ÇOMMISSION OF THE EUROPEAN COMMUNITIES

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Proposal for a

COUNCIL DECISION

on the adoption of a programme of technological research in the field of clay minerals and technical ceramics

(submitted to the Council by the Commission)

COM(79) 273 final

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PRESENTATION OF THE PROGRAMME

The Commission is presenting a multiannual programme of joint research and development extending over four years, the cost of which, for the duration of the projects, is estimated at 8.2 million EUA (4.50 million EUA to be borne by the Commission).

The programme which has been drawn up in close consultation with the Community ceramics industry, will be implemented by way of shared-cost research contracts, on the one hand with CERAME-UNIE for the clay minerals, and on the other hand with GROUPISOL for the industrial ceramics.

Both national research organisations and private industry will participate in the joint research programme, which will employ 20 research workers and 22 assistants per topic. The programme, which is aimed essentially at encouraging a deeper integration of research and development in this industrial sector will cover two main subjects, namely :

- the technology of clay minerals (I)
- the technology of industrial ceramics (II)

(see technical annex)

It is justified by the following considerations :

The basic properties of ceramics; resistance to heat and wear, chemical inertness, electrical behaviour and more recently, higher mechanical strength, have led to their use in a whole range of industrial products from domestic ceramics to areas of advanced technology. Many other industrial sectors depend on ceramic components for their further development and growth so that a coordinated research programme will not only benefit the ceramics industry itself, but will strengthen the technological base of Community industry in general. It is justified by the following considerations :

Clay minerals

Improvements in the technology of clay minerals will principally be of benefit to the traditional ceramics industry.

- This subsector consists of a multitude of small and medium-sized firms who supply a growing internal and export market for basic ceramic products.
- The firms are located principally in regions where the raw materials occur naturally or are easily accessible, and these are frequently economically less favoured areas where the ceramic industry plays an important role in the regional economy.
- In view of diffuse structure of the industry it is essential that research is carried out on a collaborative basis to ensure the best use of the limited contributions available from industrial sources and that the results are applied as widely as possible. Community participation will encourage and strengthen this collaborative base.
- Improved product quality and the evolution of new products is essential to maintain the competitive position of the industry on the Community and world markets.
- A better knowledge of the technology of clay minerals would lead to a lower specific energy consumption in the production process and the

development of better heat resisting ceramics will also make a contribution to the rational utilization of energy.

- A more effective use of clay minerals and the re-use of industrial mineral wastes would reduce environmental pollution by wastes and spoil heaps.

Industrial ceramics

- Industrial ceramics are replacing metals as structural elements where extreme operating conditions require heat resistance and strength at high temperatures or inertness, for example in the development of high temperature gas turbines and power plant and in units for use in aggressive chemical conditions. Their use allows the development of higher efficiency units where material properties are a limiting factor.
- In additional fields such as electrical insulators, the competitive position of the Community industry can only be maintained by the development of more effective products.
- The unique semiconducting properties of ceramics can be exploited not only in electronic circuit components but in more massive form in a variety of process equipment components such as heater elements and solid electrolytes. These properties also permit the development of specific instrument sensors which can be used in improving engine and plant performance.

Stimulation of joint research in these fields will strengthen the industrial tissue and reduce Community dependence on imported technology.

SCOPE OF THE PROGRAMME

I. As regards clay minerals:

1. Determination of the characteristic properties of clay minerals (chemical composition, state of the surface, porosity and pore size, morphological properties, etc.) and study of their effect on the behaviour of clays during moulding. This entails:

   1. study of the interactions in suspensions of aqueous clays (bonds between ions, between molecules, at the water surface, ion exchange, etc.);

   2. study of the electrochemical and electrokinetic properties of clay minerals.

The purpose of this project is to lay the technological foundations for upgrading the less valuable clay minerals and adapting ceramic production processes to the requirements imposed by less valuable clay minerals and the wastes of other branches of industry, taking into account the need:

- to ensure that the process is economically viable;
- to raise the technological level of the industry;
- to plan for the demands which the market places upon ceramic products;
- to use production energy in the most economical manner;
- to protect the environment;
- to improve working conditions;
- to use the Community's natural resources in the best possible way;
- to maintain the level of employment;
- to enlarge the basis for industrial innovations.

2. Scientific study of drying, which requires among other things a knowledge of the interaction of clay particles in industrial suspensions with different components such as feldspar or quartz, in order to ascertain the mechanism of water absorption and of drying.

The main operations which consume energy in the ceramic industry are the preparation of basic products, drying, baking and fusion of refractories. A variety of techniques will be studied from different angles, for instance drying by radiation or by heat pump in these operations, their feasibility, the energy and quality aspects.

3. Study of the baking of selected clays alone or in mixtures. In particular, the loss of weight, the gas composition, the energy balance and the mineralogical changes will be determined.

The rate of vitrification, the tensions in the materials, the phenomenon of thermal shock and of black heart in ceramic masses, and the possibility of saving energy will likewise be analysed.

To save energy a number of technical solutions can be proposed, such as use of low density smoke evacuation systems, recovery of heat, and improvement of the isotherms and the baking cycles.

4. Study of the properties of the baked masses from the mechanical, physical, electrical and chemical point of view.

5. Study of the effect of mineralogical properties of clay minerals on the behaviour of the product during the different phases of the manufacturing technology (moulding, drying, baking) and on the properties of the finished products.

Finally, correlations of a general type will be established, linking up all the data collected during the studies of the different items mentioned above.

