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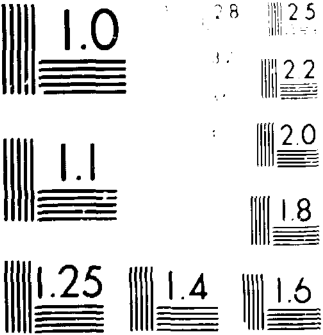

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STUDY TOUR AND WORKSHOP TO PROMOTE TECHNOLOGY DEVELOPMENT AND TRANSFER IN THE AREA OF SPONGE IRON MANUFACTURING IN DEVELOPING COUNTRIES OF THE ESCAP REGION (INDONESIA AND INDIA)

29 March - 8 April 1983

Report of the workshop*

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1. BACKGROUND INFORMATION AND OBJECTIVES OF THE WORKSHOP

In view of the growing importance of direct reduction processes in the ESCAP region, several technical advisory missions and meetings have been carried out under the auspices of UNDP and UNIDO to focus attention on problems and potentials of developing viable iron and steel industries in the developing countries of the world. In recent years promising technological changes have taken place in the iron and steel industries and it is now possible to establish viable plants on a much smaller scale, based on sponge iron production and its melting in electric arc furnaces to produce commercial grades of steel. Ways and means of increasing regional steel production by means of application of modern steelmaking technology and, in particular, the direct reduction process, remain yet to be explored.

Within the UN family, ESCAP and RCTT (Regional Centre for Technology Transfer, Bangalore) have also been active in promoting activities in the planning, establishment and operation of direct reduction units. With assistance from UNDP and the Government of Netherlands, UNIDO, ESCAP and RCTT organized during 1979 a workshop on problems of technology transfer for promotion of sponge iron industry in the countries of the ESCAP region, in Bangkok, Thailand. UNIDO organized in Jamshedpur, India, in December 1981 a workshop on regional co-operative research among metallurgical research and development centres in Asia and the Pacific where the importance of exchange of information on direct reduction was also discussed.

In order to further promote regional co-operation and continuous exchange of information on the subject, UNDP, UNIDO and RCTT have organized the present Study Tour and Workshop in Indonesia and India to discuss latest technological advances in direct reduction processes and use of sponge iron and discuss possibilities for further development of this industry in the region.

Two plants were chosen for the study tour:

1. P.T. Krakatau Steel (PTKS), Indonesia, a large DR plant utilizing natural gas, established at Cilegon, with HYLSA (Mexico) technology. The plant has an ultimate capacity of 2 million tons of sponge iron per year.

2. The Pilot and Demonstration Plant of Sponge Iron India Ltd. (SIIL), at Paloncha Kothgudem, with a capacity of 30,000 tons per year, using the SL/RN (LURGI) direct reduction route based on non-coking coal as a reductant.

Apart from the above plant visits to study the solid reductant and gas based reductant direct reduction technology, the Workshop had the following objectives:

1. To discuss the status of the DR industry in the ESCAP countries (current state, future projections and possibilities in the global context of the iron and steel industry);
2. To review the current state of the DR technology based on various reductants (solid, gaseous);
3. To study the introduction of a regional project for the promotion of sponge iron production for different technological groups in the ESCAP countries;
4. To consider a request for UNDP assistance in the development of sponge iron industry through direct reduction technology for mini-steel plant operations in those countries which express interest and have the potential for such an industry;
5. To consider other regional activities in this field including the establishment of a network of institutions engaged in the area of sponge iron.

2. PROGRAMME OF THE WORKSHOP

The following programme was observed:

29 March 1983	Arrival of participants in Jakarta, Indonesia
30 and 31 March 1983	Travel to Cilegon, visit to Krakatau Steel Plant, briefing by plant authorities and discussion and return to Jakarta
1 - 3 April 1983	Travel to Hyderabad, India, via Singapore and Madras
4 April 1983	Arrival at Paloncha and visit to Sponge Iron India Limited followed by discussions
5 April 1983 to 7 April 1983	Arrival at Hyderabad for Opening Session, presentation of Country Papers and Discussions including observers from HYLSA, LURGI and MIDREX
8 April 1983	Concluding Session with adoption of the report and approval of the project document for the proposed regional project.

Visits were undertaken to the Pilot Plant of the National Mineral Development Corporation in Hyderabad and to the Nagarjuna Steels Ltd., at Patancheru, with cold rolled steel strip production.

3. ATTENDANCE AT THE WORKSHOP

The Workshop was attended by participants from 13 developing countries of the ESCAP region. The list of participants is contained in Annex I.

The Workshop was officially inaugurated on 5 April 1983 by Mrs. N. Buch, Joint Secretary to the Government of India, Ministry of Steel and Mines, Department of Steel. UNDP was represented by Mr. M.J. Priestley, Resident Representative, UNDP, New Delhi, and Mr. P.N. Pathak, Programme Officer. Opening speeches were also given by Mr. B.R. Devarajan, Director, Regional Centre for Technology Transfer, Bangalore, Mr. B.R. Nijhawan, Senior Interregional Adviser, UNIDO and Mr. S. Vangala, Managing Director, Sponge Iron India Ltd. The international organizations were further represented by Mr. C.V.S. Ratnam, Adviser on Science and Technology Policy, Regional Centre for Technology Transfer, Bangalore, Mr. V.I. Gorchkov, Economic Affairs officer, ESCAP Secretariat, Bangkok, and Mr. A.B. Krasiakov, Senior Industrial Development Field Adviser of UNIDO, stationed at New Delhi. Mr. F. Iqbal, Senior Industrial development Field Adviser of UNIDO stationed in Jakarta only attended the study tour to the Cilegon P.T. Krakatau Steel Plant.

During the opening session the efforts of UNDP, UNIDO and RCTT in organizing such a Workshop and Study Tour were highly appreciated and hope was expressed that these would result in a regional project of cooperation.

4. ELECTION OF CHAIRMAN AND VICE-CHAIRMAN

Mr. S. Vangala, Managing Director of Sponge Iron India Ltd. was elected Chairman. Messrs. Wi Juxian, Engineer, Central Iron and Steel Research Institute, Beijing, Peoples Republic of China and Mr. Fazwar Bujang, Direct Reduction Plant Super-intendant, P.T. Krakatau Steel were elected as Vice-Chairmen. Mr. M.Z. Qazi, Principal Scientific Officer, Pakistan Council for Scientific and Industrial Research, Lahore, was elected Rapporteur of the Workshop.

5. STUDY TOUR TO DIRECT REDUCTION PLANTS

(a) Visit to P.T. Krakatau Steel on 30 and 31 April 1983

The plant tour with emphasis on the DR plant and the billet plant took place on 30 April whilst participants were provided with general information, followed by discussions on 31 April. Two papers were presented to the participants which provide detailed information on the plants: "Direct Reduction Plant as Part of the First Indonesian Integrated Steel Plant" by Mr. Fazwar Bujang, Super-intendent, Direct Reduction Plant, and "Aspects of High Ratio DRI Melting Practice for the Production of Weldable High Tensile Reinforcing Bars in the Electric Arc Furnace" by Mr. Chosdu Sai'in, Super-intendent, Process Engineering and Quality Control -

Primary Operation. These papers can be made available upon request. The welcome speech and introduction to the plant was made by Mr. Djoko Subaigo, Associate Production Director.

Participants were informed that the second stage of the DR plant of one million tons which brings total installed capacity of the plant to 2 million tons had been completed in August 1982. A hot strip mill, of semi-continuous type, with a capacity of 300 tons/hour, had also recently been commissioned (February 1983). This mill, together with the sheet strip mill will have a total capacity of about 1 million tons/year.

The P.T. Krakatau Steel Plant further comprises a billet making plant equipped with 65 t EAF, 4 stands, 2 continuous billet casters, with 500,000 tpy capacity. The bar and section mill which were originally supplied from USSR have undergone expansion and modernization, with a present capacity of over 200,000 tpy, and also the wire rod strip mill with a capacity of 200,000 tpy made by a German company. The spiral pipe manufacturing plant has a capacity of 65,000 tpy, with the maximum size of 2 m pipe diameter. The cold rolling mill complex is a joint co-operation with the private sector, PTKS has a share of about 40 %. Most of the hot coil to be produced will be taken by the cold rolling mill. The construction of the mill will start during 1983 to be completed by 1986. The plant also disposes of a training centre for vocational training. After presentation of the papers by Messrs. Fazwar Bujang and Chosdu Sai'in a number of technical and economic questions were raised, such as the possible affect of the recent devaluation of the Indonesian Rupiah on the steel price. Participants were informed that hte price was Government controlled through import control and orientation on world market prices. The high energy consumption 4.85 Gkal per ton of iron in the sponge produced was also pointed out. This could possibly be brought down by adapting the plant which is of HyL I type to more recent developments in the process, such as HyL III. It was admitted that the plant was designed before the oil crisis and that in the light of world economic developments revamping would become desirable.

The labour force at PTKS is about 5,000. Training for the direct reduction plant took place in Mexico and for the slab steel plant in the Federal Republic of Germany. Of the 2 modules of the plant one is always in operation, a minimum amount of gas has to be taken under contract. With the billet plant operations reach about 48 weeks per year.

Asked about the possibility of providing assistance to other developing countries PTKS expressed their willingness, with the consideration that they themselves were very young steel producers. Staff for training could be accepted for short periods in the plant as such or 1 - 2 staff members from PTKS may visit the plant to assit in a limited field such as in the method of melting sponge iron and in the production of sponge iron itself, taking into consideration that the process used in PTKS plant is based on HyL I. Questioned about the approximate investment cost participants were informed as follows: including infrastructure the plants' investment cost were about 2,5 billion US dollars. Before completion of the slab mill the ratio was 65 % for infrastructure and 35 % for production facilities. With the completion of the slab mill the production facilities now account for 70 % of the total investment. The UNIDO representative referred to plants in Iraq and Venezuela using the same process and an investment cost of about 110 US$ per ton of installed capacity was recorded in the early 70ies for Iraq and about 200 US $ for Venezuela. He pointed out that latest figures were given in a recent publication by Father Hogan, USA.

With a combination of 80 % coal and 20 % oil the DR plant with 150,000 tpy capacity in Orissa will have an energy consumption of about 3 Gcal per ton of sponge produced.

The licence agreement of the company is based on a lump sum payment for ten years, independent of production.

In the experience of PTKS the consumption of electrodes in a plant using 60 % of sponge iron in the charge was not increased.

At the inquiry of PTKS UNIDO expressed its readiness to provide technical assistance that might be required such as in the revamping of the plant.

Further information on the plant is available in Mr. Fazwar Bujang's second paper entitled "Some Notes on the Commissioning of the Direct Reduction Plant" which he presented during the Workshop deliberations in Hyderabad.

(b) Visit to Sponge Iron India Ltd., on 4 April 1983

Sponge iron India Ltd. (SIIL) is located about 280 Kms from Hyderabad, at Paloncha, Kothagudem, in the State of Andhra Pradesh. The plant was established with assistance from UNDP/UNIDO and cost sharing by the Indiay Government, both convertible and non-convertible contribution. The plant is a pilot and demonstration plant with a test centre intended to test various raw material combinations mainly iron ore and coal from India and abroad to establish their suitability and techno-economic feasibility of producing sponge iron from lumpy iron ore and non-coking coal. The test centre is specifically designed for catering to plant production and process control, bench scale and semi-commercial test work and for carrying out fundamental and applied research work in the field of coal-based direct reduction processes. The plant uses the SL/RN process know-how of LURGI Chemie, FRG. Details of the 30,000 tpy plant are contained in the country paper of the Indian representative. Mr. S. Vangala, Managing Director, SIIL, which provides data on Indian raw materials for iron and steel making and present developments in India. At the time of visit of participants to the Test Centre testing of reducibility was under way using coal from Pakistan and iron ore from the Indian deposit of Hospet. The technical details about the test programme were explained. Some of the main features of the Test Centre are:

a) Plant process control (chemical laboratory, X-ray fluorescence spectrometer; magnetic balance; Leitz heating microscope);
b) Bench scale test work (laboratory salvis rotary kiln, static reducibility apparatus, apparatus for reactivity of coal; short rotary kiln tester);
c) Semi-commercial demonstration test runs;
d) R and D facilities including differential thermal analysis; vacuum emission spectrometer' X-ray fluorescence spectrometer and metallurgical microscope. Engineering and consultancy services in basic and detailed engineering of coal based direct reduction sponge iron plants can be provided from the conception stage into the commissioning of the plant.

For those participants who joined the Group later in Hyderabad and could not visit the plant, a 18 minute movie was shown. Various technical questions were raised and information provided is summarized as follows:

The plant is operating at 95 % of rated capacity of 30,000 tpy and is selling its sponge to mini steel plants in different parts of India. In view of the successful operation which was achieved right from the start, expansion is envisaged and construction work is under way to establish an identical unit with the same capacity. Equipment for second plant will be produced mostly in India. Operation is expected by end 1984. The same capacity was chosen for reasons of identical equipment, spare parts and maintenance and ready infrastructure facilities available for the plant layout.

For this purpose, independent feeding circuits for iron ore, coal and limestone will be introduced.

Solutions will also be found for waste material and UNIDO is presently assisting with a study on the processing of sludges into value added products such as using them for production of roof and wall tiles.

The process is working on 100 % coal. Initially the rotary kiln was heated up with oil whilst now coal tar is being used. The kiln is 40 metres long and has a diameter of 3 meters. Energy consumption of 5.5 - 5.6 Gkal. ton of iron is rather high due to poor quality of coal with a high ash content. A 20 % decrease could be achieved with a better quality coal.

The refractory lining of the kiln is about 200 mm in thickness. It was assured that the lining would last at least 4 years and would at no time have to be replaced in toto. The kiln has refractory brick lining and high alumina refractory in the reduction zone. Critical points were only the reduction and discharging area. The RPM of the kiln may be selected between 0.3 and 1, depending on the feed. Operating days are about 300 per year with breaks every 90 - 95 days. The cooler is of similar construction as the rotary kiln, with 20 m length and 2.2 m diameter.

The carbon content of the sponge iron ranges between 0.15 and 0.5 % mostly around 0.25 - 0.3 %. it is free graphitic carbon type.

The separation of the sponge iron depends on the efficiency of the magnetic separation which may lead to contaminants in the product. Initially such contaminants counted for 5 - 6 % which is now down to 2 % with the objective of bringing them down to 1 % only. The lack of carbon may create a problem in steelmaking, a carburizing product could be added to the EAF charge and would offset such a shortcoming.

The sponge presently produced is sold to mini steel plants in India which are using it in various proportions with scrap charge. In the transportation and storage, the low carbon sponge has a much higher resistancy to re-oxidation. In fact, when exposed to rain in wagons only the outer material had lost some 5 % of metallization. Sponge such as from PTKS was more liable to re-oxidation, which had reportedly occured.

On an inquiry SIIL informed about the charging proportions and consumption per ton of sponge produced: Iron ore run-of-mine 2.5 tons, from which after crushing 1.5 tonsof screened ore are used, coal 1.4 tons and limestone 0.15 tons.

The quality of iron ores tried ranges from 62 % minimum Fe to 66 - 67 % Fe content. The plant is based on 62 % Fe containing iron ore, with acid gangue of 7 %. Other common ores used have an Fe content of 64 % with acid gangue of 5 - 6 %. S content is about 0.01 and P content 0.05.

The investment cost of the plant could be taken at around 400 US$ per ton installed capacity. The production cost is around 1200 - 1400 Rs per ton including raw material cost, fixed costs, operation costs.

The generation of iron ore fines during crushing was considered large and one of the participants suggested autogeneous grinding of ore to reduce the fines. The Managing Director informed that steps are being taken to cope with this shortfall and development work is under way to utilize them through sintering. The initial trials produced sinters of sufficient mechanical strength. Samples were shown. However, after the sinter was reduced the iron content was still found to be low and may not be suitable for the EAF charging. They may however be used for ironmaking by melting in hot blast cupola furnace. Work is going on to find a satisfactory solution. Further testing was considered necessary.

Retention time of the charge in the rotary kiln was reported at 5 - 5.5 hours, including time in the cooler about 7 hours.

Limestone used was about 5 % of the total feed. Initially limestone to an extent of 10 % was used. Due to the quite low S content of the coal (about 0.7%) the limestone consumption could be reduced. Instead of limestone dolomite could also be used. In case of very low S content of the coal no limestone may be needed and it is advisable to avoid use of limestone as it increases the tendency of sticking in the kiln. Asked about the size disgribution of sponge iron, SIIL informed that 1 - 8 mm fraction accounts for 20 - 25 % and the balance is 8-18 mm. Buyers preferred the +3 mm size range in order to avoid any risk of sticking of the fines in the EAF. In India most of the furnaces do not have continuous charging systems. Such material of -1 to - 3 mm range could be briquetted.

The maximum storage capacity of the plant is about 1,500 tons or 1 1/2 to 2 months.

Asked about slag volume generated in the EAF this was reported to be about 15 - 25 % in case of 50 to 60 % sponge iron charge. The product required by the EAF plants should have a minimum of 88 % and a maximum of 92 % metallization.

6. PRESENTATION AND DISCUSSION OF PAPERS

On 5 April 1985 the Workshop started with the presentation of country papers. Papers were presented by all the participating ESCAP countries. The list of papers is contained in Annex II. Summary of the papers, or in case of short papers, the entire papers are reproduced in Annexes III to XV. Presentation of papers were taken up in alphabetical order. Short summaries of the discussions are provided as follows:

Democratic Republic of Afghanistan

The country has plans to build a mini steel plant based on scrap and asked for UNIDO assistance in the practical implementation of such a project. It was informed that UNIDO, although not financing investment, may provide all necessary technical advisory services that were required, arrange for training and supply certain items of equipment of laboratory and investigation type.. Iron ore deposits are reportedly of high quality. Total steel requirement is about 10,000 tpy only. Infra-structure is lacking which couses a serious problem. The summary of the country paper is given in Annex III.

