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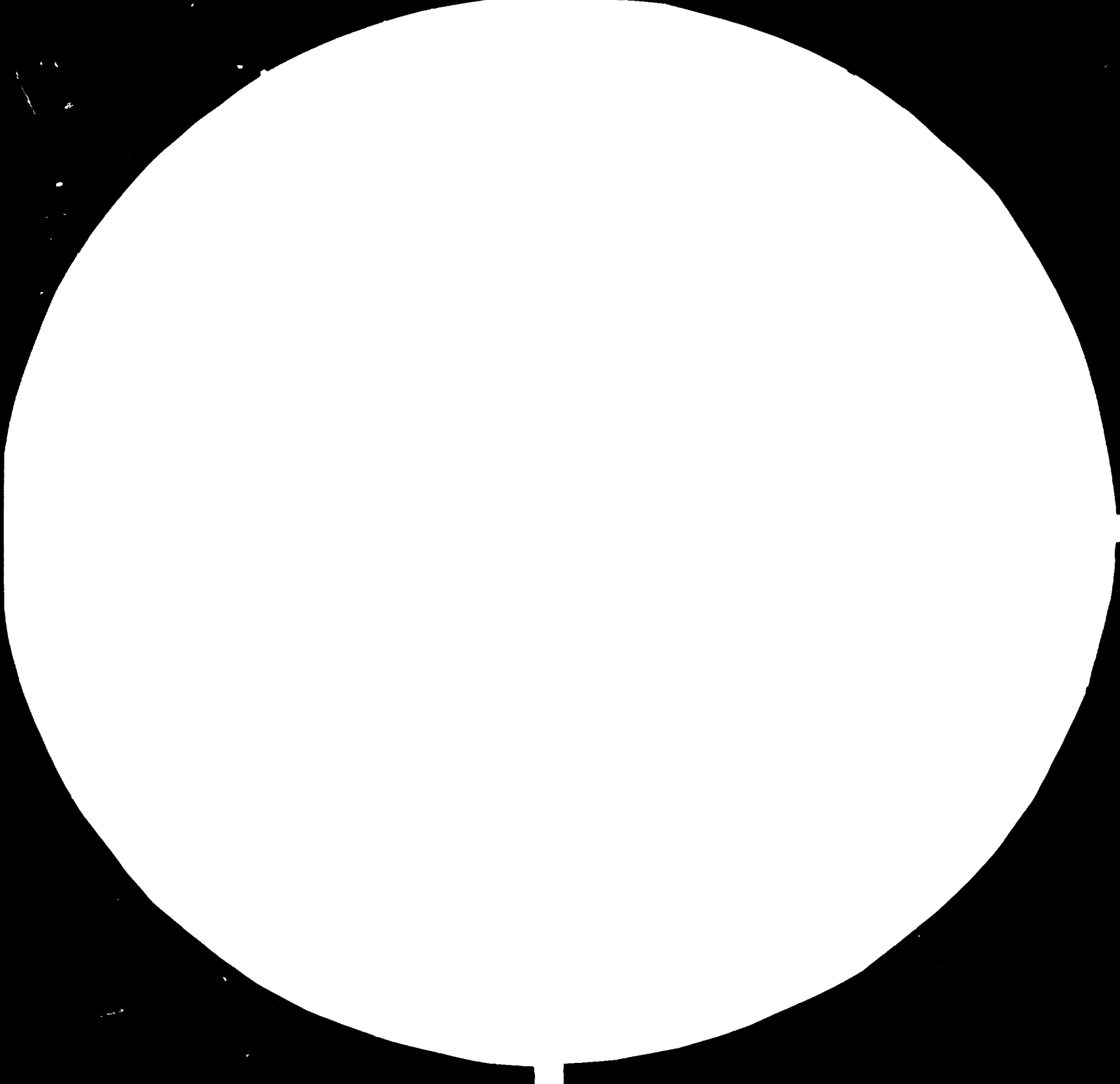

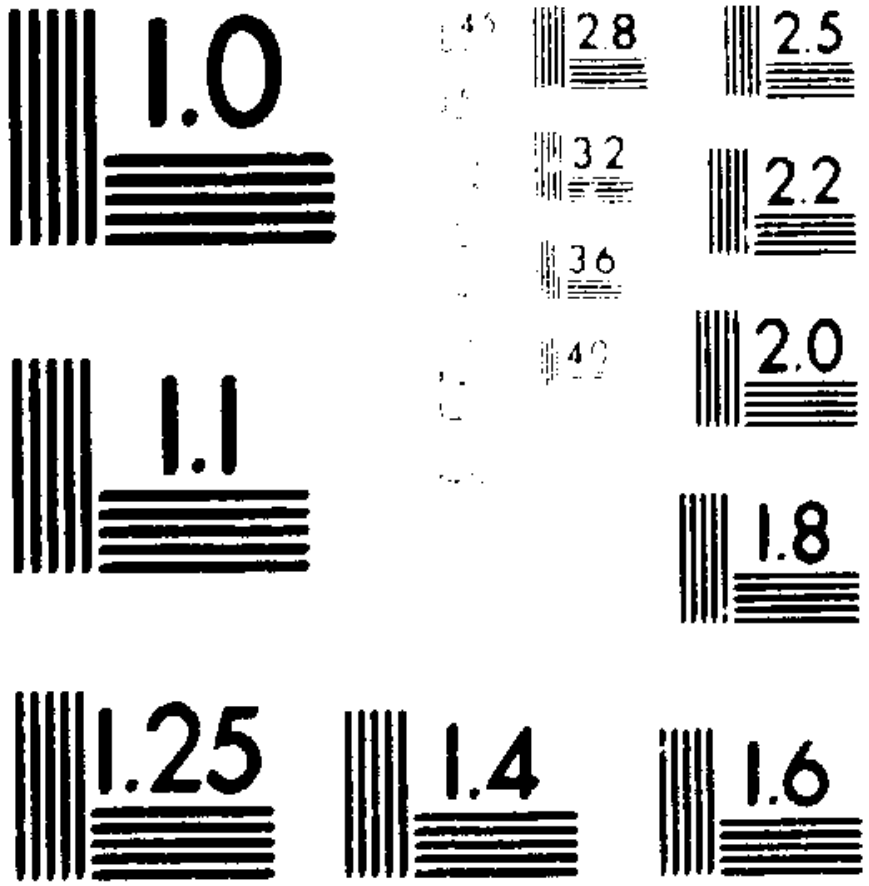

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DECEMBER 1984
ENGLISH

DEVELOPMENT OF A BASIC INDUSTRY FOR THE PRODUCTION OF ALUMINA FROM INDIGENOUS ALUMINO FERROUS ORES, STARTING WITH ALUNITE

DP/IRA/82/004/11-02(31.8.A)

THE ISLAMIC REPUBLIC OF IRAN

TECHNICAL REPORT: ESTABLISHMENT OF AN ALUMINIUM RAW MATERIALS TESTING LABORATORY

PREPARED FOR THE GOVERNMENT OF THE ISLAMIC REPUBLIC OF IRAN BY THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION ACTING AS EXECUTING AGENCY FOR THE UNITED NATIONS DEVELOPMENT PROGRAMME

BASED ON THE WORK OF DR. CONRAD DOUGLAS
CONSULTANT ON MATERIALS TESTING

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
VIENNA

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ABSTRACT

The activities of the Consultant reported on below were carried out under the project entitled: "Development of a Basic Industry for the production of alumina from indegenous alumino ferrous ores, starting with alunite", DPA/IRA/84/002/11-01. The consultant was specifically engaged in work with the Aluminium Raw Materials Programme (ARMP) counterparts of the Ministry of Mines and Metals and other Iranian Personnel supplying design services from external organizations.

