



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org



DO 4706



United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.146/15
22 March 1973

ORIGINAL: ENGLISH

Third Interregional Symposium
on the Iron and Steel Industry
Brasilia, Brazil, 14 - 21 October 1973

Agenda item 8

ASSISTANCE BY METALLURGICAL RESEARCH
INSTITUTES TO DEVELOPING COUNTRIES^{1/}

by

Jacques E. Astier
Institut de Recherches de la Sidérurgie Française (IRSID)
France

^{1/} The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

S U M M A R Y

The important role of the usual transfer of knowledge from scientific and educational institutions to the whole world and, specially, to developing countries - Assistance of metallurgical research institutes to the development of the Iron and Steel Industry in developing countries for improving operations, designing new plants, or projecting long-term development

The importance of equipment and personnel in a research organization which can be considered a TESTING CENTER. Different ways of supporting the Research Organization - Possibilities of assistance to developing countries : use of existing equipment and experts for testing raw materials - The case of IRSID with description of facilities for research, development, and testing in ore concentration, agglomeration, prereduction, steelmaking, and testing of steel samples - Facilities for testing coal and coking processes.

The possible role of a research organization as a "CONSULTANT BUREAU" - Group of experts for improving operations or designing new equipment - Interest of such groups for developing countries specially when new schemes have to be devised coming from unusual combination of raw materials and energy resources . -

The utilization of a research organization as a "TRAINING CENTER" : long-term trainees or short seminars or courses . Organization to receive trainees in laboratories or pilot plant teams - Possibilities to organize lectures, short seminars or long-stay metallurgical courses in developing countries .

INTRODUCTION

It is well known that scientific and educational institutions, specially in industrialized countries, have been providing a large amount of information to the whole world and, specially, in this connection, to the developing countries. These information can be valuable to start and to accelerate the development of the developing areas both in developing countries and developing areas of the most industrialized countries.

Regarding the metals industry, and particularly iron and steel, more specific assistance has also been given by a number of metallurgical research institutes around the world and notably our Institute : the INSTITUT DE RECHERCHES DE LA SIDERURGIE FRANCAISE, known as " I R S I D " .

This assistance can be made available to developing countries or developing areas in one of the following ways :

- a direct assistance to the operation and specially the optimization of operation of existing plants ;
- assistance in the planning of new plants, either in the designing stage (with the choice of the raw material and the best metallurgical processes) or in projections for a more distant future .
- planning for the general and long-term future development of the iron and steel industry in a given area.

In fact, it is well known that, in a less developed area, the main problem is to find competent specialists for selecting and studying the best metallurgical scheme for the development of the area and also properly qualified people to design, build, and operate smoothly the facility that is to be built.

In this way, a metallurgical research center can provide assistance on three different levels :

- it can be a very interesting and useful "testing center" ;
- it can be used as a very efficient "consultant bureau" ;
- and, of course, it can be regarded as a "training center" .

These will be the three points that are discussed in this paper .

I - THE RESEARCH ORGANIZATION AS A " TESTING CENTER "

I - 1 - Background -

A research and development organization has, by definition, special and important devices, apparatus and, more important, competent people, to develop and test the newest techniques or processes, as well for the production of steel as for the development of new grades of steel and the study of new applications of existing steel grades.

This has generally been designed for the organizations supporting the center which can be, depending on the status of the center :

- a company, more particularly a steel company, which possesses its own research and development facility ;
- or a group of companies building and operating together a common research center ;
- or a state, which is supporting a national research institution ;
- or sponsors, specially in the case of an organization that operates mainly by contracts with sponsors .

Several organizations are, of course, operating as a combination of such cases . For example, in some countries, there is a research organization which is common to several companies and which can be supported by the state . On the other hand, a private research organization, supported by all the steel companies of a given country, which is the case of IRSID, supported by all the French steel companies, can be open to " contract " operations where a number of research and development studies can be made for any kind of government or private company, in France, in the Common Market area, or in the whole world .

I - 2 - Possible assistance to developing countries

From the brief description that has been given, it can be seen that an established and well equipped research center can provide considerable assistance to the developing countries . All these facilities can be of value for a developing country or a developing area in two respects :

- if this country is relatively small and has a comparatively small steel industry, it will be better to use the testing facilities of an established center instead of building a large research organization which will be too costly and inefficient in a small country, where such facilities will be too large for the local industry, even when considering a large development of the Iron and Steel Industry in this area .

- In a large country, where a major iron and steel industry development can be anticipated, it is also possible to start with using the research and development facilities of an established center in the same time as the local research facilities are being built . This, as is well known, takes a long time and it is better to use existing facilities in the meantime, i. e. when the facilities are being built and while they are beginning to be operated .

I - 3 - The case of IRSID

In this connection, our Institute has the policy of being an open center in that the information (except information that is confidential to the French steel companies sponsoring IRSID) and the testing facilities have been made available to developing countries who may wish to take advantage of it .

In this respect, we do not want to describe in detail the IRSID facilities and we are giving, on Figure 1 and Figure 2 general views of our two research centers in Saint-Germain-en-Laye and Maizières-lès-Metz . As an example, we shall describe briefly some research facilities which are being used extensively for developing countries and which, in our opinion, will be more and more used in the future for such assistance to developing countries or areas, in the field of iron and steel making. These examples are :

- the research facilities for testing coal and specially coking properties of different kinds of coal which exist in the common facilities built at MARIENAU, between the CERCHAR (Centre d'Etudes et Recherches des Charbonnages de France) and IRSID . They are described in Appendix I .
- Iron ore concentration and agglomeration facilities, which cover a large number of research facilities in the field of crushing, grinding and beneficiation, sintering, pelletizing and prereduction . As an example, Appendix II gives some information about our facilities in this field .
- Steelmaking facilities : Appendix III gives a few data and some pictures of our facilities, which show clearly that we can test different steelmaking processes from several varieties of hot metal, pig iron, sponge iron, or scrap.
- Testing of steel samples and developing of new steel grades : Appendix IV gives some ideas about the facilities of IRSID in Saint-Germain-en-Laye in this respect . -

II - THE RESEARCH ORGANIZATION AS A CONSULTANT BUREAU

II - 1 - Background

The mere existence of a number of specialized engineers and technicians in the various fields of extractive metallurgy, process metallurgy, and physical metallurgy, specially in large research and development centers, creates the possibility of assembling groups of consultants for projects .

They are able to give advice on the following :

- operation of existing equipment as well for producing steel as for testing it ;
- design of new equipment (either a given shop of a plant or a whole new steel plant);
- a future expansion programme for a given company, a given country, or a given area .

It must be borne in mind in this respect that a research and development organization has a special knowledge about new processes and this can be quite important as we shall see later .

