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I R A N

FINAL REPORT

PROPOSED CENTRE FOR METALLURGICAL TECHNOLOGY 1/

by

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SUMMARY AND RECOMMENDATIONS

1. The long-term need for a Centre for Metallurgical Technology (C.M.T.) clear from previous missions and on general grounds, but it is essential ensure that work will be channelled to it and adequate funds made available to support its continued operation. Further stimulation of the demand both the Government and industry is necessary.

2. This should be done by sending a team of experts from a metallurgical research organization in a developed country (collaborating institute) to advise the Iranian Government on problems which are worthy of Government funding and to give technical help and advice to Iranian industries with technical problems. Counterpart Iranian personnel should also be provided. The team would form the nucleus of the Centre when it is set up at a later date.

3. Where possible such problems should be tackled with existing Iranian facilities in universities or ISIRI, but where facilities or expertise are inadequate in Iran, the problems should be tackled in the collaborating institute overseas using Iranian graduates on fellowship grants as investigators or assistants.

4. Offices and appropriate facilities for this first stage should be provided by the Ministry of Economy or an organization such as IDRO or the Mining and Metallurgical Corporation of Iran.

5. The first or preliminary stage should occupy a total time of three years at an estimated cost to the Iranian Government of 20,000,000 rials* and of $370,000 to UNIDO and involves a bilateral link with a collaborating institute.

6. Planning the setting up of the C.M.T. should not take place until the end of the first two years of the preliminary stage and it will be part of the duties of the team to ensure an adequate income. A figure of US$1,000,000 p.a. is suggested as the target.

7. Detailed recommendations regarding location, staffing and equipment of the C.M.T. should not be made until it is clear from the work of the preliminary stage what work will be required and what problems will need to be solved, but the capital expenditure on buildings and equipment should be approximately equal to the anticipated annual income. The team operating the first stage should prepare plans for the C.M.T. during the third year.

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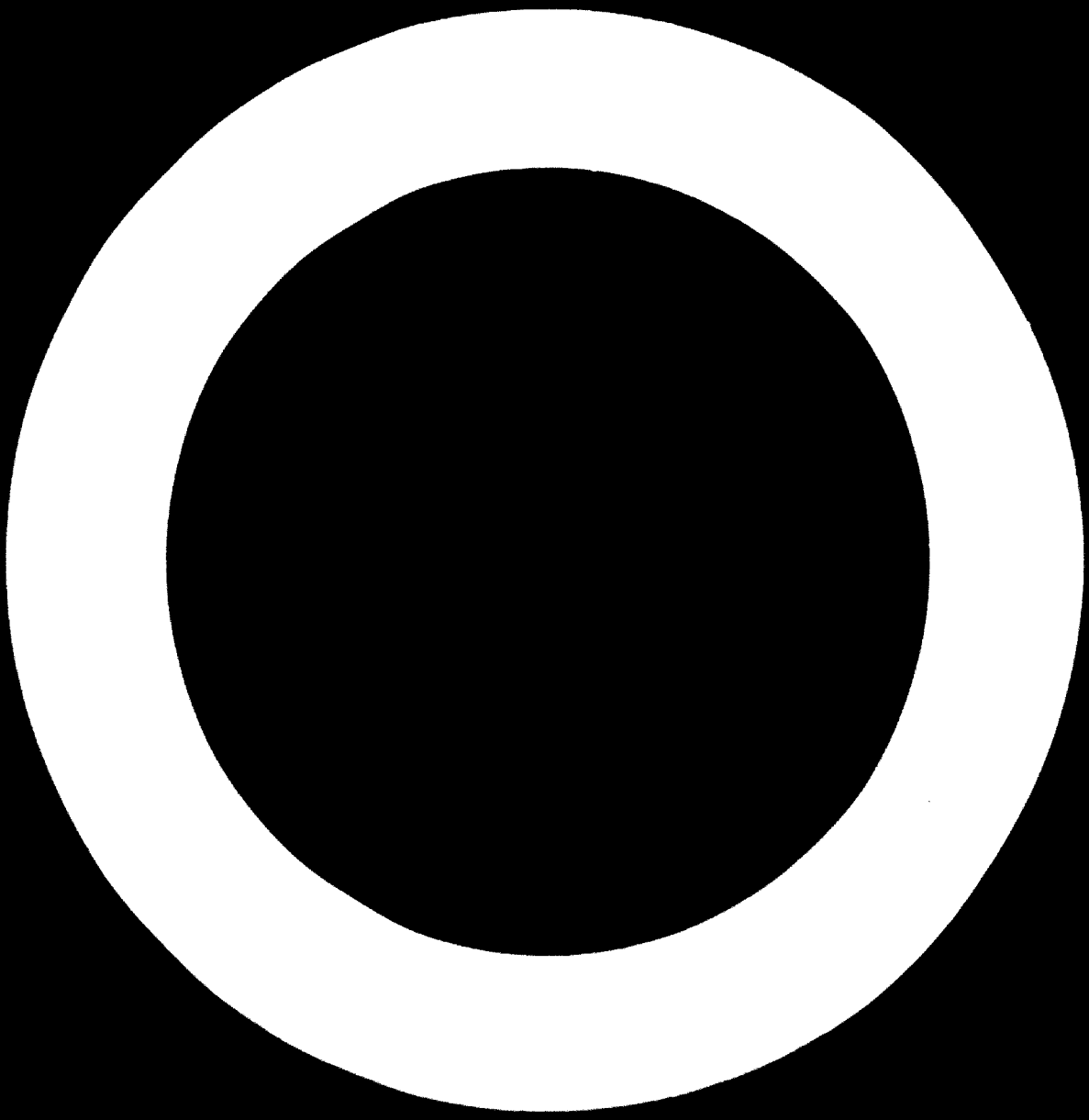
* 20,000,000 rials = US$266,666 - 75 rials = US$1.00.



