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Commission of the European Communities

Evaluation of the European Community's radiation protection research programme (1976 - 80)

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Evaluation of the European Community's radiation protection research programme (1976 - 80)

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PREFACE

In accordance with the terms of the Euratom Treaty the Commission has been charged with the "Study of the harmful effects of radiation on living organisms".

Research on radiation protection has consequently been initiated by the Commission to provide the scientific knowledge required to make an objective evaluation of the effects and hazards of ionising radiation. On this basis, preventive and protective measures can be established for man and his environment. Promotion of research in this field at Community level is particularly appropriate to accelerate scientific progress, to avoid duplication of efforts and to stimulate exchange of information. It contributes to the scientific background for the "Basic Safety Standards for the Health Protection of the General Public and Workers against the Dangers of Ionizing Radiation".

The Community's Radiation Protection Programme spans over more than two decades, and its scope and objectives have been adapted to suit the evolving needs and priorities in radiation protection.

In view of a possible extension of the Radiation Protection Programme for the period 1985–1989 the Commission decided to proceed to its evaluation by means of a panel of external experts. This exercise is part of present efforts devoted to setting up a system of research evaluation to be progressively applied to all Community R&D programmes.

The evaluation panel focused principally on the 1976–1980 programme without, however, neglecting the current programme (1980–1984). This report represents the outcome of their deliberations and is published as submitted to the Commission.

The appraisal is very positive with regard to the structure and definition of the programme, along with its achievements and its management, which, in view of the authority and independence of its authors, is motive for major encouragement.

At the same time it does not lack constructive criticism where the panel felt it appropriate. A number of suggestions of possible improvements have been made, which are largely taken into account in the preparation of the programme extension.

I wish to express my gratitude to all panel members for carrying out their assignment with such commendable dedication.

Paolo Fasella
Director-General
for Science, Research and Development

TO THE READER

The Panel members would like to draw attention to the fact that in the arrangement of the evaluation material, each of the chapters is intended to be essentially complete in itself. Thus, there is some repetition of content between the Conclusions, the Recommendations and the main body of the document, as well as, of course, with the Executive Summary. The Panel requests the indulgence of the reader in this matter.

CONTENTS

I. INTRODUCTION

In the late summer of 1982 the Commission of the European Communities (CEC) appointed a Panel of seven independent outside experts to examine in depth the scientific work of the Radiation Protection Programme for the period 1976-1980, as well as to review the main features of the current programme (1980-1984).

They were invited to consider the following aspects:

- scientific and technical achievements of the Programme (quality and practical relevance of the results, possible spin-offs)
- evaluation of the social and economic impact of the Radiation Protection Programme
- assessment of the contribution of the Programme to Community objectives
- evaluation of the effectiveness of the management of the Programme and the utilisation of resources
- elaboration of recommendations and suggestions for future orientation of the Programme, the exploitation of results, the harmonisation and coordination of work, improvements in management, etc.

II. METHOD OF PROCEDURE

The Panel met six times (two day meetings) between October 1982 and March 1983, examined in detail some 30 or more documents and many reprints of published work; interviewed many persons such as senior investigators on the contracts, chairmen of groups such as the Advisory Committee on Programme Management (ACPM) and the European Late Effects Project Group (EULEP), the Head of the Biology Group at Ispra, programme managers, supervisors and others on the CEC staff; collected information via a questionnaire for all contracts, analyzed the results and developed an approach to determining the socio-economic impact of the programme.

The main scientific portion of the evaluation was performed sector by sector for the six sectors of the Radiation Protection Programme, namely

A). Radiation Dosimetry and its Interpretation;

B). Behaviour and Control of Radionuclides in the Environment;

C). Short-term Somatic Effects of Ionizing Radiation;

D). Late Somatic Effects of Ionizing Radiation;

E). Genetic Effects of Ionizing Radiation;

F). Evaluation of Radiation Risks.

Two Panel members accepted responsibility for each sector and after a preliminary survey a flexible approach was adopted which allowed considerable latitude for these Panel members to use their own judgement concerning criteria and ranking of contracts, but only after extensive general discussion had established principles. Among the criteria used by members of the Panel were the scientific merit of the objectives of each contract, the methodology and techniques used, the originality of approach and methods, the progress made, the results (in the form of publications etc.), the degree of achievement of stated objectives, the contribution to international cooperation at the Community level, the relevance of the contract to the Radiation Protection Programme and to its main objective, viz. protection of man and his environment, and finally, the overall value of the project to science in general and to the public as well. Cost was not evaluated in detail because of the difficulty of assessing the cost effectiveness of the partial support provided by CEC, and the sometimes apparent lack of correlation between the size of the contract, the quality of reporting and the actual scientific value of the results. In a gross way however, more was expected by the evaluators from a large well funded contract than from a smaller contract.

After the first quantitative evaluation of individual sectors by the two Panel members, discussions in the Panel resulted in more uniform approaches to the sector evaluations, although sectors were not all treated exactly alike because their nature and character differs.

Similar principles were used in the evaluation of management but the approach was more general and stressed features that were either common to or noticeably different in the sectors, as indications of the results of management policy. In addition, the Biology Group at ISPRA and the programme on Coordination and Transfer of Information were evaluated separately and the Programme Proposals for 1980-1984 and 1985-1989 were considered in some detail.

The overall evaluation is a synthesis of the sector evaluations, the management evaluation, the questionnaire results, socio-economic considerations, comments on the Programme Proposals for later 5 year periods, and the Panel discussions themselves. The essence of this overall evaluation is to be found in the conclusions and the recommendations.

The Panel delivered this report in April 1983 after extensive discussions. The report reflects the consensus of those discussions.

III. CONCLUSIONS

The main conclusions of the report are contained in Chapter 9 and are summarized here.

1. Scientific Aspects

The Panel notes that the Radiation Protection Programme is mature, in the main, well-balanced, productive and reasonably comprehensive and that most of the major laboratories in Community countries active in radiation research are involved in it.

Its division into six sectors is appropriate and effective although other arrangements of the programme content might be considered.

The programme from 1976 to 1980 was productive, yielding 600 publications per year, about 50% of them in the open refereed literature. Some sectors, e.g. the sector on evaluation of radiation risks, had very few refereed literature publications, < 10%, others, such as dosimetry, had a low percentage, 25%, presumably due to the number of proceedings available for the publication of papers; yet others such as late effects had high percentages, ~ 60%.

The programme appears to continue to broaden in scope through successive Programme Proposals, such as those for 1980-1984 and 1985-1989 and appears to be increasingly responsive to public needs in the Community, except in the matter of providing information directly to the public.

In some sectors the programme was less cohesive than in others. These were notably areas where collaborative groups did not exist and fewer meetings of the kinds sponsored by CEC occurred.

The contracts in each sector were generally meritorious, very few were considered unsatisfactory, some were satisfactory but

not outstanding, many were good to very good and some few were outstanding. The methods and techniques used were up to date, and the investigators clearly at the fore-front of their fields. The programme as a whole was characterized by competent, thorough, sound work rather than highly innovative approaches or risk taking with new ideas that might fail.

The 1976-1980 programme contained some experiments aimed at low doses but few at very low doses where the present focus of much radiation protection work lies.

In spite of the breadth of the programme there were some surprising gaps in important programme areas. Some of these have been included in later programmes (1980-1984, and especially 1985-1989) but in cell transformation work and in studies at very low doses further emphasis is considered appropriate.

The achievements of the programme in the 1976-1980 period have demonstrated the power of CEC in successfully developing specific subject areas such as microdosimetry. This power could be used more widely to foster less developed areas of the programme.

The Biology Group at ISPRA is doing good work but appears to be anomalous in being the only intramural research unit in the programme.

2. Management Aspects

The procedures for establishing the scope and budgetary content for each five year programme appear to be well worked out.

The implementation phases of the programme decisions relating, for example, to consideration of contract proposals, also appear to work well between CEC staff and ACPM.

One of the main aims of the programme is to develop European collaboration and this has been highly successful in some areas of the programme notably where cooperative groups and many meetings occur. It is less successful in areas receiving less of this attention or perhaps of a character which is less suitable for cooperation.

The monitoring of progress is in general satisfactory but the Panel has two suggestions to make. First, more complete and uniform final

reports are needed, and second, for long term contracts additional review by peer groups might be helpful.

The Panel believes much of the success of the programme is due to the continuity and stability that the five year blocks of support can provide. This stability has limitations in terms of flexibility which have already been recognized by CEC. The Panel has two suggestions here. First the establishment of a portion of the funds for a "new idea fund" to provide for greater risk taking and more venturesome research. Second, a very specific evaluation of programme content and strategy by ACPM as noted in recommendation 2, later.

Finally, the Panel has another important suggestion, that the programme administration establish working relationships with other large programmes (in USA, in Japan, etc.) and thus perhaps extend the community wide success of the CEC intercontinentally.

The ACPM functions extremely well. It is the most important advisory element in programme management and it is important that it has evolved into a scientific peer group. The recommendations suggest an even more important role for ACPM in programme strategy.

3. Socio-Economic Aspects

Overall, the Panel finds the socio-economic impact of the programme very high. It has made and is making extensive contributions to European co-operation, to the field of radiation protection as a portion of world science, to education and training within the Community, to the protection of about 300,000 radiation workers in the Community and to the radiation protection of the 260 million persons in the Community. In addition, the Community programme has contributed to the provision of an important power option, it has served as a pilot for the control of other hazardous agents, and has had important research spin offs in commerce and industry and especially in the medical field, in the application of neutron therapy and the therapy of blood diseases by bone marrow transplantation, and it has also made contributions to the prevention of duplication of research efforts by its various meetings and publications.

The Panel notes that the CEC has not attempted to communicate the base of knowledge and the value of the Radiation Protection Programme to

the general public in the Community. This difficult but most important problem should be addressed in future programmes.

The specific recommendations made by the Panel are outlined in Chapter 10. It is virtually impossible to summarize these further so they are reproduced here in their entirety.

IV. RECOMMENDATIONS

Through a continued effort that has now lasted for more than 20 years the CEC has been able to develop a programme of research in radiation protection of wide scope and great scientific significance. Therefore the Panel recommends that:

1. First and foremost, the overall programme be continued essentially as it is with only relatively minor modifications. Future research strategies of the CEC should contain this important integrated programme as one of its essential components. The Panel believes that the Programme is being so successful in its primary objectives that nothing should be done that might hamper this success, at the same time everything should be done to capitalize on what has been achieved to enhance the programme further. Any policy decision by the CEC which might be likely to affect this programme should be carefully considered for its possible adverse as well as beneficial effects. Proposed changes should be carefully implemented in order to minimize negative effects on programme performance.

As to scientific and managerial aspects the Panel would like to make the following additional recommendations:

2. Greater attention should be given to the scope of the sector work and of the overall programme, especially with regard to important gaps in content. A very specific evaluation of programme content, sector by sector, against the template of an ideal programme, as well as the arrangement of the sectors, should be undertaken by ACPM and suitable additional experts at the time of the Programme Proposal development.

3. Continued emphasis should be devoted to important areas such as risk evaluation. Greater emphasis should be placed on undertreated programme areas such as embryo and fetus sensitivity, transformation studies in cultured cells, natural and enhanced radioactivity, and

possibly in some dosimetry areas and perhaps in the development of more sensitive techniques for detecting genetic effects.

4. Programme wide, investigators should be encouraged to design and conduct more experiments at lower doses in order to cover ranges where the main needs for radiation protection work exist.

5. A portion of the total budget (not large) should be assigned to a "new idea fund" to initiate a programme in which only projects that are truly new and potentially innovative and have not been supported before will be chosen. These may involve somewhat higher risk of success or failure.

6. As many other means as possible should be examined and introduced to keep the stable five year programme flexible so that new approaches can be explored.

7. The Panel recommends further increase in coordination in less cohesive programme areas such as in the sector on Short-term Somatic Effects and the sector on Behaviour and Control of Radionuclides in the Environment, possibly by establishing groups of the EULEP type or increasing the number of meetings on these topics.

8. A further peer review should be added to the existing procedures especially for larger long-term contracts. It is suggested that groups of experts, be appointed to visit and prepare a written report on the status of the contract with the aim of assisting in planning future programmes.

9. More complete five year reports should be requested which lay out clearly the original objectives of the work and exactly what has been achieved. These reports should be supplemented subsequently with a full set of reprints derived from the contract in that period.

10. The Panel recommends that CEC use every means at hand to encourage publication, in the open refereed literature, of the results of CEC supported work, while at the same time recognizing the value of rapid publication provided by some CEC publications. The CEC should be appropriately acknowledged in all publications deriving from the programme.

11. The Panel recommends the institution of exchange and training programmes at the pre-and post-doctoral level in order to further develop scientific subjects related to radiation protection.

12. An ad hoc panel should be constituted soon to consider the future of the Biology Group at Ispra and its role in the CEC programme.

13. The Panel recommends that mechanisms be developed to (a) exchange information on programme scope and content with other large similar programmes such as those in the USA and Japan (b) explore methods for mutual participation in programme areas of joint interest.

14. The Panel recommends that the CEC consider the initiation of a substantial public information programme to convey to the public the important knowledge that already exists in the area of radiation protection and the efforts the programme is making to address unsolved problems.

BACKGROUND

Chapter 1

Introduction

The Radiation Protection Programme of the Commission of the European Communities (CEC) is based on the Treaty which established the European Atomic Energy Community (see later, Chapter 3). Its purposes are to promote the study of the harmful effects of radiations on living organisms and the development of adequate prevention and protection measures and corresponding safety standards, radiation detection, radiation measurement and therapy, to evaluate and to counteract the effects of radiation. The programme, in other words, aims to study the impact of ionizing radiations on man and his environment. It also aims to establish and improve all measures necessary for prediction, prevention and protection from radiation injury as well as therapy for such injuries.

Four consecutive programmes have been executed by the Commission in the Community since 1959, the date at which the first Radiation Protection Programme was implemented. The continuity of this action has been considered necessary by CEC in view of the steady expansion in the exploitation of nuclear energy, in the handling of nuclear fuels throughout their cycle including power plants, effluents and waste, and the increased use of ionizing radiations and radioisotopes in medicine and by industry. The CEC believes these events call for a continuing development of prevention and control measures in order to achieve high standards of safety in the nuclear industry as well as in all the other manifold uses of radiation.

The stated aim of the Commission is to contribute to the protection of man and his environment and to the application of basic standards for protection against ionizing radiation through the increase and accumulation of scientific knowledge pertaining to this subject. This not only results in continuous adaptation in standards of safety but also provides the opportunity for developing new methods for diagnosis and therapy, and for contributing in a fundamental way to our knowledge of genetics and cancer induction. The Commission, by virtue of its multiple relations with all the important European scientific

institutions engaged in the study of radiation effects, hopes to recognize and define research needs as they arise and to develop programmes to deal with them. The Commission aims at organizing research in such a manner that duplication of efforts and important research gaps are avoided within the Community. It also hopes to engender in the Radiation Protection Programme a climate of cooperation where scientists become members of a large European society, where information is regularly circulated and discussed and where problems are studied in common.

The Radiation Protection Programme of the Commission also aims at providing a consistent base of support for experiments of long duration, such as those on the late effects of radiation, epidemiology, radioecology, and to promote research at the molecular level, on the understanding and tools which ultimately will enable man to predict and prevent the onset of radiation-induced lesions. Such efforts are believed by CEC to be vulnerable to financial pressures and might decline in Europe if not supported by the Commission. Finally, based on the results of such programmes, the Commission of the European Communities hopes to speak clearly on controversial issues related to radiation protection and to preserve an objective position.

In concert with the Commission's planned evaluation of all of its on going research programmes, the Commission of the European Communities decided during 1982 to undertake a post-performance evaluation of its Radiation Protection Programme for the five year period 1976-1980 as well as a shorter review of the current 1980-1984 programme. For this purpose a Panel of independent experts was set up. Its members were selected on the basis of their personal experience and expertise and this report reflects their own views and not those of any of the organizations with which they are affiliated.

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One member of the Evaluation Panel was formerly a contractor and a member of the Commission's Advisory Committee on Programme Management (ACPM), another is a recent appointee to the ACPM, but none of the other members have any connection with the Commission's programmes. The members are drawn from Belgium, France, Germany, Norway, The United Kingdom, the United Nations Secretariat and the United States.

The terms of reference were contained in the initial letter of appointment to the members from the Director General Dr Fasella and in more detail in the technical annex to the contract as follows

"Technical Annex"

"Evaluation of the European Community's Radiation Protection Programme"

"The research carried out by the Commission of the European Communities in the field of radiation protection is structured into successive pluriannual programmes. The five-year programme 1976-1980 has been completed and is now continued by the 1980-1984 five-year programme. The contract concerns the postperformance evaluation of the Community's 1976-1980 Radiation Protection Programme, as well as a review of the current programme (1980-1984).

This task forms part of the efforts undertaken by the Commission over the past few years to objectively inform the appropriate political authorities as well as the scientific community of the value and the impact of the Community's research and development programmes so that the resources are optimally utilised and oriented towards activities which are likely to most benefit European society.

The evaluation will be performed by a panel of independent external experts. The experts are invited to cover the following aspects:

- the scientific and technical achievements of the programmes (quality and practical relevance of the results, possible spin-offs),

- evaluation of the social and economic impact of the Radiation Protection Programme,

- assessment of the contribution of the programme to Community objectives,

- evaluation of the effectiveness of the programme management and of the utilisation of resources,

- elaboration of recommendations and suggestions for future orientation of the programme, the exploitation of results, the harmonisation and coordination of work, improvements in management, etc.

The results of the work of the panel of experts, their conclusions and recommendations, will be presented in a final report which will be published."

Acknowledgements

The Panel wishes to acknowledge the assistance of Mr Matthieu and Dr Boggio of the Evaluation group of CEC, Mr Van Hoeck, Dr Ebert and their staff, Dr De Nettancourt, Dr Gerber, Dr Myttenaere, Dr Schibilla, and Dr Sinnaeve who have been a constant and unobtrusive source of information and assistance. Prof. Dr Gössner, Chairman of the ACPM, Prof. Dr Duplan, Chairman of EULEP, and other interviewees, Prof. Dr Sobels, Prof. Dr Bridges, Dr Devreux, Mr Uzzan, Mr Hurst for Mr DeSadeleer, and Mr Gabolde, were informative, patient and most helpful. The Panel also wishes to acknowledge the valuable help of the ACPM in obtaining views from the national delegations on the socio-economic impact radiation protection research at the national level.

Without the generous donation of time, effort and cooperation from all these persons, production of this report in a timely fashion would not have been possible.

Chapter 2

Description of the Programme

Introduction

The Radiation Protection Programme of the European Communities has been in existence since 1959 and has evolved up to 1980 through four multiannual research programmes, the last of which, 1976-1980 is the period under evaluation. The programme continues in the current period 1980-1984 and is expected to continue thereafter. The programme embraces all the Commission (CEC) supported work in the life sciences related to the effects of radiation and protection from it and is therefore wide ranging in scientific scope.

The programme for the period 1976-1980 consisted of 142 contracts (or 311 different projects) spread throughout the Commission countries for a total expenditure of 39 mio ECU (1 ECU ≈ 1 $ U.S.). The support given by CEC to each contract is partial (in 1976 it was 39% of the total cost of the contracts and for the entire period 1976-80 it was 37%) It thus averages about 50,000 ECU/year per contract, even though extremely variable in amount per contract. During 1976-80, 61% of the projects were new and 39% were continued from 1971-75. In 1980-84, 24% of the long term projects begun in 1971-75 continued.

The Commission programme involves about 700 scientists, contributing about 300 scientific man-years of effort per year and 600-800 technical and supporting man-years of effort per year. These workers produced about 600 publications per year from Commission supported work during 1976-80, i.e. an average of 2 publications per scientific man-year per year at a cost of about 12,000 ECU per publication for the CEC contribution. In its call for tenders and elsewhere the Commission states its intention to foster especially programmes of a cooperative nature such as intercomparison studies in dosimetry (ENDIP), the standardization of procedures undertaken by EULEP (pathology atlas etc.) and programmes concerned with intercommunication. It has supported an average of some 25 meetings a year including study groups, conferences and symposia. In total these are attended by a thousand or more scientists from both Member and Non-member States and the proceedings of conferences and symposia are usually published.

The programme is aimed at addressing the concerns of many people in the European countries about the long term effects of ionizing radiation, especially perhaps, those arising from man-made sources such as in industry and medicine. It aims especially to study the effects of ionizing radiation at low doses and to seek the mitigation of these effects by appropriate means. It is recognized that the control over radiation sources and protection practices are likely to result in exposures both occupationally and to the public which are quite low. However, even at these low doses the risks of stochastic effects such as carcinogenic and hereditary effects, although low, still exist. Some degree of controversy also exists over the magnitude of the risks at a given dose although there is comparatively good agreement between the results of widely different assessments such as those made by UNSCEAR 1977 (1) and BEIR 1980 (2). Thus, it is necessary to focus the research in radiation protection on low dose effects, including not only those studies relating to mechanisms at the molecular, cellular and animal level, but also epidemiological studies in human populations from which a direct estimate of the risk may be possible.

The Commission recognizes that its programme must be responsive to the needs of the public in the Community and for that reason it must remain closely linked to the European Commission legislative activity. At the same time the Commission's scientific progress must not only flow dynamically with the changing emphases resulting from new scientific knowledge but also maintain steady support for those longer term programmes that can only be fruitful if continued over long periods. The Commission's scientific programme cannot hope to be fully comprehensive in all phases of research but rather can hope to foster especially those areas in which research seems to be lacking in national programmes, or to develop and foster those activities which could especially benefit from international cooperation.

The programme structure has evolved during twenty years through a variety of forms and in this period is subdivided into six sectors,

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(1) United Nations Scientific Committée on the Effects of Atomic Radiation. Levels and Effects of Ionizing Radiation, United Nations, New York 1977.

(2) Committee on the Biological effects of Ionizing Radiation. National Academy of Sciences, Washington, D.C. 1980.

A). Radiation Dosimetry and Its Interpretation,

B). Behaviour and Control of Radionuclides in the Environment,

C). Short-term Somatic Effects of Ionizing Radiation,

D). Late Somatic Effects of Ionizing Radiation,

E). Genetic Effects of Ionizing Radiation,

F). Evaluation of Radiation Risks.

The relative expenditures of CEC funds upon these sectors in 1976-80 were A, 10%; B, 16%; C, 13%; D, 18%; E, 34%; and F, 9%.

This description includes also a section on the Biology Group at Ispra and a section on Coordination and Transfer of Information.

Detailed descriptions of these sections follows.

SECTOR A

RADIATION DOSIMETRY AND ITS INTERPRETATION

The work in this sector is directed towards the determination of absorbed dose, radiation quality, and various other parameters which describe irradiation circumstances. It includes especially the interpretation of radiation effects and risks in terms of these parameters. Dosimetry underlies the work of all other sectors and indeed because the assignment of work to sectors is somewhat arbitrary, projects on internal dosimetry, on medical dosimetry and on dose effect relations are also found in other sectors of the programme.

The contractual work is executed in a total of 28 contracts and covers a comprehensive range of dosimetry items, including:

1. Realization and measurement of specific radiation protection quantities. These include field quantities such as the index quantities, the measurement of external beta, gamma, and neutron radiation for radiation protection purposes, and measurements of radiation quality, mainly for mixed radiation fields.

2. Organ dosimetry and internal dosimetry. These include measurements and calculations of organ doses for both external radiations and incorporated radionuclides. For x rays, sex-specific somatic indices are described while for neutrons organ specific quality factors are determined. For radionuclide dosimetry, several factors needed for the estimate of risk are investigated, such as dose distributions and modifying factors.

3. Radiation physics and microdosimetry. Information and data on the magnitude and microscopic distribution of discrete amounts of energy (microdosimetry) is fundamental to the interpretation of biological effects of ionizing radiations especially at low doses. Also necessary are a knowledge of the values of dosimetric parameters, such as W-values, stopping powers, ranges, kerma factors, and organ doses.

4. Interpretation of dose-effect relationships. Studies of biological effects as a function of absorbed dose, dose rate, and LET are now based mainly on microdosimetric concepts which have provided new approaches to examining correlations between, for example, chromosome aberrations and tumour induction, and between molecular lesions and somatic effects.