The Consultancy, which was carried out over a three week period from the 25th July, 1984 to 15th August, 1984, served the following objectives:

- Advise the ARMP on the requirements for and selection of necessary equipment for the establishment of an aluminium raw materials testing laboratory including the preparation of a detailed list of equipment.
- Advise on the implementation of training programmes for national staff, both on-the-job and abroad.
- Make recommendations on the procurement of equipment to be installed in the aluminium raw materials testing laboratory including the physical conditions and support facilities required for their effective use to meet the ARMP's objectives.
- Present a report containing conclusions and recommendations for the future work programmes of the testing laboratory, equipment and staffing as well as its organization and maintenance, and required follow-up technical assistance.

The Consultant worked in close collaboration with Dr. Karoly Solymar, consutlant i.. the processing of alumino ferrous ores, Mr. M. Shariari, Manager of the ARMP and had the opportunity to meet with Mr. K. Singh, UNDP Resident Representative and members of his staff on two occasions. Discussions in these meetings were centred on the scope and status of the project.

Two field trips were undertaken by the consultant to examine the deposits of alunite and bauxite.

The establishment of the ARMP laboratory testing facilities envisages a vertically and horizontally integrated geo-scientific, chemical analytical, physical testing, technological and engineering complex which will form a key component in the pursuit of a programme aimed at exploiting Iran's aluminium bearing minerals resources for the production of alumina to meet the country's domestic needs.

The programme is well underway with a feasibility study on the exploitation of alunite being conducted. However it is strongly recommended that a similar study on bauxite be pursued in parallel in order to provide the information for the critical selection of alternatives for decision making and investment purposes later.

It is noteworthy that several recommendations made have already been accepted and implemented.

This report is of a complementary nature to Dr. Karoly Solymar's, for this reason it is recommended that they be read together. In adition substantial recommendations were made jointly with Dr. Solymar.

RECOMMENDATIONS

The recommendations presented in annex No.2 were developed jointly with Dr. Karoly Solymar, Consultant in the processing of alumino-ferrous ores. The following recommendations are additional.

1. It is critically important to pursue a feasibility study on the use of bauxite for alumina production. This will require intensifying the bauxite exploration programme and the careful selection of representative samples for detailed analysis and technological testing. The information from this activity which should be pursued as soon as possible, will prove to be invaluable.

2. It is recommended that a critical approach be taken in the selection and procurement of equipment against the objectives of the raw materials laboratory in order to maximise the utilization of funds and to ensure that the maximum expected outputs from each equipment is realized. In addition the equipment selection should take place in the context of available maintenance services, locally, in-house and internationally. Further, modular type equipment which can adapt to expansion/upgrading later should be selected where possible in order to minimise the effects of early technological obsolescence and optimise the benefits from increased outputs by component additions later. This will also serve the purpose of enhancing the training/development of staff members on a phased/stepwise basis.

3. In the selection of equipment it should be made conditional, where possible, that suppliers crews conduct on-the-spot training programmes on the use of the equipment and fully

demonstrate its potential before their departure. Basic troubleshooting of the equipment must be an integral part of this training programme. A written report on the installation and related training on each piece of equipment by a staff member must be prepared.

4. The procurement and delivery of equipment must be done on a timely and carefully scheduled basis involving

   (a) Preparation of the facilities to minimise storage time

   (b) Detailed checking of equipment against purchase orders and packing lists to ensure complete delivery and conformity to specifications.

   (c) Selection of the national staff members who will be using the equipment.

   (d) Scheduling the visit of the installation team after (a),(b) and (c) above have been satisfied.

5. Warranties and guarantees must be carefully examined and efforts be made to ensure that none of the conditions are breached.

6. On the placement of firm equipment orders a detailed delivery schedule should be developed to be followed by monitoring of the delivery status of each piece of equipment through UNIDO to minimise time over-runs and project implementation slippages.

7. The sample preparation area of the laboratory is particulary critical because of the hardness of the bauxites and it is strongly recommended that standard shelf item grinding equipment is not selected. Instead the samples should be submitted to prospective suppliers of grinding equipment for their testing and recommendation on the most appropriate equipment.

8. The ongoing recruitment programme of staff members should be continued on an accelerated basis against the organizational structure and work functions to be performed in the laboratories.

9. A detailed training programme involving:

   (a) In-house and local training

   (b) Study Tours and Fellowships

   (c) On the spot training by visiting Consultants and equipment suppliers representatives

   is of critical importance.
   Local training should be arranged in appropriate organizations/ institutions where possible. Where possible this should precede the selection of candidates for further specialized training on fellowships/study tours abroad.

   The services of UNIDO should be used in identifying suitable institutions internationally for the specific training requirements and for arranging fellowships and study tours. Consultants and suppliers representatives should be notified in advance that they will be required to provide training. Where possible this should be written into contracts.

   It is recommended that, funds permitting, at least two staff members be sent on the same training course especially in the case of overseas fellowships particularly for highly specialized high technology disciplines and study tours.

   It is also recommended that in addition to reports on the training programme overseas, participants present an in-house seminar on the subject pursued on fellowships and study tours to broaden the scope of the technology transfer.

10. Where Consultants are used to conduct in-house training programmes it is recommended that the trainees be carefully selected and also that a pre and post-course examination be conducted to facilitate critical evaluation.

11. A detailed mechanical, electrical, electronic preventive maintenance programme must be developed for all the equipment. Where possible the service of local maintenance companies should be used and they should work in concert with the overseas equipment suppliers especially in the absence of local representatives.

12. In-house maintenance services should also be developed at least for basic trouble-shooting and minor repairs. Personnel for this purpose should work closely with the contracted maintenance company for control purposes.

13. An inventory of all spares must be established including the establishment of stock and re-order levels. This can be done manually as well as by computer.

14. In addition to the spares normally delivered, on request, it is recommended that the project management determine the possibility of establishing a system of receiving spares on consignment from equipment suppliers and make arrangements to pay for them only when they have been put in use.

INTRODUCTION

Iran currently consumes 120,000 tons per year (tpy) of aluminium of which 45,000 tpy is produced locally at its Iralco Smelter using imported alumina. It is projected that the country's alumina requirements will be in the order of 600,000 to 2,000,000 tpy by the early nineteen nineties. This volume of alumina imports will require foreign expenditure of about US$200 million per year and readily justifies the need to develop a domestic alumina industry based on indigenous raw materials such as alunite, bauxite and alumino-silicates.

For this reason the Government of the Islamic Republic of Iran established an Aluminium Raw Materials Programme (ARMP) in 1981. The ARMP is a division of the Ministry of Mines and Metals charged with the responsibility of implementing the following major activities:

(i) Continuation of the necessary geological prospecting and mining work for producing the required samples of alumino-ferrous ores in order to prove the quantity and quality of the reserves.

(ii) Establish a raw materials testing laboratory

(iii) Enter into contracts for the undertaking of feasibility studies for alumina production from alumino-ferrous ores such as alunite, bauxite and alumino-silicates.

(iv) Construct and operate alumina plants based on the results of the feasibility studies.

Three main types of alumino-ferrous ores are found in Iran, these are

1. Alunite (found in the north-western region of which 100 million tons constitute proven reserves and 250 million tons estimated reserves).

2. Bauxite (found in the north-western region, with reserves estimated at 70-80 million tons).

3. Alumino-silicates (found extensively in Iran in large tonnages).

The three ores vary significantly in their physico-chemical properties requiring substantially different processing technologies for extraction of their alumina values. Consequently their alumina production costs are different.

In addition, in the case of alunite, the ability to market by-products, K_2SO_4 and H_2SO_4, imposes constraints on the capacity of the alumina plant.

The variation in the properties of the three ores also require different materials handling and testing methods for their technological evaluation. In the earlier and current investigations which required testing of the ores, samples were collected and shipped to external laboratories for testing at great cost in foreign exchange and time. This necessitated embarking on a programme to establish the materials testing laboratory.

The current status of this element of the project is as follows:

(a) The ARMP has been provided with some of the monetary resources required for implementation of the initial phases of the project.

(b) It has commenced recruitment of the necessary staff and has started its training programme.

(c) It has been provided with land by the Ministry of Mines and Metals to locate the laboratory facilities. This is located at Karadj which is about 37 km from Tehran.