Socialist Republic of the Union of Burma

Burma operates a 20,000 tpy Kinglor-Metor DR plant . Several questions were raised and information was provided as follows:

The cost of production of sponge cannot be compared, in the case of Burma, with scrap based steelmaking since scrap is very cheap there (war surpluses). The need of the country is around the 20,000 tpy level. The EAF has to be stopped during peak hours because of lack of electricity. Storage facilities for sponge are available for about 6 months.

Some mechanical maintenance problems had occured when taking out the sponge to the cooling hopper water jacket. The cooling zone and reduction zone is subdivided.

The P content in sponge iron is 0,04. The plant can operate 330 days per year as claimed by the process supplier. Due to energy supply and maintenance problems they had to stop for about 6 weeks. A rate of 60 tons/day can be achieved. The total cost of the project including EAF and sizing plant was about 17 million $

Operating temperatures at the top zone are 800 °C, in the reaction/reduction zone 1050°, 1st stage of cooling hopper 400 °, second cooling hopper this will be decreased to 80 °. Cooling time is about 2 hours. An expansion of another 20,000 tons is foreseen which will bring total investment to about 40 million $. UNIDO considered the investment to be a very high one and suggested that Burma should also look into other possibilities, i.e. alternative routes. UNIDO assistance may be required in this aspect. The summary of the country paper is contained in Annex IV.

People's Republic of China

A number of laboratory and pilot plant work has already been undertaken towards the operation of DR route. UNIDO participant referred to assistance that had been provided to China in a number of other metallurgical projects. UNIDO had also proposed a project for establishment of a pilot and demonstration plant and this had been taken up during the recent visit of UNIDO representatives to China. Steel production in 1982 was well over 37,8 million tons.

The summary of the country paper is contained in Annex V.

Republic of India

The summary of the Indian country paper is presented in Annex VI. As all participants were fully aware of SIIL activities and had been given opportunity to discuss all questions earlier, no discussions took place.

Republic of Indonesia

Mr. Fazwar Bujang,s paper "Some notes on the commissioning of direct reduction plant" provoked a number of comments and questions outlining as it does, all the difficulties encountered when establishing the first module of the Hyl I plant.

A summary of the paper is contained in Annex VII.

It was recommended that the raw materials proposed to be used for such a plant should be carefully tested, at least on a semi commercial, if not a commercial scale.Such work should be undertaken by the Contractor, as the source of raw material supply was usually known before establishment of the plant.

Adequately trained personnel in a sufficient number should always be available as counterparts during the construction and erection stages. It was questioned whether the HyL I plant could be transformed into an HyL III one and energy consumption decreased. The process supplier's representative confirmed that this could be done would however be a large size project. As in Monterrey a moving bed reactor could be installed to replace the 4 reactors.

It was felt that the process and equipment suppliers should give performance guarantees on sound techno-economic parameters. In the case of Indonesia the technology may have to be modified to prevent clustering and sticking and bring energy consumption down.

The Midrex representative informed that his company undertakes complete testing of the ores proposed to be used, laboratory, tumble and sticking tests and basket tests and commercial trials before guarantee for running the plant is given. He suggested that in some cases it was advisable to send a representative to the mine site and observe shipping to make sure the agreed type of ore is received.

Testing was usually low in cost compared to overall investment. Laboratory and basket tests would cost around 2,000 to 3,000 $. each.

Training was considered a very important factor. It should however be tailored to the needs of the country and the Contractor should work out what training is recommended rather than to offer what they have.

The SIIL representative again referred to the possibilities for countries having their raw materials tested in India, if the DR coal based route is envisaged.

Islamic Republic of Iran

When the HyL and Midrex plants will be commissioned than the experience may be reported. The representative felt that companies after having supplied the first engineering and equipment they were not willing to inform readily on improvements to the process. It was suggested that UNIDO and RCTT gather enough information about raw materials and products like sponge iron oxide pellets and steel for the countries of the ESCAP region.

The UNIDO representative referred to his previous visits to Iran and that testing of ores also took place, years back. Work for Isfahan and Ahwaz project was presently under way with large contractors on bilateral basis. For Isfahan, bidding is taking place The LURGI representative mentioned that the pelletising plant is being finalized while the Ahwaz plant was under construction. The Dastur and Co representative inquired how revamping of the Purofer plant was foreseen. He was informed that Iran plans to operate it with their own experts, having gained the experience. The only problem was the briquetting plants were the segments are braking very often and a lack of spare parts.

The process suppliers pointed out that improvements were taken place continuously. Introduction of such improvements in relatively new plants can be done but is expensive. Sinc e the plant in Iran has not yet started the Iranian representstives asked that lates technology be introduced, they are wlling to pay the cost.

The text of the paper is contained in ANNEX VIII.

The Iranian Delegate made a closing statement which is presented in Annexure VIII A.

Malaysia

A DR plant will be established with Nippon Steel as the Contractor. That will be Nippon Steel's first commercial plant to operate. The other contract, for a plant in Sabah is with Midrex.

The Japanese plant will cost about 833 million Malaysian $.

The Malaysian representative asked if UNIDO assistance could be provided in the training programmes that are envisaged and was advised to submit an official request from the Government through the UNDP office.

The Country Paper is given in ANNEX IX.

Islamic Republic of Pakistan

A DR plant is under consideration. At present Pakistani coal together with Indian iron ores are being tested at the SIIL plant. The coals are of high S content. The tests are not yet completed and will taken another 3 months.

UNIDO had at many occasions provided assistance to Pakistan such as in the establishment of Metals Advisory Services and in preparing a Master Plan for the Iron and STeel Industry until the year 2000.

The natural gas that is available is used for household and fertilizers. Until new deposits are discovered this reductant would not be available for sponge iron production.

The summary of the country paper is contained in Annex X.

Republic of the Philippines

A sponge iron plant is under consideration. All the necessary raw materials are available. Technology and a financing scheme are needed. It seems that the plan for establishing the plant has been postponed and emphasis will be laid on modernizing existing iron and steel production facilities.

The summary of the country paper is given in Annex XI.

Republic of Korea

The country paper is contained in Annex XII. No comments were made, since the country has no plans of establishing DR plant at the moment.

Democratic Socialist Republic of Sri Lanka

The Country paper is contained in Annex XIII.

UNIDO has been providing assistance to the country in processing of heavy mineral beach sands (ilmenitic) for which investigation work was successfully carried out by UNIDO. No fuel, apart from coconut shell is available. Coconut is the third largest export item.

Kingdom of Thailand

UNIDO has been very actively involved in assisting Thailand. A Master Plan for development of the iron and steel industry until the year 2000 has been prepared with the help of a UNIDO sub-contractor.

Iron ore will have to be imported. Lignite coal is available. The price of natural gas is rather high.They might now consider the SL/RN process. They would like to procude sponge iron as a secure supply for the EAFs in the country.

Half of the scrap demand is now importes. This could be substituted by locally produced sponge iron. Above all, scrap prices are fluctuating.

India reported that a 10 - 2o kWh increase in poer consumption was noticed using 20 - 25 % sponge iron in the EAF instead of 100 % scrap. In an ordinary EAF a charge of 50 - 60 % sponge iron could be used. In super and ultra-super power furnaces the sponge iron portion could be increased to as much as about 80 %. The rest could be made up by scrap from the internal generation of the steel plant.

A summary of the paper is given in Annex XIV.

Socialist Republic of Vietnam

The country paper is contained in ANNEX XV.

The representative from Vietnam expressed desire to obtain training, through UNIDO, for specialists abroad. They have one rotary kiln, of local manufacture, operating.

7. INTRODUCTION OF PROCESS TECHNOLOGIES BY REPRESENTATIVES

FROM HYLSA, MEXICO

LURGI Chemie und Huttenwerke, FEDERAL REPUBLIC OF GERMANY

MIDREX CORPORATION, USA; and

IPITATA SPONGE IRON LTD, TATA STEEL, INDIA

Leaflets and brochures and papers were handed out by LURGI on SL/RN coal based direct reduction - The state of the Art

A paper was presented by the MIDREX representative "MIDREX Direct Reduction Process - State of the Art Technology"

The HYLSA representative will send brochures to the participants.

The representative from IPITATA Sponge Iron Ltd. presented a paper on " An appraisal of the current status of DR processes with particular reference to their adaptation in developing countries of the ESCAP region" and informed on the TATA DR process. The paper is available upon request.

Many technical questions were reaised and discussed during the Workshop. These will be contained in the Proceedings which SIIL intends to compile.

The primary conditions for selection the DR route were considered to be;

1. Adequate reserves of high grade iron ore in the form of lump ore or pellets
2. Lack of matching availability of researves of coking coal, otherwise the conventional BF route could be chosen more economically
3. Adequate quantitites of alternative reductants should be available (gaseous, solid, liquid).

The quality of DRI should be measured by the degree of metallization and the carbon content.

Questions specifically centered around the presence of non-metallics in the product (with special reference to LURGI). A certain amount of such non-metallics was always present, about 4.5 % with pellets, 1 - 1.5 % with lumpy ore, depending on the iron ore.

In the LURGI process the carbon content was around 0.2 - 0.4 %. It can be raised up to 1 or 1.2 %, with oil injection. The economics of such injection would have to be investigated in terms of liquid steel produced. Sponge iron with a higher carbon content was certainly better for EAF feeding but has a higher tendency for re-oxidation during storage and transport.

Fluctuations in the quality of natural gas supplied may cause a problem in the reformer are and it was advisable to to have the quality frequently checked, even the associate gas, in order to avoid heavy hydrocarbons, etc. in the Midrex or Hyl process. Catalyst life in Midrex plants lasts some 5 - 7 years. Sulphur may cause damange. Preheating of top gas fuel to the reformer can be done and significantly increases temperature. 100 % recycled gas may be used.

Generation of fines could be tackled in various ways, such as briquetting, and unconventional ones such as packing them into paper bags for charging to the EAF.

8. ACTIVITIES OF UNIDO, ESCAP AND RCTT FOR THE BENEFIT OF ESCAP REGION COUNTRIES

The activities of the Metallurgical Industries Section of UNIDO were outlined. A summary is given in Annex XVI. Many countries of the region expressed keen interest in such assistance, particularly Indonesia.

RCTT proposed a net-work on sponge iron for ESCAP developing countries which aims at promoting the continuous exchange of experience among the countries. The proposal was accepted and RCTT was requested to initiate such activities as soon as possible. An outline of the proposed network is given in Annex XVII.

The RCTT Secretariat also prepared a paper "Issues in the promotion of technology development and transfer in the area of sponge iron manufacture and use in developing countries of ESCAP region" which can be found in Annex XVIII. In addition, Leaflets were handed out to the participants describing the objectives of RCTT to enhance the economic and social advancement of developing countries in Asia and the Pacific.

The ESCAP Secretariat has prepared a special paper for the Workshop on "Problems, Trends and Technology Development in Iron and Steel Making including Sponge Iron Production" which was presented to theWorkshop by Mr. V.i. Gorchkov, Economic Affairs Officer, Joint ESCAP/UNIDO Division of Industry, Human Settlements and Technology. The paper is available upon request.

8. REGIONAL CO-OPERATION TO PROMOTE TECHNOLOGY DEVELOPMENT AND TRANSFER IN THE AREA OF SPONGE IRON MANUFACTURE AND USE IN DEVELOPING COUNTRIES OF THE ESCAP REGION

After being fully informed about the activities of UNDP/UNIDO/ESCAP/RCTT and in the light of Workshop's deliberations many participants expressed keen interest in UNDP/UNIDO's technical assistance programme and in regional co-operation. A project document for a regional project had been prepared in draft and was introduced to the participants in all its parts. The project has the aim of regional development of sponge iron industry through direct reduction technology for mini steel plant operations; the Project Document as attached herewith was fully endorsed by all participants concerned. Within the principal context of industrial development of the ESCAP countries region, based on the exploitation of those countries' natural resources and raw materials, the major development objectives are to survey, investigate and technologically assess the possibilities of promoting sponge iron production for development/ expansion of the steel industry, with a view to economically utilize raw material resources and apply the most appropriate sponge iron production technology (gas or coal as a reductant) as well as estimating the domestic market for sponge iron and consider possible exports, including intra-regional trade. The project proposal/Project Document was endorsed and fully supported by the participants and they requested UNDP/UNIDO to start implementation of the project as soon as possible. The full text of the Project Document as proposed is contained in Annex XIX.

9. ADOPTION OF THE REPORT

The Report with all its attachments including Regional Project Document (UNDO/UNIDO) and the RCTT Network was adopted by all participants on 8 April 1983 during the Closing Session.

The effort undertaken by UNDP/UNIDO/RCTT to assist developing countries of the Asian region in development of local sponge production facilities was highly comended special thanks were expressed to the Indian Government, Indonesian Government and Krakatau PT and SIIL Plant for their remarkable assistance in the organization of the Workshop and Study Tour to SIIL. What remained to be done was the implementation, at the earliest possible date, of the proposed regional project, as a first step towards regional co-operation in production of sponge iron in the ESCAP Region Countries.

ANNEX I

LIST OF PARTICIPANTS

Sl.No.	Name	Status	Country/Place/ Organisation
1	2	3	4
A. Delegates			
1.	Mr.Nasir Ahmad	General Director of Investment Department, Ministry of Mines and Industries.	Afghanistan
2.	Mr. U.Myint Thein	General Manager No.1 Iron Project	Burma
3.	Mr.Wei Jun Xian	Central Iron and Steel Research Institute.	China
4.	Mr.V.Subba Rao	Manager(Incharge) Sponge Iron India Limited.	India
5.	Mr.Fazwar Bujang	Superintendent DR Plant PT Krakatau Steel	Indonesia
6.	Mr.M.R.T.Shahrain	Deputy, Ahwaz Steel Complex, Ministry of Mines and Metallurgy	Iran
7.	Mr.Cho, Chun Heaing	Assistant Director Non-ferrous Metals Division Ministry of Commerce and Industry	Korea
8.	Mr.R.H.Ismail	Heavy Industries Corporation of Malaysia Berhad Perwaja	Malaysia
9.	Mr.W.M.Z.Ismail	- " -	Malaysia

1	2	3	4
10.	Mr.M.A.Qazi	Principal Scientific Officer, Pakistan CSIR, Lahore.	Pakistan
11.	Mr.F.S.Samson	Assistant Chief Product Standards Ministry of Trade and Industry	Philippines
12.	Mr.L.C.R.Wijesingha	Sr.Metallurgist Ceylon Steel Corpn	Sri Lanka
13.	Mr.T.Chairat	Director of Office of Basic Industry Development	Thailand
14.	Mr.Pham Chi Cuong	Metallurgical Engineer, Metallurgical Institute of Engg and Metallurgical Industry	Vietnam

B. Countries

1) Indonesia

1.	Mr.T.Ariwibowo	President Director	PTK Steel
2.	Mr.Djoko Subagio	Associate Production Director	-do-
3.	Mr.Chosdu Saiin	Superintendent Process Engineering	-do-
4.	Mr.Kusna	Maintenance Supdt(DR)	-do-

ii) India

1.	Mrs. N.Buch	Joint Secretary Deptt of Steel	Government of India
2.	Mr.D.C.Bajpai	Director Deptt of Steel	-do-
3.	Mr.P.K.Aggarwal	Industrial Adviser Deptt of Steel	-do-
4.	Mr.S.Vangala	Managing Director	SIIL & VNSL
5.	Mr.V.L.N.Murthy	Dy General Mgr(O)	SIIL
6.	Mr.K.P.Patnaik	Dy General Mgr(E&M)	SIIL

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1	2	3	4
B. Countries			
ii) India(contd)			
7.	Mr.P.S.Raju	Chief Public Relations Officer	SIIL
8.	Mr.K.S.N.Murthy	Dy Manager(O&M)	SIIL
9.	Mr.P.Srinath	Asst Manager(E&P)	SIIL
10.	Mr.V.Narahari	Asst Manager(A&PR)	SIIL
11.	Mr.S.K.Chabria	Sr.Engineer(E&P)	SIIL
12.	Mr.V.M.Daptardar	Sr.Metallurgist(TC)	SIIL
13.	Mr.A.Rajasekharan	Sr.Metallurgist(O)	SIIL
14.	Mr.M.Ramachandran	Sr.Engineer(O)	SIIL
C.	UNDP		
1.	Mr.M.J.Priestley	Resident Representative.	New Delhi
2.	Mr.P.N.Pathak	Programme Officer	-do-
D.	UNIDO		
1.	Dr.B.R.Nijhawan	Sr.Inter-regional Adviser.	Vienna
2.	Mr.F.Iqbal	SIDFA	Djakarta
3.	Mr.A.B.Krasiakov	SIDFA	New Delhi
4.	Miss G.Hynek	Research Asst	Vienna
E.	ESCAP		
1.	Mr.V.I.Gorchkov	Economic Affairs Officer	Thailand
F.	RCTT		
1.	Mr.B.R.Devarajan	Director	Bangalore
2.	Dr.C.V.S.Ratnam	Advisor on S&T Policy	-do-
3.	Mr.N.Suryaprakash		-do-

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1	2	3	4
G. Observers			
1.	Dr.W.Schlebusch	Lurgi Chemie	West Germany
2.	Mr.R.Dayal	Lurgi India	New Delhi
3.	Mr.J.E.Helle	Midrex	USA
4.	Mr.J.M.Pena	HyL	Mexico
5.	Dr.A.Chatterjee	IPITATA	India
6.	Mr.Supriyadasgupta	M.N.Dastur & Co	India
7.	Dr.T.K.Roy	-do-	India
8.	Mr.K.T.V.Desikachar	Vijayanagar Steel Project	India
9.	Mr.Nagaraj	-do-	India

