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UNIDO'S TECHNICAL ASSISTANCE ACTIVITIES IN THE
FIELD OF THE IRON AND STEEL INDUSTRY
INCLUDING DIRECT REDUCTION PROCESSES

prepared by

the Secretariat of UNIDO

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SUMMARY

This background paper outlines the nature, type and scope of technical assistance activities of UNIDO in the field of the iron and steel industry and also refers to the technical assistance projects concerning direct reduction processes for the production of sponge iron.

Reference has also been made to supporting activities of UNIDO in the field of iron and steel industry including the proposed "Third Interregional Iron and Steel Symposium" expected to be held in Brazil during 1973. The spectrum of activity in the above fields is as wide as it is interesting and challenging and which UNIDO is striving to fulfil.

INTRODUCTION

1. Technical assistance activities of the Metallurgical Industries Section of UNIDO in the fields of the iron and steel industry have been encompassed in the following overall areas covering the metallurgical industries as a whole. Without going into the details of the "modus operandi" of such technical assistance channels and programmes, it may be said that the technical assistance coverage is comprehensive. The following examples are illustrative of the general trends of the technical assistance provided by UNIDO in the fields of the iron and steel industry.

- a) Technical feasibility pre-investment and techno-economic studies.
- b) Appraisals of capital costs, negotiation of contracts for metallurgical plants in developing countries.
- c) Projection and project evaluation including expansion and modernisation of existing facilities.
- d) Promotion (developing, implementing, evaluating) of metallurgical industry projects.
- e) Metallurgical industrial development planning on a national, regional and interregional levels.
- f) Technical appraisal of raw-materials including their processing for iron and steel and non-ferrous metallurgical industries.
- g) Production technology, selection of technological processes and equipment; new methods, quality of products; techno-economic evaluation of competitive processes and latest innovations and their implementation/adaptation with suitable measures in developing countries.
- h) Market surveys and projections for developing countries and regions.
 - i) Provision of facilities for metallurgical testing, development and research including pilot plant installations
 - j) Formulation of projects related to the development of iron and steel and non-ferrous metallurgical industries for developing countries and regions.

2. Review of the technical assistance programs of UNIDO in the field of iron and steel industry in developing countries.

The establishment, expansion or operation of iron and steel plants continued to be the object of numerous requests submitted to UNIDO, showing the interest of developing countries for this basic branch of industry. A comprehensive study was completed in 1971 as a basis for planning the long-range development of the Peruvian iron and steel industry; a number of projects are also envisaged as a follow-up. UNIDO is also preparing a comprehensive study for the Brazilian Government, regarding the implications of technological innovations for the long-range planning of the country's rapidly expanding iron and steel industry.

UNIDO will also prepare an integrated comprehensive long-range study of the present situation and prospective development of the Colombian iron and steel industry.

UNIDO is carrying out a regional feasibility study for the ferro-alloy industry in the Mekong countries and the establishment of iron and steel industries in the Khmer Republic, Laos, Thailand and Vietnam, with the co-operation of ESCAPE. Preliminary assistance for long-range planning of the Thailand steel industry was provided in 1971.

UNIDO has prepared, for the Government of Togo, a pre-feasibility study on the possibility of establishing a small re-rolling mill. Similar assistance is being provided to Qatar in assessing the possibilities of setting up a steel rolling mill in the country.

Technical assistance for iron and steel industry planning has been provided to the Syrian Arab Republic. A pre-feasibility study on iron and steel industry development is being carried out at the request of the Mali Government. With the aim of increasing the short and long term profitability of the existing steel works, UNIDO is providing technical assistance to the Ghana Industrial Holding Corporation.

Experts were provided to the steel industry of Yugoslavia, to assist in increasing productivity and quality at the Zenica steel plant.

A feasibility study for the establishment of an integrated iron and steel plant is being prepared during 1972 for the Government of Iraq.

3. UNIDO has been assisting the Government of the Arab Republic of Egypt with a comprehensive programme of technical assistance in the iron and steel sector; the pilot plant tests with the Assuan iron ores carried out in 1971 will be followed by a feasibility study for the establishment of an integrated steel plant; pilot plant tests on Bahariya iron ores may be followed by a feasibility study for a direct reduction plant; assistance is being provided in the establishment and operation of a pilot project for technical data processing and organising maintenance services at the Egyptian Iron and Steel Works, Helwan; in addition, expertise was provided to the Helwan works for the modernization of their steel shop.