(d) The architectural design of the facilities including utilities and laboratory infrastructure has been completed by Iranian consulting firms, with substantial inputs from the Consultant.

The activities of the Consultant were effectively organized by the manager of the ARMP Mr. Mohammed Shariari. Detailed discussions were held with members of his staff, representatives of the two Iranian Consulting firms responsible for the design and construction of the laboratories. Discussions entailed, equipment selection, installation, commissioning and maintenance, logistics of laboratory layout, support facilities and infrastructure and the safe use of equipment. The training needs for the maximum effective use of facilities was also discussed. Discussions were not always limited to the consultants job description but also involved considerable sharing of relevant experience gained on ST/JAM/80/001 "Upgrading the Scientific and Technological Capabilities of the Jamaica Bauxite Institute" of which the consultant is Project Manager.

In addition literature of relevance was handed over to theARMP by the Consultant.

The duration of the consultancy was for three weeks over the period 25th July to 15th August, 1984 including briefing/debriefing and travelling. Annex No.1 is the activity schdule pursued by the consultant while the consultant's job description is given below.

- Advise the ARMP on the requirements for selection of necessary equipment for the establishment of an aluminium raw materials testing laboratory including the preparation of a detailed list of equipment.
- Advise on the implementation of training programmes for national staff both on the job and abroad.
- Make recommendations for the procurement of equipment to be installed in the aluminium raw materials testing laboratory including the physical conditions and support facilities required for their effective use to meet the ARMP's objective.

. Present a report containing conlusions and recommendations for the future work programme of the testing laboratory equipment and staffing as well as its organization and maintenance and required follow-up technical assistance.

PART 1

REQUIREMENTS FOR AND THE SELECTION OF NECESSARY EQUIPMENT FOR THE ALUMINIUM RAW MATERIALS TESTING LABORATORY

The aluminium raw materials testing laboratory (ARMTL) will be equipped and staffed to analyse a minimum of 25-30 samples per day. The tests to be carried out will include:

- Wet Chemical determinations (routine) of the macro-components and trace elements of alunite ore, bauxite and alumino-silicates. This will include comprehensive determinations on all the components of these materials which are critical for their thorough scientific and technological evaluation. The components in these kinds of materials have been documented variously and relevant literature was handed over to the counterparts by the Consultant.
- Wet Chemical determinations for the development of new analytical methods.
- Mineralogical - phase analyses
- Textural and physico-chemical analyses
- Technological testing for simulation of the various unit operations for processing bauxites, alunites and alumino-silicates to determine the optimum technology for the most cost-effecient process and for selecting the most suitable processing variants from the alternatives available. This section of the laboratory will not have the capacity to handle 25-30 samples per day.

The recommendation was made by the Consultant (and accepted) that a Reserves Division be incorporated into the facilities. This will enhance the effectiveness of the ARMP and is critical for the efficient and early achievement of its objectives.

Figure 1 is an operations flowsheet which shows the activities which will be pursued in the ARMTL, with the exception of the pilot plant testing, which will be pursued later. The technological tests shown in the flowsheet will therefore be done at the bench scale.

Table 1 is a list of the equipment required for each operation and their function/output with remarks as necessary.

The equipment listed will provide the ARMTL with the maximum capability for the analysis and testing of the alumino-ferrous ores in the light of available technology (analytical and ore processing methods) and the critical parameters which the laboratory will need to evaluate for each ore. The fact that a reserves prospecting programme is an on-going process was also taken into consideration as well as the need to lay the foundation from the outset for a well equipped research laboratory since the ARMTL could conceivably develop into the national alumina research institution for servicing the alumina plants after their construction later.

It is noteworthy that the facilities will also enable generation of data on the specific consumption of bauxite (tons bauxite/ton Al_2O_3) which is critical for the technological mapping of the reserves recommended by Dr. K. Solymar. Furthermore the soft-gamma ray settler will enable detailed and accurate characterisation/modelling of the sedimentation properties of the muds generated from both bauxite and alunite processing. These are critical for the selection of the most economically suitable variant for processing the bauxites.

The equipment will also enable the simulation of the reductive-roasting and leaching technologies for Al_2O_3 production from alunite.

Some of the equipment listed in table 1 are highly specialised - non-standard items especially in the area of technological testing. Examples of these are:

- The Soft Gamma Ray Settler
- The desilication, precipitation, temperature controlled water bath and
- The Thermo-analytical equipment.