1. INTRODUCTION

The terms of reference for this assignment as set out in the service agreement were: To "advise the Government on the creation of a Centre for Metallurgical Technology" (hereinafter [illegible]) this will include "an assessment of the services needed by [illegible] and of those already available, to determine the sectors [illegible] of metallurgy for priority assistance and establish a time-table [illegible] commissioning the various departments and sections of the Centre". Other duties included in the job description covered location, [illegible] administration, staffing, equipping, and costing.

The need for such a centre in Iran is considered to have been established by previous missions and reports (1, 2 & 3) and the [illegible] mission was to consider how to implement the decision. Accordingly an attempt was made to determine :-

(a) what problems were likely to need solution

(b) who would submit problems and how would work on them be financed

(c) how can industry in both public and private sectors be made aware of their problems and the need to solve them and contribute financially to their solution

(d) what existing facilities might be used

(e) what equipment would be needed, with what priorities and at what cost

(f) how adequate staff could be obtained or trained

(g) where the C.M.T. should be located and under whose guidance or administration

(h) time-table.

II. PROBLEMS TO BE SOLVED AND SERVICES TO BE PROVIDED

(a) Extractive Metallurgy

The future metallurgically-based industries in Iran must start with the utilization of indigenous ores. To establish the nature, location and extent of minerals of metallurgical significance is the duty of the Geological Survey assisted, where necessary, by consultants, foreign experts and commercial organizations. The dressing, beneficiation, and processing of such ores and minerals is the responsibility of the mining companies assisted by the Geological Survey, but in certain cases some overlap may occur and the C.M.T. may be expected to advise and assist, particularly where some less conventional approach is required, e.g. the leaching of certain low-grade copper ores, followed by electro-winning rather than smelting, or the carbo-thermic (arc furnace) reduction of ores to produce ferro-alloys.

The smelting stage comes into the orbit of the C.M.T. which must be expected to recommend or devise processes for dealing with available raw materials, operating them up to the pilot plant stage.

In the case of major metals, iron, copper, and aluminium, the necessary technical expertise for primary reduction is being supplied in part by foreign experts or partners working in association with Iranian counterparts. It is unlikely that the C.M.T. will be called upon to assist in these projects, which

are, or soon will be, in production or in an advanced stage of development. However, some problems may well arise outside the primary reduction units. It is understood, for example, that there is a small copper extraction unit near Teheran which may well assistance. Moreover, new lines of approach may be required in these fields, e.g. direct reduction of iron ore, electro-refining copper, or carbo-thermic reduction followed by catalytic disproportionation of aluminium and in these a C.M.T. will undoubtedly participate.

The C.M.T. could with advantage collaborate with the Geological Survey in exploring the possibility of utilizing indigenous kaolin or other aluminium-containing minerals as an alternative to the alumina at present being imported from Australia.

Other potential extractive metallurgical industries may well be set up with the assistance of the C.M.T. For example, lead and zinc smelting, although owing to the poor economic outlook for lead in the world markets and the present low domestic demand for both, that for lead, and to a lesser extent zinc, seems unpromising. However, the situation may change in the case of domestic zinc, particularly if the proposal to establish a semi-finished and finished copper and copper alloy manufacturing facility in Iran (5) is implemented. This will greatly increase the demand for zinc in the manufacture of brass and there is also considerable likelihood of a substantial domestic die-casting industry emerging for the supply of zinc-base die-castings for car manufacture. Hesse (6) recommends a research programme up to the minor or pilot plant stage pending the expected change in domestic demand. This is the sort of work that could well be done at the C.M.T.

Treatment of chromite ore either to produce ferro-chrome or supply chromic oxide for the electroplating industry could well be a subject for further study in a C.M.T. The move to encourage domestic production of lead batteries would also stimulate demand for antimony, some ores of which are currently exported from Iran, and the development of the gold mining industry would be assisted by technical advice on cyanide leaching.

(b) Melting and Casting

The need for helping the foundry industry has been emphasized by many authorities. The large foundries associated with machine tool and automotive industries at Tabriz and Arak will undoubtedly need technical assistance for quality control and in the selection of suitable sand and other foundry materials. The backwardness of the small scale foundries has been emphasized in an earlier survey (3). From the standpoint of tonnage, iron and steel will represent by far the greatest part of the foundry industry, but when the value of the product is taken into consideration the part played by aluminium and zinc (particularly in die-casting) and brass and bronze becomes more significant and the technical problems involved in the production of sound castings are equally numerous for each metal. The C.M.T. will have a particularly useful part to play in encouraging new enterprises in this field.

Many metallurgical processes, particularly blast furnaces and metal melting furnaces in foundries, use metallurgical coke, which has to be of high quality and purity and normally is imported into Iran. The possibility of substituting oil or natural gas should be studied.

(c) Metal Forming

The design of plant for rolling, forging, extrusion and pressing of metal is largely an engineering operation, but the behaviour of the metal in these processes poses many metallurgical problems. Laboratory tests carried out at various temperatures indicate the temperature range in which such operations can be performed with the minimum of power requirement and damage to the material. Quality control, both of the raw material and finished product, is essential and metallurgical control and technical advice will be needed to ensure that material is produced which will be adequate for the intended service, e.g. steel pressings for car bodies, aluminium alloy extrusions for car trim and for windows, copper wire of high conductivity for cables, brass sheet for cartridge making. These are but a few examples of metal applications which will require control and advice in developing industries.

Shipbuilding is also likely to become a major user of metals and the aircraft industry, when it starts in Iran, will require the most advanced metallurgical control of the products used, ranging from stainless steel to titanium, since the design of aircraft involves utilizing the strength and endurance of high duty materials as nearly as possible up to the safety limit.

In fabricating metal parts welding makes heavy demands on both the material and the operator, and training and constant monitoring of welders is necessary, as well as quality control of the material to be welded.

