

# COMMISSION OF THE EUROPEAN COMMUNITIES

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## MEMORANDUM

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

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M E M O R A N D U M

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I - I N T R O D U C T I O N

It is widely recognised that, of the numerous measures the Commission of the European Communities is now undertaking to stimulate the modernisation, rationalization and restructuring of the iron and steel industry, the promotion of research and development work under Article 55 2c of the ECSC Treaty is seen as one of major importance. This enables the Commission to encourage the development of new technology for subsequent incorporation in the construction and operation of steel plant and equipment and to advance the quality of the wide range of semi-finished and finished products that are manufactured within the Community's industry. The ultimate objective of this effort is to enhance the ability of European steel producers to compete in both home and export market.

In view of the continuing adverse situation in the steel sector, it is increasingly recognised by the Commission and by the industry that there is a need to concentrate resources for research on short-to-medium terms objectives in selected key areas.

There is a growing trend, therefore, for research proposals to be concerned with more immediate problems in steel production, processing and fabrication where the possibility exists for the rapid transfer of the results into innovation either in the plant or in the product. This represents a necessary and desirable shift in strategy on the programme and to ensure that it is sustained the Commission is now formulating, in conjunction with the industry, new guidelines for this research effort for the period 1980-85.

It is against this background that the proposed programme of research outlined in this document has been drawn-up from a total of 146 proposals submitted to the Commission requesting a total aid of  $47.8 \times 10^6$  EUA. After detailed study by the services of the Commission in collaboration with the Iron and Steel Technical Research Committee, 73 proposals have been selected as first priority and constitute the iron and steel research programme for 1979.

In examining the aims of the applications and assessing their relevance to the needs of the steel industry, particular attention was given to projects directed at increasing productivity and reducing costs (including energy conservation), enhancing product quality and improving the properties, service performance and utilization of steels.

The technical content of the programme covers various aspects of iron and steel research connected with problems both in the producer and the user sectors with the level of funding distributed as follows - ironmaking (18,2 %),

steelmaking (27,6 %) rolling mills and mechanical working (5,5 %) measurements and analysis (11,1 %), properties and service performance of steels (36,8 %) and miscellaneous (0,8 %).

In line with the requirement to intensify effort in selected areas, it should be noted that, within this programme, 66 % of the resources have been allocated to five major collaborative projects on the sintering of iron ores (7,1 %), blast furnace technology (11,1 %), continuous casting of steel (11,8 %), electric arc furnace steelmaking (14,2 %) and formable high strength sheet steels for automobile applications (22 %).

The financial aid for the 73 selected research projects totals 19 494 950 EUA. To this is added 505 050 EUA for ancillary costs and dissemination of information, giving a total financial commitment for 1979 of 20 000 000EUA.

## I I - T H E R E S E A R C H P R O J E C T S

### II.1 - ORE REDUCTION

#### a) Sinter

The objectives pursued in the sinter projects are productivity improvements, energy savings and quality improvements. It is well known that sinter quality is of decisive importance in keeping down blast furnace coke rates and hence of special relevance today.

One project is the continuation of an ECSC research project already in progress. The aim is to optimize the overall process. This will be achieved by a new method of sinter strand control based on the measurement of the degree of oxidation of waste gases.

Another project is primarily aimed at securing energy savings in the sinter process. This will be achieved by oxygen enrichment of the blast and blast pre-heating while a further project is also aimed at improving the heat economy of the process. The flexibility of the energy sources used will be increased. Particular attention will be devoted to the zone of high temperature, since it is the key factor in the mechanical properties of the sinter.

The problem of the low-temperature strength of sinter produced from low-grade Lorraine ores is also investigated. Where strength is poor in the cold state a higher proportion of fines arise when the sinter is charged into the blast furnace, which results in less satisfactory permeation of gases and higher consumption of energy.

#### - P 613 "Thermal optimization of the sinter process"

The research will be carried out on an industrial sinter plant having a suction area of 168 m<sup>2</sup> belonging to Italsider in Cornigliano. The intention is to determine the end point of the sintering process by way of the change in degree of oxidation of the waste gases in the last wind boxes and to correlate it with the quality of the sinter.

Applicant : ITALSIDER - Genova.  
Amount : 717 000 EUA  
Duration : 2 years

- P 666 "Oxygen enrichment of firing gases for DL sintering"

The research is planned for a sinter plant with a suction area of 320 m<sup>2</sup> belonging to Arbed, at the Esch-Belval works, in conjunction with Lurgi in Frankfurt.

After the necessary reconstruction of the plant the combustion air will be gradually enriched with up to max. 30% oxygen. The gas used will be blast furnace gas which, where necessary, may be mixed with natural gas.

In a second phase the waste heat of the stack gases will be used for pre-heating the air.

Applicant : ARBED - Luxembourg  
              LURGI - Frankfurt  
Amount : 308 500 EUA and 52 000 EUA.  
Duration : 2 1/2 years

- P 668/2 "Optimization of the sintering process with particular reference to fuel savings"

The investigations are intended to cover the following programme : pre-heating of the sinter mixture, improvement and monitoring of sinter grain sizing enlarging the ignition hood, heat recovery, detailed study of the high-temperature zone and development of a sinter model for process control.

Applicant : BSC - London  
Amount : 570 500 EUA  
Duration : 3 years

- P 702 "Sintering of Lorraine ore"

The research will be carried out by IRSID in cooperation with the firm Sollac.

To begin with the interaction of the individual parameters responsible for the mechanical properties of Minette sinter will be investigated. Subsequently the sintering mechanism itself will be investigated and finally the properties of the sinter, with determination of the exact origin of the fine fraction.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 638 500 EUA  
Duration : 3 years

b) Blast furnace

Of all the research objectives in the blast furnace sector, energy saving is the most important.

Three of the projects are aimed at reducing the blast-furnace coke rate.

It is well known that the width and shape of the zone of softening in the blast furnace exerts a considerable influence on the consumption of energy. For this reason, a broadly based Community programme is to be conducted to investigate the behaviour of different sinters in the 1 000 - 1 500°C temperature zone. The investigations range from laboratory studies of the kinetics of reactions between molten iron oxide and carbon to full-scale blast-furnace tests.

One of the preconditions for a low coke rate is good mechanical behaviour of the coke in the blast furnace. One project will investigate the special problem of the influence of alkalis on the mechanical properties of the coke and on coke gasification.

Another project is concerned with the problem of operating safety and the availability of blast preheaters. A monitoring system for the domes of the hot-blast stoves will be developed and tested.

A project is a continuation of a project with the future in mind, namely, the injection into the blast furnace of the reduction gas product in a plasma furnace from cheap sources of energy. Because of its high temperature (approximately 2 000°C), the gas will be injected at the level of the tuyere blast mains.

- P 723 "Kinetics of iron oxide reduction in the conditions prevailing in the bosh"

The conditions prevailing in the bosh will be simulated in laboratory tests. The kinetics of liquid FeO reduction using fixed carbon in the presence of slag will be investigated. A detailed analysis will be made of the effects of gangue, coke and grain size. On the basis of the results obtained, the reduction mechanism will then be determined as a function of the degree of reduction.

Applicant : CSM - Roma  
Amount : 152 500 EUA  
Duration : 2 years

- P 616 "Effects of the softening and melting zone on blast furnace performances"

The investigation will be carried out in the Italsider 10 m-diameter blast furnace at Taranto. After softening, the ores are reduced by means of fixed carbon. The course of the process is largely determined by the position and shape of the softening and melting zone, which influence productivity, energy consumption and refractory wear. This zone will be examined in detail.

Applicant : ITALSIDER - Genova  
Amount : 703 500 EUA  
Duration : 2 years

- P 637 "Influence of burden properties on the performance of blast furnace of approximately 10 m hearth diameter"

Of the five ironworks involved in this research, four produce low-phosphorus and one high-phosphorus pig iron.