II. As regards the programme of development of industrial ceramic materials, the industrial and research laboratory experts suggested the following six studies (see technical annex):

1. Development of the production technology for the manufacture of powders optimized for a particular product or purpose, using oxides and mixed oxides as the basic materials for industrial ceramic products.

2. Improvement of the surface state of semi-finished and finished ceramics in alumina in order to increase their mechanical strength.

3. Development of the technology of using zirconium oxide ceramic products by increasing their mechanical strength.

4. Development of the technology of using ceramic materials containing electricity-conducting zirconium oxide.

5. Development of the possibilities of using the electrical properties of tin oxide.

6. Development of the technology of further processing and utilization of ceramic fibres and perfecting of the technological bases for new production procedures and perhaps invention of new products.

The projects outlined assume that the technological research will not be conceived solely at the national level, but that later on Community aspects will emerge and guidelines be laid down, which should allow the separated research systems, where up until now exchanges have only been sporadic, to be transformed into an overall efficient system. The joint research programme which is the subject of this Commission proposal opens the way for this promising development.

FINANCIAL FORECAST.

The maximum EEC contribution for implementation of the proposed programme amounts to 4.50 million EUA (see annex: Financial record).

The detailed breakdown of the financing, by topic and by project, will be carried out by the programme management body (see below).

The Community funds will serve:

(1) to finance shared-cost research contracts with the research organizations, industry and the universities of the Member States, to the extent of 50% of the effective cost of the research carried out with a maximum of 2.05 million EUA for each of the two topics.

(2) to manage the programme which will amount to 0,40 million EUA.

Management of the programme

The Commission will carry out the research programme by means of contracts. The Commission's Services will assure the collaboration with the contractors (CERAME-UNIE and GROUPISOL) and their programme Management Council, and will refer, on matter concerning the programmes operation, to the Consultative Committee for management and research and development programmes in accordance with the Council's resolution of 18. July 1977 relative to consultative Committees for the management of the research programme (O.J. N° C 192 of 11.8.1977, p. 1).

DISSEMINATION OF INFORMATION

The dissemination of knowledge resulting from the programme will be governed by Council Regulation (EEC) No 2380/74 of 17 September 1974.

The contract clauses applicable to know-how and inventions will be based on the principles defined in Annex 3.

ANNEX 1

FINANCIAL RECORD

NEW PROJECT.

1. Budget heading: section 3720.

2. Title of budget heading: actions in the ceramics sector.

3. Legal basis : Proposal for a Council decision based on article 235 of the EEC Treaty adopting a programme of collective technological research in the field of clay minerals and technical ceramics.

4. Description, aim and justification of the project

4.0 Description of the project - persons involved

4.0.0 Execution of two research projects, one on the technology of clay minerals (I), the other on the technology of special ceramics (II)

4.1.0 Persons involved

4.0.1.1 the ceramics industry

4.0.1.2 the whole Community

4.1 Aim of the project

4.1.0 General aim

- to improve the technology of using clay minerals (I)
- to broaden the scope of technical ceramics (II).

4.1.1 Specific objectives

- use of clay minerals of lesser quality; improvement of technological conditions for the supplying of raw materials and for innovation of products and production methods in the context of the economic policy for the environment and energy (I);
- creation of starting materials necessary for production; substitution of ceramic products for rare metals; development of industrial ceramics through the promotion of innovations, in the context of the economic policy for the environment and energy (II).

4.2 Justification of the project chosen

Implementation of the programme is financed jointly by the Community and industry. The joint character of the research allows more economic use of public funds and encourages private endeavours, in particular in the form of supplementary programmes carried out at their own expense by certain firms. These projects are aimed essentially at encouraging greater integration in this industrial sector and at strengthening it to face competition.

5. Budgetary aspects of the project (in million EUA, at current prices)

5.0 Effect on expenditure

5.0.1 Multiannual timetable

Multiannual projects to be entered in the budget as single budgetary commitments for the whole period of the projects and as payment appropriations (TABLE I)

	Budgetary commitments	Payments forecast - need for payment appropriations			
		1st year	2nd year	3rd year	Subsequent financial years
Budgetary commitment (single commitment for the period of the projects)	4.50	0,9	1,70	1,10	0,80
TOTAL	4.50 million EUA				

These projects will be pursued until 1984, Table II shows the balance sheet of possible payments.

	Topic I: clay minerals	Topic II: special ceramics	Management of the programme	
1st year	0.40	0.40	0.100	0.90
2nd year	0.80	0.80	0.100	1.70
3rd year	0.50	0.50	0.100	1.10
4th year	0.35	0.35	0.100	0.80
TOTAL	2.05	2.05	0.400	4.50 million EUA

5.0.2 Rate of use of the payment appropriations during the firts exercise :

First half-year: 30%; second half-year: 70%.

5.1 Possible effect on resources

5.1.1 Method of calculation. Expenditure by contracts.

The costs of the contract will depend on the nature of the subjects and the nature of the legal systems of the participating laboratories. It is not possible to set up a uniform method of calcution for the participation rates per project.

In any case, the Commission's Services and the contractors together with their Management Council, will consult the Consultative Committee on the management of the research and development programme to be set up in accordance with the Council resolution of 18 July 1977 (O.J. No. C 192/1 of 11.8.77) on the allocation of the credits.

