

COMMISSION OF THE EUROPEAN COMMUNITIES

COM(85) 391 final.

Brussels, 24 July 1985

PROPOSAL FOR A COUNCIL DECISION

ADOPTING MULTIANNUAL R&D PROGRAMMES
IN THE FIELD OF THE ENVIRONMENT
(1986 - 1990)

(submitted to the Council by the Commission)

PROPOSAL FOR A COUNCIL DECISION
ADOPTING MULTIANNUAL RESEARCH AND DEVELOPMENT PROGRAMMES
IN THE FIELD OF ENVIRONMENT
(1986-1990)

- I. ENVIRONMENT PROTECTION
- II. CLIMATOLOGY
- III. MAJOR TECHNOLOGICAL HAZARDS

(presented by the Commission to the Council)

TABLE OF CONTENTS

	<u>Page</u>
Proposal for a Council Decision adopting three Multiannual Research and Development Programmes in the field of Environment (1986-1990)	1
I. Environment Protection	7
II. Climatology	9
III. Major Technological Hazards	11
- Draft Council Decision	13
- Financial Data	22

DETAILED PROPOSALS :

PART I : Environment Protection	35
- Annex IA : Scientific Content	48
- Annex IB : Scientific Programme of Concerted Actions	56
- Annex II : List of Publications	61
- Annex III: Opinion of the CGC	68
PART II : Climatology	70
- Annex I : Opinion of the CGC	85
PART III : Major Technological Hazards	87
- Annex A : Outline of Research areas of Sector A	99
- Annex B : Opinion of the CGC	107

PROPOSAL FOR A COUNCIL DECISION
ADOPTING THREE MULTIANNUAL RESEARCH AND DEVELOPMENT PROGRAMMES
IN THE FIELD OF ENVIRONMENT
(1986-1990)

- I. ENVIRONMENT PROTECTION
- II. CLIMATOLOGY
- III. MAJOR TECHNOLOGICAL HAZARDS

(presented by the Commission to the Council)

A. Introduction

Concern for the environment is now a matter of national and international policy throughout the world. Whereas, initially, the main preoccupation was to protect people against pollution and to preserve wildlife, it has been realized during the recent years that long term economic development is predicated upon the conservation of environmental resources.

The international dimension of environmental problems is generally acknowledged. It is also recognized that science and technology can help bridge the gap between economic and environmental policy by providing, on the one hand, a sound basis for environmental regulation and on the other the technical means to correct or prevent environmental damage. High quality objectives for the environment may indeed spur technical innovation and can contribute to energy and raw materials conservation.

Community cooperation in environmental research is thus particularly appropriate as it addresses a common policy concerned with essentially cross-frontier problems for which two main instruments are joint regulatory measures such as standards and incentives for the development of technologies.

The European Community has been involved in environmental research since 1972, initially in the COST framework and subsequently through programmes carried out at the Joint Research Centre and through shared-cost contract programmes and concerted actions.

In 1981, these programmes, except that of the JRC, were grouped in a sectoral R & D programme (1981-1985) Environment (Environmental Protection and Climatology).

They have produced a large number of results which are valuable from both the scientific and the practical standpoint, recognized, for instance, by the report of the independent panel entrusted with the evaluation of the Environment Protection Programme. Results of research funded by the Community are recorded in numerous publications in international scientific journals. Wherever appropriate, the Commission edited specific reports which received a wide distribution. The Environment Research Programme contributed significantly to the scientific basis of various Community directives and proposals at present under discussion at the Council. Details are given in the proposals for the individual programmes.

The proposals presented hereafter aim at further developing these research activities and defining them for the period 1986-1990, taking into account

- new research requirements derived from the evolution of the European Community Environment Policy and other sectoral policies dealing with environmental problems, for instance in areas like acid deposition, toxic and dangerous waste, soil protection and the increase of atmospheric CO₂,
- the redefinition of the Communities' R & D Policy, laid down in the Framework Programme, including the concept of Research Action Programmes.

They are part of the Research Action Programme (RAP) Environment*.

B. The European Communities Environment Policy

The Community Environment Policy was defined in 1973 in a first Environment Action Programme¹) and reconfirmed and updated in 1977²). A further revision of this policy resulted in the Council Resolution of 7 February 1983 on the continuation and implementation of a European Community policy and action programme on the environment (1982³ to 1986³), which identified also a list of priority actions.

It is obvious that Environmental Research must be consistent with the goals of the Community Environmental Policy, inasmuch as research needs are derived therefrom, and this not only as far as the short term goals are concerned, but also with regard to the foreseeable medium and long-term objectives. Emphasis is therefore given to elaborating the

* The term "Action Programme" is currently used in various contexts. In this document, the following terminology is used:

- "ENVIRONMENT ACTION PROGRAMME" is the legal instrument (Council Resolution) defining the Environment policy of the European Communities;
- "RESEARCH ACTION PROGRAMME ENVIRONMENT" is an instrument for the management and coordination by the Commission of various R & D programmes (JRC, contract research, concerted actions) in the field of environment. For convenience, the abbreviation "RAP Environment" is used.

1) O.J. N° C 112, 20.12.1973, p.1
2) O.J. N° C 139, 13.06.1977, p.1
3) O.J. N° C 46, 17.02.1983, p.1

links to this policy, implemented through the Environment Action Programme, which essentially consists of an inventory of environmental problems identified on Community level together with a framework of Community actions envisaged for their solution.

The main objectives of the Community environmental research are therefore as follows :

- to establish a scientific basis for the implementation of the Community environmental policy,
- to promote long-term basic research on important environmental problems,
- to coordinate relevant national research in selected and suitable areas.

A more specific definition of these and other objectives is given the individual programme proposals.

Within this context, the proposed programmes correspond to the objectives of the Environment Action Programme as follows :

- the environment protection programme addresses most of the short and medium term policy goals of the Action Programme, as far as they imply research requirements;
- the climatology programme addresses the effects of human activities on climate, such as those of increased CO₂ levels as a consequence of burning fossil fuels and deforestation, and the impact of climate on natural resources, referred to in the Environment Action Programme.
- the programme on major technological hazards addresses primarily the issues underlying the directive on the major accident hazards of certain industrial activities.

As mentioned above, the Environment Action Programme identifies a list of priority actions; emphasis is given, of course, to these same subjects in the research programmes, and specific reference is made to these where appropriate in the proposals.

Furthermore, the research programmes take into account the updating of the Environment Action Programme for the period 1987-1990, at present in preparation.

C. The Community Framework Programme for Science and Technology

In the Council Resolution of 25 July 1983 on Framework Programmes for Community research, development and demonstration activities and a first Framework Programme 1984 to 1987¹⁾, seven Community goals and corresponding scientific and technical objectives are defined. The following proposals find their main justification within the goal

¹⁾ O.J. N° C 208, 4.8.1983, p.1

Improving living and working conditions :

- improving safety and protecting health,
- protecting the environment.

They will contribute substantially to all other goals. While it is difficult and, to a certain extent arbitrary, to give indications regarding the relative contribution of the proposed programmes to the various goals of the Framework Programme, the Commission services estimate that the distribution will be as roughly follows :

Community goal	Approximate contributions in %			
	Environment Protection	Climatology	Major technol. hazards	Total
Promoting agricultural competitiveness	10	20	-	10
Promoting industrial competitiveness	10	-	20	10
Improving the management of raw materials	5	-	-	2.5
Improving the management of energy resources	5	-	-	2.5
Reinforcing development aid	-	20	-	5
Improving working and living conditions	70	60	80	70

The Council resolution on the Framework Programme lists 4 selection criteria, to be taken into account for defining specific Community R & D Programmes; three of these criteria apply to the proposed programmes for the following reasons :

- in view of the regulatory power of the Community concerning environmental matters, a joint research effort to back Community regulations will obviously offer financial benefits;
- many environmental problems are of a transboundary nature and hence involve research on a large geographical scale;
- the impact of environmental regulation on the free trade of products demands the development of uniform standards, common assessment procedures, etc., for which the proposed programmes will provide a scientific basis.

D. The Research Action Programme (RAP) Environment

In its proposal for the Framework Programme¹⁾ the Commission stated its intention to apply for its implementation the concept of research action programmes as a tool for improving the management of its specific R, D & D programmes.

¹⁾ COM(83) 260 final

The RAP Environment covers the following proposals on R & D programmes

- Environmental Protection (contract research, concerted actions and coordination)
- Climatology (contract research and coordination)
- Major technological hazards (contract research and coordination)

together with the relevant sections of the programme of the JRC (1984-1987)

- Environmental Protection
- Industrial Risk
- Remote Sensing.

With the present proposals, an effort is made to increase the coherence between the various parts of the RAP Environment; thus the proposal for the R&D programme on Environmental Protection is designed to match the relevant programme of the JRC and will be complemented by parts of the remote sensing activities of the JRC, which as such do not correspond to an objective, but to the application of a new technique to various environmental and agricultural problems. The new action on major technological hazards complements and augments the JRC programme on industrial risk.

The research activities within the RAP Environment are complemented by a demonstration programme defined in the Council Regulation on Action by the Community relating to the Environment (ACE) of 28 June 1984, mainly in the area "clean technologies"¹⁾.

There are also close links to other research programmes, in particular the R & D Programme "Recycling of urban and industrial waste", which is part of the RAP Materials and Materials Technology.

The objectives, justifications and scientific/technical contents of each of the 3 programmes are summarized below.

E. Implementation

The programmes will be implemented in four ways :

- a) shared-cost contracts concluded with research organizations, universities and industry : preference will be given to transnational projects which may be carried out under a single contract or a set of related contracts. The call for proposals will stipulate as precisely as possible the objectives of each project, which will relate to one of the research areas and topics listed in the programme proposals. A certain amount of funding will however be reserved for original proposals proposed singly;
- b) coordination, either by formal concerted actions in suitable research areas, in which a substantial amount of research is on hand at national level, or by ad hoc arrangements with research institutions in the Member States whenever this offers benefits for Community research;

¹⁾ O.J. N° L 176, 03.07.1984, p.1.

- c) "catalytic" activities consisting of workshops, assessment studies, etc.;
- d) training activities (doctoral and post-doctorate fellowships, exchange of scientists, etc.).

In view of the nature of the programmes international collaboration will be encouraged, especially in the COST framework.

The Commission will manage the programmes with the assistance of the Management and Coordination Advisory Committee (CGC) "Environment and Climatology".

F. Funding and staff

For a 5-year period (1986-1990) the following financial allocations are requested

- Environmental Protection (contract research, concerted actions and coordination)	65 MECU
- Climatology (contract research and coordination)	25 MECU
- Major technological hazards (contract research and coordination)	15 MECU

	105 MECU

These allocations take account of

- the enlargement of the Community to be effective in 1986
- the incorporation of training activities, so far financed from a specific budget.

In addition to these provisions no significant increase of the allocations for the Environment Protection Programme is foreseen above the level of funding for the period 1984/85 (after the revision of the 3rd programme) although new activities have been incorporated. This can be achieved only by shifting emphasis from contract research to coordination and concerted actions in some areas, which implies a modest increase in staff.

For the Climatology Programme, besides the reasons given above, the allocations take account of the costs necessary to increase modelling capabilities, especially in view of the seasonal (3 to 6 months) forecasting of the European climate, to the analysis and application of satellite data, and to the intensification of research on the climatic effects of enhanced CO₂ and consequent climatic impacts.

The allocation of the Major Technological Hazards Programme only reflects initial activities. This programme addresses, by very nature, a great many scientific, technological and regulatory/policy issues. Relevant experimental and modelling work, inevitably expensive and diversified, constitutes a large part of the activities.

The structure and funding of the whole RAP Environment are shown in the following table :

	Contract Research 1986-90	Concerted Actions 1986-90	JRC 1984-87 ²⁾
Environmental Protection	60.45 (43.3) ¹⁾	4.55 (3.2) ¹⁾	48.2 ³⁾
Climatology	25.0 (8.0) ¹⁾	-	-
Remote sensing	-	-	29.0 ³⁾
Industrial risk (major techno- logical hazards)	15.0 (0) ¹⁾	-	21.5 ³⁾

The staff requested to manage the new programmes is 27, subdivided as follows :

- environmental protection	17 (13) ¹⁾
- climatology	6 (3) ¹⁾
- major technological hazards	4 (0) ¹⁾
	<hr/> 27

G. Outlines of the three Programmes

I. ENVIRONMENT PROTECTION

The proposal concerns the 4th Community R & D Programme in the field Environment Protection (1986 - 1990), covering contract research and Concerted Actions. The proposed programme is a logical continuation of the present programme (1981 - 1985), taking into account new research needs identified after a careful analysis of the achievements of previous programmes and of the requirements derived from the implementation of the Community Environment Policy.

The programme is the core of the RAP Environment and is closely connected with environmental research at the Joint Research Centre as well as with other Community research programmes (climatology, recycling of wastes, etc.).

1) corresponding allocations for 1981-1985
 2) adopted programme
 3) 1983 ECU's

The main aim of the programme is to give scientific support to the implementation of the Community Environmental Policy (Environment Action Programme) by providing specific knowledge needed, at short and medium term, for its implementation. The programme addresses, however, also longer-term environmental problems in view of the development of preventive and anticipatory policies. Emphasis is given to promoting, at Community level, the coordination of national research activities by fostering joint projects and by implementing concerted actions and by less formal arrangements for cooperation. A further scope of the programme is the promotion of training in environmental sciences.

The programme will contribute significantly to most of the other objectives of Community R & D, as defined in the Community R, D & D Framework Programme.

The programme covers research on :

- Health effects of pollutants;
- Ecological effects of pollutants, i.e. effects on non-human targets;
- Assessment of chemicals, in particular improvement of the methodology for testing;
- Air quality, including the effects of air pollution on terrestrial (e.g. forests) and aquatic ecosystems;
- Water quality, aimed at protecting the freshwater, estuarine and marine environment;
- Soil quality, in view of an integrated approach to the protection of soil;
- Noise research;
- Ecosystem research, mainly in view of the acquisition of basic knowledge on the dynamics of ecosystems and their vulnerability;
- Waste research with emphasis on treatment of toxic and dangerous waste and recycling;
- Reduction of pollution by "clean" and advanced abatement technologies.

The programme will be implemented in part by contract research and coordination, in part by concerted actions. In addition to a renewal of 5 existing concerted actions

- Air pollution effects on terrestrial and aquatic ecosystems,
- Physico-chemical behaviour of atmospheric pollutants,
- Organic micropollutants in the aquatic environment,
- Treatment and use of sewage sludge,
- Coastal benthic ecology,

two new concerted actions are proposed

- Indoor air quality and its impact on man,
- Bird protection.

The programme provides also for the possibility to extend laboratory and field research to evaluation and assessment, aiming at the establishment of a consolidated scientific basis of environmental legislation and management.

The proposal provides for the possibility to associate interested non-Member States, in particular within the COST framework.

The allocations necessary to implement the programme, for the 5 year period, are estimated at 65 MECU, 4.55 MECU of which are earmarked for the management of concerted actions. For the implementation a total of 17 staff (10 A, 2 B, 5 C) is necessary.

II. CLIMATOLOGY

The continuation of the First Climatology Programme (1981-1985) of the Research Action Programme "Environment" into a Second Programme (1986-1990) is proposed as a component of the European Communities' Environmental Policy, of which the long-term availability and rational management of climate-dependent resources is a declared objective.

As one of the most important components of man's environment, climate is the factor upon which the quality and quantity of our water resources, our harvests, our needs in terms of energy and shelter, ultimately depend. Therefore, the economic implications of whatever knowledge we may gain about climate need not be stressed. Intrinsically variable, climate can have in store a major change which could be brought about by the increase of atmospheric CO₂, mainly due to fossil fuel burning. Hence the urgent need of improving our understanding of climate and of the response of land and water resources to any climate variation.

As the first Programme has shown, the complex and transfrontier character of climatic problems need an interdisciplinary approach and international cooperation such as a Community Programme can ensure.

The European programme would thus contribute in an effective way to the solution of the problems posed to our age by climate and its interactions with man.

The Programme consists of the following three Research Areas:

1. THE PHYSICAL BASIS OF CLIMATE

- 1.1. Past climates and climatic change.
- 1.2. Climatologically significant processes.
- 1.3. Modelling and predicting European climates within a global context.
- 1.4. Seasonal (3-6 months) forecasting of elements of the European climates.

2. CLIMATE SENSITIVITY

Priority will be given to studies related to the possible effects of human influences and concerning European climates particularly.

- 2.1. The climatic effect of changes in atmospheric composition, especially the enhanced carbon dioxide.
- 2.2. The climatic effect of changes in land-surface properties.
- 2.3. Early detection of climate change.

3. CLIMATIC IMPACTS

- 3.1. Impact of climatic change or variability on land resources, including soil and ecosystems, with special attention to desertification problems.
- 3.2. Impact of climatic change or variability on European water resources, including the development of climate-based models for their evaluation and forecasting.
- 3.3. The photosynthetic response of European vegetation to increasing atmospheric carbon dioxide.
- 3.4. Impact of climatic change or variability on sea resources and fisheries.
- 3.5. Application of climatic knowledge to a better management of land and water resources.
- 3.6. Causes, mechanisms and impacts of climatological anomalies and extreme or abrupt events, with the aim in view of reducing human and material losses.

In addition to contract research the programme will include an effort to coordinate the ongoing research activities within the Member States of the European Community.

The amount of EC funding estimated necessary for the five-year period is 25 MECU and the number of staff is set at 6.

III. MAJOR TECHNOLOGICAL HAZARDS

This new programme focuses on the understanding, prevention and mitigation of major industrial and transport-related accidents, of chemical and petrochemical origin, recent examples being e.g. Bantry Bay, Mexico City, Bhopal, etc. In a majority of cases, large inventories of flammable, very reactive or toxic substances are involved. Other major hazards (natural/ecological, high explosives) or other regulated activities (mining, transportation of people, nuclear energy) are not addressed at this stage.

A Community approach to research and regulation in this field is needed for several substantial reasons. The considerable problems extant are shared by the entire European chemical/petrochemical sector and exhibit transnational aspects. The research is complex and expensive, calling for a pooling of expertise and resources. Common, mutually agreed predictive or regulatory tools, to prevent and mitigate major technological hazards, are the ultimate objective, in view of the implementation of the Council Directive "On the major accident hazards of certain industrial activities".

The programme is one element of this broader Community approach, which includes on-going research at the J.R.C. (industrial risk sector, within the R.A.P. Environement), activities of other Directorates-General and exchange of information schemes. It meets several options and objectives of the Framework Programme, on life and work quality, industrial competitiveness and management of energy resources.

The three sectorial aims of the programme are: improving the scientific foundations of risk analysis; improving or substituting hazardous processes/technologies; taking account of the human/geographical context and of the likelihood of catastrophic events. Correspondingly, the scientific and technical contents are subdivided as follows:

- Sector A. Physical and chemical phenomena and mitigation of consequences of accidents, covering
- Source term aspects;
 - Dispersion in air of dense/cold clouds;
 - Combustion of flammable/explosible clouds;
 - Blast propagation and interactions; missiles; confined explosions;
 - Catastrophic fires; fireballs; conflagrations;
 - Runaway reactions;
 - Toxic substances dispersion, excluding toxicology;
 - Dust explosions, physics and venting.

The areas listed are closely interrelated, calling for large-scale experimentation, reduced-scale simulations and theoretical modelling. Sector A is given high initial priority, as problems are well identified.

Sector B. Technological aspects, covering

- Safety and reliability of existing technologies, their improvement;
- Alternative, safer technologies and processes;
- Instrumentation, for detecting/mitigating high-risk situations.

Sector B calls for predominant industrial participation.

Sector C. Assessment and management of risk, covering

- Risk analysis and accident prevention: hazards mapping, risk aggregates; cost/benefit of safety in complex systems; human factor; risk perception; development of expert systems; proababilistic approach.
- Accident management: measures in an emergency; population behaviour; emergency planning.

Several of those aspects are also addressed by the J.R.C. programme, industrial risk sector.

Several "cross-sectoral" studies, to be launched at first, will identify links and feedbacks between sectors and guide research options and topics selection in Sectors B and C. As examples of relevant themes: transportation of bulk hazardous substances; hazardous production cycles (pesticides) involving highly toxic substances.

Implementation will be by way of: shared-cost contracts, with emphasis on transnational projects; cross-sectoral studies; coordination actions.

For the five-year period of validity, an allocation of 15 Mecu and a management staff of four are foreseen.

PROPOSAL FOR A COUNCIL DECISION
ADOPTING MULTIANNUAL R&D PROGRAMMES
IN THE FIELD OF THE ENVIRONMENT
(1986 - 1990)

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 (1),

Having regard to the opinion of the Economic and Social Committee (2),

Whereas Article 2 of the Treaty assigns to the Community the task, inter alia of promoting throughout the Community a harmonious development of economic activities and an accelerated raising of the standard of living;

Whereas the Council on 7 February 1983 approved a resolution on the continuation and implementation of a European Community policy and action programme on the environment (1982 to 1986) (3);

Whereas in that resolution the Council stated that the harmonious development of economic activities and a continuous and balanced expansion are inconceivable without making the most economic use possible of the natural resources, which is one of the fundamental tasks of the European Economic Community;

Whereas the European Council at its meeting at Stuttgart from 17 to 19 June 1983 emphasized the urgent necessity of accelerating and reinforcing action at national, Community and international level aimed at combatting the pollution of the environment;

Whereas in its Resolution of 25 July 1983 the Council adopted a first framework programme for Community research, development and demonstration activities (4);

(1)

(2)

(3) OJ N° C 46, 17.2.1983, p. 1.

(4) OJ N° C 208, 4.8.1983, p. 1.

Whereas Community research in the field of the environment and climatology has contributed and will contribute effectively to the implementation of the policy and action programme for the environment ;

Whereas the Treaty does not provide the specific powers of action required for these ends;

Whereas the Scientific and Technical Research Committee (CREST) has delivered its opinion on the Commission's proposal,

HAS DECIDED AS FOLLOWS :

Article 1

- (1) The research and development programmes of the European Economic Community in the field of the environment covering the areas environmental protection, climatology and major technological hazards, as described in the Annex, are hereby adopted for a period of five years from 1 January 1986.
- (2) The programmes shall cover work carried out as shared-cost contract research, concerted actions, coordination and training activities, as described in the Annex.

