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# COMMISSION OF THE EUROPEAN COMMUNITIES

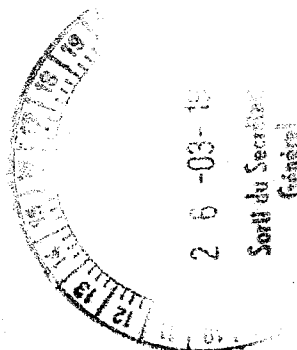
COM(85) 131 final

Brussels, 25 March 1985

## MEMORANDUM

on the implementation of an iron and steel research programme,  
with a view obtaining financial aid under article 55 (2) c of  
ECSC Treaty

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COM(85) 131 final

M E M O R A N D U M

on the implementation of an iron and steel research programme, with a view to obtaining financial aid under article 55(2)c of the ECSC Treaty

I. INTRODUCTION

The ECSC programme of research on iron and steel for 1985 presented in this memorandum consists of projects that have been selected from a total of 155 proposals that were submitted to the Commission on the European Communities requesting aid under Article 55, 2(c) of the ECSC Treaty. All requests have been examined in detail by the services of the Commission in collaboration with the Iron and Steel Technical Research Committee and 73 proposals have been selected for inclusion in the programme.

In the continuing effort to concentrate ECSC resources on those projects that correspond most closely to the criteria outlined in the medium-term orientation for steel research (1981-85) (\*), priority has been given to proposals aimed at improving the industry's international competitiveness through reducing costs and improving productivity in iron and steel-making and through promoting the utilisation and application of steel in product-related studies.

The technical scope of the proposed programme covers various aspects of process-oriented and product-oriented research and the level of funding for the different fields is as follows :

- ironmaking	5.17 %
- steelmaking	26.82 %
- rolling mills and mechanical working	19.20 %
- measurement and analysis	7.56 %
- properties and service performance	40.17 %
- miscellaneous	1.08 %

In the field of ironmaking, the research proposed is aimed at optimising blast furnace performance through further studies of the cohesive zone and burden behaviour while in sinter production the main objectives are the development of on-line monitoring and of simulation tests in order to improve the uniformity of sinter quality.

With the continuing growth in the quantity of steel produced by continuous casting which has now reached some 70 million tonnes/year in the Community, improving the associated technology remains a priority objective; the eight projects included

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(\*) OJ. C.99 - 2.5.1981.

in this programme deal with three main aspects : improved product quality, enhanced plant performance and extending the range of steels that may be cast continuously.

One of the interesting developments in ironmaking is the increasing attention being given to pretreatment methods as a means of modifying the composition of liquid metal. With the objective of obtaining a European assessment of the current situation, a study is proposed to make a technical and economic investigation of various pretreatment processes. Also, in ultra-high-power electric arc steelmaking, two related projects will be concerned with the development and introduction of bath stirring and agitation techniques aimed at improving the economics of the process while the research proposed on refractories is related to the continuous casting process and to ladle metallurgy.

In rolling mill technology, laboratory and plant studies are proposed covering improvements in the quality of flat-mill products as well as the influence of hot deformation, precipitation and cooling on the mechanical properties of strip. In the area of long products, two of the major objectives are the improved dimensional tolerances of bar and the improving strength and toughness properties by means of thermomechanical treatment.

The research dealing with service properties and utilisation has the important overall objective of developing and adapting steels to meet increasingly stringent customer requirements in traditional as well as in new markets. This sector of the programme has assumed increasing importance in recent years and now covers a range of subjects from weldability and formability to alloy and special steels. The main effort in this year's programme is directed at studies of corrosion and surface protection where the emphasis is on protective coatings and fundamental studies of corrosion, of constructional steels and of brittle fracture. In the latter area further work is proposed on the fracture behaviour of linepipe steels to include the problem of hydrogen induced cracking and the toughness and safety of welded joints.

The financial aid for the 73 research proposals amounts to a total of 17.564.500 ECU to which is added 341.900 ECU for ancillary costs and dissemination of information giving a total financial commitment of 17.906.400 ECU. It should be noted that proposals P.1746, P.1660, P.1729 and P.1693 in the memorandum, for which a total aid of 806.400 ECU is requested, will be held in reserve only to be undertaken should additional funds become available during 1985.

The memorandum also contains one demonstration project concerning a neutral pickling process for sheet steel for which an aid of 1.015.000 ECU is requested.

## II. RESEARCH PROJECTS

### II.1. Ore reduction

#### II.1.1. Sintering

In the field of iron ore sintering, two projects are proposed for promotion. In project P.1746 it is proposed to design and try out an automatic monitoring system capable of controlling the uniformity of the sintering process across the grate. The system is intended to provide the necessary information to enable the operator to intervene in the sintering process if required. The aim of project P.1774 is to define the sintering conditions that result in optimum sinter quality, will due regard to disintegration, reducibility and energy consumption.

#### P.1746            System to provide sintering conditions across the grate

1. In the first stage the basic components of the monitoring system are to be defined and specified.
2. In the second stage the system is to be installed and tried out in an industrial sintering plant of Nuova Italsider, Taranto.

Applicants            : CSM, Rome  
                              Nuova Italsider, Taranto

Budget                 : 400.500 ECU

Probable duration : 3 1/2 years

#### P.1774            Improvement of sinter quality

The studies are to be carried out in a simulator in which the temperature/time conditions in the furnace can be simulated.

Experimental sinter mixtures with different MgO and Al<sub>2</sub>O<sub>3</sub> contents are to be investigated. Moreover, the gas composition and the temperature/time conditions will be varied so as to simulate the conditions at the centre and edge of the furnace. Lastly, there are to be mineralogical studies to identify undesirable phases.

Applicant             : Hoogovens, IJmuiden

Budget                 : 279.500 ECU

Probable duration : 3 years

## II.1.2. Blast furnaces

In the blast-furnace sector, too, there are two projects proposed for promotion. The aim of project P.1673 is to define possible ways of influencing the shape and position of the cohesive zone. In project P.1682 the rate of descent and layer depth of the burden are to be traced by measuring the electrical conductivity.

### P.1673      Monitoring the position of the cohesive zone

The research programme is in two stages :

In the first phase, experiments are to be carried out on a simulation model.

In the second phase, industrial-scale blast-furnace experiments will be performed.

The input values for monitoring will be direct measurements of the cohesive zone.

Applicants               : CRM, Liège  
                              Cockerill Sambre, Seraing  
                              Sidmar, Gent

Budget                    : 369.500 ECU

Probable duration       : 2 years

### P.1682      Determination of the burden material in the blast-furnace stack (II)

This is a continuation of the research done in ECSC project 7210.AA/115 of the same title. In the second part of the project, the measuring technique is to be extended to the lower section of the furnace. Suitable electrodes are to be developed and tested for that purpose. The process is to be developed to the stage of industrial maturity.

Applicant                : Thyssen Stahl AG, Duisburg

Budget                   : 464.500 ECU

Probable duration       : 2 years

## II.2. Steel-making

### II.2.1. Casting and solidification

All the seven projects on casting and solidification relate to continuous casting, though in some cases the objectives differ greatly. In project P.1683 an attempt will be made to extend the range of continuously castable steels. Projects P.1668 and P.1718 are designed to in-

investigate the crack formation mechanisms in slabs. The aim of project P.1690 is the warm and hot charging of continuously cast slabs into the reheating furnaces upstream of wide-strip mills. Hence the heat content of continuously cast slabs is to be determined more accurately. In project P.1715 the influence of phosphorus on the hot-toughness of austenitically solidifying steels will be studied. P.1719 provides for the development of an automatic system for the metered feeding of casting powder, which will record the overall and local powder consumption and relate it to product quality. P.1747 is concerned with the design of a mathematical flow model: the "preferred paths" for inclusions are to be determined.

P.1683      Continuous castability

The object of this research is to determine contractions, expansions, stresses and rheological high-temperature characteristics during the continuous casting of alloy steels susceptible to cracking. It is a Community programme that provides for laboratory and industrial experiments.

