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REPORT
ON
AN EXPLORATORY MISSION TO ASSESS THE DEVELOPMENT OF THE LEAD AND ZINC INDUSTRY IN IRAN

Teheran, Iran
22 January - 2 February 1970

This Report has not been cleared with the secretariat of UNIDO which does not, therefore, necessarily share the views expressed.

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This paper has been prepared by Mr. B. Crowston, Industrial Technology Division, UNIDO, Vienna.

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INTRODUCTION

The Ministry of Economy and the Industrial Development and Renovation Organization (IDRO) of Iran are currently examining the possibilities of developing a local lead and zinc industry.

The author, a UNIDO staff member, was requested by the Government to assess the studies which had been prepared on the development of such an industry. In addition to examining the technological aspects, a detailed examination of the capital costs, capital charges and operating costs included in the studies was requested by IDRO, to assist in the discussions being held with a potential plant supplier.

The report includes the main findings from the assessment of the studies, together with a draft proposal for a Special Fund project to assist IDRO in developing this industry in Iran.

A number of discussions were held with the Resident Representative and officials from the Ministry of Economy of the Government of Iran, regarding future technical assistance projects to be backstopped by UNIDO. The results of these discussions are included in this report.

ITINERARY OF THE MISSION AND MAIN MEETINGS HELD

21 January 1970: Arrival in Teheran by air from Vienna

22 January 1970: Meeting with Mr. M. Shallon, Resident Representative and Mr. D. Bernander, Assistant Resident Representative
It was agreed that on the spot assistance should be given to the Industrial Development and Renovation Organisation (I.D.R.O.) of Iran at the same time as assessing the possible future UNIDO technical assistance in this sector. The evaluation of the possibilities for a Metallurgical Centre in Iran would be the subject of a subsequent, separate, mission.

22 January 1970: Meeting with Mr. R. Assefi, Ministry of Economy.
Mr. Assefi outlined that a USSR delegation was currently discussing with I.D.R.O. a proposal to build a lead and zinc plant in Iran. Recommendations of a lead and zinc plant in Iran would be made, based on the outcome of these negotiations.

22 January 1970: Meeting with Messrs. Kiamand, Kia, Jahanmiri, and Touba of I.D.R.O. and Mr. R. Assefi, Ministry of Economy.
I.D.R.O. requested an examination of the various studies made on the development of a lead and zinc industry in Iran. In particular a detailed study of the technologies suggested and capital and operating costs proposed by GIPROTSVETMET (the USSR State Institute for Designing Non-Ferrous Metallurgy Enterprises) was required.

1 February 1970 (Sunday): Meeting with Mr. Assefi, Ministry of Economy.
The future development of Iran's metallurgical industry was discussed. Mr. Assefi indicated that assistance was required by the Ministry of Economy in determining the feasibility of obtaining pigments from red iron ore.

The expert was required to assess the feasibility of processing these ores. (A document giving more information on this potential project is attached as Appendix III.)

1 February 1970: Discussions with Mr. G.J. Williams, Project Manager and Mr. N. Khadem, Director of the Geological Survey of Iran.

It was suggested that part of the facilities and information obtained during the Geological Survey might be useful to the ceramic industry in Iran. The possibility of a ceramic industry consultant being provided by UNIDO under SIS fund for some two months to prepare a programme of work and specify the manpower and equipment required for a Special Fund project to assist the improvement of present operation and extension of the ceramic industry was mentioned. It was agreed that this would be discussed further with the appropriate officers in UNIDO.

2 February 1970: Meeting with Mr. N. Shallon, Resident Representative.

It was agreed that an individual expert in lead and zinc production would be suggested as a pre-liminary to the Special Fund project outlined in Appendix II of this report. A proposed job description for the expert is set out in Appendix IV.

The potential Special Fund projects for a Ceramic Centre and Metallurgical Centre could both be attached to the existing Geological Survey. A geological, mineral dressing, metallurgical and ceramic complex supported by individual Special Fund projects but having common administrative facilities, was considered desirable.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

1. The Technical-Economical Report on the Development of Lead-Zinc Industry in Iran by the USSR Institute for Designing Non-ferrous Metallurgy Enterprises, made in 1968, indicated that the deposits of oxide ores of lead and zinc in Iran cannot be utilised for the production of these metals in the near future. The study therefore proposes that a lead and zinc complex be erected in Iran based on the sulphide deposits found in the central area of Iran. The extent of the reserves of these ores, however, have not been established.

2. Oxide ores, similar in chemical and physical characteristics to those found in Iran, can and are being processed in a few developing countries. The Waelz Process is generally used, followed by conventional processing in zinc electrolytic and lead blast furnace plants or in an Imperial Smelting Furnace. The flow-sheet is more complicated and less well established than the conventional sulphide flow-sheet, and consequently the production costs involved are higher. A feasibility study of the treatment of the oxide ores found in Iran has recently been completed by J.M. Reimers of Canada as part of UNIDO's SIS programme of technical assistance.

3. The internal market for lead and zinc in Iran is small. For this reason the majority of these metals produced by smelting plants erected in Iran will be exported. It is essential, therefore, that if any future lead and zinc complex is to be profitable, it must produce these metals at costs below the International Metal Exchange price. There are, however, no qualified metallurgists in Iran with practical experience in this area. Based on these parameters, it would appear that primary consideration should therefore be given to utilising the sulphide ores. These can be separated by simple flotation and the concentrates produced can be treated in conventional zinc electrolytic and lead blast furnace or electric arc furnace plants. Such flow-sheets have been successfully adopted in a number of developing countries.