Article 2

The appropriations necessary for the execution of the programmes shall be fixed at 105 m ECU, including expenditure on a staff of 27, subdivided as follows:

- Protection of the environment	65 m	ECU	17 staff
- Climatology	25 m	ECU	6 staff
- Major technological hazards	15 m	ECU	4 staff

Article 3

The programmes shall be reviewed in the course of the third year; this review may lead to a revision of the programmes effective at the beginning of the fourth year, following the appropriate procedures, and after the Committee referred to in Article 4 has been consulted. The Council and the European Parliament shall be informed of the results of the review.

Article 4

The Commission shall be responsible for the execution of the programmes. It shall be assisted in its tasks by the Management and Coordination Advisory Committee (CGC) on the environment and climatology.

The terms of reference and composition of that Committee shall be in accordance with Council Decision 84/338/Euratom, ECSC, EEC of 29 June 1984 dealing with structures and procedures for the management and coordination of Community research, development and demonstration activities (5).

Article 5

1. With regard to the concerted actions, the participating Member States and the Community shall, in accordance with a procedure to be laid down by the Commission, after having consulted the Committee referred to in Article 4, regularly exchange all useful information concerning the execution of the research covered by such activities.

The participating Member States shall provide the Commission with all information relevant for coordination purposes. They shall also endeavour to provide the Commission with information on similar research planned or carried out by bodies which are not under their authority.

Any information shall be treated as confidential if so requested by the Member State which provides it.

2. Following completion of the programme, the Commission shall, after having consulted the Committee referred to in Article 4, send to the Member States and the European Parliament a summary report on the implementation and results of the concerted actions.

It shall publish this report six months after it has been sent to the Member States, unless a Member State objects. In the latter case, the report shall be distributed, in agreement with the said Committee, only to those institutions and undertakes that request it and whose research or production activities justify access to the results of the research arising from the concerted actions. The Commission shall make the necessary arrangements for the report to remain confidential and not to be divulged to third parties.

Article 6

1. In accordance with Article 228 of the Treaty, the Council may conclude agreements with third States, in particular those involved in European cooperation in the field of scientific and technical research (COST) with a view to associating them wholly or partly with these programmes.

(5) OJ N° L 177, 4.7.1984, p. 25.

2. The Commission is hereby authorized to negotiate the agreements referred to in paragraph 1.

The agreements with third States participating in COST shall be negotiated in accordance with the conclusions of the Council of 18 July 1978 concerning European Cooperation in the Field of Scientific and Technical Research (COST) (6).

Done at Brussels, 24 July 1985

For the Council

The President

(6) OJ N° C 100, 21.4.1979, p. 1.

PART I : ENVIRONMENTAL PROTECTION

<u>Funding</u> :	total	65.000.000 ECU
	- contract research	60.450.000 ECU
	- concerted actions	4.550.000 ECU

Staff : 17

Scientific Content of the Programme

- 1) Health effects of pollutants
 - Chronic and late effects at low exposure levels and early indicators of health effects
 - Epidemiology and exposure trends
- 2) Ecological effects of pollutants
 - Effects on sensitive key species
 - Effects on ecosystems
- 3) Assessment of chemicals
 - Development and assessment of testing procedures
 - Replacement of vertebrates used for toxicity testing
 - Structure/activity relationships (SAR)
 - Evaluation of chemicals
- 4) Air quality
 - Analysis, sources, transport, transformation and deposition of pollutants
 - Effects on air pollution on the natural environment
 - Effects of air pollution on materials
 - Stratospheric chemistry
 - Remote sensing techniques
 - Indoor air quality
- 5) Water quality
 - Analytical methods
 - Biotic and abiotic degradation of pollutants
 - Eutrophication
 - Remote sensing techniques
- 6) Soil quality
 - Analytical methods
 - Behaviour of pollutants in soil
 - Effects of pollutants in soil
 - Effects of agricultural and forestry practice on soil quality

- 7) Noise research
 - Effects of noise on the cardiovascular system
 - Comparison between effects of impulse noises and those of continuous noises
 - Synergism between noise and vibrations
- 8) Ecosystem research
 - Basic research on the functioning of ecosystems
 - Effects of agricultural practice and urbanisation on ecosystems, loss of genetic diversity
 - Environmental oceanography
 - Bio-geochemical cycles
 - Conservation of flora and fauna
- 9) Waste research
 - Waste management
 - Organic wastes
 - Toxic and dangerous waste
 - Abandoned disposal sites
- 10) Reduction of pollution
 - Advanced abatement technologies
 - Clean technologies
- 11) Scientific basis of environmental legislation and management

Concerted Actions

In the following areas within the scientific programme, concerted actions are implemented :

- 1) Air pollution effects on terrestrial and aquatic ecosystems;
- 2) Physico-chemical behaviour of atmospheric pollutants;
- 3) Organic micropollutants in the aquatic environment;
- 4) Treatment and use of sewage sludge;
- 5) Coastal benthic ecology;
- 6) Indoor air quality and its impact on man;
- 7) Bird protection.

PART II : CLIMATOLOGY

Funding : 25,000,000 ECU

Staff : 6

Scientific Content of the Programme

1. THE PHYSICAL BASIS OF CLIMATE
 - 1.1 Past climates and climatic change.
 - 1.2 Climatologically significant processes.
 - 1.3 Modelling and predicting European climates within a global context.
 - 1.4 Studies concerning the feasibility of the seasonal (3-6 months) forecasting European climates.

2. CLIMATE SENSITIVITY
 - 2.1 Changes in atmospheric composition.
 - 2.1.1 The climatic effect of enhanced CO₂.
 - 2.1.2 Aspects of the global carbon cycle important for climate prediction.
 - 2.1.3 The climatic effect of other trace gases.
 - 2.2 The climatic effect of changes in land-surface properties.
 - 2.3 Early detection of climate change (identification and monitoring of parameters which could be used as early indicators of climate change. Improvement of techniques for detecting the signal above noise level).

3. CLIMATIC IMPACTS

- 3.1 Impact of climatic change or variability on land resources, including soil, and ecosystems, with special attention to desertification problems.
- 3.2 Impact of climatic variations on European water resources, including the development of climate-based models for their evaluation and forecasting.
- 3.3 The photosynthetic response of European vegetation to increasing atmospheric CO₂ in the context of a climate change.
- 3.4 Impact of climatic variations on sea resources and fisheries.
- 3.5 Application of climatic knowledge to a better management of land and water resources.
- 3.6 Causes, mechanisms and impacts of climatological anomalies and extreme or abrupt events, with the aim in view of reducing human and material losses.

PART III : MAJOR TECHNOLOGICAL HAZARDS

Funding : 15.000.000 ECU

Staff : 4

Scientific Content of the Programme

- A. Physical and chemical phenomena and mitigation of consequences of accidents
- A 1. Source term: phenomenology/modelling of release, its influence on early stages of dispersion;
 - A 2. Dispersion: atmospheric advection, diffusion and deposition, with emphasis on dense/cold gases, mists and aerosols;
 - A 3. Combustion: flammable clouds and mists covering flash fires, deflagration, transition to detonation and detonation (unconfined/partly confined situations);
 - A 4. Blast formation, propagation, interaction with structures; generation of missiles; confined explosions and their venting;
 - A 5. Catastrophic fires: pool fires, torches and fireballs; highly reactive substances; conflagrations;
 - A 6. Runaway reactions: thermodynamics, flowdynamics, venting aspects;
 - A 7. Toxic substances: dispersion in air, synergies; excluding toxicology;
 - A 8. Dust explosions: phenomenology and venting.

B. Technological aspects

- B 1. Safety and reliability of existing technologies and their improvement;
- B 2. Alternative technologies and processes, susceptible of increasing the safety of processes, plants and production cycles;
- B 3. Instrumentation, for the detection and mitigation of high risk situations.

C Assessment and management of risk

- C 1. Hazards identification and mapping, risk aggregates, vulnerability of complex industrial/urban systems;
- C 2. Safety and reliability of complex industrial systems, cost/benefit of safety/mitigation devices;
- C 3. Human factor, man-machine interaction;
- C 4. Risk perception by the public, acceptable risk level;
- C 5. Development of "expert systems" (coupled to data banks), for risk assessment and accident management;
- C 6. Probabilistic approach to the analysis and simulation of major accident scenarios, with emphasis on hazardous transports.
- C 7. Decision-taking and countermeasures in an emergency, emergency planning;
- C 8. Behaviour of the populations in an emergency.

Cross-sectoral studies, to be launched early, will evidence interrelationships and determine priority issues, guiding selection of topics and implementation in Sectors B and C.

FINANCIAL DATA
CONCERNING R&D PROGRAMMES
IN THE FIELD OF ENVIRONMENT
(Indirect and concerted actions)
1986-1990

BUDGET HEADING : ENVIRONMENT

Article 732

Item 7328

Entitled	<u>Budget</u> <u>(in MECU)</u>	<u>Staff</u>
0 - Protection of the environment	60.450	14
1 - Organic micropollutants in the aquatic environment	0.650	1/2
2 - Physico-chemical behaviour of atmospheric pollutants	0.650	1/2
3 - Coastal benthic ecosystems	0.650	1/2
4 - Treatment and use of organic sludges and liquid agricultural wastes	0.650	1/2
5 - Effects of air pollutants on terrestrial and aquatic ecosystems	0.650	1/2
6 - Bird protection	0.650	1/2
7 - Indoor air quality	0.650	-
8 - Climatology	25.000	6
9 - Major technological hazards	15.000	4
TOTAL	105.000	27

FINANCIAL RECORD

ENVIRONMENT PROTECTION PROGRAMME

1. RELEVANT BUDGET HEADING

- Item : 7328
- Title : Environment

1.1 Title of the project :

- Environmental protection
- s/Item : 7328.0

2. LEGAL BASIS

- Application of Article 235 of the Treaty establishing the EEC
- Council Decision of

3. DESCRIPTION OF THE PROJECT

Continuation of a coordinated research programme in the field of environmental protection carried out by means of shared-cost contracts concluded with research bodies in the Member States.

3.1 Objective

In the general context of the framework programme, the main objective of this research sector is to lend scientific support to the implementation of the European Community's environment policy. This policy has been redefined in the third programme of action on the environment (Council Resolution of 7 February 1985).

4. JUSTIFICATION OF THE PROJECT

A coordinated European research programme executed by research contracts with scientific institutions in the Member States is necessary in order to supply a sound scientific basis for implementing the Community Environment Policy. The programme will also contribute significantly to all other priority objectives of the Framework Programme.

Research in this field is particularly suited to Community coordination in order to achieve comparable results and to avoid useless duplication.

5. FINANCIAL IMPLICATION OF THE PROJECT IN RESPECT OF EXPENDITURE
(including staff expenditure and administrative and technical
operating expenditure)

5.1 Overall cost for the whole of its expected duration :
113,450,000 ECUS

5.2 Proportion financed from :

Chargeable to the Community Budget : 60,450,000 ECUS

Chargeable to national budgets :
+/- 53,000,000 ECUS

Chargeable to other sectors at national level:

5.3 Multiannual time-table

5.3.1.1 Appropriation for commitment in ECU

Type of expenditure	1986*	1987	1988	1989	1990	TOTAL
Staff	931,800	1,000,800	1,043,900	1,135,600	1,135,600	5,200,900
Administration	357,100	309,800	323,100	337,000	351,400	1,678,400
Contracts	12,511,100	22,929,400	5,533,000	12,597,200	---	53,570,700
Total	13,800,000	24,240,000	6,900,000	14,023,000	1,487,000	60,450,000

5.3.1.2 Appropriation for payment in ECU

Type of expenditure	1986*	1987	1988	1989	1990+	TOTAL
Staff	931,800	1,000,800	1,043,900	1,088,800	1,135,600	5,200,900
Administration	357,100	309,800	323,100	337,000	351,400	1,678,400
Contracts	871,100	7,889,400	13,033,000	17,774,200	14,003,000	53,570,700
Total	2,160,000	9,200,000	14,400,000	19,200,000	15,490,000	60,450,000

* 1986 8 A - 1 B - 4 C 1st Semester
8 A - 2 B - 4 C 2nd Semester and 1987 . . .

5.3.2 Method of calculation

In estimating expenditure for the years 1986-1990, a rate of increase of 4.3 % has been assumed on a) and b).

a) Staff expenditure :

Staffing needs have been calculated on the basis of a staff of 14 for the programme :

- 8 Category A staff,
- 2 Category B staff,
- 4 Category C staff.

b) Administrative and/or technical operating expenditure :

This heading covers in particular expenditure connected with the coordination and cooperation within the programme, the organisation of meetings and elaboration of reports, missions, the technical operation expenditure.

c) Contract expenditure :

Since the type of subject and the contractors' qualifications vary, it is not possible to establish a uniform method of calculation. However, an average contribution of 50 % to the contractual partners' total costs has been taken as a basis for the estimate. At all events the Management and Coordination advisory committee will be consulted when the amount of Community participation is finally determined.

6. FINANCIAL IMPLICATIONS ON THE STAFF AND NORMAL OPERATING APPROPRIATIONS

(See under paragraph 5 above)

7. FINANCING

Appropriations to be entered under future budgets.

8. FINANCIAL IMPLICATIONS OF THE PROJECT IN RESPECT OF REVENUE

- Community tax on officials' salaries
- Officials' contributions to the pension scheme
- Possible contributions from non-member states.

9. TYPE OF CONTROL TO BE APPLIED

- Scientific control by the responsible officials in DG XII advised by the Management and Coordination advisory committee (CGC).
- Administrative control by the Directorate-General for Financial Control with regard to the implementation of the Budget and to check that the expenditure is in order and conforms to the relevant provisions; and by the Administrative Directorate of DG XII.

FINANCIAL RECORD

ENVIRONMENT PROTECTION PROGRAMME

1. RELEVANT BUDGET HEADING

- Item : 7328
- Title : Environment

1.1 Title of the project :

- Concerted actions
- s/Item : 7328.1 to 7328.7

2. LEGAL BASIS

- Application of Article 235 of the Treaty establishing the EEC
- Council Decision of

3. DESCRIPTION OF THE PROJECT

Coordination at the community level of the most important research which are part of research programmes of the Member States in the following areas :

- a) Organic micropollutants in the aquatic environment
- b) Physico-chemical behaviour of atmospheric pollutants
- c) Coastal benthic ecosystems
- d) Treatment and use of organic sludges and liquid agricultural wastes
- e) Effects of air pollutants on terrestrial and aquatic ecosystems
- f) Bird protection
- g) Indoor air quality

3.2 Objective

Development and extension of research work carried out under Community-COST agreements.

4. JUSTIFICATION OF THE PROJECT

The coordination of the national research in these areas, possibly in association of COST-Non-Member States, would be a valuable contribution to European cooperation in environmental research.

5. FINANCIAL IMPLICATION OF THE PROJECT IN RESPECT OF EXPENDITURE
(including staff expenditure and administrative and technical
operating expenditure)

5.1 Overall cost for the whole of its expected duration: 4,500,000 Ecus

5.2 Chargeable to the Community Budget : 4,500,000 Ecus

Chargeable to national budgets :

Chargeable to other sectors at national level :

5.3 Multiannual time-table

5.3.1.1 Appropriation for commitment in ECU

Type of expenditure	1986*	1987	1988	1989	1990	TOTAL
Staff	106,050	221,200	230,700	240,600	251,000	1,049,550
Administration	347,900	362,800	378,400	394,600	411,500	1,895,200
Contracts	456,050	326,000	300,900	274,800	247,500	1,605,250
Total	910,000	910,000	910,000	910,000	910,000	4,550,000

5.3.1.2 Appropriation for payment in ECU

Type of expenditure	1986*	1987	1988	1989	1990+	TOTAL
Staff	106,050	221,200	230,700	240,600	251,000	1,049,550
Administration	347,900	362,800	378,400	394,600	411,500	1,895,200
Contracts	456,050	326,000	300,900	274,800	247,500	1,605,250
Total	910,000	910,000	910,000	910,000	910,000	4,550,000

* 1986 2 A - 1 C 2nd Semester

5.3.2 Method of calculation

In estimating expenditure for the years 1986-1990, a rate of increase of 4.3% has been assumed.

a) Staff expenditure

Staffing needs have been calculated on the basis of a staff of 3 for the programme :

2 Category A staff
- Category B staff
1 Category C staff.

b) Administrative and/or technical operating expenditure

This heading covers in particular expenditure connected with the coordination and cooperation within the programme, the organisation of meetings and the dissemination of information, missions, the technical operating expenditure.

c) Contract expenditure

Since the type of subject and the contractors' qualifications vary, it is not possible to establish a uniform method of calculation. However, an average contribution of 50% to the contractual partners' total costs has been taken as a basis for the estimate. At all events the Management and Coordination advisory committee will be consulted when the amount of Community participation is finally determined.

6. FINANCIAL IMPLICATIONS ON THE STAFF AND NORMAL OPERATING APPROPRIATIONS

(See under paragraph 5 above)

7. FINANCING

Appropriations to be entered under future budgets.

8. FINANCIAL IMPLICATIONS OF THE PROJECT IN RESPECT OF REVENUE

- Community tax on officials' salaries
- Officials' contributions to the pension scheme
- Possible contributions from non-member states.

9. TYPE OF CONTROL TO BE APPLIED

- Scientific control by the responsible officials in DG XII and the Management and Coordination advisory committee (CGC).
- Administrative control by the Directorate-General for Financial Control with regard to the implementation of the Budget and to check that the expenditure is in order and conforms to the relevant provisions; and by the Contracts Department of DG XII.

FINANCIAL RECORD
CLIMATOLOGY PROGRAMME

1. RELEVANT BUDGET HEADING

- Item : 7328
- Title : Environment

1.1 Title of the project :

- Climatology
- S/Item : 7328.8

2. LEGAL BASIS

- Application of Article 235 of the Treaty establishing the EEC
- Council Decision of . . .

3. DESCRIPTION OF THE PROJECT

Continuation of a coordinated research programme in the field of climatology, carried out by means of shared-cost contracts concluded with research bodies in the Member States.

3.1 Objective

To help the correct understanding of our climatic environment and the management of our climate-dependent resources.

4. JUSTIFICATION OF THE PROJECT

Climate behaviour and uncertainty are important factors in framing governmental policies. This demands research on a continental scale and interdisciplinary cooperation including the best specialists.

5. FINANCIAL IMPLICATION OF THE PROJECT IN RESPECT OF EXPENDITURE
(including staff expenditure and administrative and technical operating expenditure)

5.1 Overall cost for the whole of its expected duration: 46,000,000 Ecus

5.2 Chargeable to the Community Budget : 25,000,000 Ecus

Chargeable to national budgets : +/- 21,000,000 Ecus

Chargeable to other sectors at national level :

5.3 Multiannual time-table

5.3.1.1 Appropriation for commitment in ECU

Type of expenditure	1986*	1987**	1988	1989	1990	TOTAL
Staff	273,900	442,400	461,400	481,300	502,000	2,161,000
Administration	220,000	198,100	206,700	215,500	224,800	1,065,100
Contracts	5,006,100	9,059,500	2,131,900	5,576,400	---	21,773,900
Total	5,500,000	9,700,000	2,800,000	6,273,200	726,800	25,000,000

5.3.1.2 Appropriation for payment in ECU

Type of expenditure	1986*	1987**	1988	1989	1990+	TOTAL
Staff	273,900	442,400	461,400	481,300	502,000	2,161,000
Administration	220,000	198,100	206,700	215,500	224,800	1,065,100
Contracts	466,100	3,159,500	5,281,900	6,063,200	6,063,200	21,773,900
Total	960,000	3,800,000	5,950,000	7,500,000	6,790,000	25,000,000

* 1986 2 1/2 A - 1 1/2 C

** 1987 4 A - 2 C

5.3.2 Method of calculation

In estimating expenditure for the years 1986-1990, a rate of increase of 4.3% has been assumed on a) and b).

a) Staff expenditure :

Staffing needs have been calculated on the basis of a staff of 6 for the programme :

4 Category A staff
- Category B staff
2 Category C staff.

b) Administrative and/or technical operating expenditure :

This heading covers in particular expenditure connected with the coordination and cooperation within the programme, the organisation of meetings and elaboration of reports, missions, the technical operating expenditure.

c) Contract expenditure :

Since the type of subject and the contractors' qualifications vary, it is not possible to establish a uniform method of calculation. However, an average contribution of 50% to the contractual partners' total costs has been taken as a basis for the estimate. At all events the Management and Coordination advisory committee will be consulted when the amount of Community participation is finally determined.

6. FINANCIAL IMPLICATIONS ON THE STAFF AND NORMAL OPERATING APPROPRIATIONS

(See under paragraph 5 above)

7. FINANCING

Appropriations to be entered under future budgets.

8. FINANCIAL IMPLICATIONS OF THE PROJECT IN RESPECT OF REVENUE

- Community tax on officials' salaries
- Officials' contributions to the pension scheme
- Possible contributions from non-member states.

9. TYPE OF CONTROL TO BE APPLIED

- Scientific control by the responsible officials in DG XII advised by the Management and Coordination advisory committee (CGC).
- Administrative control by the Directorate-General for Financial Control with regard to the implementation of the Budget and to check that the expenditure is in order and conforms to the relevant provisions; and by the Administrative Directorate of DG XII.

FINANCIAL RECORD

MAJOR TECHNOLOGICAL HAZARDS PROGRAMME

1. RELEVANT BUDGET HEADING

- Item : 7328
- Title : Environment

1.1 Title of the project :

- Major technological hazards
- s/Item : 7328.9

2. LEGAL BASIS

- Application of Article 235 of the Treaty establishing the EEC
- Council Decision of

3. DESCRIPTION OF THE PROJECT

Coordinated research programme on the major technological hazards carried out by means of shared-cost contracts concluded with research bodies in the Member States.

3.1 Objective

Protection of people and their environment against the consequences of catastrophic events of chemical/petrochemical origin.

4. JUSTIFICATION OF THE PROJECT

This programme addresses, by very nature, a great many scientific, technological and regulatory/policy issues. Relevant experimental and modelling work, inevitably expensive and diversified, constitutes a large part of the activities.

