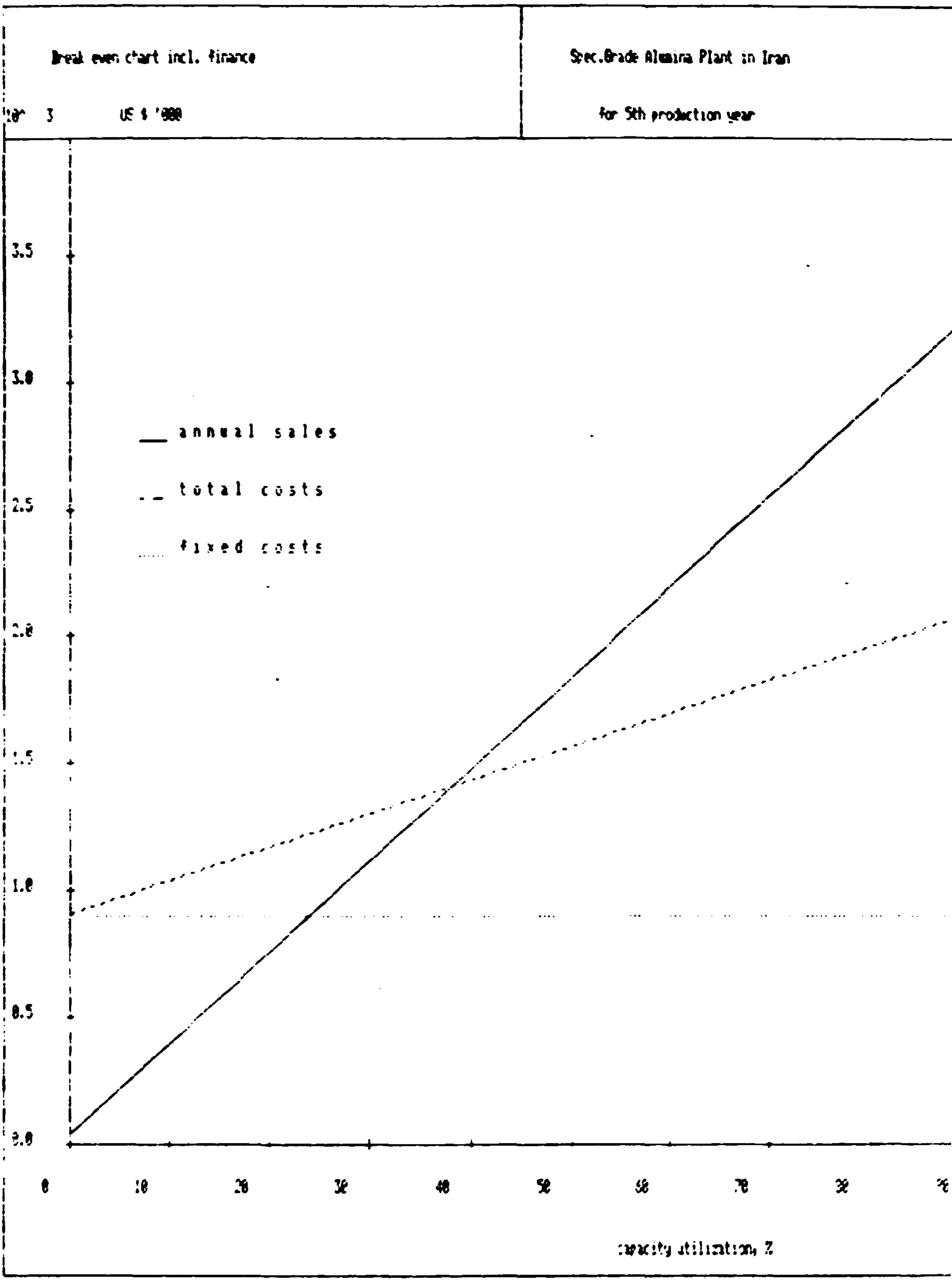


Fig.2. Breakeven point
(5th operating year)

Table 10.3

Main financial and economic figures of the project

Item	Description	Unit	Value
1	Annual output of special grade alumina	t	3000
2	Sales of annual output of finished product	$ 000	3600
3	Initial capital	$ 000	4485
	with: local funds	$ 000	1345
4	Working capital	$ 000	360
	with: local funds	$ 000	90
5	Interest during construction	$ 000	198.2
6	Total personnel	man	44
	with: workers	man	43
7	Annual labour costs	$ 000	112.5
8	Average annual production costs:		
	a) total	$ 000	2112.2
	with:		
	b) operating costs	$ 000	1729.4
	c) financing costs	$ 000	83.8
	d) depreciation	$ 000	299.0
9	Average annual plant profit:		
	- gross (para 2-8(b))	$ 000	1870.6
	- net (after tax)	$ 000	282.6
10	Payback period of initial capital with gross profit (incl. construction period)	years	3.4
11	Internal rate of return on:		
	- total capital	%	31.2
	- equity	%	55.8
12	Breakeven point	%	38
		t	1140

10.7. Sensitivity analysis

To evaluate stability of the project with respect to fluctuation of the major factors affecting its viability (special grade alumina prices, production cost and capital investment) there was provided a sensitivity analysis.

Fig. 3 shows its results with deviation of the above parameters in range from +20% to -15% from the base. It was shown that the IRR stays above the minimum permissible level (Appendix 2, para 14.13 of the major criteria assumptions) of 20% in all the considered cases except for drop in special grade alumina price by more than 10% of the preset figure.

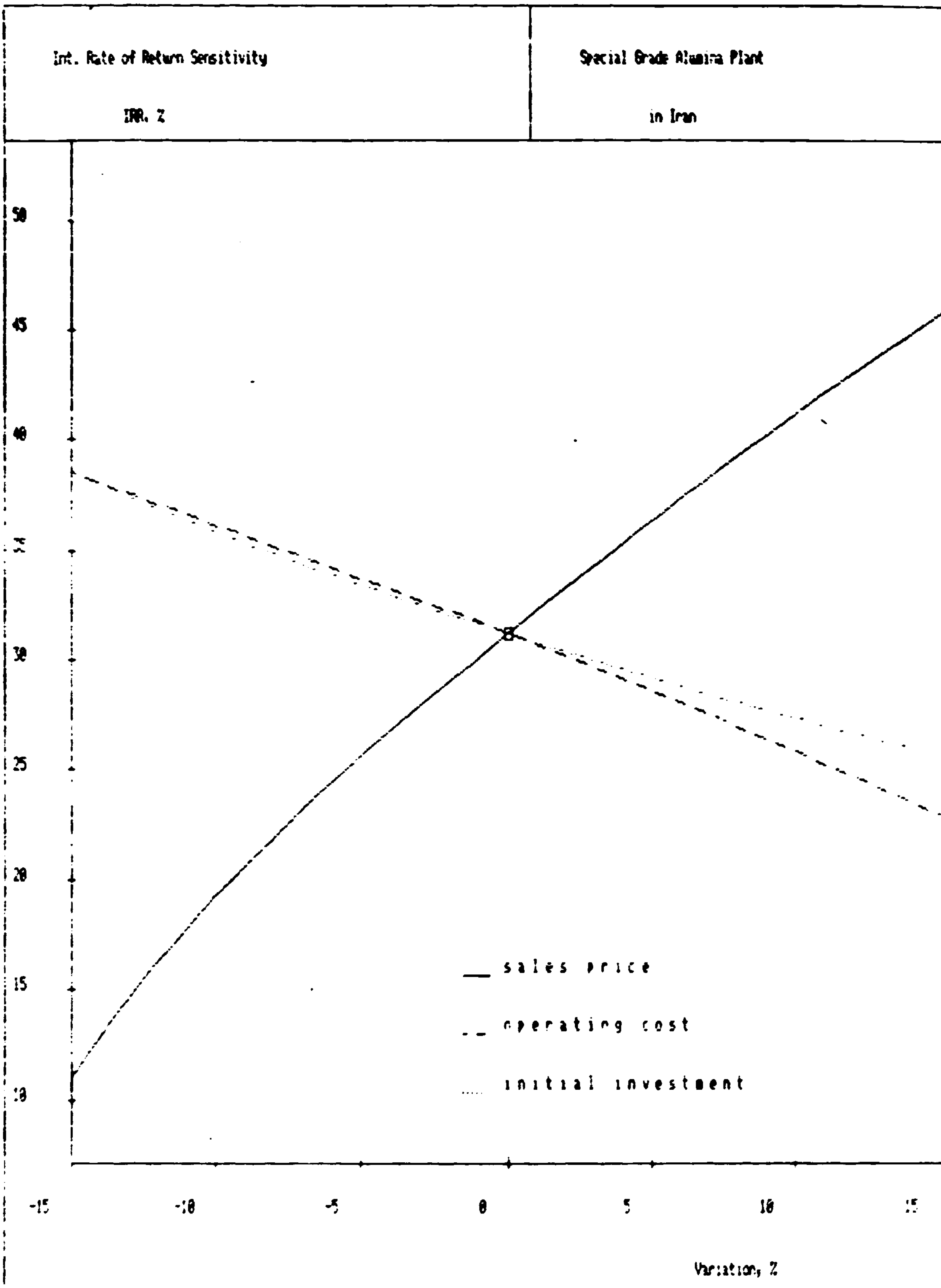


Fig.3. Internal rate of return (IRR) in function of special grade alumina prices, operating cost and capital investment

10.8. PROJECT IMPACT ON NATIONAL ECONOMY

To assess project impact on the economy of the Islamic Republic of Iran estimates of the gross domestic value added product (GDVA), net domestic value added product (NDVA), net national value added product (NNVA), and undistributed NNVA were provided.

The estimates were provided by means of the ECBA module of the COMFAR program on the basis that the plant product will replace the currently imported product.

The magnitude of GDVA is calculated as a difference between Sales revenue and Operating costs less Wages.

NDVA was calculated as a difference between GDVA and Depreciation.

The magnitude of NNVA is calculated by deducting repatriated payments from NDVA: Interest and Repayment on foreign loan.

Rate of the undistributed NNVA is calculated by deducting Labour costs, Interest on local credit and Income tax from NNVA.

For results of the calculations refer to Table 10.4. The structure of the indicators considered is shown in Fig. 4 (for the 4th operating year) and Fig. 5 (for the 6th operating year).

Thus, establishment of the special grade alumina production facility in Iran will allow accumulation of GDVA in amount of US $29.75 million, NDVA in amount of US $25.26 million, NNVA in amount of US $22.53 million, and undistributed NNVA in amount of US $6.75 million. Hence, each dollar invested in the construction of the plant will bring the NNVA in amount of US $1.5 (6.75 : 4.485).

The structure of NNVA (% of GDVA) is as follows:

GDVA	100
NDVA	85
NNVA	76
Salaries	6
Interest	2
Tax	45
Undistributed NNVA	23

Distribution of Net Domestic Value Added in US $ '000
Net Income Flow Analysis excluding indirect effects

	grand total	total constr.	total produc.	construction 1	production 2	3	4	5
gross domestic VA .	29746.50	0.00	29746.50	0.00	1623.10	1983.10	1983.10	1983.10
annual depreciation	4485.00	0.00	4485.00	0.00	596.40	546.64	512.60	493.21
net domestic VA . .	25261.50	0.00	25261.50	0.00	1026.70	1436.46	1470.50	1489.90
repatriated payments	2733.75	101.25	2632.50	101.25	607.50	567.00	526.50	486.00
wages	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
interest. f.loans	708.75	101.25	607.50	101.25	202.50	162.00	121.50	81.00
dividends. repatr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
other payments .	2025.00	0.00	2025.00	0.00	405.00	405.00	405.00	405.00
net national VA . .	22527.75	-101.25	22629.00	-101.25	419.20	869.46	944.00	1003.90
wage earners VA w	1687.50	0.00	1687.50	0.00	112.50	112.50	112.50	112.50
profit.interest VA p	735.35	85.05	650.30	85.05	182.00	156.10	124.88	93.66
government VA g	13351.75	0.00	13351.75	0.00	0.00	0.00	0.00	0.00
undistributed VA u	6753.15	-186.30	6939.45	-186.30	124.70	600.86	706.62	797.73
distribution indices								
(VA w)/VA . . .	0.07	0.00	0.07	0.00	0.27	0.13	0.12	0.11
(VA p)/VA . . .	0.03	-0.84	0.03	-0.84	0.43	0.18	0.13	0.09
(VA g)/VA . . .	0.59	0.00	0.59	0.00	0.00	0.00	0.00	0.00
(VA u)/VA . . .	0.30	1.84	0.31	1.84	0.30	0.69	0.75	0.79

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Net Income Flow Analysis excluding indirect effects

	production 6	7	8	9	10	11	12	13
gross domestic VA .	1983.10	1983.10	1983.10	1983.10	1983.10	1983.10	1983.10	1983.10
annual depreciation	[illegible]	[illegible]	[illegible]	459.08	65.33	65.33	65.33	65.33
net domestic VA . .	1500.35	[illegible]	1507.95	1524.02	1917.77	1917.77	1917.77	1917.77
repatriated payments	445.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wages	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
interest. f.loans	40.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
dividends. repatr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
other payments .	405.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
net national VA . .	[illegible]	[illegible]	[illegible]	[illegible]	1917.77	1917.77	1917.77	1917.77
wage earners VA w	112.50	112.50	112.50	112.50	112.50	112.50	112.50	112.50
profit.interest VA p	62.44	31.22	0.00	0.00	0.00	0.00	0.00	0.00
government VA g	[illegible]	[illegible]	[illegible]	1050.68	1345.99	1345.99	1345.99	1345.99
undistributed VA u	-75.61	347.12	356.83	360.54	459.28	459.28	459.28	459.28
distribution indices								
(VA w)/VA . . .	0.11	0.07	0.07	0.07	0.06	0.06	0.06	0.06
(VA p)/VA . . .	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00
(VA g)/VA . . .	0.91	0.67	0.69	0.69	0.70	0.70	0.70	0.70
(VA u)/VA . . .	-0.07	[illegible]	0.24	0.24	0.24	0.24	0.24	0.24

Distribution of Net Domestic Value Added in US $ '000
Net Income Flow Analysis excluding indirect effects

	production			
	14	15	16	17
gross domestic VA .	1983.10	1983.10	1983.10	360.00
annual depreciation	65.33	65.33	44.45	0.00
net domestic VA . .	1917.77	1917.77	1938.65	360.00
repatriated payments	0.00	0.00	0.00	0.00
wages	0.00	0.00	0.00	0.00
interest, f.loans	0.00	0.00	0.00	0.00
dividends, repatr	0.00	0.00	0.00	0.00
other payments .	0.00	0.00	0.00	0.00
net national VA . .	1917.77	1917.77	1938.65	360.00
wage earners VA w	112.50	112.50	112.50	0.00
profit,interest VA p	0.00	0.00	0.00	0.00
government VA g	1345.99	1345.99	1221.25	0.00
undistributed VA u	459.28	459.28	604.90	360.00
distribution indices				
(VA w)/VA . . .	0.06	0.06	0.06	0.00
(VA p)/VA . . .	0.00	0.00	0.00	0.00
(VA g)/VA . . .	0.70	0.70	0.63	0.00
(VA u)/VA . . .	0.24	0.24	0.31	1.00

d) plant profit tax was calculated in accordance with para 14.1 of the major criteria assumptions starting from the 5th operating year.

Tables calculated with application of COMFAR program and showing the main financial and economic figures are given in Appendix 3.

Table 10.3 shows summary of the base case estimates.

For demonstration purposes Figure 1 shows the structure of production costs of the plant, Figure 2 - breakeven point with minimal level of the capacity utilisation while maintaning profitable operation of the plant.

Thus, the above results indicate the high viability of the establishment of the special grade production facility in Iran for fabrication of spark plug insulators.