LIST OF DOCUMENTS

Country Papers

Country	Title	Author
Afghanistan	Country paper	Eng. Nasir Ahmad General Director of Investment Dept.
Burma	Country Paper	U Myint Thain General Manager No. 1 Iron project
China	General Situation of the Study of Direct Reduction in China	Wei Quan Xian Central Iron and Steel Research Institute, Beijing
India	Country Paper	S. Vangala, Managing Director Vijayanagar Steel Ltd. and Sponge Iron India Ltd.
Indonesia	Some Notes on the Commissioning of Direct Reduction Plant	Fazwar Bujang Superintendent, DR plant P.T. Krakatau Steel
Iran	Country Paper	M.R. Taheri Shahrain, Deputy Ahwaz Steel Complex
Malaysia	The development of sponge iron plant in Malaysia	R.H. Ismail General Manager Heavy Industries Corporation of Malaysia Berhad/Perwaja
Pakistan	Possibility of Utilization of Domestic Iron ores for Sponge Iron Production	M.A. Qazi and Izharul Haque Khan, Pakistan Council of Scientific and Industrial Research
Philippines	Iron and Steel Industry in the Philippines (sponge iron manufacture)	Felix Samson, Assistant Chief Product Standards Ministry of Trade and Industry
Rep. of Korea	Country Paper	Chun Heaing Cho Assistant Director, NF Metals Div. Ministry of Commerce and Industry
Sri Lanka	Country paper	L.C.R. Wijesinghe, Senior Metallurgist Ceylon Steel Corporation
Thailand	Development of the sponge iron industry in Thailand	Trakarn Chairat Director of Office of Basic Industry Development
Viet Nam	Country paper	Mr. Pham Chi Cuong Metallurgical Engineer Institute of Engg. and Metallurgy

Company/organization	Title	Author
UNIDO	UNIDO,s technical assistance in the field of metallurgical industries	UNIDO Secretariat
UNIDO	UNDP Project Document for "Regional Development of Sponge Iron Industry through Direct Reduction Technology for Mini Steel Plant Operations"	UNIDO Secretariat
ESCAP	Problems, Trends and Technology Development in Iron and Steel Making Including Sponge Iron Production	V.I. Gorchkov Economic Affairs Officer ESCAP/UNIDO Division of Industry, Human Settlements and Technology
RCTT	RCTT Network on sponge iron for ESCAP developing countries	RCTT Secretariat
RCTT	Issues in the promotion of technology development and transfer in the area of sponge iron manufacture and use in developing countries of ESCAP region	RCTT Secretariat
MIDREX	Midrex Direct Reduction Process - State of the Art Technology	J.A. Lepinski and G.G. Carinci Midrex Corporation
LURGI	Various papers and leaflets including SL/RN coal-based direct reduction The State of the Art	presented by D. Schlebusch
TATA Steel	An appraisal of the current status of DR processes with particular reference to their adaptation in developing countries in the ESCAP region	A. Chatterji, Managing Director, IPITATA Sponge Iron plant Ltd. Tata Steel
Indonesia	Direct Reduction plant as part of First Indonesian Integrated Steel Plant (presented at CAFEOT Conference in Jakarta in August 1982)	Fazwar Bujang, Superintendent Direct Reduction plant, PTKS
Indonesia	Aspects of high ratio DRI melting practice for the production of weldable high tensile reinforcing bars in the electric arc furnace	Eng. Chosdu Saiin Superintendent, Process Eng. and Quality Control Primary Operation

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29 March - 8 April 1983

SUMMARY OF COUNTRY PAPER

DEMOCRATIC REPUBLIC OF AFGHANISTAN

by Eng. Nasir Ahmad
General Director of Investment Department
Ministry of Mines and Industries

The Democratic Republic of Afghanistan is a land-locked country located in Central Asia, covering 647,5 thousand km^2 of rugged mountain and desert areas.

The climate is semi-arid, with an average annual precipitation of 416 mm per annum ranging from 75 mm to 1,164 mm per annum between the driest to the wettest observation points.

During the 1975 census, the population was estimated at 17 million people, largely rural.

Available reserves of natural resources have yet to be fully gauged. Among those known there are important deposits of oil, coal, iron ore, copper and natural gas.

Industry in the sense of modern industry is in its early stages of development and contributes only 6.5 % of GNP.

Available resources

Raw Materials of the country may be classified into agricultural and natural resources.

Agricultural production includes mainly food grains, fruits and vegetables, cotton, and some quantity of beetroot, sugar canes and oil seeds.

Afghanistan possesses a good potential of natural resources. Since the past several years, mapping, surveying and exploration of interesting areas has been carried out for the mineral resources and subsequently substantial reserves of mineral deposits have been opened up and are being worked. The main mineral resources discovered are as follows:

	Estimated reserves:
1. Coal	65.8 million tons
2. Iron ore	176 million tons
3. Copper	5.5 million tons
4. Beryl	15,659 tons
5. Lithium	158,5 thousand tons
6. Fluorite	8,792 thousand tons
7. Talc	531,3 thousand tons
8. Asbestos	162,3 thousand tons
9. Sulphur	200 thousand tons
10. Barite	1,693 thousand tons
11. Lapis Lazuli (only sari-sang)	1,501 tons

12. Aragonite 1,091.5 thousand tons
13. Chromite 185,000 tons

Cr_2O_3 55.1 % : 27,000 tons

Cr_2O_3 44 % : 158,000 tons

14. Some other minerals like kunzite, emeralds, ruby, green tourmaline, etc. are also found

The Democratic Republic of Afghanistan, in order to meet the need of the country is paying special attention to industrialization of the country based on raw materials available within the country. One of those are the mini steel plant based on scrap available in the country, the feasibility study of which is being carried out by UNDP/UNIDO technical assistance.

Constraints on Industrialization

1. Limited financial resources

2. Lack of adequate technical personnel

3. Lack of experience and management and planning in the industrialization process

4. Lack of technical know-how in many cases

5. Afghanistan being a mountainous country with spread deposits, the highways to villages and mountain areas are in poor condition which slows down the progress of industrial development

Recommendations

UNDP/UNIDO and ESCAP are kindly asked to assist in the following

1. To carry out a feasibility study on sponge iron production in Afghanistan

2. To arrange for training of staff in the field of sponge iron production as well as in mini steel plant operations

3. (a) To investigate iron ores, coal and limestone by using the testing facilities at Sponge Iron India Ltd. at Paloncha, Kothagudem

   (b) The purpose is to determine the possibility of suitability and utilization of the natural resources in the DR process

4. To finance the establishment of the mini steel plant.

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SUMMARY OF COUNTRY PAPER

SOCIALIST REPUBLIC OF THE UNION OF BURMA

by
U Myint Thein
General Manager, No 1 Iron project

Burma started her first sponge iron plant in October 1981. It was the Kinglor-Metor direct reduction method that was chosen, using local resources of lignite and hematite ores.

The plant is situated at Anisakan near Maymyo in the northern part of Burma. The iron ore deposits are about 12 miles from the plant site . Coal comes by rail from Lashio, about 125 miles from the plant site. Limestone is mined near Sagaing, about 50 miles from the plant.

The capacity of the sponge iron plant is 20,000 tons per year and there are also facilities for melting sponge in the electric arc furnace of 15/17 tons capacity. At present, sponge iron is used in producing pig iron in the electric arc furnace.

Operation parameters and average results obtained during 17 months of operation are given in the paper.

An expansion programme to increase the sponge iron production to 40,000 tons per year and to produce steel by EAF and continuous casting plant with two strands will be added. The expansion project is scheduled for start-up at the end of December 1983.

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SUMMARY OF COUNTRY PAPER

PEOPLE'S REPUBLIC OF CHINA

by Wei Jun Xian
Central Iron and Steel Research Institute
Beijing, China

The Chinese iron and steel industry has been developing rapidly. 1982 production was upt o 37 million tons.

The direct reduction process is at a trial stage.

China has rich resources of iron ore and coal and also has oil, natural gas, water and electricity which is being developed. All of these form a raw material base for the iron and steel industry.

Most of the ore is of low grade, the rich ore with an iron content of more than 50 % accounts for only 6 % , most of the ore with an Fe content of around 30 % must be selected and agglomerated. Many ores are of comlex nature, i.e. vanadium-titaniferous magnetites; iron ore containin rare earth elements, etc.

Although the country possesses rich coke, it is concentrated in the northern provinces.

In some areas the direct reduction process may be adopted. From the developments of the DR process abroad it could not only solve the problems of development of the iron and steel industry in areas with little coke but it could also utilize the complex ores and treat industrial waste slag which contains iron.

Studies are going on since 1958, on the rotary furnace process, pre-reduction of rotary furnace, electric furnace, shaft furnace, fluidization, etc.

Some results could be obtained. Among these the semi-industrial application of rotary furnace, pre-reduction in rotary furnace-electric furnace has achieved an international level of trial. At present the total volume of testing equipment of rotary furnace is about 1300 m^3 and most of them are small testing furnaces.

There are 3 shaft furnaces, 2 of them located in Guangdong province and their production is 5 tpd and 100 tpd respectively. Water-gas reduction is used for both, the coal consumption is 1.5 ton/1 sponge iron and is not economic.

One shaft furnace with 25 tpd production operates in the Sichuan province. The reducing gas is produced from the natural gas in the reformer with a catalyst. The reformer is of regenerative type. Vanadium-titaniferous magnetite was used for testing and a metallization rate of more than 90 % was achieved with low contents of S and P. Energy consumption was about 500 m^3 natural gas per ton of sponge iron. The process needs improvement.

A number of other experimental furnaces exist. In order to strengthen and

and develop the direct reduction method in China, the following points should be considered:

1. A new plant should be build in an area with reliable supplies of material and fuel, successful semi-industrial equipment, convenient transportation and good technical management.

2. For the complex ore, general utilization should be considered, so as not to waste any valuable metals.

3. There are some ores in the interior of the country suitable for making high-quality sponge iron and special steels. Gas DR process may be recommended.

4. In China, only Sichuan province has rich resources of natural gas. Therefore the future of shaft furnace and fluidized methods largely depend on the development of gas-making techniques with coal and its economy.

Annex VI

Study Tour and Workshop to Promote Technology Development and Transfer in the Area of Sponge Iron Manufacturing in Developing Countries of the ESCAP Region, Indonesia and India.

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SUMMARY OF COUNTRY PAPER

REPUBLIC OF INDIA

by S.VANGALA
Managing Director,
Sponge Iron India Ltd and
Vijayanagar Steel Ltd.

India has about 17,000 million tonnes of iron ore reserves of which about 11,000 million tonnes are of Hematite quality and remaining of the Magnetite type. The Country also has reserves of non-coking coal estimated at 82,000 million tonnes, whereas the availability of coking coal is limited. Natural gas though available is committed to other priority end uses and as such the country has considered it necessary to develop sponge iron production capacity based on lump iron ore and non-coking coal to provide feed material forthe electric arc steel melting furnaces located in different parts of the Country having a total licensed capacity of 4.2 million tonnes. As processes of sponge iron production from lump iron ore and non-coking coal are not fully established, Government considered it necessary to set up a Demonstration Sponge Iron Plant of 100 tonnes per day capacity to test at a semi-commercial level different iron ores and coals occurring in India to generate data for planning of commercial sponge iron plants. UNDP/UNIDO whose assistance was sought by the Government of India also endorsed this approach and a Demonstration Plant has been set up at Kothagudem in Andhra Pradesh based on the SL/RN process of Lurgi Chemie. The plant which was constructed in 1980 at a cost of US $ 20 million received UNDP assistance amounting to over US $ 4 million, the remaining foreign exchange cost as well as Rupee cost of the project having been borne by the Government of India.

As an adjunct to the Demonstration Sponge Iron Plant, UNDP assisted in the setting up of a well equipped laboratory capable of undertaking bench scale test work to assess the suitability of different raw materials for direct reduction. The Demonstration Plant went into regular operations in November,1980 and during the last 2½ years it has tested various ores occurring in India. It has also been established that Sponge Iron of high quality can be produced at or above rated capacity; that the product can be safely stored and transported and that it can be satisfactorily melted in Electric Arc Furnaces. With the assistance of UNDP/UNIDO, designs have also been developed for continuous feeding of sponge iron for optimal results. On the basis of the excellent record of this plant, Government of India have also approved doubling of the capacity of the plant. The expansion work which would be based entirely on the engineering expertise available with SIIL, is expected to be completed by 1984.

In addition to the testing of Indian Iron ores, UNIDO have assigned to SIIL recently, projects covering the evaluation of the suitability of Pakistan coals for Direct Reduction in a Rotary Kiln and beneficiation and reduction studies on iron ores from Hungary. Taking note of the testing facilities available at the Demonstration Sponge Iron Plant and also the capability of the Engineering Division of SIIL, UNIDO have registered SIIL as a Consultancy organisation in the field of Direct Reduction.

ANNEX VII

Study Tour and Workshop to Promote Technology Development and Transfer in the Area of Sponge Iron Manufacturing in Developing Countries of the ESCAP Region,
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29 March - 8 April 1983

SUMMARY OF COUNTRY PAPER

REPUBLIC OF INDONESIA

by
Eng. Fazwar Bujang
Superintendent, DR plant
P.T. Krakatau Steel

Thanks to all the experience we have accumulated during and over the last 4 5 years today we are able to run the DR plant very smoothly and maintain the production level at the designed rate.

The first DR plant was commissioned in August 1978 but the design performance was reached only two years later after such difficulties/problems like process, equipment failures, improper design and/or a combination of them.

The second DR plant was completed in 1982 and started very successful performance in August 1982. Some factors which contributed to the success of the DR plant II performance test are:

a. careful steps taken by PTKS management prior to the start-up and performance;

b. Improvement to the plant initiated by the contractor modification and additional equipment requested by the plant owner based on experience drawn from operating the DR plant I over 2 years;

c. Plant owner personnel had more experience and also better advice from the Contractor who supervised and directed the plant operations More participation and more support for the Contractor from PTKS personnel during commissioning and performance tests of DR plant II could be provided.

d. Better knowledge behaviour of pellets to be reduced during performance

e. The Contractor wished to fulfil his obligations with good reputation.

<u>Conclusion</u>

The commissioning of 2 DR plants and their related facilities has given PTKS the opportunity to document some of their experiences as follows:

1. A well prepared organization to handle activities as soon as the construction is terminated such as cold test, commissioning, etc. with sufficient qualified personnel is required.

Assumed that there is still a warranty period after the contractor handed over the plant to the owner, but it is more difficult to claim equipment failures or inferiority during the warranty period rather than refuse to accept the equipment during commissioning period, which may be decided by qualified commissioning personnel.

2. It is not recommended to build twin plants at the same time which only duplicates the possible design mistakes, construction errors, etc. Although a lot of modification was done to DR plant 2 (also to plant I, later on), still there are some important things which could not be modified because the contractor was not obligated to bear the cost and/or could not be done due to time constraint. Such modifications were e.g.

a. The finfan condensors are not a suitable type for a plant like the DR plant since a lot of dust is generated. The location of the fin fan must be selected far from the material handling system and the fin fan must be provided with filters to prevent dust accumulation on the fin tubes.

b. Aside from low efficiency of small steam turbine drives, it is better to have a big stream turbine generator rather than a lot of stream drives for pumps and compressors which requires more maintenance effort, than electric motors.

3. As soon as the performance test is finished it is advisable to stop the plant immediately and start to establish punch list of items to be fixed by the contractor from internal plant/equipment inspection, and weakness of the plant detected during start-up/performance test of the plant.

4. Selection of suitable raw material is very important for the performance test in order to identify plant weaknesses separately from poor raw material

5. The philosophy of plant performance evaluation must be based on maximum load, e.g. all common facilities to be tested on simultaneous load and if it is not possible at least a simulation operation must be performed.

6. In the case of the DR plant, which looks more like a chemical plant than a metallurgical plant, the monitoring of the mechanical condition of the plant will make an important contribution both to production and to the safety of the plant.

Study Tour and Workshop to Promote Technology Development and Transfer in the Area of Sponge Iron Manufacturing in Developing Countries of the ESCAP Region, Indonesia and India, 29 March - 8 April 1983

COUNTRY PAPER

ISLAMIC REPUBLIC OF IRAN

by
M.R. Taheri Shahrain, Deputy,
Ahwaz Steel Complex
Ministry of Mines and Metallurgy

1. General Condition of Steel Industry in Iran:

A- The Steel making capacity readily completed and started-up are as follows:

Blast Furnaces: 1.5 million tons per year

Scrap Melting: 360 000 " " "

(Purofer) Direct
Reduction: 330 000 " " "

B- Projects under construction and near completion:
3 moduls midrex DR Plant total capacity 1200000 tons per year

3 moduls Hyl DR Plant total capacity 1,000,000 tons per year

C- Project under bid evaluation:
3 million tons sponge iron per year

2. PLANNING: For the First Period of our 4 steps 20 years planning (Next 5 years) we have in mind to: a - completing the existing projects.
   b. Bringing them to the designed production capacity
   c. Adjusting sponge iron production and melting capability by adding new melting facilities.

3. PROBLEMS:

a- The licencing companies after having supplied the first engineering and equipment are not willing to keep us aware of new improvements resulting in better process and efficiency.

b- A big amount of fines (Metalic 4 oxide) and slurry will be wasted in the midrex. Purofer and Hyl plants of awaz steel complex which are not considered in the initial engineering of the companies involved.

c- While our country in this period of revolution needed a lot of steel for it's development programmes Iraqi Regime attacked to the South-West of our country where about half of our steel industries are located. It took us a large amount of money and time to refacilitate them again after pushing back the aggressor troops.