5. FINANCIAL IMPLICATION OF THE PROJECT IN RESPECT OF EXPENDITURE
(including staff expenditure and administrative and technical
operating expenditure)

5.1 Overall cost for the whole of its expected duration :
28,000,000 Ecus

5.2 Chargeable to the Community Budget : 15,000,000 Ecus

Chargeable to national budgets : +/- 13,000,000 Ecus

Chargeable to other sectors at national level :

5.3 Multiannual time-table

5.3.1.1 Appropriation for commitment in ECU

Type of expenditure	1986*	1987**	1988	1989	1990	TOTAL
Staff	44,250	313,500	327,000	341,000	355,600	1,381,350
Administration	150,000	125,100	130,500	136,100	142,000	683,700
Contracts	2,595,750	5,111,400	432,500	4,795,300	---	12,934,950
Total	2,790,000	5,550,000	890,000	5,272,400	497,600	15,000,000

5.3.1.2 Appropriation for payment in ECU

Type of expenditure	1986*	1987**	1988	1989	1990+	TOTAL
Staff	44,250	313,500	327,000	341,000	355,600	1,381,350
Administration	150,000	125,100	130,500	136,100	142,000	683,700
Contracts	275,750	1,651,400	3,282,500	3,912,900	3,812,400	12,934,950
Total	470,000	2,090,000	3,740,000	4,390,000	4,310,000	15,000,000

* 1986 1 A 2nd Semester

** 1987 3 A - 1 C

5.3.2 Method of calculation

In estimating expenditure for the years 1986-1990, a rate of increase of 4.3% has been assumed on a) and b).

a) Staff expenditure :

Staffing needs have been calculated on the basis of a staff of 4 for the programme :

3 Category A staff
- Category B staff
1 Category C staff.

b) Administrative and/or technical operating expenditure :

This heading covers in particular expenditure connected with the coordination and cooperation within the programme, the organisation of meetings and elaboration of reports, missions, the technical operating expenditure.

c) Contract expenditure :

Since the type of subject and the contractors' qualifications vary, it is not possible to establish a uniform method of calculation. However, an average contribution of 50% to the contractual partners' total costs has been taken as a basis for the estimate. At all events the Management and Coordination advisory committee will be consulted when the amount of Community participation is finally determined.

6. FINANCIAL IMPLICATIONS ON THE STAFF AND NORMAL OPERATING APPROPRIATIONS

(See under paragraph 5 above)

7. FINANCING

Appropriations to be entered under future budgets.

8. FINANCIAL IMPLICATIONS OF THE PROJECT IN RESPECT OF REVENUE

- Community tax on officials' salaries
- Officials' contributions to the pension scheme
- Possible contributions from non-member states.

9. TYPE OF CONTROL TO BE APPLIED

- Scientific control by the responsible officials in DG XII advised by the Management and Coordination advisory committee (CGC).
- Administrative control by the Directorate-General for Financial Control with regard to the implementation of the Budget and to check that the expenditure is in order and conforms to the relevant provisions; and by the Administrative Directorate of DG XII.

PROPOSAL FOR
A RESEARCH AND DEVELOPMENT PROGRAMME
IN THE FIELD OF
ENVIRONMENT PROTECTION
1986 - 1990

as part of the RAP Environment

A. INTRODUCTION

This proposal is concerned with a new R&D programme in the field of environmental protection for the period 1986 to 1990. It is the fourth Community programme in this area concerning contract research and Concerted Actions (1st programme: 1973-1975; 2nd programme: 1976-1980; 3rd programme 1981-1985) and is a logical continuation of the preceding ones.

The programme should be seen as an integral part of the RAP Environment, which at present encompasses, in line with the Council Resolution of 25 July 1983 on Framework Programmes for Community R, D & D (1984 to 1987)¹, research in four different sectors

- environmental protection,
- climatology,
- industrial risk,
- remote sensing,

implemented either as part of the JRC Programme 1984-1987² or by means of contract research and concerted action.

¹ : O.J. No. C 208, 4.8.1983, p. 1
² : O.J. No. L 3, 5.1.1984, p. 21

B. JUSTIFICATION AND AIMS

1. Community Environmental Research; History, Aims and Achievements

1.1. Evolution of Community Environmental Research

Community Environmental Research has evolved, in parallel with the definition and updating of a Community Environment Policy (see below), from a modest start in 1971 to a substantial research activity. Three COST agreements, signed in 1971, were followed by a first (1973) and second (1976) programme on contract research.

Environmental Research was incorporated in the JRC programme in the early seventies and gradually increased. During the seventies, several COST projects were redefined in close association to Community programmes.

In 1981, the third Environment Research Programme (1981-1985) was approved, which encompassed for the first time both contract research and Concerted Actions, providing for the association of non-Member States.

With the presentation of the Framework Programme in 1983 (see below), the RAP concept was introduced, providing for a closer connexion between contract research and Concerted Action on the one side and the pertinent JRC-research on the other; however, for legal reasons these are based on separate Council decisions.

The present proposal is a logical continuation of the third Environment Research Programme (1981-1985), approved in 1981¹ reviewed in 1983/84 and formally revised by Council decision in 1984².

1.2. Aims of Community Environmental Research

In preparing the last (3rd) Environment Research Programme three major aims were defined, which are still valid. These are:

- to provide scientific and technical data which support the Community Environment Policy (Environment Action Programme, see below);
- to address longer-term environmental problems, thus preparing the way for the development of preventive and anticipatory policies taking account of foreseeable environmental trends, and to provide the means to evaluate the effectiveness of current environmental policies;

¹ : O.J. No. L 101, 11.4.1981, p. 1
² : O.J. No. L 71, 14.3.1984, p. 13

- to serve as an instrument for enhancing further, at Community level, the coordination of national research activities in the environmental field, in order to improve the productivity of the overall effort through the encouragement of joint projects; the elimination of duplication; and the evaluation of gaps in research coverage.

In the light of the R & D Policy of the Communities defined in the Framework Programme and after a review of the achievements of the previous programmes, these aims need to be supplemented by three further items :

- improvement of industrial competitiveness;
- the processing and evaluation of research results in the environmental field in view of their use in environmental regulation and management;
- promotion of training in environmental sciences.

These supplementary aims can be justified as follows :

Reduction of emissions, waste disposal, testing of products, etc., are more and more of an economic factor for industry. It should be mentioned that a number of processes, e.g. the removal of nitrogen oxides from fluegases or the catalytic conversion of car exhausts are at present mainly based on imported technologies. Any development which will result in an improvement of the economic viability of abatement technologies or the acceptability of products from an environmental point of view will certainly increase the competitiveness of European industry. The assessment of cost/benefit relationships of various options for regulatory approaches will also contribute to this goal.

Since the establishment of a Community Environmental Policy in 1973, substantial data have been generated on the effects of a multitude of pollutants; much of this information, however, still awaits qualified expert appraisal in order to make it usable for regulatory purposes. Community regulation on chemicals covers with few exceptions only products not previously marketed; there is a need for the evaluation of data on an enormous number of "existing" chemicals for which only scarce and often contradictory information is available, waiting for a critical assessment, also in view of setting priorities for testing. Furthermore, the Commission was encouraged in a more general way by the panel entrusted with an evaluation of the preceding programmes (see below), to make strong efforts to present the results of the programme in a form which enhances their immediate utilisation for regulatory purposes. The scientific expertise associated with the programme can profitably be used for assuming an important role in this task.

The training of scientists, in particular through transnational exchange, has always been recognized as an obligation of the Community. To date, this has been promoted as an independent activity; this has now to be incorporated within the specific research programmes, as appropriate.

1.3 Achievements of Community Environmental Research

It is widely recognized that the Community Environmental Research Programmes have contributed significantly to present knowledge in environmental sciences, and many results found practical applications or have been considered in drawing up environmental legislation of the Communities. These achievements are well documented.

Syntheses of selected results are given in general reviews of Community research¹⁾ and of the Community Environment Policy²⁾.

In Annex II, a list of publications of the Commission is given, which either summarise the results or give, via their bibliographies, access to specific publications on research funded within the programme.

As far as contract research is concerned, contract partners were encouraged to publish in the open literature, hence ensuring a wide dissemination of results. The summary reports on research contracts, published in several volumes by the Commission, comprise extensive bibliographies (see Annex II).

In suitable areas, reports have been prepared which provide a critical synthesis of Community research (e.g. epidemiological survey of air pollution effects; interim report on the ILE-project, conjointly with the JRC).

With regard to Concerted Actions, special emphasis has been given to collate the results at various levels of condensation :

- executive reports have been edited at regular intervals, outlining the main achievements in a condensed way;
- numerous "European Symposia" and workshops on specific subjects have been organized, the proceedings of which have been published and made available to the scientific community and to regulatory bodies.

In addition to the conferences directly connected to the programme, many open conferences were organized by the Commission, alone or in cooperation with other institutions, and contract partners were preferentially invited to report on results from Community research. Such conferences served in particular to better define Community research and to identify priorities (e.g. Clean Technologies, 1980; Acid Deposition, 1983; Environment and Chemicals in Agriculture, 1984).

¹⁾ La politique communautaire de la recherche et la technologie; ses développements jusqu'en 1984, EUR 9229, in print.

²⁾ Ten Years of Community Environment Policy, Commission of the European Communities, 1984.

As regards the utilization of research results for regulatory purpose, a few examples are highlighted below:

- many data sets on the effects on health and the environment of various pollutants have been used by the Commission as a basis in proposing quality objectives for various substances (heavy metals, organic pollutants);
- a series of tests for the assessment of chemicals elaborated or evaluated within of the programme are already incorporated or proposed for inclusion in the protocols annexed to Directive 67/548/EEC (base set and level 1 and 2) and other regulatory texts;
- the results from sewage sludge research provide the main scientific basis of a proposed directive on the use of sewage sludge in agriculture;
- the elucidation of the mechanisms of the conversion of pollutants in the atmosphere are an integral part of the scientific basis for various regulations enacted or proposed for the control of air pollution.

The second programme (1976-1980) and the first phase of the third programme (1981-1983) together with the relevant JRC activities are at present subject to an evaluation by an independent panel of high-ranking scientists. The evaluation report will be available by mid 1985.

2. R&D in support of the Environment Action Programme

In preparing the programme proposal, the Commission has been guided mainly by the updating of the Environment Action Programme approved by the Council in 1983 (Resolution of the Council of the European Communities and of the representatives of the Governments of the Member States, meeting within the Council of 7 February 1983 on the continuation and implementation of a European Community policy and action programme on the environment (1982 to 1986))¹⁾.

In the annex describing the content of this programme, reference is made to the relevant chapters of the 3rd Environment Action Programme and to the priorities identified in the Council Resolution; these are the following :

- a) integration of the environmental dimension into other policies;

¹⁾ J.O. C 46, 17.2.1983, p.1.

- b) environmental impact assessment procedure;
- c) reduction of pollution and nuisance, if possible at source, in the context of an approach to prevent the transfer of pollution from one part of the environment to another, in the following areas:
 - combating atmospheric pollution;
 - combating fresh-water and marine pollution;
 - combating pollution of the soil.
- d) environmental protection in the Mediterranean region, paying particular attention to the specific aspects of that region when giving practical application to the action programme;
- e) noise pollution and particularly noise pollution caused by means of transport;
- f) combating transfrontier pollution;
- g) dangerous chemical substances and preparations;
- h) waste management, including treatment, recycling and re-use and in particular toxic and dangerous waste;
- i) encouraging the development of clean technology;
- j) protection of areas of importance to the Community which are particularly sensitive environmentally;
- k) cooperation with developing countries on environmental matters.

It should be emphasized, that the above Resolution underlines the need to carry out careful research before submitting proposals for regulation to the Council.

This proposal also takes into account the research needs derived from the implementation of various specific Council Directives approved during recent years or at present under discussion by the Council.

An effort has been made to anticipate new research needs which will arise from the next Environment Action Programme (1988-1991), at present in preparation, such as research related to an integral concept of soil protection.

3. Environmental R&D and the Framework Programme

As regards the general research policy of the Communities, in preparing this document attention has been paid to the Council Resolution of 25 July 1983 on framework programmes for Community research, development and demonstration activities and a first Framework Programme, 1984 to 1987, in which protection of the environment is among the scientific and technical objectives, related to the goal "improving living and working conditions". The contributions to all other goals, in particular to

- promoting industrial competitiveness,
- improving the management of raw materials,
- promoting agricultural competitiveness,

are fully recognized.

More specifically, the proposal for the Environment Research Programme takes into account the relevant chapter (6.2) of the Framework Programme¹⁾, as well as the "Plan by Objective Protection of the Environment and Prevention of Health Hazards"²⁾ elaborated during the preparation of that Programme. In the latter document, an attempt is made to put Community research on the Environment in the general context of research in Europe and overseas.

The programme proposal meets 3 out of the 4 selection criteria for Community R & D programmes :

- financial benefits arising from a joint research effort by providing input to Community regulations, in view of the regulatory responsibilities of the Communities in environmental matters;
- research over a large geographical scale which is required in view of the transboundary nature of environmental pollution;
- research strengthening the cohesion of the common market and leading to the establishment of uniform standards, justified by the impact of the Community Environmental Policy on free trade (regulation of products, common assessment procedures, etc.).

1) Doc. COM(83) 260 final

2) Doc. XII/35/82, January 1983

C. RESEARCH PRIORITIES AND SCIENTIFIC CONTENT OF THE PROGRAMME

1. Research Priorities

Environmental research in general covers a huge area of activities, encompassing also investigations of sometimes only local importance. Specific consideration was therefore given to setting priorities on problems of undoubted importance on Community level. The main criteria for setting research priorities were the requirements derived from the Community Environment Policy (Environment Action Programme).

Furthermore, in setting such priorities, the Commission could not ignore recent strong reactions of the public to major environmental problems such as acid deposition, forest die-back, disposal of toxic and dangerous waste, protection of soil, etc. Due consideration was given, in particular, to several resolutions of the European Parliament on such issues, many of which include forceful recommendations for increased research effort in these areas.

Substantial input to the definition of the programme came from the numerous symposia and workshops organized by the Commission, alone or in cooperation with other institutions (see Annex II). Usually, outstanding personalities were entrusted with drawing the conclusions of these conferences, with particular attention to the establishment of research priorities. The most important of these conferences were:

- Clean Technologies, The Hague, November 1980
- Acid Deposition - a Challenge for Europe, Karlsruhe, September 1983
- Environment and Chemicals in Agriculture, Dublin, October 1984.

The Commission cosponsored the Conference on Environmental Research and Management Priorities for the 1980's, organized by the Swedish Academy of Science in Rättvik in 1982, which had, as the prime objective, the establishment of research priorities. Among those identified, this proposal addresses, in particular, the following :

- Reduction of biological diversity;
- Acid deposition;
- Impact of hazardous substances on ecosystems and man;
- Impact of urbanisation;

(the other priorities concern mainly climatology and problems in developing countries).

With regard to acid deposition and effects of air pollutants, intensive discussions within the Commission's services took place in order to match regulatory and research activities which resulted in a specific report¹⁾.

This programme proposal attempts also to meet some requirement of the Community in view of its involvement in the follow-up of the 1982 Versailles Summit of the Heads of State and Government and the Representatives of the European Communities, reconsidered at the 1984 London Summit; during the latter, environmental protection was identified as a major issue of cooperation. The Working Group Technology, Growth and Employment, established to respond to the summit declarations, reviewed the situation in environmental research, recognized the value of the Community programme and recommended the following research priorities, which are to a large extent identical to those of the RAP Environment :

- atmospheric pollution
- toxic and radioactive wastes
- marine pollution
- pollution of soils and waters
- appropriate land husbandry
- climatic change.

The Commission's services, with the assistance of the formal advisory bodies and in numerous informal contacts with Member States, analysed the national environmental research programmes and their funding, in order to avoid duplications, to identify those areas requiring specific input by Community research and to explore the possibilities for effective coordination (e.g. by concerted actions).

Guidance for setting research priorities was given during comprehensive discussions during 1984 by the Advisory Committee on Programme Management for Environmental Research. These discussions were continued by the recently established Management and Coordination Advisory Committee "Environment and Climatology" (CGC), which expressed a formal Opinion on 19 March 1985 (Annex III).

The scientific content of the programme is outlined in Annex I and is introduced in the following chapter. This content represents a balanced conclusion of the aforementioned considerations. The most appropriate way of implementing the proposed scientific programme are indicated.

¹⁾ Report on the actions of the Commission of the European Economic Community on acid deposition, Doc. XI/886/84, December 1984.

2. Scientific Content of the Programme

In the light of experience gained in the preceding programmes, which were divided into rather broad areas, it is proposed to subdivide the fourth programme in 11 more strictly and logically defined areas as follows:

- 1) Health effects of pollutants
- 2) Ecological effects of pollutants
- 3) Assessment of chemicals
- 4) Air quality
- 5) Water quality
- 6) Soil quality
- 7) Noise research
- 8) Ecosystem research
- 9) Waste research
- 10) Reduction of pollution
- 11) Scientific basis of environmental legislation and management

A detailed description of these areas is given in Annex I A.

Annex I B describes the content of formal concerted actions; these require further details in view of the possible association of non-Member States within the framework of the COST. The scientific content of these actions was reviewed in 1983 in preparing the revision of the 3rd Environment Research Programme; a major updating at this stage is therefore not necessary.

The proposed subdivision meets best the requirements of the Environment Action Programme and will facilitate the management of the programme, in particular the formulation of well defined calls for proposals.

Areas 1 and 2 concern the establishment of exposure/effect relationships (criteria) within the meaning adopted for the 1st Environment Action Programme, and as required for the regulation of individual pollutants. Research in these areas has been considerably reduced compared to previous programmes.

Area 3 is related essentially to the assessment of chemicals, with a strong emphasis on the development of methodologies.

Areas 4, 5 and 6 permit a consistent approach to the protection of the media air, water and soil.

Area 7 concerns noise research.

Area 8 will allow a better insight into the functioning of ecosystems, which is vital for a sound, long-term approach to environmental protection.

Areas 9 and 10 are focussed on technological research aimed at investigating efficient means to reduce pollution.

Area 11 encompasses activities which will permit a better application of research results to management and the establishment of links to other scientific disciplines (economics, sociology), which are of vital importance for the implementation of the Community Environment Policy.

With regard to the distribution of available funds between these research areas and to the priorities within them, the Commission will consult the Management and Coordination Advisory Committee (CGC) "Environment and Climatology".

D. WAYS OF IMPLEMENTATION

It is proposed, to introduce "catalytic activities" as a further type of activity complementing contract research and formal concerted actions and also to incorporate training activities. It is hoped that by these means sufficient flexibility will be obtained to respond to new problems arising during the implementation of the programme;

Thus in the future, the programme should be implemented using the following means:

a. Contract Research

Shared Cost Research Contracts should be funded in areas which are of immediate relevance to environmental policy, as defined in the Environment Action Programme, in order to generate, within acceptable time limits, the knowledge necessary for its implementation.

Projects will be selected normally on the basis of well-defined calls for proposals, phased in such a way as to allow continuity in the work of the Commission's Services and the advisory bodies.

b. Coordination and Concerted Actions

Formal Concerted Actions should be defined in suitable areas, preferably those in which research is more of a long term nature. They should receive a specific budget for their implementation; the Council Decision should, as in the past, incorporate an obligation on the Member States to introduce appropriate national research into the coordination process. In general, such actions should be open to cooperation with Non-Member States within the framework of COST.

Concerted Action can be complemented by contract research, provided that the projects to be funded fill real gaps. Such projects should be identified in cooperation with the Member States.

Formal concerted actions will be complemented in a flexible way by coordination of national research in areas which, due to their size or nature, do not justify a formal concerted action, whenever such a coordination offers benefits to the Community.

c. Catalytic Activities

A number of areas within the programme to date could not be handled in the most appropriate way since the available tools (contract research and concerted action) were not sufficiently flexible, e.g.

- the evaluation of chemicals
- "packaging" of knowledge, in order to make them easily accessible to the users
- societal and economic aspects of environmental protection

Such "catalytic activities" should allow

- the organization of panels to evaluate chemicals and to draw up assessment papers on specific problems pertinent to the Environment Action Programme;
- the organisation of workshops in certain areas (also with the participation of scientists from Non-Member States) and the subsequent compilation and evaluation of the results, in general to be commissioned to qualified scientists;
- the award of small (normally fully paid) contracts for handling specific problems mainly in borderline areas, e.g. societal or economic aspects of environmental protection;

Specific examples of such "catalytic activities" are given in Annex IA under the respective programme areas.

d. Training Activities

These will allow support for the transboundary exchange of scientists between institutes participating in the programme, and to organize, if appropriate, training courses in suitable subject areas.

The Management and Coordination Advisory Committee (CGC) "Environment and Climatology" will be consulted to give guidance on the most appropriate means of implementation of research in the various areas.

E. FUNDING AND STAFF

For a 5 year period (1986-1990) the allocations necessary to implement the programme are estimated at 65 MECU, comprising 4.55 MECU earmarked for the implementation of 7 concerted actions.

These allocations constitute a small increase in real terms above the present level of funding, as calculated on the basis of annual appropriations to the third Environmental Research Programme (sub-programme Environmental Protection), after the programme revision in 1984.

Such an increase is justified by :

- a shift of emphasis to research in more resource intensive technical disciplines (waste research, abatement technologies, clean technologies);
- the incorporation of 2 new concerted actions;
- the enlargement of the Communities by two new Member States, to be effective in 1986, which will require supplementary funds to promote research in these countries;
- the incorporation of training activities, which were financed till now from a separate budget.

For the implementation of the programme, a total of 17 staff is necessary. This constitutes an increase of 4, justified by supplementary concerted actions and by new tasks, in particular scientific input to a number of catalytic activities (evaluation of results, coordination of national research) which are not part of formal concerted actions. Furthermore, the general trend to reduce contract research while expanding concerted actions and coordination of national research in suitable areas will inevitably increase manpower requirements for the execution of the proposed programme.

Scientific Content of the Programme

1. Health effects of pollutants

1.1 Chronic and late effects at low exposure levels and early indicators of health effects

This area covers the effects of pollutants of all environmental media on human health.

In view of the considerable knowledge accumulated in recent years, it is intended to limit the research effort (essentially by contract research or, wherever appropriate, by catalytic activities) to a number of issues particularly relevant to environmental exposure, i.e. low exposure levels for prolonged time, such as

- effects of lead on the CNS and on intellectual performance,
- effects of certain metals and organic pollutants on specific organs (e.g. effects of Cd on kidney function),
- identification of subclinical effects and of "early indicators" of exposure,
- risk of cancer induction from pollutants, e.g. organic products in Diesel exhausts, solvents, agrochemicals (e.g. EDB),
- effects at molecular level.

1.2 Epidemiology and exposure trends

Epidemiological research, in view of its long-term nature, should be promoted predominantly as catalytic activity, e.g. by contributions to planning and coordinating such studies, but not to the operational cost.
Example : Monitoring the decrease of blood lead levels following regulatory action to be implemented (reduction or elimination of lead in fuel).

