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MASTER

IEA STEEL STUDY

Final Report

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Gordian

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IEA
ENERGY CONSERVATION IN
THE IRON AND STEEL INDUSTRY

FINAL REPORT

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DOE Contract DE-AC01-79CS40300

January 1981

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1. INTRODUCTION AND BACKGROUND

This project involving R and D work in the iron and steel industry, to be carried out under the auspices of the IEA, originated to a great extent from work sponsored by the NATO Committee on the Challenges of Modern Society. The CCMS project, begun in 1974, had the objectives of collecting data on material requirements and energy consumption patterns in selected energy intensive industries in the U.S. and Western Europe, of identifying technologies and operating practices with the potential for energy conservation in those industries, and of recommending R and D projects that could lead to improved energy efficiency. The steel industry was selected for analysis under the CCMS project, and ideas for an international cooperative R and D program were developed.

As the CCMS organisation has no mandate to initiate R and D activities, these ideas were transmitted to the International Energy Agency in late 1978, through the Conservation Working Party. The CWP gave its approval for efforts to be made to develop a research program, the lead country for this work being Sweden (through the National Swedish Board for Technical Development - STU).

2. SUMMARY OF MEETINGS HELD

The first experts meeting was held in Stockholm in May 1979. A total of 30 representatives from seven countries⁽¹⁾ and the IEA secretariat were present (See Appendix 1). During the course of this meeting, about 25 projects were discussed: after careful review, a total of 19 projects (or potential projects) were identified in five general working areas:

Hot surface inspection	4
Hot surface conditioning	1
Heat recovery	7
Energy conversion and combustion	5
Material properties	2
	<hr/>
	19

A list of these projects, and detailed project descriptions, are given in the Meeting Report prepared by STU.

(1) Austria, Belgium, Canada, Japan, Sweden, U.K., U.S.

In addition, the possible form of an IEA Implementing Agreement was discussed. Interest was expressed primarily in task-sharing programs whereby participants agree to contribute to a cooperative research program by performing defined tasks (research projects) and providing the results of the work to all other participants. This type of program is in contrast to cost-sharing, in which participants contribute to a common pool of money, which is then used to pay for the conduct of a particular effort.

The two basic types of Implementing Agreement utilised by the IEA members are as follows:

- (a) An "umbrella" agreement, signed by the contracting parties, who commit to work together to develop research programs, which are later defined in separate Annexes to the agreement. The contracting parties to the main agreement may agree to work on one or more Annexes, choosing to participate only in those Annexes of specific interest to them. For example, a contracting party contribute work in Annexes A and B, but not in C. In such a case, the contracting party has the right to share the results of all work performed by the other parties to Annexes A and B, but not to work performed under Annex C. The advantage of the umbrella agreement is that it is relatively easy to expand by the addition of new Annexes, without the formality of developing a completely new Implementing Agreement each time (and without requiring formal signature each time).
- (b) A "specific" agreement where the research program is defined at the outset. All contracting parties agree to contribute to the work program and they have the right to share the results of all work performed within the program. The program itself may cover a small area of work, or may cover several broad areas, as is the case for the IEA cement program. This type of agreement is suitable where a contracting party has various levels of interest in the research topics, some being of high interest and others of lesser interest. The contracting party is willing to contribute a project in an area of high priority interest, and wishes to receive results from others in all areas, even those of lower interest. This is in contrast to the first type of agreement described above, in which the contracting party is not interested in receiving results in areas of no interest, and decides accordingly not to contribute his results to contracting parties working in those areas of no interest to himself.

Preference was generally expressed for the "umbrella" agreement, as this was thought by many participants to encourage the contribution of the most innovative projects within well-defined Annexes.

The next experts' meeting was held in Paris in November 1979. The purpose of the Paris meeting was to decide upon the type of implementing agreement to be adopted, and to decide upon the form and content of technical annexes, i.e. the program of projects to be undertaken. Fifteen representatives of five countries (*) and the IEA secretariat were present.

In previous discussions, Japan and Sweden had indicated they had several projects to contribute to an "umbrella" type agreement. The U.K., with one project possibly in the area of high temperature heat recovery, preferred an overall agreement. At this meeting, Sweden again insisted that their industrial contributors wanted an "umbrella"-type agreement, which Japan also continued to favor. The U.K. spoke strongly for the "overall" type, but agreed to leave their ceramic heat wheel project in the program pending a reconsideration of the implementing agreement as a whole.

The various projects offered by Japan, Sweden and the U.K. were reviewed, and as a result of the discussions, it appeared that two annexes could be proposed for an "umbrella" agreement, hot inspection techniques and heat recovery techniques. The Hot Inspection annex would have as its objective the development of automatic methods for identifying defects in slabs, blooms and billets at temperatures in excess of 300°C. The work would be carried out on a task-sharing basis. The Heat Recovery annex would be a collection of projects covering various aspects of heat recovery, also to be carried out on a task-sharing basis. Although the U.K. agreed to contribute the heat wheel project at this time, it was made clear that the draft form of the implementing agreement and all associated annexes would need to be re-evaluated before a final decision could be made. A third annex, on coal gasification, was discussed only briefly at this meeting: the possibility of Sweden and Japan cooperating on a cost-sharing basis was raised.

(*) Sweden, Japan, Netherlands, U.S., U.K.

Informal talks, primarily about this coal gasification annex, were carried out in June 1980 in Stockholm between representatives of Sweden and Japan. As a result of these discussions, a third annex was confirmed.

In order to inform potential participants further about the proposed IEA Iron and Steel R and D Program and invite them to participate in the discussions on the suggested Agreement, STU experts once again visited some European countries after the June meeting. However, no country expressed an interest in participation. The situation was thus as follows:

STU thus called a third experts' meeting, informing the "interested" countries as well as all other IEA member countries about the situation. Special reference was made to the fact that only Japan and the U.S. had registered for the meeting. A telex was also sent to Japan, U.K. and U.S. as well as to the Chairman of the Energy Conservation Group and the IEA Secretariat, pointing out that the successful outcome of the third meeting was exclusively dependent on the inputs of the registered participants, since Sweden was not prepared to propose further projects.

The meeting was held in December 1980 in Stockholm. The purpose of this meeting was to finalise the form of an implementing agreement for a research and development program, including the list of projects to be contributed by participating countries within three technical areas:

- (1) Hot surface inspection
- (2) Heat recovery
- (3) Coal gasification

It was agreed that the projects to be included in the first Technical Annex,

"Hot Surface Inspection Methods", would be as follows:

Annex I

1. Optical Methods (Japan)

Optical Methods for Hot Surface Inspection

Optical Test Method - Nippon Steel Corporation

Optical Test Method - Nippon Kokan

Optical Test Method - Kawasaki Steel

Optical Test Method - Sumitomo Metal Industries

Optical Test Method - Kobe Steel

2. Induction Method (Japan)

3. Electromagnetic Ultrasonic Method (Japan)

4. Electromagnetic Ultrasonic Surface Testing Method (Sweden)

5. Eddy Current Method for Hot Surface Inspection (Sweden)

6. Infra-Red System (possible U.S. contribution)

Details of these projects are given in Section 4 of this report.

The Second Annex, "Heat Recovery" is to include the following projects:

Annex II

1. Ceramic Heat Wheel Development (Sweden)

2. Demonstration of Granular Bed/Heat Pipe System for
Heat Recovery (Japan)

3. Demonstration of Tubular Ceramic Recuperators (possible U.S.)

Finally, Japan and Sweden again discussed the possibilities of cooperating on a major project to design and demonstrate a new process for coal gasification which utilises a converter containing molten iron. In order to formulate Annex III on coal gasification, a brief review of the status of current work on coal gasification was made. The necessary work can be divided into three areas:

(1) Converter Process

(2) Gas Treatment

(3) Iron Treatment

Most progress has been made by Sweden (MEFOS) on the converter process, although some ideas (and initial laboratory work) have been developed for gas and iron treatment. It is intended that this project results in the construction and operation of a full-scale prototype plant: the steps which now need to be taken are indicated in Section 4.

3. DRAFT IMPLEMENTING AGREEMENT AND TECHNICAL ANNEXES

The proposed draft implementing agreement and technical annexes are to be circulated by the IEA Secretariat. The version developed in Stockholm in December 1980 is reproduced in this report as Appendix 3.

4. PROJECT DESCRIPTIONS

This section includes summaries of the projects which are to be contributed to the IEA Iron and Steel R and D program.

ANNEX I

HOT SURFACE INSPECTION METHODS

1. OPTICAL METHODS

Optical Methods for Hot Surface Inspection (JAPAN)

Optical Test Method - Nippon Steel Corporation

Optical Test Method - Nippon Kokan

Optical Test Method - Kawasaki Steel

Optical Test Method - Sumitomo Metal Industries

Optical Test Method - Kobe Steel

2. INDUCTION METHOD (JAPAN)

3. ELECTROMAGNETIC ULTRASONIC METHOD (JAPAN)

4. ELECTROMAGNETIC ULTRASONIC SURFACE TESTING METHOD (SWEDEN)

5. EDDY CURRENT METHOD FOR HOT SURFACE INSPECTION (SWEDEN)

6. INFRA-RED SYSTEM (POSSIBLE US)

TITLE Optical Methods for Hot Surface Inspection

PARTICIPANT Various Japanese Steel Companies; coordination by Iron and Steel Federation of Japan.

DESCRIPTION (background - description of work - proposed programme, etc.)

In this method, optical signals transmitted from the surface of the material being inspected are received and analyzed to detect surface abnormalities. As optical signals, those generated by the radiation of high temperature material being tested or those transmitted from an external light source and reflected by the material surface are used.

Among the hot surface inspection technologies the optical method for slabs rolled from ingots is the most advanced in the sense of practical application. The method is now being gradually put into practice by major steelmakers and this project will consist of assembling test results and demonstration programme information from several Japanese steel companies, namely Nippon Steel, Nippon Kokan, Kawasaki, Sumitomo and Kobe Steel. Brief descriptions of each of the systems undergoing test are provided in the following pages

TIME SCHEDULE - see separate project descriptions -

COSTS - see separate project descriptions -

Optical Test Method - Nippon Kokan

Method and purpose

A hot slab is illuminated by an extra-high voltage mercury lamp, and the image of its surface is intermittently and instantaneously taken by a TV camera equipped with a mechanical shutter. The picture signals are recorded and played back on a video-monitor as still images. Slab surface inspection is performed by visually inspecting the images on the video-monitor. This equipment is designed for inspecting slabs rolled from ingots. The inspection results are used for determining the amount of material removal in hot scarfing and for determining the applicability of hot direct rolling.