4. The general strategy for development of a lead and zinc complex, based on sulphide ores and utilising the conventional methods of metallurgical processing outlined in the GIPROTSVETMET study appears therefore to be justified. Two important aspects of the study, however, appear to require further consideration.

(a) Capital costs: The capital costs for an electrolytic zinc plant appear to be more than three times higher than estimated made by large international lead and zinc producers and plant suppliers for similar capacity electrolytic zinc plants - $ 37 million as compared with $ 12 million. A detailed analysis of these costs is shown in Appendix I.

(b) Profitability: The profitability of the lead and zinc plants is largely based on inflated domestic prices for lead and zinc, in comparison with the International Metal Exchange prices. An estimate of remuneration of capital for an electrolytic zinc plant producing 30,000 tons of zinc per annum is to be found also in Appendix I.

Recommendations:

1. Further exploration should be made of the reserves of sulphide ores of lead and zinc in the central area of Iran as suggested in the GIPROTSVETMET study. The team of experts recruited to carry out this work might be attached to the Geological Survey Institute of Iran in order to be able to utilize the information and service already available in Iran.

2. The GIPROTSVETMET study suggests the erection of an interlinked lead and zinc smelting complex recovering all values. In view of the shortage of qualified personnel available in Iran in the production of these metals, it might be advisable to consider the erection of a simple zinc or lead plant, either combined or as single units. The recovery of leach residues and sulphurous gases from the zinc plant and lead furnace slags could be developed later as a second phase when the main units are operating efficiently.

3. The conventional flow-sheet, roasting, leaching and electrolysis, could be used for the production of zinc from zinc sulphide concentrates. A further study of the advantages of producing lead in the electric arc lead smelter developed by the Boliden Mining Company in Sweden and the lead blast furnace might be made. Similarly, a comparison of electrolytic and thermal refining of lead bullion could be elaborated.

4. The necessary metallurgical know-how required in the short term to assist the successful development of a lead and zinc industry based on sulphide ores in Iran might be provided by experts with specialised knowledge of various aspects of lead and zinc production and, in the long term, through fellowship training. This assistance could be financed from the UNDP Special Fund. A draft proposal for a Special Fund project to assist the Industrial Development and Renovation Organization of the Government of Iran in the planning, the designing and the operating policies required for a lead and zinc complex in Iran is set out in Appendix II.

5. If the resources of sulphide ores are found to be insufficient, however, to support the erection of lead and zinc sulphide plants, a detailed feasibility study of the production of these metals from oxide ores should be made. Such a study might be the subject of a mini-feasibility study financed by the UNDP Special Fund.

ASSESSMENT OF THE STUDIES ON THE DEVELOPMENT OF A LEAD AND ZINC INDUSTRY IN IRAN

The GIPROTSVETMET study:

The "Technical-Economical Report on Development of Lead-Zinc Industry in Iran" by GIPROTSVETMET, concludes that the locally occurring oxide ores of lead and zinc cannot be utilised in the very near future. The study proposes that the smelting units use the sulphide ore deposits found in the central region of Iran.

While accepting that the actual extent of the reserves and analysis of the sulphide deposits have not been established, the GIPROTSVETMET report states that information gathered by Soviet specialists during 1968 indicate that the sulphide deposits should be sufficient to support the erection of a lead and zinc complex.

The GIPROTSVETMET study assumes an analysis for the sulphide ores. The ores were considered typical with no impurities which would complicate processing. The standard conventional flow-sheet, roasting, leaching and electrolysis of zinc sulphide concentrates was suggested. For the lead concentrates, sintering followed by blast furnace reduction and thermal refining was indicated.

No comparative assessment is made in the GIPROTSVETMET study of the possibility of using alternative techniques. For example, no consideration is given to using the Boliden process developed in Sweden as an alternative to sintering and blast furnace reduction. The thermal refining of lead bullion is assumed, and the possibility of electric refining is not mentioned. It is recommended that the Boliden Mining Company in Sweden, Lurgi GmbH in Frankfurt (FRG) and Monteponi and Montevecchio SP in Milan (Italy) might be approached to supply capital cost quotations and/or production cost data.

GIPROTSVETMET has estimated the capital operating costs and income from sales and profitability for conventional smelting of lead and zinc sulphide concentrates and has indicated an annual operating surplus of 660 million Rials equivalent to US$ [illegible] million for 30,000 tons zinc per annum and 30,000 tons lead per annum, and 625 million Rials equivalent to US$ [illegible] million for the 30,000-tons-zinc-per-annum and 30,000 tons-lead-per-annum plants.

Capital cost assessments and estimation of remuneration of capital

As previously stated, the GIPROTSVETMET costs are based on assumed ore analyses and are therefore only typical. No breakdown of the capital cost estimates was given, and only a small breakdown of operating costs was included. In addition, the capital charges used were not clearly defined. A much higher selling price to the domestic market compared with the International Metal Exchange price was also assumed.

The capital and operating cost estimates made by GIPROTSVETMET did not appear sufficiently realistic to determine whether further geological surveying of the Iranian lead and zinc sulphide ores and their subsequent smelting by the conventional methods would be a worthwhile investment. IMRO was anxious, however, to assess the potential profitability of treating these ores.

A detailed capital cost assessment and estimate of materials and operating costs and capital charges for a 30,000-tons-per-annum electrolytic zinc plant was therefore made. This was based on typical capital cost figures obtained from Canada, India and UK. The operating costs of raw materials and services used in this analysis, however, were those used by GIPROTSVETMET. The capital charges were based on estimates generally made by large international companies.

Particular attention was paid to compare like with like. For example, all plants were considered erected on a greenfield site which presented no civil engineering problems. Roasting, leaching, electrolytic zinc, sulphuric acid and cadmium recovery plants were included in each case. Provision was made for central works services and a minimum of inbuilt capacity for further expansion was assumed. The analysis is set out in detail in Appendix I.