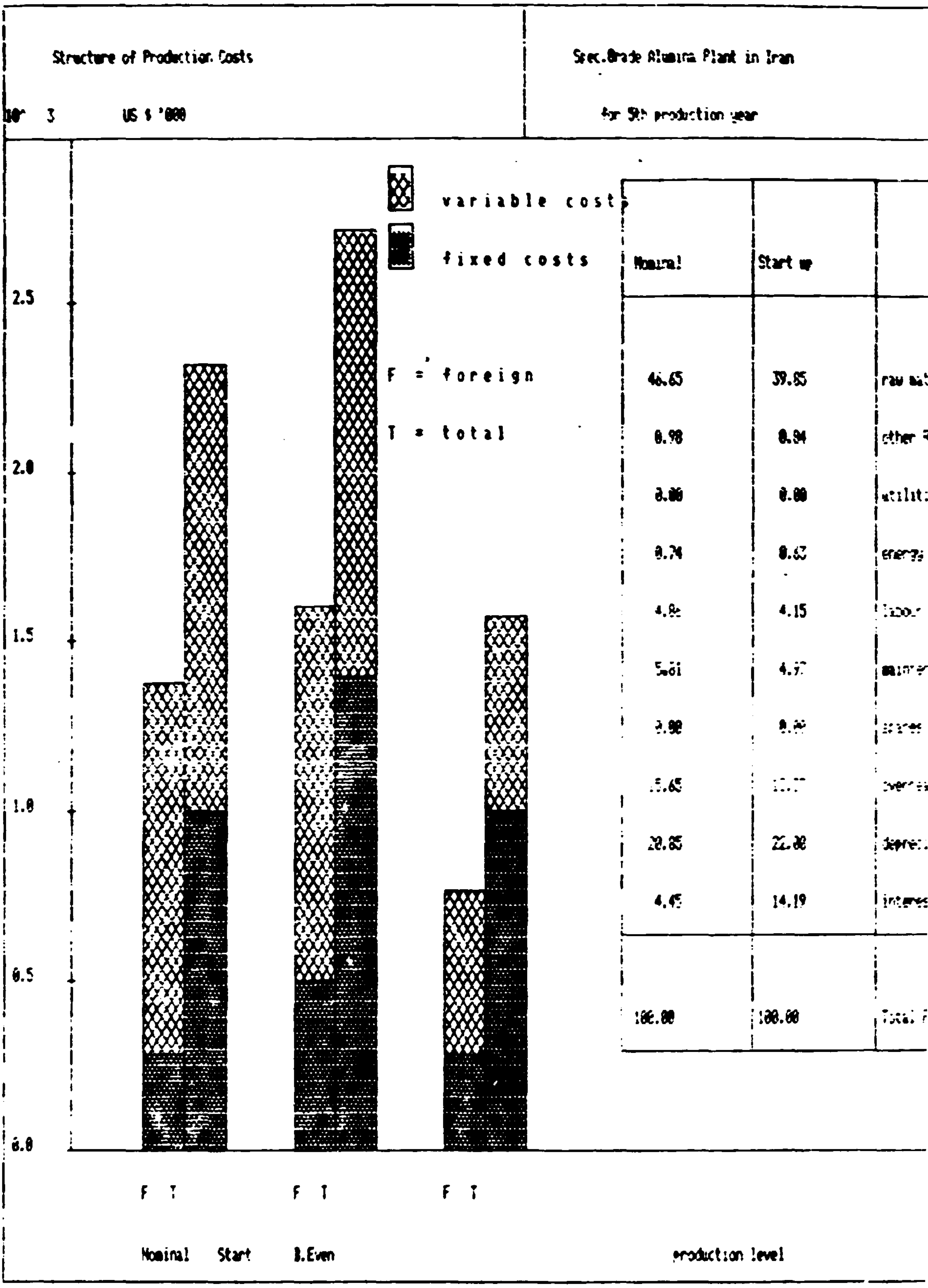


Fig.1. Production costs structure for special grade alumina production (5th operating year)

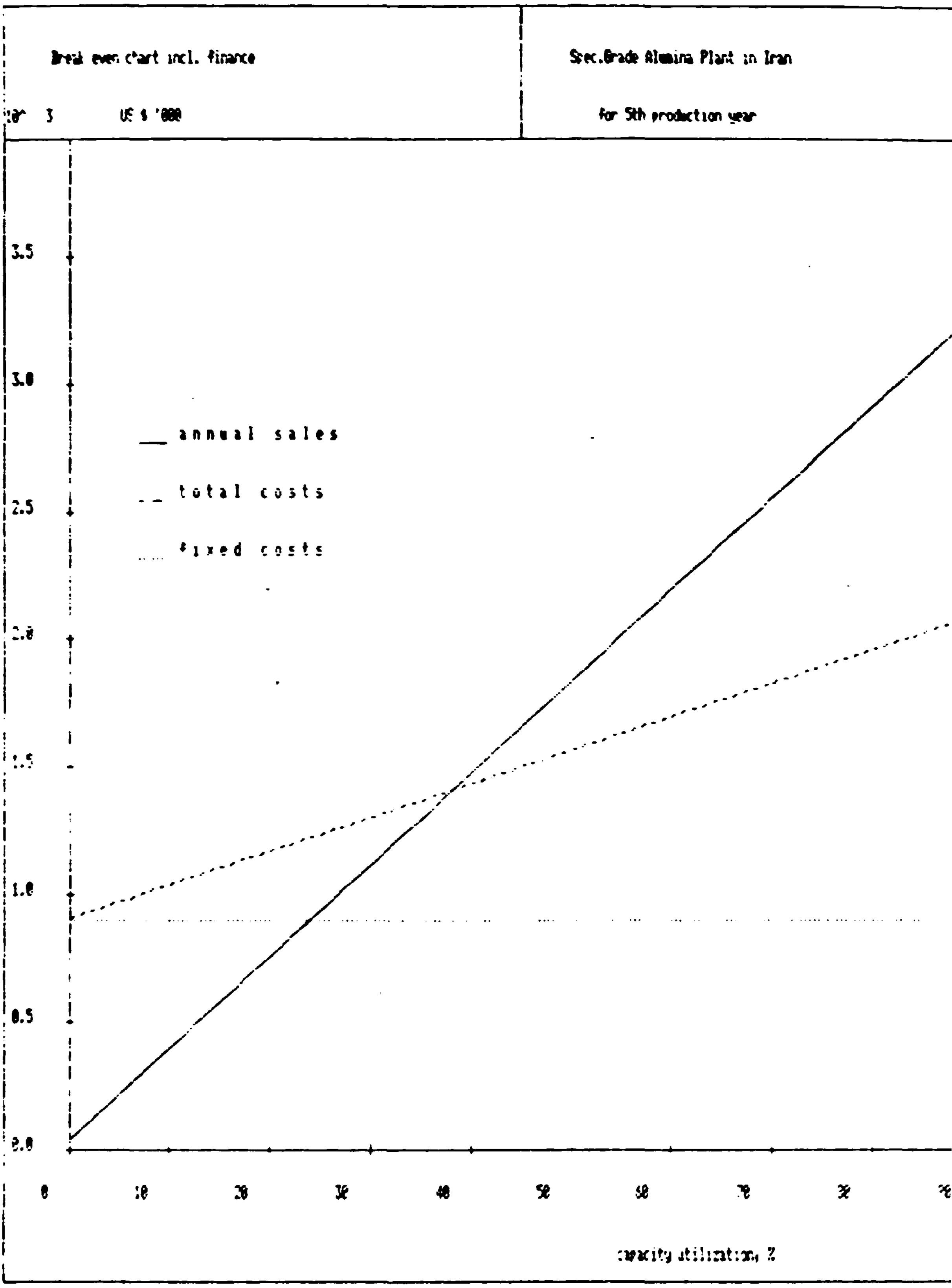


Fig.2. Breakeven point
(5th operating year)

Table 10.3

Main financial and economic figures of the project

Item	Description	Unit	Value
1	Annual output of special grade alumina	t	3000
2	Sales of annual output of finished product	$ 000	3600
3	Initial capital	$ 000	4485
	with: local funds	$ 000	1345
4	Working capital	$ 000	360
	with: local funds	$ 000	90
5	Interest during construction	$ 000	198.2
6	Total personnel	man	44
	with: workers	man	43
7	Annual labour costs	$ 000	112.5
8	Average annual production costs:		
	a) total	$ 000	2112.2
	with:		
	b) operating costs	$ 000	1729.4
	c) financing costs	$ 000	83.8
	d) depreciation	$ 000	299.0
9	Average annual plant profit:		
	- gross (para 2-8(b))	$ 000	1870.6
	- net (after tax)	$ 000	282.6
10	Payback period of initial capital with gross profit (incl. construction period)	years	3.4
11	Internal rate of return on:		
	- total capital	%	31.2
	- equity	%	55.8
12	Breakeven point	%	38
		t	1140

10.7. Sensitivity analysis

To evaluate stability of the project with respect to fluctuation of the major factors affecting its viability (special grade alumina prices, production cost and capital investment) there was provided a sensitivity analysis.

Fig. 3 shows its results with deviation of the above parameters in range from +20% to -15% from the base. It was shown that the IRR stays above the minimum permissible level (Appendix 2, para 14.13 of the major criteria assumptions) of 20% in all the considered cases except for drop in special grade alumina price by more than 10% of the preset figure.

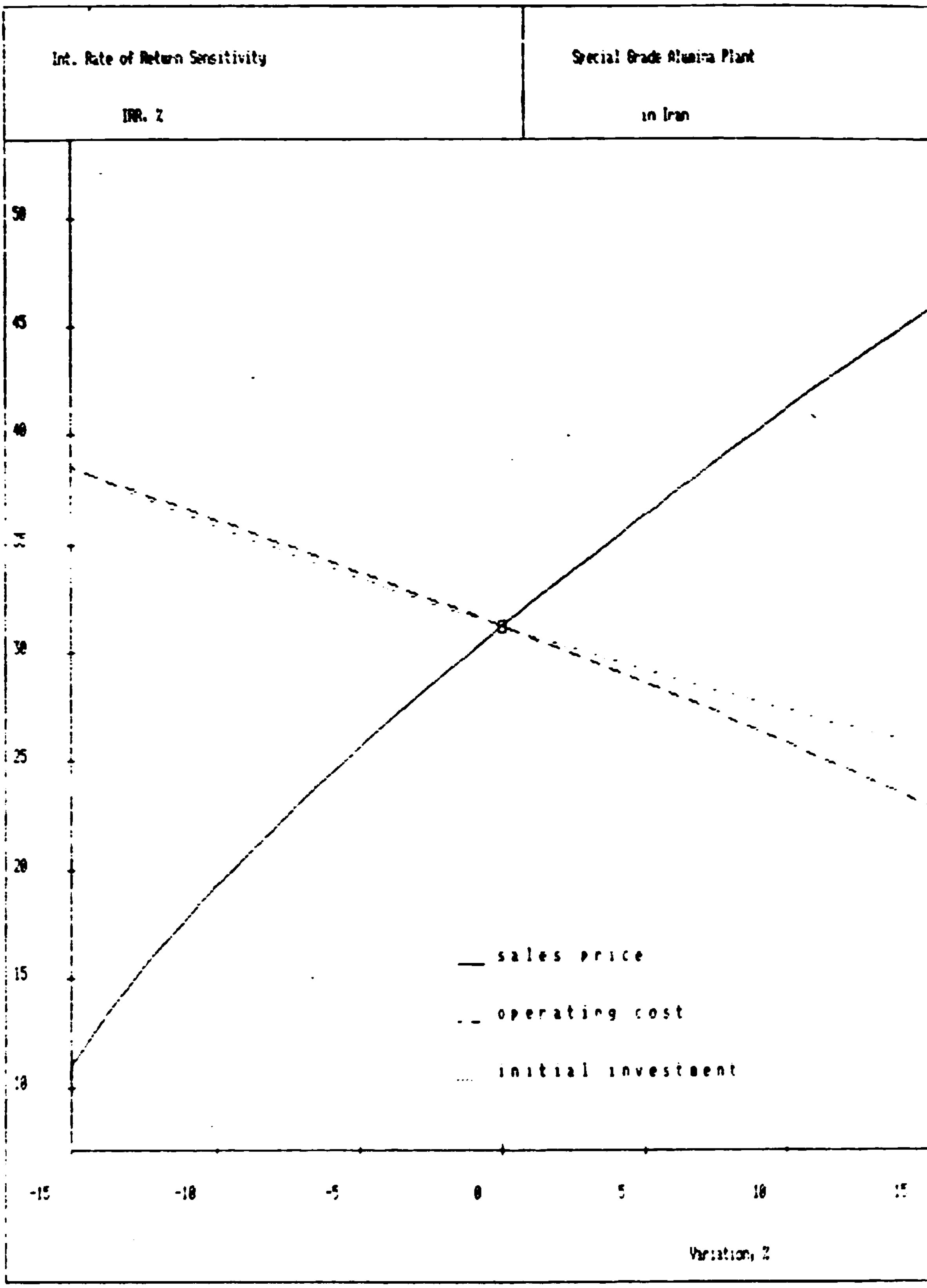


Fig.3. Internal rate of return (IRR) in function of special grade alumina prices, operating cost and capital investment

10.5. PROJECT IMPACT ON NATIONAL ECONOMY

To assess project impact on the economy of the Islamic Republic of Iran estimates of the gross domestic value added product (GDVA), net domestic value added product (NDVA), net national value added product (NNVA), and undistributed NNVA were provided.

The estimates were provided by means of the ECBA module of the COMFAR program on the basis that the plant product will replace the currently imported product.

The magnitude of GDVA is calculated as a difference between Sales revenue and Operating costs less Wages.

NDVA was calculated as a difference between GDVA and Depreciation.

The magnitude of NNVA is calculated by deducting repatriated payments from NDVA: Interest and Repayment on foreign loan.

Rate of the undistributed NNVA is calculated by deducting Labour costs, Interest on local credit and Income tax from NNVA.

For results of the calculations refer to Table 10.4. The structure of the indicators considered is shown in Fig. 4 (for the 4th operating year) and Fig. 5 (for the 6th operating year).

Thus, establishment of the special grade alumina production facility in Iran will allow accumulation of GDVA in amount of US $29.75 million, NDVA in amount of US $25.26 million, NNVA in amount of US $22.53 million, and undistributed NNVA in amount of US $6.75 million. Hence, each dollar invested in the construction of the plant will bring the NNVA in amount of US $1.5 (6.75 : 4.485).

The structure of NNVA (% of GDVA) is as follows:

GDVA	100
NDVA	85
NNVA	76
Salaries	6
Interest	2
Tax	45
Undistributed NNVA	23

Distribution of Net Domestic Value Added in US $ 1000
Net Income Flow Analysis excluding indirect effects

	grand total	total constr.	total produc.	..construction.. 1	2	production 3	4	5
gross domestic VA .	29746.50	0.00	29746.50	0.00	1623.10	1983.10	1983.10	1983.10
annual depreciation	4485.00	0.00	4485.00	0.00	596.40	546.64	512.60	493.21
net domestic VA . .	25261.50	0.00	25261.50	0.00	1026.70	1436.46	1470.50	1489.90
repatriated payments	2733.75	101.25	2632.50	101.25	607.50	567.00	526.50	486.00
wages	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
interest. f.loans	708.75	101.25	607.50	101.25	202.50	162.00	121.50	81.00
dividends. repatr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
other payments .	2025.00	0.00	2025.00	0.00	405.00	405.00	405.00	405.00
net national VA . .	22527.75	-101.25	22629.00	-101.25	419.20	869.46	944.00	1003.90
wage earners VA w	1687.50	0.00	1687.50	0.00	112.50	112.50	112.50	112.50
profit.interest VA p	735.35	85.05	650.30	85.05	182.00	156.10	124.88	93.66
government VA g	13351.75	0.00	13351.75	0.00	0.00	0.00	0.00	0.00
undistributed VA u	6753.15	-186.30	6939.45	-186.30	124.70	600.86	706.62	797.73
distribution indices								
(VA w)/VA . . .	0.07	0.00	0.07	0.00	0.27	0.13	0.12	0.11
(VA p)/VA . . .	0.03	-0.84	0.03	-0.84	0.43	0.19	0.13	0.09
(VA g)/VA . . .	0.59	0.00	0.59	0.00	0.00	0.00	0.00	0.00
(VA u)/VA . . .	0.30	1.84	0.31	1.84	0.30	0.69	0.75	0.79

Net Income Flow Analysis excluding indirect effects

	6	7	8	production 9	10	11	12	13
gross domestic VA .	[illegible]	[illegible]	1983.10	[illegible]	[illegible]	[illegible]	[illegible]	1983.10
annual depreciation	[illegible]	[illegible]	475.12	[illegible]	[illegible]	65.33	[illegible]	65.33
net domestic VA . .	[illegible]	[illegible]	1507.98	1524.02	[illegible]	1917.77	[illegible]	[illegible]
repatriated payments	445.50	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00
wages	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
interest. f.loans	40.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
dividends. repatr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
other payments .	405.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
net national VA . .	[illegible]	[illegible]	[illegible]	1524.02	[illegible]	[illegible]	[illegible]	[illegible]
wage earners VA w	[illegible]	[illegible]	112.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
profit.interest VA p	60.44	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00
government VA g	[illegible]	[illegible]	1038.65	1050.55	1345.39	1345.39	1345.39	1345.39
undistributed VA u	-75.81	347.12	356.63	360.54	459.28	459.28	459.28	459.28
distribution indices								
(VA w)/VA . . .	0.11	0.07	0.07	0.07	0.06	0.06	0.06	0.06
(VA p)/VA . . .	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00
(VA g)/VA . . .	0.91	0.67	0.69	0.69	0.70	0.70	0.70	0.70
(VA u)/VA . . .	-0.07	0.23	0.24	0.24	0.24	0.24	0.24	0.24

Distribution of Net Domestic Value Added in US $ '000
Net Income Flow Analysis excluding indirect effects

	production			
	14	15	16	17
gross domestic VA .	1983.10	1983.10	1983.10	360.00
annual depreciation	65.33	65.33	44.45	0.00
net domestic VA . .	1917.77	1917.77	1938.65	360.00
repatriated payments	0.00	0.00	0.00	0.00
wages	0.00	0.00	0.00	0.00
interest, f.loans	0.00	0.00	0.00	0.00
dividends, repatr	0.00	0.00	0.00	0.00
other payments .	0.00	0.00	0.00	0.00
net national VA . .	1917.77	1917.77	1938.65	360.00
wage earners VA w	112.50	112.50	112.50	0.00
profit.interest VA p	0.00	0.00	0.00	0.00
government VA g	1345.99	1345.99	1221.25	0.00
undistributed VA u	459.28	459.28	604.90	360.00
distribution indices				
VA w /VA . . .	0.06	0.06	0.06	0.00
VA p /VA . . .	0.00	0.00	0.00	0.00
VA g /VA . . .	0.70	0.70	0.63	0.00
VA u /VA . . .	0.24	0.24	0.31	1.00