Figure 1. OPERATIONS FLOWSHEET FOR EVALUATION OF ALUMINO-FERROUS ORES

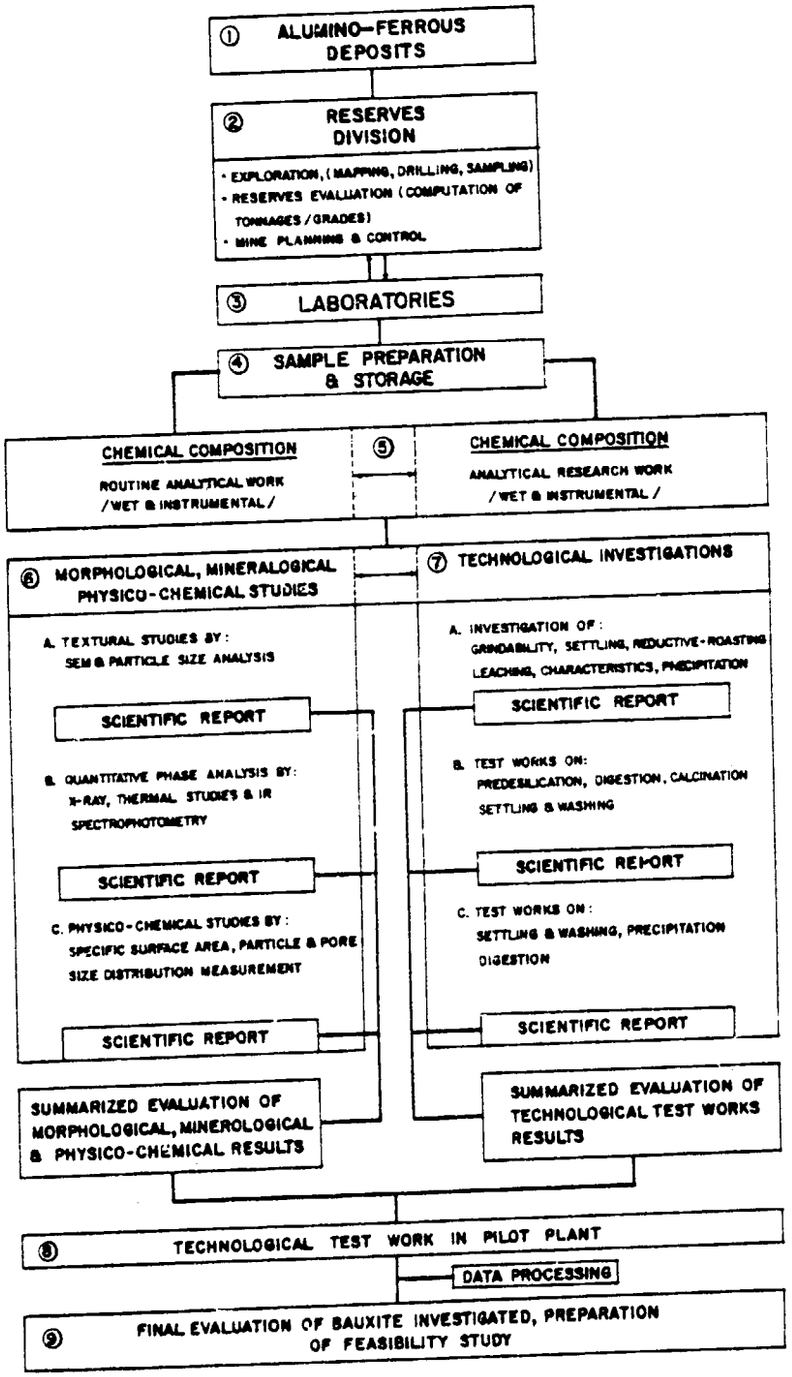

TABLE I

OPERATIONS FROM FIGURE 1 AND REQUIREMENTS/OUTPUTS

OPERATION	EQUIPMENT REQUIRED	FUNCTION/OUTPUT	CONDITIONS	REMARKS
RESERVES DIVISION	1. Surveying Equipment 2. Cartographic Equipment 3. Copying Machines 4. Microfilming equipment 5. Computer Terminal 6. Optical Microscopes and thin section sample prep. equipment.	Exploration, Surveying Mapping Blueprints Copying/information storage Geostatistical analyses, data storage, computations Petrography.	Facilities must be air conditioned. Blueprinting room must have exhaust for ammonia gas. Infrastructure and utilities (special lighting and boards necessary).	Will provide graphic, statistical and qualitative and quantitative information/ geological evaluation of the ores.
Sample Preparation and Storage	1. Grinding mills 2. Mixing equipment, sample splitters. 3. Rifflers 4. Sieves (dry and wet screening) 5. Air classifiers 6. Balances & Scales 7. Disposables (bags and tags) 8. Drying Ovens.	Comminution, preparation of representative samples, Samples separation segregation studies, packaging and storage.	Safe operation of equipment must be emphasised. Respirators necessary. Dust exhaust is critical to avoid sample contamination, for good industrial hygiene and to minimise damage to equipment. Water, compressed air and vacuum must be among utilities. Electricity supply must be explicitly specified.	It is critically important to submit samples of bauxite and alunites - especially bauxites (which are very hard) to potential suppliers of grinding equipment for their evaluation and recommendation.

TABLE I Continued

OPERATION	EQUIPMENT REQUIRED	FUNCTION/OUTPUT	CONDITIONS	REMARKS
Chemical Composition, Routine Analytical Work, Analytical Research Work, Wet & Instrumental	1. Top loading and analytical balances	Sample weighing	Except for item 10, (Industrial Rapid Analyser - Neutron Activation), which will be located elsewhere, all the equipment in this area require the complete infrastructure required for an efficient and effective modern aluminium raw materials wet analytical laboratory. Stainless steel fume exhaust systems capable of resisting attack from all types of corrosive fumes must be installed. Furniture: tables, cupboards, sinks, shelves. Utilities: water, compressed air, vacuum, gas, electricity and suitable drainage. An exhaust system must also be installed for the AAS. The water distillation and deionised water preparation area will be located in an adjacent building.	The wet analytical laboratory is of fundamental importance to the entire facility it will engage in routine as well as research work employing classical analytical methods and techniques. Data generated from this laboratory will be critical for the calibration of dry instrumental analyses in other laboratories. New methods will be tested and evaluated in this laboratory before being put into routine use. Preliminary data for exploration and other purposes will be generated in this area. The laboratory will interact strongely with other areas. "Glassware" must be carefully selected to avoid contamination with Na^+, especially for alunite analysis.
	2. Heavy Duty Furnaces	Fusion and L.O.I. determination.		
	3. Drying Ovens	Sample drying.		
	4. Hot plates, Hot plates/ magnetic stirrers.	Sample dissolution, mixing and volumetric analysis.		
	5. pH meters	Determination of pH, pH adjustment.		
	6. Glassware (flasks, rods, burettes, pipettes etc.)	Volumetric analysis		
	7. Crucibles; porcelain, platinum and nickel	Gravimetric analysis and sample preparation		
	8. Sieves	Sample preparation		
	9. Rotary Aluminium Block Heaters - 16 place with 45cc mini-autoclaves. Temperature range up to 260°C maximum.	Determination of extractable Al_2O_3, Sol. SiO_2 and Sol. P_2O_5. Extraction studies Bauxite/ Al_2O_3 ratio.		
	10. Industrial Rapid Analyser (Neutron Activation).	Determination of Al_2O_3, SiO_2 Fe_2O_3, Na_2O, K_2O, CaO, TiO_2.		
	11. Centrifuge 4000 r.p.m.			
	12. Atomic Absorption Spectrophotometer (AAS).	Determination of Al_2O_3, SiO_2 P_2O_5, Fe_2O_3, TiO, MnO.		
	13. Flame Photometer	Trace elements		
	14. UV-Vis Spectrophotometer.	Rapid determination of Na_2O K_2O and CaO.		
	15. Thermatic Titrator	Determination of A/C, C/S NaOH.		
	16. Fully automatic XRF (Phillips) and fusion apparatus Leco Vitrocast	Fe_2O_3, SiO_2, P_2O_5, TiO_2, etc.		

TABLE I Continued

OPERATION	EQUIPMENT REQUIRED	FUNCTION/OUTPUT	CONDITIONS	REMARKS
	17. Still, deionised water, apparatus	Rapid automatic determination of Al, Fe, Si, P, Mn, Ca etc. Distilled and deionised water.		
Morphological, Mineralogical, Physico-Chemical Studies.	1. Scanning Electron Microscope (S.E.M.) with EDAX and capability for adapting an electron microprobe, complete with sample preparation equipment, sample supports and cameras for electron micrograph preparation. Disposable include adhesives. An ultrasonic vibrator critical for cleaning of sample holders/support.	Detailed micro-textural and micromorphological data on bauxites, alunites and alumino-silicates and on aluminas, al mina-hydrates, and by products, scales etc. Information on pore structure porosity and particle size. Detailed mineralogical/crystallographic information.	A photo-lab (Darkroom) is important for development of electronmicrographs. The electron microscope laboratory must be fully air conditioned and should be designed to eliminate all natural illumination as necessary. Dust levels to be kept at minimum (dust proof conditions). Sink and water necessary.	The S.E.M., XRF and XRD units are to be located in the area of the complex designed for equipment generating ionizing radiation. The standards prevailing in the country as well as international standards must be investigated and implemented. A system for monitoring dosimetry must be implemented and conditions for safe operations must be strictly adhered to. All personnel working in these areas frequently must wear radiation detection badges.
	2. Optical Microscopes and sample preparation equipment.	Petrographic and morphological data.		
	3. X-ray diffractometer fully automated with software. Complete set of powder diffraction files.	Quantitative phase analysis.	To be located in radiation area.	
	4. B.E.T. Surface area meter and liquid nitrogen transportation thermos flasks. Gas cylinders, regulators/pressure guages.	Specific Surface area determination. Pore size.	To be located in area in which gas cylinders can be safely anchored.	

TABLE I Continued

OPERATION	EQUIPMENT REQUIRED	FUNCTION/OUTPUT	CONDITIONS	REMARKS
	5. Thermoanalytical equipment with gas titrimeter (Q-1500 Derivatograph), complete with accessories.	Thermo-gravimetric (TG) Data, Differential Thermo-gravimetric data (DTG) Differential thermal analysis (DTA)	Detailed conditions to be specified by equipment supplier. Stable support for balances. vibration free room, temperature controlled air-conditioned room.	Equipment critical for quantitative phase determination as well as quantitative determination of SO_2 and CO_2. Equipment will be especially useful for analysis of alunite.
	6. Infra Red (IR) Spectrophotometer	Gas determination SO_2, CO_2.		
Technological Investigations	1. Rotary aluminium block digestion system with mini-autoclaves (45cc capacity). as in operation 4 above.	Simulation of extraction/leaching conditions. Studies on iron mineral transformation, investigation of SiO_2 reactivity.	Hooded fixtures Cooling water.	Except for the soft gamma ray settler which will be located in the area designated for ionizing radiation all equipment will be located in a two process research laboratories. One engaged in alunite investigations and another in bauxite investigation.
	2. One (1) oil bath and six (6) 250cc capacity autoclaves for operation at temperature up to 250°C.	Digestability simulation/ studies with greater mud output for detailed investigations.	Exhaust system required.	
	3. One (1) leaching assembly	Simulation of leaching step in Al_2O_3 products from alunite.	Exhaust system for corrosive gases necessary.	Most of the equipment are flexible enough to handle and effectively simulate (interchangably) the basic unit operations of Al_2O_3 production from alunite and bauxite.
	4. One (1) Rotary kiln (1600°C			
	5. One (1) Fluid Flash kiln (1600°C)	Simulation of reduction roasting. pyrolysis and alumina hydrate calcination		
	6. One 7.5 litre autoclave complete with instruments and expanders (flash tanks) and two (2) 2.0 litre capacity autoclaves with instruments and expanders.	Large scale digestion studies and sedimentation, investigation in water bath (graduated cylinders) and gamma ray settler.	Firm supports for autoclave and externally mounted expanders.	The expanders flash tanks, for the 7.5 and 2.0 litre autoclaves can be fabricated locally. The design must be for tangential discharge into the
	7. Desilication/Precipitation/ Causticization/temperature controlled water bath up to 100°C equipped with	Simulation of predisilication, and precipitation.		