5. Development of instruments and methods. New instruments have been developed for area monitoring of neutron-gamma fields, for environmental dosimetry, personnel dosimetry and neutron spectroscopy. Efforts are focussed on proportional counter techniques and the development of solid state dosimeters, using thermoluminescence, lyoluminescence, exo-electron emission, scintillation techniques and track counting in plastic foils.

6. Collection and evaluation of dosimetric data, intercomparison programmes. Absorbed dose measurements for fast neutrons, and measurements and standardization of dosimetric instruments, methods, and calibration facilities constitute important programme areas. Intercomparisons among different laboratories in the Community and with laboratories in the USA have been of key importance and continue to be one of the objectives of the programme.

7. Biological and accident dosimetry. The development of a new low-dose biological dosimeter, applicable down to 1 rad of x or gamma rays, where chromosome aberration analysis is not usable, is an important item in this programme.

During this period a more or less stable balance between the various elements of the programme was established. Projects on microdosimetry and neutron dosimetry each constitute about 25% of it. Basic data and parameters constitutes about another 20%. Personnel dosimetry and monitoring account for about 15% and so also do dose-effect relations and intercomparisons.

SECTOR B

BEHAVIOUR AND CONTROL OF RADIONUCLIDES IN THE ENVIRONMENT

The main aim of studies on the behaviour of radionuclides in the environment is to provide the information required for the evaluation of potential doses which may result from releases occasioned by man's activities, including medical and industrial uses, the operation of nuclear plants and the disposal of radioactive wastes. This information is required for implementing protection recommendations through mathematical models for the evaluation of individual doses and collective dose commitments. A better knowledge of the processes responsible for the space- and time-dependent distribution of radionuclides between the various compartments of terrestrial and aquatic ecosystems, accompanied by "in situ" radioecological investigations, could result in the improvement of these mathematical models. The radionuclides to which some attention has been given are the transuranic elements and some other important fission and activation products (tritium, krypton, iodine and cesium). For long-lived radionuclides (transuranics, ^{99}Tc, ^{129}I) it is urgent to acquire more data on their migration into the environment and their transfer through the food chains. The behaviour of most radionuclides is strongly dependent upon their physico-chemical form, thus both abiotic and biotic transformations (acid-base and redox reactions, complexation, adsorption, metabolism, etc.) should be taken into consideration.

The programme comprises 19 contracts which address a number of different issues related to environmental contamination. These are:

1). Sea and Continental Water Environments including the distribution of radionuclides in sea water, their accumulation in sediments, both sea and estuarine, and bioaccumulation.

2). Terrestrial Environments including soil accumulation of radionuclides, availability for plants, long term transformation of nuclides in soil, toxicological aspects and metabolism of radionuclides in animals.

3). Atmospheric Environments including dispersion in the atmosphere, physical resuspension from seawater and from land surfaces, and atmosphere - plant exchanges.

4). Evaluation of Doses to Man including transfer coefficients and in particular the transfer of tritium in organic and inorganic forms.

5). Control of Contaminated Areas which might result from accidental circumstances.

6). Conventional Pollution Due to Nuclear Power Plants, which includes the study of thermal impacts as well as small radionuclide releases.

7). Release of Radionuclides from Non-Nuclear Plants, which results from the burning of coal containing products of the Uranium and Thorium series and also from phosphate plants processing fertilizer.

Although some data exist on the behaviour of several radionuclides in soil and water systems, their accumulation in living organisms and their transfers through food chains, the information is not sufficient to provide a solid scientific basis for the assessment of potential exposures from a variety of radionuclide sources, including the nuclear fuel cycle. Radiation protection requires input data from a broad range of practical circumstances, including pathway information and transfer rates, for the evaluation of collective dose commitment and for procedures involving ALARA (As Low As Reasonably Achievable).

For that reason, most of the research carried out recently has been concerned with the behaviour and transfer of transuranic and other long-lived radionuclides, (^{99}Tc and ^{129}I) and their significance for human radiation exposure. Limited studies have also been made on the impact of nuclear wastes on fresh water ecosystems (Meuse River) and the transfer of radionuclides within them, as well as on the impact of thermal discharges and biocides used in cooling towers.

However, the processes of dispersion, reconcentration and transfer are not fully understood. For example, recent experimental data suggest that the uptake of ^{99}Tc by vegetation from soil may be two or three orders of magnitude higher than the value currently being used in radiological assessments. Thus the dose delivered to man by ^{99}Tc via food chain pathways may be higher than previously assessed. This matter must be investigated further.

Other important gaps in our knowledge exist, for example on the kinetic aspects of the initial distribution of radionuclides in the environment and the biogeochemistry of long-lived radio-elements. Both "in situ" and laboratory studies are needed to provide the scientific background essential for the assessment of the dose arising from discharges of radionuclides into the environment.

SECTOR C

SHORT TERM SOMATIC EFFECTS OF RADIATION

1. Primary Effects of Ionizing Radiation on Nucleic Acids.

Included in this sector is a part on primary effects which has 8 contracts dealing with studies on free radical intermediates formed directly or indirectly, and on molecular changes produced by radiation such as strand breaks and base damage. Primary effects concern themselves with characterizing those products formed in a few seconds as the result of initial molecular events leading to early chemical damage and eventually to cellular effects.

Nine laboratories were engaged in the execution of the programme on primary effects. All the project leaders and their staff belong to the "European Group for the Study of Primary Effects on Nucleic Acids", a group initiated ten years ago under the aegis of the Commission with the object of facilitating the exchange of ideas and information between European scientists working in this field.

2. Short term Somatic Effects of Ionizing Radiations.

This segment of the programme concentrates mainly on effects on the hemopoietic and immune systems. Impairment due to ionizing radiation of the normal activity of the hemopoietic and the immune systems is closely related. Indeed, the different cell lines of these systems have common precursors, originating in the same anatomical sites, and their development is closely interconnected.

During the 1976-1980 period 13 research laboratories performed experimental and clinical studies dealing with hemopoiesis, the effects of irradiation on immune cell populations and their consequences and bone marrow transplantation.

The purpose of these investigations is:

1) to improve existing methods and to develop new ones for the evaluation of the consequences of radiation exposure,
2) to increase our knowledge of the effects of ionizing radiations on the hemopoietic and immune system,
3) to study the hemopoietic and immune restoration after exposure to ionizing radiations with or without cell grafts treatment. These studies were carried out at the fundamental as well as at the preclinical or clinical level.

SECTOR D

LATE SOMATIC EFFECTS OF IONIZING RADIATION

Long term effects due to irradiation from external sources or from incorporated radionuclides constitute important problems in radiation protection because they may affect a relatively large number of persons and cannot, in general, be prevented once exposure has occurred. The principal effects at low dose are stochastic and include both somatic and genetic damage and these are of primary concern for the protection of the population and radiation workers. They arise in full severity without a dose threshold but with some finite, although small, probability even at the lowest dose levels. Stochastic somatic effects should be distinguished from non-stochastic late effects which develop only above a threshold dose and with a severity dependent on the dose level. They are characterized by atrophic and dystrophic lesions leading to impairment of organ function and mainly occur in persons exposed to large doses accidentally or following medical treatment.

This sector involves 31 contracts which include studies such as:

1. Non-Stochastic Effects on blood vessels, connective, parenchymal and nervous tissues, early and late effects on pig skin, hamster cheek pouch, lung damage in rodents, rat brain, and rat thyroids. The principal mechanisms in these studies involve damage to blood vessels, tissue fibrosis, atrophy of parenchymal tissue, damage to nervous structures.

2. Stochastic effects refers in this sector specifically to the induction of tumours. The CEC programme includes studies on:

   (a). Carcinogenesis after external irradiation such as leukemia in mice, breast tumours in rats and skin tumours in mice.

   (b). Carcinogenesis from internal irradiation, i.e. induction of tumours resulting from incorporated radionuclides, especially of bone tumours induced in mice by ^{239}Pu, by ^{224}Ra and ^{227}Th and others, and lung tumour induction for inhaled ^{239}Pu.

3. Distribution and metabolism of radionuclides, particularly of particles deposited in lung, involving both human and animal studies. One aim is to examine the ICRP lung model which is not entirely satisfactory as a model for human lung cancer.

4. Decorporation of radionuclides, which involve studies with alginate or cryptant for the alkaline earths and a new chelating agent for plutonium, Puchel.

5. Epidemiological studies in human populations, especially of thorotrast patients in whom liver tumours and cirrhosis are found, persons treated with ^{224}Ra who have been developing bone tumours and are now showing some non-stochastic lesions, and patients treated with ^{131}I for thyrotoxicosis.

6. Exposures to medical diagnostic procedures, aimed at assessing the value of the procedures and optimizing the quality of the images technically while reducing patient dose from both external radiation and from nuclear medicine procedures. This activity concentrates initially on physical factors such as spectra controlling image quality and organ doses. It will move gradually to the more procedural aspects of dose reduction.

One unique activity in this sector is the European Late Effects Project Group (EULEP), an association of 14 European laboratories whose work embraces the first 3 segments of the sector (pathogenesis of radiation-induced neoplastic and non-neoplastic diseases and the action of internal emitters). Studies of late effects in animals are time-consuming and expensive, and careful standardization with respect to experimental design and animal care is advantageous. EULEP has two standardisation (dosimetry and pathology) and three research Committees for this purpose. The Committee on dosimetry carries out intercomparison programmes in member laboratories for dosimetry of whole- and partial-body x-ray exposure. The Committee on pathology maintains a consultation centre to help member laboratories establish pathological diagnoses in difficult cases. It also holds regular slide seminars which have resulted in the standardization of the terminology of histological diagnoses of late radiation effects. An important product of this undertaking is the publication of an Atlas on Radiation Pathology.

EULEP organizes yearly meetings on critical topics in late effects research, sometimes in cooperation with relevant international societies. The proceedings of these meetings are published with the aid of the European Community. EULEP is an example of coordinated research on an international scale, its support being essentially catalytic, with the main aim of fostering cooperation between laboratories.

SECTOR E

GENETIC EFFECTS OF IONIZING RADIATIONS

Genetic damage due to irradiation occurs in addition to a relatively high rate of spontaneously occurring disease of a genetic character in human populations. For reasons of public health as well as because of public interest, genetic effects and research upon them are highly important. The development over the past few decades of sensitive molecular genetic techniques have led to increased understanding of the processes involved in the induction and manifestation of genetic damage in experimental materials and to some extent in man.

The programme in the sector on genetic effects reflects this situation in several ways. It is large (41 contracts and the Biology Group at Ispra, 23 mio ECU total expended) and varied because contracts fall in all categories from basic biology and the genetics of microorganisms to radiation damage in mammalian cells and embryos.

The programme of the Commission concentrates on three different areas of research dealing respectively with:

- the biochemistry of sensitivity and repair
- the nature of genetic damage in eukaryotes
- the modification of dose-effect relationships and the prediction of aberration yields in humans.

There are so many studies that they cannot be described comprehensively in a few pages. Thus, only some of the more significant research aims are presented here.

The sector programme includes studies on the following subjects:

1. Biochemistry of sensitivity and repair, includes work with microorganisms on the molecular nature of induced lesions and their repair, work with mammalian cells on the polypeptides and enzymes involved in cellular responses, or on inducible and error-prone repair, on repair deficiencies, complementation studies, localization of human repair genes, differences in radiosensitivity and the biochemistry and prenatal diagnosis of repair deficiencies.

2. Nature of Genetic Damage in Eukaryotes including human meiosis, non- disjunction in mammals, chromosomal aberrations in somatic and germ cells, the doubling dose, repair in mutagenesis and aberration

formation, the molecular nature of radiation damage and correlation between different biological endpoints.

3. Dose-Effect Relations in Eukaryotes involves studies of the shape of the dose-effect curve, the modification of dose-effect relationships, neutron RBEs (in Drosophila, human lymphocytes, Chinese hamster cells, epidermal cells of Saint Paulia, and protoplast cells of Nicotiana, and in yeast), and the effects of low doses of radiation, including cytological studies of aberrations in workers.

The field is characterized by extremely rapid developments due to collateral knowledge on the genetic material and its physiology and new techniques for the study of radiation damage.

SECTOR F

EVALUATION OF RADIATION RISKS

This sector was developed as a separate sector for the first time in this 5 year programme, studies in this area having been previously incorporated in other sectors of the programme, especially in the environment and late effects. The aim of the research in risk evaluation is the development of quantitative and comprehensive methodologies for determining as accurately as possible the consequences of population and worker exposure. These methodologies are a prerequisite for implementing radiological protection recommendations and have an impact on decision making, siting, emergency planning, etc...

The sector was unusual in that the entire research was embraced within a single contract (apart from the contract with ICRP), a contract of association between the Commission and the CEA, Fontenay-aux-Roses, Paris. Some research was sub-contracted by the CEA via 17 subcontracts to eight other laboratories.

During this period the publication of ICRP 26 established three principles of radiation protection, viz justification, optimization and dose limitation. Implementation of these three principles requires a knowledge of levels of exposure of individuals and of groups of the population, the resulting radiological detriment, and the economic and social consequences of irradiation.

The contract had three projects in which a similar method of working was adopted. First, a review of literature to establish existing knowledge, next, if appropriate, work was carried out either at Fontenay or sub-contracted to provide some missing information or model. Finally recommendations were based on the information assembled. The projects are:

Project 1. Methods for the Evaluation of Individual and Collective Doses Resulting from Normal Discharges and Accidental Releases.

Project 2. Methods for the Evaluation of the Radiological Detriment to Man.

Project 3. Methods for Evaluation of Economic and Social Consequences of Irradiation.

THE BIOLOGY GROUP AT ISPRA.

This group was conceived originally as a place for intramural research in the CEC Radiation Protection Programme and as a home base laboratory for CEC staff engaged in contract work during the 1960s and early 1970s. It constituted a sizable and well directed effort within the Radiation Protection Programme including ecological, toxicological, cell biology and dosimetry studies carried out by a total of 36 staff, of which 15 were scientists.

Financial difficulties, some criticisms of the work programme and the desire by some Member States that the CEC programme should be based more on contractual than on intramural actions, led to a drastic cut of the group which in 1979 included only 19 workers in total, of which 6 were scientists. The group currently totals 18 people, 6 are scientists.

The reduction in size and scope of the group took place during the years which form the subject of the present evaluation and a precise description of the programmes going on at that time would be of little value. The present structure is thought to be more representative of the final operational levels achieved by the reduction of the Biology Group. A document (Appendix 4, #31) prepared for the ACPM in 1980 summarizes in historical perspective the past activities of the group and the work it undertook at around 1980. Further information was also submitted on the present programme and future trends of the group.

There are at present two main lines of work in the laboratory:

1. Genetic analysis of radiation sensitivity. This aims at integrating the data drawn from plant and insect cell lines to assess quantitatively the damage induced by radiations of different quality; to analyze the spectrum of recessive mutations and the pathways of repair in DNA; to understand the relationships between physiological and developmental cell stages and radiosensitivity. All this is made possible by the unique properties of the plant system available, which may be handled in haploid conditions and regenerated afterwards in differentiated homozygous fertile individuals; and of the insect cells exhibiting a high turnover of DNA and high radiation resistance. The purification of protoplast subpopulations and their radiation response to high- and low-LET radiation, the response of synchronized cell cultures, the measurement of repair synthesis in these cells are among the most important lines of research pursued.

2. Biochemistry of DNA damage and repair. The main line in this programme includes the isolation, purification and functional characterization of DNA repair enzymes from various cell types, aiming at a precise description of pathways of repair. There is also another line of study on the toxicity of tritiated aminoacids at the level of nuclear chromatin, which is carried out on mouse embryos in vitro.

COORDINATION AND TRANSFER OF INFORMATION

The coordination of the activities of the contractants and the transfer of information between the contractants within the European Community and to the outside world, as well as the exploitation of research data are achieved by means of ad hoc meetings and specialized publications.

Meetings

Four different types of meetings were organized by the Commission during the period 1976-1980:

- Meetings of study groups, where scientists involved in the contract programme, independent experts and staff members of the Commission discuss specific subject areas of the programme. The aim is to provide coordination and joint planning. An average of 17 such study groups were held annually.

- Seminars or workshops are organized by the Commission around themes directly related to contemporary problems in radiation protection. These establish the importance of a field, determine whether further interaction is necessary and organize contact with scientists inside and outside the CEC, as well as providing a forum for the presentation of results. An average of six of these were held per year.
- Symposia. These are organized or co-organized by the Commission to provide a large scale confrontation of CEC research with research outside the Community. Usually a single theme is chosen and the aim is the advancement of research on a world-wide basis. On the average there was one per year.
- Meetings of experts specifically designed, in accordance with Chapter III of the EURATOM Treaty, for the co-ordination and stimulation of efforts towards practical measures of radiation protection. The task of such working groups included, among others, the revision of Basic Safety Standards, the examination of radioactive effluent discharge from nuclear power stations, the assessment of individual dose and the review of reference accidents.

The Commission organized, from 1976 to 1980, a total of 85 study groups involving 1300 participants mainly scientists working on contracts and 36 seminars, symposia and meetings of experts involving 2700 scientists from 25 countries. Details on each of these meetings are to be found in the progress reports issued annually by the Commission (Appendix 2, #4 and #6-9).

Publications

The results obtained during the 1976-1980 period have been published by the contractants in nearly 3000 articles in refereed scientific journals of international standing, in reports, papers and proceedings of symposia and conferences. References to these are given in the progress reports published by the Commission (Appendix 2, #4 and #6-9). In addition the Commission initiated surveys of detailed results of specific activities in the field of radiation protection and published them as monographs (~ 1-2/per year), proceedings (~ 2-3/year) and other European reports (~ 2/year) totaling 32 such volumes in the 1976-80 period.

The CEC also publishes annual progress reports on the programme, which are short accounts of ongoing research (Appendix 2, #6-9). At the end of five years a progress report for the entire period is published (Appendix 2, #4). At a subsequent time the Commission publishes a document on the Synthesis of Results for the five year period of the programme (Appendix 2, #5) which includes other publications by the CEC in this period. Others are also to be found in Appendix 2.

Chapter 3

Management of the Programme

Background

Treaties: The three Treaties creating the European Communities are the one for the European Coal and Steel Community (ECSC, 1952,) the European Economic Community (EEC, 1958) and the European Atomic Energy Community, Euratom, (EAEC, 1958). The EEC Treaty concerns the entire economy of the Member States* whereas ECSC is limited to coal and steel and Euratom is limited to nuclear energy, although both involve some health effects aspects. EEC and Euratom are solely public money, ECSC includes resources from private industries on the basis of a levy on coal and steel production.

Institutions Initially there were three separate administrations but these were later fused (1967), even though the treaties themselves remained distinct. The institutions of the European Community are shown in Figure 1.

The Council (of Ministers) takes the legal actions for the European Community in the form of resolutions, regulations, directives and decisions but can do so only on proposals made by the Commission. The Commission is the chief executive body of the European Community.**

Programme Decisions Research Programme Proposals are prepared on a five year basis. The initial phases require extensive consultation including national viewpoints as ultimately Member States have to agree. The proposal is prepared by Commission staff with the aid of external experts, study groups and the Advisory Committee on Programme Management. The final draft goes to the Scientific and Technical Committee (STC) and then to the Commission. These initial phases take about one year to develop. The Commission submits proposals to the

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*Initially there were six Member States: Belgium, the Federal Republic of Germany, France, Italy, Luxembourg, the Netherlands; Denmark, Ireland and the United Kingdom joined in 1973 and Greece in 1981.

**In this document "CEC" stands for Commission of the European Communities.

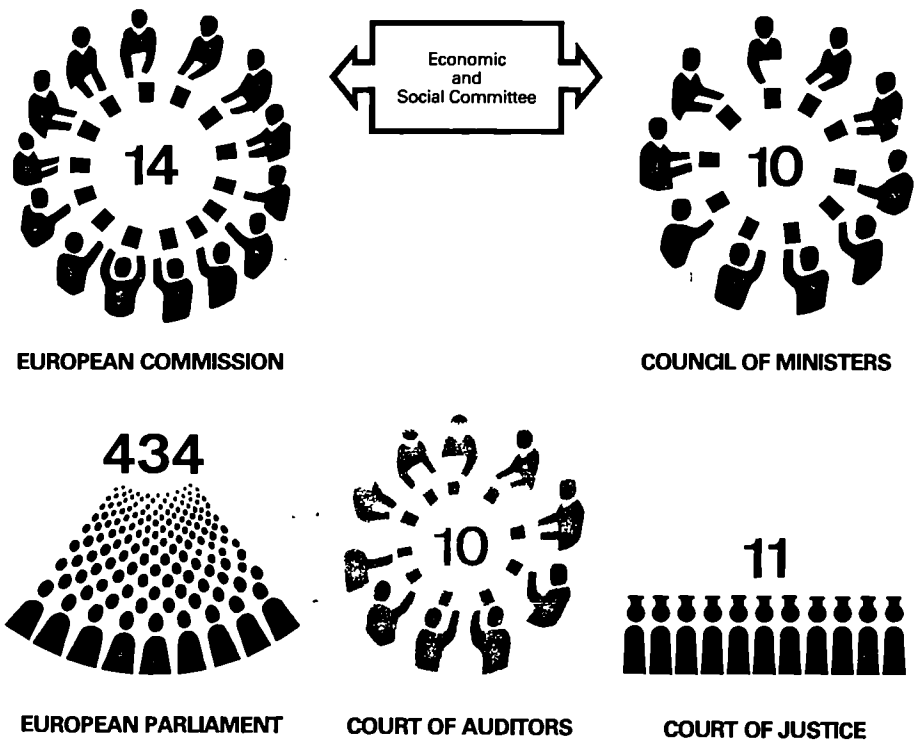

Fig. 1 **- Institutions of the European Community.**

Council and to the Parliament, where they are subject to review by the Economic and Social Committee, the Committees of the European Parliament and COREPER (Committee of Permanent Representatives of the Member States) which is assisted by the Working Party on Atomic Questions (WPAQ) and from there to the national administrations. The procedure is shown in Figure 2. Final decisions are made by the Council after all the consultations indicated in the figure. These decisions are binding on the CEC for the content of the proposal as presented and for the five year period addressed. The entire decision process takes usually up to two years.*

Budgets The budget required is presented under certain headings such as Staff; Administrative Operation; Contracts. After decision of the Council the budget becomes part of the General Budget of the European Communities.

The programme budget for a given period includes a gross basic amount extrapolated from the previous programme plus various increments. For example, the budget for the period 1976-80 included provision for integration of new Member States (Denmark, Ireland, United Kingdom) provision of funds for new aspects to strengthen the programme and to correct research deficiencies (e.g., in risk evaluation) and provision for the increase in costs. No actual overall increase in the budget (beyond that required for inflation) was provided in spite of the broadening of the scope of the programme. Budget amounts allocated to contracts, initially 40% of the total, decline to a smaller percentage over the five year period, the differences being made up by the individual Member States.

Radiation Protection Programme

The organization of the program and its relationship to the Commission structure is shown in the truncated diagram of Figure 3 together with the names of those involved in the Radiation Protection Programme.

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*For the 1985-1989 period for example, Programme Proposal preparation began in January/February 1982 for a decision expected December 1983 for implementation during 1984 and initiation in 1985.