(d) Metal Finishing

Neither foreign nor domestic customers will be content with unattractive looking objects and the surface finish of metal products can be decisive in customer choice. Methods of producing satin or mirror finish on many non-ferrous products must be introduced and, where necessary, adequate means of protection by painting, lacquering, zinc or aluminium coating (by dipping, spraying or cladding), electro-deposition (especially nickel and chromium), and plain and colour anodizing of aluminium, must be used industrially. Many technical problems will arise at this stage.

(e) Corrosion and Protection

Iran is fortunate in having very little trouble with atmospheric corrosion, owing to the relatively low humidity in most areas for most of the year, but products intended for export may have to withstand more severe atmospheric conditions and it will be necessary to take adequate protective measures both in design (e.g. avoiding contact with dissimilar metals) and packaging.

Corrosion by soil and water is likely to be more serious owing to high salinity of many natural waters and the possibility of traces of heavy metals in solution. Irrigation pipes are likely to be particularly vulnerable.

(f) Tribology (Friction, wear, lubrication, etc.)

Any machinery with moving parts is liable to fail by wear or seizure and any piece of machinery produced locally must have a comparable life to that made abroad. Precision engineering and adequate lubrication are not always sufficient and metallurgical problems arising from the tendency of certain metals to "scuff", i.e. weld together and tear, often occur. The choice of suitable "running mates" in the form of bearings, piston rings, etc., is often crucial.

(g) Failure and Accident Investigation

Most knowledge is based on trial and error and much can be learned from mistakes if sufficient trouble is taken. In the case of failure of a metal part most competent metallurgists with adequate back-up facilities can ascertain whether this was due to defective material, overloading, fatigue, impact, overheating, corrosion, or combinations of these, and point the way to avoiding such trouble in future.

(h) Pollution, Waste Disposal, and Secondary (scrap) Metal

The contribution of the metallurgical industries to pollution of the environment is not inconsiderable, but fortunately the metallurgist can contribute to prevention and cure of both his own and the pollutants from other industries. Measurement of the degree of contamination can be made by accurate analysis, e.g. the mass spectrometer, which can detect 0.001 parts per million, and techniques for particle size measurement which are essential in powder metallurgy can be used in pollution studies.

Much pollution can be prevented by adequate attention to the collection and disposal of metallurgical waste products, e.g. zinc oxide fume from brass melting furnaces by bag filtration or recovery of spent electro-plating solutions. Often the recovered value of the waste product pays for its collection. This is

particularly true of scrap metal but also [illegible] depends on proper sorting and classification and [illegible] blending in the re-melting furnace.

In all the above problems the [illegible] give help and guidance and to provide a [illegible] and experience on which new and [illegible]

III. RECOMMENDED PRELIMINARY STAGE - (STAGE ..)

Before setting up any centre for [illegible] essential to ensure that suitably qualified staff and adequate financial support will be available to enable work to be carried out and well. It is not always realized that the initial cost of setting up any such establishment is approximately the same as the cost of the upkeep. The problem is, therefore, not to [illegible] but rather how to ensure income. This is why the first consideration has been given to the problems to be solved and services to be rendered. These have been stated in general terms in Section II, but they must be made more specific and it must be known how work on them will be carried out. For this reason a preliminary stage is recommended, during which a team of competent metallurgists, preferably associated with an existing centre for metallurgical technology (see Section VIII), will make contact with industry and Government departments to define specific problems, to deal with as many as possible using existing facilities in Iran or their own knowledge, and arrange for others to be dealt with as research contracts by overseas organisations. Simultaneously, counterpart metallurgists will be trained by working with UNIDO experts in Iran, by secondment by way of travelling fellowships to the overseas organisations carrying out research projects.

In this way it will be possible to ensure that the Iranian Government and industry appreciate the need, not only to establish a permanent C.M.T., but also to finance its upkeep. In this initial stage a technical information and advice service should be set up for [illegible]

and industry. This, combined with the suggested initiation of [illegible] to set up and oversee, will ensure that up-to-date [illegible] is available to serve not [illegible] years before the [illegible] is found and [illegible]. The start of the preliminary stage will later [illegible] and experience [illegible] and modifications of the [illegible] itself. It is envisaged that [illegible] with the [illegible] project and manual [illegible] likely to be available as envisaged during the early part of this stage. The [illegible] and costs for this preliminary stage are set out [illegible] in Appendix B.

In this connexion reference should be made to the report on the joint meeting of a selected group of European scientists and Directors of Research with members of the Advisory Committee for the Application of Science and Technology to Development (ACASTD) held in Geneva in November 1971. Paragraph [illegible] reads as follows:

> "The past experience of the organisations represented at the meeting led to a wide consensus on the following points:
>
> (a) Programmes to stimulate "bilateral links" had been a success and should receive continued support.
>
> (b) Bilateral links were normally easier to arrange than multilateral projects. They could often be based upon simple exchanges of letters or simple agreements. They were most successful when strong personal links were established over periods longer than one year and ideally longer than five years. They were most successful when they had a clearly defined research programme and an economic or social objective which were understood and agreed upon by both parties.
>
> (c) It was probably best that the United Nations and its agencies first stimulate the interest of Governments, that Governments then form bilateral agreements expressing a wish to co-operate and preferably committing the necessary funds, that the appropriate national institutions then establish co-operative projects with an economic and social objective and for these two institutions to identify individuals. The last phase should be as free as possible from cumbersome administrative procedures.
>
> (d) Programmes would be more successful than was now often the case if the individual leaders of a "bilateral link" had sufficient team support to ensure a succession of leadership. It was also important to ensure that good and growing relationships did not terminate merely because individuals did not receive fellowship

or salary payments between the end of one project and the commencement of the next. Cheap short-term arrangements are doomed to failure because the newly established activity in a developing country will need follow-up assistance, guidance and advice.

(e) There was a need to canalize additional funds into the institutes of developed countries to enable such [illegible] to take place."

The proposal to set up a preliminary stage in association with a similar institution in a developed country is entirely in line with the view of this meeting.

