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DEVELOPMENT AND SITUATION OF THE ALUMINIUM INDUSTRY IN HUNGARY

by

György Dobos
Director General of the
Hungarian Aluminium Corporation

Submitted by the Government of Hungary

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SUMMARY

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1. This paper gives a brief historical perspective of Hungary's aluminium industry, discussing some of its specific aspects particularly in relation to the international division of labour.

2. CHAPTER I covers the development of aluminium industry from the start of bauxite mining through the initial phase of alumina manufacture and aluminium metallurgy and its intensive post-liberation development to the Hungarian-Soviet alumina-aluminium agreement and, within its framework, the industrial expansion projects for the manufacture of alumina and semi-finished products. An outline is given of the development policy and trend, as a result of which Hungarian aluminium industry, which prior to the war was mostly a primary producing and exporting branch, is gradually becoming a developed vertical sector making fuller use of the possibilities inherent in Hungarian bauxite riches.

3. CHAPTER II gives a brief account of the technological and economic position of aluminium industry and its development plans, covering the main phases of production from bauxite mining through alumina production and aluminium metallurgy to the manufacture of semi-finished and finished products. The chapter ends with the presentation of investment outlays necessary for the vertical development of aluminium industry.

4. CHAPTER III deals with the organizational pattern of aluminium industry, including the main lines of activity of this branch as well as the companies and institutes functioning within the framework of the Hungarian Aluminium Corporation.

5. CHAPTER IV outlines the institutional framework for technical development and its functioning in this branch of industry, including the Designing Centre of Aluminium Industry and its activity, and the technological and geological research carried out by the Research Institute for the Metal Industry and the development units and pilot projects of the various enterprises as well as by the Bauxite Prospecting Enterprise, respectively. The technical advising and propaganda activity carried out by the Centre for Aluminium Application Techniques are also discussed.

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6. CHAPTER V offers a survey of the international relations of aluminium industry, with particular emphasis on the significance of international co-operation in ensuring the basic conditions for the development of Hungarian aluminium industry, primarily electric energy of which Hungary has a limited supply. In the light of this need, coverage is extended to the Hungarian-Soviet alumina-aluminium agreement and the Hungarian-Polish agreement for co-operation in the field of aluminium industry. Similarly, account is given of the contribution by Hungarian specialists to the development of the aluminium industry in other countries.

7. CHAPTER VI contains the general and specific conclusions to be drawn from the above experience in the aluminium industry.

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Introduction

1. In Hungary aluminium industrial activity has been carried on for some 40 years. In the present paper we endeavour to make a short review of the development of this branch of industry, to supply information on our plans for further development, and, finally, to give a brief outline of the technical level achieved up to the present. In addition we shall refer to the scope of activity of the industry and shall analyse those circumstances which have led to a relatively broad international co-operation with some of the friendly countries with a view to the solution of some development questions within the aluminium industry.

I. UNFOLDING OF THE ALUMINIUM INDUSTRY AND ITS PLACE IN THE HUNGARIAN PEOPLE'S ECONOMY

2. As a result of geological exploration activity carried out after 1920, bauxite riches were discovered in Hungary in a quantity significant even on a world scale, amounting to approximately 1.5 - 1.7 per cent of the world's known or estimated bauxite deposits. The year 1926 may be considered as the starting point for the aluminium industry, when with a yearly output of 3700 tons of bauxite, production began in Hungary. Regardless of the stagnation caused by the economic crisis of 1930, the quantity of extracted ores per year showed a steady increase and in 1937 it surpassed half a million tons; the 1943 production figures show a one million ton production level per year.

3. Bauxite processing in Hungary started in 1932 under rather modest circumstances, with the erection of a bauxite-cement factory. In that very same year a small-capacity alumina factory was also built. Manufacture of aluminium started only in 1936 when the German armament interests made the stepping up of production capacity in Hungary urgent. Building of further alumina factories and metallurgical works started in the years immediately preceding World War II as well as during the war, when the production of semi-finished and finished goods began to be developed.

4. Both bauxite mines and processing works started their activity backed by foreign capital investments, mostly from Germany. The character of development is well illustrated by the fact that in 1944 only 21,000 tons of alumina, about 10,000 tons of aluminium, and about 9,000 tons of aluminium semi-finished goods were manufactured in Hungary whose bauxite production then totalled some 1 million tons.

5. Following the war, and according to the Potsdam Treaty, German concerns in the Hungarian aluminium industry went over into Soviet ownership. Thus, up to 1954, the aluminium industry worked within the frame of a Hungaro-Soviet mixed enterprise; then the Soviet partner sold its share to the Hungarian Government under favourable conditions. In this period up to 1954 the level of alumina production surpassed 130,000 tons per year and the manufacture of aluminium ingot increased up to 30,000 tons, that of semi-finished goods to about 25,000 tons.

6. In the course of development between 1955 and 1962 Hungary succeeded to approach the results of highly developed countries in aluminium manufacture and aluminium metallurgy. In 1962 Hungary produced around 1.5 million tons of bauxite, about 240,000 tons of alumina, 53,000 tons of aluminium and 38,000 tons of semi-finished goods.

7. Within the 17 years following the liberation of the country noteworthy results were achieved in all phases of bauxite processing. Thus in 1962 alumina production increased over ten-fold, that of aluminium ingots over five-fold and that of semi-finished goods over four-fold as compared to figures registered in 1944. However, at the beginning of the 1960's it became increasingly obvious that Hungarian energy sources did not prove sufficient for the further development of one of the very significant sectors of the aluminium industry, namely electrolytic aluminium manufacture. Therefore, a choice had to be made between the following potentialities at hand: to abandon development of the very advantageous finishing phase, i.e. semi-finished and finished goods manufacture; or, to solve the question of broadening aluminium metallurgy production through international co-operation.

8. The alumina-aluminium agreements signed with the Soviet Union in 1962 and with the Polish People's Republic in 1960, to which we shall revert later, made it possible for Hungary to increase considerably her aluminium resources in the near future and to make the necessary preparations for the manufacture of semi-finished and finished goods.