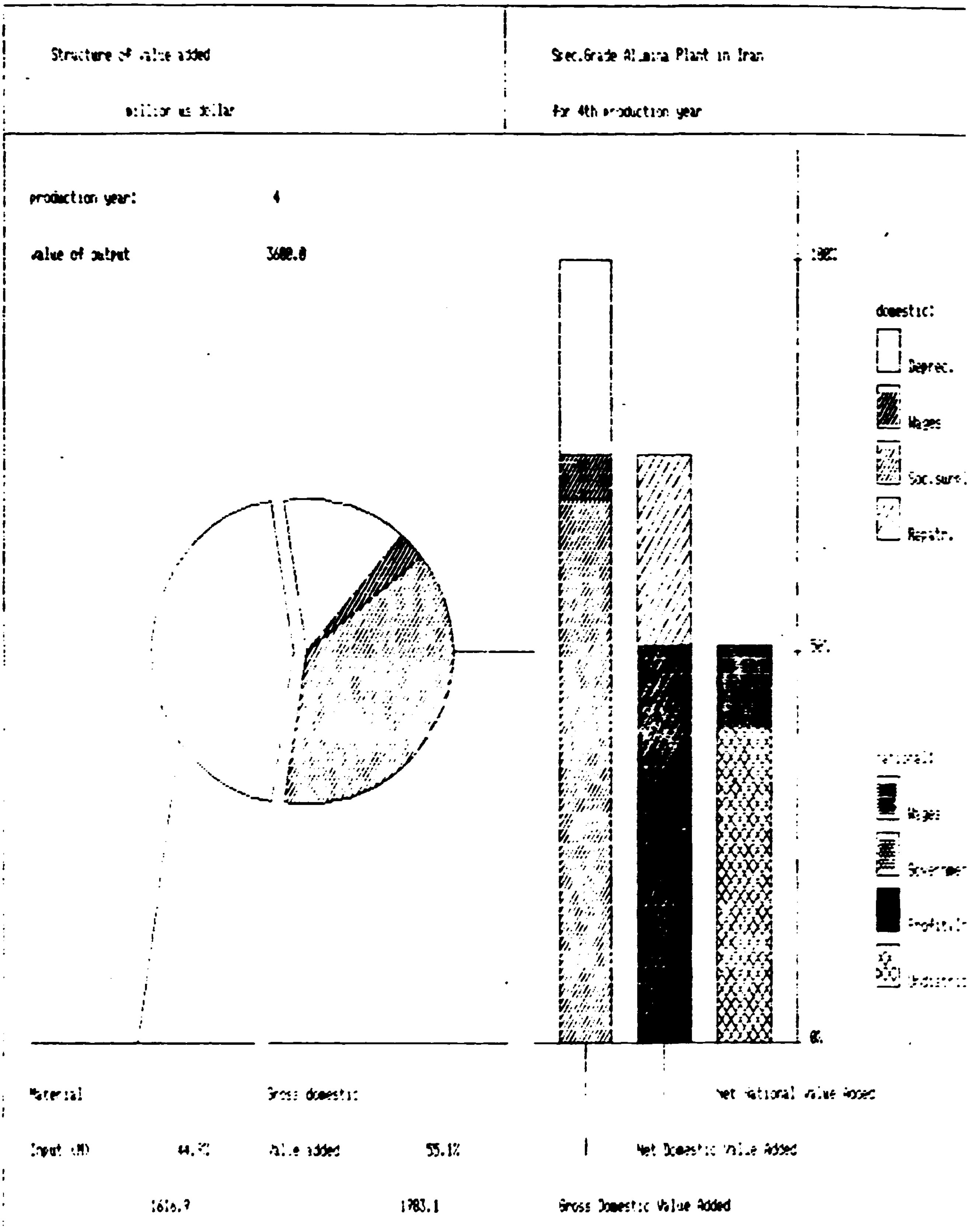


Fig.4. Structure of value added
(4th operating year)

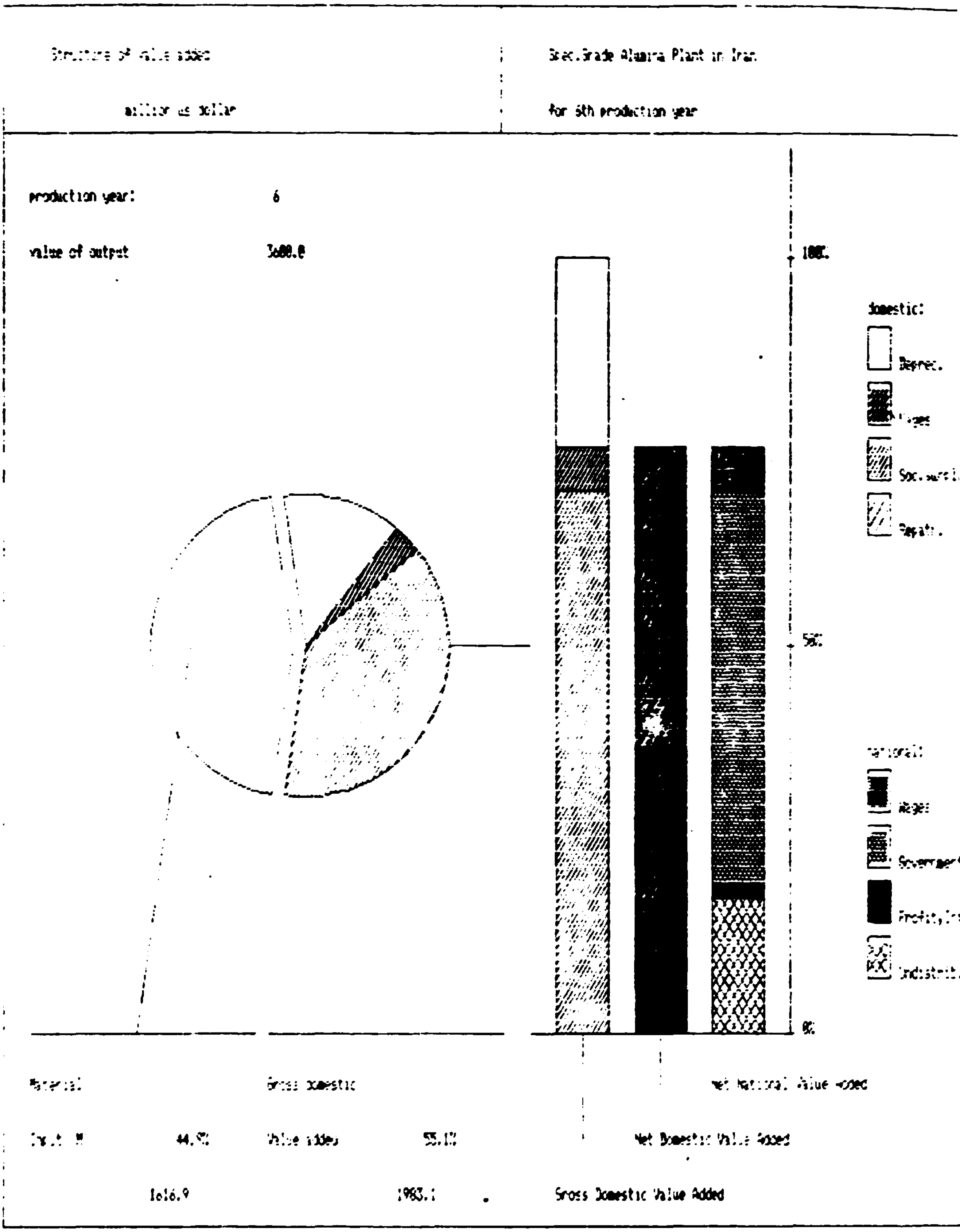


Fig.5. Structure of value added
(6th operating year)

11. CONCLUSIONS

11.1. Establishment of the production of special grade alumina for fabrication of spark plug insulators with capacity of 3000 tpy in the Islamic Republic of Iran is a beneficial, highly profitable capital investment.

11.2. With the total project capital investment of US $4,485,000 the average annual gross profit will amount to $1,870,600, which will allow payback of the initial capital in 3.4 years from start of construction.

11.3. Profitable operation of the plant is secured with production of at least 1140 tpy of special grade alumina.

11.4. Establishment of the production of special grade alumina in the Islamic Republic of Iran will allow in the future consideration of construction of the highly profitable large scale facility for meeting demand of various industries in this product and export to the international market.

12. APPENDIXES

APPENDIX 1

Memorandum

Of stay of V/O " Technoexport's " team

in Islamic Republic of Iran.

(Tehran' January 3-17 , 1991)

UNIDO Project No. XP/IRA/88/062

Contract No 88/139

Present:

From Soviet side:

Dr.S.Sorokine	Team Leader VAMI Institute
G.Kaim	Project manager VAMI Institute
A.Nemchine	Project Economist VAMI Institute
V.Glazatchev	Ceramics laboratory manager " Avtoelectronica " NPO

From Iranian side:

S.Gh.H.Khezri	Member of board. Plants Manager I.A.A.I
Sh.Mashayekhi	Member of board I.A.A.I
H.Faradj- zadeh	R.and D.Manager I.A.A.I
A.Arjangi	R.and D.Expert I.A.A.I
F.Heidarpour	Commercial Director I.A.A.I
Dr.Ing.F.Moztarzadeh	Director MERC

1. Soviet specialists visited IDRO' IAAI' MERC and had discussions on the progress of the project.
Soviet side together with Iranian side discussed the Interim - Report and the main concepts of the project concerning both special alumina and spark plugs ceramics fabrication. On the Basis of additional research data it was confirmed that alumina imported from Turkey can be considered as a good source of material for production of different types of special alumina. Soviet team has also visited IRALCO Aluminium plant in Arak as an alternative site for special alumina production.

2. According to the Contract Soviet side fabricated 50demonstration spark plugs (types W7D and W8D as per Iranian side proposition) from the sample of alumina sent by Iranianside. By the terms of Reference for the Contractor these spark plugs were to be tested in I.A.A.I. Considering the fact that Iranian side is interested mostly in spark plugs ceramics manufacturing, attention was paid to the testing of ceramic properties. Some tests were made of the quality of assembled spark plugs with the use of BOSCH equipment at IAAI plant in Qazvin.These equipment is used for assemblence quality control.But due to the fact that I.A.A.I does not have all the required facilities for spark plugs and ceramics testings it was agreed that Soviet side would made all necessary tests at "LABECO"equipment available at Autoelectronics institute in Moscow and include the test certificate into the Draft Final Report. Simultaneously Iranian side sends samples of the demonstration spark plugs to some other internationally accepted spark plugs ceramic manufacturer for testing in order to include both certificates into Draft Final Report. Contractor should get the certificate from Iranian side not later than March 4,1991.

3. During the soviet team stay Iranian side with consultations from soviet side prepared and transfered to Contractor the list of Basic initial data required for carrying out the investigations on opportunity study of special grade alumina production for spark plugs ceramic manufacturing. Initially the capacity of the plant was determined as 1000 tpy. Iranian side expressed the wish to increase the capacity of the plant due to supposed increase of demand for special alumina for spark plugs insulators manufacturing. Soviet specialists informed Iranian side that the equipment already chosen for the plant makes it possible to produce up to 3000 tpy of special alumina. Iranian side confirmed the possibility of using this quantity of special alumina for manufacturing of spark plugs insulators as well as exporting of excessive special alumina.

Both sides agreed that the economic calculations of the plant construction cost will be made by adoption that the supply of equipment will be made by soviet side.

4. Iranian side informed the soviet side that in future the demand for special alumina in Iran may inerease for the use in developing electric, refractory, microelectonics industries. Approximate demand in special alumina in Iran may be about 20000 tpy for manufacturing of different types of ceramics. Soviet side has informed Iranian side that this problem may be the subject of another contract.

5. During the discussions held in MERC Iranian side informed soviet side about it's intentions to develope the research works in the field of special alumina production. Soviet side is ready to provide a help in establishing of research work concerning this problem.

Soviet specialists express their gratitude to IAAI's management for great help in work and their worm hospitatity.

From Iranian side:	From Soviet side:
Sh. Masnayekhi	Dr. S..Sorokine 16.01.1991
Member of Board	Team leader
A. Arjangi	G. Kaim
R & D Expert	Project Manager

APPENDIX 2

Basic Initial Data
Required for carrying out the investigations
on possibility study of special Alumina
production for Insulators of Spark Plugs
in Islamic Republic of Iran.

UNIDO Project No. XP/IRA/88/062
Contract No.: 88/139

1) Region and job site.

1.1 Qazvin - Industrial Region Albors (150km West from Tehran). The Site of Spark Plugs Fabrication Plant.

1.2 Capacity of the plant - 3000 type of special alumina.

1.3 Alternative site is Arak Aluminium Plant.

1.4 To be prepared for the next stage of project.

1.5 Maximum seismisity of the region is 7.3 points of Richter seale.

1.6 See annex. 1.

1.7 The site is plane. Height at the sea level is 1000m.

1.8 To be done according to the Soviet Standards.

2) Climatic and metheorological data of region.

2.1.-2.2. Maximum temperature + 40^0C, minimum - 25^0C.

2.3 Precipitation, annual rain amounts to 300mm

2.4 relative humidity of Air: varries from 10% to 100% during the year.

2.5 Not required.

2.6 Prevailing winds - south east 120°-150°

2.7 Duration of heating season - 4 months

3) Water Supply and Sewerage

3.1 From the existing pipelines and sources of IAAI plant.

3.2 Clean

3.3 15°C

3.4 4kg/cm^2

4) Electric Power Supply

4.1 From the existing power supply sources of IAAI plant.

4.2-4.3 Not required.

4.4 380r , 50Hz , three fases current.

4.5 Not required.

5) Compressed Air and Steam Supply

5.1 It is required to install additional compressor.

5.2 Existing boiler plant.

Steam parameters: Pressure - 10kg/cm^2

Temprerature - 250°C

6. Raw Materiials, Inputs and Fuel

6.1 Alumina from Turkey (same quality as for Laboratory Tests.

6.2 AlF_3 of the same quality as used at Arak Aluminium Plant.

6.3 Natural Gas from existing pipeline alumina from Turkey, AlF_3 and H_2So_4 from the internal market.

6.4 Density : $0.65 kg/M^3$

Gross Calorific value of Gas · $10370 kcal/m^3$

Chemical composition : CH_4 - 84%

C_2H_6 - 16%

Critical point · $380.97^{\circ}c$, critical Pressure : 673.27psi.

5-7% damp.

7) Plant Layout and Transport

7.1 All kinds of Raw Materials are delivered by Lorries.

7.2 Will be needed for the next stage of project.

7.3 Not required.

8) Workforces

8.1-8.2 Necessary man power and qualified personnel are locally available.

9) Civil - Engineering Concepts

9.1-9.2 Rotary Kiln - In the open air, its hot and cold ends - in the buildings.

Foundations to be made of concrete, ribbon type,

Walls - from the Bricks,

Roofs - from Asbestos - Cement sheets

10) Organization of Repair Works

10.1 Spare parts mainly to be supplied by Iranian side form the market inside the country.

10.2 Repair service to be done by the means of IAAI plant with the help of special repair organizations.

11) Patents

11.1 Not required at the present stage.

12) Operating Costs

12.1 All prices used in calculations to be considered by the same on the 1991.01.01 in Iranian Rials. The exchang rate - 800Rials for One(1)US$. Prices for raw materials and constraction materials are shown in item 12.2(including transportation costs to the site).

12.2 To adopt the following prices for raw materials, construction materials, gas and enerergy:

- Metallugical Alumina, Rials per ton - International price
- Aluminium Flouoride , Rials per ton - International price
- Sulfuric Acid, 98%H_2So_4, per kg - Rls75.-
- Natural Gas., Rials per m^3 - Rls10.-
- Electric Power, Rials/kwt.h - Rls5.-
- Technical Water, Rials/m^3 - Rls10.-

The costs of steam, compressed air and filter cloth to be adopted by contractor's experts.

12.3 Included in prices of materials (see item 12.2).

12.4 250 working days in a year, 44 hours per week, 8 hours per shift, day-off an fridays, on thursdays-4 hours of work. Duration of leaves-30 days/ year

12.5 Average wages for workers, (2) Million Rials per year, for Engineers, (4)Million Rials per year(including all additional payments and bonesses).

12.6 Included in average wages (see item 12.5).

12.7 Fixed assets are stated at cost, after deduction of accumulated depreciation which is computed at annual rates.

Asset	Rate	Basis
Plant and building	8%	Reducing balance
Machinery	12.5%	Straight line
Transport	35%	Reducing balance

Preproduction costs to betransfered on the costs of equipment,transport and buildings and to be depreciated by the corresponsent rates.

12.8 Routin repair and maintanance of equipment and installations to be taken as (3%) of all investment costs.

12.9 Rates of administrative charges - (10%), other overheads (15%) of production costs of the plant (not including depreciation).

12.10-12.11 Duration of construction- (1) one year, start up in the beginning of the second year. (30%) of capital requirement will be covered by internal sources,(70%) - by the long term credits:

- Internal credit for civil engineering and otheer expenditures.

- External credit for bying equipment.

Volume and conditions of external (foreign) credit to be adopted by Contractor's experts.

Internal long term loan will be taken for period of 5-7 years with repayment of (14%) of interest per year. Repayment will be made by equal parts (12) months after the start-up.

12.12-12.13 Not required.

12.14 In accordance with UNIDO's Manual for preapration of feasibility study.

13) Capital Investment

13.1 For evaluation of constaruction and installation cost the following data to be adopted (in Rials):

- Steel Structures , (1)One Ton :	Rls540,000.-
- Installation of platforms and guards, One Ton:	Rls700,000.-
- Installation of steel inserts, (1)One Ton:	Rls540,000.-
- Concrete, $1m^3$	Rls13,500.-
-Concrete paving 50mm thick, $1m^2$	Rls925.-
-Brickwork of walls, $1m^3$	Rls23,500.-

13.2 See item 13.1

13.3 To be determined by Contractor's experts

13.4 Will be determined in the next stage of project

13.5 -13.8 Should be considered in item 13.3.

14) Economic Evaluation

14.1 - Demand of special alumina for spark plugs insulators will be about (3000) t/year At present Iran is importing insulators from Germany (by the price of 14 US cents/1 piece) and from Yugoslavia (11 US cents/1 piece).

14.2 (3000) ton per year.

14.3 Not less than 1200US$ per ton of special alumina.

14.4-14.5 Included in finished product price.

14.6 (15) years

14.7 Duration of construction is One year.

14.8 Interests during construction period are capitalized (added to the sum of debt) and repayed together with the total debt.

14.9 (25%) of working capital is financed by internal investments the other part of it - by the short-term loan (14% per yer).