IV. STAFF AND TRAINING

The conventional way in which UNIDO seeks to assist developing countries in establishing new industries or technical centres is for them to recruit experts from various developed countries on relatively short-term assignments (usually not more than 3 years) to work in the new industries or centres with native counterparts and to give grants (fellowships) to suitable trainees to be sent to the developed countries.

Although admirable in many ways, the system has its disadvantages, particularly where the technologies involved are sophisticated and subject to constant growth and change. The individual experts are recruited from those services can be dispensed with in their own country. They may be experienced and capable but at or near retiring age, in which case their useful working life is limited, or they may be younger people who find themselves out of employment. These are likely to be rather less capable on the average than those who are already fully employed. Some of the young people who would take on this type of work from choice may make up for their lack of experience by energy and enthusiasm but it is the experience coupled with an expertise constantly kept up to date that is most essential in guiding others in new technologies. In major projects, team work is essential but this is more difficult if the experts chosen have never previously worked together and may not speak the same language. There is much more to be said for establishing a relatively permanent connexion with a scientific/technological institution that is active and growing in a developed country, so that the individual experts retain their connexion with the sister institute and can expect continuity of employment, pension rights, etc., if and when they return. The experts can be changed without losing the benefit of

experience gained and the staff can be adapted to the changing needs of the developing institution.

A second point is that training of staff becomes easier. It is an essential requirement that no expensive equipment should be installed unless staff are available who know how to use and maintain it. Fellowship trainees at the sister institute can be used on projects which will be similar to those in the developing institute and can learn to use the equipment which will eventually be installed there. In the event of a trained operator leaving he (or she) can be temporarily replaced from the sister institute and a further man (or woman) trained under the fellowship scheme. Most important of all is the provision of "back-up" facilities. No scientist or technologist is fully efficient in isolation without the background knowledge available in a good technical library or the apparatus necessary for test and experimentation and above all, without the benefit of the knowledge and experience of colleagues specialising in other fields.

For these reasons it is recommended that the responsibility for organizing and staffing the C.M.T. should be given to an existing metallurgical institute already operating in a developed country, preferably English-speaking but, in case this recommendation poses political or other problems, a broad recommendation regarding staffing using conventional UNIDO procedure is as follows:

Stage 1 - See Section III

Priority A (essential)

UNIDO Experts	Iranian Counterparts
1. Project Manager. Metallurgist with as wide experience as possible, including the planning and organization of a metallurgical research and/or development organization. Preferably 40 to 60 years of age.	1a. English-speaking metallurgist with doctorate or other post-graduate experience, preferably in English-speaking country. Preferably 25 to 35 years of age. May eventually be chief executive C.M.T.

2. Extractive metallurgist or chemist with experience in physical chemistry, analysis and mineralogy. 30 - 45 years of age. University graduate or equivalent qualification.

2a. Metallurgical graduate with some form of graduate experience and qualified to at least M.Sc. English speaking. 25 - 35 years of age.

3. Metallurgist with training and/or experience in foundry practice, preferably training in physical metallurgy. 30 - 45. University graduate or equivalent qualification.

3a. As 2a above.

Priority B (advisable later during Stage I if additional funds become available or if any of the above prove no longer necessary.)

4. Physicist or electrical engineer with some training and/or experience in electronics, solid state physics, electronics and instrumentation. 30 - 45. University graduate or equivalent qualification.

4a. Physicist or electrical engineer with training or experience in electronics or solid state physics. 25 - 35.

5. Structural or mechanical engineer with knowledge or experience in mechanical testing, design stress analysis and capable of controlling laboratory workshop graduate or chartered engineer. 30 - 45.

5a. Engineering graduate. 25 - 35.

6. Electro-chemist or metallurgist with knowledge and/or experience in corrosion, electrodeposition and metal finishing. Graduate. 30 - 45.

6a. Graduate in metallurgy or chemistry. 25 - 35 years of age.

The above staff will form the nucleus of the senior staff of the C.M.T. and all counterpart staff will spend at least 3 months and preferably

one or two years in an institution/country in the from which equivalent experts have come. The No. 1 expert will be expected to act as managing director of the C.M.T. until his Iranian counterpart is judged to be capable of taking new responsibility.

It is important that no member of the staff, whether a UNIDO expert or his counterpart, should be regarded as having an established or permanent position by right as is the case in the Civil Service or in the academic profession. Continual employment must be dependent on work becoming and remaining available for him to do as well as on the efficient performance of his duties. Each member will have the responsibility of "selling" his services and satisfying sponsors and clients to the extent that they continue to support him and his department with problems and funds necessary to solve them.

V. STATUS, LOCATION, AND INSTITUTIONAL RELATIONSHIP

Any scientific or technical organization must establish contact and friendly relationship with other institutions in the same country but with different disciplines, as well as with sponsors or clients for whom it is working. This will be done in the Preliminary Stage outlined in Section III. For this reason it is recommended that, in the preliminary stage, the institutional relationship should be with a foreign organization possessing all the necessary knowledge and skill, and representing the foreign counterpart of the proposed C.M.T. This relationship need not be permanent but would have many immediate advantages, namely:-

1. Positive and useful work would commence immediately on problems of national importance as set out broadly in Section II.

2. Counterpart Iranian staff on UNIDO fellowship schemes would work on these problems under the direction and using the facilities of the sister institute.

3. Iranian technicians could be trained in the use and maintenance of the equipment which will eventually be installed in the C.M.T.

4. Back-up facilities would be provided, including library and information services and contacts with specialists in other fields.

5. There would be overall continuity even with individual staff changes.

In the longer term, association with a multi-discipline Iranian organization is desirable but there appears to be a tendency for institutions in Iran to become insular or self-sufficient and to be competitive rather than co-operative. A fully autonomous organization, on the other hand, might suffer from neglect.