The optimum properties of sinter will be determined under optimum charge distribution conditions. In the subsequent tests of mixtures of sinter, pellets and lump ores, the ore base, FeO content and sinter binding phases will be varied systematically.

Applicant : VDEh - Düsseldorf  
Amount : 1 257 500 EUA  
Duration : 3 years

- P 703 "Alkalines and properties of coke"

A detailed investigation will be made of the effect which the physico-chemical conditions prevailing in the tuyere zone have on the properties of coke.

In particular, it is planned to investigate the catalytic effect of the alkalines on the gasification of coke and the interaction of alkalines with the ash constituents of coke. The project is designed to provide an explanation for the decomposition of coke.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 433 500 EUA  
Duration : 3 years

- P 672 "In-service monitoring of intercrystalline stress corrosion in hot-blast-stove domes by acoustic emission"

The work will be carried out in the Teesside Laboratories and the Reader Works.

The noise emission method will initially be tested as to its suitability for the detection of cracks in the domes of hot-blast stoves at an early stage.

In addition to noise emission, the humidity,  $\text{NO}_x$ ,  $\text{SO}_2$  and temperature of the domes will be recorded.

Applicant : BSC - London  
Amount : 501 000 EUA  
Duration : 5 years

- P 634 "Rational use and diversification of types of energy that can be used in the blast furnace"

It has proved possible to reduce the coke rate in the 0.3 m test blast furnace from 680 kg/t to 180 kg/t pig iron by the simultaneous injection of 650 Nm<sup>3</sup>/t cracked gas. A wide range of malfunctions will now be simulated and investigated before the process is used on an industrial scale. These investigations will relate to both blast furnaces and the circulation of top gas.

Applicant : CRM - Liège  
Amount : 536 000 EUA  
Duration : 3 years

## II.2 - STEELMAKING

### a) Casting and Solidification

The transition from liquid to solid steel is an important stage in the production of steel. This is the decision stage in the determination of the quality of the product. The quantity of internal return scrap also depends to a large extent on the type and quality of the casting process. Improvements in this sector thus directly influence the profitability of the steel plant.

On one project the aim is to improve deoxidation and desulphurization with the aid of alkaline earths, particularly calcium. Calcium deoxidation is of increasing interest in the production of free-cutting steels.

The remaining projects all have to do with continuous casting. One project is aimed at improving the continuous casting machine, particularly the pinch rolls. Replacement of the pinch rolls currently represents a substantial cost factor in the overall operating costs.

Casting speed depends largely on cooling. The aim of one project is to secure more intensive secondary cooling and hence to increase productivity.

Two projects are aimed at improving the quality of continuously cast products and are therefore concerned with the special problem of slab swelling.

In a further project an attempt is to be made, to extend the field of application of continuously cast products the heavy-plate sector.

One project is aimed at improving process control by automatic control of the shell thickness on emergence from the mould. This will increase the operating safety of the process.

One research proposal deals with quality control in continuously cast products. A rapid and rational method is to be developed to determine the homogeneity of products with respect to microsegregations.

Finally, the aim of one application is to link the casting process with the rolling process. In recent years, considerable progress has been made in this respect in the field of non-ferrous metals. An attempt is to be made to transfer experience gathered so far to the technology of steel production.

- P 726 "Treatment of steel by injection of materials containing alkaline earth elements"

Various deoxidation techniques will be tried out in a 15 kg experimental furnace :

- injection of alkaline earth elements with an inert carrier gas through the bottom;
- injection with a submerged lance;
- introduction of the deoxidizer by means of a wire with a core containing calcium;

Various alkaline earths, either pure or in the form of mixtures with aluminium and silicon, will be tried. The best method will then be used for the production of 20-50 ingots.

Applicant : CSM - Roma  
Amount : 636 500 EUA  
Duration : 3 years

- P 674 : "Evaluation, development and design of transport rollers in continuous casting plant"

In this project the intention is to carry out a systematic evaluation of transport and backup rollers in continuous casting plant. The thermal and mechanical operating conditions will be determined precisely. Tests will be carried out in practical operation and in the laboratory. In the practical tests the main causes of damage will be determined (surface deterioration, wear, brittle fracture, deformation). In the laboratory tests, one solid piece, built-up and surface-hardened rollers will be exhaustively tested to determine their advantages and drawbacks.

Applicant : BSC - London  
Amount : 429 500 EUA  
Duration : 3 years

- P 631 "Intensive cooling of continuously cast billets"

This consists of the industrial application of the research project on the thermal investigation of the strand. It was found that special cooling devices could reduce the surface temperature from 900°C to 700°C. On a 120 X 120 mm<sup>2</sup> billet casting plant, it will be ascertained how far productivity can be increased by more intensive cooling. Atomizer jets will be used as the cooling device.

Applicant : CRM - Liège  
Amount : 341 500 EUA  
Duration : 3 years

- P 632 : "Influence of secondary cooling on slab swelling and internal quality"

The casting speed on a 200 mm slab casting machine will be varied from 0.7 to 1.3 m/min. The influence of casting speed on segregation will be investigated. At the same time the mechanical properties in the temperature range 700-1 450°C will be studied. The influence of the alloying elements Ni, Cr, Mn, Mo, C, Si, S and P will also be examined in a given concentration range (low-alloy steel).

Applicant : CRM - Liège  
Amount : 402 500 EUA  
Duration : 3 years

- P 705 "Technological improvements to the continuous projects process"

The project relates to the continuous casting of slabs and is designed to enhance the safety of the continuous casting machine, increase with drawal speed and improve quality. The research is concentrated on the continuous casting mould. The influence of the length of the mould and of its taper on the above mentioned factors will be investigated. Data on material characteristics at high temperatures are required in order to evaluate the taper by means of a thermomechanical mathematical model. Consequently cooperation with project P 632 is planned.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 567 000 EUA  
Duration : 3 years

- P 706 "Role of mechanical working on the quality of plates from continuously cast slabs"

At present the maximum slab thickness obtainable by continuous casting is 250-300 mm. With a degree of reduction of 5 to 6, this gives a maximum plate thickness of 50 to 70 mm. The mechanical properties of the plates are largely determined by the macrostructure. This in turn depends on the interrelations between the degree of reduction and the superheating temperature (during casting). These interactions are to be thoroughly investigated with the aim of obtaining greater plate thicknesses from the same slab dimensions. The influence of electromagnetic stirring will also be investigated.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 458 500 EUA  
Duration : 3 years

- P 639 "Continuous determination of shell thickness in the continuous casting of steel to improve process control"

A method of determining shell thickness during casting at one or more



points is to be developed. If the shell thickness is known the pouring process can be better controlled and there is less risk of breakout. The measurement itself will be carried out with the aid of electromagnetic stirring coils. Through the rotation of the liquid steel a torque reacting on the inductor is formed. This torque depends on the shell thickness. The research will be carried out on the model, on a billet casting machine and later on a slab casting machine.

Applicant : BFI - Düsseldorf  
Amount : 489 000 EUA  
Duration : 3 years

- P 715 "Electron probe microanalysis of microsegregation in steels depending on casting method"

Under this project electron probe microanalysis will be further developed for fast and efficient determination of the homogeneity of the steel. The system will be used in particular to evaluate pouring methods in continuous casting.

The results obtained with the electron probe will be compared with conventional metallographic results. The measurement results will be evaluated by means of the new technique of statistical geometry.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 434 000 EUA  
Duration : 3 years

- P 700 "Development of a direct strand reduction method for steel"

A preliminary study will first be made. This will be based on experience of direct strand reduction for non-ferrous metals. The programme of work is as follows :

1. Determination of the requirements for a continuous casting method for steel with a mould moving with the strand
2. Discussion of problems specific to steel and development of ways of solving them
3. Selection of a suitable pouring system
4. Description of possible solutions
5. Evaluation of the prospects of success

Applicant : KRUPP - Essen  
Amount : 30 000 EUA  
Duration : 10 months

b) Electric steelwork

The main objectives of the steelmaking research projects are process optimization, energy saving and more rational use of scrap. The last-mentioned could be of considerable macroeconomic interest.