4. RESULT AND PROPOSALS :

a- While the people of our country are trying to overcome the aforementioned and other problems since these problems will be similar for the countries of the ESCAP Region I would suggest that instead of having every country separate research and investment UNIDO and or RCTT take care of these problems.

b- I suggest that UNIDO/RCTT by gathering enough information about raw materials and products of sponge iron, oxio pellets and steel from the countries of the ESCAP region, Study and recommend required adjustments and try this to be handled.

With regards and best wishes

For the development and

Independency of the countries

Of Region

M.R. TAHERI SHAHRAIN

Annexure VIII-A

In the name of Allah

1. Considering that the previous activity and investment of UNIDO has been in the area of Coal based direct reduction it is reasonable that the new project will be in the area of gas based direct reduction including finding best methods of using sponge iron.

2. The new project should be under the direction of UNIDO so that the result and information easily been conducted through the countries of ESCAP region.

3. Whilst the contribution of UNIDO/UNDP in the Indian project was about 5 million dollars, in this Regional project the UNDP/UNIDO contribution is only 500 000 US $, it should be much more for the Regional Project as it would assist all the ESCAP countries.

4. In the case which we come to the result that the new project shall include also a semi-commercial plant on the gas based direct reduction. I suggest that the process employed thereof should not be the licence of the companies which in their turn cause restriction for technology transfer. I think that the UNIDO experts together with the experts of the countries of the ESCAP region now will be able to establish a good process among the existing processes and the experiences obtained from them.

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SUMMARY OF COUNTRY PAPER

MALAYSIA

by

R.H. Ismail
Heavy Industries Corporation of Malaysia Berhad/Perwaja

The Development of Sponge Iron Plant in Malaysia

Introduction

The economy of Malaysia has been traditionally agriculture oriented. In the past the growth of the manufacturing sector was minimal with the economy being heavily dependent on the income from export of rubber, tin, palm oil, timber and of late crude oil and natural gas. In recent years there has been a marked shift in the national planning strategy, with growing emphasis being laid on the creation and development of strong and modern industries.

Steel is synonimous with industrial progress and the level of steel production in a country is often considered as the yardstick of that country,s industrialization. The crude steel consumption in Malaysia is estimated at around 1.85 million tons per year in 1981 and projected to reach 3 million tons per year in 1990, which is equivalent to a per capita steel consumption of about 200 kg. Hence the establishment of direct reduction plants in Trengganu (capacity 600,000 tpy) and Sabah (capacity about 700,000 tpy).

The resources situation in Malaysia

The iron ore resources of Malaysia are very limited thus requiring import of iron oxide feed.

In regard to the energy situation, Malaysia has large reserves of off-shore natural gas but no known deposits of metallurgical grade coal. In addition there are substantial reserves of oil. Therefore, from the energy resources situation creation of new steelmaking capacity in the country should be logically based on the adoption of direct reduction (DR) of iron ore/pellets using natural gas and use of DRI as metallic charge in the electric arc furnace. This route of iron and steelmaking is commonly referred to as DR/EF route.

The first DR/EF plant in Malaysia

In early 1982, a contract was signed for the first DR-EF plant in Malaysia. The project is a joint venture between the Government of Malaysia and Nippon Steel Corporation (NSC) who are also the leader of the Japanese Consortium that will supply and erect the plant on a turn-key basis. The plant is to be located at Kemaman in Trengganu state on the east coast of Peninular Malaysia.

The DR plant will be based on the NSC/DR process and will be the first commercial plant to adopt this recently developed process. The DRI from the shaft furnace will be hot briquetted, about 0.52 million tons of DRI briquettes will be consumed in the plant for production of billets (through electric arc furnaces and continuous casting machines) and the balance will be sold to various Arc Furnace plants in Malaysia.

Construction work on the project commenced in October 1982. The plant is scheduled to go on stream by early 1985.

Conclusion and Technology Transfer

Malaysia is now entering into an era of sponge iron production in joining the rank of other sponge iron producers. It is opportune to state that any valuable assistance from UNIDO in the field of training of operation and maintenance of DR plant in particular, and of overall steel plant would be most appreciated.

Transfer of technology in steelmaking industry (sponge iron in particular) is the main theme of this UNIDO Workshop and has been the main topic to many works on steelmaking industry. What is now needed is a positive and sincere contribution from the experienced countries in the field of DR to the newly established ones, with a view to production efficiency. Industry's common objective is optimum utilization of the available resources, mineral, energy, etc.

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29 March - 8 April 1983

SUMMARY OF COUNTRY PAPER

ISLAMIC REPUBLIC OF PAKISTAN

Possibility of Utilisation of Domestic Iron Ores for Sponge Iron Production

by M.A. Qazi
Principal Scientific Officer
Pakistan CSIR, Lahore

The Steel production in Pakistan which was about 20,000 tonnes per year in 1947 rose to 224,000 tonnes by 1974 and 550,000 tonnes by 1982. The demand for Iron and Steel is about double this production. Up to 1981 the Steel Industry in Pakistan was based on Electric Steelmaking with 50% of the scrap requirements of the rated capacity of 600,000 tonnes per year through imports. The first integrated Iron and Steel Plant based on imported iron ore and coking coal went into production in 1982. On present estimates the demand for iron and steel in Pakistan by 1985 would be about 1.7 million tonnes and additional capacity required, is proposed to be created with Electric Arc Furnaces.

As the availability of good quality scrap is limited, Pakistan is considering establishment of sponge iron production capacity based on local iron ores. Preliminary studies in this direction have been carried out by the Pakistan Council of Scientific and Industrial Research and on present indications a capacity of 400,000 tonnes per year is expected to be created.

IRON ORE RESERVES

The iron bearing deposits of Pakistan are conservatively estimated at 450 million tonnes, the properties of which are summarised in Tables I and II. As the ores contain large amount of impurities, systematic beneficiation studies have been taken on hand by the Pakistan Council for Scientific and Industrial Research. The results of the beneficiation tests are summarised in Table III. Pelletisation and reduction tests have also been carried out on the ores and pellets produced in the concentrates, the results of which are furnished in Tables IV and V. The concentrates and pellets were also tested at the Japan Consulting Institute, Tokyo and Armco in USA and both the organisations have recommended the use of concentrate for sponge iron manufacture.

CHOICE OF REDUCTANTS

As the available natural gas reserves are committed for use in Fertilizer and other industries, coal is to be considered as the reductant. The estimated coal reserves of Pakistan are over 500 million tonnes. The coals contain ash between 3-30% and Sulphur of 1-7%.

TECHNOLOGICAL REQUIREMENTS

In the context of the future development of sponge iron production capacity in Pakistan, it is considered necessary that

i) Technical information and data on R&D as well as on the production levels on DR iron is made available to the ESCAP countries.

ii) Short courses and in-plant training facilities are extended to the scientists and technicians of the member countries so desiring.

iii) For a situation, as in the case of Pakistan, R&D facilities on laboratory and pilot plant scale may be strengthened, so as to enable the scientists to carry out preliminary evaluation and testing of domestic raw materials. Also, technical guidance for the production of low sulphur iron ore concentrate may be provided.

iv) Frequent workshops are held to exchange ideas and to disseminate information.

v) A panel of experts is organised to assess and advise the country on the sponge iron manufacture and assist in preparing techno-economic feasibility reports.

TABLE-1: IRON RESOURCES OF PAKISTAN

Deposit	Reserves Mt	Fe %	SiO_2 %	Minerals
Sedimentary				
Chichali	165 - 335	32.5	21.2	Lim Sid Gla
Kutch	34.0	33.1	23.2	Cham Sid
Makerwal	52 - 200	33.4	24.5	Lim Sid Cham
Rakhi Munh	14.5	37.5	13.9	Lim Sid
Pezu	12	31.0	-	Sid Lim Hem
Langrial	28	40.2	14.8	Cham Lim Hem
Galdanian	60	20.0	9.9	Hem Claystone
Igneous & Metamorphic				
Dammer Nissar	6.5	59.43	9.9	Mag
Swat	300	14.5	32.1	Mag Ilm
Chilghazi	2.5	45.3	12.0	Mag Hem
Chigendik	5.2	39.2	20.0	Mag
Pachinkoh	25.0"	46.8	15.6	Mag

Lim Limonite; Ilm Ilmenite; Cham Chamosite; Mag Magnetite; Sid Siderite; Ham Hematite; Gla Glauconite

" Probable 100 Mt

TABLE-2: AVERAGE CHEMICAL ANALYSES OF SOME PAKISTANI IRON ORES(%)

	Kalabagh	Chitral	Chigendik	Pachinkoh
Fe(t)	32.5	59.43	39.16	46.80
Fe(II)	14.3	-	5.6	14.62
SiO_2	22.4	9.94	20.01	15.6
Al_2O_3	5.8	0.80	3.19	4.41
CaO	3.0	3.36	9.19	5.86
MgO	3.[illegible]	0.80	0.83	1.39
Na_2O	0.14	-	-	-
K_2O	2.34	-	-	-
P	0.34	-	0.02	0.10
S	1.58	-	1.07	3.96
LOI	15.91	0.91	7.76	2.72

TABLE-3: CHEMICAL ANALYSES OF IRON ORE CONCENTRATES TEST(Wt%)

	Chichali (indurated)	Chitral	Chigendik	Pachinkoh
Fe(t)	54.7	66.72	65.30	68.20
Fe(II)	-	23.38	14.77	26.39
SiO_2	9.5	3.47	3.28	2.10
Al_2O_3	0.5	0.71	0.51	-
CaO	3.6	0.66	0.85	-
MgO	4.41	0.22	0.04	-
Na_2O	0.04	0.09	0.03	-
K_2O	0.09	0.05	0.01	-
P	0.15	0.01	0.07	-
S	0.11	0.01	0.56	0.66

TABLE-4: REDUCTION TESTS OF CHITRAL, PACHINKOH AND CHIGENDIK ORES

	Chitral A	Chitral B	Chigendik	Pachinkoh
Fe(t)	65.31	66.49	65.58	68.34
FeO	0.38	0.53	1.18	0.15
Static bed reduction				
Direct Reduction%	97.67	98.31	95.05	97.36
Compression strength(Kg/p)	82	110	101	60
Clustering test				
Shrinkage %	21.3	21.1	7.3	17.5
Pressure drop(mm)	4.8	4	3	4
Cluster strength(2min)	8.8	8.9	80	18.1
Fines%	3.75	2.04	1.2	12.1
Linder test				
Direct reduction%	98.28	98.26	93.24	97.05

TABLE-5: REDUCTION PROPERTIES OF INDIGENOUS ORE PELLETS

	Chitral A	Chitral B	Pachinkoh	Chigendik
Chemistry				
Iron contents	Little low for DR feed	Acceptable DR feed	good for direct reduction feed	Acceptable DR feed
Phosphorous	very low	very low	very low	very low
Sulphur	low	low	very low	very low
Physical properties	good	good	good	excellent
Reduction properties				
Reducibility	good	good	good	excellent
Fine generation	little	little	little	little
Clustering	little	little	little	little

ANNEX XI

Study Tour and Workshop to Promote Technology Development
and Transfer in the Area of Sponge Iron Manufacturing in
Developing Countries of the ESCAP Region
Indonesia and India,
29 March - 8 April 1983

SUMMARY OF COUNTRY PAPER

REPUBLIC OF THE PHILIPPINES

by

Mr. Felix Samson
Assistant Chief Product Standards
Ministry of Trade and Industry

The Philippines has been in the iron and steel industry for decades. However, in the recent years she has lagged behind her Asian neighbours.

After a series of feasibility studies conducted since early 1960, the Government seriously considered the construction of an integrated iron and steel mill complex. In 1981 the project was deferred and the Minister of Industry stated that instead expansion and modernization of existing facilities would be taken up.

In the meantime the Ministry of Industry investigated the possibility of other routes to produce steel instead of the originally foreseen coke-oven BF route. A DR plant was under consideration which could use 100 % locally available raw materials. The new plan calls for an integrated plant complex with an annual capacity of 1.5 million metric tons. 6 kilns are proposed .

The Workshop can be an eye opener on the pros and cons of the proposed processes and capacities. The Philippines may even request the sponsors (UNDP, UNIDO, RCTT, India and Indonesia) for an actual observation and traning programmes in different operating plants for personnel directly involved in the proposed DRI manufacture in order to avoid failures.

ANNEX XII

Study Tour and Workshop to Promote Technology Development
and Transfer in the Area of Sponge Iron Manufacturing in
Developing Countries in the ESCAP Region
Indonesia and India,
29 March - 8 April 1983

COUNTRY PAPER

REPUBLIC OF KOREA

by

Mr. Chun Heaing Cho
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Non-ferrous Metals Division
Ministry of Commerce and Industry

Since the Korean Government policy emphasized the promotion of heavy industries including machinery, automobiles and shipbuilding, the demand and supply of steel has increased rapidly. Crude steel production in 1982 was about 11 million metric tons, making Korea the second largest steelmaking cou country in Asia, next to Japan.

Parallel with a rapid increase in steel production, iron scrap requirements also increased to 3.7 million metric tons in 1981, and about 50 % of this requirement has been met by imports from abroad. Domestic demand for iron ore and coal use used as a raw material in iron and steel industries was imported from abroad and natural gas and oil are not produced in the country. The electricity cost is very high compared to the energy-rich country.

The Rep. of Korea does not have any working unit producing sponge iron and does not have plans or programmes for development of the sponge iron industry in the near future, as there is neither natural gas nor oil or iron ore. When the price of iron scrap will be increased, the possibility of establishing a sponge iron industry would be considered. Information about properties, price and the status of the sponge iron in the world is welcomed.

Supply and demand of steel

million tons

	1981	1987 (estimate)
demand	12.4	18.4
Export	5.3 (43%)	
Domestic	7.1	
Production	10.8	14.1
Import	1.6	4.3

Supply and demand of raw material in 1981

	Demand	Domestic production	Import	
Iron ore	11.6	0.4	Australia	40 %
			India	25 %
Scrap	3.7	1.8	USA	80 %

Study Tour and Workshop to Promote Technology Development and Transfer in the Area of Sponge Iron Manufacturing in Developing Countries of the ESCAP Region, Indonesia and India
29 March - 8 April 1983

COUNTRY PAPER DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

by
L.C.R. Wijesinghe, Senior Metallurgist
Ceylon Steel Corporation

With the inauguration and implementation of several large scale development projects, the steel making industry in Sri Lanka has received a great impetus due to an increased demand for steel products, especially the reinforcing steels. The present requirement for reinforcing steels in the country is about 150,000 MT/year.

The largest manufacturer of reinforcing steels in the island is the Ceylon Steel Corporation which has a rolling mill of capacity 100,000 MT/year. The Corporation has also recently commissioned a 25 MT Electric Arc Furnace (EAF) with an associated 4 strand continuous billet casting facility of capacity 60,000 MT/year. The next phase of development is the installation of another 25 MT EAF which would bring the total capacity to 120,000 MT/year. In addition to these facilities the Corporation also has a steel foundry and a Wire Mill.

The feed material for steel making at present is a 100% scrap charge, and at the projected levels of production, the Corporation's stockpile of scrap would be depleted by mid 1984. As with most developing countries scrap is not widely available in Sri Lanka too, and hence it is mandatory that scrap will have to be imported to the country, expending precious foreign exchange. Due to these circumstances the Ceylon Steel Corporation has been looking actively at the possibility of using an alternative feed material to scrap. With the acceptance of the Direct reduction/Electric Arc Furnace (DR/EAF) route for lower capacities, the viability of sponge iron as a feed material has grown. Hence Sri Lanka will be looking closer at the experience of others in the region in the use of sponge iron in steel making.

The Island though not endowed with large mineral deposits have discovered a Magnetite ore body with an estimated 7 million MT of ore extending to a depth of about 50 metres. The metallic iron content of the Magnetite is about 40% and compares well other Magnetite Ores of the world. This Ore is also associated with a copper bearing chalcopyrite, with a metallic copper content of 1%. Preliminary Laboratory studies on the behaviour of the local magnetite to direct reduction with a solid reductant such as coconut shell charcoal has been promising.

The major drawback Sri Lanka faces in producing sponge iron is the non-availability of a gaseous reductant locally which is the reductant most widely used in well established DRI Plants of the world Sri Lanka wishes to share the experiences of countries in the region which uses a solid reductant to produce sponge iron, with the intention of setting up a DR plant which would make the Ceylon Steel Corporation a fully integrated mini mill.

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29 March - 8 April 1983

SUMMARY OF COUNTRY PAPER

KINGDOM OF THAILAND

by

Mr. Trakarn Chairat
Director of Office of Basic Industry Development

The sponge iron industry in Thailand was considered when the commercial quantities of natural gas were discovered in the Gulf of Thailand. The quality of natural gas is qualified to feed various types of industries. Moreover, there are semi integrated steel plants which need scrap as a raw material for electric arc furnace in order to produce non-flat steel. Thailand has to import scrap in the amount of 300,000 tons per year. However, steel scrap has become relatively scarce and expensive.

In the year 1978 the Ministry of Industry received the technical assistance from the Austrian Government in the form of a pre-feasibility study for the establishment of a sponge iron plant based on natural gas. It is recommended in the report which was submitted to the Ministry of Industry in May 1978 that a 600,000 tpy sponge iron plant be established. This plant will need natural gas in the amount of 22 million cubic feet per day and need to import iron ore in the amount of one million ton per year. The total investment is about US$ 100 million. The sponge iron produced can substitute the imported steel scrap and feed the local semi integrated steel plants. From the other amount of spongeiron, billets could be produced in order to distribure to the re-rolling mills. It was anticipated that the sponge iron plant could operate by 1983.

The Ministry of Industry perceived that this project was essential to the economic development of the country and therefore encouraged the local investors to form a company named the Siam Ferro Industry Co, in 1979. As the Government concurred with the project it considers to participate as a minor shareholder of about 11 per cent. Besides, the Government will support the project by providing the necessary infra-structure.