The most effective compromise would seem to be to start the first or preliminary stage of the C.M.T. under the sponsorship of the Ministry of Economy, with offices located so that staff can be in close touch with the Research Centre for Industrial and Trade Development, and the Institute of Management. The C.M.T. in its initial stages should operate in the same way as these centres, except that the aim should be to supply technical assistance and knowledge rather than management or economic guidance. None the less economic factors must affect, and in some cases may determine, the technical problems which require solution.

The first stage C.M.T. must also maintain contact with organizations in Iran able to provide facilities for experimental work, notably I.S.I.R.I., the universities, and industrial laboratories with appropriate facilities that may not be fully utilised. The staff of the C.M.T. should advise on metallurgical work those bodies which decide national research policy, e.g. the National Council for Scientific Research.

When the C.M.T. is fully established, it is hoped to strengthen relationship with universities by arranging for work done by graduates in the C.M.T. to count towards higher degrees, but this must be subject to the over-riding rights of the sponsor, whether public or private. In general, the results of the work done by the C.M.T. will belong to the organization or individual paying for the work, and publication will be subject to the sponsor's approval.

Although any final decision must await the findings from Stage I, the location of the C.M.T. itself (2nd stage) has been given some consideration. The Geological Survey would seem at first sight to be a possible partner owing to the overlap between ore dressing and extractive metallurgy, but there seems to be little space available in the immediate locality and most of the work of the C.M.T. will be quite different from that of the Geological Survey. There also seems no desire on the part of the Geological Survey staff to expand into the metallurgical field.

A more obvious choice would be at Karadj, in association with I.S.I.R.I. There certainly seems to be a real danger of serious overlap between the I.S.I.R.I. metals testing laboratory and the C.M.T. The recommendations made by Professor P. Asanti (9) involve some very expensive sophisticated equipment, including electron microscopes (transmission and scanning), microprobe analysis, and quantimet image analysing computer. These items are not of high priority, but each costs in the region of 100,000 US$ and the total cost of recommended equipment would be well in excess of 500,000 US$ if all recommendations were accepted*. Since the development of the Metrology Centre is also a UNIDO S.F. project it follows that duplication of expensive equipment must and could easily be avoided.

There must therefore be a strong case for locating the C.M.T. at Karadj and in association with I.S.I.R.I. This does not rest solely on the need to share expensive equipment; the location is good from the point of view of industry on the west side of Teheran and easy communication by motorway with the capital city. Contact with industry is also assured through the work of specifications and standardization, by way of the twelve branch offices in the main industrial centres (11).

However, doubts may be expressed as to the compatability of research and service to industry with the strict control and in some cases compulsion implicit in standardization. The helping hand should not be confused with

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* This is unlikely. A.Thulin UNIDO project Manager (10) keeps the 1972 requisition to 41,525 $, with an additional 34,650 $ and further planned requisitions of 21,000 $, making a total of 97,145 $. Ordering of apparatus for analysis of metals is postponed awaiting policy decision and availability of funds.

the iron fist. Perhaps more important is the fact that the [illegible] research side of I.S.I.R.I's work has been far from successful [illegible]. Harold K. Work, himself a metallurgist, recommended inter alia that research be separated from test work, although he does not [illegible] recommend a separate establishment. There seems to have been [illegible] support from either the private or public sector of industry for the research work at I.S.I.R.I., again emphasising the need to secure such support before setting up any additional research establishment.

The second location with strong claims is in Isfahan, and [illegible] with Arya Mehr University, which it is planned to move or extend* from Teheran. The advantages of close contact with a multi-discipline academic institution have already been stressed and Arya Mehr certainly [illegible] the author very favourably in its equipment and approach.

Contact with industry is encouraged (12) and a member of the academic staff, Dr. Toosi, a structural engineer, is also acting as liaison officer for industrial contacts. The Vice-Chancellor, Dr. Amin, estimates that the volume of contract work for Government and industry is running at between 200,000 and 300,000 US$ per annum. There is a fixed scale of charges, ranging from 1000 rials/hour for Ph.D and 700-850 rials/hour for M.Sc. and B.Sc's. This seems realistic in relation to salaries and overheads but may be too high for some sections of industry. Half the fees are paid to the staff and the balance to the university.

Good contacts already exist with the Geological Survey and with universities in the UK, notably with Imperial College and Strathclyde. A joint research project is in progress in association with Imperial College. Recruitment to the C.M.T. from the university would be helped. A substantial area of land is available in Isfahan and, according to Dr. Amin, there would be no difficulty in making some available for the C.M.T. Alternatively, if the university is to be transferred to Isfahan in its entirety, the buildings and space would be very suitable for a complex of industrial

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* There seems to be a difference of opinion on this point. The university staff seem quite sure that the university will remain on its present site indefinitely and that Isfahan will be an extension. Ministry and Plan Organisation officials are equally sure that the university will be moved in its entirety.

research centres, which would include the C.M.T.

The objections lie in the likelihood of administrative control by the university. The university authorities and their existing services to industry would be in competition with the C.M.T. and work would be directed there rather than to the C.M.T. University policy would not necessarily always favour the C.M.T., an essential requirement of which would be that all work going on in the C.M.T. would be confidential to the sponsors in the first instance and should not be influenced by university staff or the student body. This latter point is a very real danger, since even in developed countries students can take action damaging to the research work in progress. The expulsion of the Stanford Research Institute, U.S.A., from the Stanford University campus a case in point and seriously damaged the contract research programme of that Institute.

Unlike university personnel, the staff of the C.M.T. should have conditions of employment allowing dismissal for redundancy. The need to do useful work is thus brought home to every member of staff. A somewhat higher salary than that paid in equivalent academic appointments would be necessary to compensate for this insecurity. This may well lead to disputes if the C.M.T. and the university are under the same administration. The C.M.T. should therefore be autonomous and physically separated from the university. Subject to this, the case for associating the C.M.T. with Arya Mehr University is very strong.