Applicants                   : VDEh, Düsseldorf  
                                  Hoesch Stahl AG, Dortmund  
                                  Krupp Stahl AG, Bochum  
                                  Thyssen Edelstahlwerke AG, Krefeld  
                                  Thyssen Stahl AG, Duisburg  
                                  Krupp Forschungsinstitut, Essen  
                                  Institut für Allgemeine Metallurgie,  
                                                                                  Clausthal

Budget                        : 1.370.500 ECU

Probable duration       : 3 1/2 years

P.1668      Mechanisms of formation of surface defects  
                  in continuous cast blooms and slabs

The studies are to be directed to the areas mould, steel and covering powder. Industrial experiments will be carried out in various plants, and the programme includes mathematical models, physical models and experiments on a simulator.

Applicant                    : IRSID, St. Germain-en-Laye

Budget                        : 501.500 ECU

Probable duration       : 2 years

P. 1718      Effect of mould and top zone corner cooling  
                  on transverse and longitudinal corner cracking  
                  in slabs and blooms

Moulds with different corner roundings are to be tried out in industrial-scale experiments. Heat-transfer



measurements will be performed in parallel, In addition, various cooling devices will be tested for the zone immediately below the mould.

Applicant : BSC, London  
Budget : 320.000 ECU  
Probable duration : 3 years

P.1690 Cooling of continuously cast slabs

The intention is to develop a process whereby the heat content of continuously cast slabs can be accurately determined by experimental means. A programmable measurement and storage device, which has so far been tried out at temperatures up to 1250° C, is to be modified for use in a continuous casting machine for this purpose.

Applicant : Krupp Stahl AG, Bochum  
Budget : 294.000 ECU  
Probable duration : 3 years

P.1715 The benefits of low phosphorus in the continuous casting of austenitically solidifying steels

Laboratory studies are to be carried out on 50 kg of vacuum melts. The cooling conditions during continuous casting will be simulated with these melts. The studies will relate to spring steels and stainless steels of Type 310. The phosphorus content is to be varied between 0.005 and 0.04 %.

Applicant : BSC, London  
Budget : 117.500 ECU  
Probable duration : 2 years

P.1719 Development of an intelligent system for automatic powder additions to the continuous casting mould

The first step will be to develop in the laboratory a detector for scanning the surface temperature of the casting powder. A number of casting practices will then be tried out in industrial scale experiments. An attempt will be made to correlate powder thickness and powder consumption with the quality of the product.

Applicant : BSC, London  
Budget : 202.000 ECU  
Probable duration : 2 years

P.1747            Casting fluodynamics in continuous casting

This project is concerned primarily with theoretical work in the field of fluodynamics. A mathematical model for the numerical solution of the Navier-Stokes equations is to be developed. It will be checked and corrected in experiments on a physical model.

Applicant            : CSM, Rome  
Budget                : 300.000 ECU  
Probable duration    : 2 years

II.2.2. Steelworks and metallurgy

One of the topics at the forefront of steel production is the manufacture of maximum-purity steels. The trend is towards dividing the various metallurgical reactions such as phosphorus, silicon, sulphur and carbon removal into discrete process phases. All of the four projects fall within this range of topics. Under project P.1670 the potential of torpedo ladles in the pretreatment of pigiron is to be examined. P.1721 is intended to examine the multi-slagging process within the converter, thus avoiding downstream processing in the ladle. The aim of project P.1751 is to produce structural and stainless steel having an extremely low phosphorus content (less than 20 ppm), while project P.1679 would introduce a technical and economical comparison of the various methods of procedure so far put forward and tested.

P.1670            "Study of metallurgical reactions in torpedo ladles"

The effects of size and blower equipment and - flowrate on bath homogeneity would be examined in large torpedo ladles. The following individual studies are planned :

- hydronynamic model studies
- preparation of a mathematical model
- operating tests at Usinor and Solmer

Applicant            : IRSID, St. Germain-en-Laye  
Budget                : 477.500 ECU  
Probable duration    : 18 months

P.1721            Flux additions, refining and deslagging procedures for the products of very low phosphorus and sulphur steel in oxygen converters when processing low silicon iron

In multi-slag processes the slag composition should be selected in such a way that further processing is superfluous. The research would be carried out at both labo-

ratory and pilot scale. Alternative slag forming constituents such as  $Al_2O_3$ , soda ash, metal chlorides and fluorides and also combinations of these would first of all be studied in the laboratory and later in a 3 t LD converter.

Applicant : BSC, London  
Budget : 309.500 ECU  
Probable duration : 2 years

P.1751 Induced dephosphorization of steel

Laboratory, pilot and industrial-scale studies are planned. Phosphorus removal processes under both oxidizing and reducing conditions for the purpose of producing high-grade steels would be examined and developed right up to the technical application stage.

Applicants : CSM, Rome  
Nuova Sias SpA, Aosta  
Dalmine, Bergamo  
Budget : 677.500 ECU  
Probable duration : 2 1/2 years

P.1679 Metallurgical and economic study of the pre-treatment processes for haematite pig iron

This project would pinpoint the technical and economic advantages and drawbacks of the various ways of pretreating pig iron. The following individual aspects would be compared :

- pretreatment of pig in separate stages (removal of silicon, phosphorus, carbon),
- pig treatment in torpedo ladles, with simultaneous removal of silicon and phosphorus,
- treatment with several slag types in the converter.

Applicants : CRM, Liège  
Cockerill-Sambre, Seraing  
Budget : 456.500 ECU  
Probable duration : 3 years

### II.2.3. Steelworks technology

Two of the following projects (P.1691 and P.1692) concern bottom blowing into UHP electric-arc furnaces. In the first case stress is placed on the problems specific to high-grade steel production and in the second on mass

steel production. Projects P.1717 and P.1750 would deal with improvements to the control of the steel temperature in the distributor vessel, thus making casting conditions more even.

P.1691 Bottom blowing into UHP electric-arc furnaces

Projects P.1691 and P.1692 have been matched to each other. Both would involve operating tests. Attempts would be made to improve the homogeneity of the liquid steel bath and increase the yield of the alloying elements (Cr and Ni).

The development of a stirring-gas control unit, including accessories and testing, is planned. This would be followed by metallurgical studies of the effects of the stirring. The ultimate aim is optimization of the process.

Applicant : Krupp Stahl AG, Bochum  
Budget : 228.500 ECU  
Probable duration : 2 1/2 years

P.1692 Bath agitation in the UHP electric-arc furnaces

The following investigations are planned :

- installation and testing of the technical equipment for introducing inert gas via bottom nozzles,
- optimization of the number and configuration of the nozzles used in the process,
- metallurgical studies depending upon the type of gas used,
- matter and energy balances.

Applicant : Thyssen Niederrhein AG, Oberhausen  
Budget : 358.500 ECU  
Probable duration : 2 years

P.1717 Electrical heating of steel in a continuous-caster tundish

Various methods of electrically heating molten steel are to be tested and compared with each other in the tundish in a pilot plant having a capacity of 500 kg of steel. Resistance and inductive heating are planned.

Applicant : BSC, London  
Budget : 196.000 ECU  
Probable duration : 2 years

P.1750      Temperature control of continuous casting by means of plasma burners

It would be examined to what extent a plasma-arc furnace would be suitable for controlling the temperature of the molten steel in the tundish in an industrial facility. Additional metallurgical treatments in the tundish are also planned. The construction and commissioning of a plasma unit with a power of 10 000 A are planned for this purpose. Its thermal efficiency would be determined under various operating conditions and various alloying elements would then be passed through the fusion zone of the plasma arc.

Applicants           : CSM, Rome  
                          Nuova Sias, Aosta

Budget                : 947.500 ECU

Probable duration   : 3 years

II.2.5. Refractories

The intention of project 1669 is to examine which of the various causes of refractory-product wear can be attributed to thermal stressing of the material. Project P.1748 concerns the special problems affecting the ingots in continuous-casting facilities.

P.1669      Steel ladle refractories

The theoretical inter-relationships leading to cracking and chipping especially in ladles - would be examined more closely. Initially the fracture mechanics would be examined on laboratory and operating testpieces.