	Community	Industry	Total
Programme topic I + topic II	4.1	4.1	8.2 million EUA

6. <u>Supervisory arrangements planned</u>

6.1 Supervision of the execution of the research contracts by Commission staff and by the ACPM.

7. Financial effect of the project throughout the period envisaged (in million EUA)

7.0.1	Expenditure (cost) to be met by the Community budget including management expenses of the programme	4.50
7.0.3	Expenditure (cost) to be met by other sectors at a national level	4.1
	Total	8.60 million EUA

8. Information on the staff and operating appropriations necessary for implementing the project

8.0 Necessary staff

1 A) (temporary agents for the dura-
1 C) tion of the programme) 0.40 million EUA

9. Financing of the project

9.3 Appropriations to be entered in future budgets.

ANNEX 2

TECHNICAL ANNEX

I. The technology of clay minerals in the ceramics manufacturing process

II. Studies covered by the joint research programme of the industrial ceramics sector

I. CLAY MINERALS

Aim:

To study scientifically and in depth the properties of the clay particle with a view to:

1. laying a sound basis of theory to support today's largely empirical knowledge of the properties and interactions of basic materials in the ceramics industry;

2. manipulating them better;

3. obtaining a better command of manufacturing technology;

4. obtaining scientifically valid data which will allow the invention of new technologies and possibly new products;

5. discovering how to use the raw materials present in the Community sub-soil which are at present rejected for want of adequate knowledge;

6. thereafter preparing a list of raw materials which could be used by the ceramics industry of the EEC.

Programme contents:

Determination of the characteristic properties of clay minerals (chemical composition, surface state, porosity and pore size, morphological properties, etc.) and study of their effect upon the behaviour of clays during forming. This requires:

1. study of the interactions in aqueous clay suspensions (bonds between ions, between molecules, at the water surface, ion exchange, etc.).

2. study of the electrochemical and electrokinetic properties of clay minerals, such as the interaction of clay particles in industrial

suspensions with different components, e.g. feldspar or quartz, in order to reveal the mechanism of absorption of water and of drying.

2. Study of the baking of selected clays alone or in mixtures. In particular, the loss of weight, the gas composition, the energy balance and the mineralogical changes will be determined.

   The rate of vitrification, the tensions in the materials, the phenomenon of thermal shock and of black heart in ceramic masses, and the possibilities of saving energy will be analysed.

3. Study of the properties of the baked masses from the mechanical, physical, electrical and chemical standpoints.

4. Study of the effect of mineralogical properties of clay minerals on the behaviour of the product during the different phases of the manufacturing technology (moulding, drying, baking) and on the properties of finished products.

Finally, correlations of a general type will be established linking up all the data collected during the studies of the different abovementioned items.

STUDIES COVERED BY THE JOINT RESEARCH PROGRAMME OF THE TECHNICAL CERAMICS INDUSTRY

Research study I:

Development of the production technology for the manufacture of powders optimized for a particular product or purpose, using oxides and mixed oxides as the basic materials for industrial ceramic products

The practice which until now has consisted in producing basic ceramic materials mainly by decomposition of hydroxides and carbonates (Bayer procedure for the manufacture of alumina) no longer answers the increased demands. Various manufacturing procedures discovered recently may broaden the possibilities of producing basic materials optimized for a given purpose, for example:

- sinterable silicon carbide powders,
- powders for isostatic pressing,
- powders of known particle size for electrical materials,
- zirconium oxide with stabilized phase and doped in an optimum way,
- beta-alumina,
- homogeneous materials for ferrites.

Among the new procedures for manufacturing powders, we would mention:

the sol-gel procedure, which is, for example, adapted to the manufacture of high-melting-point oxide powders (thorium oxide) that can be sintered at relatively low temperatures, i.e. with lower energy consumption and less pollution of the environment;

co-precipitation, for the preparation of ultra-fine powders, e.g. of alumina or of barium titanate, which are suitable starting materials for extremely homogeneous and microcrystalline products;

hot atomization of solutions using a flame or plasma torch, and the procedure consisting of projecting solutions on to a hot plate or into an oven, which allows the manufacture of powders as fine as those produced by co-precipitation, with variable associated properties;

hydrolysis of organometallic compounds, which readily offers the possibility of gearing the process towards the acquisition of specific powder properties.

Enlargement of the technological scope for the creation of ceramic starting powders optimized for a particular product or purpose will lay the foundations for new and improved products, capable of fulfilling key technological functions and important from the standpoint of social and economic policy. Examples of these are:

- substrates, supports and housings for electrical circuits,
- piezoelectric sensors,
- solid electrolytes in beta-alumina for electrical energy accumulators (electric drives, nuclear energy, low-voltage electricity grid systems),
- bioceramic materials (pins for fractures, bone replacements, receptacles for implantations, parts for artificial organs),

- substitution for articles made from valuable materials, e.g.:
  - alumina to replace vanadium carbide or tungsten carbide for carbide platelets, milling spindle heads and drill heads,
  - alumina or zirconium oxide to replace platinum for crucibles,
  - silicon carbide to replace molybdenum in steels.
- highly-stressed machine parts such as gas-turbine blades of silicon nitride or silicon carbide.

The research will cover, as the most important points, the technology of powders of zirconium oxide, tin oxide, alumina, beta-alumina, and the mixed oxides of zirconium oxide, silicon oxide, alumina or titanium oxide. Once the production technology of these oxides has been developed, the research can be extended to other powders such as those of silicon nitride, silicon carbide, carbon, titanate, zirconates, niobates and ferrites.