VI. VISITS AND DISCUSSIONS

A diary of the mission has been kept and will be available. The number of visits and discussions has been less than had been expected. The author's similar mission to Pakistan (14) and the UNIDO instructions had led him to expect that the Iranian Government would be responsible for arranging a programme of visits with appropriate guides and travel arrangements. This did not occur, from which it may be inferred that the Iranian Government's interest in this project is not very great. Stimulation of this interest is clearly necessary if the project is to be

successful. Nevertheless, substantially all individuals in the Government service expressed support for the C.M.T. in general terms, although most were against setting up a prestige establishment and favoured a preliminary exploratory stage. Offers of office accommodation in this proposed first stage were made by Mr. Zand, Managing Director of the Mining & Metallurgical Corporation of Iran, and by Mr. Nakhai at the Ministry of Economy, and these were much appreciated.

VII. REGIONAL CO-OPERATIVE DEVELOPMENT

Similar recommendations have been made regarding a proposed C.M.T. in Iran. The universities in Pakistan were less in touch with industry than Arya Mehr University and the facilities for post-graduate research were very much less. In view of the association between Iran and Pakistan under the R.C.D. scheme, it would seem worth exploring the possibility of co-operation in the provision of metallurgical expertise.

VIII. COLLABORATING INSTITUTE

If all the proposals in Section III are accepted, the collaborating institute in a developed country should have experience in dealing with all the problems likely to be submitted and should have comparable equipment to that eventually envisaged. ~~and set out in Section~~ _____. It should have demonstrated success in dealing with both private industry and Government research contracts and should preferably show that it can and does operate in such a way that an excess of income over expenditure is available to be ploughed back to increase the facilities. It should be able to advise on research management, including the control of research programmes using the planning diagram technique. It should provide library and information services and be prepared to train technologists in the use of instruments that it is proposed to install in the C.M.T. and allow Iranian graduates to participate in research projects. Rapid and effective communication by air should be possible and, since English is generally regarded as the second language in Iran and the first in technology, it should preferably be in an English speaking country. The Fulmer Research Institute, Stoke Poges, England, fulfills all these conditions and has an added advantage of being owned by a scientific society, the Institute of Physics.

The Institute of Physics provides the secretariat for the U.K. Council for Science and Technology Institutes, which includes the Institution of Metallurgists, the Royal Institute of Chemistry, the Institute of Mathematics and its Applications, and the Institute of Biology. It also houses the R & D Society and the Association of Consulting Scientists and is in a unique position to call on the advice and services of people and organizations from a wide range of disciplines.

There is a need in Iran to improve relationships between different academic institutions and this could well be done by forming local societies, such as an Iranian Metallurgical Society, which could be associated with and helped by the appropriate institute in the U.K. Such institutions are also prepared to advise on education and training and in giving professional qualifications which supplement academic degrees and ensure professional and practical competence in the holders.

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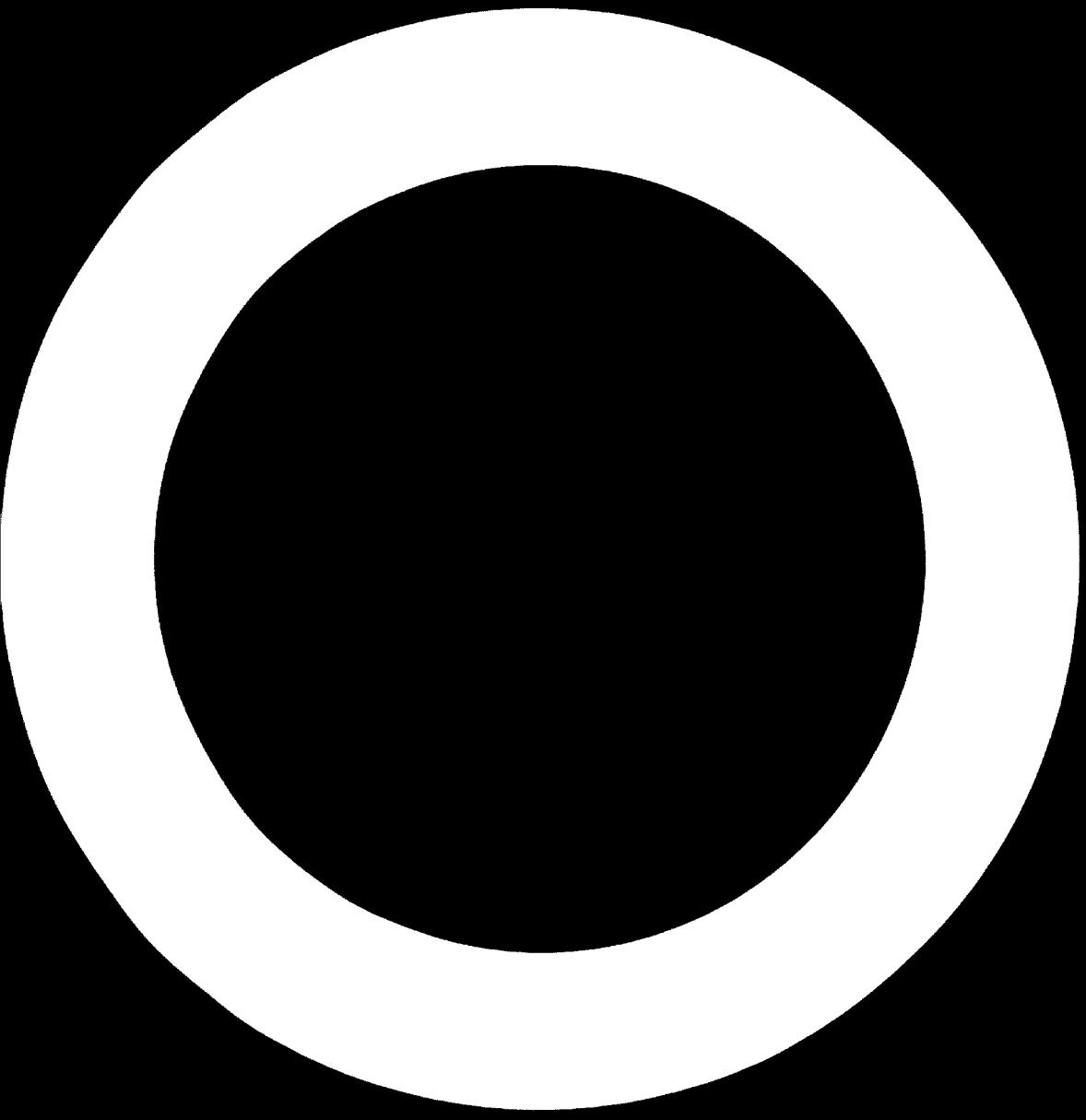

ANNEX I.