II - 2 - Application to developing countries

In fact, many developing countries, or developing areas of industrialized countries have special conditions that affect the size of new steel plants depending on the market, the nature of the raw material (specially iron ores) and the context of energy supply .

In this way, the metallurgical scheme which has been developed in industrialized countries is not always the best suited for developing countries . Many new schemes which have been developed more or less as curiosities in industrialized countries could find far more applications in less developed areas . We are specially thinking about gas or carbon reduction processes and melting of prerduced materials in different types of furnace.

In this respect, the research and development centers have far more knowledge than operating companies , which are using, as it was indicated before, more classical schemes which are, by the way, more or less alike all over the world .

In other words, the research and development organizations are certainly among the best places for finding experts in new processes that are needed by developing countries .

II - 3 - The case of IRSID

It is in this respect that IRSID manages to have a good knowledge of almost all the processes being studied and specially developed on a semi-industrial or commercial size, all over the world .

It is evident that IRSID, like other research centers, is not able to test all these processes, or even carry out practical research work on all of them . However, it is possible to have a good knowledge from a limited amount of laboratory tests, visits to different plants, and theoretical calculations about the possibilities, especially those indicated by physical and chemical basis on these new processes .

From these bases, IRSID has been able to work as a consultant bureau for many developing countries . This kind of work can :

- start with lectures, participation in meetings and other activities such as the ones which are sponsored by UNIDO, and specially this Third Symposium following the very successful meetings in Prague and in Moscow .
- special consultant work for given projects, either in special locations or in larger areas . In this respect, IRSID has acted as a consultant more or less in all the different areas in the world, specially in Latin America, in Africa and in the Middle East .

These " consultant " missions can start from short terms job for a given limited programme up to long term or permanent technical assistance assignments .

III - THE RESEARCH ORGANIZATION AS A TRAINING CENTER

III - 1 - Background

It is usual, in a research organization as in an University,

- receive trainees, who can get, in this way, a good post-graduate education
- organize post-graduate courses in the way of short seminars or longer courses .

This can be done , especially for the courses, either in the laboratories of the research organization, or in other places in the same country or a developing country .

III - 2 - The case of IRSID

Since the beginning of IRSID, this post-graduate and training function was looked on as very essential by the French Steel Industry . As we have mentioned before, just like the other activities of IRSID, it was open to trainees from developing countries from the beginning .

Such activity can be performed in various ways :

- the first one is to have trainees in the laboratories or the pilot plants of IRSID this has always been done and will still be done in the future , but we want to emphasize that there is a stringent limit upon the number of people who can be accepted in a given time in a research center . It is, indeed, quite clear that this number cannot be increased too much if the center has to function as a research organization . In that way, the function of post-graduate training has to be taken for a large part in a separate organization, as we shall see later about the " C E S S I D " , and it will be described in the special paper given at this Symposium on the " C E S S I D " .

Coming back to the number of trainees, it must be remembered that in a research center, the trainees have to stay a sufficient time, say at least six months , and preferably between one and two years, to be able to " receive " the training which can be given by their colleagues . In the same time, such a trainee is able to do some personal work (either alone on a given programme, or more generally, inside a team), which is an essential function for a trainee in a research organization .

- a special training programme can be made at the institute , in the form of a seminar, for one or several weeks, on a specialized subject . In this way, people can come and attend such a seminar to be able to know a given subject better. Such seminars are, of course, as a rule, open to engineers and specialists from developing countries .
- longer courses, extending from one month to one year, can be provided by a special institution, which is, in France " C E S S I D " . As it is covered by a special paper, we are only mentioning this activity .
- Another possibility is, of course, to do the reverse and to send people from IRSID, or any other similar organization, in a developing country, to organize courses in metallurgy . This has been made many times by IRSID and, if we take the case of Brazil, the setting for the present Symposium, we can mention both :
 - the courses which have been given by a number of our specialists and experts, such as Mr MICARD in the field of Blast Furnace, Mr LECOMTE , in the field of steelmaking, Mr BLAIN, in the field of rolling mills, Mr POMEY in the field of physical metallurgy
 - longer courses in the frame of the existing university or school . Specially in the case of I R S I D , it has to be remembered we sent a number of professors to the School of Mines of OURO PRETO during about six years .