2. Ecological effects of pollutants

This area, to be implemented mainly by contract research, covers the effects of individual pollutants (organic and inorganic) on non-human targets in all media (marine and freshwater environment, terrestrial environment) in order to support the establishment of quality objectives. Consequently, it is intended to limit research, as far as the aquatic environment is concerned, essentially to those substances which are in the priority list of the Council Directive 76/464/EEC (J.O. C 176, 14.7.1982). Emphasis will be on effects at low concentrations; compounds already regulated are excluded. Interactive effects are dealt with in areas 4, 5 and 6.

2.1 Effects on sensitive key species

To a limited extent, laboratory and field research (by contracts) on sensitive key species should be funded, in view of their use as bio-indicators or for the definition of pollution indices.

2.2 Effects on ecosystems

Emphasis is to be on overall effects at the ecosystem level, by field studies, model ecosystems or experimental microcosms.

3. Assessment of chemicals

Environment Action Programme:
Chapter 22, priority item

Research in this area is directly related to existing Community regulations on dangerous substances, in particular to the 6th Amendment of Council Directive 67/548/EEC and to forthcoming initiatives to be taken with regard to existing chemicals.

3.1 Development and assessment of testing procedures

Research will be limited to test systems likely to be considered for incorporation in Annex VIII of Directive 67/548/EEC (levels 1 and 2) and to research necessary for the interpretation of test results (e.g. mechanistic and quantitative aspects of mutagenicity and carcinogenicity testing, which will permit the comparison of concentration in vitro vs. dose in vivo, tests for epigenetic carcinogens, etc.) to be implemented mainly by contract research.

3.2 Replacement of vertebrates used for toxicity testing

It is likely that some of the tests already specified in the 6th Amendment of Directive 67/548/EEC and other Community regulations will have to be replaced by tests using no, or considerably fewer, laboratory animals. Contract research in this area will be promoted (complementary to some aspects of the Communities' biotechnology programme).

3.3 Structure/activity relationships (SAR)

SAR are of increasing importance for the evaluation of chemicals and for the selection of existing chemicals for testing and assessment. This topic is to be dealt with by catalytic activity.

3.4 Evaluation of chemicals

It is considered necessary to generate within the Environmental Research Programme a capacity to generate reports, assessments, etc., compiled by competent scientists, for the evaluation of important environmental chemicals, also with a view to assist the "user packaging" of knowledge elaborated within the programme. This topic will be handled by catalytic activities only (panels, small fully-paid contracts).

4. Air quality

Environment Action Programme:
Chapter 21, priority item

This area will be one of the most important within the programme in view of current regulatory activities of the Communities. Dramatic effects on terrestrial ecosystems (in particular forests) and aquatic ecosystems have been observed in recent years, which gave rise to major public concern. These effects are attributed, at least in part, to the influence of air pollutants and their reaction products, although the exact mechanisms and the interaction with other environmental factors are poorly understood. A greatly increased research effort is needed immediately to elucidate these phenomena. Similar concern is expressed with regard to the effects of air pollutants on buildings and monuments (see also research area 8, in particular 8.4).

4.1 Analysis, sources, transport, transformation and deposition of pollutants

Mainly by concerted action (follow-up of COST 611, see Annex IB) with some complementary contract research to fill gaps in national research.

4.2 Effects on air pollution on the natural environment

Research will cover the effects on

- terrestrial ecosystems, in particular forests,
- aquatic ecosystems and wetland ecosystems,
- agricultural productivity,

and will be executed by a combination of contract research and concerted action (follow-up of COST 612, see annex IB).

4.3 Effects of air pollution on materials

Contract research will be essentially limited to the mechanisms of deterioration of materials used in historical buildings and monuments, and to fundamental aspects of their conservation.

4.4 Stratospheric chemistry

The follow-up of ongoing activities will essentially be done by catalytic activities (panels, workshops), not excluding, however, some selected contracts. Emphasis will be given to exchange with the troposphere and to the role of the stratosphere as a sink for tropospheric pollutants (e.g. N₂O) (see also 8.4, biogeochemical cycles).

4.5 Remote sensing techniques

Catalytic activities only (organisation of measurement campaigns and evaluation of new instruments).

4.6 Indoor air quality

Concerted Action only, complementing JRC-activities (see Annex IB).

5. Water quality

Environment Action Programme:
Chapter 16, priority item

5.1 Analytical methods

Development of analytical methods with emphasis on organic compounds which might be included in Directive 76/464/EEC, by concerted action only (COST 641 - follow-up, see Annex IB).

5.2 Biotic and abiotic degradation of pollutants

Mainly as concerted action within the framework of COST 641 follow-up with some complementary contract work, in particular with regard to mechanisms of abiotic degradation especially by photochemical processes.

5.3 Eutrophication

Although substantial knowledge is available in this area, some specific problems, in particular in the coastal and estuarine environment, may be subject of contract research and/or evaluation of control measures.

5.4 Remote sensing techniques

Catalytic activities (e.g. organisation of campaigns for comparative measurements) in support of the JRC-programme.

6. Soil quality

Environment Action Programme:
Chapter 26 and others, priority item

There is increasing concern about the deterioration of soil quality, the accumulation of pollutants in soils and their transfer to ground water and the food chain, which justifies a significant research effort in this area, to be complemented by specific research on waste disposal (see area 9).

6.1 Analytical methods

Exclusively as part of a concerted action (COST 681 follow-up, see Annex IB) with emphasis on problems arising from annex IIB of the sewage sludge directive (under discussion at the Council), taking into account possible future amendments of this directive (in particular organic pollutants).

6.2 Behaviour of pollutants in soil

Substantial gaps in knowledge remain in this area regarding

- the mobility of pollutants (metals and organic pollutants) and their transfer to ground water,
- the degree of availability of pollutants to plants as a function of soil type and crop characteristics,
- degradation of organic pollutants.

A substantial effort by contract research is required to elucidate these phenomena.

6.3 Effects of pollutants in soil

Contract research in this area should elucidate the effects of pollutants and agrochemicals on soil organisms.

6.4 Effects of agricultural and forestry practice on soil quality

A limited effort may be devoted to the effects of agricultural and forestry practice (cultivation techniques and management, excessive spreading of fertilizers) on soil and water quality, including specific erosion problems arising from human activities, as far as these are not covered by the Climatologie Programme (contract research).

7. Noise research

Environment Action Programme:
Chapter 23, priority item

In this area, essentially a continuation of ongoing activities is foreseen, taking into account the priorities identified at the two last congresses "Noise, a public health problem", organised by the International Commission on the Biological Effects of Noise (ICBEN) in Freiburg (1978) and in Torino (1983), and also by the noise advisory group of the CEC.

7.1 Effects of noise on the cardiovascular system

Experimental data demonstrate that noise is one stressor, among others, which induces effects on the cardiovascular system, including that of children. It remains to identify groups at risk, and to obtain quantitative relationships between noise levels at home, during leisure activities and at work, on the one hand, and morbidity on the other. Longitudinal epidemiological studies on ischemic heart disease related to noise, carried out in Member States, should be coordinated.

7.2 Comparison between effects of impulse noises and those of continuous noises

Because of ISO Standard 1996, accepted by many countries, impulse noise sources have to be considered separately from other noise sources in the environment. This distinction creates many difficulties. It is necessary to investigate in detail how to take into account the impulsive component of the noise in the environment, in particular as a function of the total noise level.

7.3 Synergism between noise and vibrations

The drivers and passengers of trains, buses and cars are subjected to a combination of noises and vibrations, each of which may have a number of effects. The combination of noise and vibrations at special low frequencies corresponding to those of internal organs of the human body might provoke enhanced reactions, especially on the vigilance of drivers. This synergism has to be investigated under laboratory conditions.

8. Ecosystem research

Substantial knowledge on many problems has been accumulated with regard to individual pollutants. The current trend in environmental research is towards a more general and multidisciplinary approach, aimed at a better understanding of the stability (or vulnerability) of ecosystems and of the impact of a combination of factors on the overall ecological balance as well as on different compartments of the environment. It is intended, during the 4th programme, to gradually introduce such concepts.

8.1 Basic Research on the Functioning of Ecosystems

It is envisaged to gradually extend the concerted action COST 647 from a baseline study to a more comprehensive research on coastal ecosystems. A further example is research into the characterisation of a number of typical European forest ecosystems, with particular emphasis on their resistance to the effects of acid deposition. Such research is first to be tackled (in addition to the concerted action mentioned above) by catalytic activities (panels, workshops, etc.), not excluding, however some selected contracts.

8.2 Effects of agricultural practice and urbanisation on ecosystems, loss of genetic diversity

The rapid changes in land and crop management in agriculture, as well as urbanisation and other human activities (e.g. tourism) lead to disturbances in ecosystems and to the extinction of species. Loss of genetic diversity causes growing concern (2nd priority among 10 identified by the Conference on Environmental Research and Management Priorities, Rätvik, 1982). To be implemented mainly by catalytic activities

8.3 Environmental oceanography

Apart from soil, ocean and estuaries are the only significant sink of persistent pollutants; little knowledge is available on the fate of such substances. In particular, the processes of sedimentation and co-precipitation merit a more careful examination, with a view to predicting the potential for immobilisation of pollutants, in particular heavy metals. Catalytic activities will be complemented by some contract research (links to 8.4.: biogeochemical cycles).

8.4 Bio-geochemical cycles

The debate on acid deposition has given a new impetus to this area, since any sound strategy for curing effects and restabilizing ecosystems is impossible without a thorough understanding of the natural cycles of sulphur and nitrogen. Research executed by contracts should also incorporate phosphorus. The carbon-cycle is to be handled within the Climatology Programme.

8.5 Conservation of flora and fauna

Environment Action Programme
Chapter 22, priority item

Research on birds as support to Community regulation will be essentially done by concerted action (see Annex IB); more specific problems (marine mammals, reptiles, amphibians) derived from the Community Environment Policy (e.g. Mediterranean Action Plan) will require contract research.

9. Waste research

Environment Action Programme:
Chapter 24 and 29, priority item

This area should receive particular attention within the 4th programme, in view of the growing concern about the long-term effects of waste disposal on soil and aquifers and the multiple health problems arising from inappropriate waste disposal. As a general rule, research will emphasize on the possibilities for waste recycling instead of disposal. Overlaps with the complementary R & D programme "Recycling of urban and industrial waste" will be avoided. As far as appropriate, research into biotechnological methods of waste treatment will be considered in close cooperation with the Biotechnology R & D Programme.

9.1 Waste management

Catalytic activities are foreseen for a number of general aspects, such as waste characterization and classification.

9.2 Organic wastes

Research on sludges and manures will continue in the form of a concerted action (COST 681, see annex IB). With regard to other organic wastes, the borderlines with the recycling programme will be defined.

9.3 Toxic and dangerous waste

Contract research will give particular emphasis to the following topics:

- special treatment of toxic industrial waste (e.g. solvents, tempering baths, residues from electrolytic surface treatment, chemical waste),
- solidification of waste prior to disposal,
- specific recycling methods (e.g. recovery of hydrocarbons from cutting oils).

9.4 Abandoned disposal sites

As special effort is necessary for research (by contracts) on monitoring abandoned waste dumps and, possibly, their recovery.

10. Reduction of pollution

Environment Action Programme
Chapters 25 and 30, priority items

Research in this area will require significant allocations (contract research) and may encompass projects for upscaling of processes developed in the laboratory in selected areas.

10.1 Advanced abatement technologies

Contract research in selected areas of air and water pollution abatement for developing new, improved or more cost-effective technologies should be funded, including the computer-assisted automation or optimisation of treatment processes aiming at a reduction of energy consumption.

10.2 Clean technologies

The efforts made within the 3rd programme should be continued, aiming at the development of technologies designed to avoid or reduce particular types of pollution and waste or to reduce significantly energy and material consumption, in line with the conclusions of the CEC symposium "Clean technologies", The Hague, November 1980. As in the 3rd programme the following industrial sectors will receive priority :

- chemical industry
- glass and ceramics
- pulp and paper
- metallurgy
- metal finishing and coating
- food and feed
- fibres and textiles
- tanning.

Research will be complementary to the demonstration activities in this area implemented by the Commission.

11. Scientific basis of environmental legislation and management

Catalytic activities (reviews, workshops, pannels, etc.) will allow the utilization of knowledge acquired within the programme (and assessing complementary information) in regulatory procedures. The scientific expertise available in the institutes under contract or associated with the programme within the framework of concerted actions should be used to achieve a presentation of the results in a way which makes them easily accessible. Due consideration will be given to the sociological and economic aspects of environmental regulations.

ANNEX I B

SCIENTIFIC PROGRAMME OF THE CONCERTED ACTIONS

1. Physico-Chemical Behaviour of Atmospheric Pollutants: (COST 611)
 - a) Improvement and standardisation of analytical methods, especially for NO_x , hydrocarbons and photochemical oxidants
 - b) Elucidation of mechanisms and rate constants of the reactions between atmospheric pollutants and of their reactions with natural constituents of the atmosphere, in particular in the aqueous state, including: oxidation and degradation chemistry of selected atmospheric pollutants in fresh and sea water, reactions with soil constituents, and the investigation of catalytic processes in cloud and rainwater chemistry
 - c) Investigation of the physico-chemical processes leading to the formation of particles, characterisation of the chemical and physical nature of very fine aerosols, and determination of the chemical composition of aerosols
 - d) Identification and quantification of sources and sinks of various pollutants, especially for nitrogen oxides
 - e) Investigation of phenomena leading to "acid deposition" with particular emphasis on:
 - conversion, transport and deposition (dry and wet) of SO_2 , NO_x and aerosol particles,
 - analysis of precipitation chemistry data for acidity trends,
 - NO_x chemistry in cloud droplets and chemical composition of cloud and rain water,
 - dry deposition of NO_x and HNO_3 ,
 - the role of oxidising agents like OH , HO_2 , H_2O_2 ,
 - physico-chemical conversion of air pollutants after deposition, considering water bodies and soil,
 - analytical techniques for the measurement of ammonia, nitric acid and hydrogen peroxide in both gas and liquid phase at low concentrations,
 - analytical methods for the determination of acidity of aerosols
 - f) Modelling of atmospheric chemistry related to photochemical pollution and acid deposition; coordination between data-producing teams and mathematicians for the quantification of source-receptor relationships with emphasis on modelling of emissions, transformation, transport and deposition of precursors and reaction products.
 - g) Elaboration of test protocols which permit to predict abiotic degradability of chemicals, in particular for persistent compounds.

2. Air Pollution Effects on Terrestrial and Aquatic Ecosystems
(COST 612)

- a) Direct effect of air pollutants (SO_2 , NO_x , HCl, ozone, photochemical oxidants and their atmospheric reaction products) on plants and terrestrial ecosystems
- b) Indirect effects of such air pollutants on plants and terrestrial ecosystems, e.g. via the acidification of soil and the mobilisation of phytotoxic elements
- c) Links between the effects of air pollutants and other factors involved in the observed phenomenon of severely damaged terrestrial ecosystems, in particular forests, such as drought, plant diseases, fungi and pests
- d) Effects of air pollutants and their reaction products on crop plants, in particular reduced productivity
- e) Effects of air pollutants and their reaction products on aquatic ecosystems (reduction of the population of fish and other aquatic organisms due to acidification and mobilisation of trace elements).

3. Organic Micropollutants in the Aquatic Environment (COST 641)

- a) Analytical methodologies and data treatment
 - Basic analytical techniques, including sampling and sample treatment, gas chromatography, high pressure liquid chromatography, mass spectrometry
 - Specific analytical problems, in particular analysis of selected classes of compounds, such as those likely to be regulated by Council Directive 76/464/EEC, chlorinated paraffins, tensides, optical brighteners, metal-organic and organo-phosphorous compounds
 - Collection and treatment of analytical data
- b) Physical/chemical behaviour of organic micropollutants in the aquatic environment
 - distribution and transport mechanisms
 - structure/activity relationships
 - bioavailability and bioaccumulation
- c) Transformation reactions in the aquatic environment
 - chemical and photochemical reactions
 - biological transformations

- d) Behaviour and transformation of organic micropollutants in water treatment processes
 - infiltration
 - waste water treatment
 - drinking water treatment (including haloform formation).

4. Treatment and Use of Organic Sludges and Liquid Agricultural Wastes (COST 681)

- a) Treatment of sludges and agricultural wastes:
 - further improvement of conventional treatment methods, mainly with regard to their economic aspects, and of processes for fuel production from sludges and manures,
 - study of technologies specifically applicable to small plants and of processes to eliminate heavy metals at their source
- b) Analysis of sludges and residues
 - development and standardisation of economic multi-element methods for the analysis of trace elements in sludges, soils and plants, and for the analysis of organic pollutants
- c) Hygienic aspects of treatment and use of sludges
 - elaboration and improvement of methods for the detection and identification of bacteria, viruses and other pathogens, and study of their survival and contamination potential,
 - investigations of the efficiency of hygienisation processes, definition of "indicator organisms",
- d) Nuisances
 - odour characterisation and emission control
- e) Environmental effects of spreading of sludges and manure
 - long-term field experiments on the accumulation of heavy metals, their availability to crops and on transfer of pollutants via soil to plants, and assessment of various application methods with regard to ground and surface water pollution
- f) Improvement of land-use of sludge and manure
 - long-term field experiments on fertilising value and soil improvement properties of sludges and manures,
 - improvement of treatment processes and spreading equipment with regard to optimum land use,

- study of the agricultural value of residues from treatment processes,
- use of sludges and derived products for land reclamation and specific crops (e.g. biomass production)

5. Benthic Coastal Ecosystems (COST 647)

Implementation of "baseline-studies" for selected key species in undisturbed conditions along the European North Sea and Atlantic coast, in the Mediterranean and in the Baltic Sea for the following habitats:

- subtidal sediments
- intertidal sediments
- subtidal rock
- intertidal rock

Assessment of the role of

- local physical factors
- biological interactions
- climatic and hydrographic factors on the population dynamics of selected components of benthic coastal ecosystems.

The programme should gradually evolve to a comprehensive investigation of the dynamics of coastal ecosystems and their modelling.

6. Indoor Air Quality and its Impact on Man

Investigation of a variety of indoor pollutants and pollutant classes, in particular NO₂, RSP (respirable suspended particulate), formaldehyde, organics, allergens, CO, SO₂, asbestos and other mineral fibres, comprising

a) Exposure determination and estimates:

- modelling
- source strength determinations
- infiltration and ventilation rate determinations
- methods of field measurements
 - . spot sampling
 - . time integrated sampling
 - . continuous monitoring
 - . personal and population exposure
 - . biological monitoring.

- b) Health effects measurements
 - controlled human exposure studies,
 - design of sequential studies,
 - epidemiological studies.
- c) Collection of exposure and health effect related data

7. Bird Protection

- a) Habitat selection by birds and breeding distribution
- b) Passerine migrations
- c) Waterfowl census according to the Annex V of the Directive on Conservation of Wild Birds
- d) Requirements of bird species dependent upon threatened habitats (notably coastal and other wetlands, scrubland, etc.)
- e) Habitat requirements and biology of endangered species
- f) Collection and compilation of the results of research on bird conservation and on wintering sites in Africa and exploitation of the information already available.

R&D PROGRAMME ENVIRONMENTAL PROTECTION

LIST OF REPORTS
PUBLISHED BY THE COMMISSION¹⁾

1975-1985

A) GENERAL REPORTS

- 1) Final reports on research sponsored under the first Environmental Research Programme (1973-1975), EUR 5970, 1978 (in series "Environment and Quality of Life")
- 2) Second Environmental Research Programme 1976-80, reports on research sponsored under the first phase 1976-78, EUR 6388, 1980 (in series "Environment and Quality of Life")
- 3) Environmental Research Programme 1976-80, report on the first phase 1976-78, EUR 6145, 1979 (in series "Environment and Quality of Life")
- 4) Second Environmental Research Programme 1976-80, reports on research sponsored under the second phase 1979-80, EUR 7884 EN, 1981 (in series "Environment and Quality of Life")

B) SPECIFIC REPORTS AND PROCEEDINGS OF CONFERENCES ORGANISED OR CO-ORGANISED BY THE COMMISSION WITHIN THE ENVIRONMENT RESEARCH PROGRAMME²⁾

- 1) Water Purification in the EEC; a State-of-the-Art Review, report prepared by Water Research Centre on behalf of the Commission, Pergamon Press, Oxford, 1977
- 2) Tests for Ecological Effects of Chemicals, Proceedings of a Research Seminar jointly organised by the Commission of the European Communities and the Umweltbundesamt in Berlin, 7-9 December 1977, Erich Schmidt Verlag Berlin, 1978 (UBA-Bericht 10/78)
- 3) Trace Metals, Exposure and Health Effects, Proceedings of a Research Seminar held in Guilford, 10-13 July 1978, edited by E. DI FERRANTE, Pergamon Press Oxford, 1979 EUR 6389
- 4) Clean Technologies, Proceedings of the European Symposium held in The Hague, 4-7 November 1980 (jointly organised by the Commission of the European Communities and the Ministry of Health and Environmental Protection, The Netherlands), edited by H. OTT and F. VAN DEN AKKER, EUR 7108, 1983 (in series "Environment and Quality of Life")

¹⁾ This list cannot give reference to the numerous publications prepared by scientific institutes under contract and submitted to scientific journals. Bibliographies for each contract are contained in the general reports 1, 2 and 4.