Performance

Field of view: 700 mm wide x 375 mm long (variable) per TV camera unit.

Temperature of material being inspected: 900 - 1100°C

Detection capability: 1 mm (W) x 2 - 3 mm (L) for blow defects

Features

- With sharp contrast obtained by the use of a special light source this equipment has excellent flaw detection accuracy comparable to visual inspection of cold slabs.
- Flaws can be displayed on the TV monitor as still images
- Descaling is necessary before inspection

Application

An actual model has been installed in Nippon Kokan's Fukuyama Works, and put into practical operation. Testing and improvement of operation is being carried out, and a comprehensive report could be prepared by mid-1981

(May 1979)

(Nippon Koken)

Optical Test Method - Kawasaki Steel

Operating principle and purpose:

Radiation from the surface of a hot slab is received by a scanning type infrared detecting probe. The received data are displayed on a CRT and processed by computer to determine the type and size of defects. Equipped with two scanning infrared detecting probes of narrow and wide fields of view in a single unit, the equipment is capable of inspecting the entire surface of slab by scanning the slab in the travelling and transverse directions. It is designed for inspecting slabs rolled from ingots, aiming at on-line partial conditioning.

Experiments were conducted on slabs after hot scarfing.

Performance

Temperature of material being inspected: $\sim 1.200^{\circ}\text{C}$

Detection capability: Flaw detecting rates with this equipment as compared with flaw detection by visual inspection of cold slabs are as follows:

Type of defect	Detecting rates
Longitudinal cracks	70 %
Net cracks	90 %
Scabs	85 %
Tong marks	95 %

Features

- No external light source is required
- Capable of inspection of the entire slab surface with a single unit
- Descaling is necessary before inspection

Application

On-line experiments were conducted in the company's Chiba Works. Reports on experience with this method can be prepared for this project.

Operating principle and purpose:

Visible rays radiated from a high temperature slab are picked up by a TV camera with instantaneous exposure by a built-in electromagnetic-operated mechanical shutter to detect defects on the material surface. The output signals of the camera are recorded on a video-disc recorder. Those instantaneous video signals are repeatedly and continuously transmitted to a colour TV monitor for display as still images. Designed for inspecting slabs rolled from ingots, the equipment takes pictures by dividing one slab into five portions to display on five TV monitors. The inspection equipment is installed before the hot scarfer. The purpose of inspection with this equipment is to determine hot scarfing mode and reject materials having large defects.

Performance

Temperature of material being inspected: 900 - 1,200° C

Travelling speed of material: ca 180 m/min.

Detection capability

Cracks of more than 100 mm in length
Scabs of more than 25 mm in diameter

Features

- No external light source is required.
- The surface of an object moving at high speed can be observed in the form of still images.

Application

On-line equipment has been installed in Sumitomo Metal Industries Wakayama Works. Test results can be provided for this project.

Optical Test Method - Kobe Steel

Operating principle and purpose

The light radiated from the surface of a hot slab is received by solid-state image pick-up elements. Defects on the material surface are detected by changes in the radiated light. The signals picked up by CCD linear scanning cameras are processed in real time into digital forms to determine the type and size of surface defects.

Designed for inspecting slabs rolled from ingots, the equipment is installed immediately after the hot scarfer to determine the grade of materials.

Performance

Temperature of material being inspected: 800-1,000° C

Detection capability

Scabs, laps, blow cracks and overlapped scabs can be detected, though spot-like scales cannot be detected.

Features

- No external light source is required.
- Capable of detecting those overlapped scabs causing only minute changes in signals through determination of waveforms.

Application

An experimental model has been installed in the company's Kakogawa Works and is now under test for practical application. A report is expected by approximately mid-1981.

(May 1979)

TITLE Induction Method for Hot Surface Inspection

PARTICIPANT Nippon Steel, Japan

DESCRIPTION² (background - description of work - proposed programme etc.)

In the induction heating method, the material being inspected is induction-heated with an external coil and abnormal temperatures are caused by defects in the material. These defects result in disturbance to the normal current flows and current densities (see diagram) and the resulting hot spots can be detected by using, for example, an infra-red thermometer. Nippon Steel has installed such a system for demonstration at its Hirohata Works on the continuous casting/hot strip mill line, and testing is about to begin.

TIME SCHEDULE

COSTS

TITLE Electromagnetic Ultrasonic method

PARTICIPANT Nippon Kokan, Japan

DESCRIPTION (background - description of work - proposed programme etc.)

The Electromagnetic ultrasonic method of hot surface inspection is a variation of the basic ultrasonic method. In this method, eddy currents are electromagnetically induced in the material being inspected, using an external source. The ultrasonic waves transmitted into the material by the eddy currents are received by an external detecting probe to detect flaws in the test material from irregularities in the received ultrasonic waves. This method permits inspection without contact between the test material and the probe, and is particularly suited to the detection of internal flaws.

This system has a number of potential applications in addition to the detection of internal flaws. For example, the thickness of hot slabs can be checked, and bulging at the outlet of a continuous casting machine can be detected. The exact point at which the molten metal solidifies inside the continuously - cast slab can also be detected, and the thickness of the solid shell of a continuous casting can also be measured at any time

TIME SCHEDULE: This method is now under development by Nippon Kokan, and a test programme of about 2 years is anticipated

COSTS

TITLE Electromagnetic Ultrasonic Surface Testing Method

PARTICIPANT: Studsvik, Sweden

DESCRIPTION (background - description of work - proposed programme, etc.)

Studsvik have begun a test programme to study the principles of fault detection using electromagnetically generated ultrasonic waves. The programme is described briefly in the attachment.

TIME SCHEDULE Present phase to be reported Sept. 1981.

COSTS US \$ 400.000.-

(May 1979)

Outline of Studsvik Programme for Development of
Electromagnetic Ultrasonic Testing Method

- A. General investigation of scattering of ultrasonic Rayleigh wave pulses of duration 1-15 usec. by artificial faults on cold continuous cast steel slab samples. The investigations are to follow, for example, the work cited by Harnik (J. of Physics E: Scientific Instruments 1977, Vol. 10, pp 1217-1218) but are to be carried out with electromagnetic surface wave transducers. Attention to be given to effects of surface roughness and oscillation marks.
- B. Development of electromagnetic surface wave transducers:
- Narrow band types
 - Broad " "
 - Design of matching transformers in receiver units
 - Transmitter pulse generator design for pulses 1-15 us duration
 - Investigation of transducers with asymmetric sensitivity in forward and backward directions.
 - Techniques for cooling of vital transducer parts
 - Transducer soak tests on hot test block
 - Compensation methods for reducing initial electromagnetic disturbance
- C. Signal conditioning:
- Amplifier development for pulses of duration 1-15 usec with fast recovery after overload, or with gated input.
 - Use of signal averaging and correlation techniques using actual transducer signals from artificial faults on continuous cast material at room temperature. Use of double receiver to discriminate against echoes traveling in wrong direction.
 - Requency analysis of broadband echoes from artificial faults using electromagnetic transducers.

- D Propagation of Rayleigh waves in hot continuous casts slab material: temp. range 700-1100°C. Frequencies 50 kHz-500 kHz. Damping, phase and group velocity measurements. Checks on a range of different alloyed steels.
 - E Checks on effects with electromagnetic surface wave transducers due to onset of magnetism in ferritic continuous cast steels. Influence of oxide scale (adhering and non-adhering).
 - F Trial runs of experimental transducer systems placed in region of straightener on slab-casting machine. Evaluation of results.
 - G Check on possibility of testing surface-treated artificial faults on continuous cast material at 700-900°C. (Test sample preferably treated by grinding or torch and then tested directly, all within above temperature limits.)
 - H Experiments on testing for edge cracks.
- Propagation of Rayleigh waves parallel to an edge.
- Echo character of electromagnetic surface-wave transducers with focusing action.
- Test of electromagnetic surface-wave transducers system on strand of billet-caster at temperature 800-900°C arranged for transmission of surface waves in spiral path around billet.

TITLE Eddy Current Method for Hot Surface Inspection

PARTICIPANT Bergstrand Kvalitetskontroll AV, Sweden

DESCRIPTION (background- description of work - proposed programme, etc.)

In the Eddy-current method for hot surface inspection, eddy currents are induced on the surface of the material to detect changes in impedance resulting from defects on the surface. The Bergstrand system uses a dual frequency technique for greater accuracy and utilises a micro-computer analyser for processing the observed signals. The system can be calibrated to recognise various types of defect in the steel slab or ingot, and tests are currently in progress in a Japanese steel mill to establish the ability of the system to detect flaws in a fully commercial environment. Successful development of a hot surface inspection method could lead to savings of the order of 600 Kwh per tonne of steel rolled.

TIME SCHEDULE

COSTS

APPLICATIONS-SAVINGS

HOT SURFACE INSPECTION BY A NEW EDDY CURRENT TECHNIQUE

BY

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MANAGING DIRECTOR

AND

PER NILSSON
HEAD OF COMPUTER DEPT.

BERGSTRAND KVALITETSKONTROLL AB
SWEDEN

The recent development within the company of Bergstrand Kvalitetskontroll AB has been focused on the development of a system for hot surface inspection. This is a classical problem within the NDT-sector and has for a long time been asked for from the steel producers.

Since the oil-crisis the interest for energy-savings within the steel-production process has raised a lot and strong efforts are made all over the world to find solutions to lower the consumption of energy.

The largest consumption of liquid and gaseous fuel in the production of steel occurs in the reheating of slabs to enable hot rolling for a final product.

The practice today is to allow the slabs (from a continuous caster or rolled from ingots) to cool to ambient temperature on cooling-beds. When the slabs are at ambient temperature they are manually inspected for surface defects and the defects are grinded away. After the grinding the slabs are reheated before the hot-rolling.

With the possibility to inspect the surface of hot slabs and by hot-scarfing remove the defects, the slabs can directly be passed to the rolling maybe with a slight incremental reheating inbetween. The advantages with this "hot material flow" are many, but the most obvious is the saving of energy. Besides the following advantages are at hand:

- straighter material flow
- faster throughput
- no material on cooling beds which implies lower costs for material bound in stock
- faster and cheaper reconditioning in hot condition
- possibility to supervise and control a caster
- no introduction of cracks due to cooling
- lower costs due to less descaling

To put some figures to these advantages the saving of energy not having to reheat the slabs between casting and hot rolling corresponds to 35-40 million barrels of oil or gas equivalent per year in the USA.