14.10 Not required.

14.11 In IRI taxation is made in percents of the Total Net Income of Company by progressive seale:

Annual Net Income, In Million Rials		Rates of Tax (in percent)
upto	0.20	12.0
0.2	0.40	14.0
0.4	0.70	16.0
0.7	1.1	18.0
1.1	1.6	20.0
1.6	2.2	23.0
2.2	2.8	26.0
2.8	3.6	29.0
3.6	4.4	32.0
4.4	5.4	35.0
5.4	6.4	38.0
6.4	8.0	41.0
8.0	10.0	45.0
10.0	12.2	49.5
12.2	15.0	54.0
15.0	18.0	59.0
18.0	21.2	64.0
21.2	25.0	69.0
more than	25.0	75.0

Company is free from taxes during first (4) years of operation due to producidng not finished product but semy-product.

14.12 Working capital is transfered into liquidation cost.

14.13 Consideing that mean interest rate in Iranian Banks is (14%) discount rate to be adopted at the level of (20%)

15). Initial data for investiment cost to be prepared for the next stage of the project.

A.Arjangi

Research & Development expert

APPENDIX 3

TABLES

RELATING FINANCIAL AND ECONOMIC EVALUATION

Special Grade Alumina Plant in Iran
1991, February
Opportunity Study

1 year(s) of construction, [illegible] 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: US $ '000

Total initial investment during construction phase

fixed assets:	4671.30	45.517 % foreign
current assets:	0.00	0.000 % foreign
total assets:	4671.30	45.517 % foreign

Source of funds during construction phase

equity & grants:	1435.00	0.000 % foreign
foreign loans :	2025.00	
local loans :	1215.00	
total funds :	4675.00	43.316 % foreign

Cashflow from operations

Year:	1	6	12
operating costs:	1729.40	1729.40	1729.40
depreciation :	[illegible]	[illegible]	65.33
interest :	[illegible]	[illegible]	[illegible]
thereof foreign	[illegible] %	59.75 %	[illegible] %
total sales :	3600.00	3600.00	3600.00
gross income :	889.70	1356.63	1805.27
net income :	889.70	347.12	459.28
cash balance :	891.10	606.97	524.61
net cashflow :	[illegible]	561.09	524.61

Net Present Value at: 20.00 % = 1556.56
Internal Rate of Return: 31.22 %
Return on equity1: 62.83 %
Return on equity2: 55.54 %

Index of Schedules produced by COMFAR

Total Initial Investment in US $ '000

Year	1
Fixed investment costs	
Land, site preparation, development	0.00
Buildings and civil works	980.00
Auxiliary and service facilities .	0.00
Incorporated fixed assets	0.00
Plant machinery and equipment . . .	3505.00
Total fixed investment costs	4485.00
Pre-production capital expenditures.	186.30
Net working capital	0.00
Total initial investment costs . . .	4671.30
Of it foreign, in %	45.52

Total Current Investment in US $ '000

Year	[illegible]
Fixed investment costs	
Land, site preparation, development	[illegible]
Buildings and civil works	[illegible]
Auxiliary and service facilities .	[illegible]
Incorporated fixed assets	[illegible]
Plant, machinery and equipment . .	0.00
Total fixed investment costs	0.00
Preproduction capitals expenditures.	0.00
Working capital	360.00
Total current investment costs . . .	360.00
Of it foreign, %	[illegible]

[illegible] Alumina [illegible] --- [illegible], February

Total Production Costs in US $ '000

Year	2	3	4	5	6	7
% of nom. capacity (single product)	100.00	100.00	100.00	100.00	100.00	100.00
Raw material 1	1080.00	1080.00	1080.00	1080.00	1080.00	1080.00
Other raw materials	22.80	22.80	22.80	22.80	22.80	22.80
Utilities	0.00	0.00	0.00	0.00	0.00	0.00
Energy	17.20	17.20	17.20	17.20	17.20	17.20
Labour, direct	112.50	112.50	112.50	112.50	112.50	112.50
Repair, maintenance	134.60	134.60	134.60	134.60	134.60	134.60
Spares	0.00	0.00	0.00	0.00	0.00	0.00
Factory overheads	205.10	205.10	205.10	205.10	205.10	205.10
Factory costs	1572.20	1572.20	1572.20	1572.20	1572.20	1572.20
Administrative overheads	157.20	157.20	157.20	157.20	157.20	157.20
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	596.40	546.64	512.60	493.21	482.75	482.75
Financial costs	384.50	318.10	246.38	174.66	102.94	31.22
Total production costs	2710.30	2594.14	2488.38	2397.26	2315.09	2243.37
Costs per unit (single product)	0.90	0.86	0.83	0.80	0.77	0.75
Of it foreign, %	59.02	59.15	59.40	59.54	59.65	59.75
Of it variable,%	45.56	50.73	52.89	54.90	56.84	58.66
Total labour	112.50	112.50	112.50	112.50	112.50	112.50

Total Production Costs in [illegible]

Year	8	9	10-15	16
% of nom. capacity (single product)	100.00	100.00	100.00	100.00
Raw material 1	[illegible]	1080.00	1080.00	1080.00
Other raw materials	[illegible]	22.80	22.80	22.80
Utilities	0.00	0.00	0.00	0.00
Energy	17.20	17.20	17.20	17.20
Labour, direct	112.50	112.50	112.50	112.50
Repair, maintenance	134.60	134.60	134.60	134.60
Spares	0.00	0.00	0.00	0.00
Factory overheads	205.10	205.10	205.10	205.10
Factory costs	1572.20	1572.20	1572.20	1572.20
Administrative overheads	[illegible]	157.20	157.20	157.20
Indir. costs, sales and distribution	[illegible]	0.00	[illegible]	[illegible]
Direct costs, sales and distribution	0.00	0.00	0.00	0.00
Depreciation	[illegible]	459.08	55.33	44.45
Financial costs	0.00	0.00	0.00	0.00
Total production costs	2204.52	2188.48	1794.73	1773.85
Costs per unit (single product)	0.73	0.73	0.60	0.59
Of it foreign, %	60.61	60.64	61.23	61.95
Of it variable,%	59.70	60.13	73.33	74.19
Total labour	112.50	112.50	112.50	112.50

Source of Finance, construction in US $ '000

Year	1
Equity, ordinary ..	1435.00
Equity, preference.	0.00
Subsidies, grants .	0.00
Loan A, foreign .	2025.00
Loan B, foreign..	0.00
Loan C, foreign .	0.00
Loan A, local....	1115.00
Loan B, local....	100.00
Loan C, local....	0.00
Total loan	3240.00
Current liabilities	0.00
Bank overdraft	0.00
Total funds	4675.00

Source of Finance, production in US $ '000

Year	2	3	4- 6	7
Equity, ordinary ..	0.00	0.00	0.00	0.00
Equity, preference.	0.00	0.00	0.00	0.00
Subsidies, grants .	0.00	0.00	0.00	0.00
Loan A, foreign .	-405.00	-405.00	-405.00	0.00
Loan B, foreign..	0.00	0.00	0.00	0.00
Loan C, foreign .	0.00	0.00	0.00	0.00
Loan A, local....	0.00	-223.00	-223.00	-223.00
Loan B, local....	170.00	-270.00	0.00	0.00
Loan C, local....	0.00	0.00	0.00	0.00
Total loan	-235.00	-898.00	-628.00	-223.00
Current liabilities	0.00	0.00	0.00	0.00
Bank overdraft	0.00	0.00	0.00	0.00
Total funds	-235.00	-898.00	-628.00	-223.00

Cashflow Tables, construction in US $ '000

Year	1
Total cash inflow . .	4675.00
Financial resources .	4675.00
Sales, net of tax . .	0.00
Total cash outflow . .	4671.30
Total assets	4485.00
Operating costs . . .	0.00
Cost of finance . . .	186.30
Repayment	0.00
Corporate tax . . .	0.00
Dividends paid . . .	0.00
Surplus (deficit) .	3.70
Cumulated cash balance	3.70
Inflow, local	2650.00
Outflow, local	2545.05
Surplus (deficit) . .	104.95
Inflow, foreign . . .	2025.00
Outflow, foreign . . .	2126.25
Surplus (deficit) . .	-101.25
Net cashflow	-4485.00
Cum[illegible] net cashflow	[illegible]

Cashflow tables, production in US $ '000

Year	2	3	4	5	6	7
Total cash inflow . .	3770.00	3600.00	3600.00	3600.00	3600.00	3600.00
Financial resources .	170.00	0.00	0.00	0.00	0.00	0.00
Sales, net of tax . .	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00
Total cash outflow . .	2878.90	2945.50	2603.78	2532.06	3416.06	2993.13
Total assets	360.00	0.00	0.00	0.00	0.00	0.00
Operating costs . . .	1729.40	1729.40	1729.40	1729.40	1729.40	1729.40
Cost of finance . . .	384.50	318.10	246.38	174.66	102.94	31.22
Repayment	405.00	898.00	628.00	628.00	628.00	223.00
Corporate tax . . .	0.00	0.00	0.00	0.00	955.72	1009.51
Dividends paid . . .	0.00	0.00	0.00	0.00	0.00	0.00
Surplus (deficit) . .	891.10	654.50	996.22	1067.94	-183.94	606.87
Cumulated cash balance	894.80	1549.30	2545.52	3613.46	3797.40	4404.27
Inflow, local	3770.00	3600.00	3600.00	3600.00	3600.00	3600.00
Outflow, local	[illegible]	1279.60	978.32	947.16	1871.66	1894.23
Surplus (deficit) . .	[illegible]	2320.40	[illegible]	[illegible]	1728.34	1705.77
Inflow, foreign . . .	[illegible]	0.00	0.00	0.00	0.00	0.00
Outflow, foreign . . .	[illegible]	1665.90	1625.40	1584.90	1544.40	[illegible]
Surplus (deficit) . .	[illegible]	-1665.90	[illegible]	-1584.90	-1544.40	[illegible]
Net cashflow	[illegible]	[illegible]	[illegible]	[illegible]	914.58	[illegible]
Cumulated net cashflow	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Cashflow tables, production in US $ '000

Year	8	9	10	11	12	13
Total cash inflow . .	[illegible]	3600.00	[illegible]	[illegible]	3600.00	[illegible]
Financial resources .	[illegible]	0.00	[illegible]	0.00	0.00	[illegible]
Sales, net of tax . .	[illegible]	3600.00	[illegible]	[illegible]	3600.00	[illegible]
Total cash outflow . .	[illegible]	[illegible]	3075.39	3075.39	3075.39	3075.39
Total assets	[illegible]	0.00	[illegible]	0.00	0.00	0.00
Operating costs . . .	[illegible]	1729.40	[illegible]	[illegible]	1729.40	[illegible]
Cost of finance . . .	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Repayment	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Corporate tax . . .	[illegible]	[illegible]	[illegible]	[illegible]	1345.39	[illegible]
Dividends paid . . .	[illegible]	0.00	[illegible]	0.00	0.00	0.00
Surplus (deficit) . .	[illegible]	819.92	524.61	524.61	524.61	524.61
Cumulated cash balance	[illegible]	6056.14	6580.75	7105.36	7629.97	8154.58
Inflow, local	[illegible]	3600.00	3600.00	3600.00	3600.00	3600.00
Outflow, local	[illegible]	1681.18	1976.49	1976.49	1976.49	1976.49
Surplus (deficit) . .	[illegible]	1918.82	1623.51	1623.51	1623.51	1623.51
Inflow, foreign . . .	[illegible]	0.00	0.00	0.00	0.00	0.00
Outflow, foreign . . .	[illegible]	1098.90	1098.90	1098.90	1098.90	1098.90
Surplus (deficit) . .	[illegible]	-1098.90	[illegible]	-1098.90	-1098.90	-1098.90
Net cashflow	[illegible]	819.92	524.61	524.61	524.61	524.61

Cumulated net cashflow	5245.32	6065.24	6589.85	7114.46	7639.07	8163.68

Special Grade Alumina Plant in Iran --- 1991. February

Cashflow tables, production in US $ '000

Year	14	15	16
Total cash inflow	3600.00	3600.00	3600.00
Financial resources	0.00	0.00	0.00
Sales, net of tax	3600.00	3600.00	3600.00
Total cash outflow	3075.39	3075.39	2950.65
Total assets	0.00	0.00	0.00
Operating costs	1729.40	1729.40	1729.40
Cost of finance	0.00	0.00	0.00
Repayment	0.00	0.00	0.00
Corporate tax	1345.99	1345.99	1221.25
Dividends paid	0.00	0.00	0.00
Surplus (deficit)	524.61	524.61	649.35
Cumulated cash balance	8678.19	9203.80	9853.15
Inflow, local	3600.00	3600.00	3600.00
Outflow, local	1976.49	1976.49	1851.75
Surplus (deficit)	1623.51	1623.51	1748.25
Inflow, foreign	0.00	0.00	0.00
Outflow, foreign	[illegible]	[illegible]	[illegible]
Surplus (deficit)	[illegible]	[illegible]	[illegible]
Net cashflow	524.61	524.61	649.35
Cumulated net cashflow	[illegible]	[illegible]	[illegible]

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	2041.68	at	[illegible] %
Internal Rate of Return (IRR1) ..	6[illegible] %		

b) Net Worth versus Net cash return:

Net present value	2010.94	at	20.00 %
Internal Rate of Return (IRR2) ..	55.84 %		

c) Internal Rate of Return on total investment:

Net present value	1593.68	at	[illegible] %
Internal Rate of Return (IRR) ..	31.[illegible] %		

Net Worth = Equity paid plus reserves

Net Income Statement in US $ '000

Year	2	3	4	5	6
Total sales, incl. sales tax	3600.00	3600.00	3600.00	3600.00	3600.00
Less: variable costs, incl. sales tax.	1316.01	1316.01	1316.01	1316.01	1316.01
Variable margin	2283.99	2283.99	2283.99	2283.99	2283.99
As % of total sales	63.44	63.44	63.44	63.44	63.44
Non-variable costs, incl. depreciation	1009.79	960.03	925.99	906.60	896.14
Operational margin	1274.20	1323.96	1358.00	1377.40	1387.85
As % of total sales	35.39	36.78	37.72	38.26	38.55
Cost of finance	384.50	318.10	246.38	174.66	102.94
Gross profit	889.70	1005.86	1111.62	1202.74	1284.91
Allowances	0.00	0.00	0.00	0.00	0.00
Taxable profit	889.70	1005.86	1111.62	1202.74	1284.91
Tax	0.00	0.00	0.00	0.00	955.72
Net profit	889.70	1005.86	1111.62	1202.74	329.19
Dividends paid	0.00	0.00	0.00	0.00	0.00
Undistributed profit	889.70	1005.86	1111.62	1202.74	329.19
Accumulated undistributed profit	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Gross profit, % of total sales	24.71	27.94	[illegible]	33.41	35.69
Net profit, % of total sales	24.71	27.94	[illegible]	33.41	9.14
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Net Income Statement in US $ '000

Year	7	8	9	10	11
Total sales, incl. sales tax	3600.00	3600.00	3600.00	3600.00	3600.00
Less: variable costs, incl. sales tax.	1316.01	1316.01	1316.01	1316.01	1316.01
Variable margin	2283.99	2283.99	2283.99	2283.99	2283.99
As % of total sales	63.44	63.44	63.44	63.44	63.44
Non-variable costs, incl. depreciation	896.14	888.51	872.47	478.72	478.72
Operational margin	1387.85	1395.48	1411.52	1805.27	1805.27
As % of total sales	38.55	38.76	39.21	50.15	50.15
Cost of finance	31.22	0.00	0.00	0.00	0.00
Gross profit	1356.63	1395.48	1411.52	1805.27	1805.27
Allowances	0.00	0.00	0.00	0.00	0.00
Taxable profit	1356.63	1395.48	1411.52	1805.27	1805.27
Tax	1009.51	1038.65	1050.68	1345.99	1345.99
Net profit	347.12	356.83	360.84	459.28	459.28
Dividends paid	0.00	0.00	0.00	0.00	0.00
Undistributed profit	347.12	356.83	360.84	459.28	459.28
Accumulated undistributed profit	4556.22	[illegible]	[illegible]	[illegible]	[illegible]
Gross profit, % of total sales	37.68	[illegible]	[illegible]	50.15	50.15
Net profit, % of total sales	9.64	[illegible]	[illegible]	12.75	12.75
R.O.E., Net profit, % of equity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Net Income Statement in US $ '000

Year	12	13	14	15	16
Total sales, incl. sales tax	3600.00	3600.00	3600.00	3600.00	3600.00
Less: variable costs, incl. sales tax.	1316.01	1316.01	1316.01	1316.01	1316.01
Variable margin	2283.99	2283.99	2283.99	2283.99	2283.99
As % of total sales	63.44	63.44	63.44	63.44	63.44
Non-variable costs, incl. depreciation	478.72	478.72	478.72	478.72	644.14
Operational margin	1805.27	1805.27	1805.27	1805.27	1639.85
As % of total sales	50.15	50.15	50.15	50.15	45.55
Cost of finance	0.00	0.00	0.00	0.00	0.00
Gross profit	1805.27	1805.27	1805.27	1805.27	1639.85
Allowances	0.00	0.00	0.00	0.00	0.00
Taxable profit	1805.27	1805.27	1805.27	1805.27	1639.85
Tax	1345.99	1345.99	1345.99	1345.99	1221.25
Net profit	459.28	459.28	459.28	459.28	418.60
Dividends paid	0.00	0.00	0.00	0.00	0.00
Undistributed profit	459.28	459.28	459.28	459.28	418.60
Accumulated undistributed profit	6981.72	7441.00	7900.28	8359.55	8778.15
Gross profit, % of total sales	50.15	50.15	50.15	50.15	45.55
Net profit, % of total sales	12.76	12.76	12.76	12.76	11.63
ROI Net profit, % of equity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Special Grade Alumina Plant in Iran --- 1991, February