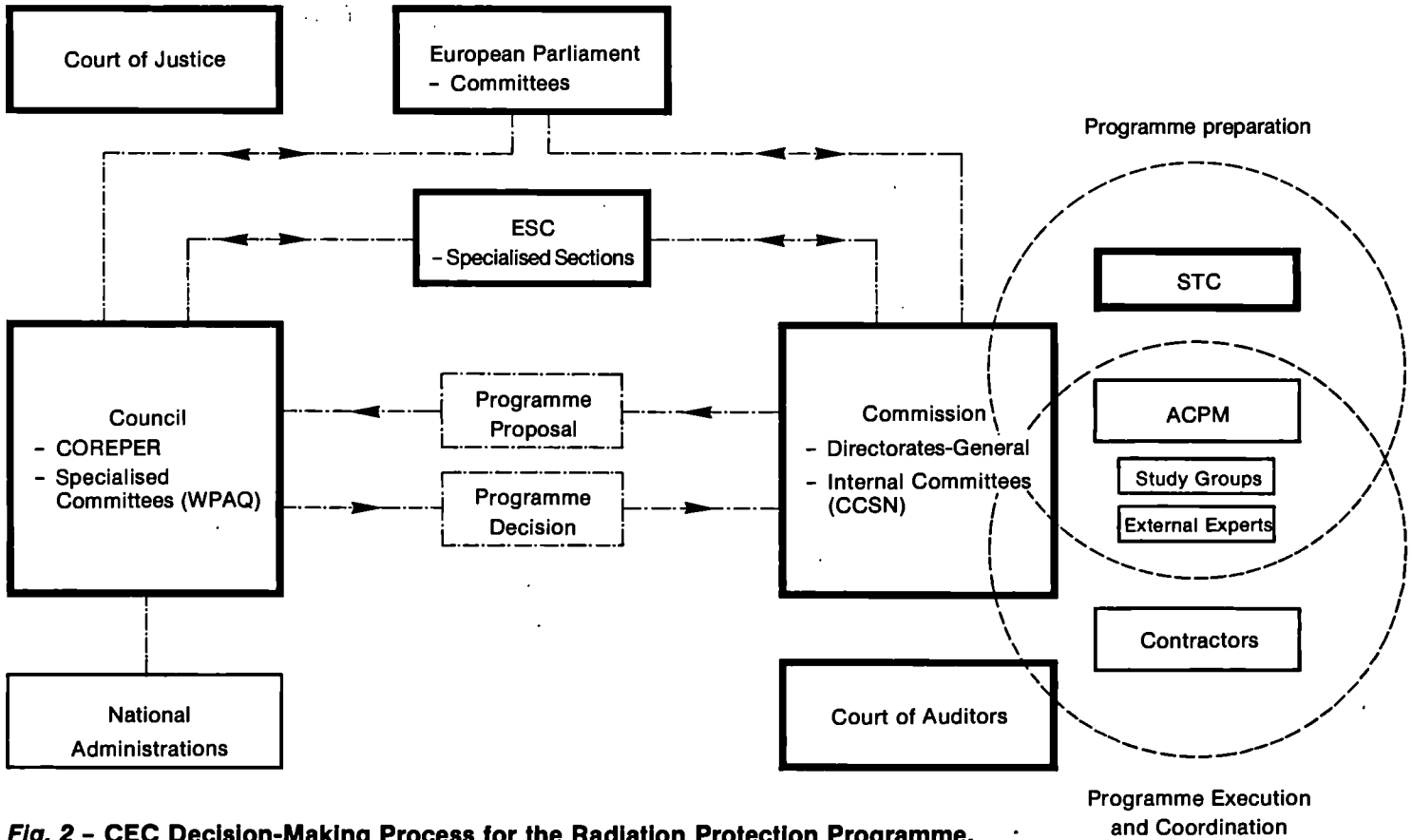

***Fig. 2* - CEC Decision-Making Process for the Radiation Protection Programme.**

Abbreviations: **ACPM** = Advisory Committee on Programme Management; **CCSN** = Interdepartmental Coordinating Committee on "Nuclear Safety"; **COREPER** = Permanent Representatives Committee; **ECS** = Economic and Social Committee; **STC** = Scientific and Technical Committee; **WPAQ** = Working Party on Atomic Questions.

CEC Staff: Under the overall guidance of F. Van Hoeck, Director for Biology, Radiation Protection and Medical Research and the specific direction of H.G. Ebert, Head of the Division of Radiation Protection each one of the programme managers and Dr. Ebert himself accept responsibility for one of the six scientific sectors of the program (Chapter 2) as indicated in Figure 3.

The Advisory Committee on Programme Management (ACPM) ACPMs were first set up by the Council of the European Community for each of the research programmes in 1969. Their role was strengthened further in 1977 to include responsibility for the preparation of the programme proposal, rendering opinion on draft proposals, involvement in research proposal selection, reviewing progress, and establishing closer links with national research activities. Their views may be sought also on such questions as the socio-economic impact of the programme as viewed by the national delegations.

Representation on the ACPM is by country, three members per country plus observers and the membership during 1976-80 is shown on Figure 4. The chairman for 1982 (a one year appointment) was Dr. W. Gössner. [It is noted that as the ACPM evolved in the course of time it became more and more a scientific peer group, a highly important and desirable development in the opinion of the Panel.]

The ACPM normally meets twice a year in May and November and advises CEC on all aspects of programme conception, management and implementation, including the subdivision of the programme into sectors, the addition of new sectors (such as risk evaluation in 1977), the scope of the programme, the selection and approval of the contracts, and the progress and results derived from the contracts.

Administrative Procedures

Development of the Five Year Programme Proposal: The responsibility for this rests initially with the CEC staff as described earlier. In the present cycle discussions were held between CEC staff, contractor scientists and external experts from European Countries in the first 3 months, January-March 1982. In May 1982, the draft outline was discussed by the ACPM and a full draft produced thereafter (June). This draft was discussed by the ACPM again at a special meeting in July, 1982. A revised draft was produced in September and formally approved by the ACPM in November, 1982.

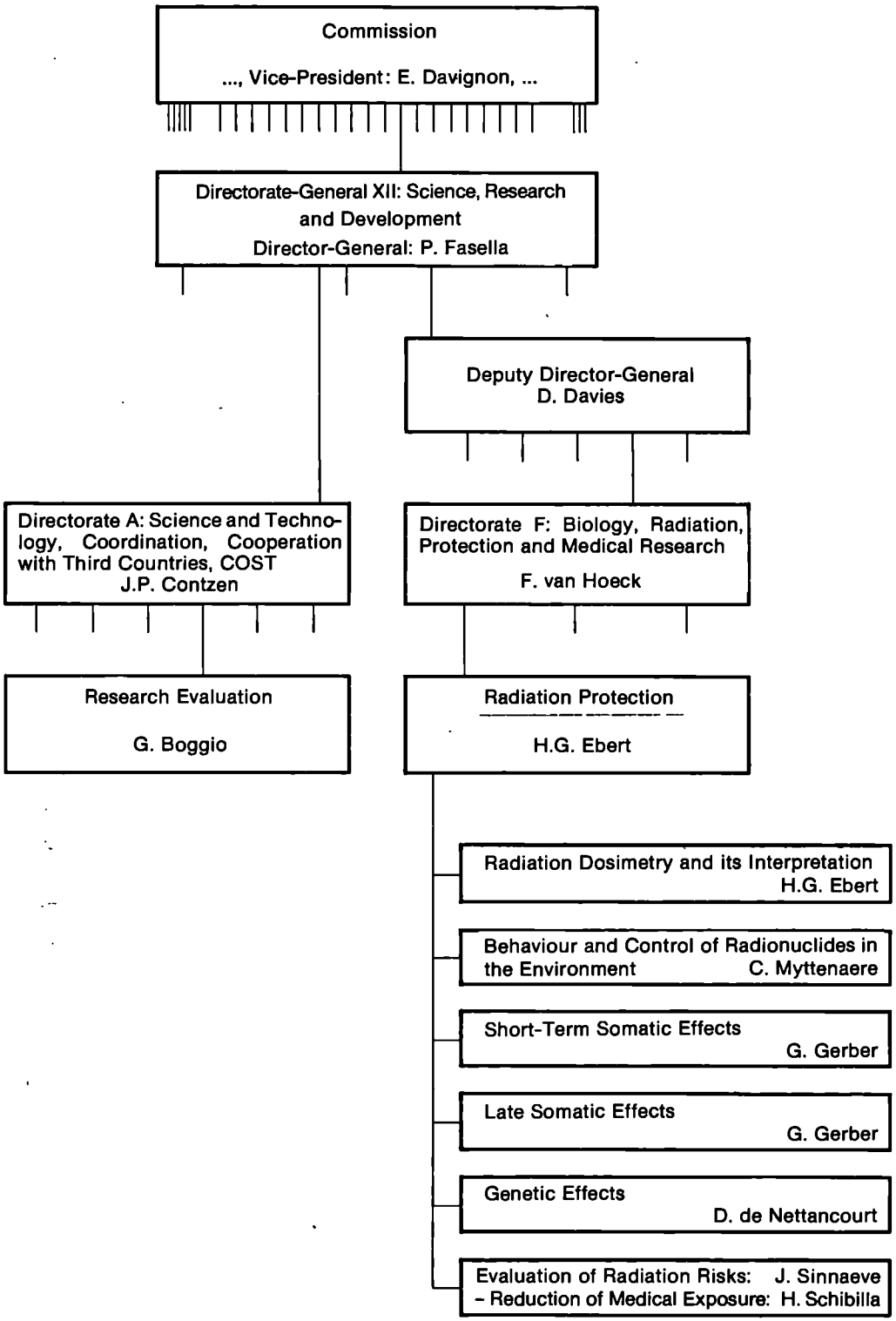

***Fig. 3* - Organisational Structure: Radiation Protection Programme.**

Members in 1976/1980 of the Advisory Committee on Programme Management:

Biology - Health Protection

BELGIQUE - BELGIE

M. ERRERA
A. LAFONTAINE (Chairman 1976)
P. LEJEUNE
J.R. MAISIN
O. VANDERBORGHT

BUNDESREPUBLIK DEUTSCHLAND

W. GÖSSNER
H. MUTH
W. PRINZ
R. WITTENZELLNER

DANMARK

M. FABER (Chairman 1976/1977)
N.O. KJELDGAARD

FRANCE

M. BERGES
R. COULON
L. FITOUSSI
M. GRAS
H. JAMMET
G. LACOURLY

IRELAND

J.D. CUNNINGHAM
J.W. HARMAN (Chairman 1978)
J. MASTERSON
A.W. MOORE
L.B. O'MOORE

ITALIA

M. BELLI
A. CIGNA (Chairman 1980)
P. METALLI
M. MITTEMPERGHER
G. SILINI

LUXEMBOURG

P. KAYSER

NEDERLAND

G.W. BARENDSEN
F.H. SOBELS (Chairman 1979)
L. STRACKEE
D.W. VAN BEKKUM
G. WANSINK

UNITED KINGDOM

G.W. DOLPHIN
Sir Edward E. POCHIN
A.G. SEARLE
N.G. STEWART
A.N.B. STOTT

COMMISSION

A.J. BERTINCHAMPS
P. RECHT
F. VAN HOECK

Secretariat (Commission)

H.G. EBERT
H. SCHIBILLA

***Fig. 4* - Advisory Committee on Programme Management 1976-1980.**

Thereafter, in about April of the 2nd year the Commission formally adopts the draft and submits it as the official Programme Proposal to the Council. The Council follows the consultation procedure indicated in Figure 2 which is usually completed by November and the Council decision is taken in December.

A budget will thus be established in December 1983 for a programme to start in 1985 which will run for 5 years. The programme content has also been established in the general terms of the Programme Proposal.

Note that in the 1976-80 Radiation Protection Programme, for January 1, 1976 to December 31, the 1980 Council decision was available only in April 1976. This caused considerable actual and more potential disruption to ongoing programmes. These difficulties were overcome for the next period by an overlapping year during 1980 for the 1980-84 programme. In the future, difficulties will be avoided by the more advanced procedure outlined above, which permits a year for the implementation of the Council decision and its translation into individual research contracts with laboratories.

Implementation of the Research Programme. After a formal decision is taken on the programme, a call for tenders is usually published in the Official Journal of the European Community and is also available via the Member States themselves, the Members of ACPM, Commission services and others. Documents distributed include information on the programme decision, an outline of the programme indicating what CEC intends to do, and the scientific documentation which backed up the Programme Proposal.

Research proposals are then submitted on forms provided and may be deposited with CEC at any time. All proposals received up to a certain deadline date are transmitted in full to each of the ACPM members. For the 1976-1980 programme, proposals were discussed within the ACPM at meetings in May 1976, November 1976, May 1977, November 1977, May 1978, November 1978, May 1979 in decreasing numbers as time went on.

ACPM Review. ACPM members receive proposals 4-6 weeks before the meeting together with a computer form for preliminary evaluations (Figure 5). Members return the form 2 weeks later and the summarized data are available one week before the meeting (about 2/3 to 3/4 of the 31 members of ACPM return the preliminary evaluation forms).

Number of proposal Sector

Name of research group leader Institution Place

Research subject

Duration

Budget of the proposal in 1000 ECU Year	1980	1981	1982	1983	1984	Total	Asked %	ECU
PROJ. 1	0	0	0	0	0	0	0	0
PROJ. 2	0	0	0	0	0	0	0	0
PROJ. 3	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0

Staff collaborating in the projects

	Scientists	Others
Proj. 1	0.00	0.00
Proj. 2	0.00	0.00
Proj. 3	0.00	0.00
Total	0.00	0.00

Preliminary evaluation

	RELEVANCE		DISCUSSION	
	HIGH	LOW	YES	NO
Project 1				
Project 2				
Project 3				

Fig. 5 - Form Accompanying each Proposal to ACPM.

There are 4 categories of response:

High Relevance - no discussion needed

High Relevance - discussion needed

Low Relevance - discussion needed

Low Relevance - no discussion needed

ACPM normally accepts without discussion a contract with a 2/3 vote for high relevance and rejects a contract with a 2/3 vote for low relevance. However, any member can initiate discussion on any proposal if he desires to do so. In any case, every individual research proposal is briefly presented by the delegation of the Member State from which it originated. ACPM then proceeds to a priority vote 1,2,3 or no priority. Scientific evaluation and if necessary, assessment of priorities for the Biology Group at Ispra, has also been done by the ACPM.

Criteria used by ACPM in judging proposals include scientific content, relevance, excellence of laboratory collaboration, budgetary considerations and other aspects. Rejection does not necessarily mean a proposal is not meritorious because there may be other constraints such as relevance to CEC programmes.

After ACPM prioritizing, CEC staff prepare budgetary figures for the proposals and present them to the ACPM at the same meeting, with an indication of what can be funded given the priorities and the budget. ACPM may modify the CEC staff proposals but normally approves them.

To give some figures relating to the 1976-80 programme, during all the meetings of the ACPM 392 research projects were discussed representing a total sum of 133 Meua of which 50 Meua were requested from the Community. A total of 253 projects were discussed at the first meeting of the ACPM in May 1976.

After deliberations by the ACPM, 68% of the projects were approved during the five year period for a total of 28.4 Meua ECU of Community support. In order to maintain flexibility, not all of the budget is allocated in the first year. In the first year (1976) 77% of the final amount of money in the contracts was approved, in 1977, 10%; in 1978, 7%; and in 1979, 6%.

New scientific projects are admissible during the contract period because the programme is designed in general terms and the flexible

budget and distribution plan enables support of new work even in the third or fourth years.

Finally, contracts are negotiated between the laboratory and the Contracts Division of D.G. XII. In 1976 the contracts could be retroactive to the beginning of 1976 because of the lateness of the programme decision. Contracts may be for one to five years.

Note that of the total funds available in 1976-80, 76.3% went into contracts, 15.2% for the Biology Group at Ispra and 8.5% for administration and coordination in Brussels. Note also that other details are in Chapter 2, Description of the Programme.

Responsibility of Contractors Contractors have to transmit at the beginning of each year a progress report for the previous year. (These are published in an annual progress report like documents #6-9 in the list of Appendix 2). They are discussed by ACPM at the May meeting and any comments transmitted by CEC staff to the contractors. Contractors are requested to submit in September their plans for the next year. These are discussed at the ACPM meeting in November but only important deviations from original objectives would be commented upon. Finally, at the completion of the contract period a final report must be submitted which is also published (Appendix 2, #4)

Other Aspects of Programme Management

Collaboration and interaction between contractors is assured by (a) study group meetings once or twice a year involving mostly informal exchange of results between the parts of a given sector of the programme; (b) symposia and conferences involving contractors and other scientists worldwide: the CEC has supported many of these, in the 1976-1980 period as noted in Chapter 2 and additional meetings are arranged by EULEP, CENDOS, etc; (c) Visits to main contractors at intervals by CEC staff to discuss progress, problems, results etc; (d) publication of results, which contractors are encouraged to do both in the CEC publication programme and in the open refereed literature.

Chapter 4

Evaluation Methodology

Introduction

The Panel was requested to perform an evaluation of the scientific and technical achievement of the Radiation Protection Programme, as outlined in Chapter 1; p. 4-5.

This represented a challenging assignment in view of the extent and the wide range of the research programme to be evaluated. The Panel had available reports of some earlier evaluations of other programmes but none of these established a single methodology or were directly suitable for the Radiation Protection Programme.

Furthermore, although the European Community has had experience with a variety of evaluation techniques and held a conference on the subject, the proceedings of which is published (Appendix #2 Evaluation Document #13), the results of their experience were purposely expressed as general guidance only for evaluation panels. Deliberately, no specific general format or procedures are provided for evaluation panels to follow. The Panel was thus intentionally free to develop its own approach and was expected to do so in a manner appropriate to the special circumstances of the programme being evaluated, namely the Radiation Protection Programme.

Members of the evaluation group of CEC and of the CEC programme staff were present during most of the deliberations of the evaluation Panel but there was no attempt by anyone to control the method of evaluation or to influence the approaches adopted by the Panel. The CEC programme staff were present for resource purposes only and at the discretion of the Panel, they were not present for some interviews or whenever it seemed more appropriate to hold discussions of evaluations, conclusions or recommendations in private.

It was clear to the Panel from the outset that there are some special considerations relating to the Radiation Protection Programme. Political and financial implications relating to studies involving health and the environment require that choices or judgements made in

formulating the elements of the research programme be rationalized, for example in the Programme Proposal. Furthermore in making judgements on the research contracts themselves, three basic items are closely interwoven, namely the objectives (principal aims and topics), the means (laboratories, budgets, etc), and the results or achievements, and a comprehensive evaluation requires consideration of all three. It was also evident early that the scope and extent of the programme was such that a sector by sector analysis would be necessary as outlined later.

Among the early general considerations discussed by the Panel were the following:

- Were the topics for the Radiation Protection Programme chosen on the basis of relevant areas in this research, as determined by the essential objectives of protecting human beings and the environment and by the pressure of public opinion?
- What is happening in the national research programmes of the Community Member States, and what does the Community have to gain from encouraging research?
- What special contributions can a Community research programme in radiation protection make to the Member States of the Community, and indeed to the world at large?

More specifically can answers be given to questions such as:

- Do the results of the research correspond to the stated objectives?
- Does the research budget match the merit of the work?
- Given a set of scientific and political criteria, is it important to continue this research?
- Can the results obtained, in particular any publications, be evaluated and do they lend themselves to a value judgement?
- Is international cooperation an important factor in this research
- Does the research have any apparent social and economic impact?

After considerable discussion of points such as these and after a rather extensive preliminary survey, sector by sector by two Panel members for each sector, of the actual scientific material to be evaluated, the Panel decided to adopt a flexible approach to the evaluation. This was intended to allow for considerable latitude on the part of each member of the Panel to use his own criteria and judgement

which, however, following further general discussion, then became part of the overall judgement of the entire Panel.

General Method of Evaluation

This Panel in its evaluation used essentially a three source approach involving: (a) a general evaluation of all the projects in the sector including a quantitative ranking; (b) examination of some projects in more detail including in some cases interviews and (c) other relevant approaches and sources including the questionnaire results.

The documents used in the evaluation are listed in Appendix 2.

The most important general resource for the evaluation of individual contracts, apart from the catalogue of contracts (document #3) which provided titles and financial and summary information, was the 5 year Progress Report for the period 1976-80 (document #4). For the evaluation of the sector and the programme as a whole, the Synthesis of Results (document #5) was a valuable additional resource.

For the detailed study of selected contracts, additional documents included the original proposal, the contract, annual reports, reprints and other published materials. In addition the Panel interviewed the principal investigator to obtain a personal view of the work and its progress and other features of handling of the contract.

The Panel also used the results of a questionnaire prepared by the Panel and sent to all contractors by the Commission.

Procedure for the Evaluation

The Radiation Protection Research Programme, as the foregoing description in Chapter 2 indicates, is divided into six scientific programme sectors each of which has a somewhat different scientific character. The expertise of each of the members of the Panel was such that, although an exact match was not sought or intended, it was comparatively straight forward for each Panel member to accept assignment to two of the sectors (one each only in 2 cases) and thus to have two evaluators for each sector. Two evaluators also studied the Biology Group at Ispra.

A preliminary evaluation of each sector was made by each of the two assignees and presented to the Panel. Following a general discussion of possible approaches the Panel decided that each member would refine his

approach to the evaluation and render it at least semi-quantitative according to his own perception of the important criteria to be used in judging a project, each member now having had the benefit of the ideas of his colleagues and the general discussion. The aim of this approach was to maintain flexibility by avoiding too rigid a set of criteria, but still be sufficient to result in a method of ranking each contract or project. The two evaluators per sector then discussed their evaluation of the relevant projects. If they were in general agreement one could assume the approach worked for a general appraisal of the projects as to scientific quality. This procedure was not expected to be appropriate necessarily for a detailed appraisal of the exact relative merits of one project versus another but sufficient to classify the projects into general groups and to appraise the sector contracts as a whole as well as their relevance to CEC programme objectives.

Among the criteria used by members of the Panel were the scientific merit of the objectives of the project; the methodology and techniques used; the originality of approach and methods and the progress made on the project; the results (in the form of publications etc.); the degree of achievement of stated objectives, the contribution to international cooperation at the Community level, the relevance of the project to the Radiation Protection Programme and its main objective, i.e. protection of man and his environment, and finally the overall value of the project to science in general and to the public as well. Cost was not evaluated in detail, because of the difficulty of assessing the cost effectiveness of the partial support provided by CEC, and the sometimes apparent lack of correlation between the size of the contract, the quality of reporting and the scientific value of the results. In a gross way more was expected by the evaluators from a large well funded contract than from a smaller contract or from a large national programme with only a small involvement by the Commission.

The approach resulted in a general appraisal of the projects in a sector which the Panel believed to be reasonably successful because, as will be seen later, in general there was surprisingly good agreement on project ranking between the two evaluators. Some common features developed in the discussions on different sectors and these enabled the sector appraisals to be synthesized into a more general appreciation of the programme as a whole.

Very helpful to the members of the Panel in conducting the sector appraisals were the initial presentations given by the CEC programme staff covering the overall aims and composition of the sector efforts. From time to time these and other members of CEC staff were consulted for assistance.

For a more detailed evaluation of some projects, two contracts each were selected for study in the sectors on Late Effects (three, if the EULEP contract is included) and Genetics and in the Risk Evaluation sector the one large contract was selected. All the documents noted above relating to these projects were examined in detail by the two evaluators of that sector. Then the principal investigator was interviewed by the entire Panel with the two evaluators leading the discussion but all members of the Panel participating. This enabled a detailed appraisal of these contracts to be made and served to confirm for the Panel that the general appraisal method was satisfactory, although it depended to some degree on the quality of the Progress Report in the 1976-80 document and the care with which that report was prepared.

The questionnaires were examined in the light of the general appraisal. Responses were received for 111 of the 142 contracts or 78% by the deadline date. Additional replies bringing the total up to 126 or 89% were received finally. Given the fact that 1983 is now after the event for some contracts, this is a high return. The response yielded valuable information on the reactions of investigators to management as well as on public and scientific aspects of the Commission's programme. On scientific matters and on matters of interaction and cooperation the responses strengthened the impressions of the Panel both with respect to the sector evaluations, the programme as a whole and the management. Very useful material for the evaluation of socio-economic impact was also derived.

On management questions, the steady availability of CEC Programme personnel and the presentations made on CEC procedures by the senior staff were most important. So also were interviews of the Chairman of the Advisory Committee on Programme Management, which plays a critical role in the Community programme, and persons responsible for broad coordination projects such as EULEP which was treated as an example of this kind of cooperative programme. In each of these interviews, not

only the more mundane and practical aspects of contract management and objectives were explored, but also matters of importance to all scientific development were discussed. These included methods for exploiting new ideas, the support of innovative work, the means adopted to ensure that important programme areas are not neglected, the need to ensure viability in the programme, and the possibility of developing special evaluation procedures for contracts which have been in existence for a long time.