Figure 1 : general view of IRSID research center in SAINT -GERMAIN-en-LAYE

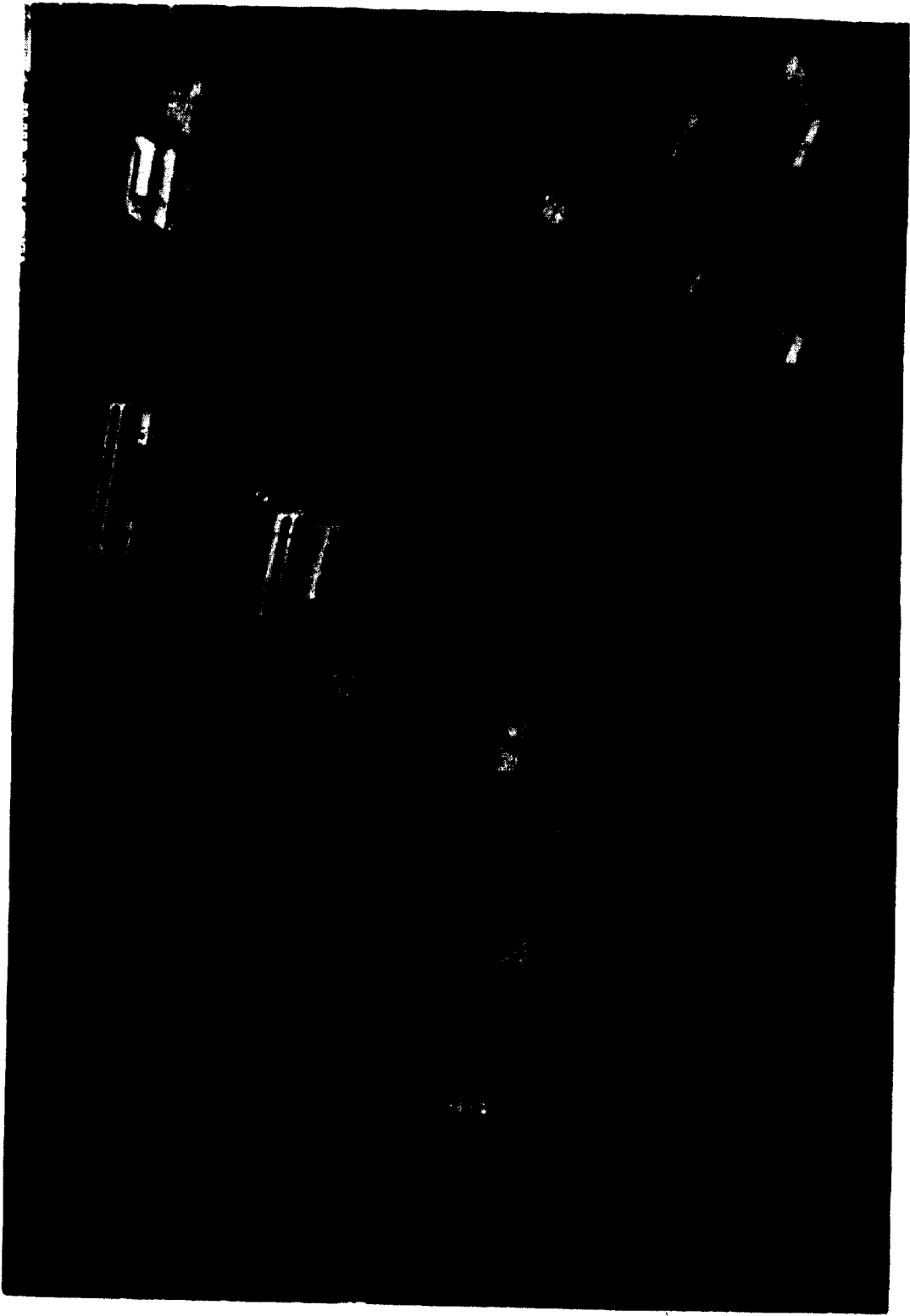


Figure 2: General view of IRSID research center in MAIZIERES-lès-METZ

APPENDIX I

FRENCH PILOT CENTER for COKE - MARIENAU (FRANCE) -

The pilot center for coke research was founded in 1947 jointly by the French Coal and Steel Industries.

This center located at Marienau in Lorraine brings its assistance to French and foreign companies in three main areas :

- choice of coal blends,
- improvement of existing coke plants,
- design of new coking plant.

I. CHOICE OF COAL BLENDS

In 25 years of research and development works, the Marienau pilot center has acquired a good knowledge of all the types of coal mined in the world and makes the following types of study :

- full characterization of coal at laboratory, including petrographic analysis ;
- pilot tests at 400 kg scale ; long practice has proved that such a pilot unit operated under well established and controlled conditions provides results which can be applied to full-size ovens.

Fig. 3 is a photograph of a 400 kg pilot oven.

- study and control of coal expansion properties, also obtained on pilot ovens with a movable side ;
- determination of technical data for buying coal.

II. IMPROVEMENT OF EXISTING COKE PLANT

The Marienau center has a team for industrial testing in the plant itself, and is equipped with up to date measurement equipment for :

- the study and improvement of existing coking conditions in a given battery ;
- the improvement of thermal yield of ovens, by determining a complete thermal balance in given operating conditions.