9. In order to realize these targets, an output of 2 million tons for bauxite, 460,000 tons for alumina, 61,000 tons for aluminium and 82,000 tons for aluminium semi-finished goods has been forseen for 1970. After 1970 the pace of development will, no doubt, increase further.

10. It is perfectly obvious that for Hungary, a country with significant bauxite riches, it is of paramount interest to find the necessary conditions for the vertical building up of her aluminium industry and to utilize metal contents extracted from the ore at the highest possible grade of processing, up to a sound, economically adequate measure.

11. Taking the average quality of Hungarian bauxite, out of six tons of bauxite two tons of alumina and out of the latter one ton aluminium and semi-finished goods respectively, can be produced. These products can be sold at the following prices:

Bauxite	US	6.-	per ton
Alumina	"	72.-	"
Aluminium	"	450.-	"
Aluminium semis	"	750.-	" (on the average)

12. Thus the selling price of semi-finished goods is roughly 20 times that of the bauxite necessary for their production. This circumstance serves as an explanation for that steady endeavour which Hungary has been making to increase the verticality of bauxite processing since the liberation as well as for our lively interest in international co-operation. The results achieved in this connexion are shown in table 1 of the annex.

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13. This table shows the production and sale of major products in some of the characteristic periods. The difference of the two rows of figures represents domestic consumption in this branch of industry.

14. From this table it appears quite clearly that in the period up to the end of World War II, bauxite, which was delivered in the form of raw material, played a decisive role in sales and that in the period following the liberation the quantity of processed goods increased considerably. Bauxite sales have been decreasing more and more in proportion to the building up of processing capacities; alumina appears on the market as an important export article, and at present aluminium semi-finished goods already represent the basic item of the goods' turnover.

15. In table 2 of the annex, we compare values of semi-finished products, which in principle can be manufactured from the bauxite produced, with actually realized sales in the period under review. This goes to show that while in the 20 years' period from the beginning of mining activities until the end of World War II we were unable to realize even 10 per cent of the useful metal contents value of the ore expressed in the price of semi-finished goods, in the same period following the liberation we could already achieve about 30 per cent of sales being possible in principle.

II. SOME CHARACTERISTIC FEATURES BEARING ON THE ACTIVITY OF HUNGARIAN ALUMINIUM INDUSTRIAL COMPANIES

16. Aluminium industrial activity requires a set of specific factors necessary for the development of the different phases of production. These factors differ from country to country and accordingly facilitate development in varying degrees. Therefore a short outline follows of the technical and economic circumstances which characterize Hungary from this point of view.

A. Bauxite mining

17. Hungarian aluminium industry endeavours to achieve reasonable exploitation and sales of the bauxite riches. With this aim in mind exploration and detailed investigation of bauxite deposits is of fundamental importance both for the quantity and quality of ore-reserves. Following World War II the aluminium industry called a special geological research organization into life for the regular exploration and analysis of bauxite deposits. Continuous exploration activity which is still in full swing made it possible to evaluate the estimated bauxite reserves and to prepare long-term development plans for the exploitation of bauxite riches.

18. Geological exploration of ore reserves renders full exploitation of their economic value possible, as well as the development of aluminium industrial centres in the proximity of the ore bases. As an example for this fact we would mention the high-capacity AJKA II alumina factory which will be based on the rather important ore deposits and coalfields of Halimba-Nyirád.

19. The majority of bauxite deposits extends under an overburden at a depth of 50-350 m under the surface; consequently the greater part of these mines has already been exploited by deep-mining. The present mining capacity is about 1.5 million tons which will increase considerably in future by means of opening up new mines.

20. A considerable part of the fields lies under the karst-water-table, thus at many places one has to reckon with dangerous water in-rush in the course of

bauxite mining water danger is eliminated by active water protection, i.e., by powerful pumping considerable water quantities are extracted from the Dolomite and limestone layers, thus the water level is regionally subsiding to the required depth, viz. under the mining horizon. Recently, sinkers capable of pushing down shafts, 2.6 m in diameter, were put into operation in order to make dewatering shafts.

21. In the period of the forthcoming ten years we plan to increase bauxite production to over double of the present yield which of course necessitates the opening up of new mines. On the basis of regular geological research activity it was proved that adequate ore deposits are at disposal. Guiding principles for the planning and establishing of new mines are the following: high yield/min. 200 000 tons/year, bulk production with maximum mechanization, regional concentration and active water protection in mining areas endangered by karst-water.

B. Alumina manufacture

22. In 1966 the production of alumina - direct raw material of aluminium metallurgy - amounted to 296.000 tons which, compared to the production figures for 1948, the time of nationalization, shows a thirteen-fold increase and is almost double the level of ten years ago.

23. The present volume of production is rather remarkable even on an international scale: only the Soviet, French and West-German alumina production exceeds that of Hungary in Europe.

24. Hungarian alumina factories are processing a bauxite ore that has higher SiO_2 and Fe contents than overseas bauxite, and is mostly of a Boehmite structure, on the basis of the traditional Bayer procedure applied with slight modifications.

25. Equipment of the alumina factories and their degree of automation are quite up-to-date. In two of the larger alumina factories the quantity of steam necessary to produce one ton of alumina was decreased to three tons at the end of 1966, whereas in 1957 eight tons of steam were necessary to produce the same quantity of alumina. Specific heat energy consumption also shows a steady

decrease and in 1966 it reached the level of 5.9 Megacal/ton on the average, reckoned on primary energy carriers, which in view of middle-size factories may be considered satisfactory.

26. In the course of alumina manufacture from Hungarian bauxite ores there remains a considerable quantity of red mud with a rather high percentage of iron. Iron recovery from red mud in iron-poor countries - as is the case in Hungary, too - is of special importance. For many years successful and encouraging experiments have been carried out in Hungary and in some of the neighbouring countries on a pilot plant and large-scale basis, aiming at the recovery of iron from red mud on the one hand and at that of alumina and caustic soda from red mud slags, on the other. Complex utilization of the red mud as a by-product can in our opinion contribute to increasing the profitability of alumina production.