4. As a follow-up of the pilot plant investigations of the Indian and Iranian iron ores and ores in a pre-feasibility study for the establishment of a direct reduction plant is under consideration by the Government of Iran. Assistance was provided to India in connection with projects for iron production by unconventional processes in Andhra Pradesh, Orissa and Maharashtra. As a consequence of the Seminar on Tin Plate Production held in 1970, in Chile, requests for technical assistance were received from Thailand, for expertise in quality control of hot-dipped tin plate, and from Peru, for technical assistance in the design and layout of an electrolytic tinning line.

5. During the last two years increasing interest has been shown by developing countries for projects of technical assistance to the foundry industry sector. Assistance is being provided for both the establishment and operation of foundries. Active projects in 1971 included the supply of specialized expertise for improving existing foundries in the Arab Republic of Egypt, Argentina, Haiti, Iran, Iraq, Mali, Thailand, Yemen (People's Democratic Republic), and for the establishment or demonstration of prototype foundry shops (in Senegal, Togo). UNIDO is continuing its assistance in the establishment of prototype foundries, in combination with mechanical workshops.

in Somalia and Sudan (partly financed from voluntary contributions to U.IDO) and initiated preparatory work for establishing a combined Foundry, Tool, Die and Mould making Centre in Malaysia in co-operation with ILO. Projects of this type will help to solve immediate problems in the production of various spare parts that are needed for repair of machinery and equipment, and, with their demonstration and training effect, will serve as nuclei for metallurgical and metal-working industries. In addition, such foundries will supply local markets with castings needed by other industries, agriculture, utility networks, etc.

6. U.IDO is assisting a number of developing countries in a more advanced stage of industrialization in the establishment of centres of metallurgical technology. The following projects are examples of U.IDO assistance in this field. UNDP/SF project assisting the Centre for Metallurgical Research and Development in the Arab Republic of Egypt is advancing its activities.

Another UNDP/SF project is providing assistance to the National Metallurgical Laboratory in Jamshedpur, India, for the creation of a creep testing laboratory. Other technical assistance projects are under consideration for the establishment or strengthening of centres of metallurgical technology in Iran, Pakistan, Turkey and Yugoslavia in which a dominant theme would be technical assistance operational projects in the fields of iron and steel industry.

7. In 1971 the total number of technical assistance projects in operation in the field of metallurgical industries was 110 corresponding to requests from 41 countries. Most of these projects were financed under SIG. The total number of projects is expected to rise to 130 in 1972 and 160 in 1973. Apart from projects financed under the Special Fund, TA, SIS or CTF, a number of important projects for assistance to metallurgical industries have been included or proposed for inclusion in the country programme of a number of developing countries.

8. It is noteworthy that in 1971 three UNDP/SF projects became operational in the field of metallurgical industries; they covered

assistance to centres of metallurgical technology in the Arab Republic of Egypt, Chile and India. Four more SP projects are in an advanced stage of preparation and should be approved in 1972 or early 1973; they would provide assistance for the establishment of a centre for foundry technology in Senegal and for setting up pilot and demonstration plants for ilmenite smelting in the Arab Republic of Egypt, Ceylon and India. Other SP projects for the establishment of centres for metallurgical technology are under consideration, such as for Iran, Pakistan and possibly for Turkey.

9. A total of nine projects were financed from the General Trust Fund of UNIDO during 1971. Six of the projects involved laboratory scale testing and techno-economic feasibility studies for processing ilmenite sands or concentrates of the Arab Republic of Egypt, Ceylon, The Gambia, India, Madagascar and Senegal, leading to the eventual establishment of pilot plants. The remaining three projects involved assistance to the foundry industry of Mali, Somalia and Sudan.

10. UNIDO's Supporting and other Activities in the Fields of the Iron and Steel Industry

The following resumé gives an outline of the supporting and other activities of the Metallurgical Industries Section in the multiple fields of the iron and steel industry; these are aligned to the operational activities of UNIDO and are undertaken in unison therewith to attain the maximum impact and utility.

The activities under this heading include the preparation of iron ores, coke-making, iron-making, steel-making, ferro-alloy production, rolling and finishing operations in the production of steel as well as wire drawing, forging, welding, tube production and other steel forming techniques.

The report of the Seminar on "Tin plate production", held at the end of 1970, in Chile, in conjunction with ECLA (ID/B/44, para. 37) has been published in 1971 (document ID/WO.73/17).