TABLE I Continued

OPERATION	EQUIPMENT REQUIRED	FUNCTION/OUTPUT	CONDITIONS	REMARKS
	stirred vessels and built-in oscimho-transmitter for continous conductivity measurement.			expander to avoid particle breakage and piping should be for return to the laboratory. Technology transfer with the soft gamma ray settler is critical.
	8. One (1) water bath and low rpm (5-7 rpm motors) for sedimentation studies temperature controlled to 95°C.	For sedimentation studies. Dosage profiles, claritius, compaction studies.		
	9. One (1) soft gamma ray settler (SAM) complete with ultra thermostat, micro-processor and mini-computer with recorder.	Detailed studies and modelling of bauxite and alunite residue sedimentation for design and process economics data.	This requires special conditions which must be specified by the suppliers.	
	10. Two (2) high speed centrifuges - up to 4000 r.p.m.	Separation and analysis.		
	11. One (1) vacuum filter and one (1) pressure filter.			
Technological Test Work in Pilot Plant				Future activity for later phase of project.
Data Processing and Final Evaluation of Bauxite, Alunite Investigated, Preparation of Feasibility Study	Multi-user micro-computer with six terminals and modem for hook up to international information systems.	Information storage and retrieval. Modelling studies Geostatistical analysis, Economic Calculations. Statistical analysis Calculations etc.		

It is recommended that these be purchased from ALUTERV-FKI along with the necessary soft-ware and technology/training as a package.

Samples collected for the exploration programme must be done with the view to have these comprehensively analysed and tested for the purpose of using them as standards in the laboratory work programme. In addition it will be necessary to procure other standard bauxite samples (diasporic and chamositic) and alunites from other countries where these are found eg. Greece, USSR, Mexico. The alumina sub-committee of the ISO can assist in the supply of some of these standards as well as analytical methods.

In addition to the main equipment the following ancilliary equipment are critical:

- Voltage stabilizers for protection of the equipment, uninterrupted operation and accurate analysis.
- Eye wash and safety showwers.
- Laboratory pipe fittings (taps, sink etc.)
- Fire extinguishers.

In addition to the basic utilities the laboratory will need the following support services/utilities:

- Compressed air central station with distribution throughout the laboratories.
- Vacuum - central with distribution throughout the laboratories.
- Glassblowing work, equipped with glass cutting equipment. torches, grinding equipment etc.
- Maintenance workshop, electrical and mechanical (tools include: voltmeters, small hand tools, lathe etc.).
- Standby electricity generator

These can be housed in a common area - services building off the main building - which will be partitioned as necessary.

In general it is recommended that the Contracts and Procurements Division of UNIDO be used for the procurement of all equipment.

Several suppliers and types of the equipment needed are listed in the UNIDO Study (UNIDO) 1.0.466, 15 September 1981: "Profile of Transferring Technology in Testing, Investigation and Evaluation of Bauxite". Manuals of the air compressor and vacuum pump were handed over to the project management.

Since benefication of the bauxite and alunite will be investigated it is recommended to purchase a simple high intensity magnetic separation for bench scale studies. The Davis tube tester shown in Sepor Catalogue 0184 will be useful for this purpose. A copy of this catalogue was handed over to the project management.

It will also be critical to establish a proper equipment spare parts and laboratory stores for reagents and disposables. A cold room for the storage of volatile chemicals is also necessary.

In selecting the laboratory ware for the wet analytical laboratory teflon and other plastic ware will be necessary for handling alunite samples in order to avoid contamination with sodium. Since this could lead to errors by confusing natro-alunite with alunite.

In addition to the eyewash and safety showers, other safety considerations include the safe storage and anchoring of gas cylinders and the procurement and location of fire extinguishers in the laboratories.

The laboratory infrastructure and utilities were discussed in detail with the consulting engineerig firms and the recommendations made accepted. The layout and logistics of the laboratory discussed should be adhered to.

Implementation of the recommendations will result in the output of a well equipped aluminium raw materials testing laboratory capable of carrying out all the analytical work and technological testing planned for the ARMP.

PART 2

IMPLEMENTATION OF TRAINING PROGRAMMES

The efficient and effective utilization of the ARMTL will require the pursuit of an intensive training programme for members of staff in highly specialized disciplines, several of which are highly specific and are not commonly offered internationally. The training programme must therefore be combined with the functions of the laboratory illustrated in figure 1 and will take the form of local and in-house training and overseas training in similar institutions. It is recommended that international training take the form of:

1. Study Tours and
2. Fellowships.

In both cases it is recommended that the training division of UNIDO organize all training programmes after the development and organization of a training plan by the project management.

1. Study Tours:

A minimum of three study tours will be necessary. The objectives of which is to provide the members of staff of the ARMTL with an understanding of the integral nature of laboratory operations/investigations as they relate to the bauxite and alunite ore deposits and mine and the operation of the alumina works. The trainees should aim to achieve a substantially high amount of technology transfer on the overall operations of alumina production technology from the ore deposits through the laboratory to the alumina plant. This should provide a thorough understanding of the context in which the ARMTL will operate and a grasp for the scope of the work involved in establishing the ARMTL and the conditions necessary for its effective use and operation. The information obtained from these study tours will also form a basis for formulating specific training programmes on fellowships.

It is recommended that the three study tours to be undertaken should be as follows:

1. Bauxite deposits and alumina plant with their attendant laboratories and ore reserves division in a major producer country such as Jamaica, producing and processing gibbsitic type bauxites by open pit mining and with low temperature alumina plants and a visit to the newly established laboratories and pilot plant at the Jamaica Bauxite Institute generated from project ST/JAM/80/001.

2. A similar tour as in 1 above to European alumina plants, laboratories, mines and bauxite deposits. It is recommended that Hungary, France, the FRG and Greece be included in these tours.

3. A study tour to the USSR - the Institute of VAMI and the Kirovobad alumina plant which is based on alunite processing.

These study tours should be organized and implemented at the earliest possible time. In each case at least two members of staff should undertake the tour and it is recommended that these should take place over a minimum of two weeks. The participants should be engineers and scientists as necessary and should be fimiliar with alumina production technology.

In all cases detailed reports should be written as required by UNIDO and an in-house seminar held by the participants.

2. Fellowships:

The fellowships recommended for the ARMTL staff are as follows:

Reserves Division:

1. Training in alumino-ferrous ores exploration (drilling, sampling. mapping).

2. Reserves Evaluation (computation of tonnages and grades)

3. Mine Planning and Control

4. Land rehabilitation and Mineral Reserves Management.

These fellowships should be pursued by a minimum of two experienced geologist over a minimum of six (6) weeks. These fellowships may be undertaken at ALUTERV-FKI or the Jamaica Bauxite Institute.

Wet Chemistry Laboratory:

Fellowships for two individuald in the organization and operation of a modern wet chemistry laboratory from sample preparation and analysis through to data computation. This should take a minimum of four (4) weeks including several demonstrations on established analytical methods and techniques and the associated laboratory instruments.