The Bergstrand company has developed a prototype system based on Eddy-current-technique for hot surface inspection of slabs, billets etc of steel at temperatures exceeding 2000°F. The system is so designed that it can control a hot-scarfer. Using Eddy-current technique for hot surface inspection has many advantages. The following are the most important;

- the measurement is non-contact and fast
- it is sensitive
- it is selective
- it gives information about a defects type and geometry
- it has higher sensitivity for defects on and close to the surface

These properties are not valid for other methods, like ultra-sonic and optical methods.

Eddy-current testing is based on the electro magnetic coupling between the test material and a test coil. The test coil is fed with high frequency AC-current which gives raise to currents -Eddy currents- in the material.

When a defect, like a crack, appears in the material the flow of currents is disturbed. This disturbance is detectable via the test coil by analysing the complex impedance of the coil.

It is possible to separate different kinds of defects like e.g. cracks from dents as they affect the complex impedance in different ways. By using and combining two different test frequencies which give different properties to the test, it is possible to make a more sophisticated analysis of the defects and thus get safer information on depth, type etc.

By using an expanded set of characteristics for each frequency -totally eight characteristics per defect- the sensitivity, selectivity and classification capabilities are even more improved.

The inspection system is built up of functional blocks as seen in Fig.1.

The transducer module is built up of several Eddy-current pick-ups where each pick-up is placed on the rotating disc that scans the surface, see Fig.2. The rotating discs are placed in a zic-zac pattern, which implies that all parts of the surface is scanned in two almost perpendicular directions, see Fig.3.

The reason for that is to avoid that just a single testcoil follows a crack, which gives raise to a decrease in sensitivity.

This solution has not this disadvantage but gives constant sensitivity for cracks independent of their direction.

An alternative solution is a mechanical system oscillating in two perpendicular directions.

As such a mechanical system can only oscillate at a few cycles per second due to the high inertia, the advantages with the fast spinning discs are obvious.

To feed the Eddy-current test coil and for evaluating the variations in the complex impedance, analogue circuits are connected to each rotating disc. These analogue circuits digitize the eight characteristics of the defect and feed this information to a micro-computer based analyser.

The micro-computer based analyser classifies the incoming signals into three head-classes.

To the first class belongs the signals recognitioned to origin from a serious defect.

To the second class belong those signals recognitioned to origin from harmless defects.

To the third class belongs such signals that are not recognized as known signals. They may origin from defects that not earlier has occured.

Within these head classes the analyser takes different measures.

In the class of dangerous signals the analyser determines the type and the seriousness of the defect. This information is fed together with

an angular position to the disc to the position calculator which is the coordinating functional block.

The class of surely not dangerous signals are left beside. The unknown signals are also fed to the position calculator with all the characteristics and their position.

The coordinating computer (position calculator) first handles the serious defects -classified as class one- and calculates their position. This information is inputdata to the hot-scarfer (position and depth).

To visualize the test result the defects together with their position are displayed in different colours on a TV-monitor as a "picture" of the material.

The unknown signals are stored on a mass-memory.

This information is available for a fast and easy following-up and also gives a powerful tool to expand and improve the setting of the system.

The coordinating computer also supervises the whole system. This is done by injection of a "synthetic defect" in the testcoil. This signal -known to all its characteristics- is followed through the system. In this way it is possible to exactly discover and localize an eventual malfunction.

Tests have been carried out on hot surface with our prototype equipment at our laboratories and at Sandvik AB in Sweden.

The tests have been concentrated on finding answers to two questions.

1. Is the sensitivity good enough?
2. Is the separation between normal surface variations and serious surface defects good enough?

We have used three types of artificially made defects when finding the answer to the first question and they are:

- notches of varying depths
- drilled holes of varying depths
- holes drilled from backside to varying depths (subsurface defects)

The material has been heated in gasheated ovens.

The answer to the first question is that the sensitivity is very good. We have with a S/N-ratio of 2 to 3 on a smooth surface detected a notch with a depth of 0.1 mm (4 thou.) This should be compared to the specification of the smallest depth interesting in hot testing which is 0.7 - 0.8 mm (30 thou). Fig.4. shows a registration when a testcoil is scanned over 0.1 mm (4 thou) deep notch.

The answer to the second question is easy found when looking at Fig.5. Fig.5. shows a registration when a testcoil is moved over 0.5 mm deep (20 thou) notch on the rough surface of a square billet (surface roughness $R_{\max} \sim 0.7$ mm (30 thou). The registration shows that the separation capability is very high using Eddy-current-technique.

The next step in the test will be done at MEFOS in Luleå, Sweden within the next few weeks.

This test will be carried out on selection of billets containing natural defects like longitudinal cracks, transverse cracks, star cracks and other typical defect types existing on billets.

This test will answer the question how well the system will separate these natural defects. We are very hopeful for these tests as we know that artificially made defects quite well simulate the natural ones.

The final step in the tests is to put the whole system in an on-line test on a slab and this will be done during the later part of this year. This test will confirm that the complete system will stand the environmental conditions representative for a steel mill.

We really expect good result from this test as:

- the labtests are very successful
- the cooling is proved to be very efficient and completely satisfying
- earlier deliveries to the same tough environment are working well since years.

THE COMPANY

Bergstrand Kvalitetskontroll AB is a Swedish company situated right in the middle of Sweden in the city of Östersund. The company was started 1973 by Karl G Bergstrand and has today 14 employees. The company develops, manufactures and markets systems for non-destructive testing mainly based on Eddy-current and Stray-flux techniques.

1973, Start in Skultuna

1973 In August, not a one-man-show any longer

1977 New expansion when the company moves to Östersund in November

The policy of the company is to deliver tailor-made and customer-specific systems. This goal is achieved by using a large set of functional blocks at low level, which together build up a general system. The system lay-out and the know-how of the techniques is kept within the company while subcontractors are used to manufacture heavy mechanics.

Since the start Bergstrand Kvalitetskontroll has delivered more than 50 systems for different NDT-purposes. Some examples; complete tube-testing stations, some of them with computerbased signal analysing, systems for detection and classification of iron-inclusions i copper-wire and copper tubes, systems for testing of rollers, grenades, tube-welds, strip, plate, wire etc.

With the 'modular based' design, any complex testsystem based on one or both of the methods can easily be produced. When other methods are used in addition, they can also easily be integrated in the system by means of auxillary inputs. Such examples are ultrasonics, diameter-length- and thicknessmeasurements.

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Fig. 1

Scanning-pattern from three spinning discs
when moved over a surface.

Notch, 0.1 mm deep

Notch, 0.7 mm deep

Notch, 0.5 mm deep, $R_{\max} \sim 0.7$ mm

TITLE	Infra-red System for Hot Surface Inspection
PARTICIPANT	USA
DESCRIPTION	(background - description of work - proposed programme etc.) United States Steel, Honeywell and the US Department of Energy have begun a project to determine surface quality of hot slabs based on an infra-red scanning system, with a computerised signal processing and pattern recognition technique. It is possible that this project will be contributed to the IEA Annex on Hot Surface Inspection Methods.

TIME SCHEDULE

COSTS

ANNEX II

HEAT RECOVERY

1. CERAMIC HEAT WHEEL DEVELOPMENT (SWEDEN)
2. DEMONSTRATION OF GRANULAR BED/HEAT
PIPE SYSTEM FOR HEAT RECOVERY (JAPAN)
3. DEMONSTRATION OF TUBULAR CERAMIC
RECUPERATORS (POSSIBLE US)

TITLE Ceramic Heat Wheel Development

PARTICIPANT

DESCRIPTION (background - description of work - proposed programme, etc.)

TIME SCHEDULE

COSTS

APPLICATIONS-SAVINGS

ADDENDUM
This project had been withdrawn Nov. 1980,
as announced at the 3:rd meeting. In spite
of the additional contributions to the
Annex, the project leaders (not present
at the 3:rd meeting) are not prepared
retract their withdrawal due to dif-
ferent aims of the respective projects.
Secretariat, Sth. 1980-12-17.

TIME	Demonstration of Granular Bed/Heat Pipe System for Heat Recovery
PARTICIPANT	Kobe Steel, Japan
DESCRIPTION	<p>(background - description of work - proposed programme etc.)</p> <p>A novel type of heat recovery system for the treatment of hot dirty exhaust gases is under development by Kobe Steel.</p> <p>The elements composing the moving granular bed type heat exchanger are arranged as shown in the diagram. Heat is transferred from the exhaust gas to the granules of the moving bed and then from granules to the heat pipes. The bundle of heat pipes transfers heat to a colder gas for utilization. The granules are screened to remove dusts after leaving the system through the constant feeder and are conveyed back to the top of the exchanger for continuous operation. Computer simulation tests indicate about 50-60% heat recovery should be easily obtained: for example, heat contained in an exhaust gas stream of 400,000 Nm³/h, having an average temperature of 250°C (varying between 200°C and 300°C), is transferred to a cold gas stream of 400,000 Nm³/h and 20°C, heating this stream up to 160°C for utilization.</p> <p>Features of the granular bed/heat pipe system include:</p> <ol style="list-style-type: none"> (1) Heat Storage <p>Fluctuation of the temperature of the exhaust gas is moderated by the heat storing capability of the granular bed. The outlet temperature of heated gas is stable.</p> (2) Dust Collection <p>The granular bed of the heat exchanger works not only for heat exchanging but also for filtering of the exhaust gas. The dusty exhaust gas is cleaned during heat exchanging.</p> (3) Reliable Heat Pipes <p>The design feature of the heat pipes of having micro grooves inside the pipe and anti-corrosive cladding outside the pipe provides stable and long-life operation in the severe atmosphere.</p>
TIME SCHEDULE	Testing of a pilot plant exchanger has recently begun, and is planned to continue over a six month period. A final report is expected by the end of 1981

COSTS

TITLE Demonstration of Tubular Ceramic Recuperators

PARTICIPANT USA

DESCRIPTION (background - description of work- proposed programme, etc.)

A project for the installation of up to 200 tubular ceramic recuperators on various types of furnace is to be undertaken by Garrett Air Research and the US Department of Energy. The recuperators are to be sized for a gas flow of about 850 cu.ft./min and a heat duty of about 1 million Btu per hour for each modular unit. They will be used to preheat combustion gas for such applications as box annealing furnaces. It is possible that this project, due to be carried out over a two to three year period, will be contributed to the IEA Annex on Heat Recovery.