The socio-economic aspects of the evaluations were developed as described later in Chapter 8. Briefly, first a member of the Panel with a socio-economic background identified some of the important points needed, then suggestions and proposals amplifying these points were made by the other members of the Panel and finally these views were synthesized into a cohesive chapter.

A brief visit of some Panel members was made to the Biology Group at Ispra. Also documents on the programme of the Biology Group were examined and the leader of the programme was interviewed by the whole Panel in Brussels.

The work of the evaluation was shared among members of the Panel. Not only did different members accept different responsibilities for different sectors of the programme, some also accepted special responsibilities for the evaluation of the socio-economic impact of this programme, and for special items such as the questionnaire analysis, the Biology group at Ispra and other items. These were integrated into the discussions in the Panel as a whole, which were frank and wide ranging. The overall judgements and recommendations were developed by the Panel as a whole. The Panel met a total of six times, usually for two days (one day for the first meeting) over a six month period. Extensive discussions between Panel members also took place outside the formal Panel meetings.

Finally, the Chairman drafted most of the evaluation report on the basis of material supplied by the individual Panel members and on the basis of discussions throughout. Ultimately the entire report was discussed extensively and in toto by all members of the Panel and the final version approved unanimously.

Chapter 5

Questionnaire Results

After the second meeting of the Evaluation Panel a questionnaire (Appendix 3) was sent out to all contractors who participated in the 1976-1980 programme. It had three main purposes:

a) to give all contractors the opportunity to air their views about the programme since the Panel could talk to only a small number of contractors.

b) to help assess the performance of the Commission in financing, managing and assisting in the performance of the contracts.

c) provide another independent quantitative base for statements about the success or otherwise of the entire programme or its parts.

Because of lack of time the design of the questionnaire was less than ideal. Some comments and recommendations are made later in this chapter on improvements in design for future questionnaires (not only in the radiation protection field) which the Commission may wish to undertake. In addition, detailed comments on individual questions are included in Appendix 4. Despite these minor drawbacks the Panel found the questionnaire very useful as an independent check on its conclusions and in providing a numerical background for them.

In all 103 responses covering 111 contracts or 78% of the programme were analyzed. For complete details of the analyses see Appendix 4.

Although attention is occasionally drawn both here and in Appendix 4 to differences between countries or between sectors in the pattern of answers to particular questions, in general such differences were small. There were no systematic overall variations either between sectors or between countries, although the Dutch replies showed an unusually high level of agreement between contractors in Holland.

Management

Contractors had a very good opinion of the way their contracts were managed. This was reflected particularly in Questions B III. 2(d) and B III. 4. Of 71 replies, 69 stated that CEC staff had reacted satisfactorily to any special request from the contractor. Concerning the management of contracts (which included both scientific and

contractual/administrative aspects) 81 out of 91 replies rated the management "fair" or better. This is judged by the Panel as a very favourable response.

The only aspect of the overall management of the programme which received substantial criticism was in the timeliness of the letting of contracts. Overall, 24% of contractors complained that their contract was not let in a timely fashion. This effect was most marked in the sector on genetic effects where participation is largely by smaller University programmes which have some special budget problems and generally lack administrative personnel to deal with administrative aspects.

It appears however that the consequences of the rather high level of delay were not very serious. Most contractors seem to have managed to bridge funding gaps by exploiting domestic funds. A few contractors mentioned that delayed funding had meant slightly later completion of their contract than originally intended, while only three contractors stated that less work had been done as a consequence. The problem has been resolved in later programme periods.

Scientific Aspects

A striking feature of the questionnaire returns was that they reflected a very high level of interaction between scientists. There was a great deal of evidence that the programme had promoted considerable and beneficial contact between contractors, between contractors and non-contractors and between contractors and CEC staff. Of 103 contractors, 88 stated that they had benefitted from CEC support other than financially and out of the 82 who went on to comment further, 74 cited either improved contacts or collaboration as the reason. Extensive interaction via discussion, site visits, study group meetings, seminars and symposia etc., was reported. Of those who responded, 75% felt that these interactions had affected the conduct and content of their research and 97% felt the interactions to have been useful.* The answers to Questions B V. 2(a), 2(b) and 3, concerning new contacts

* The fact that 18 contractors felt that the interactions would have been even more useful if some meetings were more specialised in nature in no way detracts from this conclusion.

generated with other researchers, reflect the same pattern.

The questionnaire also reflected the fact that contractors had considerable faith in the quality of the work undertaken by their fellow contractors.

Finances

There was little evidence in the questionnaire that CEC funding simply substituted for national funding in the contracting institutions. Indeed, there was considerable evidence to the contrary. Replies to question A.1 indicated that 64% of contractors felt that CEC funds had either created or developed the capacity of their institution in their particular field of work. A sizeable minority of contractors, 41%, felt that domestic funds were increased as a consequence of CEC funding, and only 3% felt they were decreased.

Only three comments were made more than once or twice about the CEC's financial policy. Fifteen contractors stated that the percentage share of funding by the Commission was too small. This comment came most frequently from contractors in the sector on Behaviour and Control of Radionuclides in the Environment, in which the smallest proportion of total costs were covered by the CEC in this period (Table 2, chapter 6, p. 71).

Eight contractors stated that more flexibility is required in CEC funding rules, either to cope with the purchase of capital equipment or with unforeseen contingencies. Some amendments to the present rules may be worth considering to provide capital instead of depreciation allowances for equipment used on CEC work when a contractor has difficulty raising the funds to make an initial purchase. Changes have already been made in this respect to cope with unforeseen contingencies more flexibly.

Seven contractors stated that too much money, relatively, went to large laboratories. Surprisingly, one of these comments came from a large laboratory.

Comprehensive nature of programmes

Only 33% of contractors replying felt that national research programmes in radiation protection should attempt to be comprehensive,

but 59% felt that this should be the case for the CEC programme. This reflects the feeling that the CEC programme should be more comprehensive than national programmes. There were some striking differences in national attitudes. None of the Dutch contractors felt that national programmes should be comprehensive and only 18% of them felt that the CEC programme should be. By contrast, 58% of the French replying and 50% of the British stated that their national programme should be comprehensive. For the CEC programme the figures for these countries were 75% and 72% respectively. The difference of view would appear to lie in the perceived value of trying to be comprehensive.

Taking risks in research

Questions B I. 2(a) and 3 were concerned with the smoothness with which work proceeded and the degree to which its objectives were finally achieved. Answers to these questions showed a very high level of achievement of objectives. Nobody reported total failure and only 5% stated that achievement of their objectives was "poor". The remaining 95% reported fair to perfect achievement. Although in one respect this outcome is laudable, in another it may not be. Quite aside from the natural bias, the absence of failures may reflect the fact that the selection of topics for research may have been too conservative and unadventurous. For major developments to be achieved, risks have to be taken and sometimes such risks may mean failure.

General questions

The response to the variety of open-ended questions included in the questionnaire was disappointing. Similarly simple yes/no answers were not often amplified even when an explanation was requested. This probably reflects the limitations of a postal questionnaire as a means of obtaining information. The open-ended questions did elicit 48 examples of socio-economic consequences of the programme, although in a programme of this kind the relatively low numbers of answers on improvements in safety standards and worker or public protection from exposure seems surprising at first sight. However, this result may be a consequence of the way the questionnaire was administered. Most of the work of sectors A-E of this programme are concerned with enabling improvements in standards or levels of exposure to take place through

improving the knowledge base rather than generating results which have an immediate application for safety and protection. Application work was confined to sector F, Risk Evaluation. This sector contained only one research contract other than the ICRP contract. The Panel had intended the questionnaire to go to sub-contractors in this sector but appreciated their different status and therefore sent the questionnaires only to the main contractor. Thus the whole of the application end of the programme was represented by only one questionnaire return, and applications were accordingly under-represented.

Weaknesses of the Questionnaire and Implications for Future Evaluations

As suggested earlier, there were some specific problems in using the questionnaire. Most of these were a consequence of the shortage of time available for design and testing. The Panel could not consider a draft questionnaire until its second meeting and the fully analysed results had to be available in time to influence the report which was to be completed only five months after that second meeting. This ruled out the possibility of properly piloting the questionnaire. The Panel attempted to weed out poor questions when considering the questionnaire draft and a few contractors were asked their views. Nevertheless in the end contractors did not respond in the way hoped and expected to some of the questions. Detailed comments on these questions are included at the end of Appendix 4.

A second limitation of the questionnaire was that it was sent to contractors only. By definition this group was successful at obtaining funds from the CEC and was therefore more likely to have favourable views on the Commission's funding policy than those who had failed. Among the questionnaire returns two contractors commented that the Commission should explain more carefully its reasons for rejecting research proposals and it would have been interesting to canvass opinion on this matter among a group that had been unsuccessful in the bids for funds.

A third, and substantial, limitation of the usefulness of the questionnaire was the fact that there was no follow-up by interview, or possibly by letter, to some parts of the questionnaire. Contractors who gave examples of direct applications of their research for the good of the Community either in radiation protection or in other areas could

have been interviewed to try to assess just how large the benefits were or were likely to be. This would have enabled a more detailed and better documented estimate of the socio-economic impact of the programme.

Other replies which could have been more informative and were, instead, disappointing, were those concerning the motivation for going to the Commission for funds, the reasons for success or failure in the achievement of scientific objectives, and open-ended questions such as those on CEC financial policy.

Recommendations for future evaluation questionnaires

The Panel believes that many of the questions included were not specific to radiation protection, so that many of them would be appropriate, with little or no modification, for evaluating other research programmes. Evaluation staff at the Commission could therefore make available for future evaluations a standard questionnaire, based on the one used, but modified to take account of the weaknesses noted. The questionnaire should be piloted for the particular group of contractors at which it is aimed and the full questionnaire results should be available to Evaluation Panels very early if not at the very beginning of their deliberations. This implies that the whole questionnaire exercise should and could begin well before the Panel meets for the first time.

Chapter 6

The Scientific Evaluation of the Programme

The evaluation of the programme was undertaken sector by sector by two evaluators per sector as outlined in Chapter 4. Thereafter comments on the individual sectors were presented by the evaluators to the Panel as a whole. Discussions in the Panel resulted in substantial modification of some of the presentations without destroying the substance of the original comments. This procedure finally resulted in a more uniform approach to the evaluation of the sectors although no attempt was made to treat them exactly alike since they vary considerably in content and in character.

In the following pages comments are provided on Sectors A to F, on the Biology Programme at Ispra and on the Coordination and Transfer aspects of the Commission programme. A brief section concerns the scientific programme as a whole and two sections of comments are provided on the Programme Proposals for 1980-1984 and 1985-1989.

SECTOR A
RADIATION DOSIMETRY AND ITS INTERPRETATION

The evaluation of the dosimetry sector of the 1976-1980 programme is in two parts, namely, a general evaluation of the goals achieved and the main orientations of the sector and a more analytical evaluation of the different contracts, their objectives, their methodology and results and some general observations about them.

A. General evaluation.

A large proportion of the contracts were oriented around two main topics, microdosimetry and neutron dosimetry. A breakdown of projects according to working areas showed; microdosimetry 25%, neutron dosimetry 25%, basic data and parameters 20%, personal dosimetry and monitoring 15%, others (dose-effect relations, etc.) 15%. Alternatively classification of the 52 projects according to subjects results as follows; microdosimetry 11, dose-effect relationships 7, internal dosimetry 10, external field dosimetry 6, dosimetric intercomparisons 6, methods and instrumentation 10, biological dosimetry 2.

The Panel observes that the CEC influenced this orientation toward microdosimetry and neutron dosimetry through:

(a) the organization of symposia at regular intervals. Symposia on Microdosimetry have been organized almost every two years since 1967 up to the 8th symposium in 1982. Four symposia on Neutron Dosimetry have been organized since 1972, the fourth in June 1981. The high scientific level and organisation of these symposia, as well as the rapid publication of the Proceedings, attracted physics teams into the field and resulted in positive feed-back stimulating new research;

(b) supporting strongly and actively research programmes in these two fields.

(c) selecting microdosimetry as one of the main topics of the Biology Group research in the laboratories in Ispra (1965).

The Panel considered the results and the impacts of these actions on this sector as follows.

Microdosimetry. Although microdosimetry was initiated at Columbia University in New York, this discipline has been highly developed in Europe and is now well advanced even compared with the USA.

In the opinion of the Panel the choice of microdosimetry as a topic to pursue was wise because:

1) microdosimetry contributes to an understanding of radiation action. Studies on the dependence of biological effects on dose, dose-rate, and LET, and on the shape of the dose-effect relationship, are now based on microdosimetric concepts. Some important contributions have been made by European investigators in this field.

2) in the field of radiation protection, microdosimetry may provide a better method for characterizing radiation quality than LET.

3) in radiation therapy with high LET particles, the influence of microdosimetry is realized more and more (see, for example, the recommendations and the current programme of the ECNEU, European Committee on NEUtrondosimetry of the EORTC, European Organization for Research on Treatment of Cancer concerning microdosimetric intercomparisons between the different neutron therapy centres).

The role of microdosimetry achieved in Europe is to a large extent due to CEC support, but it has also been recognized by other international organizations such as ICRU, who recently completed a report on this topic (in press). A staff member of the CEC was the

chairman of the Committee responsible for the initial preparation of this ICRU report.

Neutron Dosimetry. Neutrons are the most penetrating type of high-LET radiation and relatively frequently encountered. The rapid development of neutron therapy in Europe and in the United States, and the importance in radiation protection of neutron carcinogenic effects at low doses are the main reasons for the interest in neutron dosimetry.

The CEC has supported contracts in therapy, in biological effects and in dosimetry of neutrons and has played a major role in coordinating the dosimetric programmes and organizing symposia as noted above. The CEC has also supported, at least partly, a dosimetric intercomparison between a number of laboratories in Europe and the USA,* and subsequently between the European centers using neutron beams.

The European protocol for neutron dosimetry adopted by ECNEU (and EORTC, see above) is now in use in the European neutron therapy centers and will soon be compared with the protocol used in neutron therapy centers in the USA (ICRU).

Evidently neutron therapy has benefitted greatly from the neutron dosimetry programme and a large amount of information has been accumulated on neutron interactions and dosimetry. Neutron biological research (carcinogenesis and mutagenesis) is particularly important because the protection field lacks experience with neutron effects in humans at low doses.

International Commission on Radiation Units and Measurements (ICRU). The ICRU contract (together with the ICRP contract discussed later) is unique in that through it the CEC makes an important contribution to the work of this International Commission. The ICRU defines radiation quantities and units and provides technical guidance on radiation measurements and dosimetry at the international level. In the period under consideration (1976-1980) the ICRU produced and published ten reports (ICRU #24 to 33). The work of the ICRU and the basic scientific information it provides is fundamental to the CEC Radiation Protection Programme and to the world at large.

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* ICRU Report 27, 1978

General comment. The successful actions of the CEC in microdosimetry and neutron dosimetry during the period 1976-1980, illustrate the power of the CEC and its staff to influence the direction of research in a given field and also to reach important objectives.

Because a large part of the efforts in dosimetry were concentrated in two main directions, the dosimetry programme of the CEC could obviously not be fully comprehensive. Consequently, it is essential that the main orientations be continuously adapted, or even modified, in order to meet the most relevant or urgent needs.

It is noted that 50% of the programme was in aspects other than microdosimetry and neutron dosimetry and some comments on these are provided in the analytical evaluation. Symposia related to those other aspects of radiation dosimetry organized by the CEC during the 1976-1980 period are listed in sources such as Appendix 2, #5.

Topics in Dosimetry not included: Some examples of topics in dosimetry which were not (or only partly) taken into account in the 1976-1980 programme and might be considered for future programmes are:

1) biological dosimetry for accidents;
2) the applicability of microdosimetry at very low doses; in that respect, biological systems with higher radiosensitivity may be necessary;
3) studies of transformation, mutation, and their value in dose-effect relationships at low doses.
4) chemical dosimetry, for intercomparison work and for the integration of heterogeneously distributed absorbed dose in a given organ or volume ($FeSO_4$ or research on a more radiosensitive system);
5) calorimetric techniques for absolute dosimetry thus providing a reference base for photon dosimetry;
6) dosimetry and radiobiology of high Z high E (HZE) particles, of importance to the European Space Agency as well as CEC.

Some of these problems such as #1 have been included in later programmes of the CEC. Others might be more relevant to other sectors. The study of HZE particles is an especially interesting problem for the future as space developments occur and more people are involved. The items on this list are however, intended only as examples and are neither exhaustive nor in priority order.

B. Analytical evaluation.

This type of analysis provides information on the value of the contracts overall and could also provide some indication of the merit of the contractors and research subjects. Two independent reviewers, using their own scoring methods, agreed on the following conclusions:

-no contract scored so poorly that it was considered to be without value and should not be in the programme;

-a small number (about 25% of contracts) were generally satisfactory but not exciting, as to purpose or achievement;

-the majority (about 50%) were good to very good in most respects;

-a small number (about 25%) were superior outstanding contracts.

The following observations also resulted from the analysis.

1. Included in the evaluation was a consideration of final reports and publications. The final reports differ markedly in quality and detail. It would be helpful if CEC could establish a standard format for annual and final reports. From the publications cited in the reports, the sector programme appears to be productive but a surprisingly large proportion are not in refereed journals (actually about 25% of a total of 355 papers are in refereed journals). One probable explanation is that many papers are published in the proceedings of the many Symposia and/or documents published by CEC in dosimetry. These proceedings have their special value because they provide fast information and constitute an up to date collection of the most relevant data on the subject but they have the disadvantage that they tend to substract some papers from the open literature. CEC might minimize this disadvantage by more strongly recommending publication of the best papers in refereed journals: this already is done to some extent, by the more vigorous researchers since the "best programmes" judged or scored by the two observers contain the highest percentages (40 to 60%) of references in refereed journals, as well as a very healthy overall productivity.

2. A high degree of competence is evident in most of the physics work, i.e. workers are familiar with the most sophisticated techniques and utilize them even though they were mainly not developed in the programme. However, with some exceptions, not a high degree of originality is evident in the dosimetry work. This may be in the nature

of dosimetry itself, as this subject often forms a base for other types of research. However some innovative work would still be expected, for example in new instrument development.

3. Besides the effort on microdosimetry and neutron dosimetry, a rather large number of contracts (7) deal with dosimetric parameters, theoretical calculations, determination of stopping powers, W, particles ranges etc. Although this research was urgently needed in the past, and was still fully justified in the 1976-1980 programme, it should not be expected to continue along the same lines indefinitely, even though refinements are always desirable.

4. On the other hand, new projects dealing with field quantities and with field monitoring should be encouraged. This has already been done to some extent in more recent programme periods, but, for example, development of new instruments, new technical ideas, should be encouraged even further, even if somewhat risky of accomplishment, in order to develop a greater degree of innovation in this programme.

5. Constant surveillance of the programme in this sector is necessary and adjustments in priorities should be made as some areas reach maturity and other areas need stimulation.

SECTOR B

BEHAVIOUR AND CONTROL OF RADIONUCLIDES IN THE ENVIRONMENT

I. General.

As already noted in Chapter IV the general approach to evaluation included an examination of the objectives, the means and the results but the cost of the research was not specifically taken into account.

Two different evaluation approaches were used:

1) First by an analytical examination of the research projects taken one by one. In order to do this a classification of types and areas of research and scales of values according to different judgement criteria were developed. This examination involved considering the contracts in the light of:

- the research areas: measurements of discharges, diffusion and transfers into physical vectors [atmosphere, water, ground] and to biotopes, plants, animals; ingestion technologies [industrial or culinary preparations, distribution circuit];

- the nature of the research: descriptive, quantitative, analytical, causative [for measurements and/or experimentation]; partial or comprehensive analysis, partial or comprehensive synthesis [for mathematical models] comparisons [between site measurements and models];
- the results presented.

In this analytical examination, the objectives were to define a research project then to assess the contract according to these different criteria by reading the annual reports and the five year summary report published by the CEC (Appendix 2, #4 and #6-9).

2. Second by a general examination of the research projects taken as a whole using the previous classifications.

II. Analytical examination (of research contracts)

The environment is a vast topic and Community activities have been instrumental in providing answers to some questions which individual countries would not be able to solve themselves. The contracts in this sector display some overlap with the work of other sectors and in that connection three points should be noted.

a. The 1976-1980 programme for this sector included initially one of the association contracts (099. PSA F) for one year (1976). It was transferred (1977-80) to Sector F, Evaluation of Radiation Risks, and was not included in this analysis.

b. Six additional contracts that are related to environmental studies are included in other sectors (Appendix 2, #4 p. 198). It would have been useful to examine why they were included in other sectors, but they were not included in this evaluation.

c. It should be noted that this sector includes an association contract (185-BIA.N) similar to the one in sector F. It comprises eight projects some of which could also have been included in other sectors. The analytical examination showed:

1. About 20% of the contracts involved practical environmental work, 42% involve laboratory experimentation, 12% involve mathematical modelling and 16% are difficult to place in a simple category. On the whole, this indicates a good balance between research areas.

2. As to type of research, about 40% of the contracts are descriptive, 30% are quantitative, 10% are analytical and 20% fall into each of those categories.

3. Regarding the research results presented in the final report, 80% are real final reports, also about 80% mention at least one previous or one forthcoming publication and many have numerous publications and, about 80% state fairly clearly the success of their project. About 75% of them fit all three of these categories.

4. In general the presentation of the research results seems to be quite satisfactory. Only two or three projects did not quite measure up to the standard expected.

5. Of some 213 references cited in the progress reports for this sector, 57 or 27% were in the refereed literature while the others were in reports, proceedings and other publications.

III. General evaluation.

The programme management staff appear to have done a good job of orienting and monitoring the work in this sector. Nevertheless, when the projects are examined as a whole some comments can be made.

As far as the objectives are concerned, an examination of the percentages presented above shows that the sector work has been mainly descriptive. Although 42% of the research areas are concerned with laboratory experimentation, very few resulted in an analytical system modelling the behaviour of radionuclides. A number of projects did not succeed in providing useful tools for making forecasts of future work. However this forward-looking characteristic is only one aspect of research and its absence may have little to do with the scientific quality of the work carried out.

As far as the means are concerned, the number of projects supported does not relate directly to the development of nuclear energy programmes in the different countries of the European Community.

In countries where radioecology is not closely structured at a national level, a large number of contracts went to small research units such as universities. This does not always allow studies requiring a large technical infrastructure to be carried out. The large laboratories may not have answered invitations to tender because they did not feel directly concerned. This has changed in the following period 1980-1984.

As far as results are concerned, they are on the whole, satisfactory, but nearly 20% of the final reports do not succeed in

clearly defining the positive or negative results of the research. Furthermore, the final result sometimes strayed considerably from the original objective. This situation is not always linked with the scientific quality of the report, but it tends to cloud judgement about the overall planning of the research. Nevertheless in most of the reports important indications on the radioactive contamination of the environment are given, in particular for nuclear fuel reprocessing plants and nuclear power stations.

It is noted with satisfaction that inter-laboratory collaboration has developed steadily over the period in the field of environmental studies. Some examples of European cooperation can be mentioned: collaboration between a number of laboratories to study tritium in the environment, periodic meetings between the marine laboratories, creation of a Union of Radioecologists.

IV Comments and conclusions.

The evaluation of the environmental contracts for 1976-80, enable certain comments to be made with regard to the future.

The major topics chosen must be consistent with other national programmes and European Community objectives and take account of real requirements as regards knowledge of the consequences of using nuclear energy. The main points are: comparisons of measuring methods at the European Community level; comparisons of models and actual conditions; possible synergism between radioactive and non-radioactive pollution; accident consequences; waste problems; knowledge of effluents.

In defining the most important elements of environmental research the national programmes must be taken into consideration and the CEC must try to link them all together into an integrated European Community system.

Also there is a need to promote exchanges of staff, knowledge and methods between the laboratories of the European Community, without however overlooking small research centres, which, with help from the Community, might undertake interesting "promotion" projects.

Public opinion is quick to respond to problems of the environment and therefore a public information programme which explains the environmental investigations being performed and the results obtained, would be highly desirable.