A UNIDO Workshop on the "Creation and transfer of metallurgical know-how" was successfully completed at the National Metallurgical Laboratory, Jamshedpur (India) from 6 - 11 December 1971. The following expert papers, prepared for this Workshop provided the background against which stimulating discussion took place during the deliberations of the

UNIDO Workshop:

1. The transfer of extractive metallurgical technology to developing countries.
2. Technical consultancy services and development of metallurgical know-how for the design and operation of non-ferrous metallurgical plants in developing countries and regions.
3. Managing the transfer of know-how.
4. Challenges to the creation and transfer of know-how.
5. Technical consultancy services and creation of technical know-how for the aluminium industry in developing countries; past experience and future recommendations for practical implementation on a self-sustained basis.
6. Design and engineering services on metallurgical projects.
7. Preparing feasibility studies for metallurgical projects.
8. The planning of LD steelworks.
9. The role of research and development work and pilot plants in the creation and transfer of metallurgical know-how in developing countries and regions.
10. Types and conditions of technical co-operation.
11. The development and acquisition of steel technology know-how in Brazil.
12. Main trends in the development of continuous steel-casting in the USSR.
13. Converter steelmaking in the USSR.
14. Creation and transfer of metallurgical know-how.
15. The transfer of technical know-how in the steel industry in Brazil.

The report of this UNIDO Workshop is now under preparation.

The subject of the "Promotion of metallurgical technology transfer to the metals transforming industries of Latin America" is scheduled for a promotional effort mid-1972.

As a number of issues of decisive importance are maturing for the planning, construction and operation of iron and steel plants in developing countries, UNIDO is proposing to hold a Third interregional iron and steel symposium (Priority A), by 1973, five years after the Second Symposium (held in Moscow) and ten years after the First (held in Prague and Geneva), it will be opportune to bring together executives, plant managers, top engineers, planners and Government officials involved in the establishment or operation of iron and steel plants in developing countries for the purpose of discussions of progress made thus far, of economic, technical and financial problems still confronting developing countries and of opportunities open to them in this branch of industry. An effort will also be made to promote special contacts of organizations and individuals capable of supplying know-how, equipment and financing with the decision-making executives and technical managers of the iron and steel industry in developing countries.

11. In the discussions the position and role of developing countries as consumers or suppliers of essential metallurgical raw materials and of steel products will be re-examined in the light of changing world market conditions and of technological innovation. Specific issues will include: The macro-economic effects of local iron and steel production; factors affecting scale of iron and steel units (integrated, semi-integrated or non integrated) and the role of "mini-steel" plants, including those based on unconventional techniques (charcoal blast furnaces, direct reduction, etc.); the need for and significance of heavy investments in "know-how", in addition to investments in "hardware"; the impact and consequences of new technologies in the world's iron and steel industry (new processes, new products); changes in the international iron and steel picture and possibilities open to developing countries as a consequence of shifts in production and trade; development of local capability to plan, design, build and operate plants and equipment; possible solutions for the serious problems caused by a limited coking coal supply; the financial, technical and manpower problems arising from the need to establish local production to satisfy a growing demand for steel in developing countries; sources and mechanisms for obtaining financing, know-how,

equipment and trained manpower. In the presentation and discussion of issues related to financing the Industrial Policies and Financing Section of UNIDO will co-operate.

12. Early in 1972, a preparatory expert group meeting was convened in Vienna to examine and advise UNIDO on the purposes and means of the proposed third interregional iron and steel symposium and to prepare its detailed agenda. The report of this expert group meeting will be instrumental for the organization and implementation of the project.

13. UNIDO is carrying out a number of technical assistance projects in this area, which cover production of iron and steel castings. The purpose of the supporting activities under this heading is to provide guidance needed by developing countries in establishing foundries or improving their operations ranging from small sand-casting installations for simple products to large, modern automated installations.

14. In view of the general interest of the developing countries in the establishment of foundry shops, UNIDO had planned for 1970 the preparation of a basic reference document on prototype design and operating standards of typical grey cast iron foundry installations. The documentation which could only be finalized in 1971 contains a description of typical grey cast iron foundry installations suitable for developing countries; layouts; essential list of equipment; typical products; manpower; estimates of capital and production costs. It will be of direct use in the planning and operation of foundries in developing countries and will also be useful in planning and implementing the assistance of UNIDO to this branch of industry. The document is scheduled for publication in 1972.