The GIPROTSVETMET capital cost estimates for a 30.000-tons-per-annum electrolytic zinc plant appear to be three times higher than estimates provided to UNIDO for similar plants built in Canada, India and the UK, i.e. US$ 37 million as compared with US$ 12 million. Similarly, the GIPROTSVETMET capital cost figures for a 50.000-ton-per-annum electrolytic zinc plant appear to more than twice as high, i.e. US$ 43 million compared with US$ 17,5 million.

In the revised calculation of renumeration of capital, the income from sales is based on a selling price at the International Metal Exchange rate, and production costs include typical international capital charges based on their revised capital cost estimates. A remuneration of [illegible] per cent of the capital employed was estimated. It should be noted that this was based on a transfer cost for concentrates. If the mines and concentration plants are operated at a profit, which is most likely, an assessment on a through cost basis would show a much higher remuneration of capital.

A revised costing of the lead capital and production costs might indicate that a similar remuneration would be obtained. This exercise was not carried out as the time available was insufficient.

Technological assessment of oxide and sulphide ores for the production of lead and zinc in Iran.

A very small proportion of the present world's production of lead and zinc is from oxide ores. Plants processing such ores are to be found in Poland, West Germany and Canada. Sulphide ores are generally favoured for lead and zinc production whenever a choice is possible and the further exploration and possible treatment of this type of ore should be given primary consideration by Iran, for a number of reasons which are set out below.

(a) The lead and zinc produced must be exported. For profitable operation, therefore, the total production cost for both metals should be below the International Metal exchange prices.

(b) There is an absence of qualified metallurgists with experience in lead and zinc production in Iran. In order to keep production costs to a minimum therefore, the simplest and most well-developed classical techniques for smelting the sulphide concentrates of these metals should be used.

(c) A certain degree of process development will be required to treat the oxide ores in Iran. This development work will increase the production costs.

The treatment of the oxide ores should, however, be a long term consideration. The future expansion of the lead and zinc industry in Iran will most probably be based on these ores, which are abundant and very rich in lead and zinc. Work on the treatment of oxide ores by ammonia leaching has already been carried out in the Geological Survey Institute of Iran. This technique is not sufficiently advanced, however, for commercial exportation, but the results are promising. Development of this type should be intensified. This would appear a most useful objective for the Metallurgical Centre which is being considered in Iran.

Future zinc smelting plant

The revised cost assessment for an electrolytic zinc smelting plant based on sulphide concentrates, together with technological considerations suggest that, provided adequate reserves of good quality zinc sulphide ore are available in central Iran, an electrolytic zinc plant be erected to produce zinc for Iran's internal needs as well as for export. The capacity and location of this zinc plant should be decided upon when the reserves and analysis of the various sulphide ore bodies are known and when a market study of Iran's internal requirement and possible export markets have been assessed. In order to obtain the maximum return on capital employed, a cheap and simple flow-sheet should be used in the first phase. The recovery of sulphuric acid and residue treatment for cadmium should be added as a second phase when the main unit is operating efficiently.

The zinc electrolytic process is well proven and highly developed, and is relatively simple to operate. In addition, a large proportion of the equipment for such a plant might be provided locally.

Future lead smelting plant

The flow-sheet to be used for the production of lead from lead sulphide concentrate requires further consideration. The GIPROTSVETMET study suggests the conventional sintering, lead blast furnace and thermal refining flow-sheet. The merits of the Boliden process, developed in Sweden, which utilized an electric arc furnace to reduce the lead concentrates, should be compared with those of sintering and blast furnace reduction. Similarly, a comparison of electrolytic lead refining and thermal refining should be made. As previously mentioned, the Boliden Mining Company in Sweden, Lurgi GmbH in Frankfurt (FRG) and the Monteponi and Montevecchio SP in Milan (Italy) might be approached to supply capital cost quotations and/or production cost data.