For each powder, the research will cover the development of

- the technology of producing the powders
- the technology of using the powders
- the technology of producing materials manufactured from these powders.

Justification:

In the manufacture of the powders, the United States is considerably in advance of the EC countries thanks to its technical development in astronautics, defence and the whole field of electronics.

Even Japan was quick to follow a parallel path and has passed on to mass production and thus gained the lead over the Community.

This advance enables the United States to deliver high-grade powders to its branch firms established in the Community, which may then deliver highly-developed products to the manufacturers of electronic components and equipment installed in Europe. Firms which are not subsidiaries of American companies are not able to obtain any of these highly-developed powders or can only procure them in small amounts at unfavourable prices. This privileged situation gives the American subsidiaries a competitive advantage over the Community manufacturers of oxide-based ceramics.

As a result, there is an acute risk that the manufacturers of industrial ceramics products installed in the Community will inevitably find themselves in a situation of dependence on the American suppliers.

The manufacturers of electronic components in the Community, who, as a result of the dominant position on the market of the American suppliers of special ceramic materials, dependent largely on US firms, could, however, free themselves from this dependence if the Community manufacturers of industrial ceramic products were in a position to supply products of similar quality.

If the industrial ceramics industries of the Community themselves develop these necessary powdered materials, they will be in a position to guarantee the requisite quality of ceramic products.

<u>Research study II</u>: <u>Improvement of the surface state of semi-finished and finished ceramics in alumina in order to increase their mechanical strength</u>

The improvement of the surface state of glass with a view to increasing its mechanical and breaking strength has, in the last twenty years, opened new fields for the utilization of glass. The surface state is improved by means of acid-polishing, fire-polishing, mechanical polishing, thermal hardening, chemical hardening or coating with tin oxide. For ceramic products no comparable process has up to now attained technical maturity, although the results of experiments so far offer good prospects for practical applications:

- by quenching sintered alumina in certain oils, it is possible to increase considerably the tensile strength of the sample;

- in a mixture of titanium tetrachloride vapour, methane and hydrogen, it is possible to deposit on alumina an adhering layer of titanium oxide, then of titanium carbide, and thus enhance the strength of the ceramic material. The treatment can be controlled by means of the reaction temperature, because below 1000°C titanium oxide is formed, and titanium carbide above that temperature.

Research will apply these and related procedures to ceramic materials, discover the structural, thermal, chemical and mechanical changes which they cause at the surface of the material and also elucidate the physical and chemical mechanisms of the treatment as a basis that will allow the greatest broadening of the technological scope offered by improvement of the surface state. The final aim of this task would be to open up to the ceramic material, alumina, new fields of use such as ball bearings or plunger pistons.

Justification:

The project must cope with the future shortage of certain noble metals by developing substitute materials. By improving the surface state of ceramic products it will be more practicable than in the past to substitute ceramic materials for the highly-stressed components in noble metals intended for machines, gas turbines, etc. In view of the high heat resistance and the corrosion strength of alumina, this substitution will even permit stepping up the function of engines and plant. How to give a ceramic component mechanical strength equivalent to that of the metal which it is to replace, however, is the key problem facing all the Community producers of oxide-based ceramics. The research necessary to bring about this aim is of such fundamental nature and general magnitude as exceeds the capabilities and the material resources of the individual producers.

Research study III: Development of the technology of using zirconium oxide ceramic products by increasing their mechanical strength

Compared with alumina, zirconium oxide possesses certain properties which are so remarkable (e.g. high melting point and great hardness) that one may look forward to considerable wider utilization of this material. However, its industrial application has so far been limited to fireproof bricks for furnaces, obtained by melting and sintering and to chemical installations or sintered machine parts, for example thread-guiding components in the textile industry, drawplates in the metallurgical and plastics industry and pulverizers in the industrial crushing technique.

The low breaking strength has until now restricted wider utilization of zirconium oxide and hindered its use in the manufacture of large production parts subject to heavy mechanical stresses.

Recently, however, new potential ways of substantially increasing the strength of zirconium oxide have been found; for instance stabilizers can be added which cause monoclinic or tetragonal precipitations in the cubic phase of the material. The higher strengths so far obtained in this manner already open the way to a number of new potential uses. It must be noted, however, that the limit to the increases in strength that can be achieved have not yet been ascertained.

In order to get higher still strength, new stabilizers must be added to the wide range which exists already, texture studies must be done, and the technique for manufacturing sample parts similar to the products used today must be developed. Another point to be examined is the extent to which the new possibility represented by immersion imparts to the material properties of value from the standpoint of utilization technology.

<u>Research study IV</u>: <u>Development of the technology of using ceramic materials containing zirconium oxide as a conductor of electricity</u>

At high temperatures, zirconium oxide is a conductor of electricity. Its conductance is due to the mobility of the electrons and the oxygen ions.

Thanks to this property, zirconium oxide tubes have already earned a place on the market as electrical heating elements in furnaces. As an oxygen ion conductor this material is also suitable for measuring the oxygen content of hot gases and melts. For example, oxygen probes made of zirconium oxide are already widely used during the melting of steel.

The potential uses of zirconium oxide as a thermal fuse and measuring probe are far from being exhausted, because the technological principles in regard to this material have not yet been sufficiently explored. It appears possible to use it for automatic optimizing of energy consumption in oil-fired heating installations, combustion engines and thermochemical production installations. Whilst its field of use is certainly not narrow, one cannot as yet perceive its full extent. It is essentially characterized by the remarkable properties of zirconium oxide, and particularly its high melting point and its chemical inertness. This material thus represents a latent factor in the technological and economic development of the industry, the rationalization of energy consumption and the protection of the environment.