Morphological Mineralogical:

A minimum of eight fellowships will be required in this area for four principal fields of study with one being for an electronic/electrical engineering candidate with a strong background in physics. These fellowships are:

1. Textural and micromorphological studies on bauxite and alunites by Scanning Electron Microscopy with EDAX 2 fellowships. Recommended institution ALUTERV-FKI.

2. Quantitative Phase Analysis by X-Ray, Thermal Studies and IR Spectrophotometry.
   Two (2) fellowships for X-ray analysis, two (2) fellowships for Thermal studies and IR spectrophotometry, one (1) for surface area, pore size and size distribution and one (1) for basic troubleshooting/maintenance of equipment - especially for the thermal analyzer.

Technological Investigations:

This area will require fellowships of long duration for effective technology transfer. It is recommended that two (2) fellowships be undertaken at ALUTERV-FKI for a minimum of three months. The main area of focus will be on sedimentation studies by the soft gamma ray settler. This will require at least six weeks (including theory and demonstrations) with the remainder of the time being spent on other areas of technological investigations. It is recommended that a short fellowship of two weeks duration be spent at the Institute of VAMI to observe the simulations for the reductive-roasting and leaching technologies for alumina production from alunites. The ARMTL engineers should be sent on these fellowships.

In all cases it is recommended that the fellows be made familiar in-house or locally (where possible) on the instruments/technologies involved as a pre-course training exercise before travelling.

To derive the maximum benefits from the training programme it is recommended that fellows note and acquire knowledge on:

1. The detail features of each instrument
2. The detail conditions for the installation of each piece of equipment.
3. All analytical methods.
4. The range of application of the equipment.
5. The degree of accuracy and precision for all components of alunite and bauxite using each method.
6. Acquire copies of all analytical methods
7. Acquire copies of manuals and brochures on each piece of equipment.

8. Acquire all technical literature (as far as possible) on the results of the application of the various methods.

9. Ensure that they develop the ability to undertake a critical analysis and evaluation of the data generated from each analysis/test for application in the ARMTL later.

10. Information on maintenance should be acquired.

The scheduling of fellowships should be carefully done in relation to the timing of the delivery of equipment for installation in the ARMTL. The time lapse between completion of fellowships and the commencement of installation of equipment should be kept to an absolute minimum with teams organized in-house to further increase the breadth of the transfer of technology.

In-House Training Programmes:

These should take the following forms:

1. Lectures and courses by visiting Consultants (these should be informed before hand).
2. Pre-course training in-house or in other local institutions.
3. Training equipment suppliers by installation crews. It is necessary to make this well in advance.
4. Seminars by Fellows and participants on study tours. It is recommended that this be a compulsory requirement of nomination.

Implementation of the training programme above should lead to the effective use of the facility. Of importance is the need to establish the laboratory work programme at an early date to ensure the timely pursuit of the ARMTL's objective.

In additon to these training needs, ARMTL personnel should begin to attend international symposia and conferences on bauxite and other alumino-ferrous ore processing.

Some of these which may be of interest are:

- TCDC Demonstration Workshop on pilot plant processing of bauxite at the Jamaica Bauxite Institute, Kingston June 1985.
- Light Metals Conference on the Occasion of the 114th AIME Annual Meeting (Bauxite-Alumina Sessions) New York, February 24-28, 1985.
- International Symposium on Bauxite Prospecting and Mining, October 2-5, 1985. Tapolca, Hungary (Organized by ICSOBA and the Hungarian Aluminium Corporation.

PART 3

CONCLUSIONS

1. At the time of visiting the project the feasibility study of alunite was well underway. It is highly recommended that the feasibility study for bauxite be undertaken at the earliest possible time since this is critical for the evaluation of the alternatives at the disposal of the ARMP and for making sound investment decisions.

2. Plans for the establishment of the ARMTL (Design and Construction Phases) are progressing satisfactorily (near completion with recommendations by the consultants accepted). The energy and architectural consulting firms have done an outstanding job.

3. Overall the project has the basis for an efficiently implemented project which will bear substantial development and economic benefits to Iran.

4. Staff recruitment is progressing satisfactorily with an enthusiastic, dedicated and fairly experienced senior staff already in place working under the guidance of a talented, competent and experienced project manager.

5. The complete equipment list now needs to be submitted to UNIDO and details obtained from suppliers with quotations for spread sheet analysis and selection of appropriate equipment followed by the documentation of a detailed delivery and installation schedule.

6. The requirements for training have been identified and a detailed training programme must be developed for submission to UNIDO.

7. The recommendations for proper maintenance of specific equipment must be obtained from equipment suppliers - including spare parts requirements.

8. A preventive maintenance programme must be established for the entire facilities including buildings and support services. This will require inputs from equipment manufacturers, the designers of the ARMTL. The services of these sub-contractors should be grouped in a comprehensive maintenance plan which should be contracted to and developed by a local maintenance company. A maintenance training programme for selected staff members must be put in place by the maintenance company.

9. With careful implementation the project should develop the capabilities to yield all the required outputs to enable the ARMTL to meet its objectives.

Follow-up Technical Asssistance:

Although the staff of the ARMP along with the Iranian Consulting companies will essentially undertake the major tasks involved in the establishment of the ARMTL, the project will benefit substantially from the involvement of UNIDO and its Consultants in assisting with:

- The selection and procurement of equipment
- Equipment installation and commissioning
- Development and implementation of training programmes and in-house training.
- Laboratory organization and operation and
- Implementation of analysis, testing and technological evaluation programmes.

Annexes:

Annex 1 is the activity schedule of the Consultant while Annex 2 are the joint recommendations made with Dr. Karoly Solymar (Consultant in the Processing of alumino-ferrous ores). Annex 3 is a list of the Senior Staff of the ARMP and the Iranian Consulting Companies. Annex 4 is a list of selected papers deliverd to the ARMP in Tehran.

ANNEX 1

CONSULTANT'S ACTIVITY SCHEDULE

25th - 26th July	Travel From Kingston to Vienna
27th - 30th July	Briefing at UNIDO Headquarters, Vienna
31st July	Arrive Tehran, Commenced discussions on equipment requirements and training.
1st August	Visit to bauxite reserves area with Mr. M. Shahriari and Dr. Karoly Solymar
2nd August	Continue visit to bauxite reserves areas with Mr. M. Shahriari and Dr. K. Solymar
3rd August	Holiday. Report Writing. Joint recommendations with Dr. K. Solymar.
4th August	Detailed discussions on equipment, laboratory layout and support facilities with ARMP staff. Discussions on project scope and status with Mr. K.G. Singh (Res. Rep.), UNDP staff members UNDP and Dr. K. Solymar.
5th August	Visit to the Alunite reserves area with Mr. M. Shahriari and Dr. K. Solymar. Discussions on maintenance requirements, and detailed basis/justification for equipment selection.
6th August	Further discussions on laboratory requirements. Especially laboratory suppliers, stocks. Data processing area/requiremetns.
7th August	Meeting with consulting engineers for design (Architecture) and energy/utilities. Agreement on final design/revisions for construction of laboratory building. Copy of common recommendations presented to Mr. K.G. Singh and discussions on progress of consultancy.

8th August	Continue discussions on laboratory requirements. Departure of Dr. K. Solymar for Vienna.
9th August	Continue discussions on laboratory.
10th August	As above
11th August	Departure to UNIDO, Vienna
13th August	Debriefing Vienna and Travel to Kingston.
15th August	Arrived Kingston.

ANNEX 2

JOINT RECOMMENDATIONS WITH DR. K. SOLYMAR

R E C O M M E N D A T I O N S

1 - The prefeasibility study for processing Bauxites should be undertaken concurrently with the feasibility study concering Alunite processing. It is important to note that the relatively low - grade, Diasporic — Chamositic, Bauxite can be processed, effectively by the Bayer process with proper process Technology selection for example using catalytic-additives and two stream digestion (saturation of the liquior by — Boehmite sweetening) and Caustic Soda regeneration Via Mud causticization. It is also critical to note that the chamosite in this — Bauxite is largely unreactive.