²⁾ Proceedings of conferences organised within Concerted Actions are listed separately

- 5) Proceedings of the first conference on the scientific bases for environmental regulatory actions: prevention of pollution by substances derived from wastes, held in Rome, 11-12 May 1981, CNR IRSA, Rome, 1984
- 6) Proceedings of the second conference on the scientific bases for environmental regulatory actions: health - environment, held in Evry (France), 14-16 December 1981, edited by E. DI FERRANTE, EUR 7952, 1982 (in series "Environment and Quality of Life")
- 7) Proceedings of the Symposium "Acid Deposition - A Challenge for Europe", Karlsruhe, 19-21 September 1983 (jointly organised by the Commission of the European Communities and Kernforschungszentrum Karlsruhe), edited by H. OTT and H. STANGL, preliminary edition 1983) (final edition in print)
- 8) Screening Tests in Chemical Carcinogenesis, Proceedings of a workshop organised by IARC and the Commission of the European Communities in Brussels, 9-12 June 1975, edited by R. MONTESANO, H. BARTSCH and L. TOMATIS, Lyon, 1976 (joint IARC/CEC publication)
- 9) Molecular and Cellular Aspects of Carcinogen Screening Tests, Proceedings of a meeting organised by IARC and the Commission of the European Communities in Hannover, 4-9 June 1979, edited by R. MONTESANO, H. BARTSCH and L. TOMATIS, Lyon, 1980 (joint IARC/CEC publication) (1)
- 10) Host Factors in Human Carcinogenesis, Proceedings of a symposium organised by IARC, the Commission of the European Communities, the Greek Ministry of Social Services, the Greek Ministry of Civilisation and Science and the Hellenic Cancer Society in Cape Sounion, 8-11 June 1981, edited by H. BARTSCH and B. ARMSTRONG, Lyon, 1982 (joint IARC/CEC publication)
- 11) Evaluation of the Effects of Chlorofluorocarbons on Atmospheric Ozone, report on a workshop held in Brussels, 13-15 January 1981, edited by A. GHAZI, 1981 (available on request)
- 12) Nickel in the Human Environment, Proceedings of an international symposium held in Lyon, 8-11 March 1983 (jointly organised by CEC, IARC, IPCS, ILO and the Ministry of the Environment of France), EUR 9163, Lyon, 1984 (joint IARC-CEC publication)
- 13) Measurement of air pollution at Drax during the 1976 CEC remote sensing campaign, prepared by R.A. SCRIVEN (CEGB), EUR 6420, 1979 (in series "Environment and Quality of Life")²⁾

(1) The reports of ad hoc working groups presented to this meeting are published under the title "Long-Term and Short-Term Screening Assays for Carcinogens: A Critical Appraisal" as Supplement 2 to the IARC Monographs, Lyon, 1980

(2) The results of other CEC remote sensing campaigns are published in scientific journals or by the co-organisers; a complete list of these reports is available

- 14) Proceedings of the World Symposium on Asbestos, jointly organised by the Commission of the European Communities, the Government of Canada and the Government of Quebec, 25-27 May 1982, Montreal, 1982
- 15) Shorebirds and Large Waterbirds Conservation, Proceedings of two workshops held in Durham (United Kingdom), 17-18 September 1983, edited by P.R. EVANS, H. HAFNER and P. L'HERMITE, Brussels, 1984 (available on request)
- 16) Report on the EC epidemiological survey on the relationship between air pollution on respiratory health in primary school children, edited by C. DU V. FLORY, A.V. SWAN, R. VAN DER LENDE, W.W. HOLLAND, A. BERLIN and E. DI FERRANTE, Brussels, 1983 (available on request)
- 17) Cadmium in the European Communities: a prospective assessment of sources, human exposure and environmental impact, report prepared by M. HUTTON for the Commission of the European Communities, published as MARC-Report no. 26, 1982
- 18) Cadmium Exposure and Indicators of Kidney Function, report prepared by M. HUTTON for the Commission of the European Communities, published as MARC-Report no. 29, 1983
- 19) Stratosphere, Proceedings of a working party meeting held in Brussels on 18 May 1984, edited by A. GHAZI, 1984 (available on request (1))
- 20) Proceedings of the European Symposium on Environment and Chemicals in Agriculture, Dublin, 15-17 October 1984, jointly organized by the Commission of the European Communities and the Irish Government, edited by P. WINTERINGHAM, 1985 (in print)
- 21) Atmospheric Ozone, Proceedings of a Symposium held in Halkidiki (Greece), 3-7 September 1984, edited by C.S. ZERFOS and A. GHAZI, D. Reidel Publishing Company, Dordrecht, 1985 EUR 9574

C) REPORT AND PUBLICATIONS GENERATED WITHIN THE CONCERTED ACTIONS

C.I) Physico-Chemical Behaviour of Atmospheric Pollutants (COST 61a) (2)

a) Executive Reports (3)

- 1) Final Report of the Management Committee of COST Project 61a "Physico-Chemical Behaviour of SO₂ in the Atmosphere", Brussels 1977 (also available in DE and FR)

-
- (1) Comprises also work funded under the Climatology Programme
 - (2) From 1972 to 1976, this project was implemented under the title "Physico-Chemical Behaviour of SO₂ in the Atmosphere"
 - (3) These reports contain a comprehensive list of internal reports available on request

- 2) Activity report of the Community-COST Concertation Committee covering the period October 1978 - December 1980 (also available in DE and FR)
 - 3) Activity report of the Community-COST Concertation Committee covering the period January-December 1981 (also available in DE and FR)
 - 4) Final activity report of the Community-COST Concertation Committee for the period 1978-1983
- b) Proceedings of Conferences and Other Publications
- 1) Proceedings of the First European Symposium "Physico-Chemical Behaviour of Atmospheric Pollutants", Ispra, 16-18 October 1979, edited by B. VERSINO and H. OTT, EUR 6621, Brussels/Luxembourg 1980
 - 2) Proceedings of the Second European Symposium "Physico-Chemical Behaviour of Atmospheric Pollutants", Varese, 29 September - 1 October 1981, edited by B. VERSINO and H. OTT, D. Reidel Publishing Company, Dordrecht, 1982, EUR 7624
 - 3) Acid Deposition, Proceedings of a CEC-Workshop, Berlin, 9 September 1982, edited by S. BEILKE and A.J. ELSHOUT, D. Reidel Publishing Company, Dordrecht, 1983, EUR 8307
 - 4) Proceedings of the Third European Symposium "Physico-Chemical Behaviour of Atmospheric Pollutants", Varese, 10-12 April 1984, edited by B. VERSINO and G. ANGELETTI, D. Reidel Publishing Company, Dordrecht, 1984, EUR 9436
 - 5) Oxidation reactions in the troposphere, Proceedings of a CEC workshop held in Orléans, 30-31 October 1984 (available on request)

C.II) Analysis of Organic Micropollutants in Water (COST 64b)

- a) Executive Reports (1)
- 1) Summary report on COST Project 64b "Analysis of Organic Micropollutants in Water" and third report of the Management Committee for the year ending 31 October 1975, Brussels, 1976 (also available in DE and FR)
 - 2) Activity report of the Community-COST Concertation Committee covering the period October 1978 - December 1981, Brussels, 1982 (also available in DE and FR)
 - 3) Summary report (1978-1983) and activity report of the Community-COST Concertation Committee covering the period January 1982 - December 1983, Brussels, 1984 (also available in DE and FR)

(1) These reports contain a comprehensive list of international reports available on request

b) Proceedings of Conferences and Other Reports

- 1) Proceedings of the First European Symposium "Analysis of Organic Micropollutants in Water", held in Berlin, 11-13 December 1979, Brussels, 1982 (available on request)
- 2) Proceedings of the Second European Symposium "Analysis of Organic Micropollutants in Water", held in Killarney (Ireland), 17-19 November 1981, edited by G. ANGELETTI and A. BJØRSETH, D. Reidel Publishing Company, Dordrecht, 1982, (EUR 7623)
- 3) Proceedings of the Third European Symposium "Analysis of Organic Micropollutants in Water", held in Oslo, 19-21 September 1983, edited by G. ANGELETTI and A. BJØRSETH, D. Reidel Publishing Company, Dordrecht, 1984 EUR 8518
- 4) A comprehensive list of polluting substances which have been identified in various fresh waters, effluent discharges, aquatic animals and plants, and bottom sediments, fourth edition, 4 volumes, Brussels, 1984, compiled by Water Research Centre, Stevenage (available on request) (1)
- 5) Behaviour and transformation of organic micropollutants in water treatment processes, Proceedings of a CEC Workshop held in Barcelona, 19-20 November 1984 (available on request)
- 6) Methodologies for the analysis of organic micropollutants in the aquatic environment, Proceedings of a CEC Workshop held in Ghent, 27-29 November 1984 (in print)

C.III) TREATMENT AND USE OF SEWAGE SLUDGE (COST 68) (2)

a) Executive Reports (3)

- 1) Final report of the Management Committee on COST Project 68 "Sewage Sludge Processing", 1972-1975, Brussels, 1975 (available on request)
- 2) Final report of the Community COST Concertation Committee covering the period 1976-1980, Brussels, 1981 (available on request)
 - Part I: General Report (also available in FR and DE)
 - Part II: Scientific Report
 - Part III: Technical Annexes

(1) 1st edition, 1974)
2nd edition, 1976) out of print
3rd edition, 2 volumes, 1979)

(2) From 1972 to 1984, this project was implemented under the title "Sewage Sludge Processing"

(3) These reports comprise a comprehensive list of internal reports available on request

- 3) Activity report of the Community-COST Concertation Committee covering the period October 1980-June 1982, Brussels, 1982 (available on request)
- 4) Final report of the Community-COST Concertation Committee covering the period 1981-1983, Brussels, 1984 (available on request)
 - Part I: General Report (also available in FR and DE)
 - Part II: Scientific Report

b) Proceedings of Conferences

- 1) Treatment and Use of Sewage Sludge, Proceedings of a CEC Symposium held in Cadarache, 13-15 February 1979, edited by D. ALEXANDRE and H. OTT, Brussels 1980 (available on request)
- 2) Phosphorus in Sewage Sludge and Animal Waste Slurries, Proceedings of a CEC seminar held in Groningen, 12-13 June 1980, edited by T.W.G. HUCKER and G. CATROUX, D. Reidel Publishing Company, Dordrecht, 1981, EUR 7112
- 3) Copper in Animal Wastes and Sewage Sludge, Proceedings of a CEC workshop held in Bordeaux, 8-10 October 1980, edited by P. L'HERMITE and J. DEHANDTSCHUTTER, D. Reidel Publishing Company, Dordrecht, 1981, EUR 7196
- 4) Characterization, Treatment and Use of Sewage Sludge, Proceedings of the Second European Symposium held in Vienna, 21-23 October 1980, edited by P. L'HERMITE and H. OTT, D. Reidel Publishing Company, Dordrecht, 1981, EUR 7076
- 5) The Influence of Sewage Sludge Application on Physical and Biological Properties of Soils, Proceedings of a CEC seminar held in Munich, 23-24 June 1981, edited by G. CATROUX, P. L'HERMITE and E. SUESS, D. Reidel Publishing Company, Dordrecht, 1982, EUR 8023
- 6) Disinfection of Sewage Sludge: Technical, Economic and Microbiological Aspects, Proceedings of a CEC workshop held in Zürich, 11-12 May 1982, edited by A.M. BRUCE, A.H. HAVELAAR and P. L'HERMITE, D. Reidel Publishing Company, Dordrecht, 1982, EUR 8024
- 7) Environmental Effects of Organic and Inorganic Contaminants in Sewage Sludge, Proceedings of a CEC seminar held in Stevenage, 25-26 May 1982, edited by R.D. DAVIS, T.W.G. HUCKER and P. L'HERMITE, D. Reidel Publishing Company, Dordrecht, 1983, EUR 8022
- 8) Nitrogen and Phosphorus Value of Sewage Sludges; state of knowledge and practical recommendations, Brussels 1982 (available on request)
- 9) Utilisation of Sewage Sludge on Land: Rates of Application and Long-Term Effects of Metals, Proceedings of a CEC Seminar held in Uppsala, 7-8 June 1983, edited by S. BERGLUND, R.D. DAVIS and P. L'HERMITE, D. Reidel Publishing Company, Dordrecht, 1984, EUR 8822

- 10) Methods of Characterisation of Sewage Sludges, Proceedings of a CEC Workshop held in Dublin, 6 July 1983, edited by T.J. CASEY, P. L'HERMITE and P.J. NEWMAN, D. Reidel Publishing Company, Dordrecht, 1984, EUR 9171
- 11) Processing and Use of Sewage Sludge, Proceedings of the Third European Symposium held in Brighton, 27-29 September 1983, edited by P. L'HERMITE and H. OTT, D. Reidel Publishing Company, Dordrecht, 1984, EUR 9129
- 12) Chemical Methods for Assessing Bio-available Metals in Sludge and Soils. Proceedings of a Seminar held at Münster (FRG) on 11-13 April 1984, edited by R. LESCHBER, R.D. DAVIS and P.L'HERMITE, Elsevier Applied Science Publishers Ltd. (in print)
- 13) Inactivation of Micro-organisms in Sewage Sludge by Stabilisation Processes. Proceedings of a round-table held at Stuttgart-Hohenheim (FRG) on 8-10 October 1984, edited by D. STRAUCH, A.H. HAVELAAR and P. L'HERMITE, Elsevier Applied Science Publishers Ltd. (in print)
- 14) Long-term Effects of Sewage Sludge and Farm Slurries Applications. Proceedings of a round-table held at Pisa (I) on 25-27 September 1984, edited by J.H. WILLIAM, G. GUIDI and P. L'HERMITE, Elsevier Applied Science Publishers Ltd. (in print)

C.IV) COASTAL BENTHIC ECOLOGY (COST 47)

- 1) Activity report of the Management Committee for the period April 1979-March 1983, Brussels 1983 (available on request)
- 2) COST 47 Newsletter (nos. 1, 2, 3 and 4), published by the National Board for Science and Technology, Dublin, Ireland
- 3) Final report of the Management Committee on COST Project 47, Coastal Benthic Ecology, in print

OPINION

expressed by the CGC Environment and Climatology
on
the draft proposal for a R&D Programme in the field of
ENVIRONMENTAL PROTECTION (1986-1990)

1. The CGC discussed the draft proposal for a Research and Development Programme in the field of Environmental Protection (1986-1990) (Doc. XII/ENV/50/84). In formulating this Opinion, it took into account the views previously expressed by ACPM Environment Research and CREST Environment Sub-Committee.
2. The Committee notes the substantial achievements of the previous programmes. It emphasises the continuing need for a Community Programme on environmental protection research, given the current concerns about environmental problems. The Committee's comments and recommendations on specific aspects of the Proposal are listed below.

Aims and objectives

3. The CGC supports the aims of the proposed Programme which is designed to provide R&D support to the environmental policy of the Communities, and in particular to its Environment Action Programmes. The Programme should also provide a basis for the development of anticipatory and preventive policies.
4. The Committee is of the opinion that the proposed Programme contributes to a number of the Communities' S&T objectives, as defined in the Framework Programme, in particular the "improvement of safety and protection of health" and "protection of the environment and prevention of pollution". It stresses the need to ensure co-ordination with the relevant activities and programmes in DG V, VI, XI, to be undertaken in close association with the CGC Environment and Climatology.

Ways of implementation

5. The Committee endorses the three types of activities (contract research, concerted actions and catalytic activities) proposed to implement the Programme, and welcomes the introduction of the last (catalytic activities) as providing additional flexibility for its execution.
6. The Committee urges a careful examination of the balance between these three activities, and requests an assurance of close links between them, as well as with relevant parts of the JRC R&D programme. It also recommends that the distribution of funds between the research areas be decided by the Commission in close consultation with the CGC.

7. As far as Contract Research is concerned, the Committee strongly urges the simplification of procedures in the selection, administration and management of research projects, in order to ease the workload on Commission Services and on itself.
8. In general, the Committee is of the opinion that Concerted Actions should be encouraged whenever appropriate. Furthermore, within the framework of the proposed Programme, cooperation between scientific institutes throughout the Community should be promoted, in particular by initiation of joint projects, exchange of scientists and organization of scientific meetings.
9. The CGC recommends that the reporting of all types of EC level environmental R&D be further improved.

Scientific Content

10. The CGC is in agreement with the contents of the proposed Programme. It suggests that within each area the priorities for EC environmental R&D be carefully defined by the Commission in consultation with it, taking into account the financial and manpower resources available, the scientific and technical capabilities within the Community, and the possibilities for effective coordination.
11. The CGC recognizes that the differences in scientific, technical and economic capabilities within the Community should be taken into consideration. In particular, the Commission is urged to promote training in the light of the needs arising from the proposed R&D Programme.
12. The CGC is aware of the current independent evaluation of EC level environmental research; it urges the Commission, in consultation with the Committee, to take proper account of the findings in the design and execution of future environmental research.

Funding and Staff

13. The proposed Programme represents a real, but realistic, strengthening of EC environmental research and development, which is necessary to meet the needs of the Environment Action Programmes.
 14. In order to achieve these aims, the CGC recognises the need for the provision of adequate financial resources and staff, and that these will require a real increase compared with the resources provided in the 3rd Environmental R&D Programme. The UK delegation reserves its position on this last point.
-

DRAFT PROPOSAL
FOR A RESEARCH AND DEVELOPMENT PROGRAMME
IN THE FIELD OF CLIMATOLOGY
(1986-1990)

as part of the

RESEARCH ACTION PROGRAMME "ENVIRONMENT"

A. THE R & D PROGRAMME "CLIMATOLOGY"

1. Introduction : the First CEC Climatology Programme

The programme proposed should be the continuation of the first Climatology Research Programme, which as a part of the Sectoral R&D Programme in the field of Environment (1981-1985) was decided upon by the Council on the 3rd March 1981. The contents of the first programme were :

Research area 1 : Understanding climate

- 1.1. Reconstruction of past climates. Exploration and analysis of : (a) natural records; (b) observational and other historical records.
- 1.2. Climate modelling and prediction

Research area 2 : Man-climate interactions

- 2.1. Climate variability and European resources : (a) impact on agricultural and water resources; (b) climatic hazards evaluation; (c) impact on energy requirements, use and production.
- 2.2. Man's influence on climate : (a) chemical pollution of the atmosphere, with special emphasis on carbon dioxide accumulation; (b) release of energy.

As regards the implementation of the first programme, the following facts and figures can be quoted :

- (a) Contracts. Overall, 115 contracts have been signed. The Commission of the EC has contributed to the total costs of each contract an average of about 30%.
- (b) Meetings. Apart from the review Symposium to be mentioned later, and the Contact-Group Meetings (Climate Modelling, Reconstitution of Past Climates, Anthropogenic Climate Perturbations, Climatic Impacts), the following specialized meetings have been organized, supported or sponsored : (i) Workshop on Palaeoclimatic Research and Models (PRAM), Brussels, December 1982; (ii) Symposium on Climate-Biosphere Interactions, Osnabrück, March 1983; (iii) Symposium on Desertification in European Countries, Mitilini, April 1984.

Three Courses of the International School of Climatology (Centre for Scientific Culture, Erice, Sicily) have been supported by the Commission, the teachers being chosen mostly among research workers involved in the EC Climatology programme, either as Advisory Committee Members or as Contractors. The third course has been directed by a member of the Climatology staff of the CEC.

(i) Course on Climatic Variations, Facts and Theories, March 1980; (ii) Course on Carbon Dioxide and Climate, July 1982; (iii) Course on Climatic Aspects of Desertification, October 1983.

- (c) Publications. In addition to publications of contract research results in international Scientific Journals, the following books have appeared or are in preparation :
- (i) The Climate of Europe, Past Present and Future, H. Flohn and R. Fantechi, Editors, Reidel 1984;
 - (ii) Interactions between Climate and Biosphere, H. Lieth, R. Fantechi and H. Schnitzler, Editors, Swets and Zeitlinger 1984;
 - (iii) Palaeoclimatic Research and Models, A. Ghazi, Editor, Reidel 1983;
 - (iv) Proceedings of a working-party meeting "Stratosphere", CEC Report, A. Ghazi, Editor, 1984;
 - (v) Climatic Aspects of Desertification, R. Fantechi, J.P. Van Ypersele and A. Longhetto, Editors (in preparation);
 - (vi) Desertification in European Countries, R. Fantechi and N. Margaris, Editors (in preparation);
 - (vii) Various Contact Group Meeting Reports.

To determine the state of the art as regards the development of the previous programme, a review Symposium was held in Sophia Antipolis, France, 2 - 5 October 1984. The Symposium was devoted to the presentation and discussion of items regarded as the highlights of the programme, but results from all the contracts were available under the form of summary reports (*). The proceedings of the Symposium will be published themselves as a book. Various rapporteurs were chosen by the Commission Services, assisted by the Climatology Advisory Committee. On the basis of the evaluation offered by their reports, the continuation of the Climatology programme is well justified.

Quoting from the various Reports, it appears in particular that the EEC programme, in addition to the specific results of the research, has accomplished the most useful function of bringing European climatologists into contact and of favouring a flow of information between them, so that they became aware of the work going on elsewhere in Europe while having the opportunity to compare their results. It has been recognized that especially in the modelling area scientists can learn a great deal by close intercomparison of sets of results derived

(*) To be published soon as a EUR Report.

independently, since it is extremely difficult to investigate mechanisms by experimental techniques, because the climate itself can neither be experimented with nor reproduced adequately in the laboratory. The contacts established between modellers and palaeoclimatologists within the CEC programme have already proved useful : palaeoclimatologists have become more aware of the possibility of interpreting their observations by means of models, and equally through this interaction modellers have learned about past climatic states, the simulation of which provides additional tests of the applicability of their models.

Concerning the prediction of climate with a high-CO₂ atmospheric concentration, the work by Mitchell (British Meteorological Office) has in particular provided data for climate impact evaluation.

As regards palaeoclimatic research, the high degree of complementarity between various techniques, which it was possible to compare through the CEC programme, has emerged. In particular, it would now be possible, on the basis of existing skills and experience, to develop a large research programme on the dynamics of the last glacial/interglacial cycle, involving the cooperation of modellers. Concerning Anthropogenic Climate Perturbations (the CO₂ issue) significant results have been obtained concerning the level of preindustrial CO₂; a low CO₂ content has been found associated with the last glacial maximum; various aspects of the global carbon cycle and mechanisms of carbon exchange between various compartments have been explored. The need of a continuing cooperative research effort has been recognized for this area which is situated at the intersection between all the others. The first programme has also been found promising as regards impact studies concerning agriculture, hydrology and energy, and successful in collecting, building and testing impact models. Further collaboration in a continuing CEC programme is recommended in order that the results of the climatic impact studies may be made soon operational as tools for European decision making. It is recognised that impact studies form an essential part of the CEC Climatology Programme.

2. Background and Justification

The justification given for the first programme remains valid, but should be expanded on the basis of the results obtained and of the needs which in the meantime have emerged.

Among all the components of the human environment, climate (*) may certainly be said to be the most important, or at least one of the most important. It is anyway the one upon which our health and well-being, the amount of our water resources, the quality and quantity of our harvests, our needs in terms of energy and shelter, largely depend.

Climate can make any given region habitable to man, or the contrary.