TIME SCHEDULE (2-3 years, starting in 1981)

COSTS

ANNEX III

COAL GASIFICATION

1. - 4. Background, Objective, Means, Work Distribution

A brief review of the status of current work on Coal Gasification was made. The necessary work can be divided into three areas:

- (1) Converter Process
- (2) Gas Treatment
- (3) Iron Treatment

Most progress has been made by Sweden (MEFOS) on the converter process, although some ideas (and initial laboratory work) have been developed for gas and iron treatment.

It is intended that this project results in the construction and operation of a full-scale prototype plant: the steps which now need to be taken are indicated in the attached diagramme (III.1).

The activities agreed as necessary, and a proposed breakdown of responsibilities, are summarised in diagramme III.2. Major points to be noted are:

- (1) The initial commitment to a co-operative IEA research programme is restricted to Phase 1, which should result in the detailed engineering design of a "Semi-Commercial" scale plant of about 60 ton size,
- (2) At this stage, an evaluation of the project will be made by the participants and a decision taken whether or not to proceed with the construction and operation of the 60 ton plant

- (3) If it is decided to proceed, Phase 2 will be undertaken. Details of the responsibilities of each party will be defined at a later date.
- (4) At the end of Phase 2, a further evaluation will be undertaken and a decision taken whether or not to proceed with the design, construction, operation and testing of a full-scale production prototype. Again, details of the responsibilities of participants will be defined at a later date.

Regarding the proposed timetable for this Annex, it is planned that an "informal" meeting of Swedish and Japanese research workers will be arranged for the middle of February 1981, at which time a full report on all experimental work carried out to date by Sweden will be available. Details of Phase 1 will then be discussed and agreed by the participants.

It is anticipated that a formal Implementing Agreement can be signed by about April 1:st, 1981, following which the work on Annex III can begin.

DIAGRAMME III.1 STATUS OF COAL GASIFICATION PROJECT

	Converter process	Gas treatment	Iron treatment
IDEAS	complete	partly complete	little activity to date
EXPERIMENTS to establish basic data and design guidelines	laboratory and small-scale work (6 tons) carried out	some laboratory testing done	some laboratory testing done (10 kg. size)
SCALE-UP DESIGN (for 60 ton size)	planning	<div> <div></div> <div>↑</div> <div>no activities to date</div> <div>↓</div> </div>	
CONTINUOUS TEST of 60 ton plant			
DESIGN of production scale plant			
CONSTRUCTION of production scale plant			
OPERATION and DEMONSTRATION of production prototype			

	Converter	Gas treatment	Iron treatment	
Ideas, development of project	S complete	J - S together	J - S together	Phase 1 - IEA Annex III ↑
Experimental work to develop design guidelines	task of Sweden	task of Sweden or Japan - to be defined later -	task of Japan	
Design of scale-up plant (approx. 60 ton)	task of Sweden	task of Japan	task of Japan	
Evaluation, decision to proceed	Decision to be made jointly by participants			

Construction of 60 ton plant	-	-	-	Possible Phase 2 ↑
Operation and testing of 60 ton plant	-	-	-	
Evaluation; decision to proceed	Decision to be made jointly by participants			

Design of production plant	-	-	-	Possible Phase 3 ↑
Construction	-	-	-	
Operation & demonstration of production process	-	-	-	

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All details to be defined and agreed after respective decisions to proceed have been made.

All details to be defined and agreed after respective decisions to proceed have been made.

5. REPORT ON CURRENT STATUS AND ACTION REQUIRED

The form of the Implementing Agreement and technical annexes has now been agreed by the major prospective participants, Sweden and Japan. STU will now compile technical data on the projects proposed for the three Annexes, and will send a final version of the Draft Implementing Agreement to the IEA Secretariat to distribute this Draft to all member countries as soon as possible. Any comments or new project proposals are to be sent to the IEA before March 1, 1981.

The Implementing Agreement could therefore be signed prior to the IEA Berlin Conference, that is, in the first week of April 1981. A first Executive Meeting could then be held in Stockholm in the week of April 13th-16th. In the meantime, Sweden will arrange a Research Workers Meeting for Annex III in the first quarter of 1981.

With respect to the U.S., participation in Annexes I and II remains possible. It will be necessary for the U.S. DOE to decide on their level of participation, if any, in the near future and to forward full project details to both the IEA and STU prior to March 1, 1981.

APPENDIX I

MEETING PARTICIPANTS

(A) STOCKHOLM, MAY 1979

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Energy R & D Office

(B) STOCKHOLM, DECEMBER 1980

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In addition, support services were provided by the STU Secretariat:

Mr. Folke Schippel (Head of Secretariat)

Mr. Bertil Hedengren

Ms. Ebba Swartling

Ms. Inga Ulvönäs

APPENDIX 2

LIST OF MEETING REPORTS

<u>Item</u>	<u>Source</u>
1. Meeting Report, Stockholm, May 14-17, 1979	STU
2. Report of Experts Meeting (Stockholm), May 14-17, 1979	Gordian Associat
3. Comments and Project Descriptions received up to 28 September 1979	STU
4. Report of Experts Meeting (Paris), November 19-20, 1979	Gordian Associat
5. Report of Informal Talks about Suggested Coal Gasification Annex (Stockholm), June 24, 1980	STU
6. Report of Experts Meeting (Stockholm), December 2-3, 1980	Gordian Associat
7. Report of Experts Meeting (Stockholm), December 2-3, 1980	STU

APPENDIX 3

D R A F T

IMPLEMENTING AGREEMENT FOR A

PROGRAMME OF RD&D

ON

E N E R G Y C O N S E R V A T I O N I N

T H E

I R O N A N D S T E E L I N D U S T R Y :

DRAFT
INTERNATIONAL ENERGY AGENCY

I M P L E M E N T I N G A G R E E M E N T
FOR A PROGRAMME OF RESEARCH
DEVELOPMENT AND DEMONSTRATION ON
ENERGY CONSERVATION IN THE IRON AND STEEL INDUSTRY

The Contracting Parties

CONSIDERING that the Contracting Parties, being either governments of International Energy Agency ("Agency") countries, governments of other countries invited by the Governing Board of the Agency to be Contracting Parties, international organizations or parties designated by their respective governments, wish to take part in the establishment and operation of a continued Programme of Research, Development and Demonstration on Energy Conservation in the Iron and Steel Industry (the "Programme") as provided in this Agreement;

CONSIDERING that the Contracting Parties which are governments of Agency Countries and the governments of Agency Countries which have designated Contracting Parties (referred to collectively as the "Governments") have agreed in Article 41 of the Agreement on an International Energy Program (the "I.E.P. Agreement") to undertake national programmes in the areas set out in Article 42 of the I.E.P. Agreement, including energy research and development;

CONSIDERING that in the Governing Board of the Agency on 15th/16th March 1977, the Governments approved the Programme as a special activity under Article 65 of the I.E.P. Agreement;

CONSIDERING that the Agency has recognized the establishment of the Programme as an important component of international co-operation in the field of energy conservation in the iron and steel industry;

HAVE AGREED as follows:

Article 1
OBJECTIVES

- (a) Scope of Activity. The Programme to be carried out by the Contracting Parties within the framework of this Agreement shall consist of co-operative research, development, demonstrations and exchanges of information regarding energy conservation in the iron and steel industry.
- (b) Method of Implementation. The Contracting Parties shall implement the Programme by undertaking one or more tasks (the "Task" or "Tasks") each of which will be open to participation by two or more Contracting Parties as provided in Article 2 hereof. The Contracting Parties which participate in a particular Task are, for the purposes of that Task, referred to in this Agreement as "Participants".
- (c) Task Co-ordination and Co-operation. The Contracting Parties shall co-operate in co-ordinating the work of the various Tasks and shall endeavour, on the basis of an appropriate sharing of burdens and benefits to encourage co-operation among Participants engaged in the various Tasks with the objective of advancing the research and development activities of all Contracting Parties in the field of energy conservation in the pulp and paper industry.

Article 2
IDENTIFICATION AND INITIATION OF TASKS

- (a) Identification. The Tasks undertaken by Participants are identified in the Annexes to this Agreement. At the time of signing this Agreement, each Contracting Party shall confirm its intention to participate in one or more Tasks by giving the Executive Director of the Agency a Notice of Participation in the relevant Annex or Annexes and the Operating Agency for each Task shall give the Executive Director of the Agency a Notice of Acceptance of the Task Annex. Thereafter, each Task shall be carried out in accordance with the procedures set forth in

Initiation of Additional Tasks. Additional Tasks may be initiated by any Contracting Party according to the following procedure:

- (1) A Contracting Party wishing to initiate a new Task shall present to one or more Contracting Parties for approval a draft Annex, similar in form to the Annexes attached hereto, containing a description of the scope of work and conditions of the Task proposed to be performed;
- (2) Whenever two or more Contracting Parties agree to undertake a new Task, they shall submit the draft Annex for approval by the Executive Committee pursuant to Article 3(e)(2) hereof; the approved draft Annex shall become part of this Agreement; Notice of Participation in the Task by Contracting Parties and acceptance by the Operating Agent shall be communicated to the Executive Director in the manner provided in paragraph (a) above;
- (3) In carrying out the various Tasks, Participants shall co-ordinate their activities in order to avoid duplication of activities.

Article 3

THE EXECUTIVE COMMITTEE

(a) Supervisory Control. Control of the Programme shall be vested in the Executive Committee constituted under this Article.

(b) Membership. The Executive Committee shall consist of one member designated by each Contracting Party; each Contracting Party shall also designate an alternate member to serve on the Executive Committee in the event that its designated member is unable to do so.

(c) Responsibilities. The Executive Committee shall:

- (1) Adopt for each year, acting by unanimity, the Programme of Work, and Budget if foreseen, for each Task, together with an indicative Programme of Work and Budget for the following two years; the Executive Committee may, as required, make adjustments within the framework of the Programme of Work and Budget;
- (2) Make such rules and regulations as may be required for the sound management of the Tasks, including financial rules as provided in Article 6 hereof;
- (3) Carry out the other functions conferred upon it by this Agreement and the Annexes hereto; and
- (4) Consider any matters submitted to it by any of the Operating Agents or by any Contracting Party.