27. Among other products manufactured from alumina in Hungary, corundum refractory material must perhaps be mentioned in the first place, considering its importance. From this product we exported around 3,000 tons to several European and overseas countries in 1966. Our factory of alumina refractory shapes (furnace lining) also produces corundum grains in a quantity sufficient to supply domestic needs. In the course of the past ten years Hungarian alumina factories have taken up the manufacture of different active alumina types and aluminium-oxyd-gel as well as the recovery of gallium metal and vanadium-pentoxyde.

28. From the 296,000 tons of alumina produced in 1966, 160,000 tons or 54 per cent of total output was exported. As an alumina exporter Hungary has occupied the first place in mid-Europe over a long period. In the years ahead we should like to maintain this position, because Hungary's bauxite riches and the lignite basins extending in the proximity of ore deposits create favourable conditions for the increase of alumina production.

C. Aluminium metallurgy

29. Given the present production level of the Hungarian aluminium metallurgy, no significant increase can be expected until the end of 1980 for reasons of scarce energy supply. Today Hungary produces around 60,500 tons of aluminium,

almost twice as much as in 1948 and over 70 per cent more than ten years ago. For the time being the trend of development is towards further modernization of existing equipment and, consequently, intensification of production.

30. On a world scale the present Hungarian aluminium production is insignificant, but regarding its technical level, some of our results have come up to international standards. This applies to the specific alumina and auxiliary material consumption as well as to the DC energy consumption for 1 kg of aluminium which in the last year decreased to 15 kWh in our vertical Soedeberg type side-stubbed reduction pots.

31. Taking the Hungarian circumstances, 65-70 kA furnaces have proved to be the most suitable. In practice, the operation of the furnaces has been fully mechanized and automation has been started. The necessary DC for electrolysis is supplied mostly by modern silicium rectifiers.

32. Beside the usual commercial quality metal, the furnaces also produce high-purity (99.99 per cent) aluminium.

33. In the present year continuous casting equipment has been put into operation, directly fed with hot-metal and located on the site of the furnaces, for the purpose of manufacturing rough wires and striped. We are likewise planning to erect a high capacity central scrap remelting and mould-casting works close to the furnaces for drawing maximum profit of advantages offered by the use of molten metal.

D. Manufacture of semi-finished goods

34. In 1966, 54,300 tons (75.7 per cent) of aluminium were used in Hungary for the production of semi-finished goods and 16,400 tons (23.4 per cent) for moulds and other purposes. According to these figures, the metal input required for the manufacture of semi-finished goods and mould-casting is roughly equal to that in the industrially developed countries.

35. However, the pattern of the manufacture of semi-finished products strongly differs from the general trend in the world. On a world average, the production

of rolled and extruded goods represents 85-90 per cent of semi-finished goods, that of wire only 10 to 15 per cent, whereas in Hungary, owing to the high requirements of the electric industry, wire production amounts to approximately 30 per cent of the volume of semi-finished goods. Thus, rolled and extruded goods make up only 70 per cent of the total volume.

36. In Hungary modern units are manufacturing wire and extruded goods, on presses with a compressive force varying between 600 to 5,000 tons, as well as foils from semi-finished goods' production totalling 54,300 tons. The modernization of sheet-metal manufacture is now under way with the installation of a wide strip mill (1,800 mm in width).

37. In order to widen the scope of products manufactured on the basic equipment and to improve their quality, our semi-producers are equipped with finishing machines and processing units. Once they are in full operation, Hungarian semi-producers will be in a position to supply consumers with high-quality goods, namely painted strips, polished and anodized tubes and profiles, embossed sheets, etc.

38. At present we are stepping up the capacity of semi-finished goods manufacture in order to enable our industry to work up the quantity of metal available under the Hungaro-Soviet aluminium agreement in accordance with up-to-date requirements. On the basis of calculations it appears practicable to double the present capacity of production by 1970.

39. The manufacture of semi-finished goods is at present developed along two lines: the setting up of high-capacity semi-finished goods works with a wide scope of products in the proximity of consumers, relying on skilled labour in the industrialized area; in the reduction plants installation of relatively small-capacity (5 - 20 thousand tons) uniplanar equipment for continuous casting of molten metal, i.e. wire or narrow strip manufacturing units.

40. The foundries are supplied with alloyed metal partly by the aluminium furnaces and partly by the specialized light-metal works. Foundry requirements

are met by three larger foundries, their yearly capacity being 7,000 tons, as well as by some relatively smaller units operating in the machine works. Die-casting and pressure-casting are making great headway in replacing sand-moulding.

E. Manufacture of finished goods

41. In the period between 1950 and 1965 aluminium consumption grew six-fold in Hungary while total industrial production increased to its quadruple. Aluminium consumption per capita in Hungary was about 6 kg in 1965. This quantity is roughly in accordance with similar data of France, Australia and Norway and amounts to about three-fold of the world average.

42. For characterizing aluminium consumption beside the quantity one may take the distribution in the main consumer sections. Beside the state of development of the aluminium industry this structure depends to a great extent upon the economic structure of the country, upon the organization of the industry as well as the production and market position of other raw materials competing with aluminium, i.e. steel, copper, timber, etc.

43. The structure of aluminium consumption in Hungary strongly differs from that of the industrially developed West-European states.

44. In Hungary the well-developed electrical industry producing to a considerable extent for export, takes over in fact 35 per cent of the aluminium processed in the country. Abroad the share of electric industry amounts to about 15 per cent only. This high ratio of aluminium consumption in the electric industry is due to the fact that for a longer time copper has been rather scarce in Hungary and therefore, stealing a march on other countries, copper was largely substituted by aluminium which could be well applied first and foremost in the electric industry.