Running parallel to this a non-destructive test method would be developed which used changes in the resonance frequency and enabled the operating behaviour of any refractory material to be recorded.

Finally, operating tests on ladles - and also on other refractory equipment - are planned.

Applicants           : IRSID, St. Germain-en-Laye  
                          Laboratoire de Réfractaires et Mine-  
                          rais  
                          Université de Nancy

Budget                : 332.500 ECU

Probable duration   : 3 years

P.1748      Nozzles containing CaO for Aluminium killed steel casting

It is first of all intended to produce and test sample ingots containing CaO in the laboratory. Industrial production of such ingots is planned by SANAC after optimization of their composition. Operating tests would be conducted at the Piombino steelworks.

Applicants                   : CSM, Rome  
                                  Piombino steelworks, Livorno

Budget                        : 423.500 ECU

Probable duration        : 2 years

II.2.6. Theoretical metallurgy

P.1693      Plasma ladle furnace metallurgy

The aim of this project is to examine the metallurgical problems arising in a 45 t 3-phase plasma-ladle furnace and to compare the results with those obtained from a 40 t 3-phase arc-ladle furnace. First of all the metallurgical conditions would be examined, such as carbon, nitrogen and sulphur behaviour and also the combustion of alloying elements.

In addition operating parameters such as temperature control, energy consumption, scavaging gas parameters, bath homogeneity and refractory material wear would be examined.

Applicant                    : Kruppstahl AG, Bochum

Budget                        : 337.000 ECU

Probable duration        : 2 1/2 years

II.3.      Transformation

II.3.1. Rolling mills - flat products

The four projects referred to below all relate to the production of hot-rolled wide strip. The parameters leading to the induced segregation of micro-alloyed steels would be examined more closely under project P.1676. The aim of project P.1680 is to improve the butt-ends in continuous mills and to establish the measuring points for the loop lifter. Project 1695 would assess the causes of edge sharpening on hot-rolled strip both qualitatively and quantitatively. Finally, project P.1698 would examine the effects on the conversion behaviour of perlitic steels used for cold working of the hot working and cooling conditions for hot-rolled strip.

P.1676 Hot working in finishing mills

The parameters affecting induced segregation would be examined within the temperature range 800-1050° C. As part of this the rolling speeds would be varied between 1 and 20 m/sec and the reduction levels between 10 and 50 %. The investigations would be carried out on various thicknesses of micro-alloyed steel sheet on a hydraulic simulation rig in the laboratory.

Applicant : CRM, Liège  
Budget : 367.500 ECU  
Probable duration : 3 years

P.1680 Improved bending edges for strip

1. The reasons for distorted butt-ends would be identified and remedies found. Computing algorithms for reverse roller bending would also be plotted.
2. A mathematical model would be developed for loop-lifter regulation purposes.

Both sub-projects would be pursued in parallel.

Applicants : CRM, Liège  
Forges de Clabecq  
Cockerill-Sambre, Seraing  
Budget : 446.500 ECU  
Probable duration : 3 years

P.1695 Causes and influences of edge thinning in hot strip

Initially the causes of edge sharpening would be re-searched and then operational cures tested. The following parameters would also be taken into account : strip tension, rolling forces, strip temperature, lead-in strip profile, free broadside rolling, roller wear, roller temperature and type of rolling. Finally, computerized model studies are planned.

Applicant : Hoesch Stahl, Dortmund  
Budget : 1.159.500 ECU  
Probable duration : 3 years

P.1698 Hot-rolled carbon steel strips

The following programme of studies is planned :

- examination of the parameters final rolling temperature, rolling speed, cooling speed and coiler temperature and the effects on structural development,
- plotting of defined strength categories for hot-rolled strip,
- identification of cold rollability,
- identification of cold workability at high and low degrees of rolling.

These tests are planned to take place on a simulation rig in the laboratory.

Applicant : MPI, Düsseldorf  
Budget : 406.000 ECU  
Probable duration : 3 years

### II.3.2. Rolling mills-long products

In addition to achieving direct savings in materials and energy consumption inherent in hot rolling, the projects listed below are intended to raise product quality either by improving processes and dimension measurements or by improving plants and converting systems to automatic operation. Also dealt with is determination of the best way of manufacturing wire with a high elastic limit by comparing continuous-casting and - rolling methods under controlled-cooling conditions.

P.1792 Dynamic monitoring of the behaviour of rolls during the hot calibrated rolling of long products

This research project is one of those intended to improve the dimensional qualities and increase the output of the long-product rolling operation (sheet piling, beams, angles, etc.). The objective which ARBED proposes to pursue is threefold, namely :

- development and construction of a system for the measurement of the vertical and horizontal displacements of the rolls during the rolling of long products;
- a study of the size and shape of products at the exit from the pass;
- a study on the integration of the newly developed system into an on-line infrastructure for the monitoring of roll separation.

The on-site work will be conducted on ARBED mill II at Esch-Belval.



Applicant : ARBED-recherches, Esch-sur-Alzette  
Budget : 363.500 ECU  
Probable duration : 3 years

P.1783 Temperature control over the cross-section  
of a rolled product

The use of thermomechanical processes in hot rolling is often hindered by objections relating to mill configuration and by the geometrical complexity of long products. The objective of this research project is to achieve the combined application of spray or mist cooling and inductive reheating in these processes on bar and section mills in order to obtain, during and after rolling, an optimum temperature distribution in the product cross-section.

The work will be divided into two distinct parts :

1. Thermal analysis,
2. Experiments.

The test results will be directly transposable to industrial sites.

Applicant : IRSID, Saint-Germain-en-Laye  
Budget : 585.000 ECU  
Probable duration : 4 years

P.1753 Mathematical models for rolled wire rod

The objective which CSM proposes to pursue in this research project is to improve the quality of rolled raw carbon-steel wire rods by developing and using a modelling system capable of simulating microstructure changes during the thermomechanical process of rolling and controlled cooling. The studies will be conducted on three grades of steel :

1. High-carbon steels for prestressed reinforced concrete and high-strength cables.
2. Average- to low-carbon steels for the screw-cutting industry.
3. Low-carbon steels for welding wire.

This work will be carried out in close cooperation with the Piombino steelworks in Italy.

Applicant : CSM, Rome  
Budget : 564.000 ECU  
Probable duration : 3 years

P.1752 Effect of working on the properties of continuously cast structural steel bars

Continuous casting is being used increasingly for structural steels (both carbon and alloyed steels) in the form of rolled bars for various applications in the automotive and general engineering sectors. The quality requirements as regards both surface and internal structure are becoming increasingly stringent. The problem is therefore to determine the most economical manufacturing cycles for ensuring compliance with the quality requirements, with due regard to the special applications for which the products are intended. The objective of this research project is to correlate the variables which determine quality, so as to be able to determine the degree of reduction in the case of as - cast steels, with due regard to their intended use. The study will be conducted on structural steels (both carbon and alloyed) for quenching, annealing and cementation, obtained by continuous casting, for comparison with ingot steels.

Applicant : CSM, Rome  
Budget : 700.000 ECU  
Probable duration : 2 years

P.1725 Extending the product size range from continuously cast sections

The range of product size that can be produced from a particular continuously cast section is limited because a minimum overall area reduction is required for special applications. The objective of this research project will be to develop a means of predicting the effects of various operating parameters on the consolidation of the centre of the products in order to ensure that certain characteristics are obtained.

When the work is completed, the optimum geometrical and thermal conditions will be specified and will enable prototype equipment to be designed.

Applicant : BSC, London  
Budget : 281.500 ECU  
Probable duration : 3 years

P.1724      Process control systems for bar mills

The objective of this BSC-BFI project is to develop systems for automatic tension and gage control on bar mills (modernization of present bar mills) in order to produce bars with improved dimensional tolerances. The work programmes of the two parties concerned are quite distinct : BSC will make use of the results of previous work which led to the creation of a data base; BFI will make use of the simulation model previously developed by its own research department in order to determine the optimum conditions to be adopted.