(d) Procedure. The Executive Committee shall carry out its responsibilities in accordance with the following procedures:

- (1) The Executive Committee shall each year elect a Chairman and one or more Vice-Chairmen;
- (2) The Executive Committee may establish such subsidiary bodies and rules of procedure as are required for its proper functioning. A representative of the Agency and a representative of each Operating Agent (in its capacity as such) may attend meetings of the Executive Committee and its subsidiary bodies in an advisory capacity;
- (3) The Executive Committee shall meet in regular session twice each year; a special meeting shall be convened upon the request of any Contracting Party which can demonstrate the need therefor;

- (4) Meetings of the Executive Committee shall be held at such time and in such office or offices as may be designated by the Committee;
- (5) At least twenty-eight days before each meeting of the Executive Committee, notice of the time, place and purpose of the meeting shall be given to each Contracting Party and to other persons or entities entitled to attend the meeting; notice need not be given to any person or entity otherwise entitled thereto if notice is waived before or after the meeting;
- (6) The quorum for the transaction of business in meetings of the Executive Committee shall be one-half of the members plus one (less any resulting fraction) provided that any action relating to a particular Task shall require a quorum as aforesaid of members or alternate members designated by the Participants in that Task.

(e) Voting.

- (1) When the Executive Committee adopts a decision or recommendation for or concerning a particular Task, the Executive Committee shall act:
 - (i) When unanimity is required under this Agreement by agreement of those members or alternate members which were designated by the Participants in the Task and which are present and voting;
 - (ii) When no express voting provision is made in this Agreement by majority vote of those members or alternate members which were designated by the Participants in that Task and which are present and voting.

(2) In all other cases in which the Agreement expressly requires the Executive Committee to act by unanimity, this shall require the agreement of each member or alternate member present and voting, and in respect of all other decisions and recommendations for which no express voting provision is made in this Agreement, the Executive Committee shall act by a majority vote of the members or alternate members present and voting. If a government has designated more than one Contracting Party to this Agreement, those Contracting Parties may cast only one vote under this paragraph.

(3) The decisions and recommendations referred to in sub-paragraphs (1) and (2) above may, with the agreement of each member or alternate member entitled to act thereon, be made by mail, telex or cable without the necessity for calling a meeting. Such action shall be taken by unanimity or majority of such members as in a meeting. The Chairman of the Executive Committee shall ensure that all members are informed of each decision or recommendation made pursuant to this sub-paragraph.

(f) Reports. The Executive Committee shall, by 31st January each year, provide the Agency with reports containing technically substantive, non proprietary information on the progress of the Programme and its results.

Article 4

THE OPERATING AGENTS

Designation. Participants shall designate in the relevant Annex an Operating Agent for each Task. References in this Agreement to the Operating Agent shall apply to each Operating Agent in respect of the Task for which it is responsible.

(b) Scope of Authority to Act on Behalf of Participants.

Subject to the provisions of the applicable Annex:

- (1) All legal acts required to carry out each Task shall be performed on behalf of the Participants by the Operating Agent for the Task;
- (2) The Operating Agent shall hold, for the benefit of the Participants, the legal title to all property rights which may accrue to or be acquired for the Task.

The Operating Agent shall operate the Task under its supervision and responsibility, subject to this Agreement, in accordance with the law of the country of the Operating Agent.

(c) Reimbursement of Costs. The Executive Committee may provide that expenses and costs incurred by an Operating Agent in acting as such pursuant to this Agreement shall be reimbursed to the Operating Agent from funds made available by the Participants pursuant to Article 6 hereof.

(d) Replacement. Should the Executive Committee wish to replace an Operating Agent with another government or entity, the Executive Committee may, acting by unanimity and with the consent of such government or entity, replace the initial Operating Agent. References in this Agreement to the "Operating Agent" shall include any government or entity appointed to replace the original Operating Agent under this paragraph.

(e) Resignation. An Operating Agent shall have the right to resign at any time, by giving six months written notice to that effect to the Executive Committee, provided that:

- (1) A Participant, or entity designated by a Participant, is at such time willing to assume the duties and obligations of the Operating Agent and so notifies the Executive Committee and the other Participants to that effect, in writing, not less than three months in advance of the effective date of such resignation; and

- (2) Such Participant or entity is approved in its function of Operating Agent by the Executive Committee, acting by unanimity.

(f) Accounting. An Operating Agent which is replaced or which resigns as Operating Agent shall provide the Executive Committee with an accounting of any monies and other assets which it may have collected or acquired for the Task in the course of carrying out its responsibilities as Operating Agent.

(g) Transfer of Rights. In the event that another Operating Agent is appointed under paragraph (d) or (e) above, the Operating Agent shall transfer to such replacement Operating Agent any property rights which it may hold on behalf of the Task.

(h) Information and Report. Each Operating Agent shall furnish to the Executive Committee such information concerning the Task as the Committee may request and shall each year submit, not later than two months after the end of the financial year, a report on the status of the Task.

Article 5

ADMINISTRATION AND STAFF

(a) Administration of Tasks. Each Operating Agent shall be responsible to the Executive Committee for implementing its designated Task in accordance with this Agreement, the applicable Task Annex, and the decisions of the Executive Committee.

(b) Staff. It shall be the responsibility of the Operating Agent to retain such staff as may be required to carry out its designated Task in accordance with rules determined by the Executive Committee. The Operating Agent may also, as required, utilize the services of personnel employed by other Participants (or organizations or other entities designated by Contracting

Parties) and made available to the Operating Agent by secondment or otherwise. Such personnel shall be remunerated by their respective employers and shall, except as provided in this Article, be subject to their employers' conditions of service. The Contracting Parties shall be entitled to claim the appropriate cost of such remuneration or to receive an appropriate credit for such cost as part of the Budget of the Task, in accordance with Article 6(f)(6) hereof.

Article 6

FINANCE

(a) Individual Obligations. Each Contracting Party shall bear the costs it incurs in carrying out this Agreement, including the costs of formulating or transmitting reports and of reimbursing its employees for travel and other per diem expenses incurred in connection with work carried out on the respective Tasks, unless provision is made for such costs to be reimbursed from common funds as provided in paragraph (g) below.

(b) Common Financial Obligations. Participants wishing to share the costs of a particular Task shall agree in the appropriate Task Annex to do so. The apportionment of contributions to such costs (whether in the form of cash services rendered, intellectual property or the supply of materials) and the use of such contributions shall be governed by the regulations and decisions made pursuant to this Article by the Executive Committee.

(c) Financial Rules, Expenditure. The Executive Committee, acting by unanimity, may make such regulations as are required for the sound financial management of each Task including, where necessary:

- (1) Establishment of budgetary and procurement procedures to be used by the Operating Agent in making payments from any common funds which may be maintained by Participants for the account of the Task or in making contracts on behalf of the Participants;

- (2) Establishment of minimum levels of expenditure for which Executive Committee approval shall be required, including expenditure involving payment of monies to the Operating Agent for other than routine salary and administrative expenses previously approved by the Executive Committee in the budget process.

In the expenditure of common funds the Operating Agent shall take into account the necessity of ensuring a fair distribution of such expenditure in the Participants' countries, where this is fully compatible with the most efficient technical and financial management of the Task.

(d) Crediting of Income to Budget. Any income which accrues from a Task shall be credited to the Budget of the Task.

(e) Accounting. The system of accounts employed by the Operating Agent shall be in accordance with accounting principles generally accepted in the country of the Operating Agent and consistently applied.

(f) Programme of Work and Budget, Keeping of Accounts. Should Participants agree to maintain common funds for the payment of obligations under a Programme of Work and Budget of the Task, the following provisions shall be applicable unless the Executive Committee, acting by unanimity, decides otherwise:

- (1) The financial year of the Task shall correspond to the financial year of the Operating Agent;
- (2) The Operating Agent shall each year prepare and submit to the Executive Committee for approval a draft Programme of Work and Budget, together with an indicative programme of work and budget for the following two years, not later than three months before the beginning of each financial year;

- (3) The Operating Agent shall maintain complete, separate financial records which shall clearly account for all funds and property coming into the custody or possession of the Operating Agent in connection with the Task;
- (4) Not later than three months after the close of each financial year the Operating Agent shall submit to auditors selected by the Executive Committee for audit the annual accounts maintained for the Task; upon completion of the annual audit, the Operating Agent shall present the accounts together with the auditors' report to the Executive Committee for approval;
- (5) All books of account and records maintained by the Operating Agent shall be preserved for at least three years from the date of termination of the Task;
- (6) Where provided in the relevant Annex, a Participant supplying services, materials or intellectual property to the Task shall be entitled to a credit, determined by the Executive Committee, acting by unanimity, against its contribution (or to compensation, if the value of such services, materials or intellectual property exceeds the amount of the Participant's contribution); such credits for services of staff shall be calculated on an agreed scale approved by the Executive Committee and include all payroll-related costs.

(g) Contribution to Common Funds. Should Participants agree to establish common funds under the annual Programme of Work and Budget for a Task, any financial contributions due from Participants in a Task shall be paid to the Operating Agent in the currency of the country of the Operating Agent at such times and upon such other conditions as the Executive Committee, acting by unanimity, shall determine, provided however that:

(1) Contributions received by the Operating Agent shall be used solely in accordance with the Programme of Work and Budget for the Task;

(2) The Operating Agent shall be under no obligation to carry out any work on the Task until contributions amounting to at least fifty per cent (in cash terms) of the total due at any one time have been received.

(h) Ancillary Services. Ancillary services may, as agreed between the Executive Committee and the Operating Agent, be provided by that Operating Agent for the operation of a Task and the cost of such services, including overheads connected therewith, may be met from budgeted funds of that Task.

(i) Taxes. The Operating Agent shall pay all taxes and similar impositions (other than taxes on income) imposed by national or local governments and incurred by it in connection with a Task, as expenditure incurred in the operation of that Task under the Budget; the Operating Agent shall, however, endeavour to obtain all possible exemptions from such taxes.

(j) Audit. Each Participant shall have the right, at its sole cost, to audit the accounts of any work in a Task for which common funds are maintained, on the following terms:

(1) The Operating Agent shall provide the other Participants with an opportunity to participate in such audits on a cost-shared basis;

(2) Accounts and records relating to activities of the Operating Agent other than those conducted for the Task shall be excluded from such audit, but if the Participant concerned requires verification of charges to the Budget representing services rendered to the Task by the Operating Agent, it may at its own cost request and obtain an audit certificate in this respect from the auditors of the Operating Agent;

- (3) Not more than one such audit shall be required in any financial year;
- (4) Any such audit shall be carried out by not more than three representatives of the Participants.

Article 7

INFORMATION AND INTELLECTUAL PROPERTY

It is expected that for each Task agreed to pursuant to this Agreement, the applicable Annex will contain information and intellectual property provisions. The General Guidelines Concerning Information and Intellectual Property, approved by the Governing Board of the Agency on 21st November, 1975, shall be taken into account in developing such provisions.