45. The manufacture of vehicles and of pots and pans amounts to 20 per cent each of the whole aluminium consumption in Hungary as in the industrially developed Western countries. The chemical and packaging industry's share in aluminium consumption is not yet satisfactory in Hungary. Aluminium consumption of the

building industry and agriculture is at present still at its low ebb, although in recent years a considerable increase could be registered in both fields. The major part of aluminium finished goods produced represents a yearly volume of about 60,000 tons; it is carried out in separate specialized works and sections. Thus a special ship-building factory manufactures light-metal water vehicles; in the cable factory an independent section deals with aluminium wire manufacture; a specialized machine factory of the chemical industry manufactures aluminium tanks and other equipment, etc.

46. In the light of consumer requirements in Hungary aluminium consumption per head and year will amount to 10 kg in 1970 and to 25 kg in 1980.

F. Investment costs required for the expansion of aluminium industry

47. As we have already mentioned, the conditions for the entire building up of the aluminium industry are rarely at hand in one and the same country; this very circumstance entails the well-known international character of this branch of industry. Besides, the entire manufacturing procedure beginning from bauxite mining up to the manufacture of aluminium ready-made goods requires considerable capital investment. In order to demonstrate this fact we have made attempts to determine investments necessary for 100,000 tons of finished goods of an average composition based on our experiences as well as on some press releases. When making this calculation we have taken into consideration the amounts necessary for the basic energy required for the operation of the metallurgical capacity for semi-finished goods production, finished goods manufacture, as well as for the installation of a proportional mould-casting capacity; investments, however, which will probably be necessary for the further development of transport, building of railway lines, ports, etc. have not been taken into consideration as these are varying to a rather considerable extent from country to country.

48. From table 3 of the annex it can be ascertained that in order to establish a capacity for 100,000 tons of finished goods extending to all phases of manufacture a very considerable investment, extending to 400 million $US is necessary. The most important part of this sum falls on the establishment of aluminium furnaces and equipment for energy supply in connexion therewith.

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III. ORGANIZATION OF THE HUNGARIAN ALUMINIUM INDUSTRY

49. The bauxite-aluminium industrial complexes of Hungary are specifics entirely in socialist state ownership, within the Hungarian Aluminium Corporation, the latter is controlled by the Ministry for Heavy Industry. The different lines of activity are the following.

- Geological bauxite research,
- Bauxite production,
- Alumina manufacture,
- Production of aluminium,
- Production of aluminium semi-finished products,
- Manufacture of corundum products,
- Processing of by- products and scraps of the aluminium industry,
- Production of steam and electric energy,
- Production of auxiliary materials for the aluminium industry,
- Remelting and casting of aluminium scraps,
- Sale of products mentioned for home consumption and to the foreign trade companies,
- Execution of investments and renewal of bauxite and aluminium industrial works,
- Manufacture of machines and maintenance service for customers abroad;
- Technological research activity in connexion with the production of aluminium industry products,
- Research in connexion with the technology and processing of non-iron metals;
- Development of aluminium finished goods' prototypes;
- Technical know-how for the aluminium processing industry,
- General projects for the bauxite and the aluminium industry, individual machines for the aluminium industry, products and constructions, projection of manufacturing works for raw and auxiliary materials in connexion with the aluminium industry for local and foreign buyers,

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- Acting as main-contractors in connexion with the export of complete factory equipment for the aluminium industry.

50. The Society incorporates: The Research Company for Bauxite, two bauxite mining enterprises, one alumina factory, one alumina and corundum factory, one alumina factory and aluminium reduction plant, two aluminium reduction plants, two light-metal works for semi-finished products, The Aluminium Trade Center, The Designing Centre of the Hungarian Aluminium Industry, The Research Institute for Light-Metals.

IV. SOME CHARACTERISTIC FEATURES OF ORGANIZATION IN REGARD TO TECHNICAL DEVELOPMENT

51. In order to foster technical development of the aluminium industry, designing research and technical propaganda organizations were called into being. Part of these activities is carried on in the development sections of individual enterprises in a decentralized manner, and another part is centralized in the Designing Centre of the Hungarian Aluminium Industry, Research Institute for Light-Metals, Bauxite Researching Company and the Centre for Aluminium Application Technique, under the control of the Hungarian Aluminium Corporation.

52. Technical development activity takes up 10.9 per cent of the total number of the staff and represents 3.1 per cent of its production value.

A. Designing activity

53. The Designing Centre of the Hungarian Aluminium Industry deals with the elaboration of vertical projects in connexion with building, machinery and technology in the field of bauxite mining, aluminium manufacture, alumina processing, manufacture of corundum, etc., aluminium reduction as well as the production of semi-finished goods. Some sections of the Centre not only prepare projects for expansion or reconstruction of existing aluminium works and for establishment of new units, but they regularly carry out foreign orders, too.

54. In the course of its activity extending over a decade they have acquired ample experience in the field of bauxite mining under the Karst water-table, active water protection, and in the designing of bauxite mining mechanization and

modern surface equipment. In the scope of designing alumina factory reconstructions and expansion projects they have successfully advanced the Bayer technology and have acquired valuable experiences in the optimization of both material and thermal balance of aluminium factories; this optimization is regularly carried out by electronic computers. In the course of designing expansion and reconstructions of aluminium reduction plants, the most up-to-date technology is applied, especially in regard to rectifiers.

55. The Aluminium Construction Department of the Institute has carried out pioneering work in widening the scope of aluminium application. They have designed a series of aluminium prototypes for the building industry, traffic, household goods and other aluminium using industries.

B. Technological research work

56. Part of industrial research activity requiring first of all work of a theoretical character is centralized in the Research Institute for Light-Metals. Over and above this the Institute deals also with some problems of aluminium processing and aluminium finished goods manufacturing, e.g. aluminium joints, surface treatment, elaboration of structure regulations, etc. with a view to fostering aluminium consumption.

57. Research of a technological character is carried out partly on a decentralized basis in the development sections of individual companies as well as in the pilot plants on site, in order to render smooth and undelayed introduction of new results possible, respectively to allow for the range of production to be adequately increased in keeping with consumer requirements.