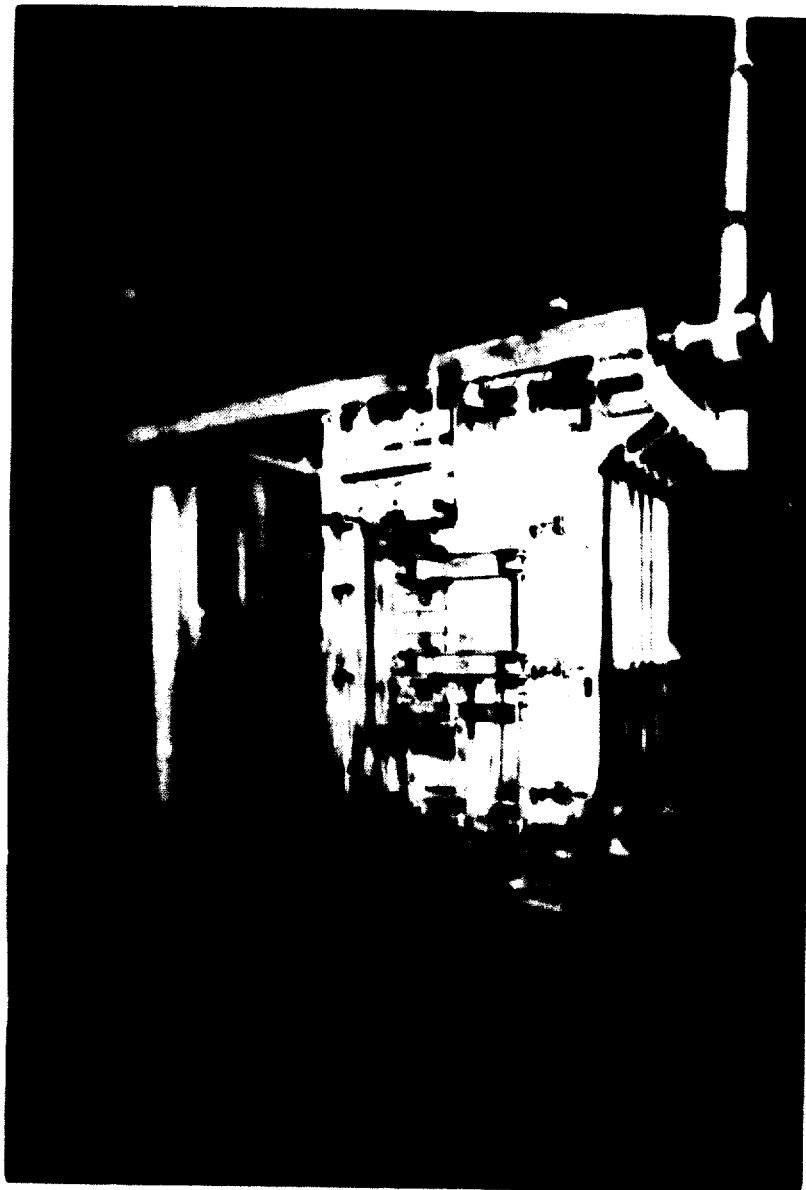


Fig. 3 - 400 kg pilot oven

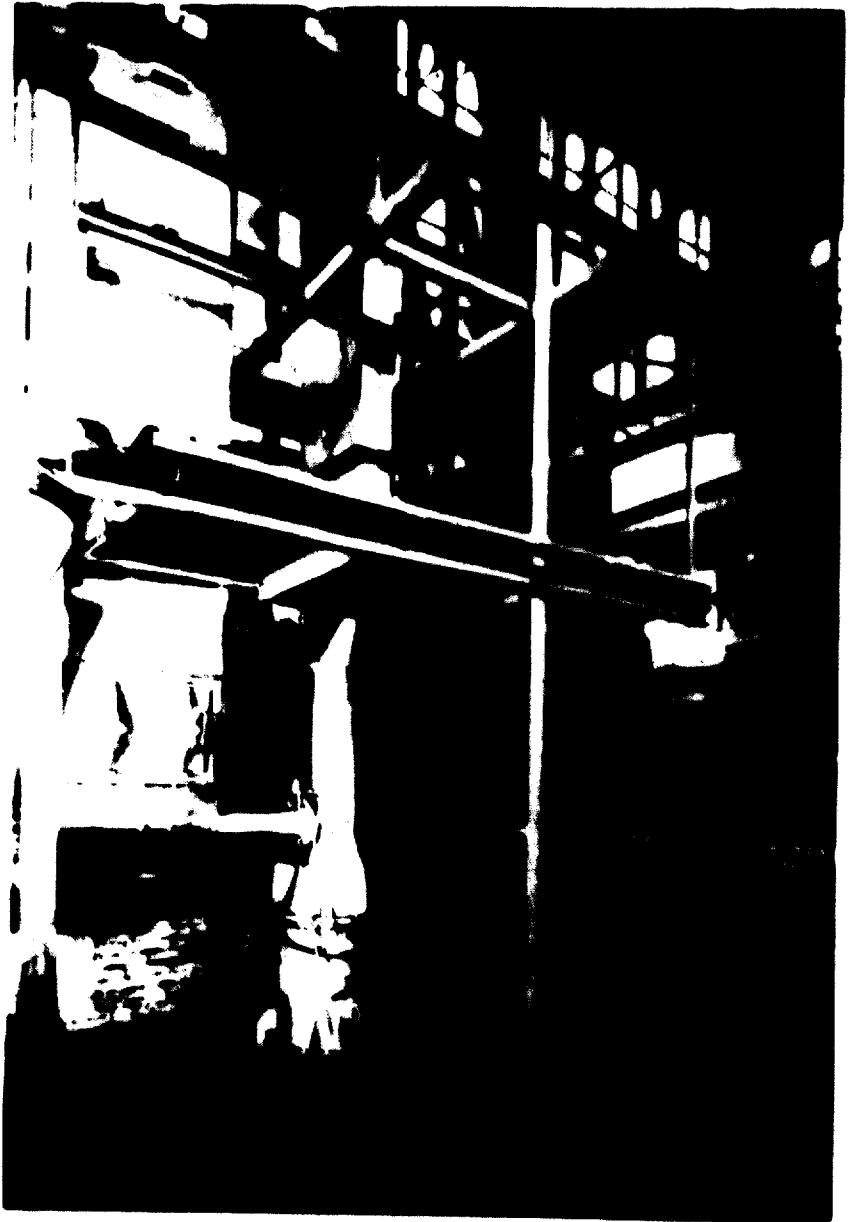


Fig. 4 - Fluidised bed preheater

III. CONCEPTION OF NEW COKE PLANTS

The Marienau center can be consultant for :

- the choice of the best technique (in particular this center has developed the coal blend preheating - Fig.4) which in connection to allied chemical gave the COALTEX process, in rapid development in the world ;
- the determination of the characteristics of the plant proper : coal preparation, size, and number of furnaces ... ;
- the design of control laboratory ;
- as a neutral agency, the commissioning of new units.

Enquiries can be sent to

**Mr FOCH - Director CERCAR
Houillères du Bassin de Lorraine
Station Expérimentale de MARIENAU
MARIENAU -
57600 - FORBACH (France) -**

A P P E N D I X I I

IRON ORE CONCENTRATION and AGGLOMERATION FACILITIES

The IRSID facilities, at Maizières-lès-Metz, allow to carry out experimental works on the field of iron-ore treatment .

For the crushing and grinding studies : a complete set of standard equipment (giratory and jaw crushers, rod, ball and roller mills, screens, etc .) and a dry autogenous mill Aerofall (1.5 m diameter) - Fig. 5.

For the beneficiation studies : high and low intensity, dry and wet, magnetic separators, electrostatic separator, jigs, shaking tables, spirals and pneumatic sluice .

For the sintering studies : two experimental pot grates (40 x 40 cm height = 20 to 50 cm) and all the equipment to determine the sinter quality : reducibility, mechanical strength before and during reduction, swelling, etc.

For the pelletization studies : a disc (90 cm diameter) and a drum (50 cm diameter and 200 cm length) - Fig. 6 - integrated in a continuous system with fines recycling, an ALLIS CHALMERS pot grate to study the green pellets firing - Fig. 7.

For the briquetting studies : a press (125 tons on 145 mm width, variable speed from 1.5 to 6 rpm) - Fig. 8.