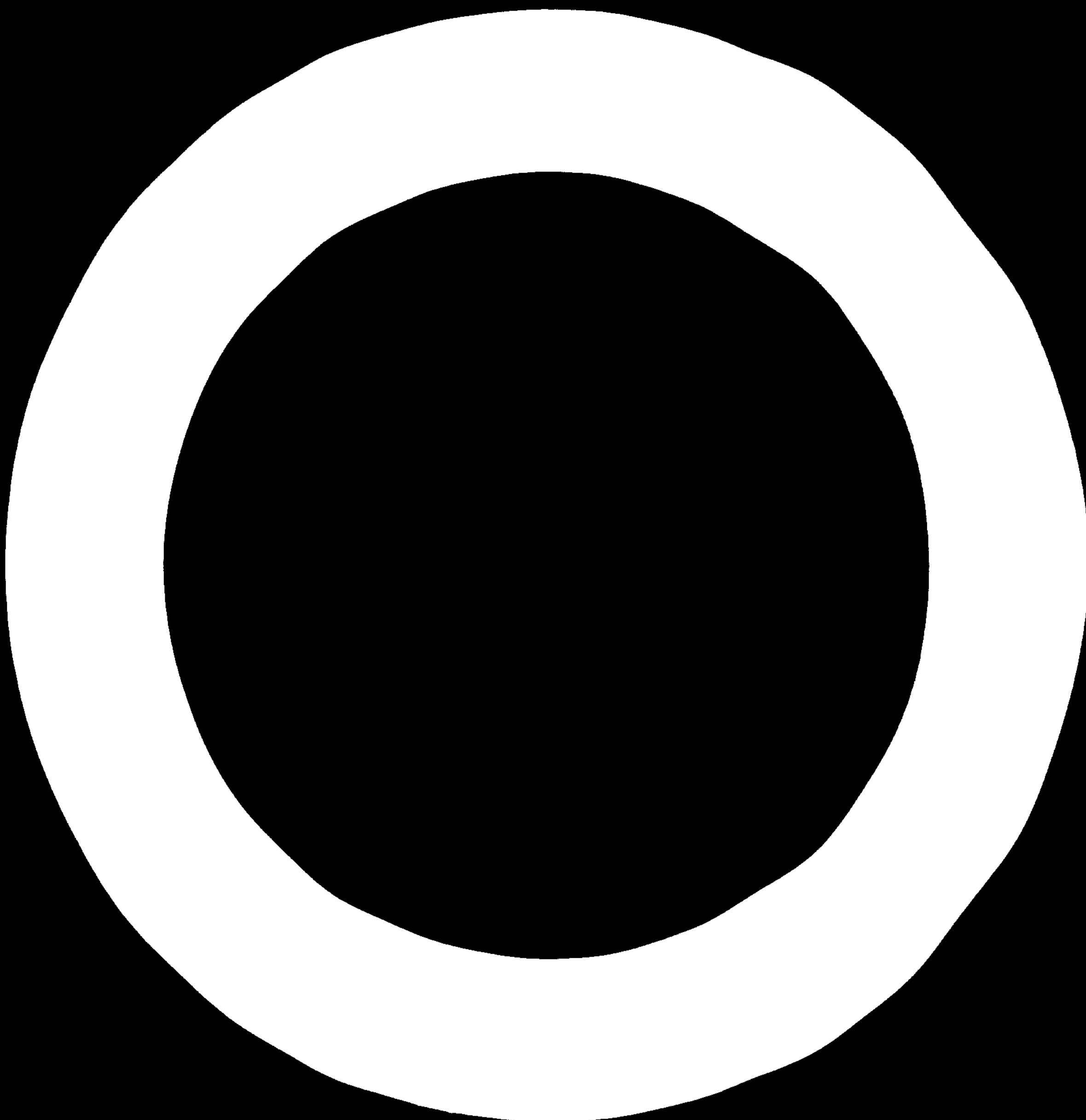
A final choice of the lead flow-sheet required should therefore be based on the results of the cost comparisons mentioned above. The lead blast furnace is a well proven and reliable unit. The Boliden process is a relatively complex and new process. The cost advantage in reality may therefore differ from any theoretical cost analysis. The difference between actual and estimated production costs for thermal and electrolytic refining of lead bullion, however, should not be great, as the two are similar in complexity

Future UNIDO assistance

The lead and zinc plants to be erected in Iran, as has been repeatedly stated, would need to be internationally competitive in order to export the greater part of their production. It is most essential therefore that the plants incorporate the latest techniques which will enable optimum capital and operating costs to be obtained under Iranian conditions.

The Industrial Development and Renovation Organisation (IDRO) should therefore be advised on the detailed design features at all stages of negotiations with plant suppliers. In addition, assistance in the operating policies with regard to production scheduling, costing, quality control, management, training and marketing and many other aspects will be required. The particular type of expertise required can only be provided by specialists with recent practical experience of lead and zinc production. There are no non-ferrous metallurgical smelting plants currently operating in Iran. As yet, therefore, no qualified metallurgists with experience in this field are available in the country. The expert and consultant component of a Special Fund project could provide, in the short term, the necessary experience of lead and zinc production and related fields. The fellowship component of the Special Fund project could provide, in the long term, a supply of mining, mineral preparation, metallurgy, engineering and economics graduates with relevant practical experience in the production of lead and zinc obtained in large smelting plants throughout the world.

A detailed description of the possible assistance which might be provided from the UNDP Special Fund, is set out in Appendix II.



APPENDIX I

Assessment and revision of capital and operating costs contained in the Technical-Economical Report on Development of Lead-Zinc Industry of Iran by the GIPROSVETMET, the USSR State Institute for Designing Non-ferrous Metallurgy Enterprises.

Basis of cost calculations

1. The GIPROSVETMET capital and operating costs are based on assumed concentrate compositions which enable typical costs to be estimated.

2. The capital and operating costs obtained in practice, however, are related to the specific design of the plant and the raw materials' analyses.

3. The GIPROSVETMET cost estimates are typical and most probably reflect current performances obtained in the USSR; however, they should be approximately the same as the capital and operating costs obtained in other lead and zinc plants in the world.

4. The following assessment of the capital costs proposed by GIPROSVETMET, and the revised calculation of production cost and return on capital costs, are confined to the electrolytic refining of zinc from zinc sulphide concentrates.

5. Particular attention has been paid in the capital cost appraisal to compare like with like. For example :

(a) All costs estimates cover the equipment and processing involved from the receipt of sulphide concentrate at the plant to the delivery of the final product to the customer.

(b) In all cases a plant treating sulphide over by roasting, leaching, electrolytical refining and final re-melting and casting to slabs is included together with the necessary auxiliary services, site, preparation and erection.

(c) The level of inbuilt capacity for each plant has been considered, as far as possible, to be the same. The GIPROSVETMET report states that their capital cost figures could be reduced by 10 to 15%. The Indian and United Kingdom estimates used for comparative purposes include provision for future expansion. The Canadian estimate probably does not, but this is not specified. The capital cost estimates proposed by GIPROSVETMET are therefore shown reduced by 15% and also as submitted in the report.

(d) All figures include a contingency allowance and escalation charges.

6. The following capital charges have been calculated from the revised fixed capital costs for a 30,000-tons-per-annum zinc electrolytic plant.