15. UNIDO's Activities in the Fields of Direct Reduction of Iron Ores for the Production of Sponge Iron

Right from its inception in 1967, the Metallurgical Industries Section, UNIDO took considerable interest in the study of direct reduction processes for the production of sponge iron from high grade iron ores/pellets. In May 1967, UNIDO sponsored a technical mission^{1/} to Mexico to study the HYL gaseous direct reduction process for the production of sponge iron using natural gas and high grade iron ores; the UNIDO's mission report UNIDO/ITD/48 aroused considerable interest in developing countries such as Iran, A.T.I., Iraq, Syria, Kuwait, Morocco, Algeria, etc.

Iran in particular requested UNIDO to sponsor comprehensive laboratory bench and bag scale tests on their iron ores/pellets to study their reducibility characteristics based on the HYL gaseous direct reduction process. Similar tests were sponsored by UNIDO^{2/} on some Indian iron ores/pellets. The purpose of this test programme was to qualitatively establish whether or not the reducibility characteristics of the test samples of the iron ores and oxide pellets are equal to better, or poorer than the Encino (Mexican) iron ore which has been processed commercially in the HYL sponge iron plants at Monterrey, Mexico. Also a qualitative comparison was made with the Almada oxide pellets which are processed in the HYL sponge iron plants. The results also indicate which ores or pellets appear unsuitable for reduction by the HYL process and should not be further tested.

The bench scale tests were carried out by the Development Division of Swinell-Dressler Company, Pittsburgh (USA).

The bag scale tests were conducted by the Research and Development Department of Hojalata y Laminas, S.A. at Monterrey, N.L. Mexico.

The required beneficiation tests and pellet production of the Ghams Abad Iranian iron ore (Sample No. 50467-A-3) were performed for Swinell-Dressler Company by the Mineral Resources Research Centre, University of Minnesota, Minneapolis, Minnesota.

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- 1/ UNIDO technical mission included a representative of the Iranian Government.
 2. UNIDO had sponsored a technical mission of a staff member to Iran and India for working out the scope of the HYL gaseous direct reductive reducibility tests on Iranian and Indian iron ores.

The Terms of Reference for the contract entered into by U.I.D.O with Swindell-Dressler Co. USA, for the above tests are given in Appendix A.

16. An identical contract was entered into by U.I.D.O with Swindell-Dressler Co. USA for laboratory bench and bag scale tests on Bahariya iron ore samples of ARE to study the latter's reducibility characteristics based on the HYL gaseous direct reduction process.^{1/}

17. Direct Reduction tests, including pre-reduction based on solid fuel reductants

There is much activity in many countries on this subject; however, considerable further development work on pilot plant and industrial prototype scale remains to be done. Recognising the importance of this subject, UNIDO has taken initiative to provide technical assistance in the field of solid reductant based direct reduction of iron ores for the production of sponge iron.

In the case of India, UNIDO is studying the provision of technical assistance programme through a Major Project (earlier termed CP project) designed to study direct reduction of iron ores in rotary kiln based on solid fuel reductant.

18. Laboratory and Pilot Plant scale tests programme on Assam iron ore of ARE

U.I.D.O^{2/} has contracted comprehensive test work programme on Assam iron ores of ARE based on their beneficiation, agglomeration, pre-reduction and direct reduction in rotary kiln and electric submerged arc smelting of the reduced sponge to produce basic iron suitable for steelmaking.

Appendix "B" gives the "Terms of Reference" of the U.I.D.O contract awarded to the National Metallurgical Laboratory Jamshedpur (India) for undertaking the above work; their interim report has already

1/ U.I.D.O had sponsored a technical mission of a staff member to ARE for working out the scope of the HYL gaseous direct reduction reducibility tests on Bahariya iron ore deposit of ARE.

2/ A UNIDO staff member undertook a mission to ARE to formulate the scope of test work programme on Assam iron ore of ARE based on their beneficiation, agglomeration, pre-reduction and direct reduction using solid reductants followed by smelting of the reduced charge in an electric submerged arc furnace for the production of basic iron suitable for steelmaking.

been received whilst the detailed report expected shortly. All the laboratory experimental and pilot plant scale investigations have been completed at the National Metallurgical Laboratory, Jamshedpur (India).