PLAN OF OPERATION AND [illegible] - STAGE I [illegible]

Objectives

(a) To provide a Metallurgical Advisory Service (M.A.S.) [illegible] to [illegible] . . . .

(b) To identify metallurgical problems of national importance [illegible] ways and means of solving them.

(c) To assist Iranian industry with [illegible] projects [illegible] to improve metallurgical technology.

(d) To use Iranian facilities wherever possible in pursuing the objectives set out in (a) to (c) above.

(e) To refer to the collaborating institute problems that cannot be dealt with locally.

(f) To ensure that sufficient funds are available to support a C.M.T. when it is established.

(g) To plan and supervise the building, equipping, and staffing of the C.M.T., subject to (f) above.

(h) To train counterpart Iranian staff in dealing with metallurgical problems and carrying out metallurgical research for both Government and industry.

(i) To train laboratory technicians to use equipment which will be set up in the C.M.T.

(j) To ensure through the collaborating institute that adequate back-up facilities in the form of technical information, research, training, and management are available for as long as these are needed by the M.A.S. and C.M.T.

Organization

It is recommended that Stage I be run as a special fund project and that the Government of Iran, through the Ministry of Economy, should provide the necessary office facilities and services and the counterpart Iranian staff. UNIDO will be ultimately responsible for providing and paying the experts, but it is suggested that recruitment be done through

a collaborating institute, which can release appropriate members of existing staff and recruit or subcontract as necessary and without delay. The collaborating institute should provide back-up facilities in the form of library and information, technical advice, carry out experimental and test work as required, and provide training for Iranian counterpart staff.

The Palmer Research Institute, Stoke Poges, England, would be willing to act as collaborating institute.

Duties and Responsibilities

It will be the responsibility of the staff of the Metallurgical Advisory Service, under the Project Manager, to meet objectives (a) to (g) and of UNIDO, through the collaborating Institute, to meet objectives (h) to (j). The M.A.S. staff will arrange with organisations in Iran having the appropriate facilities to carry out test or research work on agreed terms. Appropriate facilities may be found in one or more of the following institutions, which are listed alphabetically and not in order of preference:-

Arya Mehr University, Teheran
Geological Survey,
Iranian Oil Company Research Laboratories, Rey
I.S.I.R.A., Karadj
Polytechnic, Teheran
Teheran University

This list is not likely to be complete and the M.A.S. staff should seek facilities and favourable terms from any other suitable organisation.

In the case of major problems, the staff of the M.A.S. will formulate research and development programmes, obtain tenders, and arrange for funding contracts wherever appropriate. Although the collaborating Institute will be available to advise and draw up planning diagrams where required, it will not have any monopoly in carrying out such contracts.

The M.A.S. staff will maintain contact through the Ministry of

Economy with those bodies responsible for research and development in Iran and will advise them on metallurgical problems. Specifically, liaison should be with organizations set out in the attached list, but this should not be taken as exhaustive.

The M.A.S. will also maintain contact with UNIDO through the resident representative, Mr. Shallon or his deputy, and with the UNDP regional advisor, Mr. Agnassi, and will report informally not less frequently than once a month and prepare progress reports at intervals of six months, or at such times as may be required.

The collaborating Institute will be responsible, through [illegible], for recruiting and maintain a suitable team of experts in Iran and for providing an efficient and rapid back-up technical and information service, preferably using Iran Air passenger and cargo. Specialist staff and equipment will be made available at short notice and flown out where necessary to deal with emergency problems. It is hoped that the Government of Iran will be prepared to waive the customs and immigration formalities.

Equipment and Staff

The only equipment necessary at this stage will be office furniture, typewriters, etc., with some books of reference and a few basic pieces of equipment such as a bench microscope and portable hardness tester, since it is proposed to use experimental facilities in other organizations.

Technical staff should consist initially of three UNIDO experts and three counterpart Iranian graduates (see Priority A, Section IV main report). Further technical staff will only be recruited if additional funds become available in the form of payment for work done. Secretarial and amenity staff will also be needed.

Timing

Stage I should occupy a total time of three years and a decision on whether to proceed with Stage II, i.e. the building and equipping of a C.M.S., should be taken towards the end of the second year. Assuming

Stage I starts in 1973, the start of Stage II will commence in 1975, but the M.A.S. will be maintained during 1975 with a view to incorporating the M.A.S. into the C.M.T. in 1976.

Costs and Funding

Apart from office equipment, etc., no capital expenditure will be necessary in Stage I. The operating costs over three years are as estimated below.