In 1979, the detailed feasibility study for the establishment of a sponge iron plant was conducted. After that, the project was proposed to the Board of Investment (BOI) for special privileges in January 1980. The project was pending for the final decision of BOI on site location. Later on, the Cabinet decided that the sponge iron plant should be established at the eastern coast of Thailand.

However, due to the site which is decided by the Cabinet and the gas price tendency to go up as well as the depression of the steel industry, the Siam Ferro Industry Company reviewed the study report again in 1981. It was decided that the sponge iron industry project should be kept in abeyance. This is owing to the depressed situation of the steel industry at that time. Moreover, the estimated cost of investment rised by about 30 % and the rather high natural gas price had to be taken into account.

The Ministry of Industry has considered that the natural gas in the Gulf of Thailand is costly, its price was determined at US$ 3.50 per thousand cubic feet. This is higher than the optimum natural gas price which could be used for the production of sponge iron at a competitive price with steel scrap. Therefore, the Ministry of Industry is interested now in the solid reductant such as lignite for producing sponge iron. This can be considered as an alternative process route.

In 1982, LURGI Chemie und Huttentechnik GmbH of the Federal Republic of Germany conducted a proposal for the establishment of a SL/RN direct reduction plant based on Thail lignite as solid reductant with a capacity of 400,000 tpy. The Ministry of Industry has realized that the detailed study on the availability and quality of lignite in main sources of Thailand. This study should go into detail, including laboratory testing.

In this resp-ct, the Ministry of Industry considers to approach the Federal Republic of Germany for the financial assistance in the frame of technical co-operation funds for carrying out the feasibility study on the implementation of a lignite-based direct reduction plant in order to produce sponge iron as the substitute for imported ferrous scrap. The said study will be an alternative process route which the Ministry of Industry shall compare with other process routes. The most economically viable and promising route for Thailand sponge iron project shall be selected. This should be the most important step towards the development of a sponge iron industry in Thailand.

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29 March - 8 April 1983

COUNTRY PAPER

SOCIALIST REPUBLIC OF VIETNAM

by
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Metallurgical Institute of Engineering
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Hanoi

Industry of iron and steel production of the SR of Vietnam is quite new. The country has just passed through a long period of war. Almost all of the steel plants and metallurgical institutes were heavily damaged during the war.

In 1975, after the reunification of the whole country, we have restored these steel plants and the institue for metallurgy was also improving its activities.

In fact, the study of sponge iron production in Vietnam has been started at the beginning of 1970.The metallurgical institute was assigned the responsibility of this task.

Background

In the industry of iron and steel production, the country faces two difficulties:
- shortage of coking coal for blast furnace
- shortage of steel scrap for steel making in electric arc furnaces.

In order to overcome these difficulties They had to consider the production process of sponge iron according to the natural resources availability in the country. At first, they have chosen the production method of sponge iron in rotary kiln, using coal of anthrazite, mostly exploited in Vietnam.

Technical characteristics of rotary kiln (small scale production)

Based on the technical documents of sponge iron production in laboratory and in order to assure the study quite similar with the production in plant with industrial equipment.

The Metallurgical Institute has built the rotary kiln for sponge iron production. The equipment was totally manufactured locally, including design. The rotary kiln started operation in November 1978.

The product from the rotary kiln was used in the steelmaking arc furnace of 10 ton capacity in the south of Vietnam.

From the results of sponge iron production in the rotary kiln (small scale) Vietnam has proposed a new design for the rotary kiln with an output of about 60,000 tons per year using domestic raw materials and anthracite and to supply the sponge iron to the steelmaking arc furnace.

To improve the technology of sponge iron as well as the steelmaking int he electric arc furnace, to overcome difficultires of shortage of coking coals and scrap, Vietnam would like to receive technical assistance and equipment from foreign countries in the field of sponge iron production.

We hope that the international organizations will offer the opportunity for specialists to be trained abroad and gain much more experience and practice in the production of sponge iron through study tours and training programmes.

gh Jan 1982

ANNEX XVI

UNIDO's Technical Assistance in the Field of Metallurgical Industries

1. The metallurgical industry, as a basic industry in laying the grounds for further industrialization, occupies an important place within the technical assistance programme of UNIDO. It assists the following branches of industries of extractive and physical metallurgy:

- Light non-ferrous metals(processing of bauxite to alumina and aluminium; titanium-oxide production based on ilmenite smelting and related operations; production of other light non-ferrous metals)
- Heavy non-ferrous metals (processing of copper, zinc, nickel, lead and tungsten bearing ores and other heavy non-ferrous and rare metal ores)
- Iron and steel industry, including choice of technologies, (such as BF vs. DR route) use of locally available reductants (coking coal, charcoal, natural gas, etc.)
- Foundry industry (both ferrous and non-ferrous)comprising alternative foundry technologies and use of local raw materials and auxiliary materials like sands; establishment of pilot and demonstration foundries in least developed countries.
- Metal transformation technologies (application of specific metallurgical processes such as rolling, forging, extruding, heat treatment and surface tratment; welding).
- Transfer of metallurgical know-how and technology (establishment and/or strengthening of Centres for Metallurgical Research and Development, development of local expertise for servicing and application in the metal industries)

2. Within the above branches the Section's technical assistance activities primarily cover the following functions:

- planning, establishment and operation of new metallurgical plants, including national planning of major metallurgical industry sectors (master plans); techno-economic and marketing studies;
- Processing of metallurgical minerals covering evaluation, concentration and beneficiation of ores and non-ore minerals including assessment of data on volumes and quality of reserves, sampling and laboratory and pilot test work to identify optimum use of indigenous raw materials for local processing into added value products;

- provision of expertise for efficient operation of existing plants and selection and application of appropriate technologies and equipment, also including:
  - technological consulting;
  - technical consulting on management, on production, maintenance, materials supply, quality control, and cost accounting of metallurgical plants;
  - Design, programming and modernization of existing metallurgical plants;
  - Advisory services on standardization of metal products;
  - Establishment of managed maintenance systems in metallurgical plants;
- Establishment of centres, laboratories or of testing/evaluation units for metallurgical technology development, thereby increasing research and development capabilities with a view to decrease dependency on or facilitate adaptation of foreign know-how;
- Establishment of pilot and demonstration metallurgical and foundry/forge plants and foundry/forge technology centres;
- Programming, organizing and implementation of specific training programmes;

3. The technical assistance programme is complemented by the organization of symposia, seminars, workshops and expert group meetings on metallurgical subjects as well as the preparation of special studies and documents and their dissemination to developing countries.

4. Special emphasis is accorded to the provision of technical assistance to least developed countries and a number of projects, particularly projects in the foundry industry sector aimed at improving the output and quality of urgently needed cast spare parts, tools and implements, are under implementation in least developed countries.

5. With the objective of promoting industrialization and increasing the share of developing countries in world industrial production, the Metallurgical Industries Section assists in the acceleration of the tempo of exploitation and processing of local ore resources to yield added value products for home use and export.

6. This objective is achieved through the following means and instruments:

(a) Direct technical assistance (field projects)

Such assistance is being provided at the request of developing countries' Governments and can take the following forms:

i. Provision of expertise: an international expert or a team of experts is provided to solve short-term problems or to render long-term assistance up to and including full management of plant operations. The duration of such assignments may vary from two weeks up to two years and more.

ii. Provision of consulting firms hired by UNIDO on sub-contract to undertake, for a requesting developing country, tasks such as the preparation of pre-feasibility and feasibility studies, techno-economic and regional studies, design of laboratory and pilot plants, investigations of ores and other raw materials, or to assist with a complex team of experts to solve complex operational and management problems.

iii. Provision of equipment: Although not financing investment, certain items of equipment needed for research and development work, such as instruments and laboratory equipment can be provided.

iv. Organization of practical training programmes:

- Group training programmes: A number of group training programmes are organized by the UNIDO Industrial Training Section on a regular basis, like the foundry in-plant training organized by the Marmara Technological Institute in Turkey; this programme is particularly recommended for supervisory staff. Another programme is the training on modern foundry technology, undertaken in co-operation with the Foundry Research Institute, Cracov, Poland, for a duration of two months, starting in April year year. Twice a year, an in-plant training programme is organized at Zaporo-Steel, Zaporozhye, USSR, in the iron and steel industry field. The spring programme has a duration of 5 months and starts in January; the autumn programme has a duration of 3 months and starts in September every year.

- Individual fellowship training: Individual training of developing countries' fellowship candidates in companies, institutes, organizations abroad can be arranged, for a period which normally should not exceed 6 months, and is tailored to the needs and requirements of the candidate to be trained.

7. During the past ten years the Metallurgical Industries Section has implemented some 300 technical assistance projects with a total value of about US$ 48 million. In many cases a few components are involved in one project. A typical case is a combination of expert and fellowship components. In case of large scale projects, such as the establishment of metallurgical research and development centres, a combination of all four components can usually be found in one single project.

(b) Supporting activities

i. Symposia, Seminars, Workshops, Expert Group Meetings

Such gatherings are organized with a view to enhance the understanding of new technologies and to discuss problems and opportunities for developing metallurgical industries. They provide a forum for an exchange of opinions between participants from both developed and developing countries. Since its inception in 1967, UNIDO has organized 26 such meetings on various aspects of metallurgical industry development in developing countries. The number of participants for each meeting ranged from 20 to 200.

ii. Special studies and Documents

About 50 special studies and documents have been prepared by various Sections of UNIDO in the last decade in the metallurgical sector. The list of documentation 1967 - 1981 can be obrained from the Metallurgical Industries Section, UNIDO, P.O. Box 300, A-1400 Vienna, free of charge.

iii. Consultation Meetings

The system of consultations, a unique and new activity of UNIDO, has been launched during 1979 in accordance with the recommendations of the Lima Declaration and Plan of Action. In the metallurgical field, the iron and steel sector is one of the few sectors which was selected as of prime importance to the system. So far, three consultation meetings on the iron and steel industry were held and a number of working groups were organized (iron ore, training, coking coal). The system provides useful fora for dialogue and consent with participation from both developed and developing countries to discuss the problems and opportunities of developing countries' steel industry.

iv. Collection and dissemination of information

UNIDO's Industrial Information Section, through its Inquiry Services, assisted by the Metallurgical Industries Section and UNIDO's Technology Group is anxious to satisfy all incoming inquiries from individuals/companies/organizations from developing countries related to industrial development and technology. The Technology Group of UNIDO has launched the operation of INTIB (Industrial and Technological Information Bank) which includes the iron and steel sector as one of the prime features of the Bank. The Bank will also publish Technological Profiles, such as the one on Iron and Steel Industry (symbol No. ID/218, New York, 1978).

Publication of UNIDO Guides to Information Sources, e.g. on foundry industry (symbol No. ID/192, New York, 1977) and iron and steel industry (ID/191, New York, 1977) is one of the useful services provided by the Information Section to developing countries.

8. Mention should also be made here of the UNIDO Newsletter, a leaflet that reports monthly on main events, Industrial Opportunities (information on resources sought by entrepreneurs in developing countries and resources available from industrial firms/organizations), Experts wanted, Publications. Interested subscribers may obtain the Newsletter free of charge, by writing to UNIDO Newsletter, P.O. Box 300, A-1400 Vienna, Austria.

ANNEX XVII

RCTT NET-WORK ON SPONGE IRON FOR ESCAP DEVELOPING COUNTRIES

I. AIMS & OBJECTIVES:

1. To promote exchange of experience among developing countries of the region in the development and transfer of technology in the area of sponge iron.

2. To promote exchange of information among developing countries of the region in the area of sponge iron technology development and transfer.

3. To promote visits to R&D institutions, factories and other establishments engaged in activities concerning technology development and transfer in the area of sponge iron.

4. To promote organisation of periodical seminars, workshops and field visits to stimulate activities in developing countries of ESCAP region concerning the development and transfer of technology in the area of sponge iron.

5. To make available on request to developing countries of the region facilities that may be available in countries of the region for testing raw materials, making laboratory tests, and conducting pilot plant and demonstration studies in the area of sponge iron.

6. To assist in the publication of a news letter for furthering activities in developing countries of the ESCAP region in the area of sponge iron.

7. To provide training facilities on request.

II. ACTIVITIES:

1. Advisory services on technology development and transfer.
2. Periodical seminars, workshops and field visits.
3. Organisation of an information exchange programmes.
4. Organisation of training programmes.
5. Publication of a sponge iron news letter.
6. Organisation of special studies in the area of sponge iron.
7. To strengthen institutions for assisting regional activities in the area of sponge iron technology development and transfer.
8. Promotion of TCDC.

III. METHODOLOGY:

1. Participants in net-work will nominate a contract person for providing support for promoting net-work. This name will be communicated to RCTT by the end of June, 1983.

2. RCTT will provide assistance to promote activities of the net-work. In this effort RCTT will take assistance from UNDP/UNIDO, ESCAP and other UN organisations and institutions outside the UN system.

3. A nodal institution will be nominated by RCTT to promote the activities of the net-work.
4. RCTT in association with the nodal institution and assistance from the members of net-work will take necessary action to achieve the objective of the net-work.

IV. INSTITUTION IN THE NET-WORK:

Afghanistan	-
Burma	- No.1 Iron Project

People's Republic of China	- Central Iron and Steel Research Institute - Beijing
India	- Sponge Iron India Ltd.
Indonesia	- PT Krakatau Steel
Iran	- Ahwaz Steel Complex
Malaysia	- Perwaja Trengganu Sdn. Bhd.
Pakistan	- PCSIR
Phillippines	-
RO K	-
Sri Lanka	- Ceylon Steel Corporation
Thailand	- Office of Basic Industry Development
Vietnam	- Metallurgical Institute of Engineering of Ministry of Metallurgy.

REGIONAL CENTRE FOR TECHNOLOGY TRANSFER
BANGALORE

UNDP/UNIDO/RCTT/Government of India/Government of Indonesia

Study Tour and Workshop to promote technology development and transfer in the area of sponge iron manufacture and use in developing countries of ESCAP Region

Cilegon, Indonesia
and
Paloncha & Hyderabad, India

29 March - 8 April 1983

Issues in the promotion of technology development and transfer in the area of sponge iron manufacture and use in developing countries of ESCAP region*

*Prepared by RCTT Secretariat

INTRODUCTION

In developing countries of ESCAP region, production of iron and steel by direct reduction processes has been receiving increasing attention during the last few years. This is due to the fact that except for a few countries like India and China, most developing countries of this region do not have coking coal which is an essential raw material for producing iron and steel by the traditional blast furnace route. However, during the last few decades, there has been a sustained effort on the part of the developing countries of the region to industrialise their countries and to increase living standards of their people. It is well known that for industrialisation, iron and steel are required. Therefore, there have been efforts by these countries to make use of their natural resources like iron ores, non-coking coals and natural gas for the production of iron and steel and for this purpose, direct reduction was the way out. Another reason why direct reduction processes are becoming popular is the high cost of integrated conventional steel plants with blast furnaces and the non-availability of large financial resources. Added to this, many developing countries do not have large domestic markets to absorb huge quantities of iron and steel that need to be produced in a large integrated steel plant. Another development which gave fillip to the establishment of direct reduction units is improvements in technologies for the production of sponge iron using either natural gas or coal. Therefore, it is no wonder that the establishment of sponge iron units all over the world is increasing apace. Table 1 lists sponge iron units in production, under construction and in the planning stage in countries of ESCAP region. Such units in the rest of the world are listed in Table 2. In 1981, about 8 million tonnes of DRI was produced in the world.

DEVELOPMENTS IN THE ESCAP REGION

As is evident from Table 1, significant developments have taken place in the ESCAP region regarding the establishment of sponge iron units. A unit for the production of 30,000 tonnes per annum of sponge iron by using SL/RN process utilising solid reductant was established at Paloncha, Andhra Pradesh, India. This plant went into regular production in Nov. 1980. UNDP and UNIDO provided financial and technical assistance to the Government of India for the establishment of this unit. This unit has been functioning satisfactorily until now.

After the successful operation of the Paloncha sponge iron unit in India, several other units are now coming up in that country. One unit is now under construction in Keonjhar, Orissa, India, utilising coal and oil as reductants. This has a capacity of 100,000 tonnes of sponge iron per annum. Another unit which is in the public sector has already come into production in Orissa. This plant located in Palaspanga, Orissa has a capacity of 150,000 tones per annum. The unit was inaugurated by the President of India on 18 March 1983. Other units in India are planned in Bihar, Madhya Pradesh, Andhra Pradesh and Karnataka states.

A large direct reduction unit utilising natural gas was established in Cilegon, Indonesia by P.T. Krakatau Steel, a Government of Indonesia corporation. This plant, having an ultimate capacity of two million tonnes of sponge iron per annum has been functioning very satisfactorily from 1980. A hot strip mill in this unit was opened by the President of Indonesia on 26 February 1983. A sponge iron unit is now under erection in Labuan island, Malaysia. This unit with a capacity of 650,000 tonnes per annum is expected to come into production in 1984. In Burma, a sponge iron plant using coal and with a capacity of 20,000 tonnes per annum is already working. Another unit with a similar capacity is expected to go into operation during 1983.

INITIATIVES IN THE UN SYSTEM

In view of the growing importance of direct reduction processes in the ESCAP region, UNIDO, ESCAP and RCTT have been implementing an active programme of providing assistance to developing countries of the region in the planning, establishment and operation of direct reduction units. Attention has been drawn already to the fact that UNDP and UNIDO assisted the Government of India in the establishment of direct reduction unit in Paloncha, India. With assistance from UNDP and the Government of Netherlands, UNIDO, ESCAP and RCTT organised during Nov. 1979, a workshop on problems of technology transfer for promotion of sponge iron industry in the countries of the ESCAP region, in Bangkok, Thailand. As a result of this Workshop, a working group consisting of several countries of the region was formed to exchange information on developments in the area of sponge iron. UNIDO organised in Jamshedpur, India, during 7-11 December 1981 a workshop on regional cooperative research among metallurgical research and development centres in Asia and the Pacific. During this workshop, direct reduction processes were also discussed. In view of important developments that have since taken place in the region, UNDP, UNIDO and RCTT have organised this Study Tour and Workshop in Indonesia and India to stimulate exchange of experience and information on latest technological advances in direct reduction processes and use of sponge iron and evolve suitable programmes for further development of this industry in this region.