Projected Balance Sheets, construction in US $ '000

Year	1
Total assets	4675.00
Fixed assets, net of depreciation	0.00
Construction in progress	4671.30
Current assets	0.00
Cash, bank	0.00
Cash surplus, finance available .	3.70
Loss carried forward	0.00
Loss	0.00
Total liabilities	4675.00
Equity capital	1435.00
Reserves, retained profit	0.00
Profit	0.00
Long and medium term debt	3240.00
Current liabilities	0.00
Bank overdraft, finance required.	0.00
Total debt	3240.00
Equity, % of liabilities	30.7%

Projected Balance Sheets, Production in US $ '000

Year	2	3	4	5	6	7
Total assets	5329.70	5437.56	5921.18	6495.91	6197.10	6321.22
Fixed assets, net of depreciation	4074.90	3528.26	3015.65	2522.45	2039.70	1556.95
Construction in progress	0.00	0.00	0.00	0.00	0.00	0.00
Current assets	360.00	360.00	360.00	360.00	360.00	360.00
Cash, bank	0.00	0.00	0.00	0.00	0.00	0.00
Cash surplus, finance available	894.80	1549.30	2545.52	3613.46	3797.40	4404.27
Loss carried forward	0.00	0.00	0.00	0.00	0.00	0.00
Loss	0.00	0.00	0.00	0.00	0.00	0.00
Total liabilities	5329.70	5437.56	5921.18	6495.91	6197.10	6321.22
Equity capital	1435.00	1435.00	1435.00	1435.00	1435.00	1435.00
Reserves, retained profit	0.00	839.70	1895.56	3007.18	4209.91	4539.10
Profit	889.70	1055.86	1111.62	1202.74	329.19	347.12
Long and medium term debt	3005.00	2107.00	1479.00	851.00	223.00	0.00
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	3005.00	2107.00	1479.00	851.00	223.00	0.00
Equity, % of liabilities	26.92	26.39	24.24	22.09	23.16	22.70

Year	8	9	10	11	12	13
Total assets	6678.05	7038.39	7498.17	7957.44	8416.71	8876.00
Fixed assets, net of depreciation	1081.83	622.75	557.42	492.08	426.75	361.42
Construction in progress	0.00	0.00	0.00	0.00	0.00	0.00
Current assets	360.00	360.00	360.00	360.00	360.00	360.00
Cash, bank	0.00	0.00	0.00	0.00	0.00	0.00
Cash surplus, finance available	5236.22	6055.64	6580.75	7105.36	7629.96	8154.58
Loss carried forward	0.00	0.00	0.00	0.00	0.00	0.00
Loss	0.00	0.00	0.00	0.00	0.00	0.00
Total liabilities	6678.05	7038.39	7498.17	7957.44	8416.71	8876.00
Equity capital	1435.00	1435.00	1435.00	1435.00	1435.00	1435.00
Reserves, retained profit	4886.22	5243.05	5603.39	6063.17	6522.44	6981.72
Profit	356.83	360.34	459.78	459.27	459.27	459.28
Long and medium term debt	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00	0.00	0.00	0.00	0.00	0.00
Equity, % of liabilities	21.49	20.39	19.14	18.03	17.05	16.17

Projected Balance Sheets, Production in US $ '000

Year	14	15	16
Total assets	9335.28	9794.55	10213.15
Fixed assets, net of depreciation	296.08	230.75	-0.00
Construction in progress	0.00	0.00	0.00
Current assets	360.00	360.00	360.00
Cash, bank	0.00	0.00	0.00
Cash surplus, finance available	8679.19	9203.80	9853.15
Loss carried forward	0.00	0.00	0.00
Loss	0.00	0.00	0.00
Total liabilities	9335.28	9794.55	10213.15
Equity capital	1435.00	1435.00	1435.00
Reserves, retained profit	7441.00	7900.28	8359.55
Profit	459.28	459.28	418.60
Long and medium term debt	0.00	0.00	0.00
Current liabilities	0.00	0.00	0.00
Bank overdraft, finance required.	0.00	0.00	0.00
Total debt	0.00	0.00	0.00
Equity, % of liabilities	15.37	14.65	14.05

Appendix 4

CERTIFICATE OF TESTING

of trial spark plugs with insulators made of ceramic mass based on Iranian alumina

Determination of burn-off number was performed at Labeco machine of american fabrication according to method expased in the Soviet standard OST 37.003.081.87 "Spark plugs".

Testing results:

N of spark plug	Plug type	Corresponding type of Bosch (FRG)	Hot plug ignition index (arbitrary units)
21	A14DB	W8D	15.6
22	A14DB	W8D	14.7
23	A14DB	W8D	14.7
24	A14DB	W8D	14.2
25	A17DB	W7D	16.1
26	A17DB	W7D	16.7
27	A17DB	W7D	18.0
28	A17DB	W7D	17.9

Lifetime testing was performed at VAZ-21011 engine during 100 hours according to "Method of selection of ignition spark plugs for four-tact carburettor engines". The measurement of gap between electrodes was undertaken after 33,66 and 100 houes of engine operation.

Testing results:

Number of spark plug	Gap between electrodes, mm			
	Starting	After 33 hrs	After 66 hrs	After 100 hrs
25	0,65	0,66	0,66	0,67
26	0,62	0,62	0,63	0,65
27	0,62	0,63	0,63	0,64
28	0,60	0,61	0,62	0,63

Conclusion.

The trial spark plugs with insulators fabricated from ceramics made of Iranian alumina by their thermal characteristics correspond to plugs of the USSR and of FRG of similar design.

Electrodes wear during lifetime testing meets the requirements imposed on spark plugs produced in the USSR.

Chief of department

Chief of laboratory

MINUTES
OF THE DISCUSSION ON THE DRAFT FINAL REPORT
"OPPORTUNITY STUDY IN THE ESTABLISHMENT OF AN INDUSTRIAL PRODUCTION OF SPECIAL ALUMINA FOR SPARK PLUGS INSULATORS IN IRAN"
PREPARED BY NPO VAMI/VVO TECHNOEXPORT, USSR, WITHIN UNIDO PROJECT XP/IRA/88/062 AND CONTRACT 88/139

Discussions were held at UNIDO Headquarters, Vienna, from 7 - 10 October 1991.

Present were:

On behalf of IDRO, Iran:

Mr. A. Arjangi, R/D Expert
Mr. S. Mashayekhi, member of the Board

On behalf of VAMI/TECHNOEXPORT, USSR:

Mr. S. Sorokine, Technologist (Team Leader)
Mr. G. Kaim, Technologist - Designer
Mr. A. Nemchin, Economist
Mr. V. Ukrainets, Expert from TECHNOEXPORT

On behalf of UNIDO:

Mr. V. Iliev, Backstopping Officer

Issues discussed:

1. Techno-economic results of the Opportunity study

2. Recommendations for follow-up actions

Results:

The discussions brought forward the following issues:

1. The Draft Opportunity Study Report has been prepared in accordance with the Terms of Reference of the contract No. 88/139 between UNIDO and TECHNOEXPORT, USSR. The content of the report is in line with UNIDO outline and requirements for the opportunity studies. The Report reflects in full the scope of the contracting services - results of technological testings, incl. methodology, results of demonstration tests, description of technological process with financial and economic evaluation.

2. The conclusion of the Opportunity study is technically and economically justified and acceptable.

   a) The imported metallurgical grade alumina is suitable as raw material for production of special high-grade alumina for spark plugs insulators and other pruposes.

   b) The establishment of the production for special grade alumina for spark plugs insulators has proved to be technically possible and economically profitable; a 3,000 tpy production capacity will cover the local demand for spark plugs insulators and provide also some quântity for export;

3. The Opportunity study could serve as a reliable basis for taking pre-investment decision by the appropriate Iranian authorities. However for taking a final investment decision it will be advisable to carry out a full-fledge bankable techno-economic feasibility study.

Recommendations:

The participants in the dicussion agreed on the following:

1. The Final Opportunity Study Repport to be submitted within one month from the date of these Minutes should be amended as follows:

   a) More detailed description and explanation of the technological and equipment flowsheet, given schematically in the annexes;

   b) Short technical explanation regarding water sewage after alumina sulphuric acid washing and fluor content in the outgoing gases;

   c) Recommendations for grinding and separation system of the plant according to the final product application.

   d) Short justification for the use of the results from producing special alumina in laboratory scale electric furnace for engineering of calcination in industrial scale rotary kiln.

   e) Justification of suitability of final product for manufacturing spark plugs insulators by using isostatic method.

2. As a follow-up (Phase II), a technical assistance project will be necessary to carry out a full techno-economic feasibility study for the establishment of an industrial production plant of special alumina for spark plugs in Iran. For this purpose the Iranian side will send through appropriate channels to UNIDO an official request with proposal for financing on the base of which the relevant project document will be prepared for consideration and approval. The request is recommended to be sent within the next two months.

3. For the elaboration of the feasibility study additional technological tests should be carried out with samples from at least three other potential sources of supply of metallurgical grade alumina.

4. The production capacity of the plant for the feasibility study is recommended to be 3,000 tpy; the location of the plant at Ghazvin (nearby production of spark plugs), and the approximate duration of Phase II - approximately 12 months.

It was also agreed that the Iranian side will send additional 2kg sample of metallurgical alumina to be processed by using acid washing method at VAMI/Institute for production of special grade alumina. The produced special alumina will be returned to Teheran for further testing.

During the discussion of the Draft Opportunity study report, the Subcontractor's representatives answered all questions raised by the Iranian specialists and gave them additional technical explanations regarding the production of special grade alumina.

IDRO and UNIDO participants expressed their full satisfaction for the positive results of the work carried out by the Subcontractor VAMI/TECHNOEXPORT.

Vienna, UNIDO, 10 October 1991

Signed by:

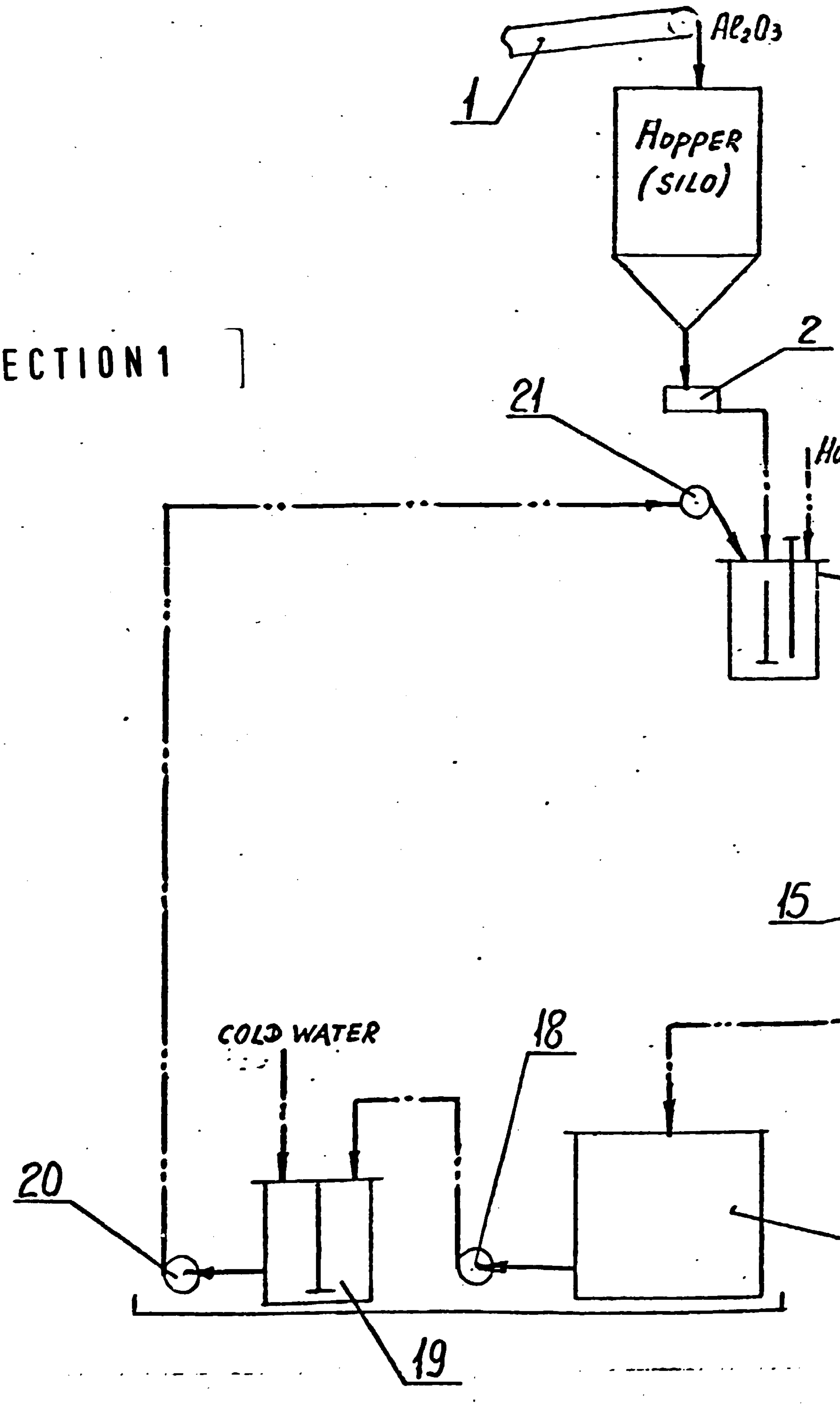
V. Ukrainets

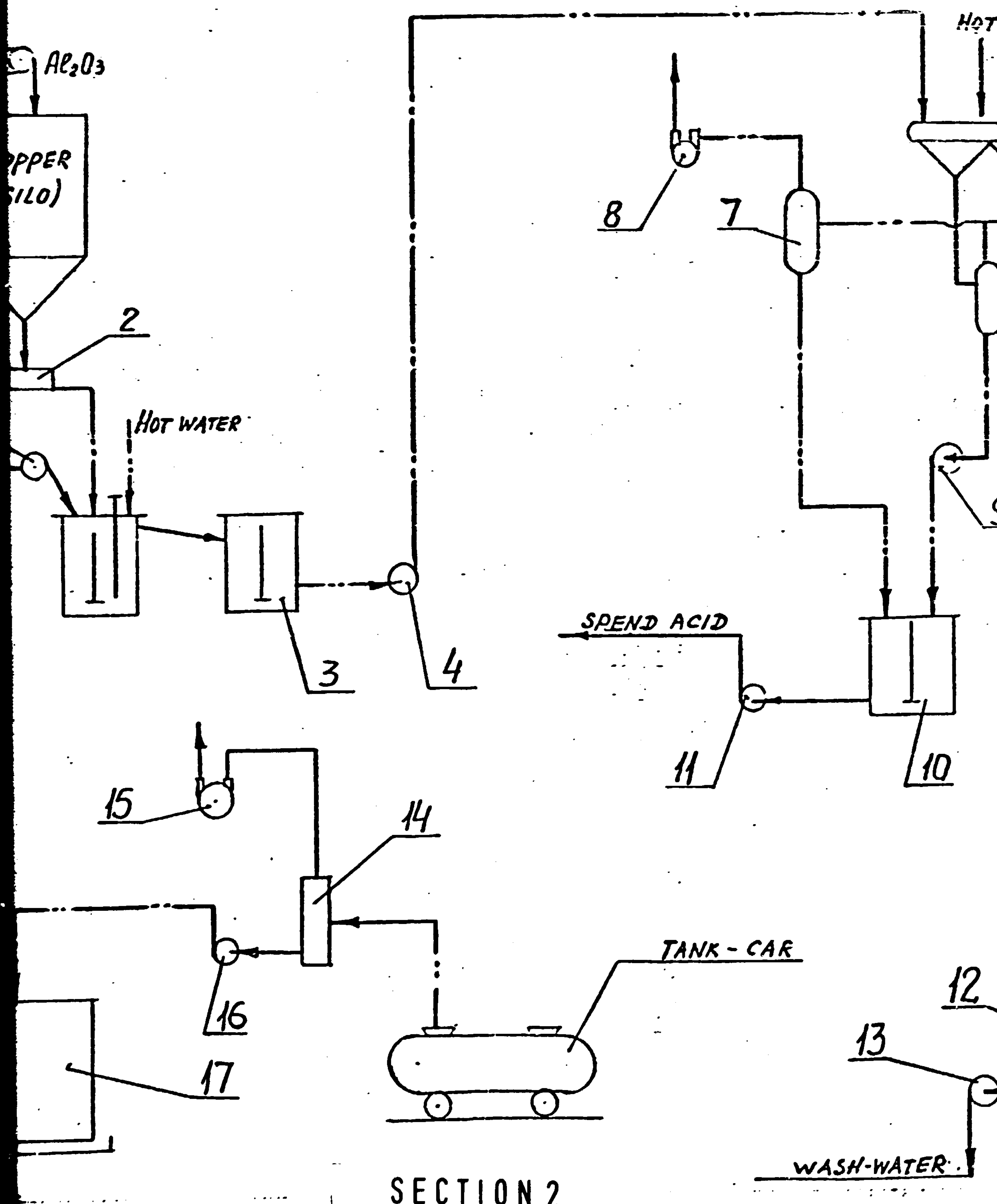
A. Ariangi and S. Mashayekhi
On behalf of IDRO