Article 8

LEGAL RESPONSIBILITY AND INSURANCE

(a) Liability of Operating Agent. The Operating Agent shall use all reasonable skill and care in carrying out its duties under this Agreement in accordance with all applicable laws and regulations. Except as otherwise provided in this Article, the cost of all damage to property, and all expenses associated with claims, actions and other costs arising from work undertaken with common funds for a Task shall be charged to the Budget of that Task; such costs and expenses arising from other work undertaken for a Task shall be charged to the Budget of that Task if the Task Annex so provides or the Executive Committee, acting by unanimity, so decides.

(b) Insurance. The Operating Agent shall propose to the Executive Committee all necessary liability, fire and other insurance, and shall carry such insurance as the Executive Committee may direct. The cost of obtaining and maintaining insurance shall be charged to the Budget of the Task.

(c) Indemnification of Contracting Parties. The Operating Agent shall be liable, in its capacity as such, to indemnify Participants against the cost of any damage to property and all legal liabilities, actions, claims, costs and expenses connected therewith to the extent that they:

- (1) Result from the failure of the Operating Agent to maintain such insurance as it may be required to maintain under paragraph (b) above; or
- (2) Result from the gross negligence or wilful misconduct of any officers or employees of the Operating Agent in carrying out their duties under this Agreement.

Article 9 LEGISLATIVE PROVISIONS

(a) Accomplishment of Formalities. Each Participant shall request the appropriate authorities of its country (or its Member States in the case of an international organization) to use their best endeavours, within the framework of applicable legislation, to facilitate the accomplishment of formalities involved in the movement of persons, the importation of materials and equipment and the transfer of currency which shall be required to conduct the Task in which it is engaged.

(b) Applicable Laws. In carrying out this Agreement and its Annexes, the Contracting Parties shall be subject to the appropriation of funds by the appropriate governmental authority, where necessary, and to the constitution, laws and regulations applicable to the respective Contracting Parties, including, but not limited to, laws establishing prohibitions upon the payment of commissions, percentages, brokerage or contingent fees to persons retained to solicit governmental contracts and upon any share of such contracts accruing to governmental officials.

(c) Decisions of Agency Governing Board. Participants in the various Tasks shall take account, as appropriate, of the Guiding Principles for Co-operation in the Field of Energy Research and Development, and any modification thereof, as well as other decisions of the Governing Board of the Agency in that field. The termination of the Guiding Principles shall not affect this Agreement, which shall remain in force in accordance with the terms hereof.

(d) Settlement of Disputes. Any dispute among the Contracting Parties concerning the interpretation or the application of this Agreement which is not settled by negotiation or other agreed mode of settlement shall be referred to a tribunal of three arbitrators to be chosen by the Contracting Parties concerned who shall also choose the Chairman of the tribunal. Should the Contracting Parties concerned fail to agree upon the composition of the tribunal or the selection of its Chairman, the President of the International Court of Justice shall, at the request of any of the Contracting Parties concerned, exercise those responsibilities. The tribunal shall decide any such dispute by reference to the terms of this Agreement and any applicable laws and regulations, and its decision on a question of fact shall be final and binding on the Contracting Parties concerned. Operating Agents which are not Contracting Parties shall be regarded as Contracting Parties for the purpose of this paragraph.

Article 10

ADMISSION AND WITHDRAWAL OF CONTRACTING PARTIES

(a) Admission of New Contracting Parties: Agency Countries. Upon the invitation of the Executive Committee, acting by unanimity, admission to this Agreement shall be open to the government of any Agency Participating Country (or a national agency, public organization, private corporation, company or other entity designated by such government), which signs or

accedes to this Agreement, accepts the rights and obligations of a Contracting Party, and is accepted for participation in at least one Task by the Participants in that Task, acting by unanimity. Such admission of a Contracting Party shall become effective upon the signature of this Agreement by the new Contracting Party or its accession thereto and its giving Notice of Participation in one or more Annexes and the adoption of any consequential amendments thereto:

(b) Admission of New Contracting Parties: Other OECD Countries. The government of any Member of the Organisation for Economic Co-operation and Development which does not participate in the Agency may, on the proposal of the Executive Committee, acting by unanimity, be invited by the Governing Board of the Agency to become a Contracting Party to this Agreement (or to designate a national agency, public organization, private corporation, company or other entity to do so), under the conditions stated in paragraph (a) above.

(c) Participation by the European Communities. The European Communities may participate in this Agreement in accordance with arrangements to be made by the Executive Committee, acting by unanimity.

(d) Admission of New Participants in Tasks. Any Contracting Party may, with the agreement of the Participants in a Task, acting by unanimity, become a Participant in that Task. Such participation shall become effective upon the Contracting Party's giving the Executive Director of the Agency a Notice of Participation in the appropriate Task Annex and the adoption of consequential amendments thereto.

(e) Contributions. The Executive Committee may require, as a condition to admission to participation, that the new Contracting Party or new Participant shall contribute (in the form of cash, services or materials) an appropriate proportion of the prior budget expenditure of any Task in which it participates.

(f) Replacement of Contracting Parties. With the agreement of the Executive Committee, acting by unanimity, and upon the request of a government, a Contracting Party designated by that government may be replaced by another party. In the event of such replacement, the replacement party shall assume the rights and obligations of a Contracting Party as provided in paragraph (a) above and in accordance with the procedure provided therein.

(g) Withdrawal. Any Contracting Party may withdraw from this Agreement or from any Task either with the agreement of the Executive Committee, acting by unanimity, or by giving twelve months written Notice of Withdrawal to the Executive Director of the Agency, such Notice to be given not less than one year after the date hereof. The withdrawal of a Contracting Party under this paragraph shall not affect the rights and obligations of the other Contracting Parties; except that, where the other Contracting Parties have contributed to common funds for a Task, their proportionate shares in the Task Budget shall be adjusted to take account of such withdrawal.

(h) Changes of Status of Contracting Party. A Contracting Party other than a government or an international organization shall forthwith notify the Executive Committee of any significant change in its status or ownership, or of its becoming bankrupt or entering into liquidation. The Executive Committee shall determine whether any such change in status of a Contracting Party significantly affects the interests of the other Contracting Parties; if the Executive Committee so determines, then, unless the Executive Committee, acting upon the unanimous decision of the other Contracting Parties, otherwise agrees:

- (1) That Contracting Party shall be deemed to have withdrawn from the Agreement under paragraph (g) above on a date to be fixed by the Executive Committee; and

(2) The Executive Committee shall invite the government which designated that Contracting Party to designate, within a period of three months of the withdrawal of that Contracting Party, a different entity to become a Contracting Party; if approved by the Executive Committee, acting by unanimity, such entity shall become a Contracting Party with effect from the date on which it signs or accedes to this Agreement and gives the Executive Director of the Agency a Notice of Participation in one or more Annexes.

i) Failure to Fulfil Contractual Obligations. Any Contracting Party which fails to fulfil its obligations under this Agreement within sixty days after its receipt of notice specifying the nature of such failure and invoking this paragraph, may be deemed by the Executive Committee, acting by unanimity to have withdrawn from this Agreement.

Article 11 FINAL PROVISIONS

(a) Term of Agreement. This Agreement shall remain in force for an initial period of three years from the date hereof, and shall continue in force thereafter unless and until the Executive Committee, acting by unanimity, decides on its termination.

(b) Legal Relationship of Contracting Parties and Participants. Nothing in this Agreement shall be regarded as constituting a partnership between any of the Contracting Parties or Participants.

(c) Termination. Upon termination of this Agreement, or any Annex to this Agreement, the Executive Committee, acting by unanimity, shall arrange for the liquidation of the assets of the Task or Tasks. In the event of such liquidation, the

Executive Committee shall, so far as practicable, distribute the assets of the Task, or the proceeds therefrom, in proportion to the contributions which the Participants have made from the beginning of the operation of the Task, and for that purpose shall take into account the contributions and any outstanding obligations of former Contracting Parties. Disputes with a former Contracting Party about the proportion allocated to it under this paragraph shall be settled under Article 9(d) hereof, for which purpose a former Contracting Party shall be regarded as a Contracting Party.

(d) Amendment. This Agreement may be amended at any time by the Executive Committee, acting by unanimity, and any Annex to this Agreement may be amended at any time by the Executive Committee, acting by unanimity of the Participants in the Task to which the Annex refers. Such amendments shall come into force in a manner determined by the Executive Committee, acting under the voting rule applicable to the decision to adopt the amendment.

(e) Deposit. The original of this Agreement shall be deposited with the Executive Director of the Agency and a certified copy thereof shall be furnished to each Contracting Party. A copy of this Agreement shall be furnished to each Agency Participating Country, to each Member country of the Organisation for Economic Co-operation and Development and to the European Communities.

Done in Paris, this

HOT SURFACE INSPECTION TECHNIQUES

1. Background

It is common practice in the steel industry to cool slabs, blooms and billets to a temperature close to ambient in order to inspect the pieces and carry out any necessary surface treatment to remove faults. The steel is then reheated prior to further processing in rolling mills. If inspection and surface treatment could be performed at elevated temperatures, significant savings in energy could be attained in the steel industry.

2. Objectives

The objective of this Task is therefore to develop automated methods for identifying defects, both internal and those that break the surface, in steel pieces such as slabs, blooms and billets at material temperatures in excess of 300°C.

3. Means

The work under this Annex will be carried out on a task sharing basis, with each participant responsible for carrying out one or more studies as specified below.

4. Work Distribution and Responsibilities of Participants

(a) Japan

- (1) The application of various hot surface inspection systems based on optical methods will be demonstrated and evaluated at several steelworks.
(Cost)
- (2) The application of the induction method for hot surface inspection utilising an infra-red scanning thermometer, will be demonstrated and evaluated at a steelworks under full-scale operating conditions.
(Cost)
- (3) The Electromagnetic Ultrasonic method will be developed and demonstrated on a full size production line at a steelworks.
(Cost)

(b) Sweden

- (1) A study will be undertaken to develop an electromagnetic ultrasonic detector for surface cracks, including demonstration and evaluation of the system at a steelworks.
(Cost)

- (2) A system for hot surface inspection using the Eddy Current method will be developed and tested at a steelworks.
(Cost)

(c) US

(may contribute a project using an optical method for detecting surface flaws.)

5. Special Responsibilities of the Operating Agent

The Operating Agent shall be responsible for the overall management of the work under this Annex and for implementing the decisions of the Executive Committee. To that end, the Operating Agent shall:

- (a) Prepare and submit for approval to the Executive Committee not later than one month after the adoption of this Annex a detailed programme of work.
- (b) Report to the Executive Committee on the results and progress of work under the Annex, at least semi-annually.