C. Geological research work

58. Its task is to trace new bauxite deposits and to carry out detailed investigation of industrially valuable bauxite deposits from the economic and geological point of view. For carrying out this activity a special company has been established with adequate drilling rigs, repair workshop, transport equipment, chemical and geological labs and specially trained personnel. Its yearly capacity amounts to about 100,000 running meters in core-drilling and

its activity covers both investigation and evaluation of research material from the geological and economic point of view. Recently the company has also taken up shaft drilling, up to 2.6 m in diameter.

D. Technical advising and propaganda

59. The Centre for Aluminium Application Techniques is responsible for the maintenance of an organized connexion and its intensification among the enterprises of the Hungarian aluminium industry and their consumers by means of: (a) regular visits to main consumers, technical purchasing service; (b) opening up new areas for the profitable usage of aluminium; (c) elaboration and propagation of modern processing procedures.

60. The Centre endeavours to spread aluminium consumption to those fields which appear to be profitable for the consumers, by applying all modern means of technical propaganda — films, series of lectures, courses, periodicals and publishing of books, etc. This also applies to the improvement of present processing techniques, thus adapting the prevailing manufacturing possibilities of the aluminium industry, as well as widening the range of products to meet the wishes of finished goods manufacturers.

V. INTERNATIONAL RELATIONS

61. In the period elapsed since World War II the development of international relations of the Hungarian aluminium industry has been shaped by two basic factors: (a) Attainment of political and economic independence; (b) Establishment of adequate international co-operation meeting the requirements of natural endowments of the country, of modern techniques and the economic interests of the participating countries.

62. Prior to World War II and during its course bauxite was exported from the country mainly in form of ore and the development of the processing industry was pushed into the background. In the period between 1925-1945 nearly 92 per cent of the bauxite exploited in Hungary was exported, mainly to Germany. A rapid development in alumina production, alumina metallurgy and semi-finished goods could be started only at the end of the war when the country regained independence.

63. The development of the aluminium industry could only gradually be realized; naturally, the export quota of exploited bauxite could be decreased only in proportion as was made possible by the development of the home processing industry. When developing the successive phases of processing it is of extreme importance for the proportions between the individual manufacturing sequences to allow the fullest possible exploitation of advantages offered by the international division of labour and co-operation.

64. In the economic co-operation of socialist countries the principles of equality and of mutual advantages create favourable conditions of development for all participants.

65. As regards to Hungary, this new type of international co-operation allows her to develop the aluminium industry at a rather quick pace by realizing one phase of its processing in the Soviet Union and in Poland, i.e. the electrolytic reduction for which there is no cheap electric energy available in this country.

66. In the recent decades it has been characteristic of the development of the world's aluminium industry that for an adequate exploitation of the advantageous natural and economic potentialities transport between distant regions becomes

imperative. For instance, the major part of the United States aluminium production is being supplied with raw material from the bauxite mines situated in the area of the Caribbean Sea. On the cheap water energy sources of Canada and Norway huge electrolytic reduction plants were built up there using bauxite and alumina from countries situated at a distance of many thousand kilometres. One may observe that in order to save transport costs, alumina factories are generally set up near the bauxite mines, and the aluminium reduction plants in the proximity of cheap water energy sources; in the majority of cases this is a paying job even if the transport of water to great distances becomes necessary.

67. A similar recognition served as a basis for the aluminium industrial co-operation agreement signed between the Hungarian People's Republic and the Soviet Union in 1962 and valid till 1980. In its scope bauxite is being processed in modern alumina factories situated in the proximity of bauxite mines in Hungary, while electrolysis has been foreseen in the aluminium reduction works now being built near the water power plant of Volgograd at about 3,000 km from the ore deposits. Transport of Hungarian alumina can be solved at a relatively low price. Under this agreement the metal contents of the alumina is returned in full to Hungary in form of either aluminium slabs and billets or, according to the requirements, in form of semi-products. In accordance with this agreement, the investment costs necessary to increase production are divided in roughly equal shares between the two countries. Hungarian alumina deliveries will gradually increase as from 1967 to reach 330 000 tons per annum and the Soviet aluminium billets deliveries will amount to 165,000 tons/year in the future.

68. The settlement of accounts will be effected on the basis of world market prices which means that in spite of transport costs the Hungarian partner will get the aluminium considerably cheaper than if it produced it with its own electric energy obtained from coal or oil or with imported energy. Hungary is paying for the costs of reduction with her traditional export

goods, mostly by industrial finished goods. This agreement is advantageous for the Soviet Union, too, because in this way electric energy produced in the Soviet water power plant can be sold at a favourable price.

69. Hungary has signed an aluminium industrial co-operation agreement also with Poland, under which Hungary delivers about 80.000 tons of alumina, whose aluminium contents of about 40 per cent is restored in form of billets. The accounts are also settled according to world market prices.

70. These co-operation agreements make it possible to process the major part of Hungarian bauxite into semi-finished and finished goods within the country under profitable conditions and to achieve thereby a high technical level of processing and utilization. Part of the bauxite produced must of course be exported further on to an extent corresponding to Hungarian interests, in order to meet the basic needs of existing customers. In the near future Hungary also intends to increase its alumina manufacturing capacity beyond the level of meeting its international liabilities already mentioned, in view of the fact that there are favourable conditions in Hungary for making this product and therefore its sale abroad also profitable.

71. By the extension of aluminium processing already mentioned, the export structure is continuously changing; parallel with the degree of processing the national income as well as the returns in foreign currency increase considerably.

72. Hungary has manufactured and exported a rather wide range of industrial goods made of aluminium, such as steel-aluminium wire, milk-cans, gas-bottles, different packaging material, pots and pans, camping furniture, tubes and cans for canned goods, etc. In addition, aluminium plays a very important auxiliary role in numerous other finished goods, the export of which can be further expanded; these are first of all motor trains, motor coaches, ships, boats, aluminium-wound transformers, insulated wires, etc. The technical level of aluminium finished goods is steadily increasing, their manufacture is spreading to fresh areas, and products of ever higher processing grade are

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turned out. All this goes to prove that Hungary is trying to make use of the favourable possibilities which serve the development of its aluminium industry on the basis of the existing raw material resources, the nationalized industry and the international division of labour--in keeping with Hungarian interests.