2 - The Aluminium Raw Materials testing laboratory (ARMTL) should have-the capability of determining the quantitative chemical and mineralogical composition of Bauxites, Alunites and Alumino - Silicate clays. It should also be capable of determining the Physico - Chemical — Characteristics and Morphological properties of these Ores and products. by - products, wastes and other raw materials used and / or — generated in Technological simulation studies. In addition it should be equipped to undertake the bench - scale simulation of the unit operations of the process technologies under consideration for the Alumino - Ferrous Raw Materials mentioned above.

3 - UNIDO's assistance in the procurement and purchasing of instruments — and equipment which require hard currency is highly recommended. A minimum of US# 1,000,000 is required to pursue this activity in the first phase which should last until the end of 1986.

4 - Technology transfer (soft ware) and the organization of special — training programme for staff members of the laboratory - specially for-orientation and effective utilization of the more technologically — advanced instruments is critically important and is recommended for — UNIDO's execution before the installation of the equipment.

5 - Maximum use should be made of the experience gained at the Jamaica — Bauxite institute (JBI), St/ Jam / 80 / 001 and in China, DP / CPR-80 / 047 and 81 (037), for manpower development and equipment —

selection, installation and commissioning and overall project —— organization and implementation. The study tour of the project —— manager's team to the JBI and the participation of selected staff — members of the ARMP in the workshop which will be held in Kingston- in the first quarter of 1985 when the operation of the pilot plant- will be demonstrated is highly recommended.

6 - As counterpart organizations in the field of design and application of pilot plant and industrial scale technologies for processing —— Alumino - Ferrous Ores based on their experience, the following —— institutions are recommended :

(1) Alunite processing : Institute Vami. Leningrad USSR.

(2) Bauxite processing : A. Aluterv-FkI, BUDAPEST,The Eng.and Dev.- Centre of the HUNGARIAN Aluminium corporation, HUNGARY, and

B. The Jamaica Bauxite Institute, Kingston JAMAICA .

(3) Utilization of Alumino - Silicates : Mansfeld Kombinat,FNE (Res. Institute of non - Ferrous — Materials) Freiberg. GDR.-

Hands - on training in the relevant disciplines are available — these institutions. Furthermore they can assist with equipment selection, installaiton, commissioning and operation and overall planning and organization of prospecting and R & D programmes.

7 - From the discussions between the Iranian Consulting firms responsible for the design and construction of the ARMTL. and the ARMP —— staff and UNIDO Consultants it is evident that these firms can —— effectively implement the tasks for which they have been contracted by the ARMP.

8 - For the effective detailed prospecting and evaluation of the ore — reserves it is recommended that the following equipment.

BE PURCHASED A PRIORI :

a. FOR CHEMICAL ANALYSES :

1. BALANCES
2. INDUSTRIAL RAPID ANALYZER (NEUTRON ACTIVATION)
3. ATOMIC ABSORPTION SPECTROPHOTOMETER (AAS)
4. FLAME SPECTROPHOTOMETER
5. UV - VIS SPECTROPHOTOMETER
6. THERMATIC TITRATOR
7. XRF (Phillips - IF SUFFICIENT FUNDING IS AVAILABLE)

b. FOR MINERALOGICAL PHASE ANALYSES :

1. XRD (PHILLIPS)
2. THERMOANALYTICAL EQUIPMENT WITH GAS TITRIMETET (Q -1500 DERNATOGRAPH)

c. FOR MORPHOLOGICAL STUDIES :

1. OPTICAL MICROSCOPES
2. SCANNING ELECTRON MICROSCOPE (S.E.M.) WITH EDAX

d. FOR TECHNOLOGICAL TESTING :

1. ROTARY ALUMINIUM BLOCK DIGESTION SYSTEM WITH MINI AUTOCLAVE —— (45cc) BOMBS.
2. LEACHING ASSEMBLY
3. FURNACE (1600 C)
4. ONE (1) 7.5 LITRE AUTOCLAVE EQUIPPED WITH PRESSURE GAUGE AND —— TEMPRATURE CONTROLLER AND TWO (2) 2.0 LITRE AUTOCLAVES WITH —— SIMILAR ACCESSORIES.

4a. THE ABOVE LIST OF EQUIPMENT IS IN ADDITION TO BASIC AND GENERAL-PURPOSE EQUIPMENT SUCH AS BALANCES, GRINDING MILLS, SEIVES ETC. THE PRIORITY OF PURCHASING THE SEM AT THIS TIME IS FURTHER JUS — TIFIED BY THE FACT THAT THERE IS NONE IN TEHRAN. PURCHASING OF-THE XRD IS JUSTIFIED BY THE NEED TO ESTABLISH THE MINERALOGICAL-COMPOSITION OF THE VARIOUS ALUMINO - FERROUS ORES AND TO DETERMINE THE DEGREE OF VARIATION FOR A GIVEN TYPE OF ORE. THE LATTER CAN NOT BE THOROUGHLY EVALUATED IN A COUNTERPART LABORATORY

5. ONE (1) OIL BATH AND SIX(6) 250cc CAPACITY AUTOCLAVES FOR OPERATING TEMPRATURES UP TO 250 C (ABOUT 50 BARS)

6. DESILICATION / PRECIPITATION / CAUSTICIZATION TEMPRATURE CONT — ROLLED WATER BATH UP TO 100 C EQUIPED WITH STIRRED VESSELS AND — BUILT IN OSCIMHOTRANSMITTER FOR CONTINUOS CONDUCTIVITY MEASUR — MENT .

7. TWO (2) HIGH SPEED LABORATORY CENTRIFUGES UP TO 4,000 RPM

8. ONE (1) LABORATORY VACUUM FILTER AND ONE (1) LABORATORY PRESSURE FILTER.

e. DATA PROCESSING EQUIPMENT

1. ONE (1) MULTI - USER MICRO COMPUTER WITH SIX (6) TERMINALS WITH — ONE TERMINAL FOR LIBRARY INFORMATION STORAGE AND RETRIEVAL EQUIPPED WITH MODEM FOR TIE IN TO INTERNATIONAL INFORMATION SYSTEMS.

2. ONE (1) MICROFILMING EQUIPMENT FOR PROCESSING MAPS AND OTHER – DOCUMENTS. EQUIPMENT 1. AND 2.e ABOVE SHOULD BE SPECIFIED —— AND IDENTIFIED AS SOON AS POSSIBLE FOR PURCHASING LATER IN RELATION TO THE PHASING OF THE SPECIFIC TRAINING PROGRAMME ——— (ACCORDING TO THE TIME SCHEDULE OF THE MASTER BAR CHART).

9 - IT IS RECOMMENDED TO SEPARATE THE COSTS OF TECHNOLOGY TRANSFER — (SOFT WARE) AND THE COST OF TRAINING AND FELLOWSHIPS FROM THE – EQUIPMENT COST (HARDWARE) WHEN CONSIDERING THE DIFFERENT SOURCES AVAILABLE FOR FINANCING.

10 - IN ORDER TO FACILITATE THE LOGICAL FLOW OF SAMPLES, OVERALL EFFICIENCY AND SAFETY IT IS RECOMMENDED THAT THE FOLLOWING GUIDELINES BE CONSIDERED IN THE MASTER LAYOUT OF THE LABORATORY :

a. THE DRY INSTRUMENTAL PHASE ANALYTICAL LABORATORY UNITS SHOULD – BE LOCATED IN THE SAME AREA.

b. ALL TECHNOLOGICAL TESTING UNITS SHOULD BE GROUPED IN THE SAME – AREA.

c. A ORE RESERVES SECTION CARRYING OUT THE FUNCTIONS OF PROSPECTING ETC. SHOULD BE CONSTRUCTED ON THE PREMISES OF THE ARMTL. THIS-WOULD ENHANCECOMMUNICATION PROMOTE GREATER INTERACTION AND IN – GENERAL INCREASE THE EFFICIENCY AND EFFECTIVES OF THE EXPLORA – TION PROGRAMME.