SECTOR C

SHORT TERM SOMATIC EFFECTS OF IONIZING RADIATION

The research activities summarized under the title "Short term somatic effects of ionizing radiation" deal with a variety of very different scientific problems. The common theme is that they concern effects occurring immediately after or within a few weeks after the irradiation. The scientific and the practical problems range from those of biochemistry to those of general medicine, especially immunology.

There is no doubt that in a general programme on radiation protection substantial attention must be given to the immediate effects because these are the starting points for both stochastic and non-stochastic end-points. But the sequence from absorption of ionizing radiation to the development of a radiation damage is very complex and not well understood. Therefore, this kind of research work was and is essential in the Radiation Protection Programme.

The research activities of the sector can be divided into the following subgroups.

1) Primary effects of ionizing radiation on nucleic acids.
2) Effects of ionizing radiation on hemopoiesis and on immune cell populations.
3) Problems of bone marrow transplantation.

This classification is somewhat arbitrary because the problems of bone marrow transplantation always imply immunological problems. However for the purpose of the present evaluation projects dealing with more general immunological questions were considered under subgroup 2.

1) Primary effects of ionizing radiation on nucleic acids:

The aim of the research work in the eight contracts of this subgroup was to explore and describe the sequence of events from the absorption of energy to the formation of primary and secondary radicals and their reactions with nucleic acids which produce damage and DNA strand breaks. Techniques of electron-spin-resonance spectroscopy were mainly utilized. Significant methodological developments were the computer-assisted identification and quantitative analysis of the different radicals and the detailed analysis of the optical and paramagnetic properties of free radicals by combined optical and magnetic resonance spectroscopy. Using analytical radiation chemistry, DNA strand breaks caused by reaction of OH with the sugar moiety and the

chemical mechanism leading to base substitution or deletion were studied.

The entire research effort on primary effects is carried out in very close cooperation between the different participating laboratories. The cooperation was initiated by the Commission with the formation of the "European Group for the Study of Primary Effects on Nucleic Acids" which has provided the stimulus for high calibre scientific work in this interdisciplinary field of physics and chemistry.

2) Effects on Hemopoiesis and Immunology:

Eleven contracts belong to this subgroup but three are only partially concerned with problems of hemopoiesis and immunology. Research work on hemopoiesis concerned mainly the experimental analysis of factors influencing the recovery of the hemopoietic system. Factors tested were, for example, erythropoietin, burst enhancing factor, glucagon, parathyroidhormone and lactoferrin. Systematic research was performed on the normal content of hemopoietic stem cells or progenitor cells in the blood of mice, dogs and humans and the relationships between these and extravascular stem cell pools. Knowledge of stem cell distribution and kinetics together with the developments of methods of storage and preservation of bone marrow stem cells may provide useful information to treat failure of the hemopoietic system.

This is a good example of research started in radiation protection which found useful application in other medical fields. The practical aspects of this type of research in relation to large accidental exposures is obvious and the techniques have also been found useful in cancer chemotherapy.

The immune system and its possible defects may play an important role in the origin of cancer, the predominant stochastic radiation effect. A better understanding of the immune system would also be of general importance in medicine. Research work was carried out on recovery of B- and T-lymphocyte populations after radiation, on the demonstration of subpopulations of T-lymphocytes and T-helper lymphoid cells, on the different T cell populations, as characterized by different radiosensitivities. Immunodepressive agents were studied in respect to their interaction with different populations of immune cells to get a better understanding of their mode of action and potential use.

3) Bone marrow transplantation:

In this subgroup there were five contracts during this period. Bone marrow transplantation offers the possibility of treating irradiated patients suffering from the hemopoietic syndrome and is thus of primary importance in the Radiation Protection Programme.

The excellent research work in 1976-1980 in all five contracts, has had as a major objective the identification of the factors for successful bone marrow transplantation between immunologically incompatible patients, i.e. the factors which cause the host versus graft reaction or the graft versus host reaction. Promising results have been obtained on the separation of hemopoietic stem cells from T-lymphocytes; on the separation and conservation for a long period of time; the typing of the donor and the host for histocompatibility; the conditioning of the recipients by an immunosuppressive treatment and the prevention of infection and graft versus host reaction by gastrointestinal decontamination.

At the present time, in several centres in the European Community, bone marrow transplantation after total body irradiation is used routinely as part of the treatment of leukemia patients. The CEC Radiation Protection Programme has contributed significantly directly or indirectly to the development of the method and to better understanding of the mechanism involved.

The importance of bone marrow transplantation is much broader than the possible treatment of irradiated patients and extends to the treatment of many diseases of the bone marrow, especially leukemia. In this case, ionizing radiation is used to kill the stem cells of the host to allow seeding of the transplanted bone marrow grafts. Due to the rapid development of the technique of bone marrow grafting in curative medicine (e.g. leukaemia or aplastic anemia) the question must be raised whether such research is still to be supported in the future within the CEC Radiation Protection Programme or by other, more medically orientated, funds or organizations, such as the EORTC.

A more analytical evaluation of the programme on short term somatic effects of ionizing radiation indicates that:

1) Eight contracts dealt with effects on nucleic acids. All eight contracts could be rated good or very good.

2) The second group on hematopoiesis and immunology consisted of 11 programmes. The work from four contracts was rated good or very good. Five contracts were thought to be fairly satisfactory, but achievements did not appear to be particularly outstanding. Two contracts were rated rather low and their contribution to the programme appeared questionable to the evaluators.

On the whole, the research effort in the group "effects of ionizing radiation on hemopoiesis and on immune cell populations" gives a somewhat confusing impression which may be due to the lack of comprehensive general knowledge in this field. But the different research activities in the programme are heterogeneous and a better exchange between the laboratories might help a lot. The Commission should therefore consider the potential value of stimulating good cooperation in the research of the immune system, as has been done, with success, in other fields.

3. Five research contracts dealt with bone marrow transplantation. They were all rated good to very good or even outstanding.

As far as scientific production is concerned the programme has been very productive there being 553 publications cited in the reports. About 65% of these were in refereed scientific journals and books. Thus most of the scientists working in this sector produced results of sufficient quality to reach the most reputable scientific literature.

SECTOR D

LATE SOMATIC EFFECTS OF IONIZING RADIATION

The contracts in this sector were evaluated independently in a quantitative way by two members of the Panel using some of the criteria mentioned in the general part on methodology. In spite of the differences in criteria and weighting used by the two evaluators, the rough quantitative scores for most contracts were comparable.

The conclusions drawn were the following:

- Some of the contracts were rated rather low by both evaluators but none were so low they would not be deemed acceptable as part of the general programme.

- About 20% of the 29 contracts were thought to be fairly satisfactory, but neither the purpose nor the achievements appeared to be particularly outstanding.
- About 60% of the 29 contracts were rated good or very good.
- About 20% of 29 contracts appeared truly outstanding.
- Both evaluators rated the EULEP programme very high, but recognized that the character of this contract and of the activities it covered were quite special, as discussed later.

Observations.

In the course of the evaluation several general observations were made.

1. The quality and the level of reporting appeared very uneven. An effort should be made to standardize the length and detailing of the reports especially the final report, in order to better reflect the effort going into the various contracts. Also, at some later stage, reprints of published work should be included as part of the report.
2. Although the standard of the methodology and techniques employed was generally high, the elements of innovation and originality in the work performed were not remarkable. This may reflect mostly the present state of development of radiation research in the countries of the European Community.
3. The publications cited in the reports were examined, and the ratio of papers in refereed scientific journals (295) to total publications (499) was about 59%, which is quite high.
4. Imbalances were noted in the programme, for example, there was a high concentration of research on bone and lung carcinogenesis after internal exposure in animals, but there was little work on classical radiobiological experiments on tumor induction and life shortening after external exposure. This may reflect the situation at the time in European Community laboratories. It may be wise for the CEC to give consideration to means of smoothing out the most striking of such imbalances by favouring the development of relatively under-represented areas, such as tumor radiobiology for example.
5. Relatively little research was carried out on the development of animal models and the extrapolation of results from carcinogenesis in animals to man. Great value is attached in this field to studies on tumor induction (and perhaps life shortening) in species intermediate in size and life span between rodents and man. However, no such studies

appear to exist in Europe owing presumably to the large financial costs involved. A more active collaboration of scientists of the European Community in larger animal programmes carried out in the United States such as those on dogs irradiated by internal or external sources, is suggested as a way to contribute to the development and success of extrapolation models. Indeed the potential mutual benefits of exchange of programme information and consideration of mutual programmes in some areas between CEC and other large programmes such as in the USA and Japan should be seriously considered, perhaps for inclusion in the 1985-89 programme.

6. Late effects of radon in man, particularly lung tumor induction, are an important consequence of exposure of workers in mines and a probable important source of exposure to the public. In some European Community countries relevant research is presently being conducted but it seemed to this Panel valuable to have a coordinated CEC approach in this area. It now appears that the CEC and the ACPM have considered their position with respect to the general levels of radon exposure indoors and outdoors and their possible consequences for the populations of the communities in the present programme for 1980-84. This subject might be expanded further in the 1985-89 programme.

7. Two fields were noted for their almost total absence from the programme, radiation effects on growth and development in utero and radiation induced transformation in mammalian cell systems. The lack of contracts in these fields is peculiar in view of the practical importance attached to the former and of the value of the latter in defining in biologically significant terms the initial steps of cancer induction. It was noted that the 1980-84 programme contains some contracts in these fields and that some, although still little, research has by now been undertaken. Considerably more emphasis has been devoted to embryo and fetus sensitivity in the draft programme proposals for 1985-1989 but more emphasis is still needed on cellular transformation.

8. Concerning future trends, data were provided by the CEC services on the relative distribution of funds between different sectors of the programme during the 1976-80 and the 1980-84 periods. Although the classification of contracts into one or another sector is to some extent arbitrary, the Panel noted that research on short-term effects is expected to increase slightly from 13% to about 16% of the total funding, while the sector on late somatic effects remained stable at

about 18%. This trend bears little relationship to the importance presently attached to the two fields for radiation protection purposes. Radiation protection research needs to develop more information at lower doses, especially in respect to carcinogenesis. The Panel would strongly advise ACPM and CEC to consider action to support research on low doses and therefore on late effects specifically since these are the principal effects remaining at those doses. In the 1985-1989 programme this sector is appropriately called "carcinogenesis" and the relative effort is expected to increase, a proposal that the Panel strongly supports.

9. It should also be noted that extending the programme to lower doses as the Panel strongly recommends will inevitably place greater emphasis on the analytical planning of the experiments and on the mathematical and statistical techniques needed for the analysis of results.

Detailed study of contracts.

In order to probe deeper into some of the work, three contracts were chosen for further study in depth (EULEP and two others). Full documentation regarding the original proposals, the contracts themselves including the financial annexes, the interim and final reports to CEC, and the published scientific papers resulting from the work were examined. It was found that a careful analysis of all the above elements was sufficient for the purpose of the evaluation exercise and provided an in depth perception of the programme not possible from the five year progress report alone. In addition interviews of the investigators were arranged. Direct contact with the contractors was helpful to clarify points of detail and particularly to set the objectives and the findings in a better perspective with respect to the state of development at the time when the project was planned and executed. Details of the interviews of contracts in this sector along with others are provided in Appendix 5.

The closer examination by the Panel of the three contracts and the interviews were helpful in filling out the evaluation of the sector as a whole. These examinations revealed that the quality of the work, the management of the contracts from the technical and the administrative sides, the results produced, the relationships between the funding agency and the research workers, were all good. The minor discrepancies noted between the scientific objectives in the research proposal and the actual results produced are characteristic of advanced research. They

are to be expected in activities of the type described and do not detract from the overall significance of the effort.

SECTOR E

GENETIC EFFECTS OF IONIZING RADIATION

The sector on genetic research is large, covering 95 projects in 36 laboratories. The reports presented in this sector give an impression of successful research, and also express satisfaction with the scope and management of the programme. This general characteristic of optimism is to be expected in a field in a phase of rapid development, with new techniques and possibilities opening up both in materials and concepts.

The research is also however, very heterogeneous in material and techniques, ranging from molecular biophysics in prokaryotes to descriptive phenomenology in higher eukaryotes. This is inevitable, since the genetic material at the molecular level is broadly uniform in all systems, and the experimental and observational material may and should be chosen to fit the problem under scrutiny. To some extent, at least, the heterogeneity is less than that at first perceived, and the common purpose of providing knowlege of use for more rational radiation protection provides an overriding structure to the reports.

Analytical evaluation.

The reports were evaluated by two independent reviewers according to a number of criteria, largely as discussed in chapter 4. The reports presented are somewhat variable in form and content, from project to project. In some cases an unnecessary profusion of detail is given, in others the results are given in too general terms. A more standardized format might be envisioned.

Good agreement resulted between the two evaluators and in the final tabulation it was found most convenient to rate the project according to two sets of criteria, one pertaining to scientific interest, and the other pertaining to relevance for radiation protection.

Rating all project reports on a scale of three levels, (low, intermediate, high) in combination with the two sets of criteria, the distribution of table 1 emerges.

TABLE 1

Radiation protection relevance

	n = 84	low	interm.	high	sum
Scientific interest	high	12%	19%	23%	54%
	interm.	6%	17%	15%	38%
	low	-	5%	1%	6%
	sum	18%	41%	39%	98%

It is apparent that the quality of research is satisfactory, as far as can be judged from the documentation presented. This is to be expected both because the applicants may have made their applications on "safe" projects, and the projects which have been awarded contracts have been selected among the best proposed. This obviously tends to make the programme in toto somewhat "non-risky", but at the same time of relatively high scientific quality.

It has been recognized from the beginning that the Radiation Protection Programme should have a portion of basic research of interest to radiation protection, and according to the evaluation Panel this fraction is deemed to be about 20% of the sector. Viewed statistically, this fraction may appear large within a programme of strong practical orientation. However, there is a highly dynamic aspect to modern biology, and basic biological techniques and problems may rapidly become relevant to central problems in radiation protection.

The present emphasis on molecular repair studies - increasing from 40% of the total effort in 1971 to about 50% in 1982 - appears somewhat high, but may reasonably be expected to recede somewhat when the now emerging techniques of cloning and sequencing are applied to problems more directly related to radiation protection.

From Table I it is seen that the category of highest scientific interest and highest relevance for radiation protection has the largest entry (20 projects, 23%), and that three quarters of the reports are deemed of high or intermediate merit in one or both categories. Only 5

reports in toto appear to be of low scientific merit and none seems entirely without merit.

Resulting fully or partially from the programme more than 860 publications have been listed. Of these, about 475 or 55% are articles published in scientific journals subject to peer review. Less than 5% (33) are internal reports or Ph.D. theses, while the rest - 40% (350) - are predominantly abstracts plus conference publications, invited lectures and review articles. The listing is heterogeneous, some projects giving only reviewed publications, others including all abstracts, and some listing the same item several times as if it has been presented to several fora. Sometimes it is difficult to know if the item is a paper or an abstract. A uniform way of presentation would be advantageous.

Observations.

In reviewing the reports some features of the programme are evident and may be worthy of further comment.

1. It is noticeable that only a small number of contracts expressly concern themselves with low doses. This is a weakness from the radiation protection point of view, but understandable from the scientist's view, since it generally is much more informative to work with doses giving clear effects. An effort to extend the dose-effect curve downwards seems in order in many systems, not only in those proven to be sensitive to small doses.

2. Possibly related is the lack of support for epidemiological projects. Today's genetic risk estimates are crucially based on information from animal data. It is becoming obvious that different species may have different radiation sensitivity, and the importance of broadening our knowledge with regard to human mutation epidemiology stands out more and more clearly.

3. Perhaps it might also be noted at this point that recent reevaluations of data in Hiroshima and Nagasaki have indicated the disturbingly high sensitivity of the brain in the 8-16 week old human embryo. It appears unavoidably necessary that psychoteratologic radiation effects be investigated experimentally in suitable systems. An element of this kind should become part of the future Radiation Protection Programme.

Detailed study of contracts.

The interviews with two contractants (see Appendix 5) provided an opportunity to probe in depth the mechanisms of cooperation within the various sectors of the programme, and the relationship between scientists, ACPM, and the CEC administration. The broad register of genetic techniques and end points brings out very clearly the success of the programme management in furthering information exchange and collaborative projects. Such collaboration thus emerges as a useful alternative to the aggregation in larger institutes, be it for the purpose of a concerted effort in a limited area of research, or to create an interaction over broad sectors of the field.

General comments.

As discussed above and elsewhere in the report, the research supported here may have scientifically speaking a "low risk profile". New techniques, even though mainly developed elsewhere have permitted an improved characterization of the mutational event, and therefore opened possibilities for better quantification of the genetic changes induced. In particular, this holds for the emerging possibilities of scoring well defined point mutations in mammalian cells in vitro and also in vivo. These techniques utilize various relatively well defined steps in DNA synthesis or metabolism and thus come as close to the initial event as possible. They also open up the prospect at least of pushing the genetic endpoint to lower and lower doses to establish dose-effect relationships especially in techniques involving mammalian cells.

The 1976-80 programme contributes to the basis for the rapid development seen in the last few years, and the more firmly based measurements of initial radiation damage now possible.

On the other hand, measurements of point mutations in single cells will never tell the whole story. The lesson from the cytogenetic studies coming under the broad description of the "parallelogram method" is clear on how complex cellular interactions may be, how differently different organisms may react, and how difficult predictions are from one biological system to another. Although the outcome of the parallelogram method was not especially successful, the method of analysis alone proved useful in providing new information.

The search for variants of radiation sensitivity and for understanding the underlying mechanisms also may have a strong impact on

radiation protection. The identification of the crucial mechanisms may have much broader implications for health and well-being.

Identification of radiosensitive materials and efficient measurements, especially perhaps the development of new amplification techniques, should in principle open the way for realistic studies at dose levels actually found in radiation protection situations. It is a notable deficiency in the programme as a whole, that so little interest is centered on this very fundamental aspect of radiation biology applied to radiation protection problems. Although studies of mechanisms of induction may often appear as scientifically more challenging and thus attractive, the complex interactions following the initial energy deposition deserves close attention both for practical reasons and in order to unravel processes pertinent to the realization of manifest genetic damage in higher organisms.

The impressions gained from the two interviews were supported by the information available in the answers to the questionnaires. A mutually stimulating working atmosphere within the groups of genetic researchers involved in the CEC programme, a deliberate orientation of the work in relation to radiation protection relevance, a close and fruitful relationship between basic biology and genetics and finally a helpful and creative outcome from the project programme were the main impressions derived.

SECTOR F
EVALUATION OF RISKS

This sector differs from the others in that it consists almost entirely of a single contract of association apart from a contract with ICRP about which a brief comment will be made.

International Commission on Radiological Protection (ICRP). The ICRP contract (like the ICRU contract discussed earlier) is unique in that through it the CEC makes an important contribution to the work of this International Commission. The ICRP deals with all aspects of radiation protection including dose assessment, guidance, specialized information, and recommendations on levels and limits. In the period under consideration (1976-1980), the ICRP and its four standing committees and task groups produced 10 reports and supplements (ICRP #24-30) published in the Annals of the ICRP. The work of the ICRP and

the broad scientific information on protection that it provides is fundamental to the CEC Radiation Protection Programme and to the world at large.

The association contract is entitled Methods of Evaluation of the Consequences of Irradiation of Populations and the Environment. Like other contracts of association the research was overseen by a management committee composed of three CEC staff and three from the research body. This committee in turn was aided by a group of scientific experts which had the role of advising on scientific content and direction of the research. Because of this structure, evaluation could not proceed as in other sectors, by the assessment of a series of contracts leading to some overall conclusion. However, an analogous method of evaluation was adopted.

Method of Evaluation

For purposes of evaluation each of the projects was broken down into its sub-divisions, for example modelling radioactive contamination of the atmosphere formed a natural part of project 1. Each sub-unit was assessed for scientific quality, in terms of methodology and techniques used, progress made and relevance to the project and sector. The scores for each subunit were aggregated to give an overall picture for each project. An assessment was also made of whether the individual pieces of research made a reasonably complete and integrated picture. Finally, this assessment was put together with an evaluation of management aspects of the sector and information on number and places of publications to give an overall picture of the whole sector.

Sources of information

The principal sources of information used in the evaluation were the final report of the main contract, the final reports of the sub-contractors and a number of publications which arose from the research, although many other background documents provided by the Commission were touched upon. The contractor was also interviewed (Appendix 5).

Evaluation of Projects

Project 1 The purpose of this project was to develop methods of evaluating individual and collective doses resulting from normal discharges and accidental releases. The coverage of the project was comprehensive, including models of atmospheric and aquatic dispersion,

deposition, washout and transfer factors from the environment to food products, and the effect of economic exchange. The models developed were also well tested in examples. No obvious piece of research was omitted. All parts of the project were rated highly in terms of relevance. The methodologies adopted were sound and well executed in all cases, particularly so in the development of atmospheric dispersion models and in the tracing of the effects of economic exchanges on the final uptake of radionuclides.

Project 2 The purpose here was to use existing knowledge derived from epidemiological studies, experimental work on animals, and theoretical studies on synthesis and modelling to search for methods of evaluating dose-effect relationships. Much of the work was sub-contracted. Unlike project 1 this project to some extent lacked coherence. The final report did not make it clear why some of the particular areas of research were chosen, and indeed some of the work undertaken could, at best, only have made a very small contribution to the objectives of this project. Nevertheless, the majority of areas of study had the potential to make a worthwhile contribution and many of the studies commissioned as sub-contracts either reviewed the evidence in a particular area or considered the feasibility of generating data from some previously untapped source. These studies were in general well done, with sound methodologies. Some perhaps did not make as much progress as might have been hoped for but this reflected a more fundamental lack of general scientific knowledge rather than any shortcoming on the part of the contractor.

Project 3 The purpose of this project was to examine methodologies for evaluating the economic and social impacts of irradiation. The evaluation of the project proved difficult because only 36 pages of the final report are devoted to this area (in a total of around 400 pages). It is therefore difficult to know precisely what was done although examination of relevant publications arising from the work made it somewhat clearer. The overall approaches adopted: those of examining, using practical examples, alternative techniques for evaluating safety levels; comparing risk levels in other industries with the nuclear power industry; and general discussion on the ethics and practicalities of valuing human life and disability are all relevant and potentially interesting. The work was, however, poorly executed. For example methodologies are compared and conclusions reached on the

superiority of some over others with scant justification. Furthermore, the criteria adopted in two of the methodologies examined seem to omit what some authors at least would regard as the most important of all, what the Americans have called "dread" of a catastrophe. It is possible to justify this omission, but the report does not do that. Secondly, a whole series of issues that can be regarded as central to socio-economic evaluation were omitted deliberately from consideration on little or no justification. Thus health costs were not considered nor were employment effects and the like. Thirdly, nowhere in the report is any reference made to the considerable English language, mainly American, literature on the valuation of human life, on risk perception and on risk evaluation. The impression one is left with is of research carried on in isolation with inadequate searching of the world's literature, and consequent weaknesses.

General

A time-honoured way of avoiding isolation from the world's scientific community is to publish in refereed journals with wide circulation. In all, this contract generated forty-one publications, but only four of these were in scientific (refereed) journals. This seems an unreasonably low proportion. In projects 1 and 2 a good deal of contact with scientific work in other countries of the CEC obviously occurred and the lack of journal publication therefore may not have been a handicap to the work. Project 3 would probably have benefitted from scrutiny by academic referees at an early stage. More journal publication would also have helped to disseminate the knowledge gained more effectively than through publications by the contractor and papers at symposia alone.

The second general comment concerns the method chosen for managing research in this area. The advantages alleged for a contract of association rather than more usual contracting of research were for closer control of the research by the CEC and greater speed in getting the work done. In retrospect neither of these reasons appears very convincing. The reasons for this scepticism are two fold. First, the final report was not submitted until more than two years had elapsed from the end of the contract and, secondly, the reason given for this

was failure on the part of sub-contractors to submit their final reports.