The objectives of the Study Tour and Workshop are the following:

1) To assess latest developments in technology for making sponge iron using solid and gaseous reductants.

2) To study the working of sponge iron plants of

   a) Sponge Iron (India) Limited at Paloncha, Andhra Pradesh, India, using solid reductant, and

   b) P.T. Krakatau Steel at Cilegon, Indonesia using gaseous reductant.

3) To determine the potential for, and itnerest of countries in the development of sponge iron industry.

4) To exchange experience among developing countries of ESCAP region in the planning, establishment and operation of sponge iron units.

5) To consider a request for UNDP assistance in the development of sponge iron industry through direct reduction technology for mini steel plant operations, in those countries which express interest and have potential for such an industry.

6) To consider other regional activities in this field including the establishment of a network of institutions engaged in the area of sponge iron.

During the course of this Study Tour, participants had the opportunity of visiting Krakatau Steel Plant at Cilegon, Indonesia. It is one of the largest plants of its kind in the world. The participants also had the opportunity to discuss problems the authorities in Indonesia had in the planning, establishment and operation of the unit. The participants had the benefit of visiting the sponge iron unit of Sponge Iron (India) Limited in Paloncha, Andhra Pradesh, India and discuss problems involved in its planning, establishment and operation, which uses a relatively poor quality noncoking coal with high ash content. In spite of difficulties inherent in using such a reductant this plant has been functioning very satisfactorily.

In the light of the above developments, the Workshop will have opportunities to discuss issues relating to exchange of knowledge and promotion of technology development and transfer in the area of direct reduction processes and use of sponge iron in the developing countries of the ESCAP region.

ISSUES FOR CONSIDERATION

Latest developments in sponge iron technology:

The countries of this region will be interested to know what have been the latest developments in the direct reduction processes using both solid reductants and gaseous reductants. There have been continuous improvements in these processes. For example, the vendors of these processes have been claiming improvements in their processes which make it possible to operate these plants more satisfactorily and efficiently. The country papers and the papers by others would give an idea of these latest developments. Discussion of these papers will enhance the awareness of countries of this region of the latest developments in technologies of direct reduction processes and production of sponge iron. Another aspect that could be discussed under this is with regard to the utilisation of sponge iron. The combination of direct reduction and electric furnace for making steel is now well developed. The latest developments are highlighted in the papers before the Workshop. These papers could be discussed in order to understand fully all the latest developments in technology.

Potential for development of sponge iron industry in ESCAP region:

Earlier in this paper, a short review has been made with regard to the development of this industry in developing countries of the ESCAP region. There is considerable interest in the establishment of such units in other developing countries of the region as well as establishment of more units in countries where such units are already working. For example, Pakistan, Sri Lanka, Bangladesh and Thailand are interested in establishing these units. More units are being planned in India. The plant in Cilegon is establishing units for making full use of facilities already established. Recently, a hot strip mill has started functioning in this unit. The Workshop, therefore, may like to discuss the potential for this industry in developing countries of this region in the light of developments that have already taken place all over the world, the establishment of this industry in some countries of this region and the availability of raw materials and other resources in these countries. Table 3 gives an idea of mineral resources available in countries of ESCAP region for establishing direct reduction units. Recent exploratory work reveals that there are possibilities of finding larger reserves of ores, oil and natural gas in some of these countries.

As already mentioned, some direct reduction units have been functioning developing countries of this region. The discussion of their experience in the planning, establishment and operation of these units will be of immense benefit to the countries of this region especially those planning to establish new units and those already having these units in their countries. Some country papers already describe this experience. The Workshop may like to discuss this experience and suggest pointers for the benefit of those who plan to establish new units. Another aspect which could be discussed will be the kind of that existing units could extend to those who are planning to establish new units. For example, it may be possible for existing units to test and evaluate raw materials available in other countries. SIIL is already in the process of doing this work. They have taken up testing of raw materials from Pakistan and some countries outside region. Sri Lanka is interested in getting their materials tested in this unit. Another aspect is training of personnel from countries of the region in planning, establishment and operation of these units. This training will be of immense benefit to those planning the establishment of such units and even those who already have such units. Another important matter is with regard to exchange of information on a continuing basis. The units already existing may be in a position to provide this information service to those who are interested in establishing new units. The Workshop may like to discuss all these aspects for sharing experience among developing countries of the region.

UNDP REGIONAL PROJECT

In order to assist countries of this region in promoting the establishment of direct reduction units, a project has been prepared by UNIDO for obtaining support of UNDP. A separate document describing this project has been circulated at this Workshop. The purpose of the project is to maximise utilisation of existing facilities for assisting countries of the region in the planning, establishment and operation of sponge iron units. This includes the testing of raw materials and training of personnel. The Workshop may like to discuss this report in detail and make recommendations for consideration by UNDP.

NETWORK OF INSTITUTIONS

At the earlier Workshop on Sponge Iron held in November 1979 in Bangkok, a 12 member working roup was constituted. In the light of developments that have since taken place. consideration may be given to the establishment of a network of institutions and chalk out a programme of activity for this network. The programme could consist, among others, exchange of experience and information, advisory services, training, group visits, seminars and workshops. The Workshop may like to nominate a lead institution such that it could act as a nodal point for promoting the network activity.

CONCLUSION

The participants of this Workshop had had the opportunity to see two working sponge iron units, one utilising solid reductant and another gaseous reductant. They had the benefit of discussions with those in charge of these units. The country papers and papers by others presented at the Workshop have given the latest position not only with regard to developments in technology but also with regard to plans and programmes of developing countries in this region in the establishment of direct reduction units. The deliberations of this Workshop will, therefore, be of immense benefit to all the countries of this region who are interested in the establishment of these units.

Table 1

Direct Reduction Installations in Operation and under Construction in the ESCAP Region

Country	Plant Name/ Location	Process Used	Capacity in 000 tpy	Major Fuel	Status
Australia	Western Titanium	SL/RN I	14	Coal	In Operation
Burma	N, A., (2 plants)	Kinglor Metor	20	Coal	1-In Operation 1-Under Construction
India	SIIL Paloncha	SL/RN	30	Coal	In Operation
	Palaspanga Orissa	ACCAR	150	Gas/Coal	Started operation in March 1983.
	IPI TATA Sponge Iron Ltd. Keonjhar, Orissa	TDR	100	Coal	Under Construction
Indonesia	P.T. Krakatau Steels Cilegon	HYL	2000	Gas	In Operation
Iran	NISC	HYL	1000	Gas	Not Started
	NISC	Midrex	1200	Gas	Not Started
Japan	Nippon Steel Hirohata	NSC	150	Kerosene	Shut Down
	Hitachi Metals	Wiberg	10	...	In Operation
	Kawaski Steel Misushima	Kawaski	240	...	In Operation as required
	Kawaski Steel Chiba	Kawaski	250	...	-do-
	Sumitomo Metals	Sumitomo	240	...	In Operation
	Nippon Kokan	SL/RN	400	Coal	In Operation as required
Malaysia	Sabah I&S Labuan Island	Midrex	600	Gas	Under Construction
	HICOM Trengganu	NSC	600		Letter of Intent Issued
New Zealand	New Zealand Steel	SL/RN I	160	Coal	In Operation
		SL/RN III	900	Coal	Under Construction

Table 2

Sponge Iron units in production, under construction and in the planning stage in countries outside ESCAP region

Major Fuel: Gas

Process	Plant	Start	In Operation*	Shut Down*	Contracted Under Construction*	
Armco	Armco Steel, USA	1972		330		
FIOR	Matanzas, Venezuela	1976	400			
HIB	Minorca, Venezuela	1973		650		
HyL I	Monterrey I, Mexico	1957	95			
	Tamsa, Mexico	1967	235			
	Puebla I, Mexico	1969	315			
	Monterrey III, Mexico	1974		475		
	USIBA, Brazil	1974	300			
	Puebla II, Mexico	1977	700			
	SIDOR I, Venezuela	1977	420			
	Khor Alzubair, Iraq	1978/81	485			
	SIDOR II, Venezuela	1981	700			
	SIDOR II, Venezuela	1982	1400			
HyL III	Monterrey II, Mexico	1980	270			
	Monterrey 3M, Mexico	1982			500	
	Sidersur, Argentina	?			500	Lol**
	Monterrey 4M, Mexico	1984			750	
	Sicartsa Stage II, Mexico	?			2000	
	Premexa, Mexico	1984			1000	
MIDREX	Oregon Steel, USA	1969		300		
	Georgetown, USA	1971	400			
	HSW, West Germany	1971	400***			
	Sidbec I, Canada	1973	400			
	Dalmine, Argentina	1976	400			
	Sidbec II, Canada	1977	650			
	SIDOR I, Venezuela	1977	400			
	Acindar, Argentina	1978	420			
	Qatar Steel, Qatar	1978	400			
	SIDOR II, Venezuela	1979	1275			
	ISCOTT I, Trinidad	1980	420			
	NFW, West Germany	1981	800			
	BSC, Hunterston, Great Britain	?		800		(not started)
	Warri, Nigeria	1982			1020	
	OEMK, USSR	1983			1670	
	ISCOTT II, Trinidad	1982			420	
	HADEED, Saudi Arabia	1982			800	
	Misurata, Libya	1984			1100	
Purofer	Thyssen, W.Germany	1970		150		
	COSIGUA, Brazil	1977		350		
Wiberg	Sandvik, Sweden	1952		25		
	Uddeholms AB, Sweden	1954		30		
	SKF, Sweden	1969		25		(conversion to Plasmared)

Major Fuel: Coal

Process	Plant	Start	In Operation*	Shut Down*	Contracted Under Construction *
ACCAR	Allis Chalmers,USA	1973	35***		
	Sudbury, Canada	1976		240	
DRC	AZCON,Rockwood,USA	1978	60		
	Scaw Metals,South Africa	1983			80
Hoganas	Hoganas Corp.,USA	1954	70		
	SSAB, Sweden	1954	30		
	Hoganas, Sweden	1963	130		
Kinglor Metor	Kinglor Metor,Buttrio, Italy	1973		11	
	Arvedi,Cremona,Italy	1976		40	
Krapp/Codir	Dunswart, South Africa	1973	120		
Rotary Kiln	Tohoku-Satetsu	1957		24	
SL/RN	Acos Finos Piratini, Brazil	1973	60		
	Hecla, USA	1975		68	
	Stelco, Canada	1975	350***		
	Siderperu, Peru	1980	120		
	ISCOR,South Africa	1984			720
Prereduction					
Lurgi-Highveld	Highveld,South Africa				
	Module 1-4	1968	1000		
	Module 5	1974	250		
	Module 6	1976	250		
	Module 7+8	1978	500		
	Module 9	1980	250		
	Module 10	1981	250		
	Module 11,12,13	1982			750

*1000 tpy   **Letter of Intent   ***in operation as required

Table 3

Natural Resources Available in ESCAP Countries for Sponge Iron Manufacture

Country	Iron Ore (million tons)	Coal (million tons)	Natural Gas (billion m³)
Afghanistan	2,100	85	-
Bangladesh	-	1,491	235
Burma	100	265	3
India	21,500	94,734	70
Indonesia	592	639	283
Iran	820	367	10,760
Malaysia	97	-	323
Pakistan	400	1,491	459
Philippines	920	91	1
Sri Lanka	32	-	-
Thailand	45	235	-
Vietnam	141	1,000	-

UNIDO - Draft World Wide Study of the Iron and Steel Industry 1975-2000

APPENDIX XIX

UNITED NATIONS DEVELOPMENT PROGRAMME

Regional Project of the Governments of

Democratic Republic of Afghanistan. People's Republic of Bangladesh, Socialist Republic of the Union of Burma, People's Republic of China, Republic of India, Republic of Indonesia, Islamic Republic of Iran. Republic of Korea. Malaysia, Islamic Republic of Pakistan, Republic of the Philippines, Democratic Socialist Republic of Sri Lanka, Kingdom of Thailand and Socialist Republic of Viet Nam

Title: Regional Development of Sponge Iron Industry through Direct Reduction Technology for Mini Steel Plant Operations

Project Number: DP/RAS/81/063 Duration: 3 years

Sector: Industry Sub-sector: Iron and Steel Industry

Primary function: Direct support Secondary function: Industry

Government Implementing agency: Ministries of Industries in participating ESCAP countries

Executing Agency: United Nations Industrial Development Organization (UNIDO)

Estimated starting date: 1 September 1983

Government inputs: UNDP inputs US$ 500,000

Signed: ______________________ Date: ______________
on behalf of the Governments

______________________ Date: ______________

on behalf of UNIDO, the Executing Agency

______________________ Date: ______________

on behalf of the United Nations Development Programme

Part I - LEGAL CONTEXT

This project document shall be the instrument referred to as such in Article I, paragraph 2 of the Agreement between the Governments of:

and the United Nations Development Programme, signed by the Parties on

respectively.

The Governmebts' Implementing Agencies shall, for the purpose of the Standard Basic Agreement, refer to the Governments'Co-operating Agencies described in that Agreement.

Part II - OBJECTIVES

A. DEVELOPMENT OBJECTIVES

Within the principal context of industrial development of the ESCAP countries region, based on the exploitation of those countries' natural resources and raw materials, the major development objectives are to survey, investigate and technologically assess the possibilities of promoting sponge iron production for development/expansion of the steel industry, with a view of economically utilizing raw material resources and applying the most appropriate sponge production technology (gas or coal as a reductant) as well as estimating the domestic market for sponge iron and consider possible exports, including intra-regional trade.

B. IMMEDIATE OBJECTIVES

The project will facilitate co-operation among the participating countries in the promotion/establishment of national and/or regional plants for the production of sponge iron, through the most suiable route, depending on individual conditions. In particular, the immediate objectives will cover the following:

(a) to study the application of well-proven direct reduction technological processes in developing countries, based on available resources, such as

i. iron ores (high grade lumps/oxide pellets)and ilmenitic ores for sponge production;

ii. natural gas including naphta resources for direct reduction;

iii. solid reductants (non-coking coals, charcoal)

(b) to select the optimum direct reduction technology best suited for sponge production in different countries of the ESCAP region, through the establishment of:

i. sponge plants on a national basis;

ii. sponge plants on a regional basis.

(c) to recommend the appropriate steps to be taken in establishing such plants on a bilateral and multilateral basis, including the mechanism of exchange of raw materials and sponge products amongst developing countries in the Asia region to meet the national and regional steel market needs.

(d) to assess the capital investment needs to set up facilities envisaged under (a) and (b) above and make techno-economic appraisals thereof including evaluation of production costs based on alternative technological routes.

(e) to prepare a master plan for the growth of the iron and steel industry based on sponge iron production on a national basis for various developing countries in the region, with particular reference to (a) and (c) above, and in doing so, to undertake wherever necessary:

i. laboratory/pilot/demonstration scale investigations on sponge production based on high grade iron ores/pellets, ilmenitic ores and solid (non-coking coals) reductants at a Demonstration Plant including the UNDP/UNIDO established Pilot and Demonstration Plant for the Production of Sponge Iron at Kothagudem, Andhra Pradesh, India (DP/IND/71/611).

ii. formulate the production flow-sheets for respective sponge plants in different countries;and

iii. assess the overall techno-economic analyses of sponge production and its use for the steel industry in the developing countries of the ESCAP region.

C. SPECIAL CONSIDERATIONS

The effective implementation of this project will, to a great extent, depend on the technical co-operation among the participating developing countries. Sponge iron production in countries of the Asia and Far East region would represent an important step in their drive to promote their steel industries on techno-economically acceptable scales, taking into account and utilizing the technical and demonstration scale facilities already established through UNDP/UNIDO technical assistance at the Demonstration Plant for the Production of Sponge Iron at Kothagudem, Andhra Pradesh (India) and other possible centres and operational plants such as the direct reduction facilities at the Krakatau Steel Plant in Indonesia.

D. BACKGROUND INFORMATION AND JUSTIFICATION

During the last decade several technical advisory missions and meetings have been carried out under the auspices of UNDP and UNIDO to focus attention on problems and potential of developing viable iron and steel industries in the developing countries of the world. However, in spite of all these efforts, on national and regional basis, the integration achieved is still far from ideal, largely because of different socio-political conditions, but also owing to numerous technical and financial problems faced by the concerned countries. However, in recent years promising technological changes have taken place in the iron and steel industries and it is now possible to establish and operate viable plants on a much smaller scale, based on sponge iron production and its melting in electric arc furnaces to produce commercial grades of steels. It is now essential to explore ways and means of increasing regional steel production by means of application of modern steelmaking technology and, in particular, the direct reduction process to produce sponge iron for mini steel plant operations.

The subject for development and promotion of sponge iron production was amply discussed at the UNDP sponsored and UNIDO/RCTT organized Study Tour and Workshop to Promote Technology Development and Transfer in the Area of Sponge Iron Manufacture and Use in Developing Countries of the ESCAP region, held from 29 March to 8 April 1983 at Hyderabad, India, and incorporating visits to the Krakatau Steel Plant, Cilegon Indonesia (Direct reduction plant using gaseous reductant) and Pilot and Demonstration Plant for the Production of Sponge Iron at Kothagudem, India (using solid reductant).