(a) Depreciation : 4% per annum on 90% of the fixed capital and working capital costs.
(The assumed depreciation is on a straight line basis over twenty-five years, with a scrap value of the plant, at the end of this period, of 10%).

(b) Working capital : 10% per annum of fixed capital costs.
(This figure assumes that average stocks of concentrate and slab zinc are maintained.)

7. The income from sales is based on
(a) zinc sales at the International Metal Exchange price;
(b) an average delivery cost from the smelter to Asian and European ports and to Iran markets of $20 per ton ;
(c) the value of by-product sales quoted in the GIPROSVETMET report.

Revision of capital costs

Estimates received :

Country	Company	Cost in US $ million	Size of plant tons/annum
Canada	Cominco Ltd.	8.8	20,000
UK	Imperial Smelting Processes Ltd.	20.2	67,[illegible]00
India	Hindustan Zinc Limited	7.6	[illegible]0,000

The following capital costs per annual ton are therefore obtained :

Canada	$ 440 / annual ton
UK	$ 300 / annual ton
India	$ 380 / annual ton

..... A graph presented in figure I (attached) shows that the following capital costs should be obtained for 30,000 and 50,000-tons-per-annum electrolytic zinc plants. The GIPROTSVETMET calculations are included in the table below for comparative purposes.

<u>30,000 tons (metric) per annum</u>

	Canada/UK	India/UK	USSR	USSR-15%
Capital cost US $ million	12.6	10.8	43.4	37.0
Costs US $ per annual ton	420	360	1,445	1,233

A figure of US $ 400 per annual ton was therefore used for the fixed capital charges of a 30,000-metric-tons-per-annum electrolytic zinc plant. (The graphical results obtained ranged from US 390 - 410 per annual ton).

Similarly

[illegible]0,000 tons (metric) per annum

	Canada/UK	India/UK	USSR	USSR-1[illegible]%
Capital cost US $ million	17.7	16.[illegible]	50.8	43.23
Cost US $ per annual ton	33[illegible]	330	1,017	864

A figure of US $ 3[illegible]0 might be typical.

Determination of GIPROTSVETMET capital cost so as to include requisite proportion of auxiliary services etc.

The capital costs quoted in the GIPROSVETMET report are as follows for Variant II.

	$ million
Zinc plant 30,000 tons/annum	23.[illegible]
Lead plant [illegible]0,000 tons/annum	13.2
Sulphuric acid plant	3.6
Auxiliary departments and services	23.1
Incidental and other jobs	7.3
	70.7

Only a proportion of the US $ 70.7 million relates to a zinc plant. Capital cost of the zinc complex should include the actual zinc electrolytic plant US $ 23.[illegible] million plus a proportion of the acid plant, auxiliary departments and incidental costs. These were calculated as follows, i.e. as a function of the capital costs of the plants :

		US $ million
Zinc plant		23.5
Acid plant (3/8 x 3.6)		1.[illegible]
Auxiliary departments and services		
$\frac{23.[illegible]}{(23.5 + 3.6 + 13.2}$	x 23.1	13.4
Incidental expenses		
$\frac{23.[illegible]}{(23.5 + 3.6 + 13.2}$	x 7.3)	[illegible]
Total cost for zinc plant		43.4

Calculation of remuneration of capital for a 30,000 tons/annum electrolytic zinc plant using sulphide concentrates based on revised capital cost estimates of $ 400 per annual ton and GIPROSVETMET operating costs.

30,000-tons-per-annum electrolytic zinc plant :

Fixed capital = $ 12 million = $ 400/annual ton
Working capital= $ 1.2 million= $ 40/annual ton

Assuming a conversion rate US $ 1 = 75 Rials

Fixed capital = 900 million Rials = 30,000 Rls/annual ton
Working capital = 90 million Rials = 3,000 Rls/annual ton

Materials and operating costs quoted on page 166, table No 36 of the GIPROSVETMET study were used. In order to extract the component of cost charged to the zinc electrolytic smelting plant, the estimates for the sulphuric acid plants and auxiliary departments have been adjusted as follows :

Sulphuric acid plant - x 3/8
i.e. in a direct ratio to the output of the auxiliary departments

n.b. although the capital costs of services are a function of the capital costs of the plants, the operating costs are a function of the output of the plants.

Annual material and operating costs	Million Rials zinc units	sulphuric acid	auxiliary departments
Material costs			
Raw materials (including transport)	215	-	-
Auxiliary materials and fluxes	24.7	0.3	-
Total materials	239.7	0.3	-

	Million Rials zinc units	sulphuric acid	auxiliary departments
Operating costs			
Fuel	31.3	-	0.6
Electric power	68.	0.8	4.5
Wages and salaries	[illegible].8	2.0	23.3
Total operating costs	152.3	2.8	28.4

T o t a l materials and operating costs for zinc complex = 423.5 million Rials

Capital charges

Depreciation	4% on 90% of capital employed	
	fixed capital 900 million Rials	= 32.4
	working capital 90 million Rials	= 3.2
	T o t a l depreciation	35.6

T o t a l production costs = 423.5 + 35.6 = 459.1

T o t a l annual income from sales

slab zinc 30,000 x 17,000 Rls	510,0
less transport (average US $ 20 per ton) 30,000 x 1,500	45,0
	465.0
plus by-products (CIPROSVETMET estimate)	72,0
	537.0

Remuneration of capital

$$\text{Remuneration of capital} = \frac{\text{Annual value of sales} - \text{Annual production costs}}{\text{Fixed and working capital}}$$