Terms of Reference for the Contract entered into by JIHO with Swindell-Drussler Co., USA

The Contractor shall, under the terms of this Contract, conduct in its Experimental Plant at ETNA in Pennsylvania, USA, bench scale tests and in its subsidiary Pilot Plant at Monterrey, Mexico, bag tests, on the reducibility characteristic on all the following iron ores and pellets for the production of sponge iron by the HYL process using natural gas:

A) Iranian Iron Ores

1. Kashan iron ore
2. Semnan iron ore - a) deposit No. 1
b) deposit No. 2

3. Shamsabad iron ore

Sample No. 3 shall be first tested for beneficiation and pelletizing and the pellets produced shall then be bench and bag tested.

All samples shall be of +1" to -3" in size and shall be representative of the ores.

All samples shall be 100 kg except No. 3 which shall be 3000 kg.

B) Indian Iron Ores/Pellets

1. High grade lumpy iron ore from Hospet iron ore deposits of Messrs. Chowgule.
2. Donimalai iron ore deposits of National Mineral Development Corporation in Hospet region.
3. High grade iron ore pellets of the size of +7 to -16 mm from Chowgule pelletizing plant at Pale (Goa).

All iron ores samples shall be of +1" to -3" and would be representative of the ores.

All samples shall be 100 kg.

Based on the above tests, and using as standard test reference the EL ENCINO (Mexico) iron ore which is normally processed commercially in the HYL industrial plants at Monterrey in Mexico, the Contractor shall qualitatively establish whether or not the tests samples of iron ores and pellets mentioned under 1.01 are equal, better or poorer than the EL ENCINO (Mexico) ore.

APPENDIX "B"

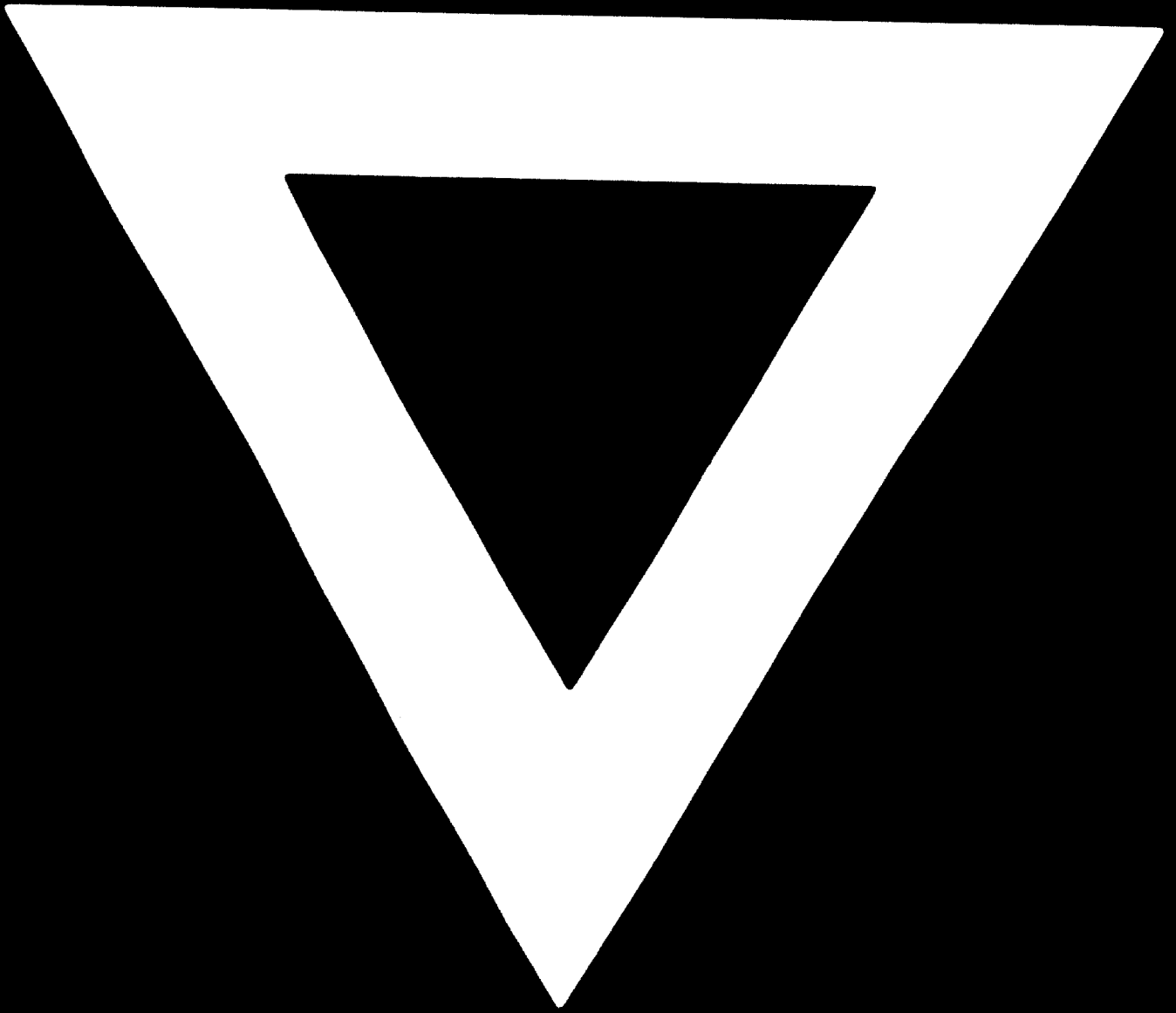
Terms of Reference for the contract entered into by UNIDO with the National Metallurgical Laboratory Jamshedpur, India