The participating countries (

urged the need for UNDP assistance in the development of sponge iron industry through the promotion of the direct reduction route to produce sponge iron suitable for mini steel plant operations. It was appreciated by the participants that the Workshop and Study Tour provided a good opportunity for them to assess latest sponge iron production developments, to study the working of sponge iron plants and to exchange experience on plant operations and planning of sponge iron plants. Support was considered desirable in strengthening their sponge technology capabilities and in the assessment of demand for sponge iron and techno-economic feasibility of setting up production units and in the selection of appropriate technology to suit conditions and resources prevailing in the various countries of the region. Such support could possible be provided in a UNDP/UNIDO sponsored project which would consider both the national and regional aspects of sponge iron production and co-operation among the countries of the region.

It has been recognized that steel scrap in recent years has been such an uncertain and unpredictable commodity, both with respect to availability and price, that electric arc steel melting capacity has to find alternative feed material for sustained growth. The scrap position for some of the developing countries for the years 1985 and 2000 are given in the table below. It shows that there will be an overall scrap deficit of about 4 million tons by 1985 and 10 million tons by the year 2000.

Table 1

Scrap position and sponge iron requirements by 1985 and by 2000

(in 1000 tons)

Country	1985 Scrap position	1985 Equivalent sponge iron requirement	2000 Scrap position	2000 Equivalent sponge iron requirement
Afghanistan	(-) 23	25	(-) 32	35
Bangladesh	(-) 75	83	(-) 364	400
Bhutan	(+) 0.35	-	(+) 1	-
Brunei	(+) 0.53	-	(+) 2	-
Burma	(+) 11	-	(-) 295	324
India	(-) 694	760	(-)1180	1300
Indonesia	(-) 630	690	(-) 715	786

Country	1985 Scrap pos.	1985 Equiv. sponge	2000 Scrap pos.	2000 equivi sponge
Iran	(-) 2,538	2,790	(-) 6,265	6,900
Kampuchea	(-) 22	24	(-) 35	38
Laos	(+) 4	-	(+) 11	-
Malaysia	(-) 212	233	(-) 978	1,075
Nepal	(-), 20	22	(-) 32	35
Pakistan	(-) 10	11	(-) 329	362
Philippines	(+) 77	-	(-) 53	58
Singapore	(+) 48	-	(-) 200	220
Sri Lanka	(-) 37	41	(-) 149	164
Thailand	(+) 16	-	(+) 151	-
Vietnam	(+) 173	-	(+) 502	-
TOTAL	(-) 3,931	4,679	(-) 9,960	11,697

The countries which will face a severe scrap deficit by 1985 to warrant establishment of spongeiron capacities would be Bangladesh, India, Iran, Indonesia and Malaysia. By the year 2000 the list would further swell by the addition of Burma and Pakistan. Other countries like Afghanistan, Kampuchea, Nepal, Philippines, Singapore and Sri Lanka will also require sponge iron which may, however, be met on export basis from sponge producing countries of the region.

Assuming that the projected scrap shortage would have to be met by sponge iron, the corresponding demand for sponge iron is projected at 4.7 million tons and 11.7 million tons by 1985 and the year 2000 respectively.

Iron ore situation

Estimates of the availability of iron ore in countries like Afghanistan, India, Indonesia, Iran, People's Democratic Republic of Lao, Pakistan and the Philippines have been outlined in various documents.

India, Iran, Malaysia and Thailand are the only iron-ore exporting countries in the Asian region and had a total production around 40 million tons in 1979. The iron ore reserves of Burma, Nepal, Sri Lanka and Viet Nam are rather low. India possesses about 20 billion tons of potential iron ore reserves, while Pakistan has about 400 million tons, Afghanistan about 2 million tons and the Philippines about 900 million tons. Total reserves of these countries is about 22 billion tons.

Whilst Sri Lanka has very meagre iron ore reserves, it possesses titaniferous beach sands which can be effectively processed through direct reduction technology to yield highly metallized sponge which will contain the titania contents of the original beach sand. This sponge can be further treated to yield a slag high in its TiO_2 content and the metallic iron content is processed on to steelmaking. Similar deposits exist in other countries such as South Africa and New Zealand and those countries are already processing these vanadiferous and titaniferous deposits respectively on an industrial scale to produce sponge iron and steel.

Hajigak iron ore deposits of Afghanistan, Pange Pet of Burma, Bailadila, Barajamda, Bellary-Hospet, Goa, Kudremukh and Bababudan deposits in India, Sebuku and Larona deposits of Indonesia, Arak and Bafque areas in Iran, Kieng Khouang deposits of Lao, Bakit Ibam deposit of Malaysia, Pulcnoke of Nepal, Mazara Laugrial and Chi Chali deposit of Pakistan, Lammin and Larap and Manicamni deposits of Philippines, Amphoe Chian Karn and Amphoe Muang deposits of Thailand are the important iron ore deposits in the ESCAP region. A preliminary examination of the type of ore and chemical analysis as can be seen from Table 3 suggests that many of these deposits could be explored either directly or after beneficiation for further processing by the DR route. The iron content in the various deposits shows a fairly wide range and in certain cases Al_2O_3 is also on the higher side. However, steps have to be taken for iron ore beneficiation/pelletizing for establishing the suitability of various grades of ores for sponge iron production.

Detailed information on iron ore reserves in ESCAP countries, major deposits and chamical analyses of iron ores are provided in the following tables 2 and 3.

Table 2

Iron ore reserves in ESCAP countries

(in million tons)

Country	Measured and indicated	Measured, indicated and inferred	Potential reserve
Afghanistan	-	-	2,110
Bangladesh	-	-	-
Bhutan	-	-	-
Brunei	-	-	-
Burma	6	30	100
India	5,580	8,646	21,500
Indonesia	30	57	592
Iran	30	160	820
Kampuchea	-	-	-
Laos	-	-	1,008
Malaysia	83	89	97
Nepal	-	14	30
Pakistan	-	400	400
Philippines	77	907	920
Singapore	-	-	-
Sri Lanka	-	10	32
Thailand	-	26	45
Viet Nam	-	63	141

Table 3

Major deposits and chemical analysis of iron ores

No.	Country	Reserves (in million tons) Measured	Measured and indicated	Measured indicated and inferred	Potential ore	Total resources	Type	Constituents (%) Fe	SiO_2	Al_2O_3	P	S
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	AFGHANISTAN											
	Hajigarh Pass	-	-	-	1,000	1,000	-	30-50	-	-	-	-
2	BURMA											
	i. Pang Pet	-	1	20	69	89	Goethite Hematite Magnetite	45-65	1.6-16.0	-	0.04-0.33	-
	ii. Tungoo	-	-	-	97	97	- do -	25-43	13.0-29.0	15.0-25.0	0.10-0.45	0.30 - 0.90
3	INDIA											
	i. Bihar-Orissa	2,578	3,420	3,050	-	3,050	Hematite	55-59	1.0-6.5	0.9-6.4	0.03-0.38	0.01-0.05
	ii. Bailadila	990	1,550	1,625	-	1,625	Hematite	59-66	0.9-3.4	-	0.05-0.16	0.03-0.44
	iii Bellary	425	837	868	-	868	Hematite	55-68	0.6-14.0	0.2-5.3	0.02-0.08	-
	iv. Goa	100	218	396	-	396	Hematite	55-65	Upto 6.0	Upto 6.0	0.02-0.06	-
4	INDONESIA											
	i. Sebuku	-	-	-	87	87	Goethite	48	2.2	-	0.01	0.12
	ii. Seidua	-	-	-	39	39	Goethite	48-50	4.5-5.0	-	0.03-0.04	0.11-0.12
	iii. Larena	-	-	-	370	370	Goethite	48-55	2.5-5.0	9.0-13.0	-	-
	iv. Erzberg	-	30	30	-	30	Magnetite	50	-	-	-	-

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
5	IRAN											
	A. Arak Aron											
	i. Kajar Ab.	-	-	-	20	20	Hematite	35	-	-	-	-
	ii. Ahmad Rowghant	-	-	-	10	10	Hematite	40	-	-	-	-
	iii Shamsabad	-	-	-	48	48	Hematite Goethite	44	14.0	-	-	0.45
	B. Bafqu Area											
	i. Chador Malu	14	30	69	-	69	Magnetite Hematite	50-60	-	1.9	-	-
6	LAO											
	Xieng Khouang	-	-	-	1,000	1,000	-	60	-	-	-	-
7	MALAYSIA											
	Bukit Ibam	11	14	14	-	14	Hematite Goethite	62	8.1	-	0.05-0.06	0.05
8	PAKISTAN											
	i. Hazara	-	-	60	-	60	Hematite	16-40	9.0	-	0.30	-
	ii. Langrial	-	-	3	16	24	Hematite	30-45	13.0	9.0	-	-
	iii. Chichali	-	-	450	-	450	Chamesite Goethite Siderite	31-34	22.0-24.0	5.0-9.0	0.39-0.69	0.07-0.22
9	PHILIPPINES											
	i. Larap	43	43	43	-	43	Magnetite Hematite	37-40	10.0	2.5	0.15	0.50-4.00
	ii. Manicani	-	-	-	20	20	Goethite	48-49	8.0-10.0	1.8-2.0	0.03	0.20
	iii. Lammin	-	-	-	14	14	Magnetite Hematite	51-71	Upto 11.0	1.2	0.03-0.14	0.30
	iv. Goto	-	-	-	12	12	Goethite Hematite	50	-	-	-	-
	v. Dinagat	-	-	104	1,444	1,548	Goethite	48	-	-	-	-
	vi. Surigao	-	-	475	139	614	Goethite	47	-	-	-	-
10	THAILAND											
	i. Amphoe Chiengkarn	-	-	-	16	16	Magnetite Hematite	59-68	Upto 16.0	-	0.02-0.09	-
	ii. Amphoe Muang	-	-	-	11	11	Magnetite Hematite	45-65	Upto 7.5	-	0.12-0.13	-
	iii. Khao Thap Khwai	-	-	8	-	8	Hematite	44-67	2.2-17.0	-	0.04-0.18	0.01-0.03

Natural gas and coal resources

Many of the South and South-East Asian countries have either natural gas or coal, or both. An estimate of the availability of natural gas in Iran, Pakistan, Brunei, Malaysia, Indonesia and Bangladesh and of non-coking coal - an alternate reductant - in India, Bangladesh, Pakistan, Viet Nam, Indo-esia, Iran, Burma and Thailand is given below. The countries which do not have either of these reductants are Afghanistan, Bhutan, Kampuchea, Laos, Nepal, Singapore and Sri Lanka. Sri Lanka may use inter alia Indian Singareni non-coking coal for direct reduction trials and investigation.

Table 4 Natural gas and non-coking coal resources

No.	Country	Natural gas x 10^9 Nm^3	non-coking coal million tons
1	Afghanistan	-	85
2	Bangladesh	235	1,491
3	Bhutan	-	-
4	Brunei	456	-
5	Burma	3	265
6	India	70	59.968
7	Indonesia	283	639
8	Iran	10,760	367
9	Kampuchea	-	-
10	Laos	-	-
11	Malaysia	323	-
12	Nepal	-	-
13	Pakistan	459	1,491
14	Philippines	1	91
15	Singapore	-	-
16	Sri Lanka	-	-
17	Thailand	-	235
18	Viet Nam	-	1,000

Considering the availability of these raw materials as well as the power potential of certain developing countries and sponge iron demand, Bangladesh, Burma, India, Indonesia, Iran, Malaysia and Pakistan could be potential producers of sponge iron in the region of South and South-East Asia. These countries fulfil exceedingly well the conditions required for the creation of sponge iron facilities. The current status and projections of sponge plants are given in Table 5.

Table 5

Logistics for sponge iron capacity planning

No.	Country	Potential reserves: Iron ore Quant. Mt.	Iron ore Fe %	Non coking coal Mt.	Nat. gas 10^9 m^3	Oil Mt.	Power situation: Inst. capacity in 1974 MW	Potent. hydro power MW	Projected EAF capacity 1985	2000	Scrap balance 1985	2000	Sponge iron requirement 1985	2000	Sponge iron capacity planned 1985	2000	Scrap/sponge demand and justification for installation of sponge iron capacity or otherwise
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1	Afghanistan	2,110	30-50	85	NA	-	284 (236)	6,000	40	80	-23	-12	25	35	-	-	Limited demand; Reductant limited. Good hydro-power potential. No planning of sponge iron capacity. EAF to operate with imported scrap/sponge.
2	Bangladesh	NA	-	1,491	235	-	661 (80)	1,300	50	650	-75	-364	83	400	1x4000	1x4000	Requirement less in '85 increasing in 2000. Enough natural gas reserves. Hydropower potential exists. Sponge iron capacity of 400,000 t planned in '85 itself will suffice upto 2000.
3	Bhutan	-	-	-	-	-	NA	-	-	-	+0.35	+1	-	-	-	-	No sponge capacity called for due to limited market and absence of raw materials.
4	Brunei	-	-	-	456	294	81 (-)	-	-	-	+0.53	+2	-	-	-	-	Demand very small; resource: natural gas and oil. No sponge iron capacity planned.
5	Burma	100	45-65	265	3	6	263 (101)	75,000	50	550	+ 11	-295	-	324	-	1x4008	Limited market; reductant: coal; very large hydro-power potential; sponge iron plant using coal as reductant envisaged.
6	India	21,500	55-65	59,958	70	118	20,196 (7,523)	70,000	4,900	9,500	- 694	-1,180	760	1,300	1x3008 1x4000	1x3008 2x4000 1x4000	Moderate demand. Ore and coal available in plenty. Very good hydropower potential. Sponge iron plant contemplated both solid and gaseous route.
7	Indonesia	502	50	639	28	1,558	1,044 (404)	30,000	1,300	2,380	- 630	-715	690	786	2x4000	2x4000	Demand not very large; ore available; gas potential good; hydro-potential good. Sponge iron plant envisaged through gaseous route.
8	Iran	820	50-68	587	10,760	9,308	4,200 (NA)	10,200	5,000	12,000	-2,538	-6,265	2,790	6,900	8x4000	8x4000 8x6000	Huge market; ore available; natural gas richest reserves; good hydropower potential. Good number of gaseous DR plants contemplated.
9	Kampuchea	-	-	-	-	-	NA	-	40	80	-22	-35	24	38	-	-	Limited demand. Absence of raw materials. No sponge iron plants envisaged. Scrap/sponge for the EAF to be imported.
10	Laos	1,000	63	-	-	-	50[2] (44)	NA	-	-	+4	+11	-	-	-	-	Small demand. Ore exists; no sponge iron capacity thought of.
11	Malaysia	97	42-62	-	323	-	1,092 (298)	1,300	550	2,050	-212	-978	233	1,075	1x4000	1x4000 1x6000	Limited demand by '85 increases by 2000. Ore exists; gas abundant. Gasbased DR plants have been thought of.
12	Nepal	30	59	-	-	-	59 (42)	NA	60	120	-20	-32	22	35	-	-	Limited demand; not favourable disposed with respect to raw materials. No sponge iron capacity planned. Scrap/sponge requirement to be met through imports.
13	Pakistan	400	30-40	1,491	459	4	1,920[2] (586)	400	1,400	-10	-329	11	362	-	-	1x4000	Limited demand. Abundant natural gas reserves. Very good power potential. DR plant gaseous based envisaged.
14	Philippines	920	38-60	91	1	-	3,090[2]	7,500	500	1,500	+77	-53	-	58	-	-	Limited sponge iron requirement. Ore available. Some power potential exists. The requirement can be easily met through imports.
15	Singapore	-	-	-	-	-	1,109 (-)	-	400	900	+48	-200	-	220	-	-	Limited demand. No natural resources. Scrap to be imported.
16	Sri Lanka	32	50-60	-	-	-	281 (195)	1,200	100	300	-37	-149	41	164	-	-	Small demand. Limited raw materials. No sponge iron plant envisaged. Scrap/sponge to be imported.
17	Thailand	45	45-65	235	-	NA	2,431 (910)	6,200	500	1,000	-776	+151		-	-	-	Ore and non-coking coal - small quantity. No sponge iron facility envisaged.
18	Vietnam	141	NA	1,000	NA	NA	NA	53,600	40	40	+173	+602		-	-	-	Lack of demand. Non-coking coal available. No sponge iron capacity envisaged.
	TOTAL								14,110	33,550			4,679	11,697	5,500	12,500	

Note (1) Analysis based on major deposits
(2) For public consumption
Figure in brackets indicate hydropotential

Considering the deep interest of a number of developing countries in establishing steel capacity based on sponge iron, the urgency of technical assistance in strengthening their technological capabilities in the sponge technological fields is imperative. These countries need technical assistance in the assessment of current demand and future projections for sponge iron and of techno-economic feasibility of setting up production units, in the selection of appropriate technology to suit their conditions and resources endowment, in the development of technological expertise.

The following areas need concerted attention and assessment:

1. Surveys of the existing and projected (over the next 10 years or so) demand for sponge iron

2. Surveys of the availability and characteristics of the raw materials for sponge production; in case the raw materials have to be imported, the economics of import and characteristics of the raw materials from the sources contemplated are to be taken into account

3. Assessment of techno-economic feasibility of projects for the production of sponge iron

4. Surveys of the available technologies and optimum selection of the most appropriate technologies and process routes suited to the conditions of the ESCAP region countries for sponge production

5. Assessment of capital and production costs for sponge production for developing countries based on sound techno-economic rationale.

The foregoing data provide the background and justification for this inter-country project for developing countries in Asia and the Pacific. The recently held Study Tour and Workshop on Sponge Iron Production (29 March - 8 April 1983 in Indonesia and India) has come up with the strong desire and recommendation to undertake the necessary surveys including laboratory/pilot scale investigations of metallurgical raw materials for the direct reduction method processing for the interested countries of the region so that a Master Plan for the development of sponge iron capacities can be established which would provide a useful document for planning and decision makers as well as technologists in developing countries of the Asia and Pacific region. The meeting approved the project concept and recommended an early implementation of the project.