**Figure 5 -
Dry autogenous mill AEROFALL**



**Figure 6 -
Pelletizing drum**

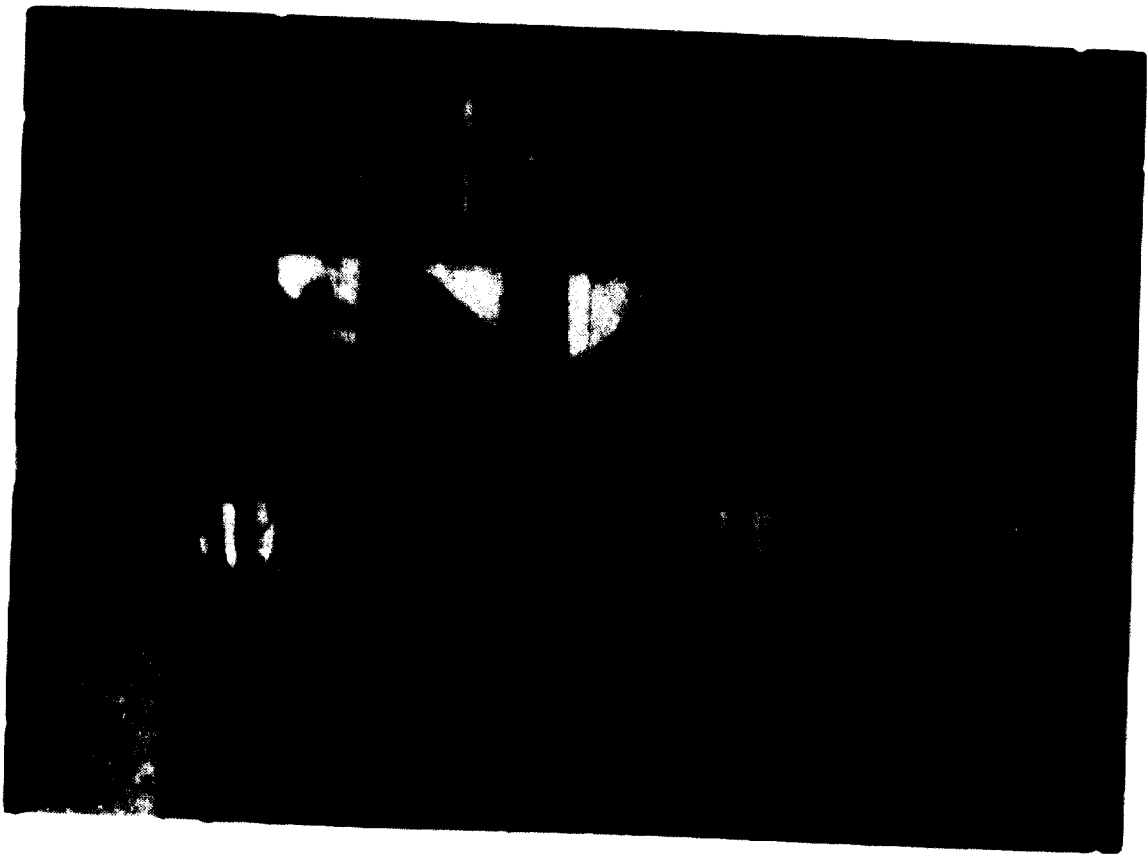


Figure 7 -
ALLIS CHALMERS Pet Grate -



Figure 8 -
Briquetting press -

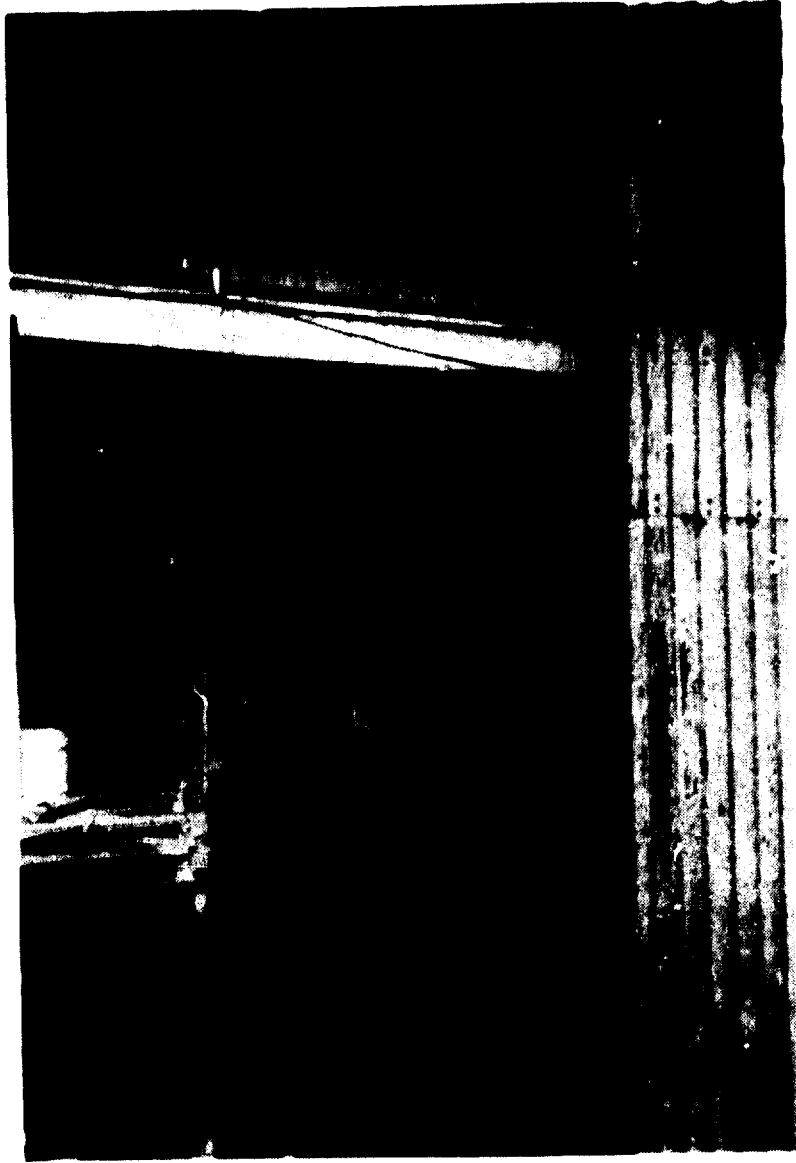
APPENDIX III

STEELMAKING FACILITIES

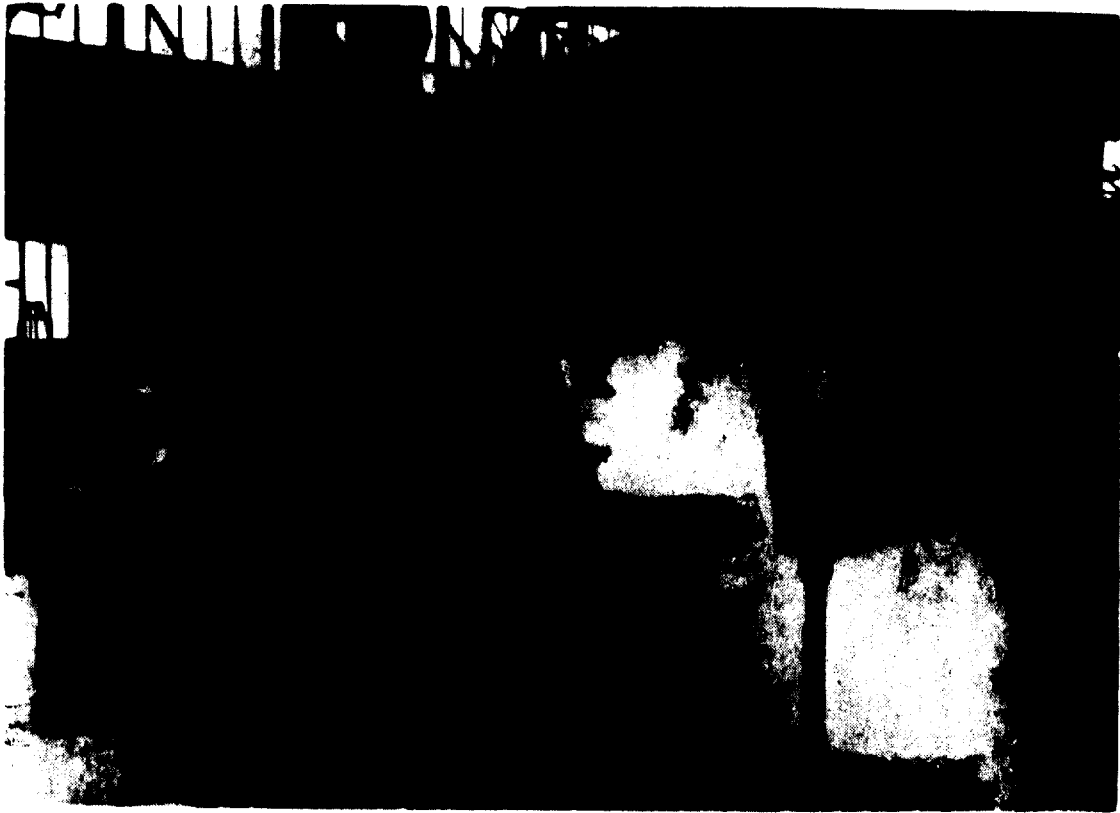
At the IRSID pilot research center, at Maizières-lès-Metz, near the industrial iron and steel area of Lorraine, the steelmaking facilities are installed in a large shop, with a floor area of about 2 000 m².