(a) Iranian Government Expenditure

	36 months 1,000 Rials
3 Iranian counterpart technical staff - 1a	2,160
2a	1,800
3a	1,800
3 Secretaries	2,160
1 Amenity staff	216
Office upkeep, postage, stationery, etc.	60
Telephones, etc.	50
Office rent	50
Travelling and staff subsistence	200
Use of outside facilities, less payments received	6,000
Half cost of experimental and test work at collaborating Institute	3,000
	17,496
Add capital expenditure - 3 electric typewriters, bench microscope, hardness tester, reference books	504
	18,000
Contingency allowance	2,000
	20,000

(b) UNIDO Expenditure

	U.S. $
36 man months, Project Manager 1	75,000
" " " " " 2	60,000
" " " " " 3	60,000
Collaborating Institute's charges for 3 years -	
Training 3 fellows (graduates or technicians - 9 man years)	35,000
Back-up facilities - library, travel, etc.	66,000
Half cost of experimental and test work at collaborating Institute	39,000
	335,000
Contingency allowance	35,000
	370,000

Contingency allowance is intended to cover inflation as well as unforeseen expenditure

Note Cost of experimental and test work at collaborating Institute will be shared. This will be costed on basis of time, materials and overheads and will be subject to modification as the volume of work varies. It is to be expected that the cost will be met in part by payments received from clients of the M.A.S. The estimated costs are based on the average cost per graduate/year at the Fulmer Research Institute of £10,000, or 26,000$, which covers salaries, materials and overheads.

STAGE II- BUILDING AND EQUIPPING C.M.T.

Detailed recommendations for the building and equipping of a C.M.T. should await the first two years of operation of Stage I and the capital expenditure should be related to the estimated income. Doubts have been expressed as to whether it would be possible to raise all this in the form of payments for work done. Although the author holds the view that this should certainly be the target, it may be necessary to ask the Government of Iran to contribute, with the object of reducing the charges to industry.

It is recommended that the target should be an annual income of not less than one million dollars, in which case expenditure of approximately 500,000 dollars on buildings, which will provide a total area of approximately 8,000 square metres and a similar sum on equipment, would be appropriate. An income of this size should support a team of approximately 40 graduates, about one-third of whom would be Ph.D's and a total staff of about 120. The salary bill will be in the region of 450,000 dollars and overhead expenses, which should include depreciation of buildings and equipment, would amount to a similar sum, leaving just over 10% profit margin available for ploughing back to increase the facilities to allow reasonable growth rate.

The author is prepared to make detailed recommendations for equipping and staffing the laboratories, but at this stage the exercise would be rather academic.

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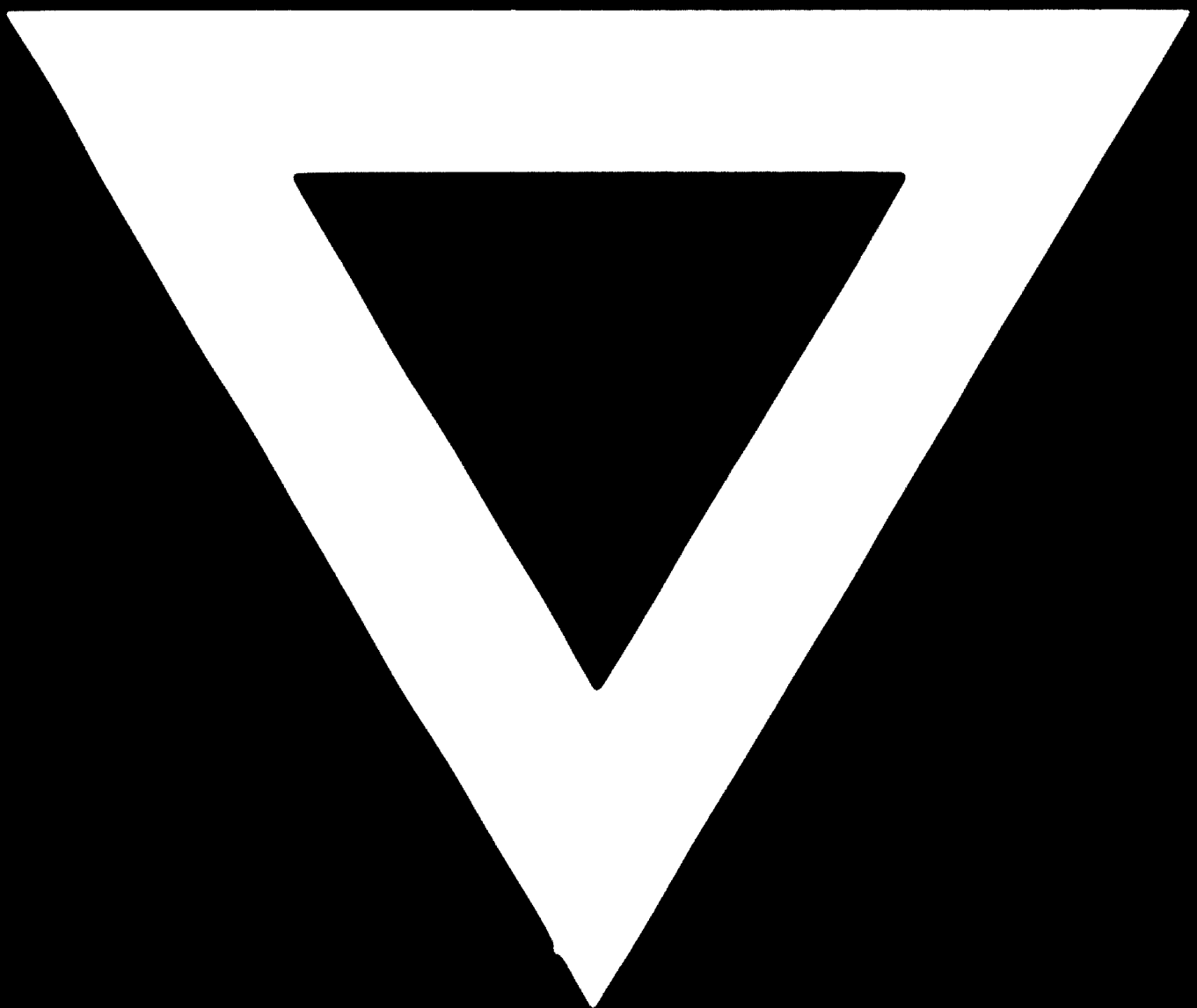

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