Climate is intrinsically variable, and natural climate variations are known to have had a major impact on human civilizations in the past, and their effects have been keenly felt in droughts, bad harvests, floods and other extremes and catastrophes even in recent years. There exists today no generally accepted explanation of these fluctuations, and there exists no reliable empirical or theoretical method for their prediction. The impact of man's expanding activities on climate also constitutes a potentially grave danger which cannot yet be properly assessed.

(*) The climatic system embraces atmosphere, ocean, floating and continental ice, soil and vegetation. All these sub-systems vary on quite different time scales and interact in complex ways, partly damping, partly amplifying the motions and variations of each other. Therefore the climatic system as a whole is capable of undergoing fluctuations on many time scales, and because of their different lengths, ranging from 10^{-1} to 10^9 years, the climatic system can never be in equilibrium.

Climate and weather are associated in the atmosphere through a complex interacting hierarchy of processes from small fine weather clouds to fully developed hurricanes and mid-latitude cyclones. But this fast-living system is only a part of the much vaster and much more complex climatic system.

As regards the atmospheric climate, it can be defined as the statistical description of the state (temperature, pressure, cloudiness, precipitation, wind) of the atmosphere at a particular location over some specified time period (usually one month or longer) together with the oceanic, biospheric and land surface data regarded as boundary conditions.

This is especially true nowadays with the manifold problems posed by the increasing of the concentration of the atmospheric carbon dioxide, due primarily to fossil fuel burning and at the same time to the clearing of large forest areas. The carbon dioxide issue may well be defined the great environmental issue of the present century and of the next one. For the first time man looks capable of inducing a drastic changing in his environment, the consequences of which may be so far-reaching as to cause irreversible disruptions not only in the natural equilibrium as known so far, but also in economic and social structures. The threat is real and serious and much research is certainly needed to at least achieve a degree of preparation towards what seems well to be an inevitable change. We may at least hope to become able to avert some of the foreseen consequences.

Among the latter, those most to be feared are those depending on perturbations of the temperature and precipitation patterns, which according to a model developed within the previous Climatology programme could result in an increase in surface temperature over the European Community through the year, with a decrease in precipitation in Southern Europe and an increase in Northern Europe. The land surface in summer would be drier over the whole European Community. If these results were confirmed by further research, the danger for European soils, agriculture and water resources would be evident.

The hydrologic cycle is in fact an important component of the climate system and determines regional water availability : precipitation and soil moisture storage add to the water supply, while evaporation, transpiration, and runoff subtract from it.

The changes in precipitation due to a climate change represent a key element in the study of potential climatic impacts on water supplies, and hence food. Precipitation is, after all, the prime source of all our fresh water. Water resource planning for a future climate regime will depend in large part upon changes in the distribution of precipitation and soil moisture over time and space, such as we should expect on a warmer earth.

Climatic research is also justified by the fact that our society, due to increasing population and complexity of societal structures, and the consequently greater demand upon climate-dependent resources, is becoming increasingly vulnerable to such extremes as droughts or heavy storms, with all their consequences, such as wind or water erosion of soils, forest fires, depletion of water resources and increased need for irrigation water, occurrence of floods, etc. Even less drastic events, depending upon the perturbations referred to above, would be cause for concern, especially for their occurrence during the sowing, growing and harvesting seasons.

Many such climatic extremes have occurred during recent years and the economic and social impacts of some of these have been sometimes rather drastic: in 1972, for example, climatically caused deficiencies in different production areas accumulated. A failure of the global cereal production by a few percent was accompanied by a price increase of a factor 3 (H. Flohn, in Climatic Variations and Variability, First Course of the International School of Climatology, Erice, 1980; Reidel Publishing Company, 1981). The starvation of millions of people in developing countries is nowadays an example of the kind of tragedies that mismanagement of resources, coupled to adverse climatic conditions, can bring about. For these reasons the need has been felt of strengthening the power of existing European climate models, so as to achieve the predictability of the European climate on the seasonal (3 to 6 months) scale. Such an effort should provide the tools we need for the kind of forecasting needed for policy decisions as regards the proper management of our land and water resources.

Climatic change is therefore not only a subject of theoretical interest: the most compelling reasons for its study are in fact the growing awareness that not only our climate-dependent resources, but our economic and social structures as well, are deeply influenced by climate, while man's activities themselves may be able to contribute to climate's instability, possibly in undesirable directions. It is that awareness that has given rise to the World Climate Programme and has led to more intense efforts in climate research all over the world.

The critical nature of climate has to be stressed in particular for the EC countries, which are closely interrelated both economically and socially, and which share regional climates extending across political boundaries. Thus any major impact, whether of climatic variability on natural resources or of human activities on climate, could never be limited to any one European country. In this respect it may also be observed that the EC Countries cover an area which has the ideal dimensions for the study of regional impacts, as distinguished from local or microclimatic, and global effects. It is therefore appropriate to have a European programme within the broader international context as a contribution to the overall effort, in the spirit of the solemn Declaration of the World Climate Conference, and with a strongly applied character aiming at a better understanding and management of our climate-dependent resources.

The expansion of the previous programme to the size proposed for the new one is therefore motivated by actual needs and is aimed at meeting vital challenges that our future has in store.

The Subject Area Report VI, "World Climate and Climate Change" (TGE ENV 9), issued by the Technology Growth and Employment working group instituted at the Versailles Summit of 4-6 June 1982, states that "for example, the determination of the effect of increased CO₂ involves palaeoclimatologists, glaciologists, biologists, chemists, meteorologists, oceanographers, agriculturalists, economists, etc...", that "the exchange of scientists, data and intercomparison of results between different countries should be encouraged to foster the development of new ideas", and that "given that the importance of a full understanding of climate change and its impact is essential to the well-being of nations, it is necessary to accept that the achievement of this degree of understanding requires the commitment of significant resources for a long period of time for the necessary projects to be made" (Sections 37-39).

Because of the transfrontier nature of climatic problems, and because of the fact that they can only be solved through an interdisciplinary approach, climatological research is a field where coordinated and problem-oriented activities are most needed and efficient. The previous EC programme has proved its capability to bring together the best specialists available in each discipline, thus making the optimum use of their knowledge and experience, besides encouraging present efforts and stimulating new research in a field of growing interest and urgency. It has accomplished the most useful function of bringing European climatologist into contact, thus favouring a flow of information between them and making them aware of work going on elsewhere in Europe. Fruitful cooperation, not existing before, has been established between modellers and palaeoclimatologists, between scientists dealing with climate impacts and modellers, between theoreticians and people concerned with data collection and application. The continuation of such a cooperative effort has been recognized necessary by top European climatologists if their work has to bring about such an understanding of climate as can lead to reliable tools for decision making as regards climate-dependent resources.

Hence the necessity of taking advantage of the many opportunities offered by the strengthening and widening of the present efforts, and hence the justification for the additional effort required for their implementation.

One of the main results would be, inter alia, the achievement of a European independent view concerning the serious problems posed to our age by climate and its interactions with man.

As regards the first Framework Programme for Community Research, the Climatology Programme concerns directly the following Scientific and Technical Objectives:

1. Promoting agricultural competitiveness (30%).
2. Improving living and working conditions (70%).

3. Objectives of the Programme

As with the previous Programme, the one now proposed is concerned with a number of basic questions concerning the correct understanding of our climatic environment and the management of our climate-dependent resources:

- (1) How does the climate system work? How did it evolve in the past, and how is it going to evolve in the future?
- (2) Upon which factors do climate variations depend? How does the system respond to various forcing factors, and especially to the consequences of certain human activities?
- (3) Especially as regards Europe, how can climate variations affect our basic resources, namely water, soil, vegetation, food? How can such climatic impacts be assessed in order to advantageously plan our future?

Upon that basis, three Research Areas have been defined, namely:

- (1) the Physical Basis of Climate;
- (2) Climate Sensitivity;
- (3) Climatic Impacts.

A description of these Research Areas is to be found in the following Section.

In respect of the previous programme, which was mainly conceived as a pilot programme, the present proposals are characterized by a marked expansion of various research items and objectives. In particular :

- (i) The growing importance has been recognized of increasing our knowledge of the history of climate in the past, especially as regards the relationship between climate and biosphere conditions.

Such understanding would improve our capability of forecasting future situations especially as regards climate-vegetation (in particular, climate-deforestation), climate-water resources and climate-soil conditions.

Hence the need of strengthening the cooperation between palaeoclimatologists and climate modellers, while expanding the power and scope of present modelling efforts.

- (ii) Due to the importance of climate models as regards forecasting future conditions, significantly greater efforts should be exerted to improve our modelling capabilities.

In this context the importance has been recognized, not only to improve existing models, but also to engage in intercomparisons of models on the European and world scales.

In particular, it has been recognized that times are ripe for European scientists to engage in exploring the feasibility of seasonal (3 to 6 months) forecasting of elements of the European climate. All such efforts should provide well-tested approaches that could be used for policy decisions and resource management.

Problems arising from possible climate change or variations could thereby be studied at a greater depth and on a larger scale. Such problems include the growing vulnerability of particular areas to climatic factors likely to cause aridity and loss of vegetation, forest fires, floods, landslides, water and wind erosion of soils, and so on.

- (iii) Impossible in the previous programme due to the small budget thereto allocated, the need of making use of the possibilities offered by satellite data analysis and applications is becoming increasingly imperative. The Commission has been already approached by various sides in search for cooperation in this field. Ocean and land surface properties, most conveniently explored by satellite data collection and imagery, are growing in importance as regards climate modelling and resource forecasting.
- (iv) The fact that Europe finds itself on the border of the northern desert belt of the Earth should add to our concerns. Desert belts lie beneath the two great atmospheric subsidence belts of our globe, and the present day circulation patterns of the atmosphere situate those belts in the subtropical latitudes. In the perspective of a climate change, induced by the increasing concentration of atmospheric CO₂, the risk of a northward shift of the nearest desert² belt is possible and should therefore receive the closest attention.

The programme would have a twofold structure : (i) a conceptual structure defined by the three research areas described below, as the basis for judging about the relevance of research projects to the programme; (ii) an operational structure, mainly defined by the condition that projects should be cooperative. It is in fact felt that a second Climatology programme should be based explicitly upon projects involving more than one Member State.

4. The Conceptual Structure of the Programme

4.1 Research Area I: the Physical Basis of Climate

The global climate system involves the atmosphere, the oceans, the snow and ice masses, the land surfaces and the biosphere. Despite the complexity of the system, it is essential to understand its mechanism, and as a matter of fact considerable progress is being made in that direction, thanks especially to new empirical and theoretical approaches involving the use of satellite remote sensing and computer mathematical modelling.

One way of gaining insight as to how the mechanism behaves would be to understand how the climate has varied in the past. Studies of past climate changes provide valuable information on the interactions of the atmosphere, oceans, ice masses and the land surfaces. The responses of the climate system to such forcing factors as changes in the orbital parameters of the Earth could also be studied.

Research into the fundamental physical and chemical processes that influence climate is also needed in order to understand the latter and predict its evolution. Studies of those processes should therefore be aimed at improving the physical formulation and the parametrisation in climatic models.

Modelling and predicting climate changes, especially as regards Europe, have in fact acquired a sense of urgency, especially with the realisation that anthropogenic activities can induce or accelerate such changes.

Models should therefore be developed and applied in order to provide accurate predictions of both natural and inadvertent climate variations, by including as many as possible of the components of the system and coupled feedback processes in a realistic manner.

A certain amount of effort should be devoted to investigations dealing with the interannual variability of climate and with teleconnections (*). Understanding gained by such studies will be a necessary foundation for simulating and predicting European climate on longer time scales and for climate sensitivity studies.

(*) The spatial coherencies that control climatic anomalies at different locations. Those anomalies are therefore not randomly distributed.

One primary objective is the development of climate simulation and prediction models able to make forecasts of the European climate. In particular, the feasibility of seasonal (3-6 months) forecasting of elements of the European climate should be studied. Such efforts should aim at providing approaches that could be used for policy decisions and resource management.

The following structure is proposed for the present research area:

4.1.1. Past climates and climatic change.

Coordinated investigations involving paleoclimatologists and climate modellers, or aiming at a quantitative evaluation of paleoclimatological parameters such as can be used in models, will be encouraged.

4.1.2. Climatologically significant processes.

Studies should be aimed at improving the physical formulation of processes, for inclusion in preferably complete 3D models, and as a basis for investigation in all the three research areas. The processes concerned include land surface processes, ocean processes, biogeochemical cycles, cloud and related radiation processes, aerosols, sun-earth processes, cryosphere. Climatological applications of satellite data analyses are here included.

4.1.3. Modelling and predicting European climates within a global context.

Interannual variability and teleconnections will be priority areas. Studies of model intercomparisons would be encouraged.

4.1.4. Forecasting European climates.

Studies would be encouraged concerning the feasibility of the seasonal (3-6 months) forecasting of elements of the European climate.

4.2. Research Area II: Climate Sensitivity

Life on Earth depends critically on climate factors such as precipitation, temperature and sunlight which interact with soil, air, water and biomass - our basic resources.

For the studies of long-term sensitivity of climate, changes in all these climate factors have to be considered. The variations of the atmospheric climate over years to decades can only be fully understood when coupled dynamics of oceans and global atmosphere and their interactions with terrestrial ecosystems are adequately described.

There is no doubt that, as regards climate, the most important problems are being posed by the increase of carbon dioxide in the atmosphere and of the possible response of the Earth's climate to that increase. A proper research strategy should also include the study of the radiative effects of other potentially active trace gases (e.g. H₂O, CH₄, O₃) and aerosols, while paying due attention to the study of aspects of the global carbon cycle important for climate together with changes in land surface factors. In addition, the data relevant to the aforementioned climatologically significant processes (3.1.2) should be continuously evaluated and compared with the model sensitivity studies.

In this way a balanced approach on the basis of modelling, monitoring and diagnostic studies should be developed in order to pave the way towards early and reliable detection of climate change.

In this context, priority should be given to studies related to the possible effects of human influences, concerning European climates particularly. The following items are considered to be essential to this research area:

4.2.1. Changes in atmospheric composition.

(i) The climatic effect of enhanced CO₂.

(ii) Aspects of the global carbon cycle important for climate prediction.

(iii) The climatic effect of other trace gases and particulates.

4.2.2. The climatic effect of changes in land-surface properties.

4.2.3. Early detection of climate change (identification and study of parameters which could be used as early indicators of climate change. Improvement of techniques for detecting the signal above noise level).

4.3. Research Area III: Climatic Impacts

It has been remarked under Research Area II that life on Earth depends critically on climate. Therefore studies of the long-term sensitivity of climate to various external factors, implying changes in the relevant climatic parameters, have to be considered.

Conversely, the impacts that climate changes or variability could have on such vital resources as soil, water and vegetation should receive all our attention in order to develop the necessary preparation to any change that climate may have in store.

The gravity of the problem is easily seized when one considers that, for instance, the hydrological cycle is a major component of the climate mechanism, and that any perturbation of the hydrological cycle would affect our only source of fresh water and consequently the water resources and the agriculture of entire regions. Of great importance would such perturbations be for Europe, with its southern semi-arid countries where climate is already a problem.

Three time and space scales have to be considered in this context:

- (1) Large-scale changes: the response to global long-term climate changes such as those resulting from natural or man-induced factors (CO₂ accumulation, energy policies, deforestation, etc.).
- (2) Medium-scale fluctuations: regional responses to medium-term climatic events, such as droughts or severe cold or heat periods.
- (3) Short term events: responses to extreme (low frequency, high intensity) phenomena such as severe storms and floods.

Correspondingly, the results of research conducted under this area should provide the basis for policy decisions and strategies in terms of general preparation to the changes, fluctuations and hazards mentioned.

Efforts should therefore be pursued in order to develop a suitable methodology for climatic impacts assessment.

With all such aims in view, research work under this area should therefore be concerned with the impacts of variations in the climate system, or in any of its components, on European land and water resources, and food production. Priority would be given to investigations based on well-documented impacts from the past and to the response to increasing CO₂.

The following research items should be considered under this area:

- 4.3.1. Impact of climate change or variability on land resources, including soil, and ecosystems, with special attention to desertification problems.
- 4.3.2. Impact of climate change or variability on European water resources, including the development of climate-based models for their evaluation and forecasting.
- 4.3.3. Response of European vegetation to increasing atmospheric CO₂ in the context of a climate change.
- 4.3.4. Impact of climate change or variability on sea resources and fisheries.
- 4.3.5. Application of climatic knowledge to a better management of land and water resources.
- 4.3.6. Causes, mechanisms and impacts of climatological anomalies and extreme or abrupt events, with the aim in view of reducing human and material losses.

5. The operational structure of the programme

5.1 Implementation

The Programme will be implemented by means of cost-sharing contracts with private and public research institutions in the Member States, according to the following criteria :

- (i) Research projects acceptable for funding should be based on cooperation between different research institutions belonging to more than one EEC Member States, without excluding that some of them may belong to the same Member State.
- (ii) Research contracts should contain specific provisions for stimulating the European scientific potential, by various means such as (a) exchange of research workers between institutions cooperating in the same project; and/or (b) participation in the project of scientists belonging to research institutions not receiving funds from the CEC Climatology Research Programme but considered to be valid collaborators within the framework of the coordination action described below; and/or (c) training of pre- and post-graduated research workers.
- (iii) The contract research should be coupled to an effort to coordinate the ongoing research activities within Member States, which should allow the achievement of a close cooperation even among research institutions not receiving funds from the programme.

(iv) With the assistance of the Advisory Committee for Management and Coordination, the following activities should be carried out :

- (a) Interdisciplinary expert meetings the purpose of which should be the examination and discussion of specific problems of special importance.
- (b) Courses on selected climatological or climate-related problems, to be held in turn in various EC research organizations involved in the programme.
- (c) Especially as an output of (a) and (b), the publication of a series of volumes dealing with important, climate-related problems.

5.2 Management and funding

The Programme will be managed by the Commission Services, assisted by the Environment and Climatology Advisory Committee for Management and Coordination.

The distribution of resources between research areas should be determined by the Commission in consultation with the Advisory Committee for Management and Coordination. A small indicative amount of about 5 % of the total budget should be used for the coordination, education and training activities described above.

Considering the transfrontier character of climatic problems, provisions will be made to offer to COST countries to participate in the research programme.

The amount of EC funding estimated necessary for the entire 5-year period (1986-1990) is 25 MECU and the required number of staff is 6.

These allocations represent an increase with respect to the previous pilot programme. Such an increase is justified by :

- the enlargement of the Community to be effective in 1986
- the incorporation of training activities, so far financed from a specific budget
- the necessity of improving our modelling capabilities, through expansion of the present models and model intercomparisons
- the planned attempt at forecasting the European climate on a seasonal scale (3 to 6 months)
- the analysis and application of satellite data
- the intensification of research on the climatic effect of enhanced CO₂ and consequent impacts on land and water resources

OPINION

expressed by the CGC Environment and Climatology
on
the draft proposal for a R&D Programme in the field of
CLIMATOLOGY (1986-1990)

1. The CGC discussed in detail the draft proposal for a Council Decision adopting a Research and Development Programme in the field of Climatology and in formulating this opinion took into account the fact that its contents have been drafted with the close cooperation of the Climatology ACPM established to assist the Commission in implementing the first research programme in Climatology (1981-1985).
2. Subject to the comments below the Committee strongly endorses the proposed programme, because of the overwhelming importance of climate and its possible variations on human activities, the transnational nature of climat issues, and the very successful outcome of the first EC research programme in climatology which will come to an end in 1985, with regard to both the scientific results and the development of European cooperation.

Aims and Objectives.

3. The CGC endorses the aims and objectives of the proposed Programme as defined in the draft proposal. Within this framework, it recognizes the continuing need to provide R&D support to the environmental policy of the Communities, and in particular to the Environment Action Programme.
4. The Committee is also of the opinion that the proposed Programme will provide a positive contribution to a number of the Communities S&T objectives, as defined in the Framework Programme, in particular the "improvement of safety and protection of health" and "protection of the environment and prevention of hazards". The Committee takes note that in coordination with the agricultural research programme, relevant research needs in agriculture will also be covered.

Scientific Contents

5. The Committee is in agreement with the scientific contents of the proposed programme. This is in line with the current concern throughout the Community about environmental problems, such as for instance those posed by enhanced atmospheric CO₂, to the solution of which climatological research can effectively contribute. The scope of the proposed Programme is also in line with the broad tenets of the Framework Programme.

In order to achieve those aims, the CGC appreciates the expansion of the previous programme particularly as regards the following items :

- (i) the strengthened cooperation both between different areas of the programme (e.g. palaeoclimatology and climate modelling) and between teams in different Member States ;
- (ii) the application to climatological research of possibilities offered by modern techniques (satellite data analysis, model intercomparison, attempts at forecasting European climates on the seasonal scale);
- (iii) the application of climatological data to the forecasting and prevention of climatic extreme or abrupt events ;
- (iv) the study of desertification processes in European countries and of the climate-induced natural disasters.

It considers that the distribution of resources between research areas should be determined by the Commission in consultation with the Committee itself.

6. It also recognizes that the differences in scientific, technical and economic capabilities and requirements within the Community should be taken into appropriate consideration.
7. The CGC strongly supports the further development of anticipatory and preventive environmental policies, and considers that EC level climatological R&D should help provide a basis for such policies.

Ways of implementation

8. The Committee endorses the ways proposed to implement the programme and especially the fact that cooperation between scientific institutes of the member states will be strongly supported by means of joint projects, exchange of research workers and scientific meetings.
9. The Committee is also of the opinion that the training activities described in the draft proposal should be encouraged whenever appropriate, and that the results of such actions be made widely available.

Funding and Staff

10. The proposal represents a realistic programme for EC climate research taking account of the needs and opportunities in the field in Europe.

The CGC recognizes the need for the provision of adequate financial resources and staff, and that this will require a real increase in funding as compared to the first Climatology programme. The U.K. delegation is not able to express an opinion on funding. The German delegation states the programme to be absolutely necessary on scientific grounds, but cannot express an opinion on funding.

PROPOSAL FOR A RESEARCH AND DEVELOPMENT PROGRAMME
IN THE FIELD OF MAJOR TECHNOLOGICAL HAZARDS AS PART OF
THE 1986-1990 RESEARCH ACTION PROGRAMME "ENVIRONMENT"

I. INTRODUCTION

I.1 The present document outlines motivations and contents of a shared-cost research programme on major technological hazards * to be implemented in the 1986-1990 period, as part of the Research Action Programme on Environment.