In order to exploit this user potential, we need to establish the technological fundamentals of the product. It is necessary, for example, to examine systematically the links existing between the mechanical, thermal, electrical and electrochemical properties and the temperature, ambient atmosphere (e.g. the partial pressure of oxygen) and doping (e.g. the valency of cations).

Justification:

This project will lay the foundations for important technical innovations, for example the manufacture of sensors for monitoring functions in motor vehicles, ovens and exhaust-gas installations. The settings made possible by the use of these sensors will allow substantial energy savings.

These sensors are of particular importance to the motor-car industry, since the settings they allow make it unnecessary to add lead to the fuel, and this will help considerably to protect the environment. Research into the possibilities offered by zirconium oxide sensors of substantially lowering the carbon monoxide content in combustion-engine exhaust gases is also important from the economic viewpoint. If legislation came in requiring this, the industrial ceramics industry today would be caught unprepared and would depend on imports from the United States, since the latter already applies provisions of this type and, as a result, the industry has already carried out developments in this direction. The major risk in the Community as regards amortizing the development costs will be distributed across the whole of the branch by means of the joint action project.

Research study V: Development of the possibilities of using the electrical properties of tin oxide

Tin oxide has long been used as an opacifying agent for glazes and enamels and as a component of matt glass.

In recent times unusual electrical properties of tin oxide have been discovered. Consequently tin oxide electrodes are used instead of molybdenum electrodes for electrically heating the glass-melting furnace when the glasses contain oxides that rank higher than molybdenum in the table of electrochemical voltages (e.g. PbO, Al_2O_3, CuO, Fe_2O_3).

Coatings or glazes containing tin oxide serve to improve the surface. They are electricity-conducting and therefore suitable for operating-theatres, organic laboratories, rooms where explosion risks exist, or high-voltage insulators, and are replacing lead glazes which are regarded as dangerous for the environment. The n-type semi-conductor tin oxide can be used as an indispensable electronic and electro-optical material.

Development of new uses depends on, first, greater mastery of the technique of manufacturing tin oxides or mixed glass-and-ceramic systems containing tin oxide and, secondly, a systematic examination of these materials from the point of view of their properties and their reactions in the field of solid state physics.

Research study VI: Development of the technology of further processing and utilization of ceramic fibres and perfecting of technological bases for new production procedures

Recently, ceramic fibres of alumina and zirconium oxide have really got off the ground. In the meantime, a European manufacturer has begun to market such fibres.

These fibres are very resistant to chemicals and to high temperatures and can also be used as heat-insulating material in places where other materials are not strong enough to last well but where insulation is particularly desirable. This is the case in the construction of metallurgical ovens and thermochemical equipment.

Simply on the grounds of the energy-saving measures imposed by economic factors, it is imperative to promote wider production and use of ceramic fibres.

Ceramic fibres in bonded fabric form have already proved their worth as oven linings. This use could be considerably simplified, and followed by other uses, if the fibres were further transformed in which ceramic starting materials prepared from fibres are pressed or cast and finally sintered. The product obtained would then be a solid construction material characterized by extreme lightness and high thermal and chemical resistance. It would be mechanically suitable for machining, but could be manufactured in an almost limitless range of shapes.

From the point of view of economic and technological policy, it is worthwhile to discover and extend the technology of manufacturing and using such a material, which moreover could be used for a number of other purposes, for example as piping for very hot, chemically corrosive liquids and gases, as structural parts for reaction tanks in the chemical industry, as a filtering medium, a support for catalysts, for confining high temperatures in the smallest possible space, and so forth.

Hitherto, ceramic fibres have been produced by drawing or blowing from the melt. In view of the significance of the fibres in the public mind, it would be desirable to create technological production foundations for other manufacturing processes. Some unconventional methods would give greater freedom in the choice of starting materials. One should, for example, find out how to obtain crude ceramic fibres, which could then be baked, by impregnation of textile fibres in suspensions of ceramics or by electrophoretic deposition of ceramic powders on metal or carbon fibres.

Justification:

The utmost must be done to enlarge the technology of manufacturing, and using ceramic fibre, a material of such importance in connection with energy policy. Isolated firms would find it too difficult to resolve the fundamental problems. But, if the fundamental technological principles, and in particular those relating to use, are researched by collective effort this study will put the industrial ceramics industry in a better starting position to conquer new markets and at the same time contribute towards the energy savings that are now so necessary.

ANNEX 3

KNOWLEDGE AND INVENTIONS

A. Knowledge

The contacts concluded in implementation of this Decision will contain clauses permitting:

1. Communication to the Commission of the knowledge resulting from the research entrusted to the contractor, with the right to use it for its own needs, particularly for the management of the programme.

2. Confidential exchange, between contractors, doing research on the same topic, of any information which is necessary to the successful execution of the research and of which they have free disposal.

3. The compiling, for each research topic, of annual status reports which the Commission may communicate to the ACPM.

4. The compiling, on the initiative of the contractor at the request of the Commission, of special reports intended for the Member States and for persons and firms who carry on in the territory of a Member State, a research or production activity justifying their access to such reports.

5. The compiling, for each research topic, of a final report intended for publication, it being understood that, at the reasoned request of the contractor, the distribution of all or part of this report may be restricted to the Member States and to persons and firms who carry on, in the territory of a Member State, a research or production activity justifying their access to these reports.