Applicant               : BSC, London  
Budget                   : 748.000 ECU  
Probable duration   : 3 years

II.4.      Measurements and analysis

The quality of iron and steel products is directly linked with competitiveness. It is absolutely vital to continue the work already started in the measurement, analysis and control sector. In this context, the projects described below will make an obvious contribution, each in its own way, namely :

- by creating new means of measuring the transverse cross-section of strip (P.1671);
- by improving means of detecting and observing surface defects with the aid of a laser technique (P.1700);
- by developing a system for the in-situ chemical analysis of liquid steel by means of laser sampling and direct analysis of the light waves by fibre optics (P.1726);
- by developing a method of examining the structure of steels at high temperatures by electromagnetic-acoustic sampling without contact.

P.1671      Measurement of the transverse cross-section of strip

Precision of measurement still presents a problem in this field. The proposer wishes to make use of a new system (Thomson) recently developed. The system comprises a linear 48-element X-ray detector to provide X-ray images. The objective is thus to demonstrate the feasibility of this technique by creating a prototype in the laboratory, under cold conditions, in order to pinpoint all the problems associated with the source and the definition (resolution). Subsequently, a prototype improved in the light of the results obtained will be developed and installed on-site to measure the edge waste

on strip mills; the useful width will be 200 to 300 mm  
+ 0.2 %.

Applicant : IRSID, St. Germain-en-Laye  
Budget : 595.500 ECU  
Probable duration : 3 years

P.1700 Surface defects

In this project, BFI wishes to develop a means of surface examination with a laser beam. The method will consist in analysing the radiation reflected and scattered in two longitudinal and transverse directions from the strip at a very high rate of about 40 million points/sec. (6 bits), and then in processing this information in order to obtain optical configurations similar to those produced by standard defects. This project follows on from the work initially undertaken as part of the earlier research project No 7210.GB/101. If it proves possible to determine and process in real time additional characteristics such as the light dispersion across the strip, the width, length and frequency, multiple defects and the juxtaposition of different elementary defect types, a major step will have been taken. Considerable improvement of control reliability and opportunities for the application of apparatus for measuring surface conditions could meet requirements in this field.

Applicant : BFI, Düsseldorf  
Budget : 418.000 ECU  
Probable duration : 3 years

P.1776 The optimization of algorithms for tensile tests

Study and research aimed at developing valid selection criteria for the acquisition or construction of data recording and processing equipment. This research will be so conducted as to lead to a standard formulation of definitions for the characterization of materials used in with data-processing equipment. The following criteria or properties will be considered for this purpose :

- |                        |                                      |
|------------------------|--------------------------------------|
| - strength             | - elongation at the point of rupture |
| - elastic limit        | - uniform elongation                 |
| - tensile strength     | - elongation at break                |
| - work-hardening index | - lankford index                     |

Provision is made for cooperation with equipment manufacturers and users.

Applicant : Hoogovens, IJmuiden  
Budget : 426.000 ECU  
Probable duration : 3 years

P.1674 Chemical analysis of rolling emulsions

It is essential to perform chemical analyses of rolling oils and emulsions, on the one hand to ensure that the quality of the oils supplied is constant and, on the other hand, to monitor the state of pollution and deterioration of used emulsions and then to be able to make the necessary corrections in good time.

CRM will initially analyse emulsions used for rolling sheet for coachwork, these emulsions having been recycled over a considerable period. Comparisons between fresh and used oils will be made. The analyses will be conducted by making systematic use of six different methods.

Applicant : CRM, Liège  
Budget : 252.000 ECU  
Probable duration : 3 years

P.1726 Liquid steel analysis

In a previous research project, No 7210.GD/801, BSC laid the foundations required for in-situ chemical analysis of liquid steel. The present project involves continuing this work up to the industrial stage, but with a modified approach; the metal will no longer be extracted in the form of powder. The proposed programme consists in studying the use of a laser source. A laser will be concentrated on the surface of the molten metal in order to produce an aerosol which will be passed to an inductively coupled plasma torch for excitation and will then undergo spectrometric analysis. The light emitted during the "ablation" process will be studied directly by means of a light-wave guide (fibre optics). The objective is to develop equipment for the rapid sampling and analysis of the constituent elements.

Applicant : BSC, Teesside  
Budget : 277.500 ECU  
Probable duration : 2 years

P.1681 Hot electromagnetic-acoustic sampling

This research project follows on from the work undertaken under Agreement No 7210.GA/211. The principal objective of the research is to develop prototype industrial-

scale equipment for the sampling of slabs at the exit of a continuous-casting machine. The new feature is the electromagnetic-acoustic (EMA) transmission of ultrasonic waves by means of a longitudinal-wave emitter-receiver of original design which functions without contact with the surface of the slab. The objectives of this research are the same, namely : the automatic detector of internal defects in steels at the exit of continuous-casting machines.

The industrial-scale trials will be conducted at the exit of the continuous-casting line at Forges de Clabecq.

Applicant : CRM, Liège  
Budget : 243.000 ECU  
Probable duration : 1 year

## II.5. Properties and service performance

A special effort is being made to meet user requirements in this sector not only by ensuring that the most appropriate steel grades for their products are available but also, and in particular, by drawing up and developing - frequently with their assistance - techniques and calculation and evaluation methods which will make possible the optimum utilization of the steels produced.

### II.5.1. Weldability

P.1688 Procedures for determining the resistance spot weldability of steel sheet materials

Resistance spot welding is one of the most widespread means of assembling thin sheet metal in industry. There are nevertheless very few codes for evaluating the quality of such welds and measuring welding parameters.

This lack of standardization became all the more pronounced on the introduction and use of steels with a high elasticity limit.

The aim of the programme put forward is to provide data enabling recommendations regarding the measurement of the current and the diameter of the weld to be made, together with specifications for the welding equipment. This would enable reproducible results to be obtained.

Applicants : Welding Institute, Cambridge  
Hoogovens, IJmuiden  
BSC, London  
Budget : 171.500 ECU  
Probable duration : 2 years

P.1765      Fatigue resistance of spot-welded joints

Motor-vehicle manufacture and the prefabrication of light-metal structural components are currently areas where the spot welding assembly technique is in use.

The work proposed - which takes account of previous work - is intended experimentally to determine residual stress levels, to model these and to incorporate them into the calculation of the stress intensity factors involved in plotting service life. The industries concerned could thus be supplied with information on the preferred arrangement of spot welds in order to provide greater fatigue and static strength.

Applicant                    : Institut de Soudure (French Welding Institute), Paris  
Budget                        : 117.000 ECU  
Probable duration : 2 years

II.5.2. Corrosion and surface protection

P.1703      The containment of rust by means of monolayers

The aim of the research project is to find a way of establishing a surface state during the production of steel sheet which is least susceptible to rusting.

Very pure iron surfaces are not as sensitive to attack by air and humidity and surfaces covered with a monolayer of segregated or adsorbed nitrogen are also very resistant to rusting. Surface layers of different elements or compounds will be established by segregation from the bulk or by adsorption, gas-metal reaction or chemical vapour deposition from the gaseous phase.

Methods will be selected and proposed which can be introduced into the production process for steel sheet, e.g. during batch annealing or continuous annealing.

Applicant                    : Max Planck Institut, Düsseldorf  
Budget                        : 327.000 ECU  
Probable duration : 3 years

P. 1704      Corrosion and hydrogen-uptake of steel

The hydrogen-uptake of steels in acid solutions can lead to various forms of hydrogen-related damage of materials and structures. The purpose of the proposed experiments is to determine whether or not the addition of the alloying elements, Ti, Nb, V, Mo or Al can retard

the corrosion and hydrogen-uptake of steels in strongly acid solutions. Surface enrichment of these elements occurs during general corrosion, probably in the form of oxides, hydrated oxides or hydroxides. These surface layers could strongly inhibit the uptake of hydrogen.