One project is aimed at the optimization of the AOD process. The idea is to automate the process with the main object of keeping down chromium losses and argon consumption.

The aim of one research project is to melt scrap and sponge iron in a shaft furnace. This new development is interesting from two points of view : the primary energy input can be reduced by approximately 40 % by comparison with the UHP furnace; and this process could increase the flexibility of scrap-charging in steel plants which have no electric furnaces.

It is proposed in another project to utilize the waste heat arising in the UHP furnace. This proposal aims at improving the BBC/BRUSA process.

The following project is also aimed at improving the operation of the UHP furnace, including line feed-back effects. This is to be achieved by stabilizing the electric arc.

As part of a further project, the technology of melting and refining is to be improved by the use of plasma burners.

The final project relates to ladle metallurgy. The intention is to build an inductively heated ladle and to test it in a steel plant. All the metallurgical work, such as heating the melt to casting temperature, alloying and degassing, will be carried out in this ladle. In this way, both casting temperature and the desired composition can be determined more accurately.

- P 605 "Refining of stainless steels in the AOD converter"

The research will be carried out in Teksid's 80 t AOD converter.

The mathematical models describing the process as regards flow dynamics and from the physical and chemical aspects will be developed in the first phase.

These models will then be tried out on the converter. The project is planned to culminate in continuous process control.

Applicant : TEKSID - Torino  
Amount : 500 000 EUA  
Duration : 3 years

- P 641 "Development of the "Klöckner" steelmaking method based on scrap and sponge iron"

In a pilot plant with a capacity of 4 000 t/month it has been shown that only 1.0 Gcal primary energy is needed to melt a tonne of crude steel. It is now planned to construct a prototype plant of 50 000 t/month. Tests on the burners and on the charging, cooling and dust removal systems will be carried out on this plant. In addition, refractory life will be investigated and finally the economic efficiency of the process will be demonstrated.

ECSC aid is limited to staff and operating costs and to research and development costs.

Applicant : KLÖCKNERWERKE - Duisbourg  
Amount : 30 708 000 EUA  
Duration : 3 1/2 years

- P 675 "Application of the modified "BBC/Brusa" scrap-preheater process to a large UHP furnace"

Scrap preheating by the BBC/Brusa process is to be tried out for the first time on a 170 t UHP electric arc furnace. The hot waste gases will preheat the scrap in a rotary kiln. The inclination of the kiln will be adjustable so that scrap can continue to be preheated during the refining period. A scrap grading plant will precede the rotary kiln. A mathematical model will be constructed for the complete process.

Applicant : BSC - London  
Amount : 339 500 EUA  
Duration : 2 1/2 years

- P 708 "Improvement of industrial arc functioning"

In the first stage the high-voltage systems themselves and the reactive effects of these systems on the mains will be investigated on the IRSID experimental furnace and on several industrial UHP furnaces. In a subsequent experimental stage an attempt will be made to improve the functioning of electric arc furnaces. This will be done by stabilizing the arc by means of slightly ionizable substances that are either injected into the furnace or added to the electrodes. Reignition of the arcs is to be facilitated by a superposed arc of low output but high frequency.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 554 000 EUA  
Duration : 3 years

- P 725 "Applications of the plasma arc technique in steel melting and refining"

The temperatures of 5 000 - 10 000°C obtainable in plasma are to be used for both the melting and refining of steel.

1. In a 3 t experimental furnace (and later in a 40 t industrial furnace) gases (argon or argon mixtures) will be injected into the arc through hollow electrodes. The influence of the gases on the harmonics, flickering, the arc itself, the arc flame, productivity, refractory wear and noise level will be investigated.
2. An attempt will be made to add desulphurizing and deoxidizing agents and alloying elements together with the carrier gas.
3. Plasma torches will be tried out for the first time outside melting plant :
  - in the tundish for continuous casting
  - in the ladle.

Applicant : CSM - Roma  
Amount : 512 000 EUA  
Duration : 2 1/2 years

- P 709 "Metallurgical treatment of steel in an induction-heated ladle"

In this project an induction-heated ladle is to be constructed and tested. The ladle will first be used to adjust the teeming temperature precisely. In a second experimental phase vacuum treatment will be carried out in the ladle at the same time. The following will be investigated :

- the energy balance
- the speed of dissolution of additions
- the precipitation speed of inclusions
- the possibility of sulphur removal

Applicant : IRSID - St. Germain-en-Laye  
Amount : 528 000 EUA  
Duration : 3 years

c) Refractories

Other refractory materials of interest to the steel industry will be tested as part of a research project in progress. The intention is to determine the behaviour of refractory materials in situ with particular reference to rapid rates of heating. The aim is to achieve, by cutting down heating periods, an increase in availability and hence a reduction in capital costs.

- P 642 "Determination of the fastest rate of heating for refractory-lined units"

In a current ECSC research project it has been found that the expansion pressures in a masonry bond are smaller than would be expected from data measured on the individual brick. This would mean in practical terms that refractory units could in future be heated up much faster than at present. In the current project fireclay, silica and magnesite bricks are being tested.

In this additional project the research will be extended to bauxite, mullite and corundum.

Applicant : VDEh - Düsseldorf  
Amount : 159 000 EUA  
Duration : 1 1/2 years

d) Theoretical steelmaking

The aim of the research is to provide thermochemical and kinetic data to serve as a basis for the calculation of equilibria in the production of iron and steel, in refining and in the making of alloy steels. The work will be concentrated mainly on the complicated equilibria of complex systems that occur in practice.

- P 644 "Critical review of metallochemical data on compounds and alloys occurring in iron and steel production"

1. Production of binary constitutional diagrams for iron and writing of computer programs to calculate the phase boundaries of ternary systems incorporating interaction factors. The systems Fe, Ni, Co, Cr, and Mo will be investigated together with the nitride and carbide equilibria in solid and liquid steels.
2. Writing of computer programs to determine the equilibria in Fe, C, H, O, N, S systems and to prepare energy balances for the reduction of iron ores.
3. Calorimetric measurements on the alloy systems Fe, Cr, Mo and Ni, Co, Cr and also on the oxide systems FeO, MnO, MgO. Compilation of diffusion speeds in oxide systems.

Applicant : RWTH - Aachen  
Amount : 333 500 EUA  
Duration : 3 years

- P 724 "Thermodynamic behaviour of compound deoxidizers"

- (a) Calculation of equilibrium diagrams for various deoxidizing agents (Ca, Si, Al) in steel. The equilibria will be determined by means of statistical thermodynamics.
- (b) In a second stage appropriate laboratory tests will be carried out on 50-100 kg melts. These measurements will serve to check the calculations.

Applicant : CSM - Roma  
Amount : 203 500 EUA  
Duration : 2 1/2 years

### II.3 - TRANSFORMATION

The main objective of the rolling mill research projects is to save costs and energy.

One project is aimed at reducing maintenance and repair costs in rolling mills. This is to be achieved by the installation of an automatic early-warning system for malfunctions.

In another project the characteristic material values still lacking for high temperatures will be determined for the fully automated programme control of a hot strip mill.

A further problem is the hot connection between continuous casting plant and hot strip mill. A hot strip mill requires varying slab widths during a rolling programme. An effort will be made to meet this requirement without having to change the slab mould in the continuous casting plant each time. A new method will be devised to reduce the width of a continuously cast slab down to 600 mm.

In the project in the reheating furnace field, the main emphasis is also on energy saving. A newly developed ceramic burner is to be tested. The expected energy saving in the soaking pits will be in the region of 25 %. The mean energy consumption is at present running at approximately 0.15 Gcal/t steel. This research thus has great economic importance.

#### - P 677 "Evaluation of an integrated operating condition monitoring maintenance scheme"

A monitoring system is to be set up in an integrated area which will monitor the operating condition of the individual components. This system will make it possible to shorten down times, reduce unintentional losses of production, make more efficient use of maintenance services and reduce costs of spare parts.