The various pieces of equipment allow tests at semi-industrial scale to be carried out on :

- pure oxygen refining ;
 - electric arc melting ;
 - metallurgical treatments (vacuum treatment, alloy additions, deoxidation, etc .)
 - casting and solidification .
- A 6 ton capacity converter which can be used either for top blowing (LD or OLP process) or bottom blowing (LWS or OBM process) . The waste gases are recovered without combustion, according to the IRSID-CAFL process . The pig iron is supplied by an electric arc furnace in which hot metal , with the required composition, is produced . (Figure 9)
- Two electric arc furnaces (capacity 6 to 10 ton , power 3 500 kVA) which can be fed batchwise or continuously with scrap, prerduced products, etc . One of these units can be operated, combined with a channel-type induction furnace, as an integrated unit for continuous electric steelmaking . (Fig. 10)
- Two channel-type induction furnaces (capacity 6 ton) in which it is possible to carry out a great number of metallurgical operations . One of these furnaces is equiped for vacuum treatments (the vacuum equipment is able to reach 0. 1 Tor) . (Figure 11)
- A continuous refining unit -
- A pilot unit of 500 ton per day has been built at the Hagondange works of the Wendel-Sidelor Group, near the IRSID research center, for continuous production of steel . -



**Figure 9 -
Oxygen converter of 6 ton capacity**



**Figure 10 -
Electric arc furnace of 6 to 10 ton capacity (3 500 kVA)**



Figure 11 -
Channel induction furnace of 6 ton capacity

A P P E N D I X I V

SAINT-GERMAIN-en-LAYE LABORATORIES

Research carried out in the laboratories of Saint-Germain-en-Laye is concerned with the properties of steels and their possibilities of improvement, as well as with non-destructive testing processes and methods of chemical analysis .

Equipment of the most modern design is used and, if necessary, specially built, in order to carry out measurements and examinations .

The accompanying figures show some examples of apparatus used for creep testing (Fig. 12), fatigue testing (Fig. 13), fracture mechanics experiments (Fig. 14), analytical chemistry (Fig. 15), for studies of metal structure in the field of physical metallurgy (Figs. 16 & 17), and for studies of controlled rolling and thermomechanical treatments (Fig. 18).



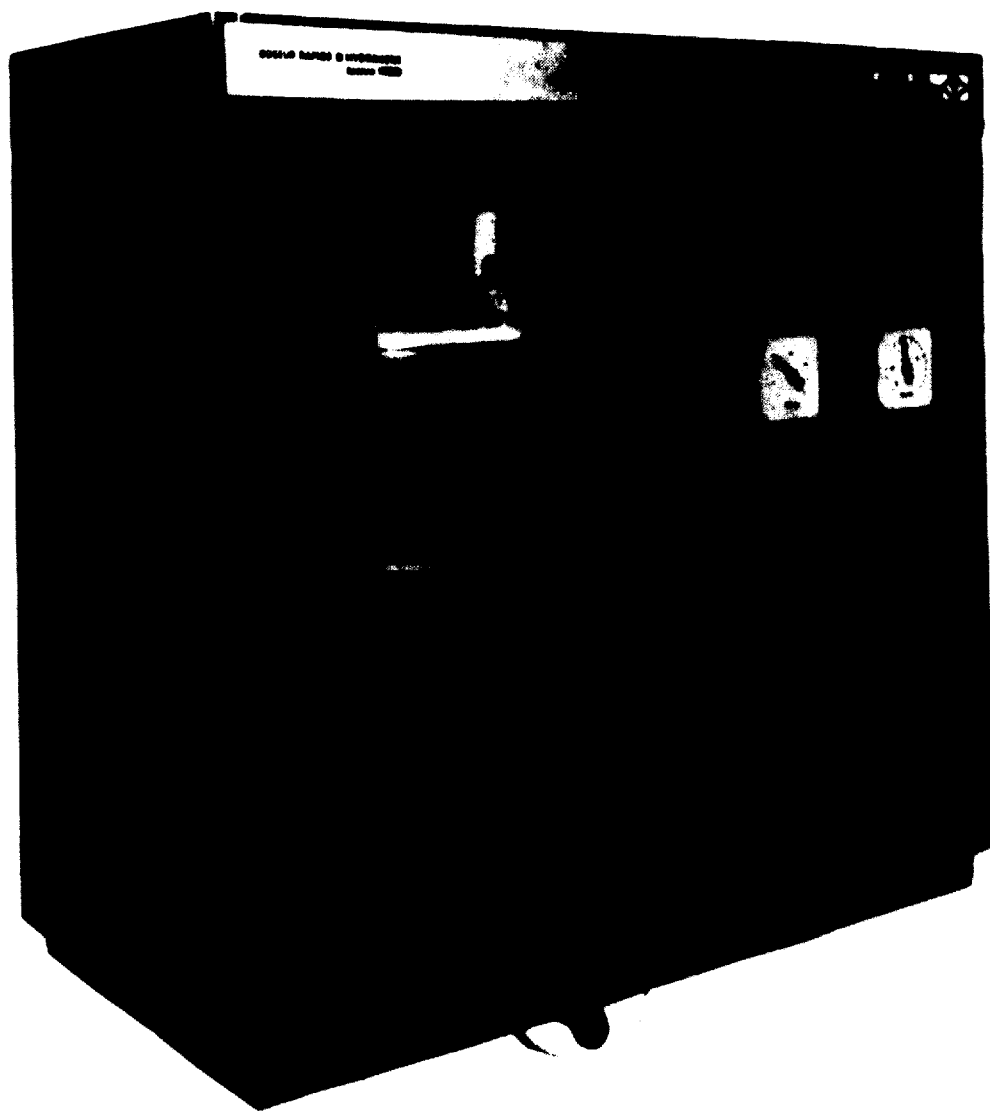
Fig.12 : Creep testing laboratory



Fig. 13 ;Programmed fatigue testing machine (\pm 250 kN)