Applicant : Max Planck Institut, Düsseldorf  
Budget : 86.500 ECU  
Probable duration : 1 year

P.1706 Zn crack formation

Hot dip galvanized steel sheet as a material with excellent corrosion resistance has proved to contribute to a longer lifetime of various automotive and other components. The corrosion resistance can be further improved by adding 5 % Al to the Zn-bath. Owing to the extended application of this product, increasing requirements concerning formability and especially surface quality have to be met. The proposed research project is aimed at finding out the cause of surface cracking and to study how to reduce or avoid the formation of cracks.

Applicant : Thyssen Stahl AG, Duisburg  
Budget : 281.000 ECU  
Probable duration : 3 years

P.1728 Constitution of oxide films and corrosion behaviour of stainless steels

Stainless steels resist corrosion through the formation of thin, passive surfaces films. Whereas it is known that passive films are composed principally of oxides of chromium, more complete information is required on their constitution and structure in order to formulate more effective grades in terms of either improved performance or lower cost.

The main object of the proposal is to derive quantitative data on the pitting resistance of stainless steels and to characterize the nature of the passive films.

As a result of this work, it should be possible to develop improved corrosion resistance or compositions that are cheaper or less dependent on strategic alloying elements.

Applicant : BSC, Rotherham  
Budget : 168.000 ECU  
Probable duration : 3 years



P.1744      Surface condition of pickled sheet steel

The purpose of the research proposed is to study the surface characteristics of pickled steel sheet as a function of its history (analysis of the steel, rolling conditions, pickling process) and to examine the importance of these characteristics for the use of the product. The various aspects studied will be, for example : surface chemistry, roughness and microgeometry, micro-defects, colour and brilliance, suitability for oil tempering.

By providing a better knowledge of the surface condition of pickled sheet, the research would provide a better insight into the major fabrication variables and enable the process conditions to be adapted to the final result desired for the direct use of pickled hot-rolled sheet.

Applicant                    : Solmer, Fos sur Mer  
Budget                        : 464.500 ECU  
Probable duration        : 3 years

P.1757      Steel/enamel adhesion mechanisms

The technological development of enameling processes and the rationalization and automation requirements in pretreatments prior to enameling impose specific requirements on the surface quality of cold rolled sheet steels, more strictly than in the past. These new requirements of the enameling industry are related to the general trend in the steel industry away from the traditional ingot steels and towards the continuous cast steels.

The specific object of the research is to define the factors governing the enameling process with a view to pre-determining them, by modifying, where necessary, the present metallurgical processing.

Applicants                    : CSM, Roma  
                                      : Nuova Italsider, Genova  
Budget                        : 704.500 ECU  
Probable duration        : 3 years

II.5.3. Cold forming

P.1678      Characterization of induced surface roughness by laser beam

The mapping of the surface roughness of rolling-mill rollers by means of a laser beam is arousing increasing interest on the part of users. As the conventional parameters used to describe surface roughness are inadequate

for characterizing the surface morphology of the sheet rolled with cylinders of this type - and contacts should be made easier between manufacturers and users - it is proposed that the most appropriate parameters be studied in order to describe this new surface roughness, and that the pressing characteristics (seizing and fretting), together with the aspect after painting be determined as a function of these parameters.

Applicant : CRM, Liège  
Budget : 348.500 ECU  
Probable duration : 2 years

P.1729 Influence of the degree and mode of forming strain on the cyclic stress-strain and strain-life behaviour on high strength sheet-gauge formable steels

With the introduction of thinner and stronger high strength steels for car body weight reduction, designers are paying increased attention to the fatigue and cyclic stress-strain properties of such materials. Fatigue life production models of vehicle structures are becoming increasingly sophisticated.

It is the aim of this research to subject a range of high strength steels, i.e. rephosphorized, high-strength, low-alloy, dual phase and bake-hardenable grades to different modes of forming strain, such as biaxial tension, plane strain and pure shear (flange drawing) and then to determine the resulting cyclic properties and fatigue performance for comparison with material not subjected to prior strain.

Applicant : BSC, Port Talbot  
Budget : 168.000 ECU  
Probable duration : 3 years

P.1730 Influence of surface properties on formability and galling resistance of sheet steel

The relative importance of sheet roughness ( $R_a$ ) and wavelength of peaks ( $\lambda$ ) has been studied but such investigations have frequently been limited by the inability independently to control the levels of these two parameters on the forming response and galling resistance of sheet steel.

The objectives of the research are to produce a wide range of independently controlled  $R_a$  and  $\lambda$  values, to subject the resulting textured strip to formability tests (drawing and stretching), and to assess strain

distribution performance and galling-resistance tests using different lubricants.

Applicant : BSC, Port Talbot  
Budget : 112.500 ECU  
Probable duration : 2 years

P.1731 Weight reduction of vehicle sub-assemblies using thin-walled adhesively-bonded steel composite structures

This research project seeks to explore the possibility of enhanced weight reduction by reducing significantly the thickness of, for example, body panels (down to 0.3 mm) and compensating for this significant thickness reduction by inducing deliberate geometric changes in the plane of the sheet to enhance the structural modulus of sub-assemblies. These composite/quilted materials will be used in conjunction with adhesive and weld bonding techniques further to enhance the stiffness characteristics. Recent developments in new adhesives and production methods will be exploited in the proposed work.

Applicant : BSC, Port Talbot  
Budget : 289.500 ECU  
Probable duration : 3 years

P.1786 In-service behaviour of hot-rolled dual-phase steel components

The industrial production of hot-rolled sheet on double-phase strip mills is on the increase.

Although the main use of such sheet, which is 2-4 mm thick, is in the manufacture of wheels, the vehicle manufacturers would like to use more in structural components.

The purpose of this programme is to study the feasibility of structural components for motor cars made of double-phase hot-rolled sheet. Preliminary tests have revealed a number of crack initiation and propagation problems after forming. It is thus essential to study the parameters governing the sensitivity of such steels to the notch effect after forming.

Applicants : IRSID (Renault, Peugeot, Sollac, Usinor) St. Germain-en-Laye  
Budget : 737.500 ECU  
Probable duration : 3 years

II.5.4. Structural steels

P.1709            Boron in steel

The effect produced by Ti, Al, Zr and N in quenched and tempered, weldable structural steels will be examined by means of laboratory and industrial heats of a clearly defined chemical composition. With a view to developing an optimum alloying combination, the interrelations will be ascertained between chemical composition, transformation behaviour and structure, as well as the resultant mechanical properties.

Applicant            : Thyssen Stahl AG, Duisburg  
Budget                : 641.500 ECU  
Probable duration : 3 years

P.1732            Control of heat-affected-zone toughness in structural steels

The control of austenite grain size at the high temperatures (> 1000° C) prevailing in the weld heat affected zone (HAZ) is becoming of increasing interest to fabricators of large scale structures, e.g. pipelines and oil rigs, because of a trend towards the specification of increasingly stringent HAZ toughness requirements.

The objective of the research proposal is to develop a greater understanding of the processing parameters, such as post solidification cooling rates, slag soaking temperature and rolling schedules, which will lead to the formation of particle distribution with characteristics suitable for the control of HAZ austenite grain size in a range of niobium or vanadium treated steels.

Applicant            : BSC, Rotherham  
Budget                : 282.000 ECU  
Probable duration : 3 years

P.1710            Phosphorus and services properties of steel

Steel with an extremely low phosphorus contents resulting in improved properties, are being used to a steadily increasing extent.

The effect of extremely low phosphorus contents on the corrosion and toughness behaviour of major steel grades has revealed the great importance attached to the adjustment of phosphorus contents to less than 0,010 %. Investigation on the effects of extremely low phosphorus contents on the service properties of the steels are

therefore required, particularly in order to determine the lower limits of phosphorus content which are both technically appropriate and economically reasonable.

The products to be subject to the tests will be made of steel from industrial continuously cast melts.

Applicant : VDEh, Düsseldorf

Budget : 1.116.000 ECU

Probable duration : 3 years

P.1793 Manufacture of high-strength bolts from wire rod

The proposed research is concerned with a comparison of the processing and service properties of high-strength bolts obtained, on the one hand, by the traditional method, i.e. quenching and tempering and, on the other, from a wire rod subjected to quenching and self-tempering using rolling heat and from a wire rod tempered and quenched in coils using reheating. These bolts are widely used in steel structures and machine construction and in the motor vehicles industry. The research programme relates to two different wire-rod diameters in the 8-14 mm range is either C-Mn steel treated in the rolling heat or C 0.20 boron steel subjected to tempering and quenching in coils.