S. Sorokine
On behalf of VAMI/TECHNOEXPORT

V. Iliev, IDO/IO/T/MET
On behalf of UNIDO

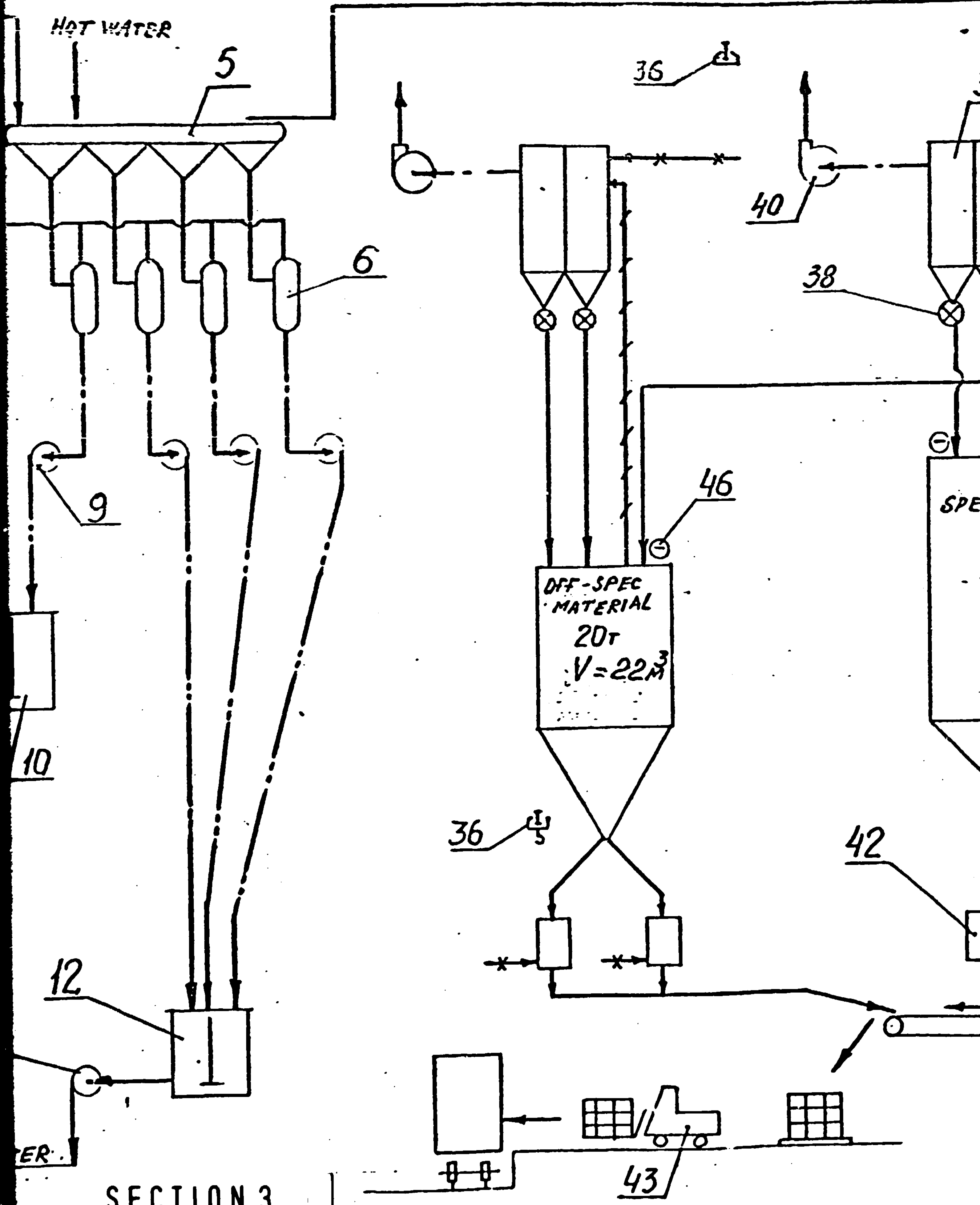
SECTION 1





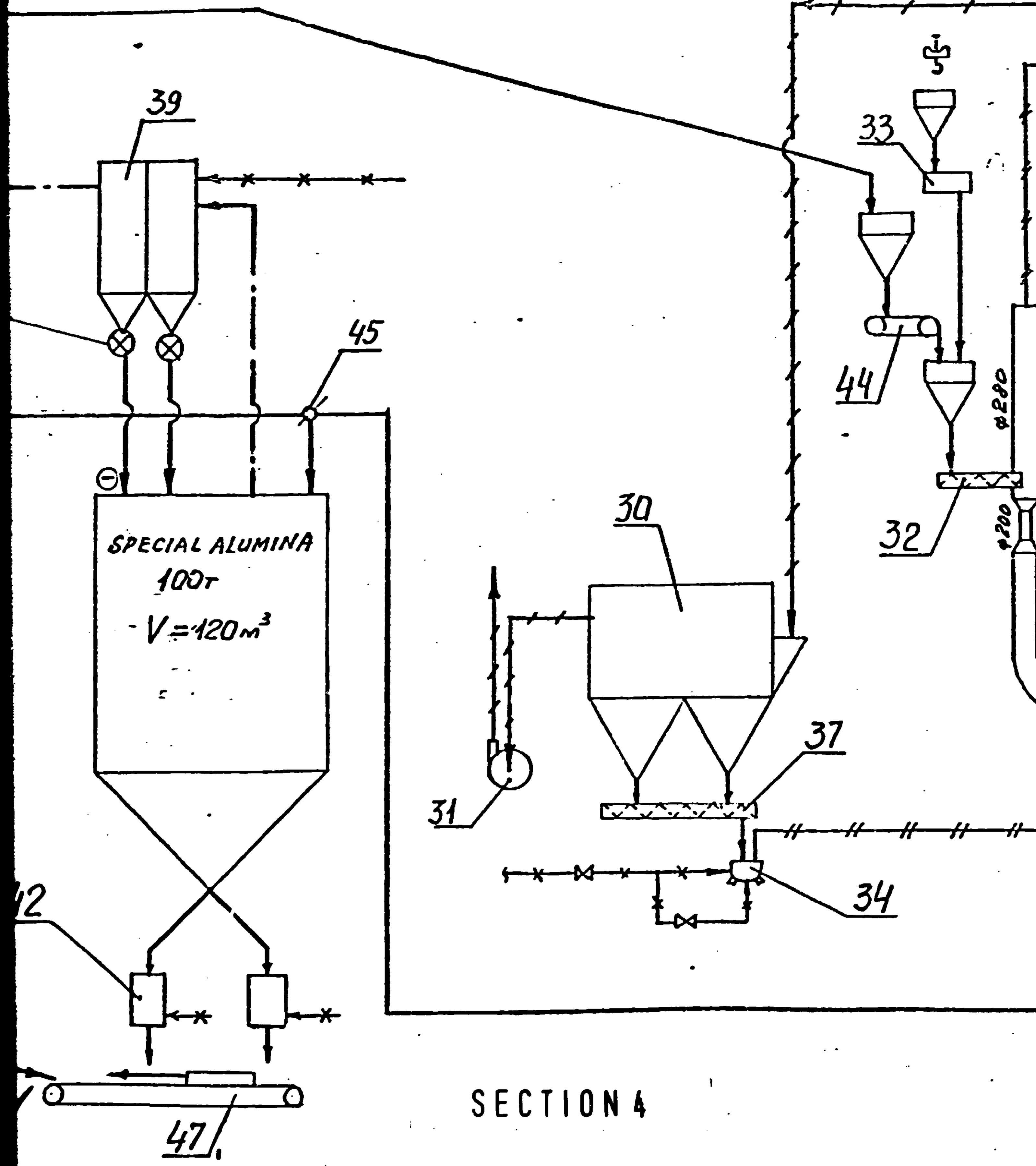
Al_2O_3
PPER
SILO)
HOT WATER
HOT
SPEND ACID
TANK - CAR
WASH-WATER
2
3
4
7
8
10
11
12
13
14
15
16
17

SECTION 2



HOT WATER
5
6
9
10
12
ER
36
40
38
46
OFF-SPEC MATERIAL
20T
V=22M3
SPE
36
42
43

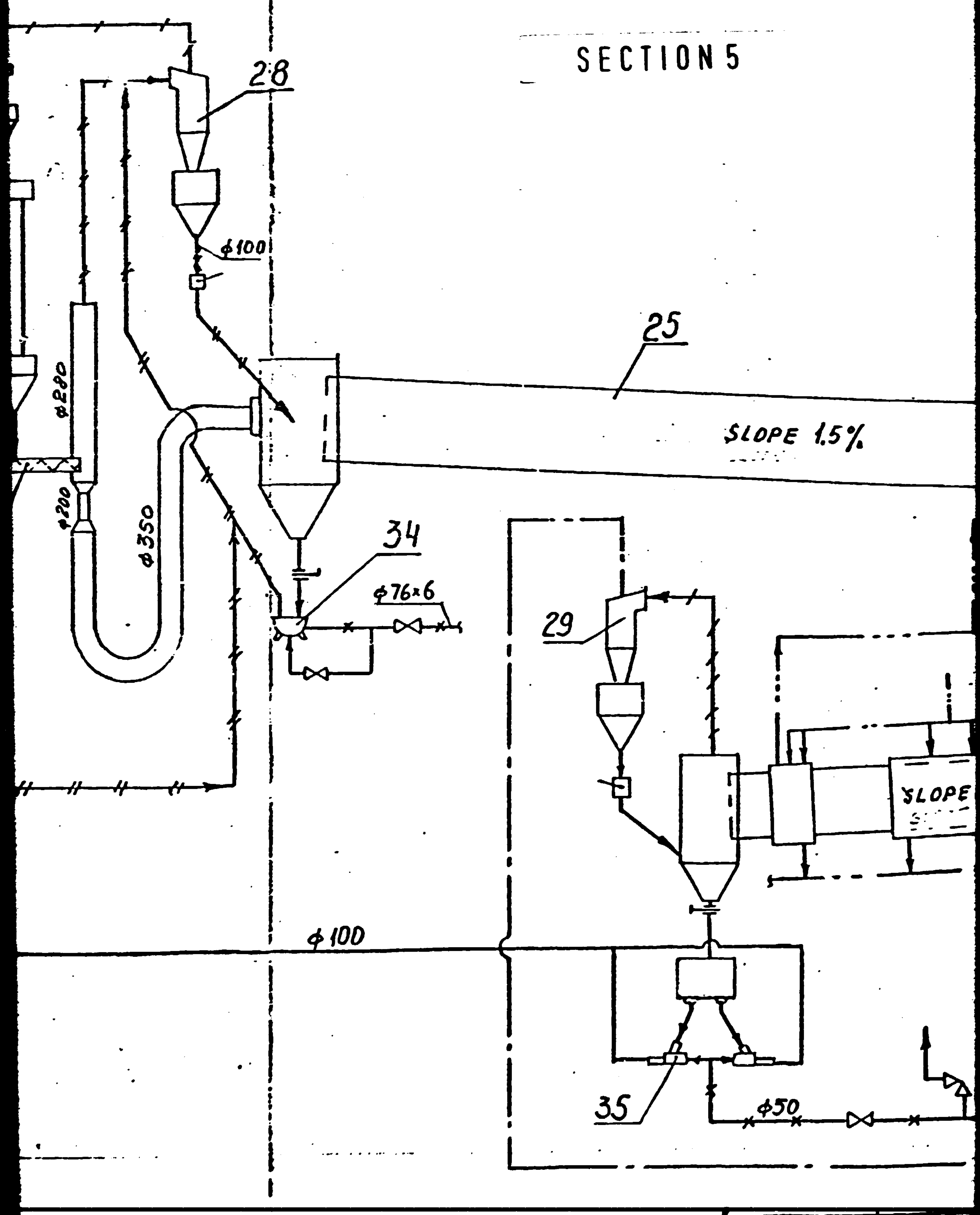
SECTION 3

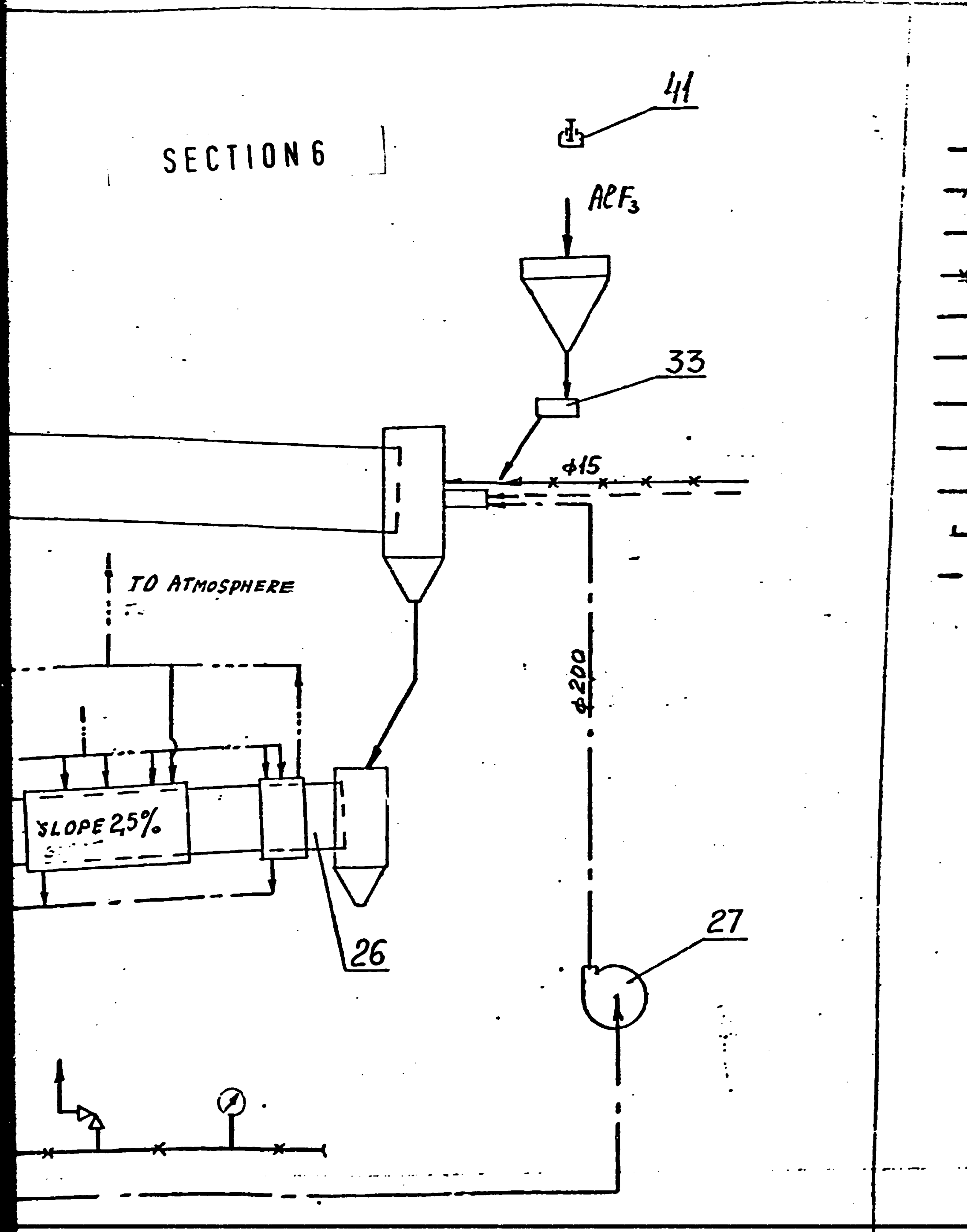


39
45
SPECIAL ALUMINA
100т
V=120m³
33
44
32
ф280
ф200
30
31
37
34
42
47

SECTION 4

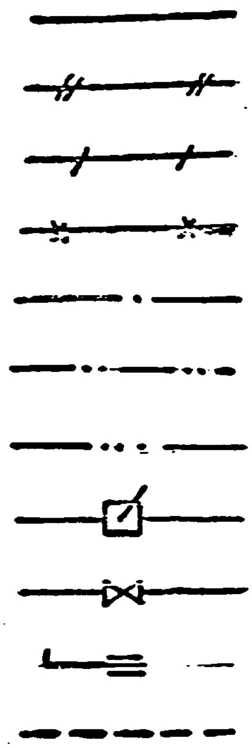
SECTION 5





SECTION 6
41
AlF3
33
ϕ15
TO ATMOSPHERE
ϕ200
SLOPE 2,5%
26
27

LEGEND



- MATERIAL
- RECYCLE DUST
- OFF-GASES
- COMPRESSED AIR
- AIR
- WATER, SLURRY
- STEAM
- FLAP VALVE
- VALVE
- DISK GATE
- NATURAL GAS

SER. №	DESCRIPTION
38	ROTARY AIRLOCK FEEDER
39	BAG FILTER
40	FAN
41	ELECTRIC HOIST
42	BAGGING MACHINE
43	ELECTRIC FORK TRUCK
44	METERING FEEDER FOR BULK MATERIAL
45	TWO-WAY DIVERTER VALVE
46	RUPTURE DISK
47	BELT CONVEYOR

SECTION 7

N	TECH. DATA	Q-TY	REMARK
CK FEEDER	ϕ150MM	4	
ER	$S = 60 M^2$	2	
	$Q=3500 \div 4800 M^3/HR$; $H=2.2 kPa$	2	
HOIST	$G = 3,2 T$	2	
ACHINE	$Q = 200$ BAGS/HR	4	
RK TRUCK	$G = 3T$	2	
FEEDER TERIAL	$Q = 0,2 \div 2$ T/HR	1	
DIVERTER	ϕ100 MM	1	
DISK	ϕ600 MM	2	
VEYOR	B = 650 MM	1	

No	DESCRIPTION
17	TANK
18	CENTRIFUGAL PUMP
19	AGITATOR
20	CENTRIFUGAL PUMP
21	METERING FEEDER
25	ROTARY KILN
26	DRUM COOLER
27	FAN
28	CYCLONE
29	CYCLONE
30	ELECTROSTATIC PRECIPITATOR
31	I.D. FAN
32	SCREW FEEDER
33	WEIGH FEEDER
34	PNEUMATIC TRANSPORT UNIT
35	JET PUMP
36	ELECTRIC HOIST
37	SCREW CONVEYOR

SECTION 8

	TECH. DATA	Q-TY	REMARK
	$\phi 4,5 \times 4,5 M$	1	
PUMP	$Q=8 M^3/HR$; $H=30 M$	1	
	$V=2 M^3$; $N=3 KVT$	1	
UMP	$Q=8 M^3/HR$; $H=30 M$	1	
EEDER	$Q=0,1 M^3/HR$	1	
LN	$\phi 1600$ MM; $L=20 M$	1	
R	$\phi 1200$ MM; $L=16 M$	1	
	$Q=1000 M^3/HR$; $H=5 \div 6$ KPa	1	
	$\phi 600$ MM	1	
	$\phi 400$ MM	1	
C R	$Q=10000 M^3/HR$; $t=350°C$	1	
	$Q=10000 M^3/HR$; $H=3 \div 3,5$ KPa	1	
DER	$\phi 200$ MM	1	
R	$Q=0,4 \div 2$ KG/HR	2	
NSPORT	$Q=3 T/HR$; $\phi 100$ MM	2	
	$Q=3 T/HR$; $\phi 100$ MM	2	
T	$G=1 T$	1	
YOR	$\phi 200$ MM	1	

SER. No	DESCRIPTION	TE
1	CONVEYOR	
2	SCREW FEEDER	
3	AGITATOR	
4	CENTRIFUGAL PUMP	Q=8
5	BELT FILTER	
6	RECEIVER	
7	TRAP	
8	VACUUM PUMP	Q=12
9	CENTRIFUGAL PUMP	Q=8
10	AGITATOR	
11	CENTRIFUGAL PUMP	Q=8
12	AGITATOR	
13	CENTRIFUGAL PUMP	Q
14	RECEIVER	
15	VACUUM PUMP	Q=12
16	CENTRIFUGAL PUMP	Q=

SECTION 9

13.