In the first stage, the necessary data will be collected. Subsequently, the actual maintenance scheme will be worked out and, finally, experience will be gathered over an extended period on the advantages and disadvantages of such a scheme.

Applicant : BSC - London  
Amount : 622 000 EUA  
Duration : 3 years

#### - P 710 "Characteristics of plastic flow in the metal under hot-strip-mill conditions"

Rolling models in general use at present have the disadvantage that insufficient account is taken of the real plastic behaviour of the material. For this reason, stresses in the hot state will be determined in mild steels, construction steels and tube steels. The test parameters are :

- chemical analysis;
- degree of deformation;
- rate of deformation;
- temperature;
- interval between passes.

The metallurgical factors to be studied here are austenite grain size, presence of precipitations and evaluation of deformation arising through non-recrystallization between passes.

The improved rolling model devised on the basis of the results of this research will then be tested in an industrial hot-strip mill.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 329 000 EUA  
Duration : 3 years

- P 739 "New method for large width reductions in a hot-strip mill"

In order to be able to cover the maximum possible range in the rolling programme of a hot-strip mill with a single slab width while retaining a hot connection, it is necessary to be able to reduce the slab width by approximately 600 mm. The following options will be explored in this connection :

- (a) synchronization of tension between two horizontal rolling stands;
- (b) use of one or more edging stands;
- (c) combination of (a) and (b);
- (d) forging in direction of slab width;
- (e) pressing in direction of slab width.

The various possibilities will be tried out first on a plasticine-model rolling mill (scale 1:10). A mathematical model will then be developed and, finally, the results will be transferred to an industrial plant.

Applicant : HOOGOEVENS - Ijmuiden  
Amount : 605 000 EUA  
Duration : 6 years

- P 745 "Thermal efficiency of reheating furnaces"

A newly developed ceramic burner, which it is hoped will provide better thermal efficiency, will be tested in several stages :

- (a) In a thermal power station belonging to ARBED Esch/Belval (AEB).  
In the first instance operating parameters will be tested.
- (b) In a small 60-tonne soaking pit belonging to AEB.
- (c) In a pilot plant.
- (d) In a large 160-tonne furnace.

Applicant : ARBED - Luxembourg  
Amount : 233 000 EAA  
Duration : 2 years

#### II.4 - MEASUREMENTS AND ANALYSIS

The increasingly stringent requirements of users in respect of quality, a broader range of steel grades and the need to reduce operating costs are all factors calling for new methods or processes for examination, inspection and analysis at the various stages of the industrial production and processing of steels.

In addition, it would appear that product quality will play a more decisive role than ever in the penetration of international markets and in competition on those markets.

The thirteen projects presented in the Measurements and Analysis sector are oriented towards studies covering :

- the process; for example, the determination of contents of aluminium in solution in steels by a hitherto unpublicized method of optical emission spectrometry. For the steelmaker, this information is essential for checking the correct adjustment to grade of killed steels. In particular, it is indispensable, in making corrections to the metal bath following certain metallurgical operations (desulphurization of metal by reaction with slag etc); hence rationalization of the process, cost savings and a product of definite and consistent quality.
- the material; without going outside the chemical analysis field (secondary ionic emission), it is essential to formulate the limits of the distribution of elements between the different phases involved in order to plot the development of properties as a function of the precipitation of certain alloying elements. The object here is to promote selectivity (new grades of steels) and to determine more effectively the technological performance of different steels, and hence to cover the range of uses to which they can be applied and so find new outlets for them on the market.
- product properties; for example, determining the degree of freedom from inclusions has a direct incidence on the quality and performance of steels. A non-destructive method of ultrasonic examination of structures will open the way to such an investigation. The economic incidence will be considerable, since the aim here is to obtain a better evaluation of product quality at the stages of steel production, processing and finished products.
- the development of an integrated industrial inspection system using scanning by ultrasonic beams to evaluate the influence of steelmaking parameters on the presence of defects in hot-rolled products of heavy thickness and slabs from continuous casting. A system of this kind is of particular relevance to continuous casting, but its application requires many precautions and adjustments. It will assist in obtaining a better and consistent product, which is what all consumers are calling for, especially pressure-vessel constructors and the nuclear sector. Irrespective of the quality aspect, there is that of safety.
- product finish; which is of great significance as regards to subsequent joining, machining and corrosion protection operations (tinning, galvanizing, phosphating). This aspect is of interest to the huge motor industry market in particular. By way of illustration, one may mention those projects which deal with examination for defects and surface condition, which require precautions, and hence research, and in which genuine developments are indispensable not only to promote the product but also to meet increasingly stringent new standards.



-- steel promotion; which embodies a complex of interlinked factors (rationalization, cost, quality, etc). The safety aspect is one of the links in this chain. It is tackled at both the technical and the regulatory level. From this point of view, one project proposes determining a working basis for the application of a method of monitoring appliances (mainly boilers and nuclear pressure vessels) during operation.

-- P 629 "Analysis of steel surface by plasma torch spectrometry"

The aim of the project is to develop a method for the chemical analysis of steel sheet surfaces and then to design an inexpensive auxiliary device to be connected to a plasma torch spectrometry unit. The normal method for the analysis of liquid solutions by plasma torch is also being studied under a current ECSC coordinated research project (the beneficiaries being Hoesch, IRSID, BSC and CRM).

Applicant : CRM - Liège  
Amount : 184 000 EUA  
Duration : 2 years

-- P 713 "Precise determination of aluminium in solution in killed steels"

For steelmakers it is essential to be able to determine the amount of aluminium in steel accurately and consistently in order to check the adjustment of the killed steel to the desired composition.

The aim of the project is to establish two methods for the rapid analysis of aluminium content (Al metal and Al in the form of  $Al_2O_3$ ) :

- (1) by developing a method of spectrographic analysis based on the integration of the light signal once interferences produced during sparking have been eliminated;
- (2) by devising a new method for investigating certain phases which might exist in the steels.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 182 000 EUA  
Duration : 3 years

-- P 714 "Method of separating, identifying and analysing inclusions in steels"

The aim of the research is to develop an efficient method for verifying the techniques for improving the freedom from inclusions in iron and steel products. It has two main objectives :

- (a) development of a method for isolating material using large-scale samples in order to ensure the presence of a sufficient number of inclusions.
- (b) practical study of the possibilities offered by this method for determining the distribution, size, nature and composition of inclusions in iron and steel products.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 200 000 EUA  
Duration : 3 years

- P 718 "Identification and analysis of steel phases by secondary ion emission"

The aim of the research is to develop a method of metallurgical investigation which will help to improve the quantification of precipitation rates of carbides (NbC, TiC, VC) or nitrides and will provide a better tool for following the evolution of certain metallographic structures.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 355 500 EUA  
Duration : 3 years

- P 746 "Investigation of low-alloy Cr and Cr-V steels for the formation and dissolution of nitrides by hot extraction of steel chippings with hydrogen"

The method involving hot extraction of steel chippings with hydrogen has so far been developed only for iron-manganese steels and iron-manganese-silicon steels.

The intention is to extend this method to the iron-chromium-nitrogen and iron-chromium-vanadium-nitrogen systems. This will make it possible to distinguish between dissolved nitrogen and chemically combined nitrogen.

For this reason a method is to be developed involving hot extraction in stages.

Applicant : MPI - Düsseldorf  
          THYSSEN - Krefeld  
Amount : 155 500 EUA  
Duration : 2 years

- P 604 "Evaluation of freedom from inclusions by ultrasound"

To use iron and steel products efficiently it is necessary, in a large number of fields, to have a thorough knowledge of the material characteristics. The aim of the project is to study an ultrasound method for the determination of freedom from inclusions in steel. The development and industrial application of the method will be concentrated mainly on new products (special steels, liquid steels, continuously cast products, flat products). The research will be coordinated with projects P 618, P 691 and P 712.