Applicants : Arbed, Luxembourg  
Arbed, Saarstahl

Budget : 351.000 ECU

Probable duration : 3 years

P.1797 Influence of stress relieving by vibration as compared to postweld heat treatment on the fatigue behaviour of repaired welds

The high strength low alloy steels are increasingly used in constructional steelwork, offshore industry in the engineering industry. These steels can have good weldability characteristics if the right precautions are taken into account. As a precaution safe-guarding against brittle fracture weldments in these steels are often stress relieved. The most common method for relieving the residual stresses is post weld heat treatment (PWHT). However, a need exists for a good alternative because PWHT has some significant disadvantages : high costs, metallurgical consequences (HAZ, weldmetal properties) and PWHT is not always applicable. The objective of the proposed research is to study an alternative method of vibration stress relief (VSR).

Applicants : Nederlands Instituut voor Lastechniek (NL)  
Fraunhofer Institut für Betriebsfestigkeit, Darmstadt

Budget : 340.500 ECU

Probable duration : 2 years

#### II.5.5. Fracture mechanics

P.1658 Full-scale and laboratory tests approach to H<sub>2</sub>S induced environmental fracture of pipeline steels and weld

The risk of failure of gas pipelines in wet H<sub>2</sub>S (sour) environment arises because corrosive reactions take place and consequently hydrogen entry into the metal is made possible. Two distinct cracking phenomena can occur in the material :

- Hydrogen Induced Cracking (HIC)
- Sulphide-Stress Corrosion Cracking (SSCC)

The risk of H<sub>2</sub>S being present in pipelines will increase in the future. Therefore the steels to be used must have the lowest possible susceptibility for HIC and SSC. In the proposed programme full scale tests will be carried out, in order to make a correlation between laboratories tests and the pipe in field service.

Applicants : Vallourec, Paris  
Mannesmann, Duisburg

Budget : 650.000 ECU

Probable duration : 3 years

P.1711 Investigation of fracture mechanics concepts

For the assessment of the safety of structural steel parts, several concepts of fracture mechanics are available but their development is not yet complete and their application (especially on weldments) requires further refinement in connection with the influence of stress state, temperature and microstructure. This project will focus on the J.R. Curve concept (method of the J. integral based crack resistance-curves), its limits of applicability are to be determined and possible simplifications for instability predictions will be examined.

Applicant : Max Planck Institut, Düsseldorf

Budget : 267.000 ECU

Probable duration : 3 years

P.1712      Effects of toughness on the load-carrying  
behaviour of notched specimens

In notched structural components the geometrical size effect results in a deformation constraint which leads to an increase of the critical load. Attention must be paid, however, to the material's toughness, which plays an important role. Until now this effect was investigated mainly on specimens with impact energy values in the upper shelf region. In this research proposal the suggestion is made to examine two test materials with very different values (200 J and 40 J) of absorbed impact energy in the upper shelf region. Tests will be made at different temperatures and will demonstrate the meaning of identical absolute values of absorbed impact energy when the associated failure mechanisms are different.

The calculation of fracture mechanic parameters and constraints by the method of finite elements will serve as a useful instrument to make clear how the fracture mechanic parameters can be transferred from small to large specimens.

Applicant               : VDEh, Düsseldorf  
Budget                   : 403.000 ECU  
Probable duration      : 3 years

P.1734      Effects of alloy segregation and yield  
strength on heat affected zone toughness  
and safety of welded joints

The production process for micro-alloyed lower carbon structural steels from continuously cast feedstock results in some degree of centerline alloy segregation which is likely to have a significant influence on the subsequent fracture toughness particularly in the heat affected zone. It is necessary, therefore, to confirm the adequacy of these steels and to provide guidance on welding procedures and HAZ toughness requirements to ensure avoidance of fracture. It is proposed to study the influence of segregation on the significance of defects in welds in low carbon grade 50 type and a higher strength structural steel, using COD and wide plate tests to extend the use of the Burdekin and Dawes approach to the assessment of the safety of welded joints in these situations.

Applicant               : BSC, Rotherham  
Budget                   : 314.000 ECU  
Probable duration      : 3 years

P.1760      Ductile fracture propagation in gas pipeline conditions

The aim of this programme is to study how the characterization of materials under simulated operating conditions in laboratory tests can be extrapolated with reference to actual high-pressure gas-pipeline conditions to this end, a detailed theoretical and experimental investigation of the following topics will be conducted :

- the connection between the deformation range associated with crack development and the R curve of the material;
- the possible effect of such parameters as dimensions, alloying elements, external factors and external stress-range irregularity on the R curve of the material.

Applicant                    : CSM, Roma  
Budget                        : 317.000 ECU  
Probable duration         : 2 years

P.1787      Toughness of tube steels in ductile tearing conditions

Gas-pipeline explosion tests have led to the proposal of correlations which make it possible to forecast crack behaviour in a pressurized tube (cessation or propagation) as a function of materials strength. These correlations must, however, be adapted with reference to new steel grades which exhibit improved characteristics. The proposed programme will relate to two tube-steel grades, namely a traditional X70 type (ferritic-perlitic structure) and a high-quality X80 type (bainitic structure), the principal objectives being to :

- evaluate the influence of geometric factors,
- define the conditions to be satisfied in order to observe a stable cracking process.

Applicant                    : IRSID, St. Germain-en-Laye  
Budget                        : 298.500 ECU  
Probable duration         : 2 years

II.5.6. High-temperature steels - Presure vessels

P.1660      Development of high-strength Cr-Mo steel for pressure vessels operating at high temperature under hydrogen

In future pressure vessels, for which a considerable potential market continues to exist, and hydrocrackers



or hydrosulphurizers will be required to operate under increasingly severe conditions involving greater stresses high hydrogen pressures and high temperatures. This research project is concerned with the improvement of the mechanical properties (Rm up to 780 MPa) of the steel grade generally used (2.25 Cr, 1 Mo) by means of appropriate additions, bearing in mind the very special service conditions to which it is subject.

The main points studied will be :

- the hot properties of castings as a function of the additions made,
- service life,
- the development of an industrial casting having what is found to be the optimum chemical composition

Applicant : Creusot-Loire, Le Creusot  
Budget : 438.500 ECU  
Probable duration : 2 years

#### II.5.7. Marine technology

P.1758 Behaviour of welded joints in offshore platforms

The project concerns the study of joint behaviour in large offshore structures for use in deep seas and/or arctic climates where there is an obvious need for advanced materials in the form of higher-strength steels which exhibit increased weldability and greater brittle-fracture resistance in the welded-joint HAZ. The research is intended to make a contribution to the solution of problems associated with low-temperature static-load fracture resistance.

Applicant : CSM, Roma  
Budget : 990.000 ECU  
Probable duration : 2 1/2 years

#### II.5.8. Light structures

P.1661 Effect of mechanical and structural properties of steel at elevated temperatures on the buckling of steels columns

The ECCS-buckling curves at elevated temperatures may be criticized on various grounds. The hypotheses behind these criticisms are different and are not verified up to the present. Some authors assume that the residual stresses vary as function of the temperature in a similar

way as the yield stress; others assume the residual stresses simply to vanish at elevated temperatures. Both the behaviour of the residual stresses and the stress-strain relationship in compression are of vital importance when trying to describe adequately the buckling phenomenon of fire exposed steel columns. Essentially, the aim of the research is to evaluate the validity of these various hypotheses.

Applicants : CRIF, Liège  
IBBC-TNO, Delft  
Budget : 79.500 ECU  
Probable duration : 2 years

P.1736 Development of computer aided design methods for steel framed composite floored multi-storey buildings

The research proposal covers a two phase approach to the general problem of providing design aid based on micro-computers and modular software programmes to promote the increased use of steel. This first phase concerns a state of the art assessment of existing micro-computers and software and the demonstration of the technical feasibility of the proposed procedure to meet the acknowledged need and to illustrate the cost effectiveness of the overall approach. This proposal concentrates solely on this aspect and aims to identify more precisely how a European Community based approach can be developed through co-operation with the various Steel Information Centers.