This shared-cost programme does not purport to encompass the whole spectrum of industrial hazards, or of loss prevention research. As guiding principle, attention is focused on categories of comparatively unfrequent, but highly significant accidents (in terms of loss of lives, material damage or environmental impact) which may occur in diverse transportation, energy-related or process activities. A similar approach is manifest in the Member States, where appropriate standing bodies exist indeed already, dealing specifically with the major hazards issue.

I.2 Major hazards presently considered are of chemical and petrochemical origin and associated, for instance, with:

- large inventories of flammable/explosive substances, principally common hydrocarbon fuels and derived chemicals;
- large inventories of unstable or very reactive substances (some nitrates, liquid hydrogen and oxygen);
- large inventories of common toxic chemicals, consumed or present in process industries (chlorine, ammonia and many other lesser ones);
- small inventories of very toxic and persistent chemicals.

It is indeed in such spirit that the E.C. Council Directive ** "On the major accident hazards of certain industrial activities" was drafted and its annexes list process activities and above all substances, with appropriate threshold quantities, to which its requirements apply. Those thresholds embody an approximate "equivalent hazard" concept. But, statistically speaking, dangers to the public-at-large arise primarily from bulk flammable and bulk toxics and more particularly from their bulk transportation and storage. Danger distances are typically of some few km.

* The term "Industrial risk" is also used, e.g. with respect to certain activities of the Joint Research Centre, but it has a broader meaning.

** Official Journal of the European Communities No L230/1 of 5/8/1982, designated next as "the Directive".

I.3 A number of other issues, sometimes of comparable or greater magnitude, are not covered here for reasons of consistency of work proposed, or because they are subject to own forms of control. For instance:

- natural/ecological disasters; nuclear energy; mining activities;
- high condensed explosives for military purposes;
- transportation of people;
- to some degree, a wide variety of industrial incidents of lesser impact, or not susceptible of escalating to major proportions.

For the latter category, however, knowledge and methodologies often accrue from the major hazards research proposed and a rigid borderline should not be drawn always. Conversely too, some methodologies developed in other fields of research (nuclear safety, atmospheric transport of pollutants, toxicology, etc.) can profitably be transposed and interdisciplinary studies are sometimes called for.

I.4 A second guiding principle restricts however the number and nature of research areas one may successfully tackle under a shared-cost scheme. Shared-cost research consists in sectorial groupings of a finite number of projects each, pooling expertise, facilities (often extant) and eventually results. The areas proposed below for shared-cost work focus on well-defined problems and situations and, as a result, potential projects.

Those projects are generally of marked experimental, physical modelling or engineering content and often call for complex and expensive experimental validations or simulations, justifying a pooling of resources and results at E.C. level. Other address common problems, of risk management and acceptance. All then lend themselves well to cooperative ventures, teaming-up of researchers and thorough exchange of up-to-date scientific and regulatory information, within the Community.

I.5 The present shared-cost research programme proposal thus addresses a limited group of highly significant issues, at this stage. Other facets of relevance are already addressed by the on-going direct action research programme on "Industrial risk" at the Joint Research Centre, or by other Directorates-General of the Commission, and also by way of concerted/catalytic actions, as will appear next. It should indeed be emphasized, that the field of loss prevention and safety promotion is extremely wide and calls for a variety of approaches.

Those approaches form a coherent whole and this shared-cost proposal should not be viewed in isolation: it is indeed one component of a broader overall Community approach, to the major hazards issue. Common guidelines result from:

- the options and objectives of the Framework Programme;
- the requirements of the Directive;
- the integration of research efforts within one single Research Action Programme (R.A.P.)* on Environment, major hazards/industrial risk sector.

The last is of particular significance here, allowing an optimum repartition of efforts and resources between the various types of activities, consideration taken of best competences extant, while preserving the benefit of integration. This is also why, of necessity, ample recall is made below (e.g. under C: evaluation and management of risk) of topics currently addressed at the J.R.C. and elsewhere.

* The acronyms R.A.P. (for Research Action Programme) and J.R.C. (for Joint Research Centre) will be used repeatedly in what follows.

II. JUSTIFICATIONS

II.1 Several recent catastrophic events (Cubatao, Mexico City, Bhopal) have once again illustrated the hazard potential of bulk fuels and chemicals. Such concern is not new and extensive lists of case histories retroactively to the last century could be cited, covering (in decreasing order of frequency) transportation, storage and process plant disasters.

Actually, considerable daily attention is paid by industry to operational safety and to the control and mitigation of accidental events; it should certainly not be thought, that the issue is one of malpractice. The problem rather resides in the ubiquity of the chemical/petrochemical hazard and, for historical reasons, its proximity to populated areas and transportation links, potentially magnifying accident consequences.

II.2 Clearly, the siting or transportation situation extant could not and cannot be improved upon in a very short time, whereas potential problems have grown together with the "size" of carriers, storages and plants and the enormous diversification of derived substances. Improvements are, however, steadily possible on several fronts:

- prevention, by appropriate design, maintenance, choice of alternative processes, transport regulations, etc.
- mitigation, by appropriate built-in counter-measures and contingency/ emergency planning.
- safety audit and appropriate siting and monitoring of plants and terminals.

These, in turn, demand well-founded knowledge for proper evaluations and predictions, of whatever major damage potential and, correspondingly, for eventual decisions. This is where and why appropriate safety research is needed, in an essential manner.

II.3 One cannot but emphasize the extreme complexity and manifold aspects of most phenomena dealt with here and, as a result, the embryonic state of much present knowledge. That complexity is physical and intrinsic, it is not simply due to the evident variety of accident circumstances and evolution *, of which proper account must also be taken. One reason is, that the underlying processes can often be strongly influenced by seemingly lesser factors and fraught with considerable "variability".

A fair amount of research has been devoted, sometimes for many years, to certain of those problems. More recently, increasing attention being paid to some areas proposed below under Sector A, progress has been achieved topically, (i.e. with respect to particular aspects or experimental conditions) but knowledge often remains too fragmentary for qualified overall predictions. Similarly, "learning from precedents" would be of limited help: the number of major accidents on record and adequately documented is reduced, the variety of conceivable ones endless.

* Proverbially, each accident is a unique event (albeit with patterns).

II.4 The formulation and implementation of the Directive, its embodiment in national legislations, will now result in the systematic safety assessment of a great many so-called "potentially hazardous industrial objects" (albeit of relevant magnitude). This pertains to fixed installations (process plants, storages, terminals), as well as to mobile items (rail- and road-tankers, marine carriers), but the predictive and assessment methodologies are basically the same.

Evaluations to come will thus require better founded methodologies and data bases and render desirable a common approach to risk analysis, guided by the common requirements of the Directive. Under that heading, research chiefly aims at improved physical understanding, modelling and simulation, in a determinist spirit, and the shared-cost approach is eminently suitable in view of expertise and facilities extant in the Member-States and of the cost and complexity of such research. Areas outlined under Sector A illustrate its major aspects and issues.

II.5 The evaluation of hazardous plants and carriers quite naturally leads to seeking the improvement or substitution of processes, technologies and built-in devices. Such technological research, evoked below under Sector B, is not always amenable to a Community approach, for reasons of industrial confidentiality. However, aspects of common interest, safety improvements in general can be dealt with, evidently in a shared-cost approach together with the industry.

Another benefit, less immediately apparent, may be to alleviate safety-motivated overconservatisms of plant design or built-in devices, which result from present insufficiencies of knowledge. Overconservatism is not only costly, but at times counter-productive and a concerted approach, towards a mutually-acceptable safety philosophy, would bring very tangible results in the design and operation of hazardous plants.

II.6 The quantitative evaluation of single hazardous objects is not, however, altogether separable from their context, human and geographical, nor from the appreciation of the likelihood of predicted events. This is why sizeable research efforts are also devoted to:

- human aspects in general, be it plant or carrier staff or the public-at-large;
- global siting and transportation issues;
- probabilistic approaches.

Broader issues are often addressed here, interfacing with policy or regulatory ones and a variety of topics results. Some salient ones are listed below, under Sector C, but the list is not exhaustive. One may note that some also pertain to the J.R.C. "Industrial risk" programme headings and that efforts will be integrated, within the R.A.P. Environment.

II.7 Some broad issues, however, are not reducible to the content (or spirit) of one given Sector and call for an integrated approach, possibly spanning all three. "Cross-sectoral" studies, to be launched early in the programme, on a few relevant themes, will highlight their interdependence. They should guide the research options and selection of priority topics in Sectors B and C.

II.8 A Community approach to the major hazards issue is strongly advocated for several principal reasons:

- the problems are considerable and extremely varied indeed, but shared by the entire European chemical/petrochemical sector. Often too, industrial safety issues evidence transnational aspects (e.g. with respect to the export of plants and processes or the transportation of dangerous substances) part of which of major hazards relevance and deserving of a concerted approach.
- the research needed is correspondingly varied and can often be quite intricate and expensive. Experimentation, simulations, some engineering developments require specific instrumentation, rigs, sites and proper know-how. For adequate scaling, elaborate and extensive field trials are sometimes needed (with recent trends towards joint projects or multisponsorships, for obvious cost reasons). Modelling of complex situations or systems can be computer-intensive and costly too.
- the ultimate purpose is, to dispose of better-founded tools, be it for prediction or eventually regulation. Three principal research sectors (A, B, C) are briefly illustrated below, of somewhat different character, but each one is relevant to that objective and deserving of a common approach: only thus will improved, common, mutually-agreed tools become available to control and mitigate major hazards.

Those are prime, cogent reasons for pooling resources and expertise and avoiding duplications, in a field mostly void of genuine commercial motivations, but wide-ranging. Outstanding expertise is extant in the Member States, on practically each topic hereby proposed and many others, but it is diffused over many organisations, institutions and industries and a need for sustained and improved Community-wide communication and cooperation is undeniable, which it would be a prime purpose of this programme to promote.

II.9 Finally, the major hazards research proposed meets primarily the following options and objectives of the 1984-1987 Framework Programme, now briefly recalled:

- on life- and work-quality, by insuring a better protection of the public at-large against the unwanted consequences of large-scale industrial and transportation activities and safer work conditions for those so-employed. Well over 1.5 million people work in the E.C. chemical manufacturing industry alone, exposed to the diverse magnitudes of its hazards. Millions more work or reside in the near-vicinity of conceivably hazardous installations or transports.
- on industrial competitiveness, by the development of safer processes and plants and by the implementation of founded siting or transportation criteria. Not only do repeated catastrophic events entail huge economic losses (whichever way they are borne), but on the long run they would also lead to a crippling public aversion towards those industrial activities at close quarters.

III. STRUCTURE

III.1 Within the framework of the R.A.P. Environment, the Commission intends to promote a broad and integrated Community research effort on major hazards/industrial risk. This - partly new - activity would be implemented by way of direct, shared-cost and concerted/catalytic actions, also in liaison with other Directorates-General of the Commission. It should, of course, be appreciated as a relatively long-term effort, in view of the magnitude and complexity of problems to be tackled, not many of which can be fully solved within the span of one multiannual programme, regardless of modalities.

III.2 It is recalled that, for pre-existing timing reasons, the direct action part of this research effort was already included in exploratory fashion in the 1984-1987 multiannual programme of the J.R.C. *, as a new chapter on "Industrial risk". Topics retained therein, under Accident prevention or under Accident mitigation and management, draw in good part on competences earlier acquired in nuclear safety and reliability activities and are essentially complementary to those proposed below, albeit with points of joint interest and allowance made for the evolutive nature of such research activities.

The areas thus presently under active development at the J.R.C. are Under Accident Prevention:

- Industrial systems safety and reliability, covering the harmonization of probabilistic risk assessment procedures, technical support to EUREDATA and, in relation to the Directive, the development of a major accidents reporting scheme (data bank);
- Structural safety and reliability, covering the assessment of the safety margins of (aged) containment systems, residual life estimates and the evaluation of inspection techniques;
- Management of industrial risk, covering the systematic evaluation of industrial risk regulations and the sequential computer modelling of hazardous substances management.

Under Accident Management and Control

- Dispersion and pathway of chemicals, relating to the assessment of the state-of-the-art and the implementation of certain remote-sensing techniques;
- Emergency plans, covering an information Centre on emergency practices and exchange-of-information schemes;
- Runaway reactions, relating to the assessment of the state-of-the-art and prospective activities.

Those activities are more amply documented in appropriate J.R.C. documents **. Complementarity aside, their implementation is also quite different from the one of the shared-cost programme, being essentially "intra-muros" work at the Ispra Centre.

* Official Journal of the European Communities No L 3/84 of 5/1/1984.

** Re: Programme progress report "Industrial risk" January-June 1984
Communication - Category 1.6 No 4159
Programme progress report "Industrial risk" June-December 1984
Communication - Category 1.8 No 4179

III.3 It is also recalled that the 1979-1983 shared-cost nuclear safety programme included an area on "the protection of nuclear plant against external gas cloud explosions", whereby quite significant research was carried out on the dispersion, combustion and pressure wave propagation/interaction aspects of dense gas cloud explosions, demonstrating too the appropriateness of the shared-cost approach. This "major technological hazards" proposal represents, in several respects, its follow-on, drawing indeed on acquired knowledge and advice. It also incorporates under Sector A other significant topics than those of vapour cloud explosions, yet related to major hazards of analogous magnitude and calling for research work of comparable style and closely interrelated.

III.4 Finally, mention must be made of diverse Commission activities related to the major hazards/industrial risk theme. For instance:

- the implementation and updating of the Directive (D.G. XI);
- the concerted action on man-machine interaction and human error and risk assessment (COST A 1, D.G. V);
- fires and fire safety (D.G. III);
- the ESRA (European Safety and Reliability Association) exchange of information scheme.

It is a purpose of the Framework Programme to place such connected activities in a common frame and promote the necessary liaisons, also avoiding duplications.

III.5 The shared-cost part of the programme places great emphasis on areas and topics of marked experimental, technological and advanced theoretical contents, generally leading to relatively sizeable projects and requiring specialized know-how, facilities, sites/stations, etc. The latter are, as said, available in the Member-States with a high level of qualification and one essential aim of the programme is, to take coordinated advantage thereof and thereby closely associate researchers and teams. Further to that, a limited number of relevant so-called "cross-sectoral" themes are proposed for study, which would shed light on more global issues and on interrelationships and feedbacks between aspects otherwise studied separately. Those studies, to be conducted early, will give guidance to the detailed formulation and selection of prime topics in the three sectors, especially in Sector C which addresses also policy and regulation aspects.

Three sectors are outlined next:

- A - Phenomena and mitigation, focusing on physical understanding/experimentation, simulations and modelling.
- B - Technological aspects, with emphasis on safer or alternative processes/technologies and on safety-related instrumentation.
- C - Assessment and management of risk, covering pre- and post-accident aspects.

IV. CONTENTS OF THE PROPOSED PROGRAMME

SECTOR A: PHENOMENA AND MITIGATION

IV.1 Consideration of the potential sources of major risks outlined under I.2 and of the correlative needs of the risk analysis discipline, account also taken of known expertise in the Member States and of present other Commission activities, has led to the restricted list of possible research areas outlined next. The classification is not disciplinary, nor related to a typing of industrial activities/processes, but rather phenomenological. As a result, certain research areas are of common relevance to a diversity of hazards (atmospheric dispersion for instance is central to the build-up and spreading of many a one) and certain research topics (multi-phase flow, blast-loading, venting) pertinent to several areas. (This is illustrated in the graph of Annex A).

IV.2 In practically all instances, dangerous substances are contained and the hazard stems from an accidental breach of containment. The ensuing accident scenario generally proceeds step-wise, conceptually at least and the identification of such steps facilitates a consensus on the classification of research themes. It is stressed again that emphasis is placed on physical understanding, simulations and modelling in future work envisaged here.

IV.3 The areas proposed at this stage are the following:

- A 1. Source term: phenomenology/modelling of release, its influence on early stages of dispersion;
- A 2. Dispersion: atmospheric advection, diffusion and deposition, with emphasis on dense/cold gases, mists and aerosols;
- A 3. Combustion: flammable clouds and mists covering flash fires, deflagration, transition to detonation and detonation (unconfined/partly confined situations);
- A 4. Blast formation, propagation, interaction with structures; generation of missiles; confined explosions and their venting;
- A 5. Catastrophic fires: pool fires, torches and fireballs; highly reactive substances; conflagrations;
- A 6. Runaway reactions: features of overall interest (thermodynamics, flowdynamics, venting);
- A 7. Toxic substances: dispersion in air, synergies; excluding toxicology;
- A 8. Dust explosions: phenomenology and protective measures (venting).

It is emphasized again that those areas are closely interrelated and interdependent, also calling for very analogous expertise, methods, equipment and facilities. In practice, Sector A is one coherent workscheme on its own, given high initial priority in the proposed programme. As issues and work items are quite well identified in this Sector, a more detailed outline is given in Annex A.

SECTOR B: TECHNOLOGICAL ASPECTS

IV.4 The study of the origins of accidental events, especially the source term and runaway aspects evoked under A.1, A.6, quite logically lead to seeking

- every possible improvement of the intrinsic safety of plants, processes and carriers;
- the timely detection and mitigation of potentially hazardous situations or conditions.

IV.5 Research on those aspects is, to some extent, more item- or process-specific than under A, above and calls for appropriate scrutiny of their engineering and operational features. The intent would then be to promote and support certain important topics of industrial/transportation safety research and development, by way of appropriate shared-cost projects with industry. It is well-recognized that, for industrial confidentiality reasons or because of the multiplicity of cases, not all such aspects would be tackled and that a natural selection will result.

IV.6 The broad areas, or themes, proposed for further exploration are, at this stage:

- B.1 Safety and reliability of existing technologies, towards their improvement by appropriate design, operational conditions, layout/siting, control/fault detection, built-in countermeasures/relief and mitigation devices, etc. This may concern plants/plant items, storages, carriers, albeit of very relevant size or containing highly hazardous substances.
- B.2 Alternative technologies and processes, tending to the substitution of particularly hazardous products/intermediates, processes and plant features and, more generally speaking, to the reduction of transient inventories, pressures, temperatures, etc. Again a selection will be needed, guidance being given e.g. by the analysis of certain sequences of feedstock procurement and storage, transformation, conditioning and transportation of the final product(s).
- B.3 Instrumentation: the aim would be to develop systems and detection devices, for high-risk situations/substances, and to study their possible coupling to mitigation devices.

IV.7 The character of the research to be carried out in Sector B is rather akin to the one of Sector A: both focus on well defined aspects, features, items of plant, etc. and aim at quantitative predictions. Sector B, however, is closer to the chemical engineering discipline and to actual plant design/operation.

Preliminary enquiries will be needed, as first priority:

- a) to circumscribe the (otherwise extensive) range of possible research/engineering topics to those of common interest and not obstructed by considerations of industrial confidentiality;
- b) to better identify possible industrial partnerships (e.g. by way of the "expression of interest" procedure);

and those activities, as well as "cross-sectoral" studies already mentioned are an essential part of rational programme preparation in this Sector.

SECTOR C: ASSESSMENT AND MANAGEMENT OF RISK

IV.8 Whereas Sector A was primarily dealing with basic phenomenology and quantitative risk analysis and Sector B with existing or alternative technologies, this Sector C addresses broader issues: primarily those of the impact of a huge and diversified industrial activity on man and its environment, albeit always in the context of resulting major hazards. Clearly, then, this part of the programme is closest to policy and regulation and it answers indeed some preoccupations of Member States authorities responsible for the protection of populations and settlements and the safety of sites, industrial complexes, transportation links, etc.

To accomplish such tasks, knowledge and evaluation tools derived from the R. & D. of Sectors A and B are quite often needed. However, some broader issues, some social aspects are not simply reducible to the elemental, step-by-step or case-by-case approach thereof. This is why "cross-sectoral" studies are also needed and would guide future developments.

IV.9 A great variety of topics could be listed here (and, at the limit, a very different balance of the programme would result). Subject to priorities which may derive from cross-sectoral studies to be first carried out, some relevant topics are listed next under Risk analysis and accident prevention or under Accident management, but the list is not necessarily exhaustive. Conceptually, several of them rather relate to the direct action part of the programme sketched under III.2, not excluding, however, complementary or joint undertakings. It is also noted that Sector C is probably destined to be evolutive together with the implementation of the Directive, the emergence of regulatory needs and the foreseeable amplification and diversification of major hazards research.

IV.10 Topics of relevance to the major hazards issue are thus, at this stage

Under risk analysis and accident prevention

- C.1 Hazards identification and mapping, risk aggregates, vulnerability of complex industrial/urban systems;
- C.2 Safety and reliability of complex industrial systems, cost/benefit of safety/mitigation devices;
- C.3 Human factor, man-machine interaction (also COST A 1);
- C.4 Risk perception by the public, acceptable risk level(s);
- C.5 Development of "expert systems" (coupled to data banks), towards risk assessment and accident management;
- C.6 Probabilistic approach to the analysis and simulation of major accident scenarios, with emphasis on hazardous transports.

Under accident management

- C.7 Decision-taking and countermeasures in an emergency, emergency planning;
- C.8 Behaviour of the populations in an emergency.

Cross-sectoral studies

IV.11 The previous three research sectors are of somewhat different nature and call for specific expertise each, as illustrated, and this has indeed motivated the grouping of research topics in accordance. However, not all issues of major hazards research and regulation can be thus categorized and tackled and broad issues necessitate a more integrated approach.

IV.12 "Cross-sectoral" studies have been suggested, to highlight that linkage of the research sectors. Their guiding theme may be the interdisciplinary examination of one particularly preoccupying hazard, say a substance or process, or the global examination of one major hazardous activity, say a production cycle or transportation and storage. Examples are, non-limitatively:

- the production, on-site consumption and off-site delivery of chlorine;
- the sea and land transportation of bulk hazardous substances;
- the production, transient/intermediate storage and transformation of highly toxic substances in a production cycle (e.g. of pesticides);
- synergies and domino-effect in major accidents or in aspects thereof;

IV.13 The reasoned choice of a few such integral schemes should be made early on in the programme implementation. Those studies also would

- highlight differences of approach, to the evaluation of risks and to resulting decision-making;
- give guidance, in Sectors B and C, to the identification of prime research options and to the selection of detailed research topics.

V. IMPLEMENTATION

V.1 This shared-cost programme would primarily be implemented by means of research contracts with Member States research institutions, public and private, following a call for proposals. A significant participation of industrial research teams should be sought. Emphasis will be placed too on transnational ventures, associating several teams.