Conclusions

Overall, research in this sector has been reasonably successful, primarily because of the good, sometimes excellent, work done under project 1, the biggest of the three projects. The high quality work in this project offset the less successful work done in the other projects. More effort should be made in future to make sure work is published in refereed journals both to provide feedback to contractors and to disseminate the knowledge gained as widely as possible. Finally, a two-year delay in the production of a final report seems unreasonable. If the problem is control of sub-contractors then some thought should be given either to the wisdom of using contracts of association or to methods of ensuring reports by sub-contractors are available in a timely manner.

THE BIOLOGY GROUP AT ISPRA

The Panel evaluation of the Ispra group was carried out through an analyses of the programmes and related publications, an interview with its present leader, Dr. M. Devreux, and a brief site visit which took place in October 1982. The evaluation proved difficult since the period 1976-80 coincides with the time when restructuring of the group was still taking place with considerable loss of output. For example, the number of publications in 1976-80 decreased, in proportion to the number of scientists, to about 100 from the approximately 220 published during the preceding quinquennium. Clearly, if restricted to the period under review, the Panel's evaluation would have been rather unrepresentative of the present posture or programme of the group. It was thought preferable to discuss the group's performance after 1980.

The group appears now in a better position by comparison with its activities in 1976-1980. This relative gain the Panel attributes almost entirely to the efforts of the scientists and technicians who have done a praiseworthy job of reshaping a programme and giving the laboratory a purpose. Focussing on the unique characteristics of their biological material they have managed to put their expertise together in a coherent programme. The Panel concluded that their work is scientifically well founded and has real value. This was achieved in spite of the

unfavourable conditions under which they operated, the insufficient size of the group, and the unfavourable political climate.

The comments of this Panel must therefore be addressed to the political and higher managerial levels where the desire to change the status of the group originated. While the Panel understood the reasons underlying this action, it could not justify why the action was not carried to its logical conclusion of abolishing the group entirely. It would not have been impossible at the time to find a suitable working environment for the remaining activities, even within Ispra itself, but it appears that social, personal and budgetary considerations prevented this. As a result, the problem was not solved and the group remains to this date as a rather anomalous situation in the whole Radiation Protection Programme. The anomaly is due to it being an intramural group in a programme consisting entirely of contractual research, in its small size which makes it isolated and scientifically inviable, and in its cost, which is relatively high compared to the budget of the entire programme (about 16% of the 1976-1980 budget).

The Panel believes that the European character of the Radiation Protection Programme should derive from an efficient integrated effort rather than from a symbolic Biology Group at Ispra and is unable to see convincing arguments to maintain this activity at Ispra at the present level of financing. The Panel recommends that such arguments, if indeed they exist, should be carefully examined and the whole problem of the Biology Group at Ispra reassessed in the light of the present realities of the Radiation Protection Programme and not of any historical consideration. The Panel does not believe that in its present structure the Group is scientifically viable and wonders whether the research efforts of the group would not be better justified within the slightly larger perspective of other biological activities in the Joint Research centre at Ispra. The Panel recommends therefore that at some suitable early time the entire justification, scope and programme of the group be examined in depth by a separate ad hoc committee, with the aim of finding another appropriate place for the present valuable programmes or of expanding the group to increase its effectiveness within the Radiation Protection or other research Programme.

COORDINATION AND TRANSFER OF INFORMATION

The programme of the Community in coordination and transfer of information is extensive and especially considering the small staff in Brussels, it is impressive.

In the period 1976-1980 a total of 85 study groups and 36 meetings (seminars and symposia) were held in different locations in mainly European Community Countries, and involving some 4000 participants and resulting in the publication of 32 Monographs and Proceedings. This is truly outstanding in volume.

It is not however, so well balanced. Among the 32 Monographs and proceedings no less than 12 are associated with work of Sector A, Dosimetry, Sector B has 6, Sector F has 5, Sector E has 4 and Sectors C and D, 3 and 2. These are certainly not in the ratio of the contract money for those sectors, see Table 2, p. 71.

While it is probably true that some areas of the subject benefit more than others from meetings and publications and other forms of interaction, it is very clear that there is a substantial imbalance in the numbers supported in Sectors like C and D. The latter one has had more EULEP meetings and publications which are not shown in the CEC list however. It is also noticeable that this includes Sector C in which the programme evaluators have commented on the heterogeneity of the programme and the possible need for more interaction.

The Panel recommends that the CEC and perhaps the ACPM examine the question of balance in more detail with a view to establishing whether a better distribution of meeting and publication support might benefit other sectors as much as they apparently do in dosimetry. The influence of the CEC in such matters is clearly very strong and can be used to benefit weaker parts of the programme as well as to further selected important areas.

The Panel does not recommend that the CEC abandon the publication of any of its existing materials. The five year reports of progress are extremely valuable in describing the programme and will be more so if the CEC succeeds in getting more uniform reporting procedures. The Synthesis of Results (Appendix 2, #5) is also a very valuable document in describing the achievements and the scientific impact of the programme. The synthesis is somewhat uneven from sector to sector

however and a little more effort to develop a more uniform text in this document would have been worth while.

GENERAL COMMENTS ON THE EVALUATION BY SECTORS

The distribution of funds between sectors is of some interest and is noted in Table 2.

TABLE 2

EXPENDITURES BY SECTOR IN THE RADIATION PROTECTION PROGRAMME 1976-1980

	Total		CEC Portion	
Sector	Mio ECU	%	Mio ECU	%
Radiation dosimetry and its interpretation	9.3	11	3.5	10
Behaviour and control of radionuclides in the environment	16.9	20	5.5	16
Short-term somatic effects of ionizing radiation	11.1	13	4.3	13
Late somatic effects of ionizing radiation	18.1	22	6.2	18
Genetic effects of ionizing radiation	23.1	27	11.7	34
Evaluation of radiation risks	5.5	7	2.9	9
Total	84.0	100	34.1*	100

Evidently some of the observations noted throughout the sector evaluations are general in nature while others are more specific to the sector itself.

These general observations about the sectors will be brought together and come into sharper focus in the chapter on Conclusions (Chapter 9).

*The CEC expenditures, together with meetings etc. and programme administration, totalled in 1976-1980, 37.2 Mio ECU. The balance, 1.8 Mio ECU, of the 39 Mio ECU available was transferred into the next programme period.

THE PROGRAMME FOR 1980 - 1984

The Panel has directed most of its efforts to considerations of the completed programme for 1976-1980, as it was required to do but references have been made from time to time to later programmes. Examinations have also been made for the 1980-1984 period of the Programme Proposal, (Appendix 2 #10) the scientific justifications, (Appendix 2, #11) and the list of contracts (Appendix 2, #12 and 14) and the description of the programme (Appendix 2, #13). The annual report for 1981 Appendix 2, #15 is available, but has not been examined by the Panel in the same detailed way as the reports for the period 1976-1980.

The 1980-1984 programme continues the six sectors of the 1976-1980 programme with essentially the same format and titles. However, consideration is given to many new emerging items for inclusion in the programme within its sectors.

These include, in Sector A, Dosimetry, environmental dosimetry, exposure in medical diagnosis and biological dosimetry for accidents in addition to microdosimetry and high LET radiation (neutrons) still heavily emphasized from the 1976-1980 period.

In Sector B, Behaviour and Control of Radionuclides in the Environment, the important elements of the programme are re-examined and the attention of investigators drawn to a larger list of radionuclides than previously, which includes the transuranics, the fission products and ^{3}H etc., as well as natural radioisotopes, radium and thorium and their daughter products. The main environmental transfer processes are defined and considered. Evidently this sector is maturing in programme content and developing a more positive, integrated flavour.

Sector C, Short Term Somatic Effects, continues the main emphasis of the 1976-1980 programme on very early effects and on tissue effects on immune and hemopoietic systems without apparently introducing any new or additional emphases.

Sector D, Late Somatic Effects. Emphasizes more than formerly, human studies and human epidemiology especially for populations for whom estimates of stochastic effects (cancer induction) may be possible. In animal work the factors controlling carcinogenesis are enumerated for investigation. Cocarcinogenesis and synergism are identified as important new problems. Still missing from this Proposal however is

emphasis on cell transformation studies or the desirability of studies at very low doses. A large portion of the programme description still discusses non-stochastic effects which occur only after high doses and might well be assuming less importance in the overall programme as time goes on. Coupled into this section however are problems of irradiation during pregnancy and the importance of teratogenic effects. This emphasis is most welcome because these risks may be appreciable even at low doses.

Sector E, Genetic Effects. The proposal describes an extensive and well balanced effort in genetics, probably more comprehensive than ever before. A most important item appears as a small one sentence programme in a 4 1/2 page description viz (Appendix 2, #10 P. 24 e) "studies on the induction of mutations in germ cells and somatic cells at very low doses and dose rates and the development of techniques to facilitate such studies." This important item is not only a candidate for much greater emphasis in the genetics programme as a whole but might also be considered an important subject for the "new idea fund" described later.

Sector F, Evaluation of Radiation Risk. This sector programme was in its infancy in the 1976-1980 period, and as noted in the evaluation, very little of the work done reached the open refereed literature. The proposal here is more mature and aimed at assessing individual and collective doses, detriment and socio- economic consequences in both normal and accidental circumstances and discusses the implementation of the programme. A further development of scientific content is to be hoped for as further maturation clearly has to occur.

Management. The programme proposes to continue the coordination, evaluation and dissemination of information techniques developed in previous programmes. It is noted that (Appendix 2, #10, p. 30, ln. 6-7,) "particular attention will be given to coordination throughout the programme." The underlining is by this Panel, as the Panel has noted the unevenness of the attention given to different facets of the programme in this respect and recommended more uniform attention to underdeveloped areas. The Panel learns from the CEC staff that this coordination has already been initiated in the first two years of the current programme.

Finally, it is noted that an increase in funds is proposed (which of course is necessary for inflation alone) as there will be 49 mio ECU

for the four years 1981-1984 i.e. an average 12.25 mio ECU/year compared with 39 mio ECU for five years (1976-1980, or an average 7.8 mio ECU/year. This does not exceed inflation over the period even though a more comprehensive and better balanced programme is to conducted, as judged by the Panel from the Programme Proposal.

Descriptions of the proposed research on each of the contracts was available to the Panel but this material was considered too massive to attempt a detailed evaluation of the programme which would in any case be before the fact.

THE PROGRAMME FOR 1985 - 1989

The Panel was also, of course very interested in the scope and aims of the programme for the 1985-1989 period since the development of proposals and scientific documentation for this period were in progress during the Panel's work. Indeed this is the period in which some of the Panel's comments and recommendations might mainly be expected to take effect. It is to be noted in this regard that although a full evaluation of the programme for a given period, as the Panel hopes it has done for 1976-1980, the period must be over, nevertheless too much time should not elapse before the evaluation begins. The Panel feels in retrospect that no more than a year after the programme ends is a good time for the evaluation to begin so that the report of the Panel can have an unhurried impact on the Programme Proposal for the period after the current period.

The initial draft of the Programme Proposal (Appendix 2, #17) describes the role of the Radiation Protection Programme in the Community, in relation to other areas of research, its justification and the assessment of problems and consequences. This material is developed in greater detail and with more appreciation of socio economic impacts, Community needs and the practical importance of radiation protection than in previous programme proposals. The relevance and benefits to the Community and to other scientific areas are well presented. It is also noted that the problems of radon are being identified in context (p.12), though perhaps not yet fully realizing that these exposures probably represent the largest single collective effective dose equivalent to people from any source. Nevertheless the sophistication of this overall description of the programme and its importance reflects credit on the ACPM, the CEC staff, and their consultants and advisors.

Among the sector programmes there seem to be some changes in emphasis also.

Sector A, Dosimetry, concentrates more on field quantities and dosimetric problems in the implementation of protection standards and perhaps less on microdosimetry and neutrons, although in the latter case there is important emphasis on personal dosimetry. Doses in accidental exposure continue but somewhat less emphasis is placed on the acquisition of more physical data (properly in the Panel's view, at this stage of development).

Sector B, Behaviour and Control of Radionuclides in the Environment, has also undergone some change in emphasis, the source terms being given special attention and the enhancement of natural background ranked first before the nuclear fuel cycle, accidents, waste disposal, and transfers within the biosphere. Again a developing maturation of this sector.

Sector C, Non-Stochastic Effects. The sector title and content has changed to include all non-stochastic effects, early and late, a welcome and desirable change. Many important components of the programme, effects on immune system and hemopoietic effects continue as new emphasis is placed on threshold effects and dose-effect relations and there is an entire section (one of five) on radiation effects on the developing organism. It is certainly to be hoped that this emphasis results in important contract work in the laboratories of the Community and the CEC might already begin to consider fostering the work by workshops and other means.

Sector D is now confined to radiation carcinogenesis, again a most welcome re-orientation of the sectors. In the general introduction "the mechanisms by which cells are transformed and tumor growth is promoted following irradiation..." is mentioned finally. However, the succeeding four sections, are entitled "molecular alterations; experimental carcinogenesis (animal studies) incorporated radionuclides; and human observations; of which (a) and perhaps (e) of six items (a-f) is cellular. The recognition of cell transformation systems is evident but not sufficiently emphasized. There is presently little work of this kind in the European Community even though for dose-effect relationships

at the lowest doses these systems presumbly provide the most promise of good quantitative information. A much greater stimulus is needed and the CEC should identify an entire segment here to establish the importance of cellular methods - i.e., one of five subheadings for Sector D should be cellular effects.

Sector E, Genetic Effects. The description of the genetics programme continues the sophistication of this work in the past. It does draw attention to work with low or small doses, but it could emphasize it much more. The geneticists have the opportunity to press hard on developing systems to get to lower doses. In this regard the potential of some mammalian systems like those of the HGPRT locus and the ouabain resistance techniques and others perhaps yet to be developed might be mentioned. A welcome emphasis is noted on cytogenetic techniques in prenatal exposures however.

Sector F, Evaluation of Radiation Risks. Now in its third five year period this sector is taking shape well and it is noted that first among the source terms are the risks of exposure to the public and worker from natural radioactivity and emphasis on radon and thoron and their daughter products. Then follows risks to both public and worker from industrial uses. Epidemiological data for risks, socio-economic considerations, optimization, reduction of patient exposure in medical diagnostics and comparative risk assessment are also included. This is a well balanced sector proposal.

Management techniques again emphasize past efforts on coordination and dissemination of information. It is not possible to tell from this account whether other groups like EULEP have formed recently, or whether progress has been made in stimulating meetings and etc in some of the weaker programme areas.*

It is noted that the proposed effort will rise to 93.4 mio ECU for 1985-1989 or 18.7 mio ECU/year, a reasonable but modest expansion of the programme after inflation is accounted for. It is noted too that the ISPRA Biology Group at 9.6 mio ECU is only just over 10% of the total

*Note the earlier comment that CEC staff state that these steps have been initiated already and more are contemplated.

programme cost but still a significant anomaly as noted earlier. The amount for management and administration, 9.o mio ECU, is now 9.1% and has increased a little. The comparative amounts of funding in each of these sector activities is not available at this time and it may be interesting to compare this later with earlier periods. However, this would clearly be prospective and would not reflect the new contractual work which might be offered in these sectors.

The amplification of the scientific details relating to the programme is available in the document on "Scientific Documentation" (Appendix 2, #16).

It is evident that some of the scientific deficiencies noted by the Panel for the period 1976-1980 have been addressed in the 1980-1984 period and even more so in the 1985-1989 period. Still to be adequately emphasized in this Panel's opinion is a greater emphasis on transformation studies, and a greater emphasis throughout on the importance of low dose studies. Hopefully those items already stressed quite well here namely sensitivity of embryo and fetus and studies with radon will result in substantial progress with laboratory studies.

The Panel would like to express the hope that the points made in this evaluation report might be reflected in the 1985-1989 Programme, since it believes that the most fruitful outcome of such an evaluation should be in orienting the future rather than criticizing the past.

Chapter 7

Evaluation of Management

The evaluation procedures discussed in Chapter 4 were aimed mainly at ensuring an adequate evaluation of the scientific merit of the research programme as a whole. However, many of these procedures were directly useful for examining management procedures as well. In addition, presentations by Mr. Van Hoeck, by Dr. Ebert, by the programme managers for the sector programmes, and by Mr. Hurst for the contract Manager Mr. DeSadeleer, Head of the Contract Division of D.G. XII, provided the Panel with material to understand the procedures used. This also helped the Panel to determine the extent to which the administrative framework was suitable for the task of providing cost-effective research funds in an equitable manner to a ten Member State Community, and the extent to which programme managers were able to work within this framework in a harmonious way. The impressions of the Panel were amplified by the interviews with senior investigators and other prominent individuals such as the Chairman of ACPM and the Chairman of EULEP. The results of the questions relating to management in the questionnaire were also very helpful in this assessment.

The Overall Process of Community Administration

This Panel of scientists decided not to comment on the administrative procedures necessary in such a highly complex organization as a Multistate Community formed by no less than three primary treaties and additional agreements. The fact that the entire Community programme works is a significant tribute to those who put it together and to those who now labor to see that the complexities of dispensing public money are accomplished cost-effectively in research in ten Member States. The two year process by which the final Programme Proposal is developed and decisions made by the Council of Ministers has an elaborate system of cross checks and balances at all levels. The Panel notes that the system seems to function successfully and to satisfy those who themselves have to satisfy the public in their respective States. The length of the procedures although perhaps cumbersome, seem to be well understood by the contractors.

The process has evidently evolved with time. The difficulties occasioned by late approval of five-year programme periods (April 1976 for programmes beginning January 1, 1976) appear now to have been solved and, judging by the questionnaire results, to have had no lasting adverse effect. Much to the credit of all concerned administratively, the procedures appear now to work smoothly and result finally in a five-year budgeted plan for research. The stability that such a plan ensures for research activities must contribute greatly to the continuity of European research programmes. It must also be the envy of many of those Member (and Non-Member) States who do not enjoy such predictable support and must face annual changes, sometimes drastic. The CEC is greatly to be commended for having achieved this important aspect of the programme.

The Content of the Programme Proposal

The very fact of this stability places additional burdens on those responsible for the Programme Proposal to ensure the soundness and scope of its overall content, its flexibility to new ideas and its ability to ensure viability and vitality in the longer term support of laboratory programmes that otherwise may become smug or blasé. The CEC has clearly addressed many of these questions and a few comments might be made.

(1) The commitment of funds on a sliding scale during the period is excellent and allows for new proposals to be developed even late in the same period.

(2) The nature of the programme scope in the Proposal is kept as general as possible to allow for significant additions. This is also good.

(3) External experts and the ACPM are consulted for new ideas and programme balance.

(4) The programmes are monitored carefully by supervision of the annual progress reports and the final report, both by CEC Staff and ACPM and by the performance of investigators at study group and other meetings, by bibliographic and other records, and by visits of CEC staff at regular intervals to many of the laboratories.

Monitoring of results seems to the Panel to be comprehensive and well carried out in general but some further suggestions may be in

order: (a) in addition to visits by CEC staff, in some of the larger and longer term contracts, a scientific group on an ad hoc or longer term basis might be appointed, to report to the ACPM on the status of the programme and to assist in further planning of the programme. Visits should be carried out with some degree of regularity that is not excessive, perhaps not more than once in five years or even less. (b) CEC should require from its contractors a more thorough and comprehensive report at the end of the 5 year period. This should specifically emphasize what was proposed and exactly what was accomplished and should be supported by reprints. (c) The CEC staff should make an effort to keep an up to date list of reports issued and work published in the literature which contains specific acknowledgement to the CEC support received; this would facilitate a more precise assessment of the programme.

(5) The additions the CEC made to the programme content in the 1976-80 programme period were concerned with more active collaboration, support of group collaboration such as EULEP, EURADOS and others, support of courses and stipends to attract younger people. These were also excellent.

(6) The additional expansion of the programme in the 1980-84 period and that proposed for 1985-89 again appear to be in desirable areas which will further expand the scope of the programme. While fully comprehensive programmes may not be possible, important research areas must not be neglected, considering together the CEC programme and its Member State counterparts. It is noteworthy that each successive proposal tends to broaden the scope of the programme further.

(7) The Panel was convinced that there should be deliberate means to ensure the appropriate completeness of the overall programme. The total programme of all the CEC supported work plus that of each of the Member States in the field of Radiation Protection is apparently not known, cannot easily be assessed and is certainly not documented comprehensively. This makes judgements about the scope of the CEC programme somewhat difficult. Clearly the CEC has very successfully emphasized some areas e.g, (microdosimetry, neutron dosimetry and effects) which could not possibly have progressed so fast without such support. Yet, it is also clear that there were gaps in the 1976-80 programme, some of which have been corrected in the 1980-84 programme

and even more in the 1985-89 programme proposal. Some still remain, especially in terms of emphasis, and reference has been made to them in the sector evaluations. Obviously, these gaps are also to some degree dependent on the perceptions of members of this Panel and may not be shared by everyone. Other important items could also have been mentioned however. It is recognized that the ACPM examines the Programme Proposal carefully in 3 stages, but it is nevertheless suggested that more emphasis still be placed on programme strategy, for example, by considering in detail the proposed programme against the template of a fully comprehensive programme and then either to dismiss a given research area as not necessary or infeasible, or to support it as an essential component of the programme. The Panel is aware that their own examination in this regard was for a very specific purpose, but nevertheless it revealed what seemed to be significant deficiencies in an otherwise exemplary broad-scope programme. Furthermore the deficiencies cited are not intended to be exhaustive. The Panel therefore suggests that at the appropriate stage in the consideration of the Programme Proposal, the ACPM hold a special meeting (like the July 1982 meeting) in which the programme of each sector is examined in detail by groups assigned to each one. These groups could consist of ACPM members supplemented with additional experts selected for sector appraisal.

Finally, the Panel suggests at this meeting it would be desirable for the entire group (ACPM and experts) to consider whether the sectors as identified are still the best under which to arrange the work of the whole programme, or whether alternative or additional sectors might not be more effective in pursuing the objectives or providing new CEC emphasis for stimulation in important new areas. It is appreciated that the arrangement of the programme by sectors is arbitrary and that other choices might have been made and perhaps sometimes should be made. For example, the CEC created a new sector on risk evaluation in the 1976-80 period and this has had a very noticeable effect on the development of further research in that area. If, at that or another stage, the CEC had decided to create, for example, a sector dealing exclusively with molecular and cellular effects, work on cellular systems (particularly on transformation and perhaps also on dose-effect relationship models) might have been stimulated. Such questions may have been considered already by ACPM but possibly in an ad hoc fashion not apparent to this

Panel. Programme strategy is so important that a deliberate mechanism, such as the meeting suggested in (7) above should be instituted and a full record of the actions taken and the reasons for them made available.

The Allocation of Contracts and Administrative Procedures at CEC Staff and ACPM Level

The Panel can only record its unconditional approval of the manner in which this phase of the programme is conducted. The CEC staff and the ACPM clearly work well together and perform their respective roles with efficiency and dispatch. To accomplish what the ACPM does in two meetings per year is a great credit to the ACPM members and the CEC staff who work with them. A large committee of multinational delegates must be very effective in its work to accomplish it so expeditiously. Thus the Panel finds virtually complete satisfaction in the implementation of the programme from the management standpoint.

The CEC staff is small, efficient and very much on top of and in touch with the work in their field, both within and outside their contracts. The investigators in the field, as demonstrated by questionnaire answers and the persons interviewed, show an overwhelming appreciation of the way in which the CEC staff display interest, monitor progress, assist with procedures but do not try to direct or interfere. Scientists cannot wish for more and apparently those receiving CEC support are aware of their good fortune. For those who may have taken the matter of reporting somewhat casually, the Panel suggests that they should be willing, in return for the good work of the CEC staff, to provide them with more careful and informative final reports that really present what has been done in perspective and in reasonable detail.

In conclusion the Panel finds the overall administrative procedures of the Community sound and effective and resulting in a stable five year programme of support. Indeed the Panel also finds the preparation and implementation phases of the programme by CEC Staff and ACPM to be quite outstanding.

The Panel has made certain recommendations based on the text above which will be outlined in Chapter 10.