Applicant : BSC, Rotherham  
Budget : 172.500 ECU  
Probable duration : 1 year

P.1773 Brochure supporting the fire safety of steel structures

Architects, decision-makers outside the industry and investors require simple, easily comprehensible guidelines which will enable them to deal with fundamental fire-safety questions, particularly in the case of steel structures. It is difficult for these groups to gain basic understanding and form a rapid overall view of the situation from the available literature.

This project will therefore be concerned with the examination and preparation of the data required for the publication of a concise brochure which will contain a considerable amount of information - backed up by fundamental concepts and suitable illustrations - and which will

only touch on theoretical aspects in general terms with a view to providing a brief, stimulating and authoritative summary of the subject.

Applicants : EUROFER (Steel Information Centres)  
Budget : 165.000 ECU  
Probable duration : 2 years

P.1795 Dimensioning of mixed concrete/steel elements subjected to fire, taking account of the interaction between normal stress and moment of bending

A comparison of the results provided by a computer program and those obtained from furnace tests on full-scale components confirmed the value of the program. Nevertheless, a complete understanding of the parameters taken into account and their incorporation in practical, realistic dimensioning procedure is essential if the vast majority of those engaged in building activities are to take advantage of the opportunities offered by mixed construction. It is therefore proposed to use the computer program to draw up practical methods, represented by tables, graphs and formulae, for the dimensioning of mixed pillars and columns.

Applicant : Arbed, Luxembourg  
Budget : 271.000 ECU  
Probable duration : 2 years

#### II.5.9. Special and alloy steels

P.1739 Grain size control in components made directly from concast billet

The cost of converting liquid steel to a finished component shape for use in the automotive and general engineering industries is governed by the number of intermediate stages and can be reduced by eliminating individual operations. The final mechanical properties are controlled to a considerable extent by the grain size developed at the end of the hot working operation and effective grain refining agents are required. The aim of the proposed research is to study the effectiveness of grain refining additions under working conditions by preparing simulated, concast strand structures and subjecting them to thermal cycles typical of post-casting strand reduction and forging operations.

Applicant : BSC, Rotherham  
Budget : 137.000 ECU  
Probable duration : 2 years

P.1742            Stainless steels for wear - resisting applications

Wear problems are responsible for downtime and major losses in production in the coal, steel and power generation industries. The purpose of this investigation is to employ the abrasive and erosive wear techniques that were developed under a previous ECSC project for the evaluation of a range of stainless steels in the wrought, cast and weld deposit condition. The correlation of wear behaviour with other material properties will be undertaken and studies of the mechanisms of degradation will provide a sound basis for the development of improved performance.

Applicant            : BSC, Rotherham  
Budget                : 170.500 ECU  
Probable duration   : 3 years

P.1743            Development of a new quality of non-oriented magnetic sheet

The proposed research concerns the development, with a view to pre-industrial-scale application, of a continuous-casting, hot-rolling and finishing process for the production of a new quality of non-oriented magnetic sheet to be used in the manufacture of magnetic circuits and, more particularly, the stators of high-powered rotary machines. The development of a material having these new qualities would enable electrical engineers to improve the output of such machines as a result of low losses, reduced anisotropy and, in particular, a significant improvement in permeability.

Applicant            : Société Métallurgique de St. Chély d'Apcher  
Budget                : 292.500 ECU  
Probable duration   : 1 year

P.1764            Effect of segregating elements (Sb, Sn) in non-oriented-grain magnetic products

It is well known that magnetic induction is highly dependent on mean grain orientation. This fact, which is of fundamental importance in the case of non-oriented-grain magnetic steels, was established, mainly with reference to Japanese technical and patent literature, by the addition of such segregating elements as Sn and Sb at the grain edge. It is therefore proposed to study Si steels containing Sn and Sb. This study will be particularly concerned with the effect of heat treatment on hot-rolled strip.

Applicants : CSM, Roma  
Terni, Terni  
Istituto Galileo Ferraris, Torino

Budget : 185.500 ECUS

Probable duration : 1 year

## II.6. Miscellaneous

P.1659 Technical literature on iron and steel

This is a continuation of previous agreements granting ASELT financial assistance for the translation unto Community languages of papers on iron and steel subjects published in "difficult languages" (in particular Russian and Japanese).

Applicant : ASELT, Luxembourg

Budget : 190.000 ECU

Probable duration : 1 year

## II.7. Pilot project

PP.044/3 Industrial development of DEN (neutral electrolytic pickling) for hot-rolled strip in carbon and low-alloy steel

This project is an in-plant sequel to the research carried out at CSM with the financial assistance of the ECSC.

For the purposes of the project, a sulphuric-acid pickling line will be shut down and adapted to the DEN process.

1. In order to ensure optimum pickling and to take account of the short distance between strip and electrodes in the DEN cells, a stripper-straightener will be installed at the head of the line downstream of the machines for unrolling the coils and butt-welding them.
2. A horizontal looping machine will make it possible to regulate strip feed. This machine has been specially designed to avoid any damage to the strip and ensure that tension is exerted on it.
3. A pickling unit comprising four vertical DEN cells.

The machines described at points 1 and 2 above were supplied by two non-Italian firms in Europe which developed them at their own expense on the basis of conventional machines. These two firms will also carry out the construction and development work.

This request represents the first phase of the project, which comprises the design, assembly and start-up of the stripper and the looping machine.

The second phase will mainly comprise the start-up of the DEN pickling line : that phase will be financed separately.

The research work will be carried out at the Turin plant of LAF.

Applicants : Laminazione a Freddo, Turin  
BWG, Duisburg  
CIM, Seraing

Budget (1st phase) : 2.030.000 ECU

Probable duration : 1 year for the first phase

S U M M A R Y   L I S T

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Project nr	TITLE OF THE RESEARCH	PROPOSED RESEARCH			FINANCIAL AID	
		by	Probably Durability (years)	Budget Ecu (30.11.1984)	%	ECU (30.11.1984)
	<u>II.I. ORE REDUCTION</u>					
	<u>II.I.1. Sintering</u>					
1746	Systems to provide uniform sintering conditions across the grate	CSM Italsider	3 1/2	400.500	60	240.300
1774	Improvement of sinter quality	Hoogovens	3	279.500	60	167.700
	<u>II.I.2. Blast furnace</u>					
1673	Monitoring the position of the cohesive zone	CRM	2	369.500	60	221.700
1682	Determination of the burden material in the blast furnace stack	Thyssen	2	464.500	60	278.700
	<u>II.2. STEEL-MAKING</u>					
	<u>II.2.1. Casting and solidification</u>					
1683	Continuous castability	VDEh	3 1/2	1.370.500	60	822.300
1668	Mechanisms of formation of surface defects in continuous cast blooms and slabs	IRSID	2	501.500	60	300.900
1718	Effect of mould and top zone corner cooling on traverse and longitudinal corner cracking in slabs and blooms	BSC	3	320.000	60	192.000
1690	Cooling of rough continuously cast slabs	KRUPP	3	294.000	60	176.400
1715	The benefits of low phosphorous in the continuous casting of austenitically solidifying steels	BSC	2	117.500	60	70.500