Programme management, by the Commission services, would be assisted by the Management and Coordination Committee on Environment (C.G.C.), also in its appropriate specialized configuration.

V.2 Prior to this, areas and contents should in some respects be further precised, with the sustained scientific and technical support of Member States experts. Such forward preparation is deemed beneficial and necessary as:

- sizeable joint undertakings require a lengthy setting up;
- articulated projects of interest must cohere with the workload and previsions of establishments concerned.

V.3 Fruitful implementation calls for regular meetings of specialized groups of experts and contractors, reporting to the C.G.C. A diversity of complementary activities and initiatives: topical workshops, panels, courses, seconding of researchers, etc. is also a quite essential part of implementation and coordination. Relevant J.R.C. staff will be involved in those activities, within the R.A.P. framework.

ANNEX A

BRIEF OUTLINE OF THE RESEARCH AREAS OF SECTOR A

A.1 Source term

Following a breach of containment, the hazardous substance is released to the immediate vicinity. Source term designates the nature of the emission: chemical, physical, as well as its rate: instantaneous, time-varying, prolonged, as inputs to the next step.

The condition and tonnage of the original inventory may be quite varied: liquified pressurized gas; refrigerated liquified gas; pressurized gas; volatile liquid; entrained toxic material, etc. Pressure is often at play.

Prime topics (or physical situations) to be investigated are, in that same order:

- flashing liquid release from the liquid or gas phase, also by instantaneous vessel failure;
- piped flashing liquid release, pipeline breach;
- turbulent momentum jet release, air entrainment and jet dilution;
- refrigerated liquified gas and cryogens spills, evaporation on solid/liquid substrates, pool spreading/evaporation, rapid phase transitions;
- pressurized gas releases, sudden cloud formation;
- volatile liquid spill and evaporation;
- large toxic fume releases, highly toxic and persistent substances.

As a whole, the source term area is generally granted very high priority, in expert opinion. Some internal priority may be given to the first four topics, out of remaining uncertainties extant in their physical modelling and of preponderant importance of the inventories/releases thus involved in actual major accident situations.

A.2 Dispersion

This concerns the atmospheric advection and turbulent diffusion of dense, gas/mist jets and plumes (generated under IV.1). Almost all substances of interest exhibit a denser-than-air behaviour at first. Situations, and needed predictions, fall under two overlapping categories:

- flammables: concentration limits (LFL - HFL) of some %, early stages of dispersion only;
- toxics: lower concentration limit in the tens of ppm range *, high degree of passive dilution to be considered (under IV.7).

* for serious discomfort, or prolonged exposure. Instantaneous lethality limits are rather in the 10^3 ppm range. Also see uncertainties mentioned under A.7.

Research is three-pronged:

- modelling: ranging from quite simple gaussian and "box" (input-output) models through intermediate (shallow layer) to highly complex 2D/3D time-dependent ones, which solve turbulent flow and conservation coupled equations. Present emphasis is on:

validating the simpler (box, intermediate) models with now available field trials data, which pertain, however, to idealized conditions; when feasible, extending those simpler models to more realistic conditions (of heat/humidity transfer, possibly terrain/obstacles); accounting more exactly for the complicated aspects of turbulence generation, entrainment/detrainment, resulting dilution by air also in 2D/3D numerical models. The latter imply advanced numerical resolution methods.

- field- and smaller-scale trials: those either document at reduced scale a postulated spill or, under well-controlled conditions, supply a reliable data base for models validations. Scaling arguments are central (and restrictive) here, when defining the test matrix.

Releases over flat terrain/on sea have been performed and documented (Thorney Island, Maplin Sands). Attention now focuses on: continuous plumes, over non-ideal terrain; heat/humidity transfer, aerosol clouds; transition to passive entrainment; meandering and variability.

Forced dilution by water curtains, a mitigation device is also conceptually part of this heading and equally relevant to A.7 below.

- scaled-down simulations in wind or water tunnels. Considerable expertise, excellent installations are available and sophisticated techniques: stratified tunnels, laser velocimetry/tomography, digital image treatment, have been developed recently.

A variety of projects may be considered under this heading, which would include too the digital image processing of photo/video records from field trials (the technique is common). The longer term objective is, to validate the wind/water tunnel as a convenient alternative to field trials, with a view to siting studies.

A.3 Combustion

This covers the deflagrative (laminar flame mostly) and detonative (supersonic shock front) modes, fundamentally different, as well as the many mechanisms and situations conducive to flame acceleration and transition from deflagration to detonation in a gas (or mist) cloud.

The phenomenology of combustion is exceedingly complex and influenced by many side-factors. Work is primarily experimental, from laboratory-to intermediate-scale to field trials. Topics principally studied are:

- under detonation: direct initiation by sparks/charges; jet ignition by hot combustion products; shock-wave initiation and planar-to-spherical transition; detonation of mists, foams, etc.

- under deflagration: spontaneous flame acceleration in unconfined (cloud) or confined (tube, lane) situations; influence of obstacles and constrictions and/or of confinement; acceleration due to concentration gradients/fluctuations (unconfined cloud); effect of cloud shape and igniter location (edge/central); enhancement by jet ignition; effect of dust/aerosols in suspension.

Much work remains to be done in this area, which should indeed be a strong point of the proposed programme. The mechanisms conducive to blast enhancement are reasonably well-identified and scaling laws have sometimes been derived, for particular configurations. However, larger-scale verifications are often still needed. This concerns, in approximate order of priority: jet ignition; lane/duct confinement; repeated obstacles with varying degrees of confinement; strong turbulence; dust/aerosols in suspension.

Modelling is per force restricted to "idealized", generally 1D - 2D geometries. The simpler models (acoustic, self-similar, piston, etc.) essentially solve fluid dynamics, but the flame path or combustion rate need to be postulated. A few highly complex codes input a turbulent burning subroutine. Solving the entire problem, coupling the (actually interactive) flow and combustion kinetics aspects is largely beyond present capabilities, but emphasis will be placed on better submodelling of turbulence, turbulent combustion and flame folding processes.

A.4 Blast and related topics

A cloud explosion generates an air blast, of incipient amplitude and shape determined by the combustion mode: slow deflagration (gradual subsonic pressure rise and rarefaction), fast/ accelerating deflagration (a leading shock followed by gradual decompression), detonation (a steep shock of high amplitude). That pressure pulse decays and steepens during travel to become a sonic shock. Hence propagation itself markedly influences the loading and response * of exposed structures.

There are several approaches to the problem:

- correlations, by means of empirical scaling laws and T.N.T. equivalences, unsatisfactory with extended cloud explosions.
- modelling: simple acoustic, linear approximation; isentropic approximation (which reduces the problem to one non-linear potential equation); numerical solution of the full Euler equations, generally limitative to 1D/2D for computer-related reasons. For all, the incipient pulse must be input and is crucially dependent on A.3, above.
- experimentation: subjecting scale-models to blast (shock tube, point charges, exploding balloons); simulation by the "water table" technique (an hydraulic blast-analogue); larger-scale blast loading of typical structural elements. By extension: damage analysis from accidents/war records, at the basis of diverse correlations.

Emphasis will be placed on the last two approaches. Requirements as regards modelling are: better prescription of the incipient pressure pulse (derived from A.3, above); improved description and numerical treatment (isentropy, adaptive grids, F.C.T., etc.). Experimentation

* It is noted that response of structures is part of present J.R.C. activities.

will include realistic deflagrative waves and non-infinitely-rigid structures.

Two very relevant topics are associated with this research area:

a) the study of large exploding vessels, covering: direct blast generation; primary and secondary missiles, their travel/distribution/ impact; ductile rupture of fire-engulfed vessels and BLEVE (boiling liquid expanding vapour explosion) accidents; the latter relates to A.5.

b) the study of internal gas/vapour explosions, in large enclosures. That research has common points with A.3 (on flame acceleration in confined situations, or jetting) and A.8 (on venting, which is central to the problem of mitigating internal explosions).

A.5 Catastrophic fires

By definition, of very swift evolution and totally uncontrollable: pipeline torch, gas cloud flash-fire, conflagration in a very reactive inventory, fire-engulfed tank BLEVE followed by fireball formation. Apart from inescapable engulfment, the danger here is radiant heat at a distance, to be evaluated. Work is chiefly experimental, covering:

- pool (bund) and channel fires, also over water; their evolution;
- vapour cloud burning, over land and water;
- turbulent torch flames;
- fireball formation, lift-off and decay following a BLEVE.

Those correspond to classic accident situations. Substances of prime interest are LNG, LPG, ethylene, propylene, etc. However, not all topics need to be covered in-depth, as fairly extensive information is already available on large LNG/LPG fires in relevant configurations. Less so perhaps for other substances, or for large torches/BLEVE/fireballing.

This area should also include relevant work on:

- mitigation by water/steam curtains, which force-dilute the cloud; the behaviour of fire-engulfed vessels and structural elements;
- the evolution of generated noxious fumes;
- the hazards of reactive inventories (some nitrates, liquid O₂);
- possibly, radiant damage-at-a-distance criteria;

A.6 Runaways

Any exothermic reaction can diverge, from loss of temperature control or chain-branching. The consequence is reactor vessel failure and spill of its contents, unless adequate and safe venting relief is provided for. Considerable attention is paid to runaway potential, by industry.

Research follows several lines:

- identification of runaway candidates, their kinetics.
- stability analyses, relating to (T, P) evolution in the reactor vessel;
- phenomenology and prediction of relief venting, also coupled to reaction dynamics;
- incipient dispersion following vessel failure or disk/stack venting;
- alternative, less sensitive process routes; reduction of reacting inventories.

Common base research excludes largely product- or process- specific investigations, out of sheer number or confidentiality. It would focus on the more general features of divergence, venting and incipient dispersion.

Venting is often from a hot pressurized liquid phase and there is a clear connection with the two-phase flow investigations of A.1, above. However, even more complicated cases must be addressed: bubbly flow, foams, viscous substances, transient reacting flows, etc. The same applies to venting from the gas phase, with consideration of liquid drops/slugs entrainment. Those would be essential topics for investigation.

The important topic of alternative, safer technologies/processes is retained under B.2, above. Other aspects mentioned may call for complementary exchange-of information schemes (e.g. topical meetings, panels, etc.). It is noted that documentation activities have been initiated at the J.R.C. and that complementarity will be particularly sought, in this area, between direct and shared-cost actions.

A.7 Toxic substances

Prime candidates are evidently chlorine and ammonia, manufactured and transported in yearly megatonnage quantities in the E.C., but also intermediates and feedstocks: phosgene, acrylonitrile, SO_2/SH_2 and many others, of lesser tonnage.

Research on toxics follows two broad and distinct lines:

- dispersion: substances of interest are generally denser-than-air or, like ammonia mists, behave as such. Correlatively: mitigation by evaporation - arresting foams, or dilution - promoting water/steam curtains.
- toxicology: animal testing for LC50/LD50 and analogous limit-values; some war records on chlorine and phosgene; probit approach.

Research on the second point is not proposed under this programme outline, as it would call for an altogether different specialization from the remainder of Sector A. One may note that considerable uncertainties are extant and that reevaluations of existing data are underway, by specialized bodies, which will be closely followed.

The first point clearly relates to A.1 and A.2, above. However, much less is known than for flammables because:

- a) toxics are dangerous at appreciably greater dilution (and downwind distance), and this is most difficult to study in the field;
- b) Cl_2 and NH_3 can display dense or passive/buoyant behaviour, depending on dilution and other factors (e.g. droplets entrainment for NH_3 , or spill temperature), so that an accurate knowledge of source term conditions is needed to properly predict the cloud behaviour.

Experimental evidence is rather limited. For Cl_2 , open data are either from ancient war records, or from limited-scale mitigation tests with suppressing foams and water curtains. For NH_3 , flashing jets and spills on land/water have been studied at moderate scale and, more recently, large on-land releases performed in the U.S.A. (Lawrence Livermore, also with N_2O_4), but detailed data are not available at this stage.

Outstanding issues of bulk toxics dispersion are then:

the transition from dense to passive behaviour;
isopleths predictions at low concentration values;
"variability" and the influence of meandering and concentration fluctuations on cloud edge exposure and dosage estimates.

Also, on more practical aspects:

forced dilution by water curtains, sprays, etc. (also relating to A.2);
mitigation by foams and powders;
alarm sensors and real-time prediction systems (also Area B.3, above).

It is noted that the field study of transient low concentrations would first require the development of adequate sensors/tracers. Some parallel developments would also be required for windtunnel simulations of dispersion at those low concentrations.

Modelling should be extended to those same aspects, as present dense gas modelling rather concentrates on the near-field, or relies on simple gaussian assumptions in the far-field. Advanced treatments extant in air pollution modelling may give guidance.

Acutely toxic and persistent chemicals are a somewhat separate issue, albeit of considerable relevance to the implementation of the Directive on major hazards. Research here relates to source term (A.1) and near-field dispersion, as well as runaways (A.6) and prime interest is probably in aerosols migration and settling. It is noted that relevant information will issue from the nuclear "source term" research, of which aerosols/vapours migration, escape and deposition is a major topic (also at the J.R.C.). More "practical" aspects may also be treated under Accident management, Sector C above (e.g. post-accident measures, area decontamination, etc.).

A.8 Dust explosions

Dust explosions are a common occurrence and almost any organic/metallic dispersed powder, in suspension, can sustain a deflagrative process. Flame acceleration and transition to devastating detonation are ascertained in confined situations (coal mine galleries, grain elevator shafts, etc.). Dust explosions, however, are always internal and confined, prime candidates being grain silos/elevators, flour/animal feed/sugar mills, etc. Major hazard potential is perhaps opinionable, but fatalities/casualties and economic losses can be quite elevated and dust hazards are truly ubiquitous, not only in manufacturing industries and mining, but in many agriculture- or forestry- related transformation activities or transportation.

Most research so far fell under two categories:

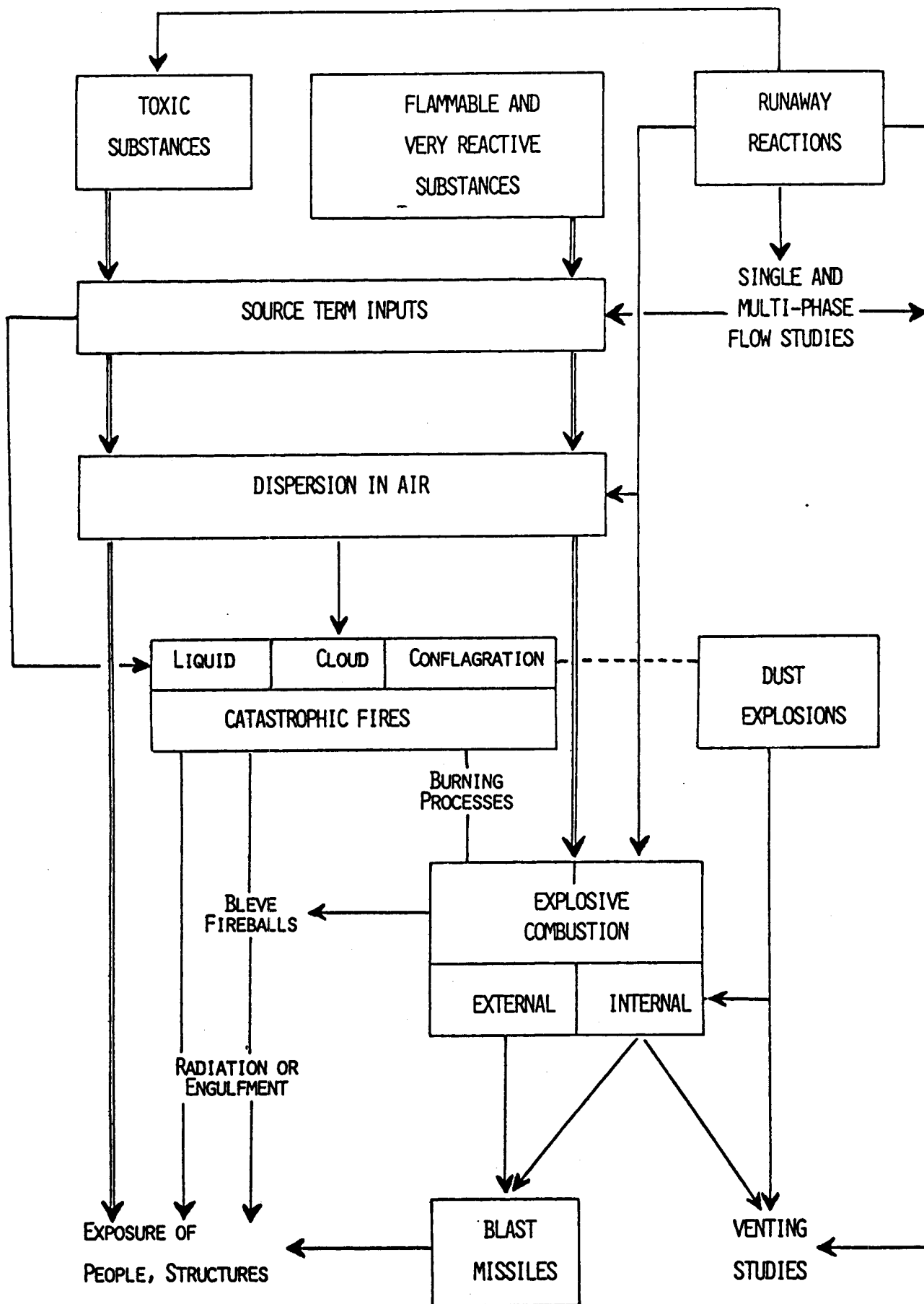
- laboratory testing of candidate dusts with standardized apparatus, to ascertain equally standardized properties (explosible concentration, ignition energy/temperature, maximum pressure/rate of pressure rise).
- venting, by appropriate flaps/bursting panels, and the validation of empirical scaling laws, nomographs, etc.

It is not proposed to cover the first topic: routine testing, competently done by specialized laboratories. Similarly, properties or accident data banks should, if need be, be addressed by the J.R.C. under "Industrial risk".

The second topic has given rise to interesting intermediate- and large-scale testing (all the way to small silo size) which, however, needs to be part-complemented and should be supported by appropriate shared-cost projects.

What is little known is the physics of dust explosions: combustion process and its propagation; influence of turbulence/radiative pre-heating/volumetric combustion; detonative processes. It is suspected that somewhat the same processes are extant as for flammable gases (A.3); available evidence is much cruder. The reason is too, that explosible dust suspensions are opaque and prevent optical recording. Instrumentation needs to be developed or simply taken over from the gas explosions work, for progress to be made (fast ionic probes, doppler sounding, infra-red sensors, etc.)

Much work remains ahead to attain a satisfactory understanding and here then lies a field almost entirely open for investigation, guidance being given in many respects by recent advances in the gas explosions research outlined under A.3.



ANNEX B

OPINION

EXPRESSED BY THE CGC ENVIRONMENT AND CLIMATOLOGY ON
THE SHARED-COST RESEARCH PROGRAMME PROPOSAL ON
MAJOR TECHNOLOGICAL HAZARDS

1. The CGC has discussed the draft proposal of the Commission, towards a shared-cost multiannual programme in the field of major technological hazards (as defined in the E.C. Council Directive on major hazards *) (Doc. XII/CGC/85/2/4 Rev. 2). The CGC also took note of supporting documents supplied by the Commission.

2. The CGC concludes that within the framework of the Research Action Programme (RAP), Environment, this proposal on major technological hazards complements and augments the current activities of the Joint Research Centre **) on "Industrial risk" which address particular aspects of technological hazards, including:

- industrial systems safety and reliability, structural safety and reliability, management of industrial risk;
- dispersion and pathway of chemicals released accidentally; emergency plans, protection against runaway reactions.

Motivations and aims

3. The CGC endorses the motivations and aims of the proposed shared-cost research programme, as outlined in the draft proposal XII/CGC/85/2/4 Rev. 2 and supporting documentation.

The CGC recognizes the importance of reducing the risks of occurrence and consequences of catastrophic events (such as those in Cubatao, Mexico, Bhopal), and that this requires high-quality research support, in particular to the many risk analysis activities which the updating and implementation of the Council Directive *) will entail.

4. The CGC considers that Community level research in this field is needed, in order to develop and harmonize consistent methodologies and standards, make use of existing expertise and facilities and promote joint undertakings. It could also benefit from methodologies developed elsewhere.

5. The CGC considers that the proposed programme should result in:

- more realistic estimates of risks;
- identification of weak points, uncertainties and gaps in knowledge;
- development of technologies appropriate to reduce risks;
- improved information for siting;

thus significantly enhancing the safety of industrial plants and processes and of transportation and storage of dangerous substances.

*) O.J. of the E.C. No. L 230/I/1982

**) E.C. Council Decision of 20-12-1983

6. The CGC is of the opinion, that the proposed shared-cost research programme meets several of the Community objectives outlined in the 1984-87 Framework Programme, in particular,

- the improvement of safety and the protection of health;
- the protection of the environment and the prevention of hazards;
- the improvement of industrial competitiveness.

Scientific and technical content

7. The CGC is in broad agreement with the major issues and research areas contained in the programme proposal,

- under sector A: physical and chemical phenomena and mitigation of consequences of accidents
- under sector B: safety and reliability of existing and alternative technologies and instrumentation
- under sector C: assessment and management of risk

The CGC considers that these fulfil some basic needs of major technological hazards research, including the main scientific, technical and social issues.

The CGC also considers that it is essential to develop an integrated approach to risk assessment and proposes to achieve this by means of cross-sectoral studies of example activities. Such studies would highlight different approaches to the evaluation of risks and to decision-making based on these evaluations. The CGC considers that initially priority should be given to sector A in view of the available information on uncertainties in this sector, and that later consideration of activities in sector B and C should follow, in particular based upon cross-sectoral studies.

Implementation

8. The CGC considers the proposed programme to be well-suited to coordinated implementation, by way of shared-cost contracts with Member States research establishments and industries and through the execution of joint projects allowing use of unique facilities.

The CGC endorses the proposed implementation and further notes that:

- a close collaboration of the interested scientific and industrial parties in the Member States is intended,
- relevant complementary initiatives and "catalytic activities", promoting exchange of information, training, dissemination of results, are also proposed.

Funding and staff

9. In order to achieve these aims, the CGC recognizes the need for the provision of adequate funding and staff.

The Greek and Italian delegations fully endorse the text of this Opinion, but wish to emphasize that the financing of the proposed Programme should not result in a diminution of resources for research on other types of environmental problems.