B. Inventions

1. Under Council Regulation (EEC) No 2380/74 the inventions, whether patentable or not, resulting from the execution of the programme can belong to the contractors, or, if some of them so wish, be disposed of to a legal person created by them. If the contractors surrender these inventions, the Commission may claim ownership of them for the Community.

The contractor will be required to exploit such inventions or to have them exploited under conditions which are in conformity with the interests of the Community, pursuant to Article 3 of the above-mentioned Regulation. The granting of licences that allow products or equipment manufactured in non-member countries to be imported into the Community will not normally be considered as conformable with the interests of the Community and will be subject to prior authorization by the Commission.

2. In selecting contractors the Commission will give preference to those who have concluded or are willing to conclude among themselves an agreement on coordinated exploitation of the inventions and know-how which emerge from research falling under the same topic. This agreement must provide for the granting of licences on other inventions or the supplying of other know-how of which the contractors have the free disposal, insofar as this is necessary to such coordinated exploitation.

ANNEX 4

Proposal for a Council Decision on the adoption of a programme of technological research in the field of clay minerals and technical ceramics

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 235 thereof;

Having regard to the proposal from the Commission;

Having regard to the opinion of the European Parliament;

Having regard to the opinion of the Economic and Social Committee;

Whereas on 14 January 1974, the Council adopted a Resolution on the coordination of national policies and the definition of projects of interest to the Community in the field of science and technology;

Whereas, under Article 2 of the Treaty, the Community has inter alia the task of promoting throughout the Community a harmonious development of economic activities and a continuous and balanced expansion;

Whereas improvements in the technology of clay minerals and also in the technology of the production and use of technical ceramic products, which have become necessary for economic and social reasons and which will help towards achievement of the above-mentioned Treaty objectives, depend upon the carrying-through of certain wide-ranging technological research work;

Whereas joint research in this industrial sector plays an important role in the development of the ceramic industry since this branch consists mainly of small and medium-sized undertakings which are not, or are not sufficiently, in a position to undertake research of their own;

Whereas, because the manufacture of classical ceramic products such as insulators is developing more and more in countries which are becoming industrialized outside the Community, it is essential that the European industry devote itself to the technology and manufacture of products embodying the highest technical knowledge and skill;

Whereas, taking into account the limited national capabilities in the technology of clay minerals and technical ceramics, likewise the general interest expressed by the sector in the development of such technology, and in order to employ in the best possible way the research potential available in the Community, the ceramics industry has drawn up a programme of joint research at Community level, the total financial cost of which amounts to 8.2 million EUA;

Whereas a Community programme is designed to raise the technological level, to increase the competitiveness of undertakings, especially that of small and medium-sized undertakings, and to further the aims of the Community policies on energy and the environment;

Whereas this programme is also designed to improve the supply of raw materials for special materials, to facilitate innovation as regards both products and production, to permit economic growth of the sector and thereby to raise the level of employment, and to strengthen development of economically unfavoured regions;

Whereas, furthermore, this Community programme, which is designed to be incorporated in the joint programme referred to above and to facilitate its implementation, constitutes an important integrating factor for the ceramics industry;

Whereas the joint research programme is the result of cooperation of several years' standing within the ceramics industry and therefore offers the assurance that it will be rationally and successfully carried through;

Whereas the research projects which are the subject of this Decision appear to be necessary if certain Community objectives relating to the functioning of the common market are to be attained;

Whereas the Treaty establishing the European Economic Community makes no provision for the powers of action required for these purposes;

Whereas CREST has delivered its opinion on the proposal of the Commission,

HAS DECIDED AS FOLLOWS :

Article 1.

A Community programme of research in the fields of technology of clay minerals and technical ceramics, as set out in the Annex, is hereby adopted for a period of four years.

Article 2.

The global requirements for the whole duration of the programme are estimated at 4.5 MUCE and a staff of 2 agents, the European unit of account being defined by article 10 of the Financial regulation of 21 December 1977 the sums quoted being given only by way of indication.

Article 3.

The Commission shall carry out the programme by means of contracts. It will be assisted in this task by the advisory committee on the management of the programme of research and development in the field of "primary raw materials" set-up by Council decision of 6 March 1978 and whose mandate and membership are defined according to the Council resolution of 18 July 1977 relating to consultative committees in the field of research programme management.

Article 4.

Dissemination of information resulting from the execution of the programme shall be effected under the terms of Council Regulation (EEC) 2380/74 adopting provisions for the dissemination of information relating to research programmes for the European Economic Community.

Done at Brussels,

For the Council,

The President.

ANNEX

Programme of research on the technology of clay minerals

Main objectives: use of poorer-quality clay minerals, improvement of the technological conditions that now restrict the supply of raw materials to the ceramic industry and the innovations in products and production which are desirable for reasons of economic, energy and environmental policy.

Programme: initially, coordination of research in the field of clay minerals, to be followed by technological research work in the context of a joint action project of the ceramics industry, namely, thorough examination and development of the bases underlying the technology of upgrading and utilizing clay minerals, and drawing-up of a proposal to intensify the use of raw materials and to improve the ceramic production process.

Programme of research on the technology of special ceramic materials

Main aims: provision of basic materials for special ceramic materials, replacement of rare metals by ceramic products, development of industrial ceramics by the encouragement of innovations in products and production which are desirable for reasons of economic, social, energy and environment policy.