Applicant : COCKERILL - Liège  
Amount : 162 000 EUA  
Duration : 3 years

- P 618 "Development of an integrated industrial system to evaluate the process parameter influence on the internal defectuosity of hot-rolled products and of HSLA continuously cast steels"

The aim of the project is to research and develop an integrated industrial inspection system using ultrasonic beam scanning to evaluate the influence of process parameters on the internal defects of hot-rolled products and continuously cast steel slabs.

In this way it should be possible to establish an efficient product quality control system and enable metallurgists responsible for production to correlate inspection results directly with the process parameters.

Applicant : ITALSIDER - Genova  
Amount : 400 000 EUA  
Duration : 3 years

- P 691 "Ultrasonic assessment of inclusions"

The development, production and performance of metallurgical products requires complete control of the manufacturing process and an understanding of the material characteristics..

Aiming these, the determination of the inclusion content and distribution is very important. A non-destructive method offers distinct advantages it is possible to carry out rapid inspection of large volumes of steel by the ultrasonic assessment of inclusions. This is the subject of this research for which the main field of industrial application will be in medium-carbon steels and forgings.

The research will be coordinated with projects P 604, P 618 and P 712.

Applicant : GKN - Wolverhampton  
Amount : 180 000 EUA  
Duration : 3 years

- P 712 "Evaluation of freedom from inclusions by ultrasound"

Freedom from inclusions is one of the most important steel characteristics to be determined. Hence, in the first phase (Agreement N° 6210 GA.201-301), preliminary research was carried to define the general parameters of a method of ultrasonic assessment of inclusions in steels.

The aim of this project is to continue the work by using the earlier results to find a method which can be applied at industrial level. The research will be coordinated with projects P 604, P 618 and P 691.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 258 000 EUA  
Duration : 3 years

- P 646 "Non-destructive determination of internal stresses in steel"

Internal stresses appear during both the production stage and most of the later processing stages. At present the measuring processes used are for the most part destructive and provide insufficient information since the depth examined is less than 30  $\mu$ .

The aim of this project is to develop a non-destructive method of stress resolution using the following two techniques :

1. Ultrasonic (Harwell)
2. Magnetic (IZfP)

Applicant : VDEh - Düsseldorf  
Amount : 392 000 EUA  
Duration : 3 years

- P 602 "Non-destructive monitoring and evaluation of residual service life in the absence of macrodefect development"

When steel is used under stress and at high temperatures, its microstructure and mechanical properties change. If this development can be evaluated quantitatively, it should then be possible to obtain data leading towards the more rational use of materials. The aim of the programme is to assess the relationships between the microstructural evolutions and non-destructive (ultrasonic and video-tape) examination in order to produce either instrumentation or a method for monitoring equipment in service.

Applicants : TNO - Apeldoorn  
              BREDA - Milano  
              CREUSOT-LOIRE - Le Creusot  
Amount : 420 000 EUA  
Duration : 3 years

- P 645 "Automatic method for the stationary industrial inspection of newly-rolled rails for surface defects and dimensional accuracy"

The aim of this project is to develop and to test under practical conditions a method of non-destructive examination using video recordings and eddy currents. The latter method should produce objective and automatic monitoring of the surface condition of rails at a speed of approximately 1.50 m/sec. The latent defects and unevennesses will be shown up as well as defects just below the rolled surface. Processing and interpretation of the results will be carried out on electronic equipment.

Applicant : VDEh - Düsseldorf  
Amount : 437 500 EUA  
Duration : 3 years

- P 679 "Advancement of surface inspection instrumentation for cold-rolled steel strip"

Under an earlier ECSC research - contract (7210 GA 804) the applicant had designed and set up in the laboratory a system for the detection of surface defects on cold-rolled products. This project is a continuation of the previous work in order to validate the complete system set up in the laboratory and to adapt it for industrial use, and in particular to develop the computer software for signal processing under dynamic operating conditions.

Applicant : BSC - London  
Amount : 271 500 EUA  
Duration : 2 years

II.5 - SERVICE PROPERTIES AND PERFORMANCE

Projects in this area relate to the following topics :

1. Processes : for example, welding by high-frequency machine will produce tubes that can be used without subsequent grinding. This will save time and resources and consequently will make for greater competitiveness on the market.

Another project concerns research into spot-welding, e.g. for high-strength steels. Welding causes local reductions in strength, the causes of which

should be further studied in order to develop methods that can be used during welding to improve, for example, the fatigue strength of structures made from these steels.

2. The steel itself : optimization of its components and alloying elements which, while ensuring that the steel conforms to technical requirements and maintains its mechanical strength and resistance to external chemical agents, will help to satisfy economic requirements. This applies to steels used in the various types of power stations, in the chemical and food industries and in sea-water desalination plant.
3. Development of new steel grades which, as in the case of dual-phase steels are intended for the huge motor vehicle market. These steels have to be used with great care and therefore research is required. This calls for more extensive experiments to investigate whether, in order to reduce costs, it is possible to modify the content of alloying elements by concentration, for example, on improving the efficiency of thermomechanical treatment.
4. Promotion of steel at both technical and regulatory level  
As regards the technical aspects, the aim is to study, with a view to the future development of the market, the improvement of and service conditions for new and stronger grades of steel. While retaining good welding and forming properties, these steels would increase the safety of buildings (stability) and vehicles. At the same time they would allow vehicle weights to be reduced, thus saving fuel. Many projects relate to the development of dual-phase steels, the making, working and use of which call for a major effort. The surface finish of sheet steel for drawing is also a constantly recurring topic of interest, since the quality of the finished product depends on the surface finish; also, if industrial forming operations are to be profitable, it is necessary to ensure that tools are not worn out too quickly by the poor surface finish of the pressings.

As regards regulatory provisions, care should be taken that the texts brought into force do not, for example in the building industry, penalize steel as compared with rival materials such as concrete. Here the results of fatigue and rupture tests will be used to demonstrate the good service behaviour of steel components and frameworks.

#### a) Weldability

- P 617 "Industrial development of a low heat input inert gas welding system as an alternative for the conventional submerged-arc welding of high-strength steel pipes"

The use of high-strength low-alloy steels for the manufacture of pipes has been facilitated by the development of procedures for plate production and treatment to continue this development, the problems with the parent metal caused by the submerged-arc welding heat cycle must be solved.

This calls for the design and industrial scale development of a low heat input welding system. The process which seems at present to meet this requirement best is complete or partial inert gas welding.

Applicant : ITALSIDER - Taranto  
Amount : 500 000 EUA  
Duration 2 years

- P 698 "Use of high-frequency welding machines to produce alloy and non-alloy special steel tubes"

The high-frequency welding process is used successfully in the production of steel tubes. The tubes can be used without subsequent strenghtening, since their geometry remains good and the tolerances are not exceeded. Another advantage of high-frequency welding is the output that can be achieved. This process is used at present for ordinary steels but not yet for low or medium-alloy steels or for high-alloy stainless steels.

The aim is to define the technique for welding these steels and the quality of the weld seam and to control the welding machine by computer.

Applicant : KRUPP STAHLWERKE - Rheinhausen  
Amount : 2 345 000 EUA  
Duration : 2 1/2 years

#### b) Corrosion

##### - P 622 "Corrosion of stainless steels in brackish and saline industrial liquors"

The problems caused by local corrosion (pitting, crevice corrosion, cracking) in brackish and saline water can be solved by means of alloys with a high nickel, chromium and molybdenum content, but as the price of these steels is very high the installations are extremely costly. The aim is to define the types of corrosion that occur under the various conditions of use (temperature, chloride concentration, electrochemical potential, level of mechanical stress) and then to reduce corrosion by selecting the most suitable grades of steel that meet the technical requirements and are satisfactory from the economic aspect.