The United Nations Industrial Development Organization (UNIDO) entrusted the National Metallurgical Laboratory, Jamshedpur, India, with the responsibility of undertaking the laboratory and pilot plant studies on the suitability of Assam iron ores in the Arab Republic of Egypt for iron-making. The contract No. 70/26 signed between the two organizations, namely the UNIDO and the National Metallurgical Laboratory provides the following terms of reference.

- (i) Laboratory scale trials as the beneficiation of the iron ores (lumps and ore fines) for the formulation of the optimum and economic upgrading flowsheet yielding the highest possible iron recovery consistent with high quality concentrate.
- (ii) Extensive pilot plant scale trials to obtain requisite data for industrial scale implementation of the beneficiation flowsheet.
- (iii) Assessment of the techno-economic aspects and cost factors for the ore beneficiation.
- (iv) Trials on the agglomeration of the ore concentrate sufficiently comprehensive to formulate requisite data for industrial scale implementation of the optimum agglomeration cycles based on:
 - a) Production of sinter (self-fluxing and super-basic sinters) of high quality;
 - b) Pelletising of the ore fines (un-fluxed and self-fluxing pellets to yield high grade pellets);
 - c) Formulation of the optimum burden-mix for sintering and pelletising test trials; and
 - d) Assessment of the techno-economic aspects of sintering and pelletising; and the operational and production costs.
- (v) Trials on pre-reduction of the agglomerated (sinter and/or pellets) burden in rotary reduction kiln using solid, liquid or gaseous fuels or their optimum combination to obtain a highly metallised product.
 - a) Calculation of the raw materials burden to be aligned to yield data for industrial scale implementation of the pre-reduction treatment of the agglomeration burden.

- b) Assessment of operational and final production costs of pre-reduction of the burden including their relationship with industrial scale operations; and
 - c) Preparation of a full scale flow-sheet showing the techno-economics of the industrial scale operations of pre-reduction treatment of agglomerated burdens.
- (vi) Trials on the electric melting of the pre-reduced product hot-charged continuously into the submerged-arc electric furnace on a sufficiently comprehensive scale of operations to yield to the following data:
- a) Power consumption for electric melting of the pig iron based on hot pre-reduced charge.
 - b) Overall economics of the melting operation and its correlation with industrial scale operational and final production costs; and
 - c) Relative advantages of the hot pre-reduced charges in relation to cold charge operations.
- (vii) The final report is to be submitted in 15 copies in English based on the results of trials outlined above, integrating and dovetailing one operation with the other with a view to highlight the following:
- a) Material balance for each stage of operation;
 - b) Operational and production costs for each stage and their interpretation to yield the overall costs from the raw materials to the liquid metal. These costs will have to be upscaled to provide requisite data for industrial scale operation both in relation to capital costs and operational costs and should also include full details about the several trial results as relating to consumption of raw materials, thermal balance, chemical analysis of raw materials used and of the products of each stage, power consumption and their relation with the overall economics of integrated operations as well as the final recommendations for the choice and implementation or otherwise of the technological processes as outlined above.
- (viii) The final report is to be submitted in eight months after the receipt of the bulk iron ore samples.





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