E. PROJECT OUTPUTS

The project will result in the preparation of a comprehensive study, a Master Plan for establishment of sponge iron production facilities in the ESCAP region countries which will be a useful policy document for decision-makers and planners of developing countries in the region. For preparation of the Master Plan the consultants will assess the current situation and markets for sponge iron and will take into account all available studies. As necessary, laboratory, pilot and demonstration scale tests with local raw material and ores will be carried out for individual countries of the region, possibly at the UNDP/UNIDO established Pilot and Demonstration Plant for the Production of Sponge Iron at Andhra Pradesh, India or at any other plants/centres that dispose of the required know-how and technological process routes. The individual tests and investigations will result in specialized country reports which will also be made available to the participating countries in the region. The Master Plan will give due consideration to regional co-operation as regards raw materials availability and supply as well as trading of the sponge iron to be produced to feed the mini steel plants of the region.

F. PROJECT ACTIVITIES

A team of individual top level experts specialized in sponge iron production through the direct reduction route or a consulting firm will be selected through international bidding and will undertake the following:

(a) Visit the countries in the region that have endorsed the project document and thus manifested their interest in the proposed regional project. The respective Governments will identify national offices/ institutions/centres/plants which will be responsible for co-ordination of activities at the national level. They would closely co-operate with the UNDP/UNIDO experts/consulting firm and provide all necessary data, such as previous reports and surveys related to raw materials availability, processing, financial studies, market studies, etc.

(b) Based on collected material and available background information at the disposal of the international experts/consulting firm they will study and appraise the iron ores, non-coking coals, natural gas and fluxes required; this will include recommendations on the required beneficiation/agglomeration techniques to upgrade iron ores should these be of low grades warranting their upgrading/concentration to high grade lumpy ore and/or pellets. Likewise the non-coking coals will be analysed for use as possible reductant to produce sponge iron. The availability of natural gas and the application of the direct reduction route using the latter reductant will also be considered where available. A techno-economic appraisal will be made of these studies/processing technologies in the report to be prepared .

(c) The above activities will entail the undertaking of investigation work which may be based on the following scale of operations, according to the individual requirements of the participating countries and their raw material resources:

i. Laboratory bench scale test work for direct reduction to produce sponge iron; the scale of operation will be limited to the processing of 100 - 300 kg/day of raw materials in laboratory kiln operation. The results will be analysed in order to investigate sponge production on a laboratory pilot plant scale operation - with 40 - 120 kg/day of produced sponge iron.

ii. Laboratory pilot scale operations will be conducted on processing about 10 - 12 tons of raw materials per day to produce 5 - 6 tons of sponge iron per day. The results will be technically analysed and if these yield promise the investigations will be conducted on to a demonstration and pilot plant scale.

iii. Demonstration scale trials will be conducted on a minimum of 10 days continuous rotary kiln trial operation which will yield about 100 tons of highly metallized sponge per day - these trials will require about 160 tons of iron ore, about 130 tons of coal per day and about 30 - 40 tons of limestone to sustain a single day (24 hours) continuous operation and the requisite raw materials will be needed in a quantity to allow for a continuous/non-stop investigation trial of 10 days on a demonstration scale or on a more extended scale of operation lasting 3 - 4 weeks of non-stop operations.

Individual sub-contracts will be issued for undertaking the required tests. The results of test work and trials based on i., ii. and iii. above will be compiled, analysed and techno-economically adjudged through the preparation of a detailed project/feasibility report which will technically analyse all the pros and cons and include a techno-economic appraisal of sponge production from demonstration scale on to possible industrial/commercial scale operations.

Apart from the above work to be undertaken and/or co-ordinated by the international experts/cpnsulting firm in the indicated sequence, the latter will also undertake the detailed study to prepare a comprehensive project/feasibility report covering inter alia the following areas:

(a) Area I (A) Reduction Process

Study of reduction process of iron ores/pellets
- technology of reduction process including direct reduction
- Assessment of capital investment needed to set up the necessary facilities for sponge iron production

(b) Area II (B) Study of Possibilities in setting up a Sponge Iron Plant

- Study of the background materials available in UNIDO and in the Regional Economic Commission
- Field visits to member countries and collection of necessary data as well as discussion of major problems and opportunities with representatives of national ministries of industries and other officials

(c) Completion of the final report/master plan for sponge production in developing countries of the ESCAP region

The above will be based on:

i. Practical investigations on laboratory, pilot/demonstration scale for sponge iron production
ii. Techno-economic analyses and evaluation of the results obtained vide i. above
iii. Assessment of capital and infra-structure costs and the production and operational costs of sponge production in the countries of the region.

The international consultants will be required to prepare an interim and a draft final report which will be discussed in the presence of UNDP, UNIDO and ESCAP countries before completion of the final report for dissemination to participating developing countries in the region.

G. PROJECT INPUTS

1. Participating Governments

(a) Each participating Government will appoint a National Co-ordinator responsible for managing the project at the national level which includes close collaboration with the team of experts/consulting firm selected under the UNDP/UNIDO project. Appropriate personnel will also be designated to assist in such co-operation. The Government/Project authorities will provide to the consultants/contractors any previous reports, studies and surveys pertaining to the establishment of sponge iron production and/or steelmaking in the country, as specified in Annex A to this Project Document (Items 5 and 6).

(b) The Government/project authorities will undertake to select, prepare and arrange for transport of representative samples of raw materials for necessary testing as specified in item 1 of the Annex to this Project Document. They have the right to send their representatives at their cost to observe the tests (see item 2 of Annex 1)

(c) The Government/project authorities will provide due local facilities to the UNIDO consultants/contractor, such as the office space, secretarial assistance and local transport (see item 4 of Annex 1).

2. UNDP/UNIDO Inputs

(a) International staff

i. Assignment of international technical consultants (team of experts or consulting firm) to undertake the preparation of a master plan for development of sponge iron production facilities in ESCAP region countries. The team of experts will comprise:

ii. Selection, through international bidding, of laboratories, R+D centres and/or pilot and demonstration plants for undertaking the following, as need may be:

- laboratory bench scale operations, including detailed report to analyse the results
- laboratory pilot plant scale operations including the preparation of a detailed report analysing the results obtained and conclusions drawn
- demonstration scale operations based on 100 tons/day of sponge production over a 10 day non-stop operation, including the preparation of a detailed project/feasibility report,analysing the results obtained and a detailed techno-economic appraisal of industrial scale operations. In certain cases the demonstration scale trials may have to be extended on to 3 - 4 weeks continuous operations.

The costs for the above three types of testing/investigation work are estimated as follows:

laboratory bench scale operations: 10,000 - 12,000 US $
laboratory pilot plant scale operations: 25,000 - 50,000 US $
demonstration scale operations (10 days, 100 tons/day of sponge production): 80,000 to 130,000 US $. If the demonstration trials are extended on to 3 - 4 weeks continuous operations, the costs will exceed 200,000 US$ and will need to be negotiated.

In addition to the bearing of costs for selection, preparation and transportation of materials to be tested, it is expected that participating Governments will provide cost-sharing of the test work to be undertaken, particularly on the demonstration scale operation level. Such arrangements will be individually negotiated.

The UNDP inputs to support the project should therefore be viewed as a stimulus to get the participants more deeply involved in the deliberate and voluntary exchange or sharing of their technical resources, skills and capabilities.

(b) Training

Participating countries will be entitled to send at their cost representatives to the Centre where the tests/investigations/demonstration trials will take place. They will be regarded as observers for the period to be mutually agreed upon in each individual case (see item 2 of Annex 1).

(c) UN mission costs

This item includes costs of UNDP/Executing Agency participation in meetings related to the discussion of interim and draft final reports and tripartite project review meetings.

H. Work Plan

A detailed Work Plan for the implementation of the Project will be finalized by the Secretariat in consultation with the Team Leader of the selected consulting firm. This Work Plan will be annexed to the Project Document and considered as part of that document. Tentatively, the Workplan may be outlined as follows:

	Activity	Location	Date, Duration 1/
1.	Project Document, as approved by Workshop participants in Hyderabad in April 1983 will be sent to potential participating ESCAP countries for endorsement	Vienna	May 1983
2.	Governments of participating countries signs project document and designates national co-operating institution and appoints representative	all participating Governments	August 1983
3.	UNIDO invites bids from international consulting firms	Vienna	September 1983
4.	Assignment of international technical consulting firm to prepare the study/master plan for sponge production in countries of the region	Vienna in co-operation with countries	October 1983
5.	Collection of data by consulting firm and identification of countries whose raw materials are to be tested (interim report)	individual ESCAP countries	November 83 - April 84
6.	UNIDO invites bids from laboratories/R+D centres/ pilot and demonstration plants for carrying out necessary test work	Vienna in consultation with countries and contractor	April 1984
7.	Negotiations with individual countries regarding cost-sharing of laboratory/ pilot/demonstration tests	Individual countries	May - June 1984
8	Assignment of laboratory(ies), centre(s), pilot and demonstration plants for undertaking required test work	Vienna, in consultation with countries	July 1984

1/ The indicated timings will be revised and updated depending upon the timing of the approval of the project.

9.	Selection of representative samples of raw materials to be tested, their preparation and transportation to the testing site	Individual participating countries	August - October 1984
10.	Undertaking of required test work at selected centre(s), with participation of representatives from participating countries, as to be agreed upon	Contractor's testing facilities	October 84 - March 85
11.	Preparation of test reports discussion with contractor of master plan and individual countries	yet to be established	April 1985
12	Preparation of draft final report by contractor Discussion in presence of UNDP, UNIDO and ESCAP/RCTT representatives	Vienna India	August 1985
13	Completion of final,report master plan for sponge iron production in the region	Contractor's residence	November 1985
14	Dissemination of report to participating countries in the Asia and Pacific region	Vienna	December 1985

I. Preparation of the Framework for effective participation of national and international staff in the project

The activities required to yield the indicated outputs and achieve the project's immediate objectives will be carried out and co-ordinated by the national staff and international consultant's personnel with UNIDO playing the catalytic role. This framework will be reviewed from time to time and, if necessary, be formulated and attached to this Project Document as an Annex.

J. Development Support Communication

The technical/progress reports to be prepared through this regional project are subject to distribution, as appropriate, for the effective maintenance of development support communication throughout the project's life/duration.

K. Institutional Framework

UNIDO will, as the Executing UN agency, be responsible for various project activities to be undertaken/implemented on a regional basis and the interests of the regional developing countries will be kept uppermost to provide the requisite institutional framework for this regional project. The national institutions/centres/plants designated by the participating countries to co-operate in the project will provide the necessary inputs as required and as specifically listed in Annex I to this Project Document. They will closely co-operate with the UNIDO sub-contractors, selected through international bidding.

L. Prior Obligations and Prerequisites:

No prior obligations and pre-requisites are envisaged other than the regional countries providing full support in the implementation of this project to UNIDO, to the international technical consultants and the testing laboratories/centres/pilot and demonstration plants involved in the implementation of the project.

M. Future UNDP assistance

The provision of future UNDP assistance will need to be identified and, if so required, formulated during the course of and at the end of this regional project.

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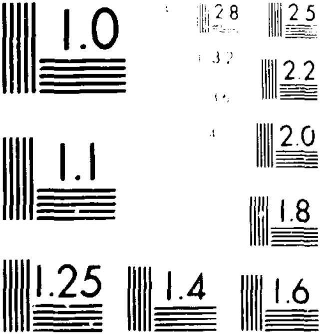
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Part III SCHEDULES OF MONITORING, EVALUATION AND REPORTS

A. Tripartite review meetings

The project will be subject to periodic review in accordance with the policies and procedures established by UNDP for monitoring project and programme implementation.

Two tripartite review meetings will be held each year. Because of the complexity of the project, provisions will be made to assure participation of all organizations involved which are partly co-responsible for the successful implementation of the project.

B. Evaluation

The project will be subject to evaluation, in accordance with the policies and procedures established for this purpose by UNDP. The organization, terms of reference and timing of the evaluation will be decided by consultation between UNDP and UNIDO.

C. Progress and Terminal Reports

Progress and terminal reports will be prepared by the international technical consultants and testing laboratories/centres/plants in accordance with UNDP policies and procedures and as agreed upon with the individual Governments of the participating countries in the region.

AGREEMENT TO BE ENTERED INTO BY THE GOVERNMENTS/PROJECT AUTHORITIES CONCERNED WITH UNIDO

1. The Government concerned will undertake to:

(a) Select and prepare requisite quantities (tonnages) of the raw materials (iron ores, coal, fluxes) to be specified by UNIDO which will be classified "representative samples";

(b) In preparing the "representative samples" of the raw materials the Government/Project authorities will ensure the representative nature of the samples through the well known method of "quartering and coning", normally followed.

(c) These samples of the raw materials vide (a) and (b) above will be transported in required tonnages to be specified by UNIDO, depending upon the scale and nature of the tests/investigations/ demonstration trials, free of all transport charges to the Centre where these tests/investigations/demonstration trials will take place; such transport charges will cover the inland road/rail transport and ocean freight as the case may be.

2. The Government/Project authorities can send at their cost their representatives to the Centre where the tests/investigations/ demonstration trials will take place, as observers for a certain period to be mutually agreed upon in each case.

3. The Government/Project authorities will be entitled to receive all the interim, draft final and final reports to be prepared by the contractors/consultants who will be contracted by UNIDO. These reports will have restricted circulation to be specifically determined by the Government concerned in each case.

4. The Government/Project authorities will provide due local facilities such as the office space, secretarial assistance and local transportation for the contractors/consultants personnel that are normally provided by them at the former's cost, unless otherwise stipulated in the contract signed by the consultants/ contractors with UNIDO.

5. The Governments/Project authorities will provide to the consultants/ contractor any previous reports, studies and surveys pertaining to the following:

(a) Raw materials studies/characteristics, mineralogical/chemical/ metallurgical data;

(b) Any prior studies conducted by the Government/Project authorities on raw materials processing, beneficiation, agglomeration, etc. and/or on spongeproduction and/or steelmaking;

(c) Any financial studies/data available with the Government/Project authorities concerned, inter alia:

   i) Extraction of raw materials and their processing/ beneficiation/agglomeration, etc.;

   ii) Labour and man power costs/wages, etc.;

   iii) Any capital investment data available on the above subjects.

6. The Government/Project authorities will provide any market studies, if available, made by them on iron and steel proeucts and which do have a bearing on the sponge/steel production in a general way;

7. The Government/Project authorities will be free to propose/make any change to this Agreement to be mutually agreed upon by them with UNIDO.

PROJECT BUDGET/REVISION

UNIDO

3. COUNTRY	4. PROJECT NUMBER AND AMEND.	5. SPECIFIC ACTIVITY
RAS	DP/RAS/81/063	31.8.C

10. PROJECT TITLE
Regional Development of Sponge Iron Industry through DR technology for mini steel plant operations

15. INTERNATIONAL EXPERTS (functional titles required except for line 11-50)	16 TOTAL		17 1983		18. 1984		19. 1985		20.	
	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$
11-01										
02										
03										
04										
05										
06										
07										
08										
09										
10										
11										
12										
13										
14										
15										
16										
11-50 Short term consultants										
11-99 Sub-total - International experts a/										

1. REMARKS

a/ If more than 16 experts are required check here ☐ and attach continuation sheet 1A. This sub-total must include all experts.

PROJECT NUMBER DP/RAS/81/063	16. TOTAL		17. 1983		18. 1984		19. 1985		20.	
	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$
OPAS EXPERTS (functional titles required)										
12-01										
12-02										
12-03										
12-99 Sub-total - OPAS experts b/										
ADMINISTRATIVE SUPPORT PERSONNEL										
13-00 Clerks, secretaries, drivers										
13-50 Freelance Interpreters (non-UNDP PROJ)										
13-99 Sub-total - Admin support personnel										
UN VOLUNTEERS (Functional titles required)										
14-01										
14-02										
14-03										
14-04										
14-99 Sub-total - UN Volunteers b/										
15-00 Project travel										
16-00 Other personnel costs (including UNIDO staff mission costs)		16,000		2,500		6,500		7,000		
NATIONAL EXPERTS (functional titles required)										
17-01										
17-02										
17-03										
17-04										
17-05										
17-99 Sub-total - National experts b/										
19-99 TOTAL - PERSONNEL COMPONENT		16,000		2,500		6,500		7,000		

b/ If additional individual budget lines are required, check here ☐ and attach continuation sheet 1A. These sub-totals must include budget lines listed on page 1A.

UNIDO

PROJECT BUDGET/REVISION

4. PROJECT NUMBER DP/RAS/81/063	16. TOTAL		17. 1983		18. 1984		19. 1985		20.	
	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$
SUBCONTRACTS										
21-00 Subcontracts		475,000		75,000		100,000		300,000		
TRAINING										
31-00 Individual fellowships										
32-00 Study tours; UNDP group training										
33-00 In-service training										
34-00 Non-UNDP group training										
35-00 Non-UNDP meetings										
39-99 TOTAL - TRAINING COMPONENT										
EQUIPMENT										
41-00 Expendable equipment										
42-00 Non-expendable equipment										
43-00 Premises										
49-99 TOTAL - EQUIPMENT COMPONENT										
MISCELLANEOUS										
51-00 Sundries		9,000		2,000		3,500		3,500		
55-00 Hospitality (non-UNDP projects)										
56-00 Support costs (CC and DC Proj.only)										
59-99 TOTAL MISCELLANEOUS COMPONENT										
SURPLUS/DEFICIT										
81-00 Surplus/Deficit (ADM/FS use only)										
99-99 PROJECT TOTAL		500,000		79,500		110,000		310,500		
c/ COST SHARING (UNDP/IPF projects only)										
c/ NET UNDP CONTRIBUTION										

c/ For information only - not for PAD input