6. Funding

The cost for the work to be carried out under this Annex will be funded by the Participants as indicated in Paragraph 4. In addition, the Operating Agent will bear all costs it incurs in carrying out its responsibilities under this Annex.

7. Time Schedule

This Annex shall enter into force on the date of signature of this Agreement and remain in force for an initial period of 36 months from that date. It may be extended by agreement of the Participants in the Executive Committee. Extensions shall apply only to Participants who agree to the extension or notify the IEA Secretariat of their decision to continue to participate.

3. Operating Agent

The National Swedish Board for Technical Development.

9. Information and Intellectual Property

- (a) Executive Committee's Powers. The publication, distribution, handling, protection and ownership of information and intellectual property arising from activities conducted under this Annex shall be determined by the Executive Committee, acting by unanimity, in conformity with this Agreement.
- (b) Right to Publish. Subject only to the patents and copyright restrictions of this Annex, the Participants in this Annex (referred to in this Annex as the "Participants") shall have the right to publish all information provided to or arising from this Annex except proprietary information, but they shall not publish it with a view to profit, except as agreed by the Executive Committee, acting by unanimity.
- (c) Proprietary Information. The Participants shall take all necessary measures in accordance with the Annex, the laws of their respective countries and international law to protect proprietary information. For the purposes of this Annex, proprietary information shall mean information of a confidential nature such as trade secrets and know-how (for example, computer programmes, design procedures and techniques, chemical composition of materials, or manufacturing methods, processes, or treatments) which is appropriately marked, provided such information:
- (1) Is not generally known or publicly available from other sources;

- (2) Has not previously been made available by the owner to others without obligation concerning its confidentiality: and
- (3) Is not already in the possession of the recipient Participants without obligation concerning its confidentiality.

It shall be the responsibility of each Participant supplying proprietary information to identify the information as such and to ensure that it is appropriately marked.

(d) Production of Relevant Information. The Operating Agent should encourage the governments of all Agency Participating Countries to make available or to identify to the Operating Agent all published or otherwise freely available information known to them that is relevant to the Task. The Participants should notify the Operating Agent of all pre-existing information, and information developed independently of the Task known to them which is relevant to the Task and which can be made available to the Task without contractual or legal limitations.

(e) Reports on Programme Work. Reports containing all arising information and pre-existing information necessary for and used in each Subtask, including proprietary information, shall be provided to each Participant by the Participants performing the Subtask. It shall be the responsibility of each Participant to identify information which qualifies as proprietary information under this Annex and ensure that it is appropriately marked. The Operating Agent shall provide summary reports of work performed under this Annex and results thereof (arising information), excluding proprietary information, to the Executive Committee.

(f) Licensing of Proprietary Information. Each Participant agrees to license all pre-existing proprietary information necessary for and used in its work in the Task and which it owns or controls to the Participants, their governments, and the nationals of their respective countries designated by them royalty-free for research, development and demonstration purposes (non-commercial uses) in the field of energy conservation in the iron and steel industry. Each Participant agrees to license all arising proprietary information to the Participants, their governments, and the nationals of their respective countries designated by them:

On reasonable terms and conditions

(f) Licensing of Patents Needed for Task. Patents solely owned or controlled by a Participant which are needed for use in the Task shall be licensed to the Task Participants for use in the Task at no cost to such Participants. If such patents are partially owned or controlled by a Participant, then efforts shall be made by the Participant to reduce or eliminate as possible the benefit that might accrue to it.

(h) Arising Inventions. Inventions made or conceived in the course of or under the Task (arising inventions) shall be owned in all countries by the inventing Participant. Information regarding inventions on which patent protection is to be obtained by the Participant shall not be published or publicly disclosed by the other

Participants until a patent application has been filed, provided, however that this restriction on publication or disclosure shall not extend beyond six months from the date of receipt of such information. It shall be the responsibility of the inventing Participant to appropriately mark reports which disclose inventions that have not been appropriately protected by the filing of a patent application.

(i) Licensing of Inventions. Each Participant agrees to license all arising inventions to the other Participants, their governments and the nationals of their respective countries

On reasonable terms and conditions

for use in their own country in order to meet their energy needs.

(j) Copyright. The Operating Agent or each Participant for its own Subtask results may take appropriate measures necessary to protect copyrightable material generated under the Task. Copyrights obtained shall be the property of that Participant or the Operating Agent for the benefit of the Participants, provided, however, that Participants may reproduce and distribute such material, but shall not publish it with a view to profit.

(k) Inventor and Authors. Each Participant shall, without prejudice to any rights of inventors or authors under its national laws, take all necessary steps to provide the co-operation from its authors and inventors required to carry out the provisions of this paragraph.

Each Participant will assume the responsibility to pay awards or compensation required to be paid to its employees according to the laws of its country..

(1) Determination of "National". The Participants may establish guidelines to determine what constitutes a "national" of a Participant.

Results

The results of this Annex will be:

(a) comprehensive reports describing the different Subtasks, including:

- (1) objective
- (2) features of method under investigation
- (3) data-processing
- (4) development apparatus
- (5) necessary conditions of testing material prior to inspection
- (6) results of inspection
- (7) characteristics and limitations of the method under investigation
- (8) overall assessment of reliability and energy conservation potential of method under investigation.

(b) A critical comparison of the various methods.

Participants

The Contracting Parties which are Participants in this sk are the following:

apan (to be specified)

eden (to be specified)

ited States (to be specified)

ANNEX II

HEAT RECOVERY

1. Background

In the process of iron and steel production, large amounts of energy are needed due to the high temperature necessary for the process and due to the high heat capacity of the material under process. A recovery of a part of this heat either from hot slag or from hot exhaust gas could considerably contribute to energy conservation in this industry.

2. Objective

To increase the energy efficiency of iron and steel making processes by developing or improving methods for the technically and economically viable recovery of surplus energy.

3. Means

To collaborate in research, development and demonstration by task sharing into new technology and new applications of existing technology directed towards the above objective

4. Work Distribution and Responsibilities of Participants

(a) Japan

A new type of heat recovery system is under development, combining a moving granular bed heat exchanger with a heat pipe exchanger. Because of its heat storage characteristics, this system is able to provide a steady heated gas outlet temperature under fluctuation conditions of temperature or flow rate of the hot gases from which heat is being recovered. The system is also able to handle dust-laden hot gases. A pilot plant demonstration will be evaluated at a steel-works and operating characteristics determined with a view to developing scale-up parameters for full size units.

(b) Sweden

The development of a high temperature ceramic rotary regenerator will be undertaken, capable of pre-heating combustion air above 1000° C, and associated burner systems capable of utilising this air will be designed and demonstrated.

(c) United States

(may contribute a project to demonstrate up to 200 tubular ceramic recuperators in box annealing furnaces and other applications.)

5. Special Responsibilities of the Operating Agent

The Operating Agent shall be responsible for the overall management of the work under this Annex and for implementing the decisions of the Executive Committee. To that end, the Operating Agent shall:

- (a) Prepare and submit for approval to the Executive Committee not later than one month after the adoption of this Annex a detailed programme of work.
- (b) Report to the Executive Committee on the results and progress of work under the Annex, at least semi-annually.

6. Funding

The cost for the work to be carried out under this Annex will be funded by the Participants as indicated in Paragraph 4. (Note: this may change as a consequence to the comment added to Paragraph 3). In addition, the Operating Agent will bear all costs it incurs in carrying out its responsibilities under this Annex.

7. Time Schedule

This Annex shall enter into force on the date of signature of this Agreement and remain in force for an initial period of 24 months from that date. It may be extended by agreement of the Participants in the Executive Committee. Extensions shall apply only to Participants who agree to the extension or notify the IEA Secretariat of their decision to continue to participate.

8. Operating Agent

(yet to be decided)

9. Information and Intellectual Property

(a) Executive Committee's Powers. The publication, distribution, handling, protection and ownership of information and intellectual property arising from activities conducted under this Annex shall be determined by the Executive Committee, acting by unanimity, in conformity with this Agreement.

(b) Right to Publish. Subject only to the patents and copyright restrictions of this Annex, the Participants in this Annex (referred to in this Annex as the "Participants") shall have the right to publish all information provided to or arising from this Annex except proprietary information, but they shall not publish it with a view to profit, except as agreed by the Executive Committee, acting by unanimity.

(c) Proprietary Information. The Participants shall take all necessary measures in accordance with this Annex, the laws of their respective countries and international law to protect proprietary information. For the purposes of this Annex, proprietary information shall mean information of a confidential nature such as trade secrets and know-how (for example, computer programmes, design procedures and techniques, chemical composition of

materials, or manufacturing methods, processes, or treatments) which is appropriately marked, provided such information:

- (1) Is not generally known or publicly available from other sources;
- (2) Has not previously been made available by the owner to others without obligation concerning its confidentiality; and
- (3) Is not already in the possession of the recipient Participants without obligation concerning its confidentiality.

It shall be the responsibility of each Participant supplying proprietary information to identify the information as such and to ensure that it is appropriately marked.

(d) Production of Relevant Information. The Operating Agent should encourage the governments of all Agency Participating Countries to make available or to identify to the Operating Agent all published or otherwise freely available information known to them that is relevant to the Task. The Participants should notify the Operating Agency of all pre-existing information, and information developed independently of the Task known to them which is relevant to the Task and which can be made available to the Task without contractual or legal limitations.

(e) Reports on Programme Work. Reports containing all arising information and pre-existing information necessary for and used in each Subtask, including proprietary information, shall be provided to each Participant by the Participants performing the Subtask. It shall be the responsibility of each Participant to identify information which qualifies as proprietary information under this Annex and ensure that it is appropriately marked. The Operating Agent shall provide summary reports of work performed under this Annex and results thereof (arising information), excluding proprietary information, to the Executive Committee.

(f) Licensing of Proprietary Information. Each Participant agrees to license all pre-existing proprietary information necessary for and used in its work in the Task and which it owns or controls to the Participants, their governments, and the nationals of their respective countries designated by them royalty-free for research, development and demonstration purposes (non-commercial uses) in the field of energy conservation in the iron and steel industry. Each Participant agrees to license all arising proprietary information to the Participants, their governments, and the nationals of their respective countries designated by them:

on reasonable terms and conditions

(g) Licensing of Patents Needed for Task. Patents solely owned or controlled by a Participant which are needed for use in the Task shall be licensed to the Task Participants for use in the Task only at no cost to such Participants. If such patents are partially owned or controlled by a Participant, then efforts shall be made by the Participant to reduce or eliminate as possible the benefit that might accrue to it.