ISLAMIC

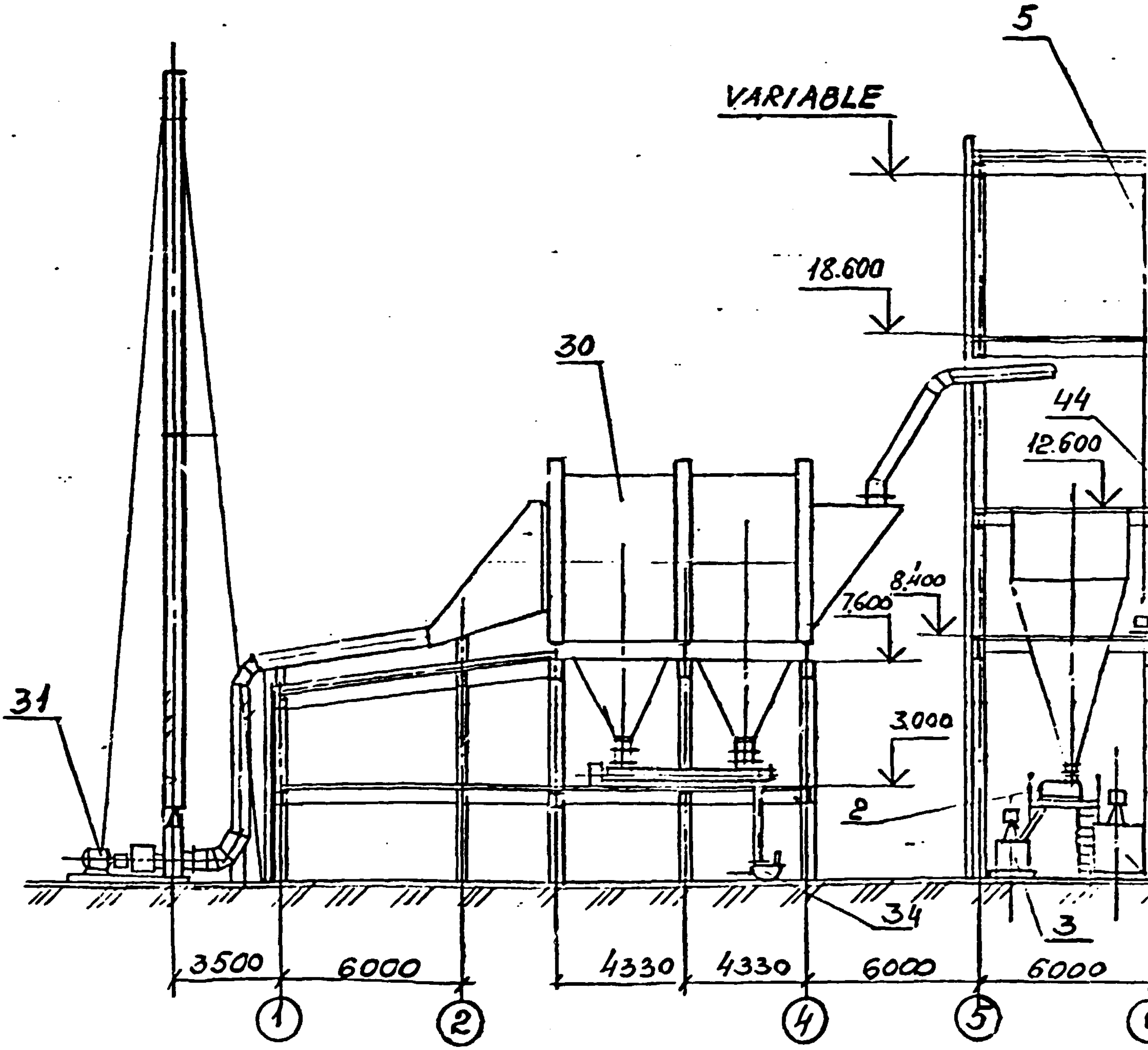
PRODUCTION OF
MINA FOR SPA
INSULATOR

EQUIPMENT

REMARK	No	DESCRIPTION	TECH. DATA	Q-TY	REMARK
	1	CONVEYOR	B = 400 MM	1	
	2	SCREW FEEDER	ϕ 160 MM	1	
	3	AGITATOR	V = 1 M^3; N=1,5 KW	2	
	4	CENTRIFUGAL PUMP	Q=8 M^3/HR ; H=30 M	1	
	5	BELT FILTER	1,8 M^2	1	
	6	RECEIVER	V = 1 M^3	4	
	7	TRAP	V = 0,4 M^3	1	
	8	VACUUM PUMP	Q=12 NM^3/MIN; H=30 kPa	1	
	9	CENTRIFUGAL PUMP	Q=8 M^3/HR; H=30 M	4	
	10	AGITATOR	V = 2 M^3; N=3 KW	1	
	11	CENTRIFUGAL PUMP	Q=8 M^3/HR; H=30 M	1	
	12	AGITATOR	V = 2 M^3; N=3 KW	1	
	13	CENTRIFUGAL PUMP	Q=8 M^3/HR; H=30 M	1	
	14	RECEIVER	ϕ 500 × 6 M	1	
	15	VACUUM PUMP	Q=12 NM^3/MIN; H=30 kPa	1	
	16	CENTRIFUGAL PUMP	Q= 40 M^3/HR; H=12 M	1	

SECTION 10

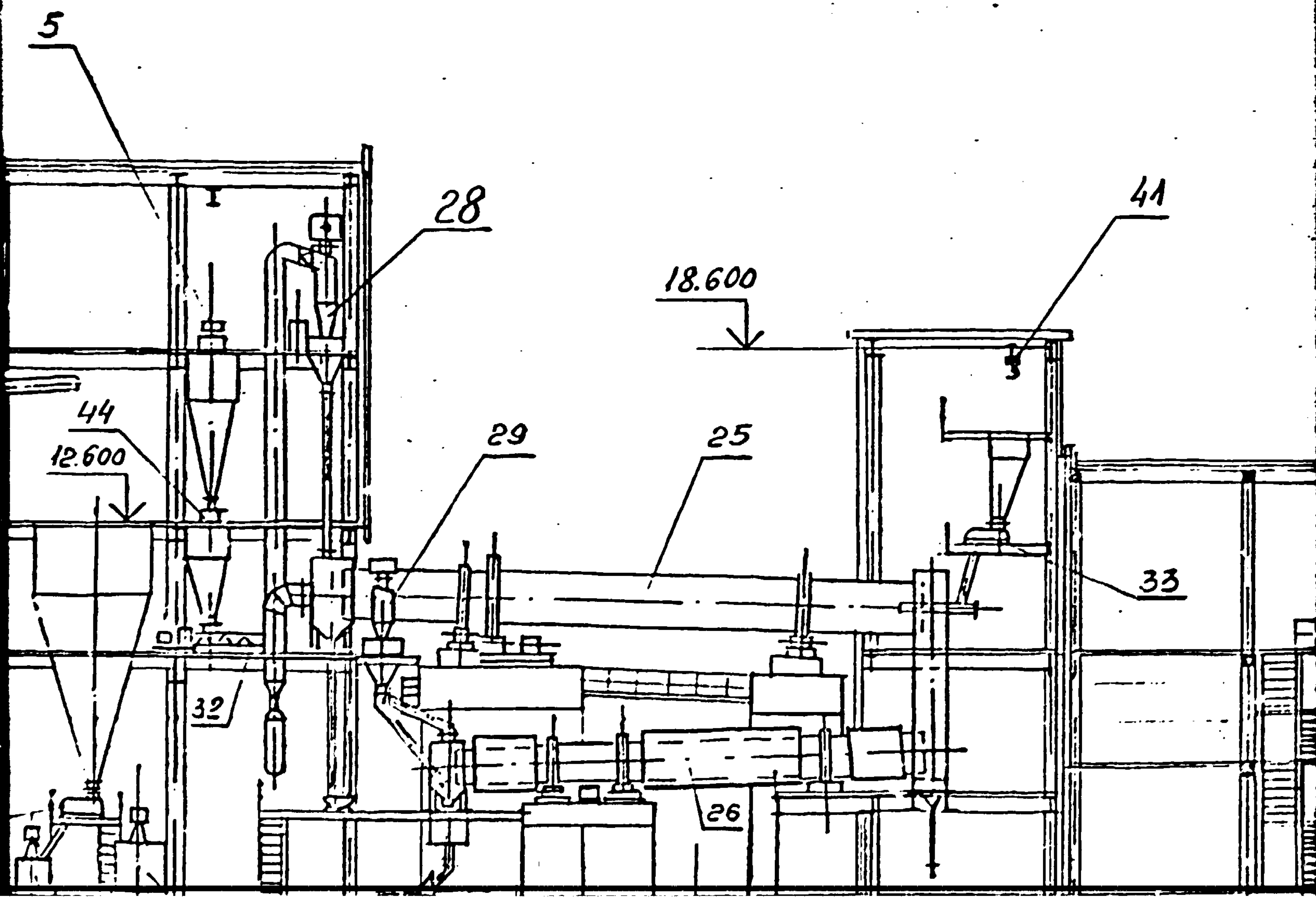
THIS DRAWING IS NOT TO BE REPRODUCED OR TRANSFERRED TO OTHER ORGANIZATIONS OR PERSONS WITHOUT AGREEMENT WITH YAMI	1398860 - TM			
	ISLAMIC REPUBLIC OF IRAN			
	PRODUCTION OF SPECIAL ALUMINA FOR SPARK PLUG INSULATORS	PHASE	SHEET	SHEETS
		·	1	3
	[illegible]	YAMI		