Fig. 14 : 400 ton machine for determination of fracture toughness of steels (test pieces up to 200 mm thickness)



**Fig. 15 :Quick - acting hydrogen dosimeter in metals
(built under IRSID Licence by Creusot-Loire Instrumentation)**

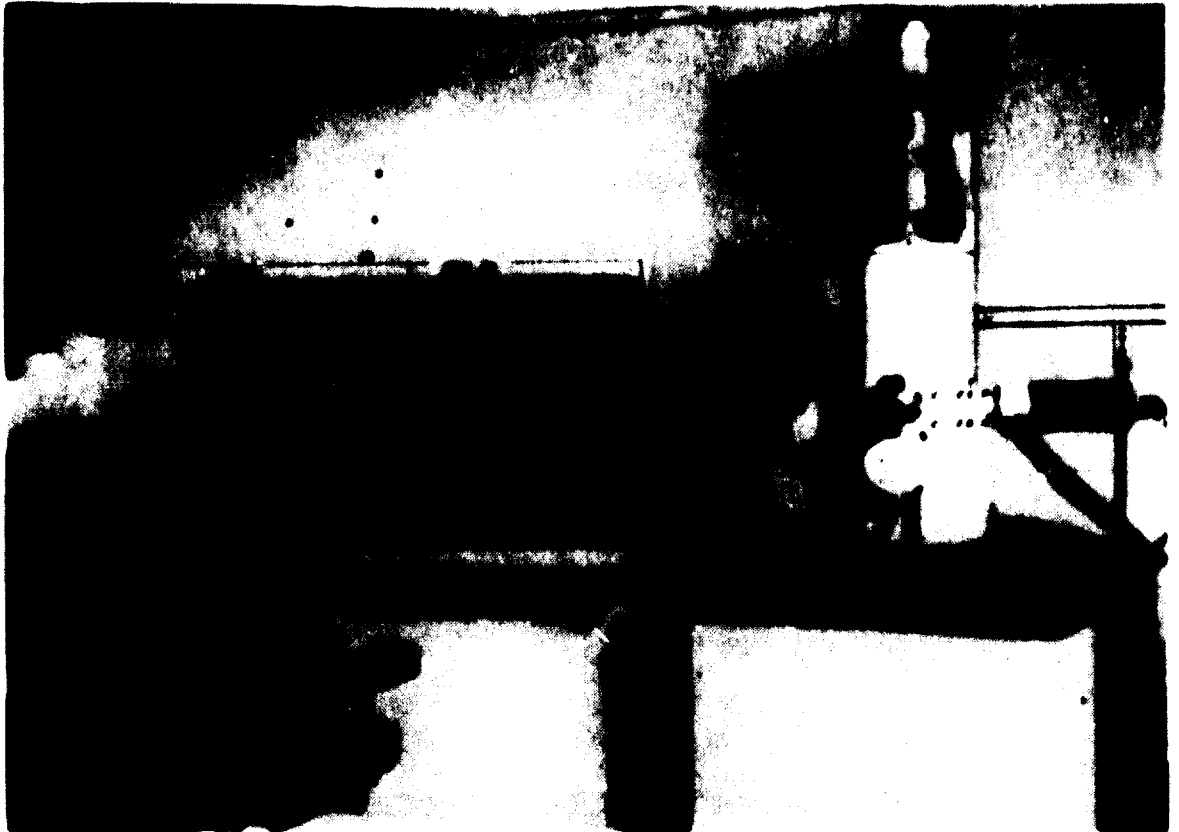


Fig.16 : Scanning electron microscope



Fig. 17 : Microanalyser

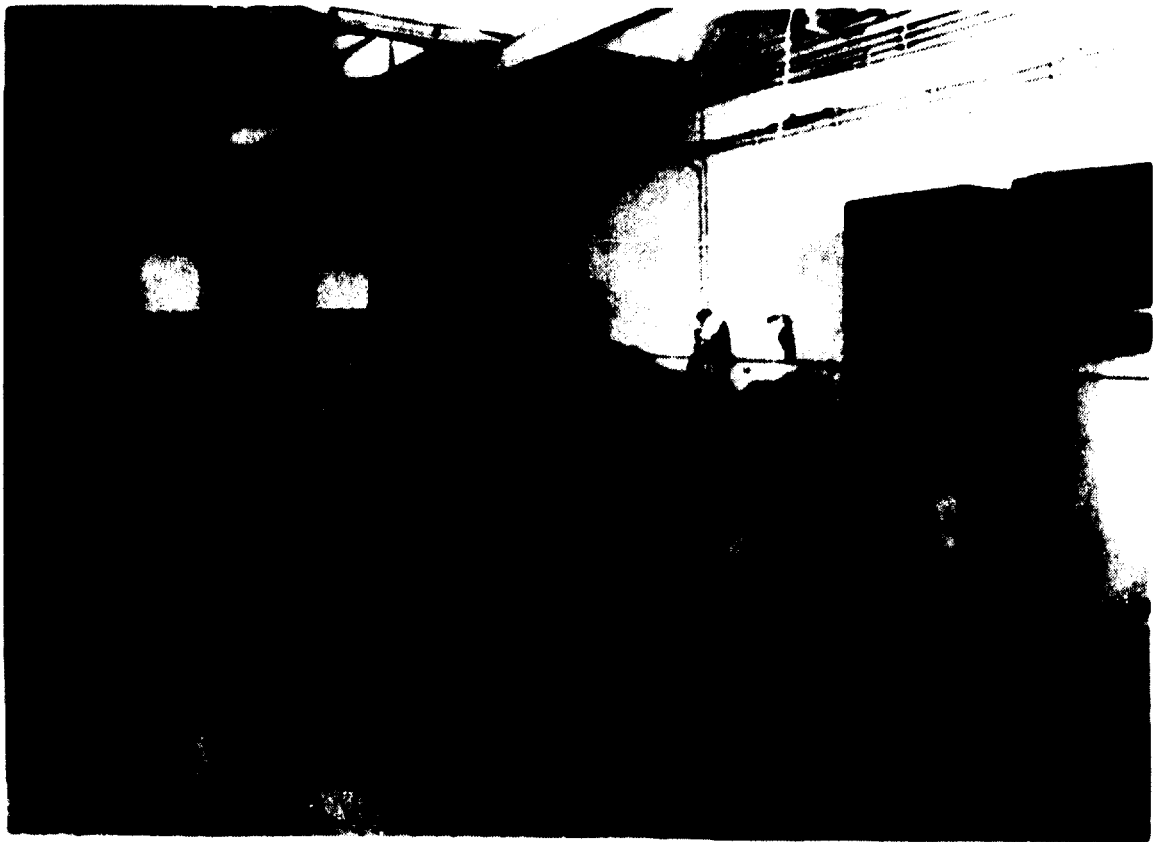


Fig. 18 :High-temperature torsion testing machine used for studies of thermomechanical treatments by simulation (built under IRSID Licence by SETARAM)