Programme: initially, coordination of research in the field of industrial ceramics, to be followed by technological research work in the context of a joint project of the industrial ceramics industry, namely, developing of methods for the manufacture and processing of basic materials for special ceramic materials, improvement of special ceramic materials and development of the technology of using them.

ANNEX 5

SITUATION, LOCATION AND DEVELOPMENT OF THE CERAMICS INDUSTRY IN THE COMMUNITY

1. STRUCTURE

The ceramics industry may be divided into:

Construction ceramics:

sanitary equipment, construction parts, tiles, stoneware pipes.

Domestic ceramics:

crockery, decorative articles

Industrial ceramics:

parts for electrical and chemical equipment and installations, for tools and machine-tools and for other purposes, medical for example.

Fireproof ceramics:

refractory parts for furnaces and metallurgical plant.

Brickworks:

roofing tiles, bricks.

The ceramics industry of the Community numbers some 1 200 firms employing a total of about 250 000 people. Some ten firms employ more than 2 000 persons. Around half the firms, and in the area of tile manufacture nearly three-quarters of the firms, employ less than 100 persons. The proportion of female labour is relatively large; in the production of crockery and decorative ceramics, it exceeds 50%.

The ceramics industry is mainly concentrated in certain regions which are distinguished by the presence (in the past) of the raw material for ceramics or are based on national factories set up in the eighteenth century. From the economic point of view, some of the regions are not very well favoured and so the ceramics industry carries particular responsibility for their development.

2. LOCATION OF THE CERAMICS INDUSTRY IN THE EC REGIONS

GERMANY:

The production of porecelain for crockery and industrial ceramics is concentrated in the north-east of Bavaria. The local production of insulators accounts for 40% of the Community output. In the case of crockery, German production amounts to 50% of the Community output.

An important zone for manufacture of pottery and sanitary equipment is found in the Saarland, centred on Mettlach/Perzig. In the Westerwald (Rhineland-Palatinate) there are a large number of firms making tiles, drawn tiles, rustic ceramics and sanitary equipment.

UNITED KINGDOM:

The production of pottery and porecelain for both domestic and industrial usage is concentrated in the district of Stoke-on-Trent (Staffordshire), a district which is in fact known as "the Potteries". United Kingdom production of earthenware crockery represents about 60% of the Community output.

NETHERLANDS:

The ceramics industry is concentrated in the regions of Maastricht and Delft where the majority of tiles, sanitary equipment and crockery are produced.

BELGIUM:

Generally speaking, the ceramics industry is established in the Borinage, the Centre, Charleroi and Liège districts.

DENMARK:

The prduction of porcelain for crockery and insulators is concentrated practically exclusively in the Copenhagen area.

ITALY:

The production of porcelain crockery and sanitary equipment is located in Lombardy and in certain parts of the south. Earthenware crockery (faience) comes principally from the Civita Castellana region. Tile production apart from that located in Lombardy, is strongly concentrated in the region of Emilia Romagna (Sassuolo zone) where 5% of the population working in industry are engaged in tile-making. Ninety per cent of the tile producers in the European Community are in Italy; local production represents 60% of Community output.

FRANCE:

Manufacturers of sanitary ceramic wares are dispersed throughout the country. A large number of tile and fireproof-product factories are found in the north, particularly in the region of Lille and Maubeuge. Factories for fireproof products are also concentrated in the Rhône Valley.

Certain eastern areas, and particularly Sarreguemines, are centres of production of earthenware crockery, tiles and fireproof products.

The Pyrenees region has a number of firms producing industrial ceramics (e.g. Tarbes). In Burgundy and in the centre of the country there are producers of tiles and earthenware crockery.

Production of porcelain crockery is concentrated in Haute-Vienne with Limoges as the centre and in Cher (Berry region). These two areas account for 90% of the French production of porecelain, three-quarters of which comes from Limoges.

A certain number of earthenware factories occur in Brittany and these make crockery and ornamental ceramics.

With the exception of sanitary ceramic wares, there has been little industrial development of ceramics manufacture in the southern regions. Nearly all the firms are of the cottage-industry type. The producers of decorative tiles in Languedoc in particular are facing serious economic problems.

Organization of the industry: at the national level the ceramics industry is not organized in a uniform way. Sometimes there is a national federation of ceramics industries, sometimes there are parallel sectoral organizations. The industrial ceramics branch, which was originally concerned mainly with the manufacture of electrical insulators, thus belongs in some cases to the organization of electrical industries.

At the Community level, the branches of fireproof ceramics, sanitary ceramics, crockery ceramics, industrial ceramics and the tile industry have their own sectoral organizations which are composed of the corresponding national organizations and are united in CERAME-UNIE (Office for Liaison of the Ceramics Industries of the Common Market). The sectoral organization of industrial ceramics is called GROUPISOL. The national umbrella associations or general associations of the ceramics branches are also members of CERAME-UNIE.

The Community sectoral organization of the brick industry is not part of CERAME-UNIE.

Production and trade: the ceramics industry has a turnover of 4 000 million u.a. It represents about 0.5% of the Community's gross national product and occupies the top position in the world, followed closely by Japan. Admittedly production saw a drop of 13% from 1974 to 1975, and in the sectors of crockery and traditional tiles fell by 21 and 25% respectively; but from 1971 to 1975 it rose by 20-25%.

During recent years (1970-75), Community exports of ceramic products have increased annually by 32% and they represent at the present time 20% of production. Imports represent 6% of production and each year they increase by an average of 18%.