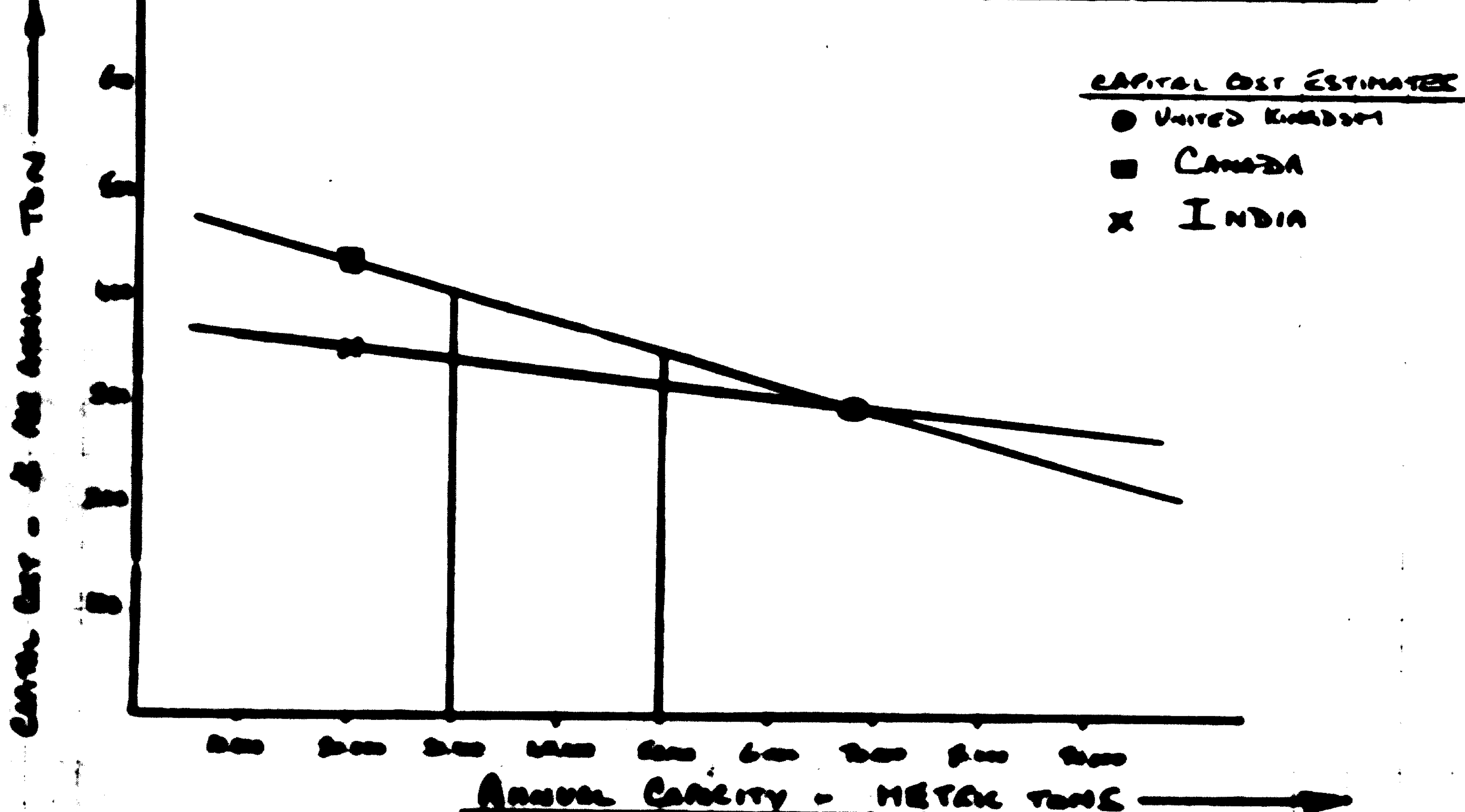
$$= \frac{537.0 - 452.1}{900 + 90} \times 100$$

$$= \underline{7.9}$$

Percentage remuneration of capital = approximately 8 %

FIGURE 1

COMPARATIVE COSTS OF ELECTROLYTIC ZINC PLANTS



APPENDIX II

UNDP SPECIAL FUND PROJECT

- Preliminary description -

1. Title of project : Assistance to the Industrial Development and Renovation Organisation of the Government of Iran in the planning, selection of technology, design of plant and equipment and formulation of the operating policies required for the development of a lead and zinc industry in Iran.

2. Country and location : Teheran, Iran

3. General justification of the project : The Ministry of Economy and the Industrial Development and Renovation Organisation (IDRO) are currently examining the lead and zinc ore deposits in Iran and the possible metallurgical smelting processes which might be used to produce lead and zinc.

There are no non-ferrous metallurgical smelting plants currently operating in Iran. As yet, therefore, no qualified metallurgists with experience in this field are available in the country.

The expert and consultant component would provide, in the short term, the necessary experiences of lead and zinc production and related fields to assist IDRO in the planning, selection of technology, detailed discussions of the design of the plant and equipment and also the formulation of operating and management policies, necessary to ensure that the plant is capable of producing lead and zinc at prices which are competitive in international markets.

The fellowship component would provide, in the long term, a supply of mining, mineral preparation, metallurgy, engineering and economics graduates with relevant practical experience in the production of lead and zinc in the large smelting plants throughout the world.

4. Background information: There are a number of lead and zinc ore deposits in Iran. They occur mainly as oxides. There are also sulphide deposits but the extent of these deposits is not known. A small amount of lead and zinc concentrates is exported, e.g. 47.000 and 40.000 tons respectively in 1967. The concentrates are obtained from a number of small mines, the ores being hand picked and the remaining ore dumped

The possibility of producing lead and zinc from sulphide ores is being examined. This would necessitate further exploration of these deposits. An alternative approach would be to exploit the more abundant oxide ores.