73. Technical and economic experiences acquired in the course of the development of the aluminium industry make it possible for Hungary to join with countries wishing to develop their aluminium industry in related activities by undertaking investigations, elaborations of projects and carrying out some investment schemes, delegating experts and training technical staff. Hungarian experts have already participated in numerous cases in the solution of problems connected with the aluminium industry.

74. In 1951 on the basis of the aluminium-energy agreement signed between Hungary and Czechoslovakia, the first Czechoslovakian reduction plant with 160 pots, 50 k_A, 800 Volts and about 25,000 tons/year capacity was built up with considerable Hungarian participation. Hungarian experts took part in the projection, building and putting into operation of this reduction plant.

75. Hungarian metallurgists also participated in the reconstruction of the Bitterfeld aluminium reduction plant in the German Democratic Republic in the period of 1965-1966.

76. Hungarian geologists have joined in the tapping of bauxite deposits in several countries, in the period between 1956-1960 in Albania, at present in Ghana.

77. In the period between 1963-1966 Hungarian metallurgists gave expert opinions and elaborated some projects for the reconstruction of aluminium reduction plants in Italy. They also prepared projects for a pigment plant to be erected in Yugoslavia.

78. On the basis of a Government order of the Republic of India, a project report for a 200,CCO ton/year alumina factory was handed over this year. In this project the quality of the Indian bauxite was duly examined, local price conditions were taken into consideration, and on the basis of optimization carried out with electronic computers the most up-to-date and the most economical technology was offered with due regard for the prevailing conditions.

79. Following an invitation of the Government of British Guyana a group of Hungarian experts consisting of four members studied the possibilities for the further development of the aluminium industry in that country in 1964 within the scope of the United Nations Technical Assistance Programme. This very thorough study by Hungarian experts was highly appreciated by the United Nations Technical Assistance Office. Meantime, some of the relevant suggestions have been realized, or are in the process of realization.

80. Since 1961 our geologists and bauxite miners have been participating in the operation and development of the Kassa - mines in Guinea. The local authorities are fully satisfied with their work in consequence of which the original order of 30 months is being currently extended to four years. In addition to strictly taken bauxite mining activities, Hungarian experts have organized a technical school for mining in Guinea in which they were teaching till 1964. Beside bauxite research, Hungarian experts successfully contributed to research and exploration of numerous other mineral raw materials: feldspar, mica, iron ore, pebbles to be mixed to cement, quartz-sand, etc.

81. From the foregoing it appears clearly that Hungary tries to take her share to the best of her ability in promoting the development of the aluminium industry in the developing countries. In case of sufficient interest we would be able to extend this activity, even to enrich it with some new elements.

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VI. CONCLUSIONS

82. Aluminium - the metal of our present days - became in a relatively short time an indispensable industrial raw material. The steep upward trend of both the consumption and production curve will, no doubt, continue in the decade ahead of us. This steady trend ensures an advantageous market for all those who, given their raw material basis, processing capacity, natural and other potentialities, wish to participate in the satisfaction of steeply rising demands.

83. The indispensable conditions for the development of the aluminium industry, i.e. raw material of good quality, cheap electric energy and relatively high investment funds, are seldom to be found in one and the same country. This goes to explain why the international division of labour, collective creation of production factors are practically indispensable pre-conditions for establishing modern vertical bases for the aluminium industry.

84. There are numerous practical examples for the international division of labour and for the collective creation of conditions which may show different characteristics along with the generally prevailing tendency. These differences may arise, for instance, from the divergent natural potentialities of the participating countries, their economic and social order and circumstances, and may also be observed, inter alia, in the actual division of the work, profitability of the venture, distribution of profit and accumulation of funds among each other, and in the regulation of the use of accumulated funds originating from joint undertakings.

85. The development of the Hungarian aluminium industry may be taken as a characteristic example for the international division of labour; in the period up to 1945 under the conditions of a capitalist economy, and in the post-1945 period under those of a socialist economy - although with totally different contents.

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86. We are of the opinion that Hungarian development is such as to allow some general and some special consequences to be drawn.

87. The Hungarian example supports the general experience that:

(a) the owner of the bauxite wealth may multiply his profit if he does not stop at the sale of the mining product but if he starts to make arrangements, as early as possible, in a tempo and measure corresponding to prevailing conditions, for the vertical processing of the ore right up to the aluminium semi-finished and finished goods;

(b) an important condition for the full exploitation of economic possibilities contained in the bauxite wealth is the participation in the international division of labour with a view to creating the necessary technical and economic conditions;

(c) the high investment cost of development justifies in practice the gradual building up of this branch of industry beginning from bauxite mining through alumina manufacture up to the semi-finished and finished goods industry;

(d) part of the results arising from the realization of higher processing grades of the gradual development may accelerate the further development of production phases requiring high investments to such an extent that after having reached the proper level fixed assets may be increased out of our accumulation;

(e) in the aluminium industry developed vertically up to semi-finished and finished goods a considerable accumulation appears, part of which may contribute to the development of other industrial branches as well as to the rising of living standards.

88. A specific experience of the history of Hungarian aluminium industry is that besides the known elements of international division of labour, the friendly socialist countries - first and foremost Hungary and the Soviet Union - have introduced new-type elements in the promotion of their economic collaboration, which derive from the basic principles of respect for each other's interests and equality among the less and more developed - weak and strong - countries, and open up new unusual possibilities for the weaker countries, not only as regards the sale of their raw material stocks in form of mining and intermediate products, but also their quick-paced development towards

the manufacture of semi-finished and finished goods, thus multiplying proceeds attainable from the sales of mining and intermediate products. Such specific elements are the following:

(a) Processing of the intermediate product, i.e. of the alumina, essentially in form of a job-work and retransport of the full metal quantity originating from the raw material after reduction so that it can supply the developing semi-finished and finished goods industry with the necessary basic material;

(b) balancing of the costs of reduction on the basis of world market prices mutually advantageous for both parties;

(c) sharing of investment costs in the different phases of development up to finished goods manufacture among countries participating in the co-operation, which is very essential and particularly advantageous for the economically less developed countries;

(d) the projects established by means of development in both co-operating countries remain in the national ownership of the respective country, and the accumulation funds thus attained may be used fully for the development of their economy.