11 - FOR ALL RADIATION EQUIPMENT USING VARIOUS SOURCES, IT IS HIGHLY — RECOMMENDED TO OBTAIN THE EXACT SPECIFICATIONS FOR THEIR SAFE USE-AND HANDLING FROM THE COMPETENT AUTHORITIES AND EQUIPMENT SUPPLIERS AND TO PROCURE AN OPERATION PERMIT IN ADVANCE OF THEIR PURCHASE — AND INSTALLATION.

THE FOLLOWING EQUIPMENT ARE TO BE CONSIDERED FOR THIS PURPOSE :

a. XRD AND XRF,
b. S. E. M.
c. INDUSTRIAL RAPID ANALYZER TYPE MTA - 1527200 BY NEUTRON ACTIVATION,
d. SOFT GAMMA RAY ABSORPTION MODEL SETTLER.

12 - IT IS NECESSARY TO DESIGN A CENTRALIZED SYSTEM FOR THE PROVISION – OF THE COMMON SERVICES OF VACUUM AND COMPRESSED AIR TO EACH LABO – RATORY UNIT (AS NECESSARY). IT IS RECOMMENDED THAT THESE SERVICES BE HOUSED IN THE BUILDING PROPOSED FOR LOCATION OF THE STANDBY DIESEL ELECTRICITY GENERATOR.

13 - PROVISION SHOULD BE MADE FOR THE INSTALLATION OF THE FOLLOWING —— SUPPORTAND SERVICE FACILITIES :

a. A PHOTOGRAPHY LABORATORY (FOR S. E. M.)
b. A GLASS BLOWING AND REPARING WORKSHOP
c. A MAINTENANCE (MECHANICAL, ELECTRICAL) WORKSHOP.

14 - THE PROGRAMME OF LOCAL TRAINING OF ARMP STAFF ALREADY INITIATED BY THE PROJECT MANAGER IS SOUND AND EFFECTIVE AND SHOULD PROVE TO BE HIGHLY BENEFICIAL LATER. IT IS RECOMMENDED THAT THIS BE INTENSIFIED AND SYNCHRONISED WITH THE PLANNED ACQUISITION OF SPECIALIZED EQUIPMENT. THIS SHOULD BE FOLLOWED BY FURTHER TRAINING ABROAD RELATING TO THE CHARACTERISTICS OF THE GIVEN RAW MATERIALS AS DETERMINED BY THE SPECIALIZED ADVANCED EQUIPMENT BEFORE THE INSTALLATION OF SIMILAR EQUIPMENT IN THE ARMTL.

15 - IT IS RECOMMENDED THAT A MASTER BAR CHART BE PREPARED FOR THE ENTIRE PROJECT REFLECTING THE SEQUENCE AND SCHEDULE OF EACH MAIN ACTIVITY AND THAT THE MAIN ACTIVITIES BE BROKEN DOWN INTO DETAILED MINI BAR CHARTS FOR CONTROLLING AND MONITORING EACH ACTIVITY AND EVENT. THESE SHOULD BE REVIEWED AND REVISED ON A REGULAR BASIS BY THE PROJECT MANAGEMENT.

16 - QUOTATIONS FROM THE POTENTIAL EQUIPMENT SUPPLIERS BY UNIDO SHOULD BE OBTAINED AS SOON AS POSSIBLE FOR ALL OF THE EQUIPMENT, STARTING WITH THE MORE EXPENSIVE ONES, INDEPENDENTLY OF THE EXPECTED SOURCES OF FINANCING.

17 - PREPARATION AND DETAILED INVESTIGATION OF SOME SELECTED SAMPLES OF EACH RAW MATERIAL IS NECESSARY FOR THEIR USE AS STANDARDS IN THE QUANTITATIVE CHEMICAL AND MINERALOGICAL ANALYZES, MORPHOLOGICAL AND TECHNOLOGICAL TESTS TO BE CARRIED OUT IN THE ARMTL.
IT IS RECOMMENDED THAT THIS WORK BE PERFORMED IN ONE (OR MORE AS NECESSARY OF THE COUNTERPART FOREIGN INSTITUTIONS.). IN ADDITION A PROGRAMME OF COLLECTION OF STANDARD ALUMINO - FERROUS SAMPLES FROM DIFFERENT REGIONS SHOULD BE INITIATED.

18 - SIMPLE PHYSICAL ORE DRESSING METHODS ARE RECOMMENDED FOR ALUNITE AND BAUXITE BENEFICIATION. IT IS RECOMMENDED THAT THE NECESSARY EQUIPMENT BE INSTALLED IN THE ARMTL.
FOR THE BENEFICIATION STUDIES ASSISTANCE MAYBE OBTAINED FROM THE COUNTERPART INSTITUTIONS NAMED BELOW :

a. MECHANOBR, LENINGRAD, USSR (FOR ALUNITE)
b. ALUTERV - FKI, BUDAPEST, HUNGARY (FOR BAUXITE)
c. RUDARSKI INSTITUT, BEOGRAD, YUGOSLAVIA (FOR PILOT TESTING)
d. FORSSCHUNGS INTITUT FUR AFBEREITUNG (FIA), FREIBERG, GDR (FOR PILOT TESTING)

PREPARED BY :

KAROLY SOLYMAR
CONSULTANT IN THE PROCESSING
OF ALUMINO - FERROUS ORES

AND

CONRAD DOUGLAS
CONSULTANT IN MATERIALS
TESTING

TEHRAN 7th. AUGUST 1984

ANNEX 3

SENIOR PARTNER STAFF

THEIR NAMES AND SPECIALIZATION

I. Senior Partner Staff of ALUMIRAN Co.

/Alumina Raw Material Programme, Gharani Ave. Bimeh Alley No.9. Tehran
Telephone: 833252-3, Telex No.: 212334 NISC-IR/

1.	SHAHRIARI, Mohammad	Project Manager of ARMP
2.	SAYAR, Mahmood	Chem. Rng., in charge of Alunite Project
3.	HASSANZADEH, Ebrahim	Chem. Eng., in charge of alumosilicates and Laboratory Project
4.	AZARANG, Mahmood	Chem. Eng., Alunite Project
5.	MALEKMOHAMADI, Aman	Mining Eng./Alunite, Alumosilicates Project
6.	JOUIZADEH, Shahriar	Mat. Sci. Eng. /Alumosilicates Project/
7.	SHAHRUKHI, Kiumarce	Chemist/Wet Chem. Anal. Lab./
8.	HABIBI, Javed	Geologist
9.	KUZEH KANANI, Ferideen	Geologist
10.	HEMATI, Kholemreza	Geologist

II. Senior Partner Staff of the Architecture Consulting Eng./ SHAHR AND BARNHMEH/:

1.	SOUKIASIANS, Ara	Engineer
2.	TAVAKILI, Esmail	Engineer

III. Representatives of Energy Consulting Eng.:

1.	KHOEE, H.	Engineer
2.	SHARIFI, Y.	Engineer

ANNEX 4

LIST OF PAPERS DELIVERED TO

THE ARMP IN TEHRAN

1.	HALL, Robert B.:	World Non-bauxite Aluminium Resources - Alunite - Geology and Resources of Aluminium, Geological Survey Professional Paper 1076 - A.
2.	SKIJAROV, R.J.:	The Global Law - Governed Nature of The Development of Bauxite and Alunite Deposits. 4th International Congrss of the Study of Bauxites, Alumina and Aluminium, Vol. 2, Bauxites. Athens, Oct 9-12, 1978.
3.	SOLNTSEV, Sergei:	The Soviet Aluminium Industry - Methods and Materials, Sept. 1983.
4.	GOVETT, M.H., and LARSEN, J. :	Aluminium - Australian Mineral Economics Pty. Ltd.
5.	DOUGLAS, Conrad G.C.:	UNEP/UNIDO Workshop on The Environmental Aspects of Alumina Production, Paris 20-23, Jan., 1981. Secretariat's Report.