Approximately one third of the lead and zinc produced will be required for home consumption; the remainder will be exported. The Government is anxious therefore that the lead and zinc smelters be capable of producing these metals at internationally competitive prices. The plants should therefore be designed to include all the recent developments which reduce capital and operating costs.

5. Brief description of the project: The Special Fund project would be attached to the Industrial Development and Renovation Organization (IDRO) which is responsible for the creation of the lead and zinc industry.

The commissioning of detailed design of the plant and equipment is not envisaged until the reserves of the lead and zinc sulphide ores are accurately assessed, or, on the other hand, until a detailed consideration of the ore preparation and smelting of the oxide ores has been made.

During the first phase of the Special Fund project, the project manager should be recruited. He should be familiar with the creation and expansion of lead and zinc plants and have recent management experience in lead and zinc production. He will thus be able to advise IDRO on the initial planning, including the assessment of the comparative cost studies which have been made of the various metallurgical smelting techniques for lead and zinc production. The first additional experts recruited would be geological survey and marketing experts who advise on the exploration and the possible internal and export markets and marketing policies respectively.

The second phase would be implemented when the detailed design of the plant and equipment is commissioned. The specialists in the various branches of lead and zinc production would be recruited to advise IMRO on the various technologies and developments which should be included to ensure that both capital and operating costs are at a minimum. These specialists could also advise the Iranian management recruited for the lead and zinc plants on the manning tables required and define the specific duties to be carried out by each operator.

6. Resources required :

The project involves three main components. These are shown in detail on the table attached and are summarised below:

(a) Experts – 16½ man years at US 2[illegible],[illegible]00 per man year
– US $ 41[illegible],7[illegible]0 – UNDP – 3[illegible]3,27[illegible]
Iranian Government 6[illegible],47[illegible]

(b) Consultants – 4 man years at US [illegible]2 ,[illegible]00 per man year
– US $ 100,800 UNDP 85,680
Iranian Government 1[illegible],120

(c) Fellowships – 10 graduates for 6 months each
– US $ [illegible]00 per month plus US $ 1,000 travel
– US $ 72,000 – UNDP – 72,000
Iranian Government zero

Based on the above components, the contributions required are

UNDP	US $ [illegible]
Iranian Government	US $ [illegible]
Total	US $ [illegible]

In addition, the Iranian Government would be required to supply the necessary office accommodation in the Industrial Development and Renovation Organisation (IDRO). IDRO would be responsible for the provision of counterpart personnel.

7. Action required: The Government of Iran should submit an official request based on the above draft proposal to the United Nations Industrial Development Organisation (UNIDO) via the UNDP Resident Representative in Teheran.

(First draft proposal)

UNDP SPECIAL FUND PROJECT

__Assistance to the Industrial Development and Renovation Organization (IDRO) of the Government of Iran in the planning, selection of technology, design of plant and equipment and formulation of the operating policies required for the development of a lead and zinc industry in Iran__.

__Experts__ : 16½ man years = $41[illegible],770

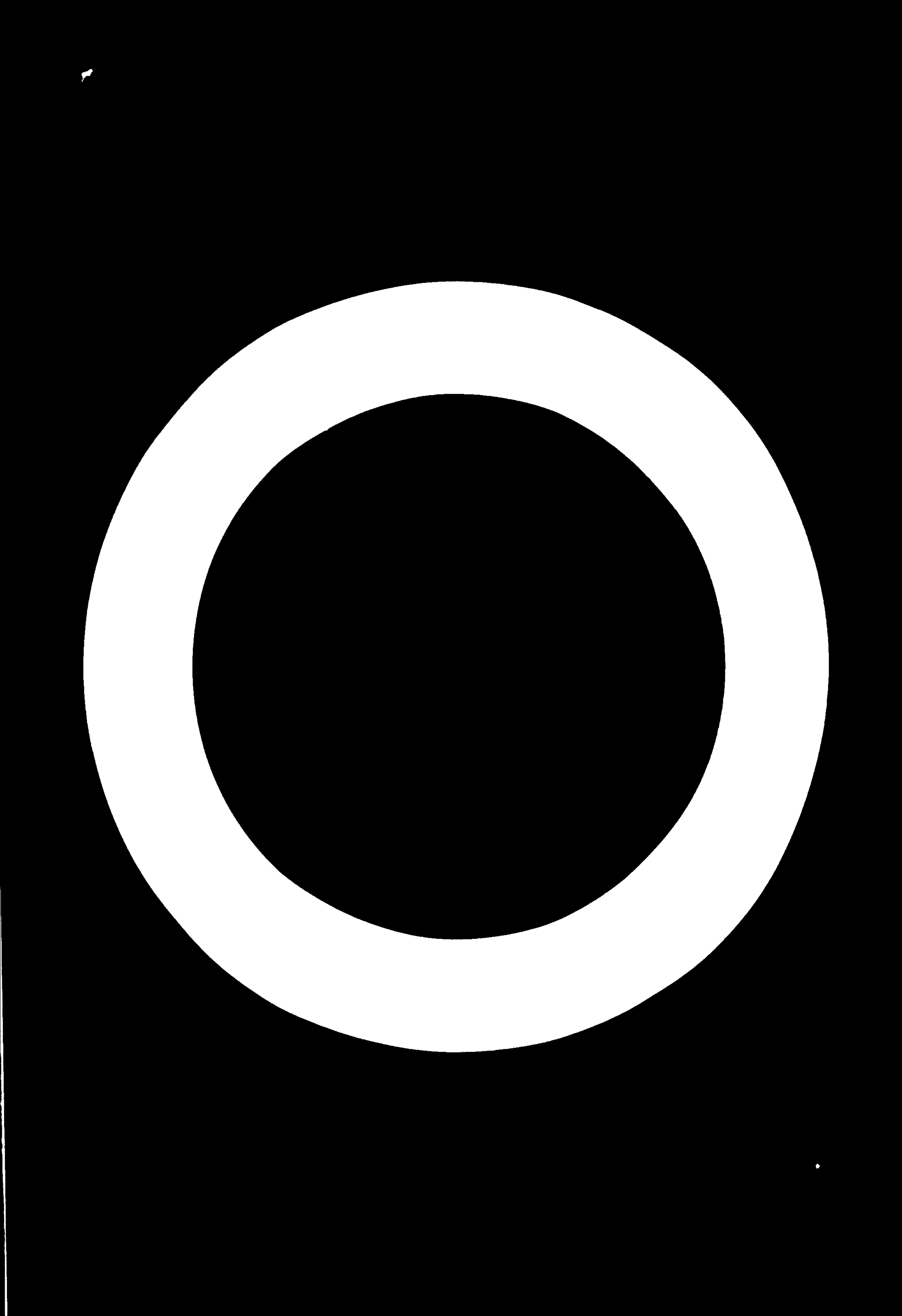
	1971	1972	1973	1974	1975
1. Project manager	1/6	1/12	1/12	1/12	1/12
2. Geological survey		1/12			
3. Lead and zinc marketing		1/6	1/6		
4. Lead and zinc mining			1/6	1/6	
5. Lead and zinc flotation			1/6	1/12	1/6
6. Zinc roasting and leaching			1/6	1/12	1/6
7. Zinc electrolysis			1/6	1/12	
8. Lead blast furnace			1/6	1/12	
9. Lead refining			1/6	1/12	1/6