Applicants : CREUSOT-LOIRE - Unieux  
CSM - Roma  
Amounts : 212 000 EUA and 224 500 EUA  
Duration : 3 years

#### c) Formability

##### - P 663 "Promotion of the use of high-strength cold-rolled and hot-rolled steel plate and sheet in the motor industry"

The strengthening of motor vehicles required by the safety regulations results in an increase in weight and consequently an increase in fuel consumption. It thus appears advantageous to use high-strength grades of steel for some components. However, the development of this use comes up against certain difficulties in connection with cold-forming, decrease in corrosion resistance on account of the reduced thickness, spot welding which is still unsatisfactory and fatigue resistance. It is also necessary to study the economic feasibility of using these steels.

Applicant: VDEh - Düsseldorf  
Amount : 2 762 500 EUA  
Duration : 3 years

##### - P 652 "Cold formability of dual-phase or duplex steels produced from rolling heat with and without special surface treatment"

On account of the more rigorous safety requirements in the motor industry, intensive development work has been undertaken, particularly in the USA and

Japan, in the field of high-strength steels with good cold formability characteristics. Thermomechanical treatment processes applied to suitable grades enables "dual-phase" or "duplex" steels to be produced directly without annealing in a hot strip mill. The objective of the work is the accurate study of the formability of hot and cold-rolled strip.

Applicant : STAHLWERKE PEINE SALZGITTER - Peine  
Amount : 298 500 EUA  
Duration : 2 1/2 years (from 1 January 1979)

- P 742 "Optimization of the use of high-strength steel sheet in the motor industry"

The use of high-strength steels is increasing in the motor industry to meet the safety criteria and the need to save fuel (by reducing weight). On the basis of the knowledge acquired of the drawing and forming of normal sheet, it is planned to study the drawability conditions for high-strength sheet and to analyse the properties of components manufactured from such sheet.

Applicant : VDEh - Düsseldorf  
Amount : 954 000 EUA  
Duration : 3 years

- P 716 "Recrystallization of hardened extra-mild steel sheet in the course of rapid annealing cycles"

Developments in the design of motor vehicles (safety, fuel savings) will greatly expand the high-strength sheet steel market. It is extremely probable that the greater part of this market will fall to cold-rolled sheet. This product should therefore meet two partly contradictory requirements : high-strength and good formability. To achieve this end, it is necessary to optimize the entire manufacturing cycle (chemical composition, rolling, annealing cycle). This optimization will not be possible unless considerable knowledge is acquired of the recrystallization and texture formation mechanisms during annealing; this is the purpose of the research.

Applicant : IRSID - St. Germain-en-Laye  
Amount : 346 500 EUA  
Duration : 3 years

- P 727 "Continuously annealed high-strength low-alloy steels for deep drawing"

High-strength steels for deep drawing have been studied for a number of years. It seems that when it is necessary to combine a high level of strength with good drawing characteristics, the hardening obtained by the second-phase precipitates provides the best results. The difficulties in industrial production are, however, considerable, since it is necessary to control the annealing cycle accurately. An understanding of the phenomena of interactions between the precipitates and recrystallization during short annealing cycles is required and, to obtain this, it is necessary to develop a pilot production unit for these low-alloy steels.

Applicant : CSM - Roma  
Amount : 155 500 EUA  
Duration : 2 years

- P 683 "Dual-phase high-strength formable steels"

High-strength low-alloy steels are being used on a large scale in the motor industry (safety, weight reduction, fuel savings). However, this market could still expand if the cold-formability of these steels were improved: this is the idea behind the "dual-phase" steels developed and used in the USA and Japan. Our industry must be prepared to produce these steels to prevent steels produced elsewhere from penetrating the Community market. The aim is to optimize both the production methods and the properties of these steels.

Applicant : BSC - London  
Amount : 304 500 EUA  
Duration : 3 years

- P 732 "Hot-rolled stamping blanks of dual-phase steels"

It is probable that, in the near future, the use of cold-rolled high-strength steels will develop rapidly in the motor industry; however, hot-rolled high-strength steels with a thickness of about 4 mm can already be used for certain components of cars and heavy goods vehicles. For applications which require only minor deformation, dual-phase steels of the same degree of strength should have better mechanical properties. To obtain such steels, it is necessary to modify the chemical composition and the rolling programmes associated with high cooling speeds.

It is planned to carry out more intensive experimental work in this field to ascertain whether it is possible to modify and reduce the contents of alloying elements by concentrating on the effectiveness of thermomechanical treatment.

Applicant : CSM - Roma  
Amount : 214 500 EAA  
Duration : 2 years

- P 682 "Influence of material properties on the buckling behaviour of sheet steel during pressforming"

During the last few years, much work has been done on the determination of forming limit curves to enable the drawing qualities of steel to be defined. The buckling and wrinkling of sheet steel are, together with fracture, reasons for rejection during manufacture. Despite the precautions taken in the use of the tools themselves, it seems that the properties of the grade of steel employed are still of primary importance.

The use of high-strength steels now requires a broader understanding of the various factors involved.

Applicant : BSC - London  
Amount : 105 000 EUA  
Duration : 2 years

- P 623 "Surface finish of steel sheet in relation to deep-drawing problems"

In industrial production, seizing is an occurrence which slows down the production line and reduces intervals at which press tools must be reconditioned. The sheet surface finish (distribution of peaks and valleys) has a definite influence on this phenomenon. Although work has been carried out on thin sheet (less than 1 mm), it must be continued on thicker sheet (3 mm) and extended to



include high-strength grades of steel.

Applicant : CRM - Liège  
Amount : 541 000 EUA  
Duration : 2 1/2 years

- P 689 "Resistance spot-welding of low-carbon and high-strength low-alloy steels"

The aim is to resolve uncertainties concerning the relationship between the composition and characteristics of low-carbon and high-strength steels and the resultant weld quality. The fatigue resistance of spot welds will be studied. The information acquired could serve as a guide for the use of these steels, particularly in the motor industry.

Applicant : B S C - London  
Amount : 315 000 EUA  
Duration : 3 years

- P 717 "Transformation and precipitation after the rolling of sheet on a continuous hot strip mill"

The knowledge of the phenomena that occur in austenite during rolling, although incomplete, is still sufficient for metallurgical inspection on the strip mill to be considered. The lack of knowledge is greatest in respect of the phenomena that occur after rolling, account being taken of the special austenitic state. It is therefore proposed to make a complete metallurgical study of the transformation and precipitation phenomena occurring under hot strip mill conditions, to include everything that occurs after rolling and affects the properties of the coil and its subsequent use.

Applicant : IRSID - St. Geramin-en-Laye  
Amount : 300 000 EUA  
Duration : 3 years

- P 625 "Influence of interstitial atom saturation level on the effectiveness of overaging treatment after continuous annealing of mild steel sheet"

The aim of this study is to define the most suitable composition, for several cooling speeds, after continuous annealing, i.e. compositions exhibiting minimal aging after overaging and skin-passing. The establishment in advance of a relationship between the effectiveness of this overaging and the degree of supersaturation itself in relation to certain continuous annealing heat treatment characteristics and to the composition is the best way of attaining this objective.

Applicant : CRM - Liège  
Amount : 377 500 EUA  
Duration : 3 years

- P 630 "Surface cleanliness of annealed and skin-passed strip"

The condition of the surface of annealed and skin-passed strip, and more especially the "surface chemistry", affect the subsequent use of the product. The purpose of this research is to determine the nature of the impurities present on the strip which are actually capable of influencing its subsequent use and then, after identification of the agent(s) responsible for these impurities, to establish the thresholds beyond which certain problems may appear.

Applicant : CRM - Liège  
Amount : 339 500 EUA  
Duration : 3 years

- P 748 "Influence of surface chemistry on phosphate coating and resistance to corrosion after painting"

The surface finish of steel sheet, i.e. its suitability for phosphate coating and its resistance to corrosion after painting, depends to a large extent on the transformations that occur from the time of casting up to the processing and protection of the steel sheet. The distribution of alloying elements, morphology and the porosity of the surface film must all be taken into account. It is proposed to acquire more extensive knowledge by means of an electrochemical study of the correlation between the painting of the sheet and the composition of the surface together with the properties of the phosphate film.