(h) Arising Inventions. Inventions made or conceived in the course of or under the Task (arising inventions) shall be owned in all countries by the inventing Participant. Information regarding inventions on which patent protection is to be obtained by the Participant shall not be published or publicly disclosed by the other

Participants until a patent application has been filed, provided, however, that this restriction on publication or disclosure shall not extend beyond six months from the date of receipt of such information. It shall be the responsibility of the inventing Participant to appropriately mark reports which disclose inventions that have not been appropriately protected by the filing of a patent application.

- (i) Licensing of Inventions. Each Participant agrees to license all arising inventions to the other Participants, their governments and the nationals of their respective countries on reasonable terms and conditions.

for use in their own country in order to meet their energy needs.

- (j) Copyright. The Operating Agent or each Participant for its own Subtask results may take appropriate measures necessary to protect copyrightable material generated under the Task. Copyrights obtained shall be the property of that Participant or the Operating Agent for the benefit of the Participants, provided, however, that Participants may reproduce and distribute such material, but shall not publish it with a view to profit.

- (k) Inventor and Authors. Each Participant shall, without prejudice to any rights of inventors or authors under its national laws, take all necessary steps to provide the co-operation from its authors and inventors required to carry out the provisions of this paragraph. Each Participant will assume the responsibility to pay awards or compensation required to be paid to its

(1) Determination of "National". The Participants may establish guidelines to determine what constitutes a "national" of a Participant.

10. Results

The results of this Annex will be:

- (a) one comprehensive report for every Subtask, including
 - (1) objective;
 - (2) features of technology under consideration;
 - (3) experimental set-up;
 - (4) data-collection;
 - (5) results, including assessment of reliability and energy conservation potential of the technology under consideration.

ANNEX III

COAL GASIFICATION

1. - 4. Background, Objective, Means, Work Distribution

A brief review of the status of current work on Coal Gasification was made. The necessary work can be divided into three areas:

- (1) Converter Process
- (2) Gas Treatment
- (3) Iron Treatment

Most progress has been made by Sweden (MEFOS) on the converter process, although some ideas (and initial laboratory work) have been developed for gas and iron treatment.

It is intended that this project results in the construction and operation of a full-scale prototype plant: the steps which now need to be taken are indicated in the attached diagramme (III.1).

The activities agreed as necessary, and a proposed breakdown of responsibilities, are summarised in diagramme III.2. Major points to be noted are:

- (1) The initial commitment to a co-operative IEA research programme is restricted to Phase 1, which should result in the detailed engineering design of a "Semi-Commercial" scale plant of about 60 ton size.
- (2) At this stage, an evaluation of the project will be made by the participants and a decision taken whether or not to proceed with the construction and operation of the 60 ton plant.

- (3) If it is decided to proceed, Phase 2 will be undertaken. Details of the responsibilities of each party will be defined at a later date.
- (4) At the end of Phase 2, a further evaluation will be undertaken and a decision taken whether or not to proceed with the design, construction, operation and testing of a full-scale production prototype. Again, details of the responsibilities of participants will be defined at a later date.

Regarding the proposed timetable for this Annex, it is planned that an "informal" meeting of Swedish and Japanese research workers will be arranged for the middle of February 1981, at which time a full report on all experimental work carried out to date by Sweden will be available. Details of Phase 1 will then be discussed and agreed by the participants.

It is anticipated that a formal Implementing Agreement can be signed by about April 1:st, 1981, following which the work on Annex III can begin.

DIAGRAMME III.1 STATUS OF COAL GASIFICATION PROJECT

	Converter process	Gas treatment	Iron treatment
IDEAS	complete	partly complete	little activity to date
EXPERIMENTS to establish basic data and design guidelines	laboratory and small-scale work (6 tons) carried out	some laboratory testing done	some laboratory testing done (10 kg. size)
SCALE-UP DESIGN (for 60 ton size)	planning		
CONTINUOUS TEST of 60 ton plant			
DESIGN of production scale plant			
CONSTRUCTION of production scale plant			
OPERATION and DEMONSTRATION of production prototype

no activities to date

	Converter	Gas treatment	Iron treatment	
Ideas, development of project	S complete	J - S together	J - S together	↑ Phase 1 - IEA Annex III ↓
Experimental work to develop design guidelines	task of Sweden	task of Sweden or Japan - to be defined later -	task of Japan	
Design of scale-up plant (approx. 60 ton)	task of Sweden	task of Japan	task of Japan	
Evaluation, decision to proceed	Decision to be made jointly by participants			

Construction of 60 ton plant	-	-	-	↑ Possible Phase 2 ↓
Operation and testing of 60 ton plant	-	-	-	
Evaluation; decision to proceed	Decision to be made jointly by participants			

Design of production plant	-	-	-	↑ Possible Phase 3 ↓
Construction	-	-	-	
Operation & demonstration of production proto-				

All details to be defined and agreed after respective decisions to proceed have been made.

All details to be defined and agreed after respective decisions to proceed have been made.

5. Special Responsibilities of the Operating Agent

The Operating Agent shall be responsible for the overall management of the work under this Annex and for implementing the decisions of the Executive Committee. To that end, the Operating Agent shall:

- (a) Prepare and submit for approval to the Executive Committee not later than one month after the adoption of this Annex a detailed programme of work.
- (b) Report to the Executive Committee on the results and progress of work under the Annex, at least semi-annually.

6. Funding

The cost for the work to be carried out under this Annex will be funded by the Participants as indicated in Paragraph 4. (Note: this may change as a consequence to the comment added to Paragraph 3). In addition, the Operating Agent will bear all costs it incurs in carrying out its responsibilities under this Annex.

7. Time Schedule

This Annex shall enter into force on the date of signature of this Agreement and remain in force for an initial period of 24 months from that date. It may be extended by agreement of the Participants in the Executive Committee. Extensions shall apply only to Participants who agree to the extension or notify the IEA Secretariat of their decision to continue to participate.

8. Operating Agent

(yet to be decided)

9. Information and Intellectual Property

(a) Executive Committee's Powers. The publication, distribution, handling, protection and ownership of information and intellectual property arising from activities conducted under this Annex shall be determined by the Executive Committee, acting by unanimity, in conformity with this Agreement.

(b) Right to Publish. Subject only to the patents and copyright restrictions of this Annex, the Participants in this Annex (referred to in this Annex as the "Participants") shall have the right to publish all information provided to or arising from this Annex except proprietary information, but they shall not publish it with a view to profit, except as agreed by the Executive Committee, acting by unanimity.

(c) Proprietary Information. The Participants shall take all necessary measures in accordance with this Annex, the laws of their respective countries and international law to protect proprietary information. For the purposes of this Annex, proprietary information shall mean information of a confidential nature such as trade secrets and know-how (for example, computer programmes, design procedures and techniques, chemical composition of materials, or manufacturing methods, processes, or treatments) which is appropriately marked, provided such information:

- (1) Is not generally known or publicly available from other sources;
- (2) Has not previously been made available by the owner to others without obligation concerning its confidentiality; and
- (3) Is not already in the possession of the recipient Participants without obligation concerning its confidentiality.

It shall be the responsibility of each Participant supplying proprietary information to identify the information as such and to ensure that it is appropriately marked.

(d) Production of Relevant Information. The Operating Agent should encourage the governments of all Agency Participating Countries to make available or to identify to the Operating Agent all published or otherwise freely available information known to them that is relevant to the Task. The Participants should notify the Operating Agency of all pre-existing information, and information developed independently of the Task known to them which is relevant to the Task and which can be made available to the Task without contractual or legal limitations.

(e) Reports on Programme Work. Reports containing all arising information and pre-existing information necessary for and used in Task, including proprietary information, shall be provided to each Participant and to the Operating Agent by the Participants. It shall be the responsibility of each Participant to identify information which qualifies as proprietary information under this Annex and ensure that it is appropriately marked. The Operating Agent shall provide summary reports of work performed under this Annex and results thereof (arising information), excluding proprietary information, to the Executive Committee.

(f) Licensing of Proprietary Information. Each Participant agrees to license all pre-existing proprietary information necessary for and used in its work in the Task and which it owns or controls to the other Participants, their governments, and the nationals of their respective countries designated by them, royalty-free for research, development and demonstration purposes (non-commercial uses) in the field of energy conservation in the iron and

steel industry. Each Participant agrees to license all arising proprietary information to the Participants, their governments, and the nationals at their respective countries designated by them:

on reasonable terms and conditions

(g) Licensing of Patents Needed for Task. Patents solely owned or controlled by a Participant which are needed for use in the Task shall be licensed to the Task Participants for use in the Task only at no cost to such Participants. If such patents are partially owned or controlled by a Participant, then efforts shall be made by the Participant to reduce or eliminate as possible the benefit that might accrue to it.

(h) Arising Inventions. Inventions made or conceived in the course of or under the Task (arising inventions) shall be owned in all countries by the inventing Participant. Information regarding inventions on which patent protection is to be obtained by the Participant shall not be published or publicly disclosed by the other

Participants until a patent application has been filed, provided, however, that this restriction on publication or disclosure shall not extend beyond six months from the date of receipt of such information. It shall be the responsibility of the inventing Participant to appropriately mark reports which disclose inventions that have not been appropriately protected by the filing of a patent application.

(i) Licensing of Inventions. Each Participant agrees to license all arising inventions to the other Participants, their governments and the nationals of their respective countries designated by them:

on reasonable terms for use in their own country in order to meet their energy needs.

(j) Copyright. The Operating Agent or each Participant may take appropriate measures necessary to protect copyrightable material generated under the Task. Copyrights obtained shall be the property of that Participant or the Operating Agent for the benefit of the Participants, provided, however, that Participants may reproduce and distribute such material, but shall not publish it with a view to profit.

(k) Inventor and Authors. Each Participant shall, without prejudice to any rights of inventors or authors under its national laws, take all necessary steps to provide the co-operation from its authors and inventors required to carry out the provisions of this paragraph. Each Participant will assume the responsibility to pay awards or compensation required to be paid to its employees according to the laws of its country.

(l) Determination of "National". The Participants may establish guidelines to determine what constitutes a "national" of a Participant.

10. Results

- (a) Participants responsible for the contributions as specified in paragraph 4 above shall prepare and circulate to all Participants a comprehensive report for every Subtask, including
- (1) objective;
 - (2) features of technology under consideration;
 - (3) experimental set-up;
 - (4) data-collection; and
 - (5) results, including assessment of reliability and energy conservation potential of the technology under consideration.

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