Organisation des Nations Unies pour le développement industriel

Distr. LIMITEE

ID/WG.146/15 RESUME
22 mars 1973

Original : FRANCAIS

Troisième colloque interrégional
sur la sidérurgie

Brasilia (Brésil), 14-21 octobre 1973

Point 8 de l'ordre du jour

RESUME

ASSISTANCE FOURNIE PAR LES INSTITUTS DE RECHERCHES
AUX PAYS EN VOIE DE DEVELOPPEMENT^{1/}

par
Jacques E. Astier
Directeur à l'Institut de recherches
de la sidérurgie française (IRSID)

Rôle important du transfert, au monde entier, des connaissances des instituts de recherches, et cela spécialement pour les pays en voie de développement. Aide des instituts de recherches en vue du développement de l'industrie métallurgique aux pays en voie de développement pour l'amélioration des opérations, le dessin de nouvelles installations ou leur développement à long terme.

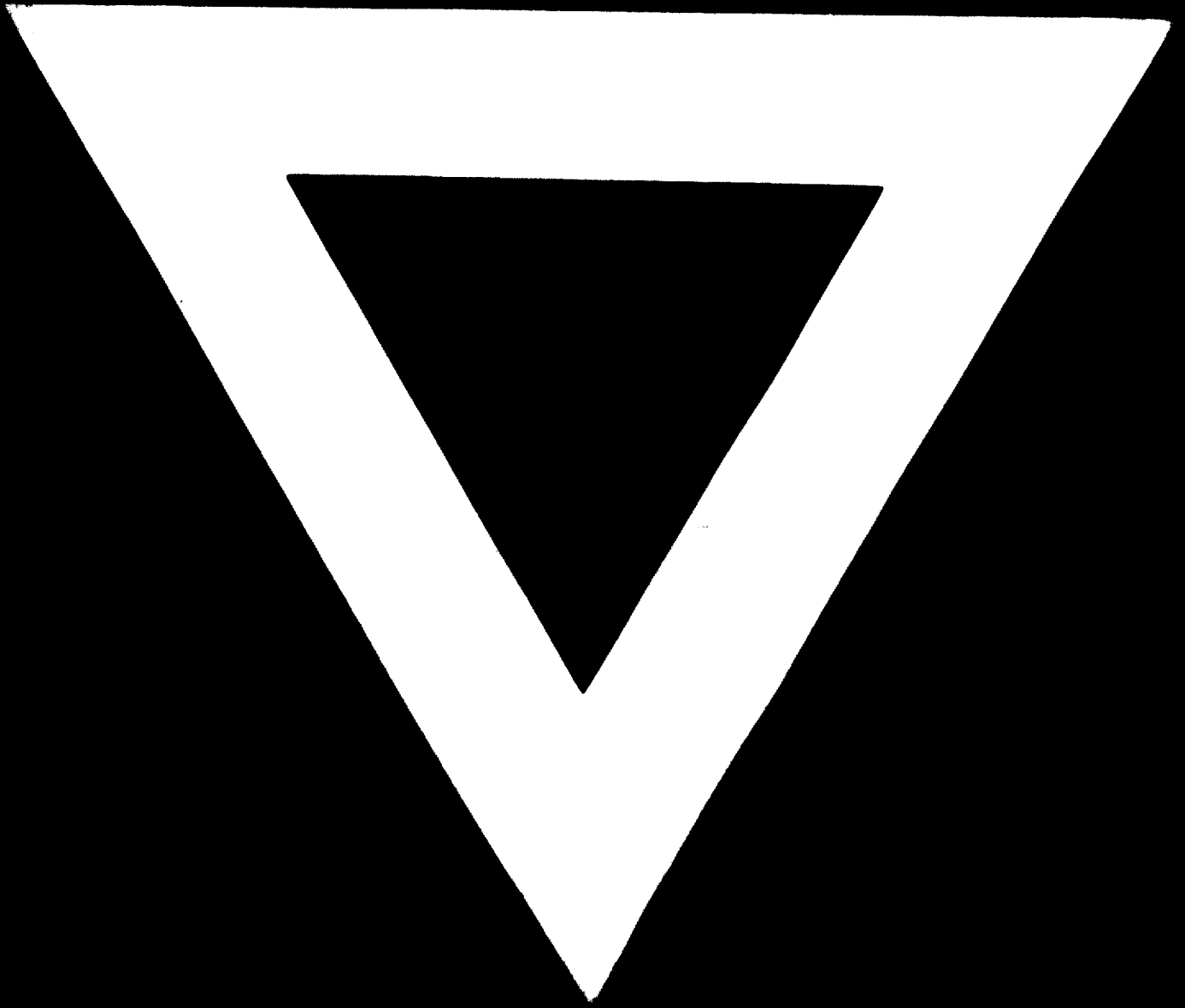
Importance de l'équipement et du personnel dans un centre de recherches faisant fonction de centre d'essais. Différents modes de subvention d'un centre de recherches. Possibilités d'aide aux pays en voie de développement : utilisation de l'équipement existant et d'experts pour les essais sur minerais. Le cas de l'IRSID, avec description de nos laboratoires de recherches et de développement, essais sur minerais, concentration, agglomération, préréduction, aciérie et essais sur échantillons d'aciers. Laboratoires d'essais pour le charbon et cokéfaction.

^{1/} Les opinions exprimées dans le présent document sont celles de l'auteur et ne reflètent pas nécessairement les vues du Secrétariat de l'ONUDI.

Rôle possible d'un centre de recherche comme Bureau d'experts. Groupes d'experts pour améliorer les opérations ou repenser de nouveaux équipements. Intérêt de tels groupes pour les pays en voie de développement, particulièrement lorsque de nouveaux schémas doivent être mis en application pour combiner de nouveaux procédés d'utilisation des minerais locaux avec les ressources locales en énergie.

Utilisation d'un centre de recherches comme Centre de formation. Cours à long terme ou séminaires de courte durée. Centre pouvant recevoir des stagiaires dans ses laboratoires ou au sein même de ses équipes d'essais. Possibilités d'organiser des conférences, des séminaires de courte durée ou bien de longs stages métallurgiques dans des pays industrialisés.





74.09.11