The main competitors of the Community ceramics industry are the state-trading countries and China, various small East-Asian countries (South Korea, Singapore, Taiwan), Spain, Brazil and above all Japan. Some of these competitors benefit from low wage-levels and government subsidies. It is mainly the competition of the state-trading countries which disturbs the market, since they can often sell their products at manufacturing costs well below those of the Community.

The United States is by far the biggest customer. Where industrial ceramic products are concerned, however, they are, with Japan, the keenest competitors.

Raw materials intended for the manufacture of ceramic products, among which clay minerals are quantitatively the most important, are for the most part extracted within the Community. Some raw materials, however, can be obtained outside the Community in better quality or under more advantageous conditions. A certain number of basic substances for special ceramic materials can be obtained only from a few non-member countries, because either the Community does not possess natural deposits of them or these substances have to be prepared by new production techniques which the Community firms have not yet mastered.

According to the estimates, production costs in the ceramics industry break down as follows: 40-65% for wages, 10-20% for raw materials and auxiliary materials, 10% for energy and 10-20% for plant and premises. From 1964 to 1970 (193 million u.a.), investments doubled.

The large fraction devoted to wages obviously creates trading difficulties for the ceramics industry of the Community, as compared with low-wage countries. On the other hand, the Community industry that makes machine tools and plant for the manufacture of ceramic products unquestionably occupies a dominant position at world level. It is therefore largely geared to export and, in numerous cases, it equips the competitors of the Community ceramics industry with the most modern means of production.

Technological development: public opinion generally underestimates ceramics technology. This is because it stems from a skill that stretches back into prehistory and people tend to think first of the craftsmanship or the artistic aspect. In addition, it has only been during the last 25 years that development has taken a great leap forward transforming the ceramic art, far more than did the technical progress of several centuries, into an industry characterized in certain cases by a very high technological content.

Production is in general largely automated and the working conditions for employees have markedly improved. In the same way, the staff are moving over from production work to supervision of materials, process control and upgrading of the product.

Forecasts on future development: the qualitative improvements in ceramic products and the opening up of new fields of use have enabled the ceramics industry to maintain the level of employment in spite of thoroughgoing rationalization and extensive automation.

Future development must satisfy the following requirements:

- In view of the fact that the present professional qualifications of workers do not always correspond to the requirements imposed by technological progress in ceramic production special attention must be given to the training of a body of highly-qualified workers.

- Increasingly, the ceramics industry has need of starting materials endowed with specific properties, and this requires innovations in the area of basic ceramic materials. Hence an effort must be made now to intensify the employment of ceramic raw materials by making usable the lower-grade materials which are today discarded and by channelling towards the ceramic production process waste from other branches of industry.

- Since energy represents a cost factor which is continuously increasing, the industry must in future seize all opportunities, however limited, of using energy in a more rational way.

- Immense possibilities are offered to the ceramics industry if it follows the path taken by this young branch, industrial and special ceramics. To this end, and independently of a continual exploration of potential uses, carried out at the interdisciplinary level, it is necessary:

  - to master the science and technology of present and future ceramic materials,
  - to study systematically the interrelationships of the properties of ceramic materials with other phenomena which occur in natural and engineering sciences,

- to develop interdisciplinary mixed technologies,
- to ensure that rare special raw materials and basic materials with a high technological content are available to the industrial ceramics industry.

<u>The political evaluation of the ceramics industry</u>: a high added value brought about by starting with generally cheap raw materials, a turnover of 4 000 million u.a., a balance-of-trade surplus, 250 000 workers and 1 200 firms, the majority of which are small or medium-sized firms, are already-mentioned factors which allow evaluation of this industrial branch from the standpoint of economic policy. As to supply policy, it is worth noting that in general the ceramic product is composed of native materials and that in various cases it can take the place of rare metallic raw materials. The fact that ceramic products are easy to crush is of importance to the environment policy. As to energy consumption, in the ceramics industry it is moderately high but, in many economic fields, its products contribute largely to rationalizing the consumption and conservation of energy. In addition, where other materials can take the place of ceramic materials, the substitutes are generally produced by energy-intensive processes or have a much shorter lifetime. In assessing the importance, in the public interest, of the ceramics industry, one should take into account all these economic factors, but also certain aspects of technological and cultural policy.

Its evaluation as regards technological policy rests upon its function as a supplier to other branches of industry and other technical activities. Here we are speaking of industrial ceramics, which is both an outcome and a driving force of technical progress, even in the area of advanced technology. Other branches of the ceramics industry also possess a high potential for technological innovation, for example ceramics for construction, which may play a considerable role in the renovation and rationalization of the buildings industry.

The "cultural policy" aspect is connected with the fact that ceramic products are for a large part durable investment goods purchased by households and used for a number of generations. Their shape and working do not only follow economic constraints of production or utilization, but are also governed by aesthetics and old traditions. To that extent, therefore, the ceramic product, particularly as regards ornamental ceramics, tiles and crockery, and to some extent also sanitary and construction ceramics, is a cultural and even an artistic product endowed with the extraordinary acceptability of a durable domestic object. It is also a challenge to the creativity, as regards decoration and shape, of the many people who work in ceramics as designers or industrial artists in the firms or as freelance or amateur artists. All give shape to individual, local, regional, national, European, traditional or avant-garde concepts, and through their ceramic creations influence the present and future sentiments, thoughts and acts of those around them. As a result, ceramic products also occupy an assured place in cultural policy.