Chapter 8

Socio-Economic Evaluation of the CEC Radiation Protection Programme

While scientific peer review of research programmes is a familiar procedure in many parts of the world it is much less common to include a socio-economic evaluation as part of the terms of reference for the evaluation. The requirements of the CEC's programme evaluations are therefore unusual. Although earlier panels were charged with the responsibility of conducting a socio-economic evaluation, none of those which have reported at the time of writing have undertaken that part of their task in detail. This Panel decided on its own interpretation of the request for such an evaluation and the methodology for putting it into effect. Because new ground is being broken, a short discussion is provided of the purpose, methodology and limitations of such analyses as a prelude to describing our conclusions.

The purpose of socio-economic evaluation

Although knowledge has value for its own sake, the prime justification for expenditure on scientific research lies in the contribution research makes to the well-being of society, i.e. the value that it has in relation to the wider objectives of the Community. Decisions on funding priorities for science must therefore involve a judgement about the likely value that a programme will have. The value might be expected to be immediate, or well into the future, as in the case of basic research. There are two major elements in the assessment of likely value. One is an estimate of the probability that a scientific programme will bear fruit in scientific terms i.e. that new scientific knowledge of a substantial kind will emerge. The other is an estimate of the contribution of this knowledge to Community objectives. All statements about future expectations are derived from interpretations of past experience. Scientific evaluations provide information about how productive programmes have been in scientific terms and may make recommendations which will affect the productivity of future programmes. Assessments of value have typically been left to decision makers, usually politicians and senior officials. The inclusion of socio-economic evaluation in reviews of CEC scientific programmes reflects the desire of the European Parliament, the Council

of Ministers, the Commission itself and others to have some firmer base on which to place their future judgements of value. The purpose of a socio-economic evaluation of the CEC research programme must therefore be seen as providing decision makers with as much information as possible about the impact of the research on the wider objectives of the Community (see also, the CEC framework programme, Appendix 2, #24). This information can then be set against similar information about other programmes as it becomes available in order to help determine priorities for expenditures on scientific programmes.

An ideal set of socio-economic evaluations of different research programmes would identify the programme benefits, quantify them and assess them in money terms so that direct comparisons could be made between the productivity of research funds placed in different sectors. In practice, even given time and suitable research staff, it will often not be possible or helpful to fully complete all these steps. The process of identification of benefit is probably feasible, provided the scientific developments are not too dramatic. In that case the ramifications may be so widespread that they cannot all be listed. Quantification and valuation are progressively more difficult steps to take than identification, and in a programme such as radiation protection where the intended outcomes are not commercial and market based, but aimed at protecting the public and workers, the final stage of valuation may be so contentious as to not be worthwhile. When outcomes are market based, given appropriate time and resources, the technique of cost-benefit analysis provides a suitable methodology for estimating the value of outcomes. However, the results are more likely to indicate broad orders of magnitude rather than precise estimates.

Methods of analysis adopted by this Panel

This Panel had little time and no research assistance etc. to enable it to perform a rather fuller analysis of the socio-economic benefits of the programme. The Panel had, therefore, to do the best it could with the resources it had available. The approach adopted had three elements. First, the Commission staff asked each country's ACPM representatives to prepare a paper setting out their views on the socio-economic benefits of radiation protection research in their own country. The replies were then examined and their content included in

the evaluation. Secondly, questions aimed at detecting socio-economic benefits were included in the questionnaire. Contractors were asked to state what the benefits were from their research both in the radiation protection field and in other fields of human activity. To try to avoid possible exaggeration of benefits, contractors were asked to specify by name the users of their results. A further, more general question was also included in which contractors were invited to comment freely on what they saw as the socio-economic benefits of the programme. Thirdly, the Panel used its own judgement on the more general aspects of the programme including its effectiveness and in particular with respect to its contribution to European co-operation and its contribution to the CEC and to the world scientific community.

Results of the evaluation

The Panel believes that a number of very positive benefits have been derived from the Radiation Protection Programme. These include:

1. Contribution to the Development of European Co-operation.

Some outstanding examples of successful co-operation have occurred under the aegis of the CEC programme. Notable among these are the EULEP programme and the development of co-operation in dosimetry, in pathology and in internal emitter research involving late effects studies of both cancer and nonstochastic effects. In dosimetry for example, this has led to standardized procedures, intercomparison of calibrations and better quantitation of overall results.

The CENDOS programme for intercomparison of neutron dosimetry in European laboratories and the earlier participation in the ICRU-inspired intercomparison in the United States, not only served to provide a better base for quantitation but solved some measurement problems and improved others.

The Primary Effects programme carried out by laboratories belonging to the European group for the study of Primary Effects on Nucleic Acids, which was initiated by CEC, has developed a concerted attack on the problem by pooling ideas and expertise and participating jointly in different portions of an agreed-upon programme plan.

It is not only the existence of these special co-operative groups but also the widespread practice of maintaining contacts between

researchers, between researchers and CEC staff and the participation in Programme Proposals via ACPM of some of the scientific members of the European Community which leads to a sense of cohesion and purpose in the whole programme. A single investigator, laboratory, or even a country could not hope to do this so effectively alone. All contractors replying to the questionnaire reported they had some interaction with CEC staff and 97% said they were useful while 76% said they affected the content and conduct of the research.

In the Panel's view these shared experiences and frequent contacts have led to a European scientific identity and a sense of Community purpose. The Community scientific programme and the spirit that lies behind it is somehow more than the sum of its parts. This sets the stage and paves the way for greater achievement than would be possible in a different and less positive scientific milieu, thereby directly assisting in one of the stated goals (Appendix 2, #24) of the Commission's scientific and technical strategy, to improve the CEC's scientific and technical potential.

The programme has also contributed to European cooperation in another and direct way. Many environmental problems involving radionuclides do not respect national boundaries. In particular, releases to atmospheric and aquatic systems tend to constitute a general European problem rather than a national one alone. A good deal of the work undertaken in the risk evaluation sector was directed toward modelling the consequences for Europe of releases both from routine operations and accidents, no matter what the country of origin. The modelling was carried out under sub contract in many different countries.

2. Contribution to the field of radiation protection as a portion of world science.

The scientific achievements of the programme have included items that would not have occurred in the absence of the CEC programme. The need to write five-year Programme Proposals and to examine the overall content of the programme have probably contributed to this. Notable among the European contributions have been, for example, the development of the EULEP pathology atlas, or the steady progress in microdosimetry, possibly greater than in the U.S.A. where microdosimetry originated.

Others include the focus on decorporating agents for radionuclides, progressive work on immune systems, and the development and testing of models for radionuclide transport in the environment.

These developments had a significant impact on the world's literature. To try to assess the magnitude of this impact, the UNSCEAR report of 1982 and several ICRU reports were screened to establish the relative share of the publications quoted coming from contractors of the CEC. The lists of references were searched for papers published by CEC contractors. This means that some publications may have been generated by the non-CEC part of the contractors' work and the list below should be interpreted as an upper limit of the impact of the CEC work. The Panel recognizes that for some subject areas the estimates are only approximately correct while for other areas, for example microdosimetry and non-stochastic effects, the estimates are probably almost exact.

From a total of 1780 references from the period 1976-82 the contractors of the CEC contributed 24%. For example:

Dose assessment models	16%
Exposures to different radiation sources	19%
Genetic effects of radiation	20%
Non-stochastic effects	20%
Dosimetry general	40%
Microdosimetry	44%

3. Contributions to education and training.

The CEC programme has been extremely active in the development of symposia and seminars within the radiation protection field, especially in microdosimetry, in neutron dosimetry, in late effects, in intercomparison results, on the biological effects of bone seekers and transuranics, primary effects etc. - a total of 32 published symposia proceedings and monographs in the 5-year period*. Thus the contributions to scientific education and training within the Community (and by the presence of many non-Community participants outside it also) has been very extensive. Undoubtedly much of the growth and scientific sophistication of the programme from 1960 to 1980 has been because of the educative value of these meetings and publications.

* See Chapter 2.

More specific contributions to training such as, say, the provision of graduate student fellowships or the support of academic groups to decide on optimum curricula or the like have been developed elsewhere by CEC but not in this programme. Nevertheless three contractors mentioned the CEC programme as being invaluable in their (small) departments in providing the opportunity to train doctoral students. With the decline noted by some in the university and other teaching programmes in radiation biology and radiological science generally, the Panel feels it would perhaps be appropriate if the CEC played a larger and more specific part in the development and maintenance of sound expertise in radiation research by means of predoctoral and postdoctoral training programme support. For while much progress has been made in radiation biology, the fundamentals in the field, the processes leading to cancer induction or mutation, or even the dose-effect relationships which control them, are still not fully understood. There is consequently much left to do in training and educating new people.

4. Protection of workers and the general population.

The formulation of basic safety standards for the Community countries is mainly based on the evaluation of research carried out by groups such as UNSCEAR and BEIR and carried into recommendations for protection by groups such as the International Commission on Radiological Protection (ICRP) and the basic standards committee of the CEC. The basic research which is essential for the preparation of these recommendations is conducted within the CEC, in the USA and elsewhere. It is difficult to apportion that part of the improvement in regulations and protection due specifically to CEC supported research but the contribution is clearly significant.

Workers: As a result of research efforts the extent of worker exposure throughout all industries, medical and academic institutions and others involved in radiation applications is carefully limited. Generally it does not exceed from 1 to 5 times the natural background on the average and is 1/10th or less of the current dose limits. These estimates apply to the approximately 300,000 radiation workers in the Member States of the community. In addition, no individual is believed to be exposed to an undue risk under normal exposure conditions because of our knowledge of protection procedures and measurement practice.

The Panel believes that the CEC research programme has made a contribution to this state of affairs as is evidenced by its contribution to the world's literature discussed above. In addition three contractors and one country's set of ACPM delegates were able to point to direct applications of research in worker safety in the nuclear industry.

General population: It is virtually impossible to avoid some small exposures to ionizing radiation. Natural background from terrestrial sources, from cosmic radiation, from internal radionuclides like ^{40}K, ^{87}Rb, ^{14}C, ^{3}H and radium and from radon and daughters, contributes an inevitable exposure which also varies with the location and circumstance. Radon and its daughters constitute a special problem of exposure to the public and indeed the source is responsible for the largest single collective effective dose equivalent. The problem has become more serious as the result of energy conservation measures in homes. Better insulation and lower ventilation rates tend to accumulate radon seeping through from the soil into the house. Although not part of the 1976-1980 programme, an extensive programme concerning radon and radon daughters is now in place in the CEC with the aim of evaluating the magnitude of the hazard to the people of the Community, the risks involved and means to reduce them.

Medical irradiation contributes especially to the exposure of older members of the population and cosmic radiation contributes higher exposures to frequent air travellers. Consumer products, including devices employing radionuclides such as smoke detectors, generating apparatus such as TV, simple building materials, all result in some small exposure. Small releases of radionuclides from nuclear power and other power plants, and from fallout from nuclear weapons testing also cause some small exposure.

Knowing what all these exposures are, providing protection or amelioration in those cases where it is warranted, limiting the dose to individuals (to ~ 5 x the average background) results in keeping additional exposures to members of the public low, probably less than half the current background on the average. The research that is done within the Radiation Protection Programme is aimed at reducing the effects of radiation to a minimum and protecting the public from the more important sources of exposure. A careful quantitative

documentation of progress in this area for both workers and public might contribute greatly to public understanding of the aims of the programme.

Accidental Exposures: Accidental exposures involve special problems. CEC research attempts to contribute to the avoidance of accident situations, to unpredicted contamination and the like, and assists in understanding how to deal with these problems when and if they occur. Especially important are the medical handling of more severely exposed individuals. CEC research has provided means of dealing with higher external exposures and for the removal of radionuclides from the body and treatment for their effects. Such knowledge and experience can be expected to save lives in cases of severe accident. Work aimed specifically at providing such knowledge is conducted in the risk evaluation sector in the development of models predicting the effect of accidents. In addition, eight contractors pointed to examples of their work having direct application to the formulation of safety standards, increased protection from exposure or better treatment after exposure.

5. Provision of an important power option for the countries of the Community.

Nuclear power is an important option for most of the countries of the CEC. Many of the Member States of the Community are not well endowed with fuel resources and nuclear power can reduce the CEC dependence on imports, with implications of greater freedom of manoeuvre in international relations and less drain on the collective balance of payments of the Member States. The latter implication was specifically mentioned by one national ACPM delegation. This option is only possible because we know so much about the risks associated with radiation because of CEC and other life science research.

Despite the fact that risks in ordinary operation for nuclear power are smaller than for most other power sources (as the risk estimations per kWh related to alternative sources undertaken in the risk evaluation sector show) and less radionuclides are released from a nuclear power plant than from some coal burning plants, the public still has considerable fear of nuclear power. This is at least partly because of the possibility of nuclear accident or the misuse of proliferative material. If the public are to have a proper appreciation of the

relative risks of alternative power sources, including nuclear power, they need to be educated in those risks. This means that not only should research be conducted into relative risks, as it was and is in this programme, but an effort has to be made to convey the information to the public.

The 1976-80 programme generated a good deal of information that was potentially important in improving this understanding and no less than seventeen contractors specifically mentioned this aspect of the programme as being a major socio-economic benefit. By contrast most of the ACPM delegates drew attention to the absence of any effort to communicate information and ideas to the general public. The importance of the Radiation Protection Programme is first that we do not know enough about radiation effects (although a lot is known too) and secondly that we need to weigh the cost/benefit equations appropriately. Scientists do almost nothing about informing the public or the decision making levels of Government about these matters. It is there that the cost/benefit equations will eventually be judged.

The Panel therefore recommends that the CEC initiate a public information programme which realistically and objectively sets out to inform the public via brochures, books, media, etc. on just what are the facts and issues surrounding radiation protection.

6. Spin-offs in other fields.

The spin-offs from radiation protection research can be classified under three headings:

(i) The development of safety standards and protection in non-radiation fields. Radiation protection research has developed a considerable understanding of dose-effect relationships and as a consequence has made possible a reasonable choice of safe limits for workers and for the public. The knowledge and the methodology should be applied to other industrial circumstances, especially those involving other carcinogenic agents. In addition radiation protection is an important pilot area for cost benefit analyses or similar rational decision-making techniques and these can be applied to other areas of risk from environmental or industrial pollutants. The International Commission for Protection against Environmental Mutagens and Carcinogens (ICPEM) has largely modeled itself on the ICRP. Two of the ACPM

delegations quoted the example of radiation protection as a pilot with respect to socio-economic benefits in their own country.

(ii) Commercial and industrial applications. By its nature this programme is unlikely to generate very many commercial applications and only one of the contractors reported in the questionnaire that his work had a direct commercial application. However, one ACPM delegation drew attention to a commercial development in their country, food pasteurization, which was consequent on the programme. An important spin-off for non-nuclear industries lies in the application of models of the movement of materials in the environment. Atmospheric, aquatic and terrestrial models have been validated with radionuclide studies, but apply generally to the transport of many pollutants. There are also other industrial applications such as the determination of the effects of thermal releases to the environment from many sources in addition to nuclear.

(iii) Medical spin-offs. There is no doubt that the work on radiation protection has had an impact on medical care technology in other fields. For example, in radiation therapy, the CEC programme has contributed to the improvement of clinical dosimetry in general and to a large extent to the development of new radiation modalities such as neutron therapy. In oncology, treatment of leukemia by bone marrow grafting and the management of patients treated extensively with chemotherapy (bone marrow stem cell preservation) are also important spin-offs. Furthermore, in diagnostic radiology and nuclear medicine, the need for a reduction of the dose to the patient arose as a result of the Radiation Protection Programme and this in turn has stimulated research and new techniques in both these fields. The CEC programme itself is adapting to encourage further research along these lines. The field of genetics has also been substantially affected and developments such as using radiation-induced genetic malfunction to fight insect pests have become possible. In all, twelve contractors mentioned examples of medical spin-offs from their research in their questionnaire returns.

7. Prevention of duplication of effort in research.

Communication in research is vital to both the progress of research and the avoidance of repetition, since ideas often occur in a number of places at about the same time. Healthy competition and more than one

approach are essential components of good research efforts, but unnecessary duplication of effort on very similar problems especially if by inferior methods can be costly in time, effort and money. CEC communication methods help very markedly to reduce this. Contractors reported very high levels of contact with each other and with the Commission staff. In addition, the CEC publish final reports and symposia documents and disseminate them widely. Typically several hundred to a thousand are printed and distributed mainly to the scientific community. The availability of these may not be as widely known as they should be however and a broader distribution of information on the publications available from the CEC would be very desirable.

However, not all aspects of the dissemination are seen as being ideal and about half of the contractors in their questionnaire returns expressed misgivings. Some felt that there was variability in the quality of final reports and in the timeliness of their distribution. It has already been noted earlier, (Chapter 6) that the distribution of meetings, workshops, symposia etc., are somewhat uneven across the sectors of the programme. In view of this, it is not surprising that some find the CEC efforts at communication more than adequate while others see them as modest.

Conclusions

In terms of the recently drawn up proposals for Community strategy for scientific and technological activities, the framework programme (Appendix 2, #24) the Panel believes that the Radiation Protection Programme has made a substantial contribution in three of the principal objectives. These are in improving the management of energy resources and reducing energy dependence; in improving living and working conditions by improving the protection of health and the environment from radiation and other hazards; and by improving the CEC's scientific and technical potential. In addition several spin-off benefits for other aspects of health care and examples of the development of new techniques for conventional industry are noted, as well as the importance of the radiation protection field as a pilot for the control of other hazardous agents.

Chapter 9

Conclusions

I. Scientific Aspects

A. Observations

1. The programme, after more than 15 years development to 1976 is now mature, well balanced, productive and reasonably comprehensive in scope. Furthermore most of the major laboratories active in radiation studies in the countries of the European Community participate in the programme.

2. The division into six sectors is appropriate and useful from the standpoint of encouraging scientific quality, the potential interaction of contractors and programme management. It is not necessarily definitive however as to whether there should be fewer or more sectors or whether the whole programme should be differently arranged.

3. The programme in the period was productive, contributing about 40% of the research funds to the work of 700 European Community scientists and resulting in 600 publications per year at an average cost of 12,000 ECUs per publication for the CEC contribution.

4. The Panel examined also the nature of the publications. Over the entire programme about (50%) of the papers described as resulting from the programme were in refereed scientific journals others being in reports, books and other publications. No comparable figures were available to assess whether this is the same or different from other large programmes. However, within the programme itself, the sectors varied from very few papers in refereed journals (Sector F, Evaluation of Radiation Risks) to about 25% refereed papers in dosimetry and in the environment, to 55 to 65% in late effects, short term effects and in genetics. The Panel recognized that these differences partly reflect CEC support of specific meetings and publications proceedings which makes available rapid dissemination in fast moving fields but which tends to subtract some papers from the refereed open literature. It is to be noted however that what were, for other reasons, considered to be the strongest contracts, in dosimetry for example, had much higher ratios of refereed papers (40 - 60%), than the average in the sector.

5. Although not expected to be completely comprehensive, but rather to complement National programmes and to achieve coordination, the scope of the programme was nevertheless very broad. There is evidence that it continues to broaden in scope and to change in emphasis with successive Programme Proposals for succeeding five year periods (1980-84 and 1985-89) in accordance with changing research needs. These Programme Proposals also exemplify an increasing awareness of and responsiveness to the needs of the public in the Community countries.

6. In some areas the programme appears to lack cohesion and the individual projects tend to be isolated from one another. These are notably areas (short term effects, environment) where collaborative groups did not exist and where somewhat fewer symposia and other meetings have occurred. Some groups may have been formed since the 1976-1980 period but more attention should be given to the stimulating effect of these interaction mechanisms across the entire programme.

B. Evaluations

1. The contracts in each scientific sector may be classified rather easily according to the methodology adopted into four main groups: a very few that were not satisfactory; more that were satisfactory but not outstanding; many that were good to very good; and a few that were truly outstanding. Thus there were few contracts in the programme (and none in some sectors) that the Panel felt did not deserve to be a part of it.

2. The methodological and technical standards of the research carried out under the programme are high and there is no question that most of the investigators concerned are fully aware of the latest developments in their field and use modern and sophisticated techniques.

3. With some notable exceptions, the contracts included research which was on the whole very competent and well conducted rather than innovative and taking risks with new ideas that might fail. Little of the latter is evident in the programme.

4. The programme in the 1976-80 period contained few experiments aimed at the effects of low doses even though radiation protection today is mainly concerned with low doses. More efforts must be made and encouragement offered to extend experiments to lower doses and this should be made a strategic requirement for the future. Work at low doses will inevitably place great emphasis on precise experimental

planning and on the development of appropriate mathematical methods of statistical analysis. Early consideration should be given to these areas also.

5. In spite of the breadth of the programme the Panel noted some rather surprising gaps or lack of emphases of important programme areas, for example, cell transformation studies, effects on the embryo and fetus, radon exposures and effects. As long as the programme is being as comprehensive as it is, these items should be addressed, and indeed many have, to different degrees, in later programmes. A more detailed and comprehensive examination, such as that suggested be undertaken by ACPM, may reveal others.

6. The programme clearly placed strong emphasis in some scientific areas such as microdosimetry in which CEC support has been most effective, and has resulted in the development of the field more rapidly than would otherwise have been possible. This capability is so important and could be used to balance underdeveloped fields that the Panel feels more attention should be given to just how the power is used. Hence the paramount importance, in the Panel's opinion of the development of overall programme strategy.

7. One item of scientific importance which also touches on managerial aspects is the Biology Group at Ispra. The Panel recognizes the scientific value of the individual efforts but believes the group in its present structure is anomalous and questions whether the work could not be as effectively carried out at another location utilizing the normal contract support mechanism.

II. Management Aspects of the Programme

1. The procedures for developing the scope and budgetary content of each five-year Programme Proposal appear to have been completely worked out. Thus a five-year plan results which has had the benefit of many kinds of scientific, administrative and political consultation and is ready for implementation one year before the period is to begin. Although this was not the case in 1976 and the delays in initiating the programme were detrimental to it, the problems of ensuring continuity have been resolved since and CEC deserves full commendation for this.

2. The implementation phases of the programme appeared to be working very well indeed. The contracts were reviewed by the ACPM, and the ranking and priorities discussed by them. The CEC staff and the

ACPM work well together. The small CEC staff appear efficient, capable and greatly appreciated by the investigators. The results of these efforts appeared to be acceptable in the European scientific community, possibly because the ACPM has evolved as mainly a scientific peer group, as indeed it should be.

3. One of the main aims of the programme is to develop collaboration and cooperation between different groups of investigators and a sense of European purpose and community of interest. In the main this has succeeded handsomely although not uniformly across all the sectors as noted above. Also in the early stages of the period 1976-80 the integration into the programme of new countries had only just begun and it takes some time for full European collaboration to develop. One of the main reasons for success seems to be in the large number of meetings sponsored by CEC or surrogates like EULEP, the support of scientists to move from one laboratory to another, the visits of CEC staff to laboratories to encourage progress and help with problems. These all give a positive flavour to the administrative efforts for the CEC Programme. Specific collaborative groups might also be set up in some of the more heterogeneous sector programmes to develop a more cohesive programme as suggested above.

4. The monitoring of progress via annual reports and final reports by ACPM review, and by the means such as meetings and CEC staff visits appear in general to be working well, but two suggestions could be considered to increase the efficiency of the monitoring procedure:

(a) More thorough final reports should be required of contractors at the end of the contract period which would more clearly outline the original goals of the project and the exact results achieved.

(b) In addition to visits by CEC staff, in some of the larger and longer-term contracts, a scientific group on an ad hoc or longer term basis might be appointed to report to the ACPM on the status of the contract and to assist in further planning of the programme. Visits might be undertaken at some appropriate intervals (e.g. once in 5 years). A regular programme of such visits might be planned and reports utilized by CEC staff and ACPM as important indicators of the progress, needs and limitations of the project examined.

5. The Panel believes that the efficiency of the programme is due in large part to the successful development of five-year blocks of

financial support. This leads to great stability in accomplishing especially the longer-term work, and is the envy of shorter-term national programmes. This may have the disadvantage of reduced flexibility and reduced risk taking, and places a heavy emphasis on not neglecting programme areas that may become important within the term of the programme. In this respect the Panel notes the following:

(a) The CEC has already recognized some of these problems and wisely distributes contract funds on a declining scale through the programme period, which enables funds to be successfully utilized but permits greatly increased flexibility as compared with committing all the funds at the beginning of the programme period. The Panel encourages the Commission to maintain this method and to seek other ways to develop flexibility.