89. This survey has been intended to give a brief information on the history of the Hungarian aluminium industry looking back on a past of approximately 40 years and on the experiences which in some cases may be generalized and may, in our opinion prove to be useful for others as well. Since the liberation of our country the considerable level of quantitative development achieved in the main articles of the aluminium industry has gone naturally hand-in-hand with the increase of the technical level, which is rather noteworthy in some of our enterprises; so that we believe, there exist real possibilities for our participation - on the basis of mutual advantages and naturally within the limits of our resources - in the successful solution of the problems of development of other interested countries.

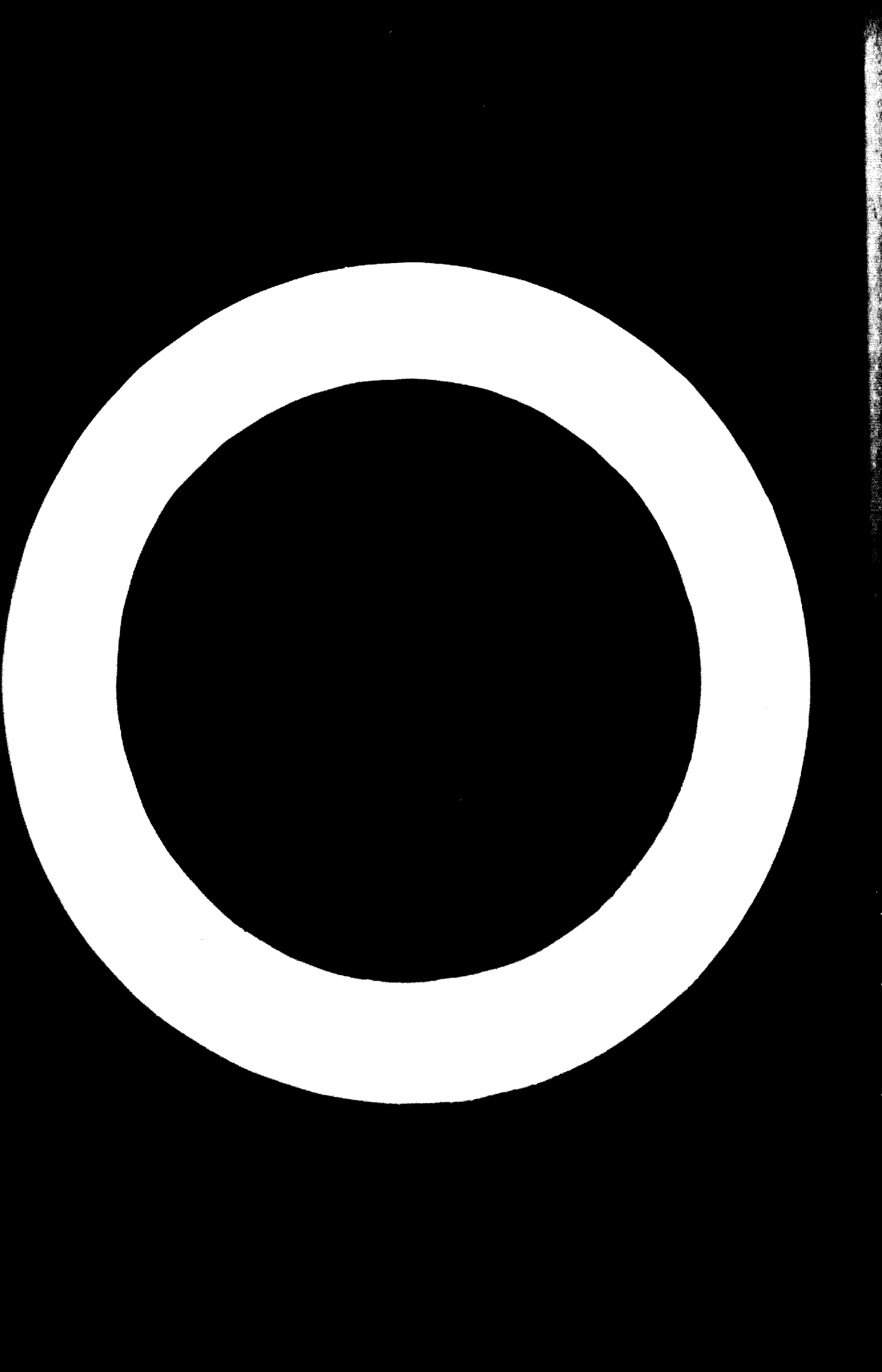

Table 1

Production of Aluminium Industrial Works in Romania: income derived from the sales of main products

	1956 - 1959				1954 - 1965				1966 - 1954				1955 - 1964				1965 - 1970			
	Production	Sale: Quantity	Sale: Value	Share in total sales	Production	Sale: Quantity	Sale: Value	Share in total sales	Production	Sale: Quantity	Sale: Value	Share in total sales	Production	Sale: Quantity	Sale: Value	Share in total sales	Production	Sale: Quantity	Sale: Value	Share in total sales
	et	et	MŞ	%	et	et	MŞ	%	et	et	MŞ	%	et	et	MŞ	%	et	et	MŞ	%
Bauxite	1434,0	1434,0	8,6	100,0	4003,7	3974,3	34,0	52,3	6603,0	4979,0	29,9	19,8	11891,5	5868,3	35,1	8,6	10,295,3	3727,2	22,4	5,6
Alumina	-	-	-	-	109,9	29,1	2,1	3,2	56..5	253,9	18,3	12,1	2834,4	1119,9	80,6	19,7	2,189,3	1465,3	105,8	26,6
Aluminium	-				40,4	3,4	1,5	2,3	153,8	34,9	15,7	10,3	447,7	119,1	53,6	13,1	362,0	6,6	3,0	0,8
Aluminium Semi-products	- -				36,5	36,5	27,4	42,2	116,6	116,6	87,5	57,8	319,5	319,5	239,6	58,6	355,4	355,4	266,6	67,0
Total Sales			8,6	100,0			65,0	100,0			151,4	100,0			408,9	100,0			397,8	100,0