Applicant : CSM - Roma  
Amount : 103 500 EUA  
Duration : 2 years

d) Structural steels

- P 662 "Study of the fatigue strength of weathering-resistant structural steels"

It is recognized that changes in the surface condition of weathering-resistant steels can reduce the fatigue strength of components made of such steels. Confirmation of this statement is not easy to obtain because of the difficulty of reproducing in a laboratory all the mechanical and environmental conditions to which these components are subjected in actual buildings. Such confirmation under actual conditions of use takes a long time (alternation of climatic conditions). The aim is to determine the relationship between fatigue strength and duration of exposure for both the base materials and the welded assemblies.

Applicant : VDEh - Düsseldorf  
Amount : 233 500 EUA  
Duration : 6 1/2 years

e) Fracture mechanisms

- P 681 "Quantitative understanding of corrosion fatigue crack growth behaviour"

The objective of this research is to enhance the understanding of corrosion fatigue crack initiation and growth behaviour on a quantitative basis. It is hoped that predictive procedures can be defined for dealing with design and material selection for optimum resistance to corrosion fatigue. It is indispensable to understand, quantitatively, the behaviour under constant amplitude loading before attempting to predict behaviour under the more complex case of variable amplitude loading.

Applicant : BSC - London  
Amount : 171 500 EUA  
Duration : 2 years

- P 729 "Structure-strength-toughness relations in the fusion zone depending on chemical composition and welding method"

The welding methods generally used, such as the submerged arc method, do not always enable satisfactory mechanical properties to be obtained in the fusion zone and, in addition, their industrial productivity needs to be increased. For

example, suitable thick plate weld properties for the manufacture of pressure vessels can only be obtained in the fusion zone with methods using low heat input. The objective is thus to carry out a systematic study of the fusion zone (structure-strength-toughness) as a function of the welding method.

Applicant : CSM - Roma  
Amount : 257 500 EUA  
Duration : 2 years

#### f) Light structures

##### - P 686 "Development of design rules for the use of structural steel in building"

The existing building rules must not jeopardize development in the use of steel in building. When they are revised, this disadvantage must be avoided. The production of a code of practice for the use of steel in building, containing both technical and economic recommendations, would serve as a basis for the crafting of a European code which would safeguard the use of steel in this sector.

Applicant : BSC - London  
Amount : 244 500 EUA  
Duration : 1 1/2 year

##### - P 664 "Multi-storey buildings of steel - Design principles for architects"

In 1974, an atlas of steel construction was published and met with considerable success in various countries. That edition has been sold out and it appears essential to republish the work; the opportunity will be taken to update the publication to take account of recent technological developments and new rules.

Applicant : DEUTSCHER STAHLBAUVERBAND - Köln  
Amount : 135 500 EUA  
Duration : 4 years

##### - P 619 "Steel structure buildings in seismic areas"

The initial phase of this study is being concluded; it concerned design calculations, the application of the building rules in force in various countries and the behaviour of the frameworks under actual conditions (Friuli).

In the second phase, this work on the study of the frameworks and their connections with other components (floors, walls) will be continued to investigating the way in which the complete assembly can add to the stability of the building and prevent its total ruin (safety, protection of the inhabitants).

Applicant : ITALSIDER - Genova  
Amount : 358.500 EUA  
Duration : 2 years

##### - P 744 "Buckling of high-strength steel structural sections"

A draft European standard for structural steelwork, establishing critical buckling loads on columns constructed with standardized sections, is being prepared. According to the known experimental results, a classification were favourable than that in the draft standard seems justified for double-T sections of high-strength steel. These initial results must now be confirmed on a broader experimental basis. This is an important point in the promotion of the use of high high-strength steels in structural steelwork, a sector in which steel columns in are in keen competition with concrete.

Applicant : ARBED - Luxembourg  
Amount : 214 000 EUA  
Duration : 2 years

g) Special and alloy steels

- P 685 "Development of steels for the fastener and cold-forging markets by testing under fastener production conditions"

The use of Community steels has considerably decreased during the last four years to the advantage of steels from non-member countries. The market is large one (bolts, nuts, rivets, etc.) and it is necessary to capture it. The effort to be made concerns the cost of both the product (optimization of chemical compositions and of heat treatments) and the manufacturing operations.

Applicant : BSC - London  
Amount : 355 000 EUA  
Duration : 3 years

- P 728 "Ferritic stainless steels with a low content of interstitial elements"

In the initial phase, a critical review was made of the existing refining process, industrial production and the definition of the products obtained and the influence of composition on service properties. It is now necessary to broaden the study to include the effects of second-phase precipitation on the embrittlement and resistance to corrosion of ferritic steels, to establish the correlation between the welding methods and second-phase precipitation and to extend to a pilot level the formability studies on steels of the 18-2 Cr Mo type.

Applicant : CSM - Roma  
Amount : 318 500 EUA  
Duration : 2 years

- P 735 "Enhancement of machinability for forging quality steels"

In certain sectors, such as the motor industry, high-quality steels must be defended against competition from other materials such as aluminium and reinforced plastics, for reasons of weight saving among others. Most of the components used have to be machined (turned, drilled, milled). To facilitate these operations, additions are made (lead, sulphur, calcium) at levels compatible with the desired mechanical characteristics. The results can be verified by fatigue tests carried out in parallel with laboratory work on the sulphide shape that helps to improve machinability.

Applicant : G.K.N. - Wolverhampton  
Amount : 350 000 EUA  
Duration : 3 years

II.6 - MISCELLANEOUS

- P 598 "Technical steel literature"

This involves the renewal of agreement 6210.08/5/002 granting ASELT financial aid to translate into Community Languages texts of interest to the iron and steel industry which are published in "difficult" languages (especially Japanese and Russian).

Applicant : ASELT - Luxembourg  
Amount : 200 000 EUA

S U M M A R Y T A B L E

Project No	Title of the research	Proposed research			Financial aid	
		by	Duration (years)	Amount EUA (7.12.78)	%	Amount EUA (7.12.78)
	<u>ORE REDUCTION</u>					
	<u>a) Sinter</u>					
613	Thermal optimization of sintering process	Italsider	2	717 000	60	430 200
666	Oxygen enrichment of firing gases for DL sintering	Arbed Lurgi	2 1/2	308 500 52 000	60 60	185 100 31 200
668/2	Optimization of the sintering process with particular reference to fuel savings	BSC	3	570 500	60	342 300
702	Sintering of Lorraine ore	IRSID	3	638 500	60	383 100
	<u>b) Blast furnace</u>					
616	Effects of the softening and melting zone on blast furnace performances	ITALSIDER	2	703 500	60	422 100
634	Rational use and diversification of types of energy that can be used in the blast furnace	CRM	3	536 000	60	321 600
637	Influence of burden properties on the performance of blast furnaces of approximately 10 m. hearth diameter	VDEh	3	1 257 500	60	754 500
672	In-service monitoring of intercrystalline stress corrosion on hot-blast-stove domes by acoustic emission	BSC	5	501 000	60	300 600
703	Alcalines and properties of coke	IRSID	3	433 500	60	260 100
723	Kinetics of iron oxide reduction in the conditions prevailing in the bosh	CSM	2	152 500	60	91 500