Project nr	TITLE OF THE RESEARCH	PROPOSED RESEARCH			FINANCIAL AID	
		by	Probably Durability (years)	Budget ECU (30.11.1984)	%	ECU (30.11.1984)
1719	Development of an intelligent system for automatic powder additions to the continuous casting mould	BSC	2	202.000	60	121.200
1747	Casting fluodynamics in continuous casting	CSM	2	300.000	60	180.000
	<u>II.2.2. Steelworks - Metallurgy</u>					
1670	Study of metallurgical reactions in torpedo ladles	IRSID	1 1/2	477.500	60	286.500
1721	Flux additions, refining and deslagging procedures for the production of very low phosphorus and sulphur steel in oxygen converters when processing low silicon iron	BSC	2	309.500	60	185.700
1751	Induced dephosphorization of steel	CSM	2 1/2	677.500	60	406.500
1679	Metallurgical and economic study of pretreatment processes for hematite pig iron	CRM	3	456.500	60	273.900
	<u>II.2.3. Steelworks - Technology</u>					
1691	Bottom blowing in the UHP electric arc furnace	KRUPP	2 1/2	228.500	60	137.100
1692	Bath agitation in the UHP electric arc furnace	Thyssen	2	358.500	60	215.100
1717	Electrical heating of steel in a continuous caster tundish	BSC	2	196.000	60	117.600
1750	Temperature control of continuous casting by means of plasma burners	CSM	3	947.500	60	568.500
	<u>II.2.5. Refractories</u>					
1669	Steel ladle refractories	IRSID	3	332.500	60	199.500
1748	Nozzles containing CaO for aluminium-killed steel casting	CSM	2	423.500	60	254.100
	<u>II.2.6. Theoretical metallurgy</u>					
1693	Plasma ladle furnace metallurgy	KRUPP	2 1/2	337.000	60	202.200
	<u>II.3. TRANSFORMATION</u>					
	<u>II.3.1. Rolling mills - flat products</u>					
1676	Hot working in finishing mills	CRM	3	367.500	60	220.500
1680	Improved leading edges for strip	CRM	3	446.500	60	267.900
1695	Causes and influence of edge thinning in hot strip	HOESCH	3	1.159.500	60	695.700



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		by	Probably Durability (years)	Budget ECU (30.11.1984)	%	ECU (30.11.1984)
1698	Hot-rolled carbon steel strips	MPI	3	406.000	60	243.600
	<u>II.3.2. Rolling mills-long products</u>					
1792	Dynamic monitoring of the behaviour of rolls during the hot calibrated rolling of long products	ARBED	3	363.500	60	218.100
1783	Temperature control over the cross-section of a rolled product	IRSID	4	585.000	60	351.000
1753	Mathematical models for rolled wire rod	CSM	3	564.000	60	338.400
1752	Effect of working on the properties of continuously cast structural steel bars	CSM	2	700.000	60	420.000
1725	Extending the product size range from continuously cast sections	BSC	3	281.500	60	168.900
1724	Process control systems for bar mills	BSC	3	748.000	60	448.800
	<u>II.4. MEASUREMENTS AND ANALYSIS</u>					
1671	Measurement of the transverse cross-section of strip	IRSID	3	595.500	60	357.300
1700	Surface defects	BFI	3	418.000	60	250.800
1776	The optimizing of algorithms for tensile tests	HOOGOSENS	3	426.000	60	255.600
1674	Chemical analysis of rolling emulsions	CRM	3	252.000	60	151.200
1726	Liquid steel analysis	BSC	2	277.500	60	166.500
1681	Soudage électromagnéto-acoustique à chaud	CRM	1	243.000	60	145.800
	<u>II.5. PROPERTIES AND SERVICE PERFORMANCE</u>					
	<u>II.5.1. Weldability</u>					
1688	Procedure for determining the resistance spot weldability of sheet steel materials	- Welding Institute - Hoogovens - BSC	2	171.500	60	102.900
1765	Fatigue resistance of spot welded joints	I.S.	2	117.000	60	70.200

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	<u>II.5.2. Corrosion and surface protection</u>					
1703	The containment of rust by means of monolayers	MPI	3	327.000	60	196.200
1704	Corrosion and hydrogen uptake of steel	MPI	1	86.500	60	51.900
1706	Zn crack formation	THYSSEN	3	281.000	60	168.600
1728	Constitution of oxyde films and corrosion behaviour of stainless steels	BSC	3	168.000	60	100.800
1744	Surface condition of pickled sheet steel	SOLMER	3	464.500	60	278.700
1757	Steel/enamel adhesion mechanisms	CSM N. ITALSIDER	3	704.500	60	422.700
	<u>II.5.3. Cold forming</u>					
1678	Characterization of induced surface roughness by laser beam	CRM	2	348.500	60	209.100
1729	Influence of the degree and mode of forming strain on the cycle stress strain and strain-life behaviour of high strength sheet gauge formable steels	BSC	3	168.000	60	100.800
1730	Influence of surface properties on formability and galling resistance of sheet steel	BSC	2	112.500	60	67.500
1731	Weight reduction of vehicle sub-assemblies using thin walled adhesively bonded steel composite structures	BSC	3	289.500	60	173.700
1786	In-service behaviour of hot-rolled dual-phase steel components	IRSID RENAULT PEUGEOT SOLLAC USINOR	3	737.500	60	442.500
	<u>II.5.4. Structural steels</u>					
1709	Boron in steel	THYSSEN	3	641.500	60	384.900
1732	Control of heat affected zone toughness in structural steel	BSC	3	282.000	60	169.200
1710	Phosphorus and service properties of steel	VDEh	3	1.116.000	60	669.600
1793	Manufacture of high strength bolts from wire rod	ARBED Saarstahl	3	351.000	60	210.600

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1797	Influence of stress relieving by vibration as compared to postweld heat treatment on the fatigue behaviour of repaired welds	NIL LBF	2	340.500	60	204.300
<u>II.5.5. Fracture mechanics</u>						
1658	Full-scale and laboratory tests approach to H <sub>2</sub> S environmental fracture of pipeline steels and welds	VALLOUREC MANNESMAN	3	650.000	45	292.500
1711	Investigation of fracture mechanics concepts	MPI	3	267.000	60	160.200
1712	Effect of toughness on the load-carrying behaviour of notched specimens .	VDEh	3	403.000	60	241.800
1734	Effects of alloy segregation and yield strength on heat affected zone toughness and safety of welded joints	BSC	3	314.000	60	188.400
1760	Ductile fracture propagation in gas pipelines	CSM	2	317.000	60	190.200
1787	Toughness of tube steels in ductile tearing conditions	IRSID	2	298.500	60	179.100
<u>II.5.6. High temperature steels/pressure vessels</u>						
1660	Development of high strength Cr-Mo steel for pressure vessels operating at high temperature under hydrogen pressure	CREUSOT-LOIRE	2	438.500	60	263.100
<u>II.5.7. Marine technology</u>						
1758	Behaviour of welded joints in offshore platforms	CSM	2 1/2	990.000	60	599.400
<u>II.5.8. Light structures</u>						
1661	Effect of mechanical and structural properties of steel at elevated temperatures on the buckling of steel columns	CRIF TNO	2	79.500	60	47.700
1736	Development of computer-aided design methods for steel-framed composite floored multistorey buildings	BSC	1	172.500	60	103.500
1773	Brochure supporting the fire safety of steel structures	EUROFER	2	165.000	80	132.000
1795	Dimensioning of mixed concrete/steel elements subjected to fire, taking account of the interaction between normal stress and moment of bending	ARBED	2	271.000	60	162.600

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		by	Probably Durability (years)	Budget ECU (30.11.1984)	%	ECU (30.11.1984)
	<u>II.5.9. Alloy and special steels</u>					
1739	Grain size control in components made directly from concast billet	BSC	2	137.000	60	82.200
1742	Stainless steels for wear-resisting applications	BSC	3	170.500	60	102.300
1743	Development of a new quality of non-oriented magnetic sheet	ST CHELY D'APCHER	1	292.500	60	175.500
1764	Effect of segregating elements (Sn, Sb) in non-oriented grain magnetic products	{ CSM { TERNI { G. FERRARIS	1	185.500	60	111.300
	<u>II.6. MISCELLANEOUS</u>					
1659	Technical literature on iron and steel	ASELT	1	190.000	100	190.000
	<u>II.7. PILOT - PROJECT</u>					
PP044/3	Industrial development of DEN (Neutral Electrolytic Pickling) for hot-rolled strip in carbon and low-alloy steel	LAMINAZIONE A FREDDO (I) BWG (D) GIM (B)	1 year, 1st stage	2.030.000	50	1.015.000