NOTE: et = 1000 tons
MŞ = million dollars

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Annex
English

Table 2

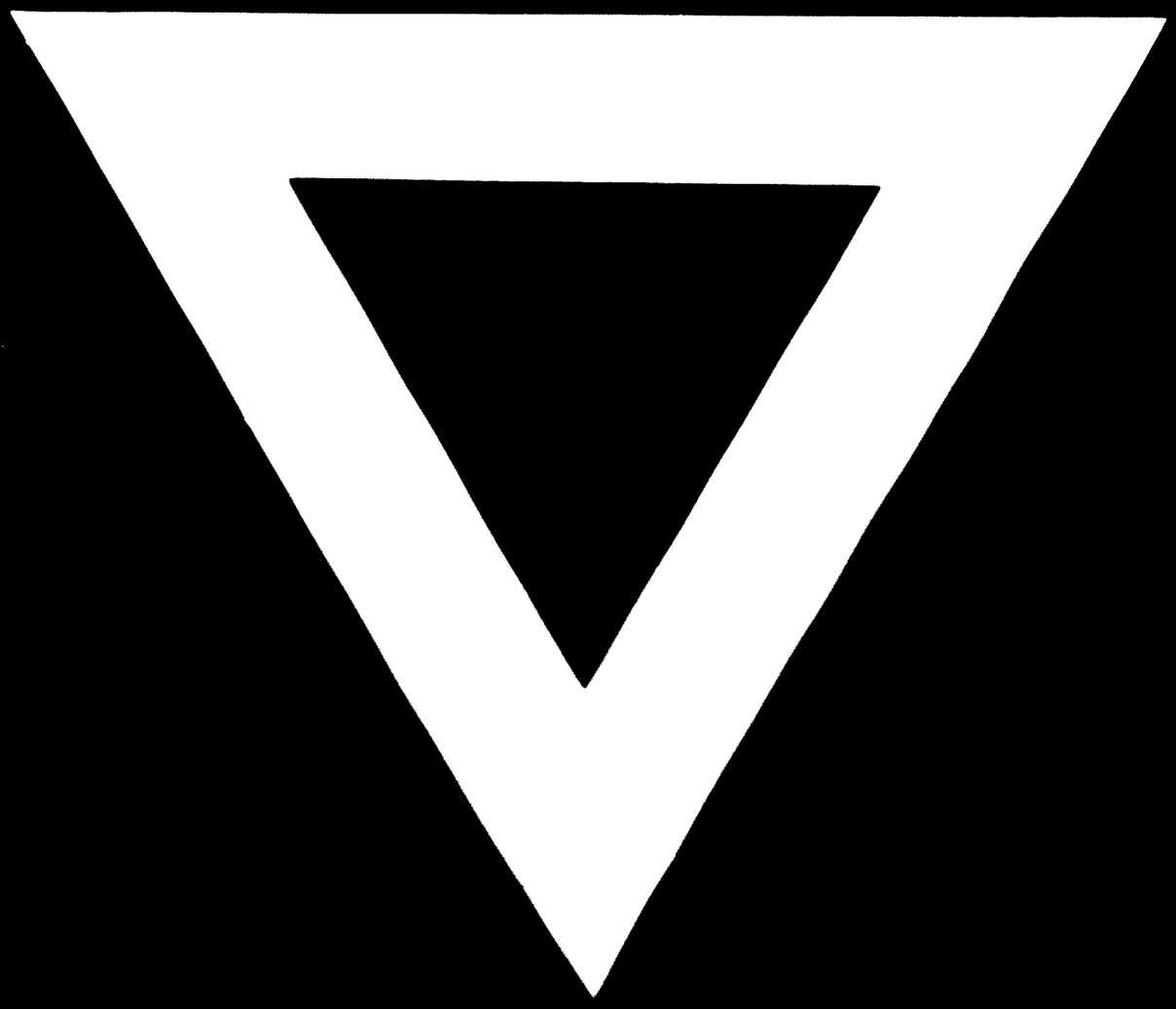
Comparison of realized sales with the value of the metal contents of the produced bauxite reckoned at an average semi-product selling price from 1926 - 1970

	Quantity of bauxite produced	Value of metal contents in bauxite calculated on basis of semis	Total sales in the period under review	Total sales in the period under review compared to the value of bauxite metal contents calculated on basis of semis
	th.t.	m/$	M/$	per cent
1926 - 1933	1434,0	179	8,6	4,8
1934 - 1945	6003,7	751	65,0	8,7
1946 - 1954	6663,0	833	151,4	18,2
1955 - 1964	11891,5	1486	408,9	27,5
1965 - 1970	10295,3	1287	397,8	30,9

Table 3

Investment necessary for a vertically built-up aluminium finished goods factory of a total capacity of 100,000 tons per year / excluding investments for the further development of transport

	Necessary investment for 1 ton capacity per year	Capacity required for manufacture of 100.000 t/year of aluminium-finished goods	Investment required for the capacity in connection with the manufacture of 100.000 t/y of aluminium-finished goods
	$US	tons	$US million
Bauxite mining	25	600.000	15
Manufacture of alumina	250	200.000	50
Increase of the energy basis necessary for the aluminium furnace and metallurgy	2200	100.000	220
Rolled goods /sheets and strips/	700	45.000	31,5
Foil	1000	5.000	5
Extrusion goods	1200	20.000	24
Wire manufacture with continuous casting from molten metal	300	10.000	3
Scrap processing	100	15.000	1,5
Die-casting	1500	25.000	37,5
Cable manufacture	1000	10.000	10
Pots and pans and mass-goods manufacture	600	20.000	12
Aluminium structures	350	20.000	7
Miscellaneous	200	25.000	5
Total			421,5



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