Project No	Title of the research	Proposed research			Financial aid	
		by	Duration (years)	Amount EUA (7.12.78)	%	Amount EUA (7.12.78)
	<u>STEELMAKING</u>					
	<u>a) Casting and solidification</u>					
631	Intensive cooling of continuously cast billets	CRM	3	341 500	60	204 900
632	Influence of secondary cooling on slab swelling and internal quality	CRM	3	402 500	60	241 500
639	Continuous determination of shell thickness in the continuous casting of steel to improve process control	BFI	3	489 000	60	293 400
674	Evaluation, development and design of transport rollers in continuous casting plant	BSC	3	429 500	60	257 700
700	Development of a direct strand reduction method for steel	Krupp	5/6	30 000	100	30 000
705	Technological improvements to the continuous casting process	IRSID	3	567 000	60	340 200
706	Role of mechanical working on the quality of plates from continuously cast slabs	IRSID	3	458 500	60	275 100
715	Electron probe microanalysis of microsegregation in steels depending on casting method	IRSID	3	434 000	60	260 400
726	Treatment of steel by injection of materials containing alkaline earth elements	CSM	3	636 500	60	381 900
	<u>b) Electric steelwork</u>					
605	Refining of stainless steel in the AOD converter	Teksid	3	500 000	60	300 000
641	Development of the "Klöckner" steelmaking method based on scrap and sponge iron	Klöckner	3 1/2	30 708 000	4	1 300 000
675	Application of the modified "BBC/Brusa" scrap-preheater process to a large UHP furnace	BSC	2 1/2	339 500	60	203 700
708	Improvement of industrial arc functioning	IRSID	3	554 000	60	332 400
709	Metallurgical treatment of steel in an induction-heated ladle	IRSID	3	528 000	60	316 800
725	Applications of the plasma arc technique in steel melting and refining	CSM	2 1/2	512 000	60	307 200

Project No	Title of the research	Proposed research		Financial aid	
		by	Duration (years)	Amount EUA (7.12.78)	X Amount EUA (7.12.73)
642	Determination of the fastest rate of heating for refractory-lined units <u>c) Refractories</u>	VDEh	1 1/2	159 000	60 95 400
644	Critical review of metallochemical data on compounds and alloys occurring in iron and steel production <u>d) Theoretical steelmaking</u>	R.W.T.H	3	333 500	30 100 050
724	Thermodynamic behaviour of compound deoxidizers <u>TRANSFORMATION</u>	CSN	2 1/2	203 500	60 122 100
677	Evaluation of an integrated operating condition monitoring maintenance scheme	BSC	3	622 000	60 373 200
710	Characteristics of plastic flow in the metal under hot-strip-mill conditions	IRSID	3	329 000	60 197 400
739	New method for large width reductions in a hot-strip mill	Hoogovens	6	605 000	60 363 000
745	Thermal efficiency of reheating furnaces <u>MEASUREMENTS AND ANALYSIS</u>	Arbed	2	234 000	60 140 400
602	Non-destructive monitoring and evaluation of residual service life in the absence of macrodefect development	Creusot-Loire } TNO } Breda }	3	140 000 140 000 140 000	60 84 000 60 84 000 60 84 000
604	Evaluation of freedom from inclusions by ultrasound	Cockerill	3	162 000	60 97 200
618	Development of an industrial integrated system to evaluate the process parameter influence on the internal defectuosity of hot rolled products and slabs of HSLA continuous casted steels	Ilva	3	400 000	60 240 000
629	Analysis of steel surface by plasma torch spectrometry	CRM	2	184 000	60 110 400
645	Automatic method for the stationary industrial inspection of newly-rolled rails for surface defects and dimensional accuracy	VDEh	3	437 500	60 262 500
646	Non-destructive determination of internal stresses in steel	VDEh	3	392 000	60 235 200



Project No	Title of the research	Proposed research		Financial aid		
		by	Duration (years)	Amount EJA (7.12.78)	%	Amount EJA (7.12.78)
679	Advancement of surface inspection instrumentation for cold rolled steel strip	BSC	2	271 500	60	162 900
691	Ultrasonic assessment of inclusions	G.K.N.	3	180 000	60	108 000
712	Evaluation of freedom from inclusions by ultrasound	IRSID	3	258 000	60	154 800
713	Precise determination of aluminium in solution in killed steels	IRSID	3	182 000	60	109 200
714	Method of separating, identifying and analysing inclusions in steels	IRSID	3	200 000	60	120 000
718	Identification and analysis of steel phases by secondary ion emission	IRSID	3	355 500	60	213 300
746	Investigation of low-alloy Cr and Cr-V steels for the formation and dissolution of nitrides by hot extraction of steel shippings with hydrogen	MPI Thyssen	2	155 500	60	93 300
<u>SERVICE PROPERTIES AND PERFORMANCE</u>						
<u>a) Weldability</u>						
617	Industrial development of a low heat input inert gas welding system as an alternative for the conventional submerged arc welding of high-strength steel pipes	Italsider	2	500 000	60	300 000
698	Use of high-frequency welding machines to produce alloy and non-alloy special steel tubes	Krupp	2 1/2	2 345 000	32	755 300
<u>b) Corrosion</u>						
622	Corrosion of stainless steels in brackish and saline industrial liquors	Creusot-Loire CSM	3	212 000 224 500	60 60	127 200 134 700
<u>c) Formability</u>						
623	Surface finish of steel sheet in relation to deep-drawing problems	CRM	2 1/2	541 000	60	324 600
625	Influence of interstitial atom saturation level on the effectiveness of overaging treatment after continuous annealing of mild steel sheet	CRM	3	377 500	60	226 500

Project No	Title of the research	Proposed research			Financial aid	
		by	Duration (years)	Amount EUA (7.12.78)	%	Amount EUA (7.12.78)
630	Surface cleanliness of annealed and skin-passed strip	CRM	3	339 500	60	203 700
652	Cold formability of dual-phase or duplex steels produced from rolling heat with and without special surface treatment	Stahlw. P+S	2 1/2	298 500	60	179 100
663	Promotion of the use of high-strength cold-rolled and hot-rolled steel plate and sheet in the motor industry	VDEh	3	2 762 500	60	1 657 500
682	Influence of material properties on the buckling behaviour of sheet steel during pressforming	BSC	2	105 000	60	63 000
683	Dual-phase high-strength formable steels	BSC	3	304 500	60	182 700
689	Resistance spot-welding of low-carbon and high-strength low-alloy steels	BSC	3	315 000	60	189 000
716	Recrystallization of hardened extra-mild steel sheet in the course of rapid annealing cycles	IRSID	3	346 500	60	207 900
717	Transformation and precipitation after the rolling of sheet on a continuous hot strip mill	IRSID	3	300 000	60	180 000
727	Continuously annealed high-strength low-alloy steels for deep drawing	CSM	2	155 500	60	93 300
732	Hot-rolled stamping blanks of dual-phase steels	CSM	2	214 500	60	128 700
742	Optimization of the use of high-strength steel sheet in the motor industry	Thyssen Krupp	3	954 000	60	572 400
748	Influence of the surface chemistry on phosphate coating and resistance to corrosion after painting	CSM	2	103 500	60	62 100
662	Study on the fatigue strength of weathering-resistant structural steels d) Structural steels	VDEh	6 1/2	233 500	60	140 100
681	Quantitative understanding of corrosion fatigue crack growth behaviour	BSC	2	171 500	60	102 900

Project No	Title of the research	Proposed research			Financial aid	
		by	Duration (years)	Amount EUA (7.12.78)	%	Amount EUA (7.12.78)
729	Structure-strength-toughness relations in the fusion zone depending on chemical composition and welding method	CSM	2	267 500	60	160 500
619	<u>f) Light structures</u> Steel structure buildings in seismic areas	Italsider	2	358 500	60	215 100
664	Multi-storey buildings of steel - Design principles for architects	D.S.T.V.	4	135 500	60	81 300
686	Development of design rules for the use of structural steel in building	BSC	1 1/2	244 500	60	146 700
744	Buckling of high strength steel structural sections	Arbed	2	214 000	60	128 400
685	<u>g) Special and alloy steels</u> Development of steels for the fastener and cold-forging markets by testing under fastener production conditions	BSC	3	355 000	60	213 000
728	Ferritic stainless steels with a low content of interstitial elements	CSM	2	318 500	60	191 100
735	Enhancement of machinability for forging quality steels	GKN	3	350 500	60	210 300
598	Technical steel literature <u>MISCELLANEOUS</u>	Aselt	-	200 000	100	200 000
	Sub-Total			62 132 500		19 494 950
	Cost of dissemination of information					505 050
	T O T A L					20 000 000