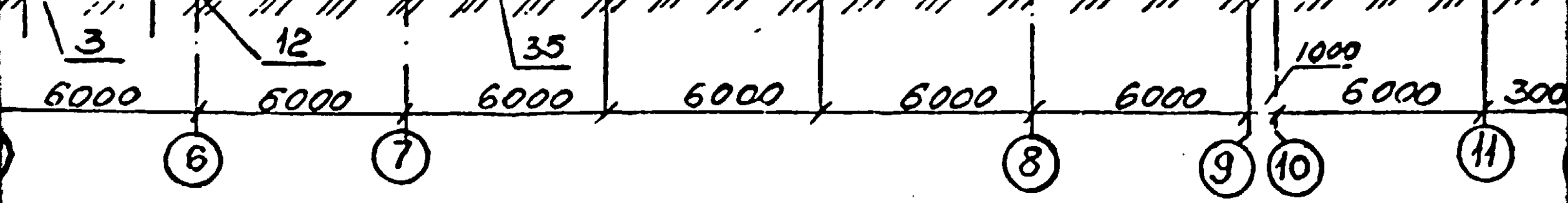


5
VARIABLE
18.600
30
44
12.600
8.400
7.600
3.000
31
2
34
3
3500
6000
4330
4330
6000
6000
1
2
4
5

SECTION 1

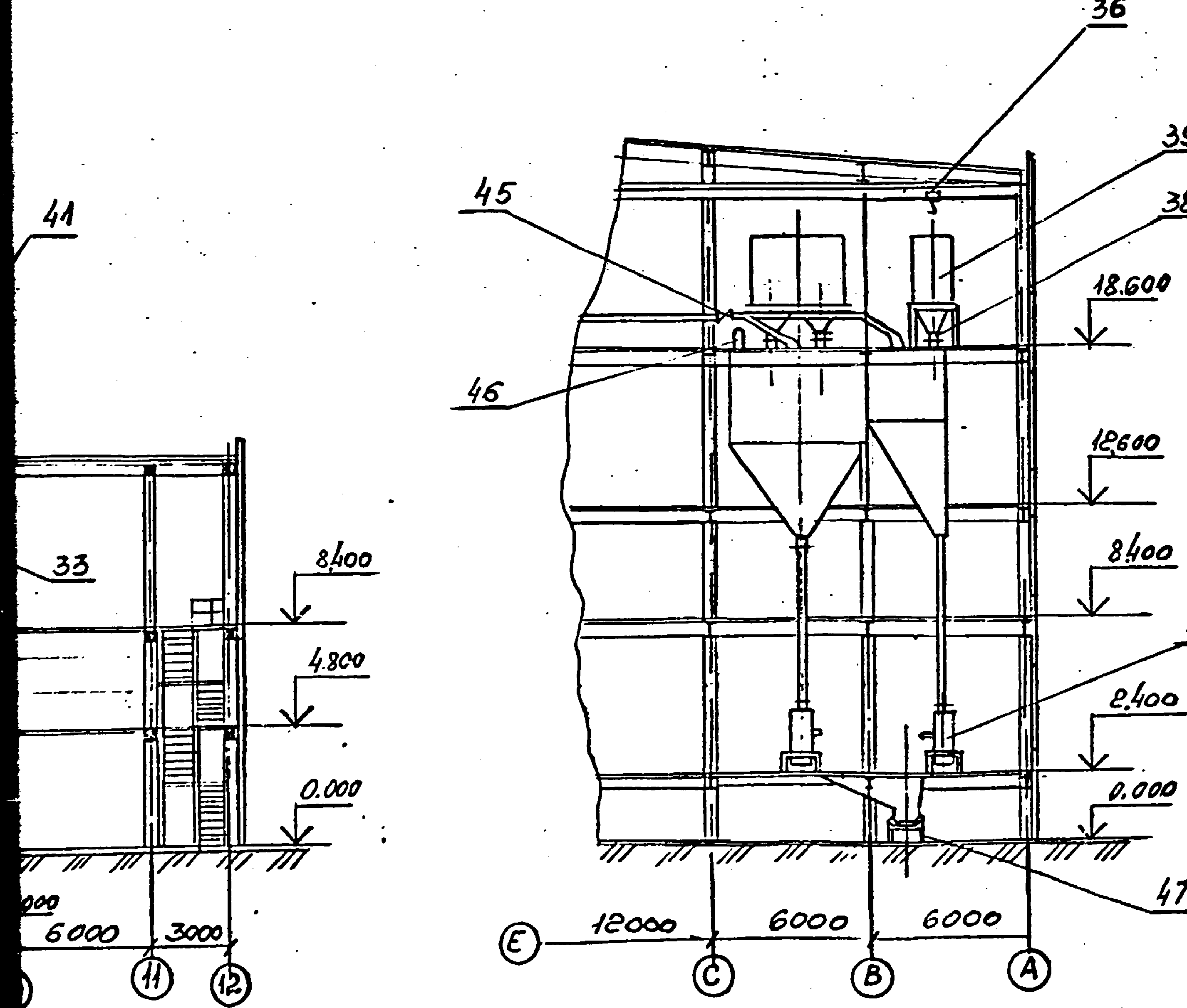
A A SHEET 3



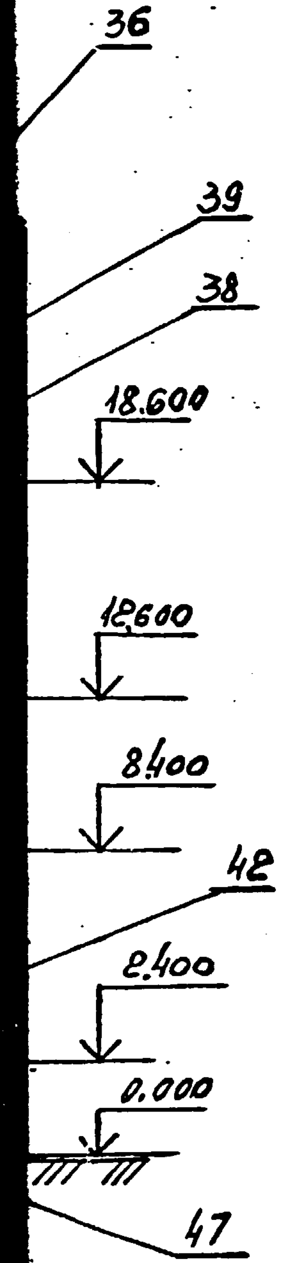


SECTION 2

B B SHEET 3



SECTION 3



SECTION 4

1398860-

ISLAMIC REPUBLIC OF IRA

PRODUCTION OF SPECIAL ALUMINA FOR SPARK PLUG INSULATORS	PHASE	SHEE
		2
SECTIONS A-A, B-B	VAM	

LENING

SECTION 5

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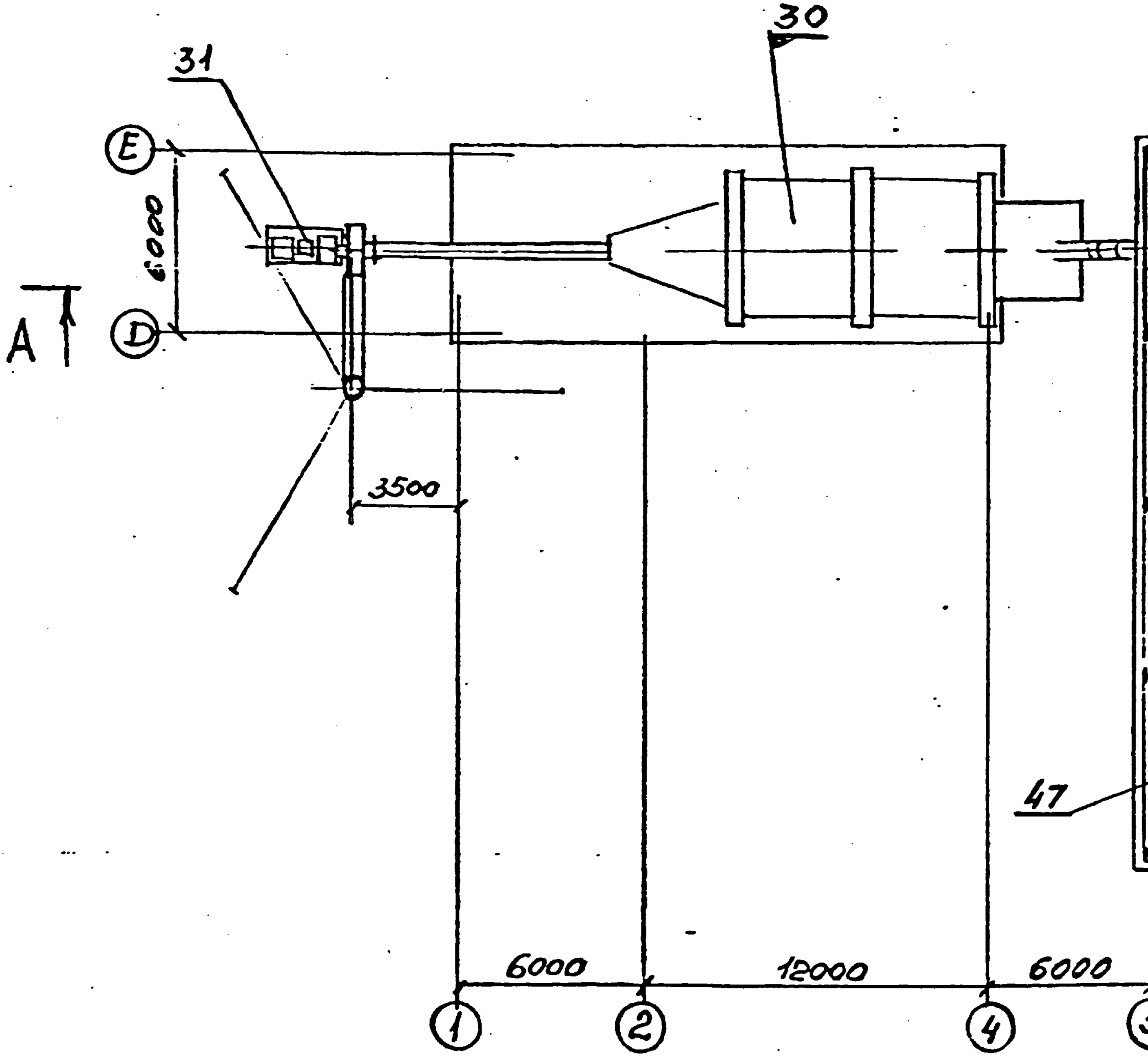
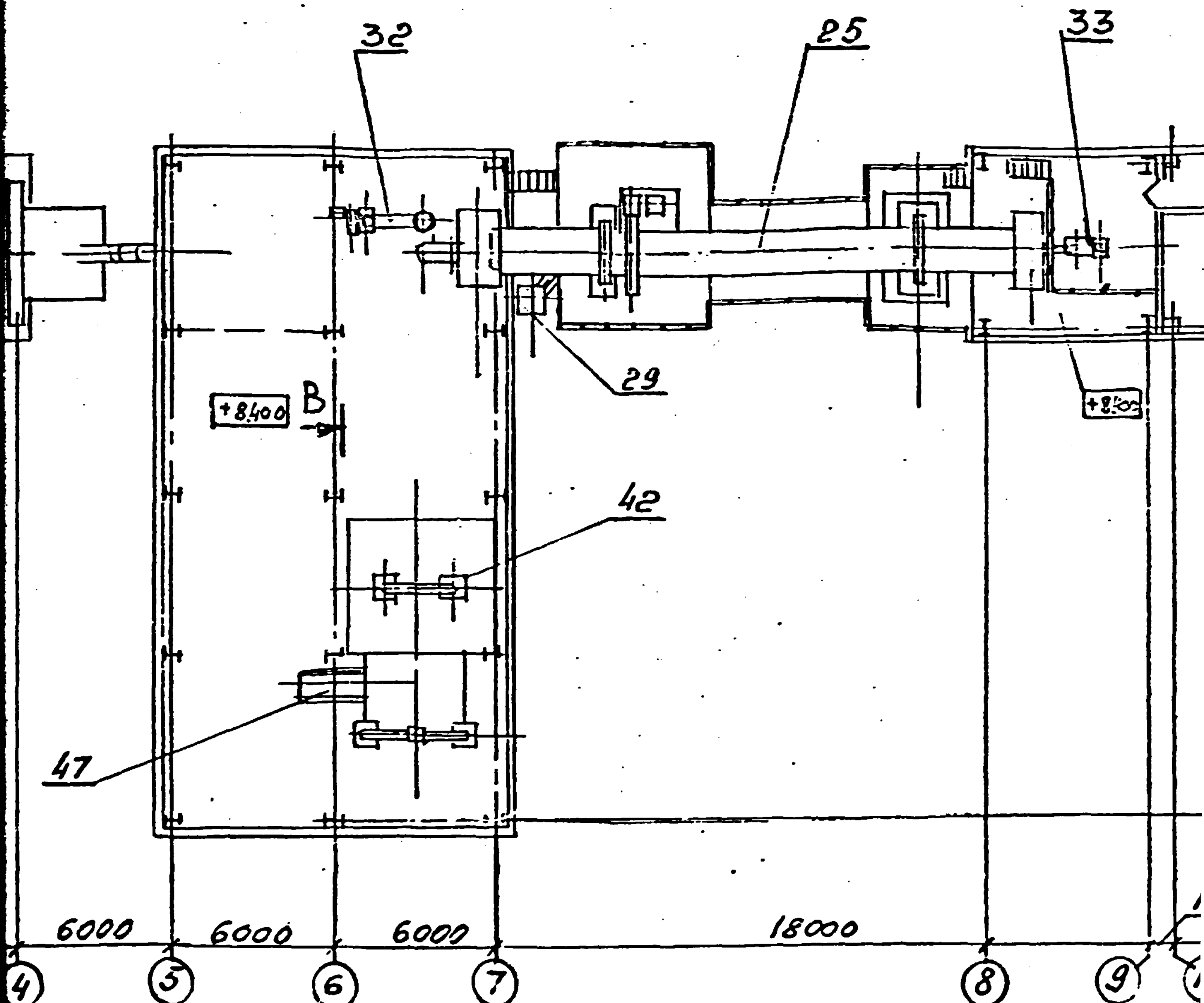
	ISLAMIC REPUBLIC OF IRAN			
	PRODUCTION OF SPECIAL ALUMINA FOR SPARK PLUG INSULATORS	PHASE	SHEET	SHEETS
			2	
	SECTIONS A-A, B-B	VAMI		



SECTION 1

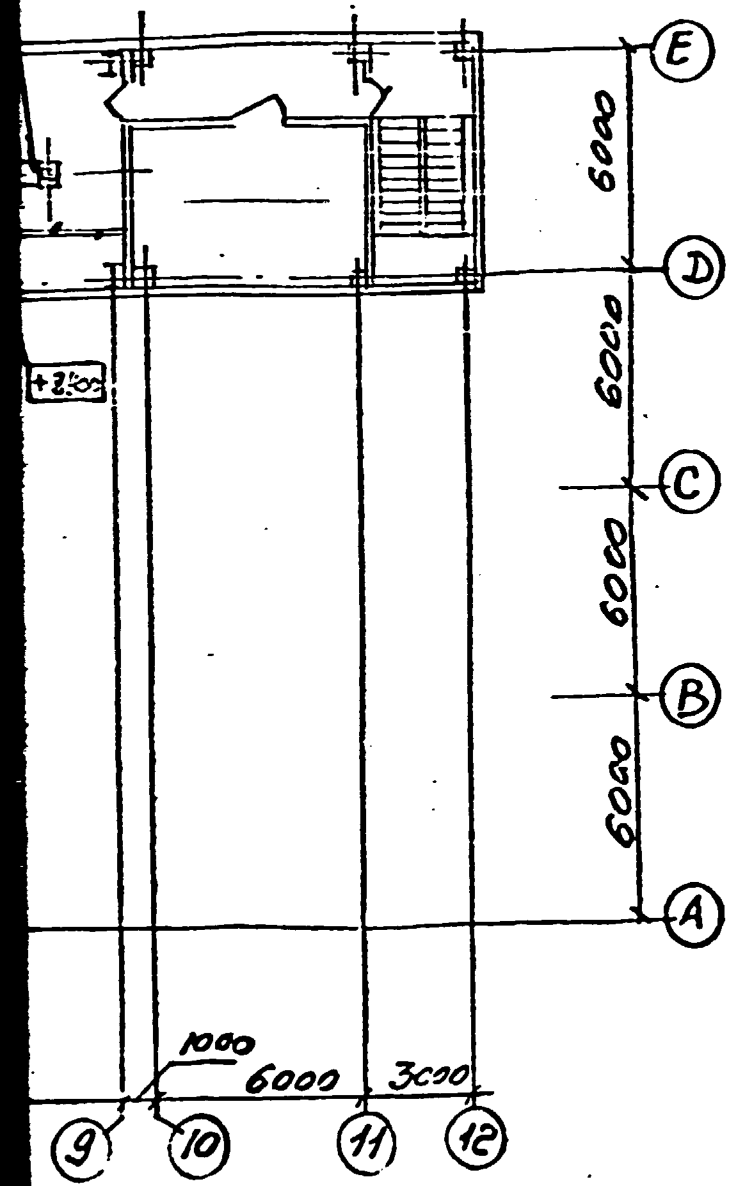
PLAN AT EL. 8400



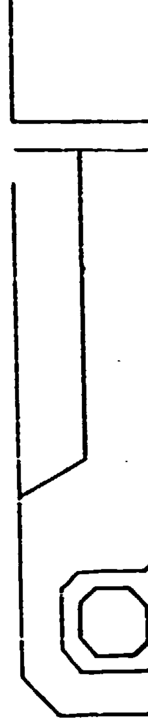
SHEET 2 B

SECTION 2

33

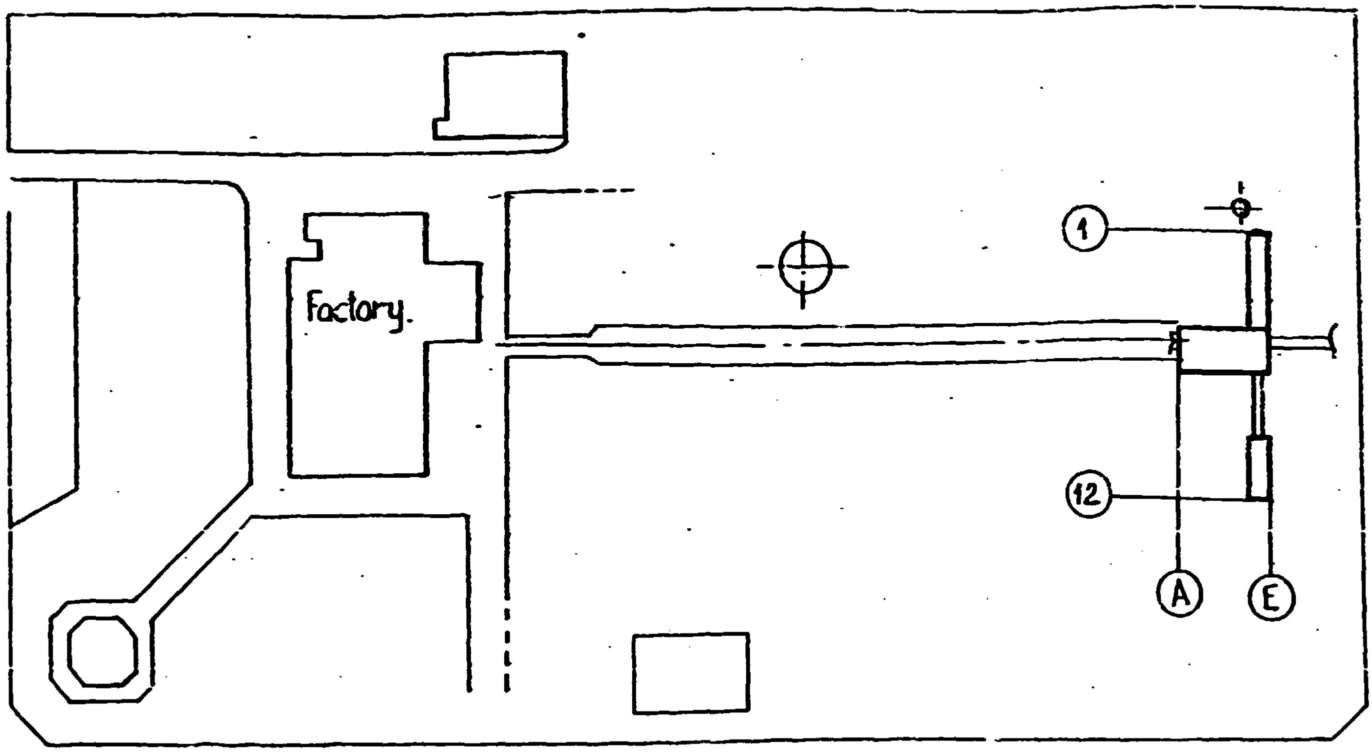


A SHEET 2



SECTION 3

General Lay out
M 1:2000



SECTION 4

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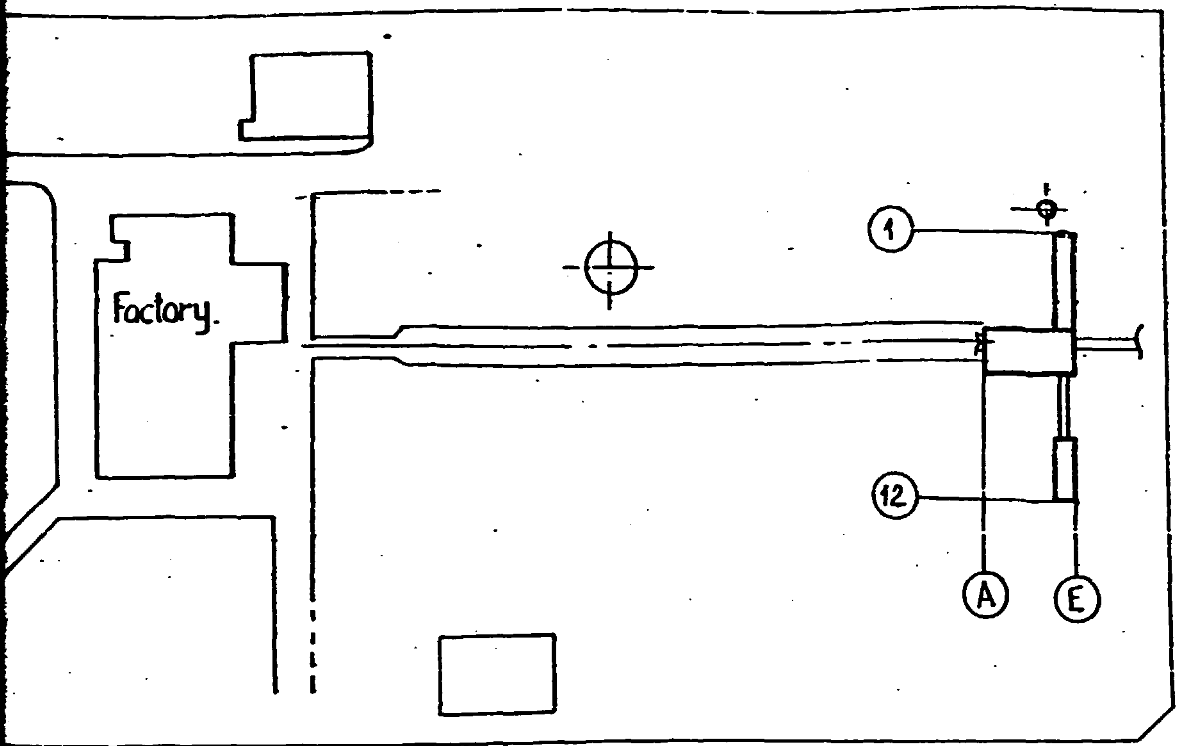
	ISLAMIC REPUBLIC OF IRAN		
	PRODUCTION OF SPECIAL ALUMINA FOR SPARK PLUG INSULATORS	PHASE	SHEET
			3
	PLAN A.T EL. 8.400	VAMI	

General Lay out
M 1:2000



SECTION 5

1398860-TM

ISLAMIC REPUBLIC OF IRAN

PRODUCTION OF SPECIAL ALUMINA FOR SPARK PLUG INSULATORS	PHASE	SHEET	SHEETS
		3	

PLAN AT EL 8400

VAMI