__Consultants__ : $100,800

e.g. Cost accountant - mettalurgical)
Lead and zinc separation flotation) 4 man years
Critical path method)

__Fellowships__ : 6 months - $ 72,000

1.	Lead and zinc mining	2 mining engineers
2.	Lead and zinc flotation	2 mineral preparation graduates
3.	Lead blast furnace	2 metallurgical graduates
4.	Lead refining	2 metallurgical graduates
5.	Zinc electrolysis	2 metallurgical graduates
6.	Lead and zinc plant maintenance	4 engineering graduates
7.	Non-ferrous metal marketing	2 economics graduates
8.	Metallurgical plant costs	2 industrial cost accountants



APPENDIX III

INFORMATION MATERIAL FOR POSSIBLE PROJECT ON FEASIBILITY OF TREATING RED IRON ORES FOR PIGMENT.

In the Hormoz Island (Persian Gulf), there exists a red iron oxide deposit, the chemical composition of which is attached herewith.

The Government of Iran are considering processing this raw material in order to produce a substance which could readily be used in the pigment industry. They are envisaging a plant with a capacity of ,000 to 7000 tons per annum in the first stage of production.

Information concerning the economics of this project, relevant technical data is required in order to assess the feasibility of processing here ores to produce pigments.

Information required :

1. Specification of plant to process natural red iron oxide for industrial use :

   a) Minimum technical and economic capacities of such a plant
   b) Approximate investment expenditure requirements.
   c) Could the plant also be used for processing other pigments ?
   d) Any other relevant data, such as amount of power and water required.

2. Specification of Hormos Island red iron oxide (Persian Gulf red iron oxide)

Fe_2O_3	76.9 %
Al_2O_3	1.14%
SiO_2	14,78%
CaO	0.34%
MgO	0.18%
Cl (total)	1.77%
Na	0.90%
K	0.08%
Nacl	0.1 %
S03	0.528%
P	0.153%
Moisture at 110°C	2.29%
Loss on heat at 900°C	2.92%

Usually Fe_2O_3 is more than 70%

<u>APPENDIX IV</u>

<u>DRAFT JOB DESCRIPTION - LEAD AND ZINC PRODUCTION EXPERT</u>

I R A N

POST TITLE: Lead and zinc production expert

DURATION: one year

DATE REQUIRED: as soon as possible

DUTY STATION: Teheran, with travel within the country

DUTIES: The expert will be attached to the Industrial Development and Renovation Organisation (IDRO) of the Government of Iran, who are responsible for the initial development of a lead and zinc industry in Iran. The expert would assist IDRO in the

(a) Evaluation and appraisal of the studies and quotations to develop a lead and zinc smelting complex in Iran.

(b) The general policy required to successfully develop their industry.

(c) Negotiations with potential plant suppliers.

(d) Formulation of a long term programme for future expert assistance required.

(e) Training of counterpart personnel.

QUALIFICATIONS: University degree in metallurgy, or equivalent. Recent practical experience, preferably management production or maintenance, in a lead and zinc smelting complex is desirable.

LANGUAGE: English.

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BACKGROUND INFORMATION:

There are a number of lead and zinc ore deposits in Iran. They occur mainly as oxides. There are also sulphide deposits but the extent of these deposits is not known. A small amount of lead and zinc concentrates is exported, i.e. 47,000 and 40,000 tons respectively in 1967. The concentrates are obtained from a number of small mines, the ores being hand picked and the remaining ore dumped.

The possibility of producing lead and zinc from sulphide ores is being examined. This would necessitate further exploration of these deposits. An alternative approach would be to exploit the more abundant oxide ores.

Approximately one third of the lead and zinc produced will be required for home consumption, the remainder will be exported. The Government is anxious therefore that the lead and zinc smelters should be capable of producing lead and zinc at internationally competitive prices. The plants should therefore be designed to include all the recent developments which reduce capital and operating costs.

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