(b) Long-term programmes result in some unwillingness in risk taking and therefore programmes tend to be sound and solid but only in a few exceptional contracts and areas are they highly creative and innovative. Something could be done in this respect by committing a small portion of the funds to a "New Idea Fund" and soliciting ideas previously quite undeveloped for a trial period of support. A list of programme areas where new ideas might seem especially valuable could be developed by ACPM and would encourage response from investigators. However, proposals should not be confined to such a list.

(c) The need not to neglect important areas is especially important in a programme supported in 5-year blocks but actually having a much longer term continuity than 5 years. This Panel has generally found the programmes broad and well balanced in scope but has nevertheless identified significant areas either absent or lacking emphasis. There may well be others. Accordingly, the Panel recommends that the ACPM address the scope of the programme against the template of an ideal programme, given the state of knowledge in the world. In this way important gaps can be addressed, and judged to be either impractical for support by CEC or worthy of inclusion and emphasis in the developing Programme Proposal. This would seem to require a sector by sector analysis by experts in the ACPM but probably with additional help. The ACPM and these experts should continue to re-examine regularly the suitability of the present sectors to address the full programme, or the need to add new sectors or to regroup the whole programme differently. A detailed examination of this kind with a full report of the findings

could be invaluable for the content of the Programme Proposal and its continued vitality.

(d) A related topic which could be helpful to (c) is the question of interactions between the CEC programme and like programmes in other major parts of the world such as the USA and Japan. Mechanisms should be developed to exchange and share programme information and to consider especially where such programmes might be mutually beneficial to one another. A possible example is the question of intermediate species studies for extrapolating rodent studies to man especially on carcinogenesis, which is needed in the CEC programme. Such programmes exist in the USA, especially those utilizing dogs and involving both internal and external exposure. These programmes would profit by input from and participation by European investigators in studies at low doses.

Scientists obviously have their own media for exchange of ideas internationally such as the scientific literature itself which is international by nature, and in International Congresses of Radiology, of Radiation Research and on Radiation Protection held at 3-5 year intervals as well as other specific symposia and meetings initiated within the scientific community. Nevertheless a more general attempt administratively to develop interprogramme communications might have successes at the intercontinental level similar to the benefits already brought about by CEC in Europe.

6. For its multi-national interdisciplinary composition and the authority it carries through governmental appointment, the ACPM is the most important advisory element in the programme management. While the CEC staff must do most of the administrative work they cannot supply the objective judgement and national flavour of the ACPM peer group, whose record, especially since the strengthening of the ACPM role in 1977 seems to be effective and appreciated by the investigators in the Community. The Panel suggests that the role of the ACPM be enhanced even further by proposing even greater responsibility for ACPM to seek greater flexibility, greater risk taking and greater attention to overall programme content as noted in (5). In other words, the Panel believes that the role of the ACPM might be further strengthened if, compatible with the statutory requirements, the strategic aspects of the programme management, rather than the detailed monitoring of the research work, could be emphasized.

III. Socio-Economic Impact

The Evaluation Panel has attempted to make judgements about the socio-economic impact of the programme as they were required to do by the terms of reference. Formal methods for doing so are still lacking and the question of methodology for assessing socio-economic impact needs addressing on a longer time frame. Nevertheless, the Panel has examined in some detail the socio-economic impact of the programme (Chapter 8). The Panel believes that the Radiation Protection Programme has made and is making extensive contributions to co-operation in the European Community, to the field of radiation protection as a portion of world science, to some degree in education and training within the Community, to the protection of about 300,000 radiation workers in the Community, to the radiation protection of the 260 million of the general population in the Community and to the provision of an important power option for the Community. In addition the Community programme has had important research spin offs in the medical field, notably in the application of neutron therapy and the treatment of leukemia, and has also made contributions to the prevention of duplication of research efforts by its various meetings and publications, as well as providing a model for guidance in the case of other pollutants.

A specific comment notes that in spite of the clear and undeniable success of the research programme little of its value is conveyed to the public in the Community. The Panel believes the CEC should undertake a public information programme via appropriate media which demonstrates what is known and what has been achieved. Hopefully funds can be made available to undertake such an effort which will not substract from the present research funds. Such a programme could be decisive to the socio-economic success of the Radiation Research Programme as a whole and should be an integral part of the future research strategy of the CEC. Indeed, the Panel believes that the Radiation Protection Programme is a very valuable programme to the CEC and would score highly for relevance to the objectives of the CEC as developed in the framework programme. More emphasis on the Programme in future strategy documents would seem to this Panel to be warranted.

Chapter 10

Recommendations

Through a continued effort that has now lasted for more than 20 years the CEC has been able to develop a programme of research in radiation protection of wide scope and great scientific significance. Therefore the Panel recommends that:

1. First and foremost, the overall programme be continued essentially as it is with only relatively minor modifications. Future research strategies of the CEC should contain this important integrated programme as one of its essential components. The Panel believes that the Programme is being so successful in its primary objectives that nothing should be done that might hamper this success, at the same time everything should be done to capitalize on what has been achieved to enhance the programme further. Any policy decision by the CEC which might be likely to affect this programme should be carefully considered for its possible adverse as well as beneficial effects. Proposed changes should be carefully implemented in order to minimize negative effects on programme performance.

As to scientific and managerial aspects the Panel would like to make the following additional recommendations:

2. Greater attention should be given to the scope of the sector work and of the overall programme, especially with regard to important gaps in content. A very specific evaluation of programme content, sector by sector, against the template of an ideal programme, as well as the arrangement of the sectors, should be undertaken by ACPM and suitable additional experts at the time of the Programme Proposal development.

3. Continued emphasis should be devoted to important areas such as risk evaluation. Greater emphasis should be placed on undertreated programme areas such as embryo and fetus sensitivity, transformation studies in cultured cells, natural and enhanced radioactivity, and possibly in some dosimetry areas and perhaps in the development of more sensitive techniques for detecting genetic effects.

4. Programme wide, investigators should be encouraged to design and conduct more experiments at lower doses in order to cover ranges where the main needs for radiation protection work exist.

5. A portion of the total budget (not large) should be assigned to a "new idea fund" to initiate a programme in which only projects that are truly new and potentially innovative and have not been supported before will be chosen. These may involve somewhat higher risk of success or failure.

6. As many other means as possible should be examined and introduced to keep the stable five year programme flexible so that new approaches can be explored.

7. The Panel recommends further increase in coordination in less cohesive programme areas such as in the sector on Short-term Somatic Effects and the sector on Behaviour and Control of Radionuclides in the Environment, possibly by establishing groups of the EULEP type or increasing the number of meetings on these topics.

8. A further peer review should be added to the existing procedures especially for larger long-term contracts. It is suggested that groups of experts, be appointed to visit and prepare a written report on the status of the contract with the aim of assisting in planning future programmes.

9. More complete five year reports should be requested which lay out clearly the original objectives of the work and exactly what has been achieved. These reports should be supplemented subsequently with a full set of reprints derived from the contract in that period.

10. The Panel recommends that CEC use every means at hand to encourage publication, in the open refereed literature, of the results of CEC supported work, while at the same time recognizing the value of rapid publication provided by some CEC publications. The CEC should be appropriately acknowledged in all publications deriving from the programme.

11. The Panel recommends the institution of exchange and training programmes at the pre-and post-doctoral level in order to further develop scientific subjects related to radiation protection.

12. An ad hoc panel should be constituted soon to consider the future of the Biology Group at Ispra and its role in the CEC programme.

13. The Panel recommends that mechanisms be developed to (a) exchange information on programme scope and content with other large similar programmes such as those in the USA and Japan (b) explore methods for mutual participation in programme areas of joint interest.

14. The Panel recommends that the CEC consider the initiation of a substantial public information programme to convey to the public the important knowledge that already exists in the area of radiation protection and the efforts the programme is making to address unsolved problems.

APPENDICES

Appendix 1: List of contracting laboratories, classified by sectors, who participated in the Radiation Protection Programme during the period 1976-1980. Note that more detail on these contracts, titles, funding, etc., is available in the catalogue of contracts (Appendix 2, document 3). Also available is a geographical listing of contracts (Appendix 2, document 5).

Appendix 2: Evaluation Documents

Appendix 3: The Questionnaire

Appendix 4: Analysis of Questionnaire Responses

Appendix 5: Interviews and Visits

Not included in the Appendices is a selection of publications issued on the initiative of the Commission during the period 1976-80. Such a list is available in the Synthesis of Results (Appendix 2, document 5).

APPENDIX 1

LIST OF CONTRACTING LABORATORIES, BY SECTORS, WHO PARTICIPATED IN THE RADIATION PROTECTION PROGRAMME DURING THE PERIOD 1976-1980

A. Radiation Dosimetry and Its Interpretation

199-BIO N	TNO, Rijswijk (Barendsen/Broerse)
176-BIO F	Univ. Toulouse (Blanc)
211-BIO D	GSF, Neuherberg (Jacobi/Burger)
170-BIO F	Univ. Strasbourg (Rechenmann)
210-BIO D	Univ. Homburg (Muth/Grillmaier)
164-BIO UK	NRPB, Harwell (Dolphin)
188-BIO UK	CEGB, Berkeley (Wheatley)
169-BIO UK	NPL, Teddington (Lewis)
177-BIO F	CEA, CEN Fontenay-aux-Roses (Parmentier)
215-BIO D	KFA, Jülich (Feinendegen)
175-BIO I	CNEN, CSN Casaccia (Silini)
208-BIO D	Univ. Würzburg (Kellerer)
209-BIO D	PTB, Braunschweig (Reich)
184-BIO UK	Univ. Dundee (Watt)
178-BIO F	CEA, CEN Grenoble (De Choudens)
246-BIO UK	Univ. Aberdeen (Mallard)
229-BIO C	CENDOS (Broerse et al.)
181-BIO C	ICRU (Wyckoff)
185-BIA N	ITAL, Wageningen (Ringoet)
167-BIO UK	AERE, Harwell (Peirson)
201-BIO C	EULEP (Duplan et al.)
103-PST I	CNEN, Bologna (Busuoli)
106-PST D	GSF, Neuherberg (Jacobi/Burger)
102-PST F	Univ. Toulouse (Blanc)
098-PST UK	AERE, Harwell (Peirson)
097-PST UK	CEGB, Berkeley (Wheatley)
109-PST F	CEA, CEN Fontenay-aux-Roses (Portal)
108-PST D	PTB, Braunschweig (Wagner)
107-PST D	KFA, Jülich (Heinzelmann)
111-PST UK	NRPB, Harwell (White)
110-PST N	TNO, Arnhem (Julius)

B. Behaviour and Control of Radionuclides in the Environment

172-BIO I	CNEN, Fiascherino (Brondi)
219-BIO UK	MAFF, Lowestoft (Mitchell)
254-BIO F	Univ. Nantes/CEA La Hague (Pieri)
280-BIO DK	Risø Nat. Labor., Roskilde (Aarkrog)
185-BIA N	ITAL, Wageningen (Sybenga)
258-BIO B	IHE, Bruxelles (Cantillon)
265-BIO B	Univ. Namur (Micha)
268-BIO N	Delta Instituut, Yerseke (Duursma)
235-BIO F	CEA, CEN Fontenay-aux-Roses (Bovard)
236-BIO B	CEN, Mol (Kirchmann)
237-BIO N	L.H., Wageningen (Van den Hoeck)
186-BIO UK	AERE, Harwell (Chamberlain)
231-BIO F	CEA, CEN Cadarache (Grauby)

260-BIO D	GSF, Hannover (Kühn)
269-BIO DK	Univ. Copenhagen (Nielsen)
255-BIO D	B.G.A., Berlin (Stieve)
187-BIO UK	AERE, Harwell (Chamberlain)
234-BIO B	Univ. Louvain (Myttenaere)
275-BIO B	Rijksuniversiteit, Gent (Deruytter)

C. Short-term Somatic Effects of Ionizing Radiation

220-BIO F	Cl. Bernard, Paris (Mathé)
221-BIO I	M. Negri, Milano (Garattini/Spreafico)
222-BIO D	Univ. Ulm (Fliedner/Heimpel)
198-BIO N	TNO, Rijswijk (Van Bekkum)
161-BIO B	Univ. Bruxelles (Tagnon/Stryckmans)
217-BIA D	GSF, München (Thierfelder)
191-BIO EIR	Univ. Dublin (Mullins/Greally)
159-BIO I	Univ. Napoli (Peschle)
173-BIO I	CNEN, CSN Casaccia (Doria)
263-BIO B	Univ. Brussel (Hamers)
230-BIO B	Univ. Bruxelles (Dumont)
250-BIO B	Univ. Louvain (Bazin)
257-BIO I	Univ. Firenze (Becciolini)
212-BIO D	Univ. Regensburg (Hüttermann)
213-BIO D	Univ. Giessen (Lohmann)
270-BIO D	HMI, Berlin (Schnabel)
214-BIO D	MPI, Mülheim (Schulte-Frohlinde/v. Sonntag)
226-BIO UK	Univ. Newcastle (Scholes/Garner)
158-BIO F	CEA, CEN Grenoble (Téoule)
271-BIO UK	Kennedy Institute, London (Harris)
227-BIO D	Primary effects (Köhnlein /Cramp et al.)
210-BIO D	Univ. Homburg (Muth/Grillmaier)
215-BIO D	KFA, Jülich (Feinendegen)
156-BIO B	Univ. Bruxelles (Brachet)
218-BIA D	GSF, Neuherberg (Gössner)
266-BIO UK	Univ. Oxford (Wiernik/Hopewell)
252-BIO UK	Univ. London (Lindop)
249-BIO UK	MRC, Harwell (Vennart)
256-BIO DK	Univ. Copenhagen (Danø)

D. Late Somatic Effects of Ionizing Radiation

201-BIO C	EULEP (Duplan et al.)
232-BIO B	CEN, Mol (Maisin)
218-BIA D	GSF, Neuherberg (Gössner)
100-PST D	DKFZ, Heidelberg (Scheer)
266-BIO UK	Univ. Oxford (Wiernik/Hopewell)
264-BIO EIR	College of Technology, Dublin (Malone/Cullen)
179-BIO UK	NRPB, Harwell (Dolphin)
182-BIO UK	NRPB, Harwell (Dolphin)
105-PST UK	AERE, Harwell (Chamberlain)
174-BIO I	CNEN, CSN Casaccia (Clemente)
104-PST UK	AERE, Harwell (Morgan)
162-BIO I	CNEN, Bologna (Prodi)
252-BIO UK	Univ. London (Lindop)
243-BIO UK	PCL, London (Simmons)
249-BIO UK	MRC, Harwell (Vennart)

267-BIO	UK	MRC, Harwell (Vennart)
278-BIO	UK	UKAEA Winfrith, Dorchester (Ramsden)
277-BIO	F	CEA, CEN Pierrelatte (Chalabreysse)
101-PST	I	ENEL, Roma (Farulla)
242-BIO	F	Fond. Bergonié, Bordeaux (Duplan)
241-BIO	B	CEN, Mol (Maisin)
256-BIO	DK	Univ. Copenhagen (Danø)
251-BIO	DK	Univ. Copenhagen (Ebbesen)
253-BIO	N	TNO, Rijswijk (Broerse/Barendsen)
207-BIO	D	GSF, Neuherberg (Kriegel)
233-BIO	B	CEN, Mol (Vanderborght)
151-BIO	UK	MRC, London (Jones)
228-BIO	I	Univ. Pisa (Donato)
216-BIO	D	Univ. Erlangen (Pauly)
244-BIO	D	GSF, Neuherberg (Drexler)
245-BIO	UK	AERE, Harwell (Peirson)
199-BIO	N	TNO, Rijswijk (Barendsen/Broerse)
215-BIO	D	KFA, Jülich (Feinendegen)
208-BIO	D	Univ. Würzburg (Kellerer)
248-BIO	N	Univ. Leiden (van der Eb)
203-BIO	DK	Finsen Institute, Copenhagen (Faber)
099-PSA	F	CEA, CEN Fontenay-aux-Roses (Uzzan)

E. Genetic Effects of Ionizing Radiation

204-BIO	DK	Univ. Aarhus (Marcker/Westergaard)
262-BIO	DK	Univ. Aarhus (Celis)
194-BIO	N	TNO/RU Leiden (Rörsch)
195-BIO	N	TNO/RU Leiden (Sobels)
193-BIO	N	TNO/RU Leiden (van der Eb)
248-BIO	N	TNO/RU Leiden (van der Eb)
156-BIO	B	Univ. Bruxelles (Brachet)
190-BIO	EIR	Univ. Dublin (Winder)
189-BIO	EIR	Univ. Galway (Houghton)
247-BIO	EIR	Univ. Galway (Houghton)
196-BIO	N	Univ. Rotterdam (Bootsma)
192-BIO	N	Univ. Leiden (Simons)
200-BIO	N	TNO, Rijswijk (Lohman)
166-BIO	UK	MRC, Brighton (Bridges/Arlett)
163-BIO	UK	Univ. Swansea (Parry)
154-BIO	I	Univ. Pisa (Loprieno)
153-BIO	I	Univ. Milano (Magni)
155-BIO	F	Fond. Curie, Paris (Latarjet)
171-BIO	UK	NRPB, Harwell (Dolphin)
167-BIO	UK	AERE, Harwell (Peirson)
165-BIO	I	Univ. Pavia (Fraccaro)
239-BIO	F	INRA, Dijon (Dalebroux)
272-BIO	F	INRA, Dijon (Dalebroux)
240-BIO	F	Univ. Toulouse (Delpoux)
273-BIO	F	Univ. Toulouse (Delpoux)
238-BIO	B	CEN, Mol (Léonard)
274-BIO	B	CEN, Mol (Léonard)
202-BIO	DK	Carlsberg Lab., Copenhagen (von Wettstein)
203-BIO	DK	Finsen Institute, Copenhagen (Faber)
160-BIO	I	Univ. Roma (Fasella/Whitehead)

168-BIO UK	PCL, London (Holt/Cohn)
183-BIO EIR	Techno., Dublin (Taaffe/Malone)
224-BIO B	Univ. Bruxelles (Radman)
152-BIO I	Univ. Pavia (Falaschi)
223-BIO F	CNRS, Gif-sur-Yvette (Devoret)
225-BIO F	CNRS, Gif-sur-Yvette (Anagnostopoulos)
150-BIO I	Univ. Roma (Olivieri)
206-BIO D	Univ. Göttingen (Hansmann)
205-BIO D	GSF, Frankfurt (Pohlit)
157-BIO B	Univ. Louvain (Goffeau)
261-BIO D	Univ. Giessen (Kiefer)
Biology Group,	CEC, Ispra (Devreux)
210-BIO D	Univ. Homburg (Muth/Grillmaier)
185-BIA N	ITAL, Wageningen (Ringoet)
232-BIO B	CEN, Mol (Maisin)
249-BIO UK	MRC, Harwell (Vennart)
101-PST I	ENEL, Roma (Farulla)
099-PSA F	CEA, CEN, Fontenay-aux-Roses (Uzzan)

F. Evaluation of Radiation Risks

099-PSA F	CEA, CEN Fontenay-aux-Roses (Uzzan)
SC 001 UK	Imperial College, London (Goddard)
SC 002 EIR	Trinity College, Dublin (Allwright)
SC 008 F	CEA, CEN Fontenay-aux-Roses (Lafuma)
SC 010 N	Univ. Leiden (Sankaranarayanan)
SC 016 I	Ist. Mario Negri, Milano (Tognoni)
SC 017 EIR	The Medical Research Board, Dublin (Dean)
SC 018 F	C.E.P.N., Fontenay-aux-Roses (Fagnani)
SC 019 F	Assoc. Willermé, Rennes (Massé)
SC 020 UK	St. George's Hospital, London (Bennett)
SC 021 F	C.C.P.N., Fontenay-aux-Roses (Fagnani)
SC 023 F	C.C.P.N., Fontenay-aux-Roses (Fagnani)
SC 024 F	C.C.P.N., Fontenay-aux-Roses (Fagnani)
SC 025 F	Hôpital Necker, Paris (Funck-Brentano)
SC 026 F	CEA, Fontenay-aux-Roses (Regnaud)
SC 027 F	CEA, Fontenay-aux-Roses (Caput)
SC 028 F	CEDHYS, Avignon (Chalabreysse)
SC 029 UK	Univ. Oxford (Gray)
180-BIO C	ICRP (Lindell/Sowby)

APPENDIX 2

EVALUATION DOCUMENTS

1. Proposal "Biology and Health Protection" Programme. Research Programme 1976-1980 July 1975.

2. Scientific Documentation "Biology-Health Protection" Programme 1976-1980. XII/49/75 rev 1. March 1975.

3. Catalogue of Contracts - Research Programme Radiation Protection 1976-1980 September 1979.

4. Progress Report - Radiation Protection Programme 1976-1980, EUR 7169 DE/EN/FR 1980.

5. Synthesis of Results - Radiation Protection Programme 1976-1980 XII/340/82. May 1982.

6. Progress Report for 1976. Radiation Protection Programme, EUR-5711

7. Progress Report for 1977. Radiation Protection Programme, EUR-5972

8. Progress Report for 1978. Radiation Protection Programme, EUR-6263

9. Progress Report for 1979. Radiation Protection Programme, EUR-6766

10. Proposal Biology Health Protection (Radiation Protection Programme) 1980-1984 XII/1145/78-E rev 3. February 1979.

11. Research Priorities and Scientific Documentation Radiation Protection Programme 1980-84. October 1979. XII/1067/79

12. Catalogue of Contracts Radiation Protection Research Programme 1980-84. Vol. I. Programme Management Data. XII/466/82-1 February 1982.

13. Catalogue of Contracts Radiation Protection Research Programme 1980-84. Vol. II Description of Research Programmes. XII/460/82-11 February 1982.

14. Catalogue of Contracts Radiation Protection Research Programme. Vol. I Updating. November 1, 1982. (Preliminary version).

15. Progress Report for 1981. Radiation Protection Programme. EUR 7800. 1982.

16. Scientific Documentation Radiation Protection Programme 1985-89. D.G. XII-F1 Draft, October 1982. XII/977/82

17. Proposal Radiation Protection Programme 1985-89. D.G. XII-F1 Draft. 6-12-82

18. Radiation Protection Programme, 1985-1989. Research priorities and scientific documentations. Draft February 1983.

19. Evaluation of Research and Development. Proceedings of a Conference held in Brussels, January 25-26, 1982. Editors G. Boggio and R. Gallimore. Reidel Publishing Co., 1982.

20. Evaluation of the Community's indirect action programme on Management and Storage of Radioactive waste. Research Evaluation Report #4. EUR 7693, 1981.

21. Evaluation of the Concerted Actions of the Community's First Medical Research Programme 1978-81. Research Evaluation Report #5. EUR 7730, 1981.

22. The Evaluation of the Community's Energy Conservation and Solar Energy R & D sub-programmes. Research Evaluation Report #1 EUR 6902, 1980.

23. The Evaluation of the Community Programme on Forecasting and Assessment in the Field of Science and Technology (FAST). Research Evaluation Report #6 EUR 8274. 1983

24. Proposals for a European scientific and technical strategy. Framework programme 1984-1987. COM(82)865 final.

25. Proposal, contract, progress reports, reprints relating to project 201-BIO-C-(EULEP).

26. Proposal, contract, progress reports, reprints relating to project 218-BIO-D-(Gössner).

27. Proposal, contract, progress reports, reprints relating to project 242-BIO-F-(Duplan).

28. Proposal, contract, progress reports, reprints relating to project 195-76-1-BIO N (Sobels).

29. Proposal, contract, progress reports, reprints relating to project 166-76-1-BIO UK (Bridges).

30. Proposal, contract, progress reports, reprints relating to project 099-76-1 PSA F (Uzzan).

31. Past, Present and Anticipated Activities of the Biology Group of CEC at Ispra Doc XXIII/4 of the Advisory Committee on Programme Management, June 1980.

32. Reprints and other material relating to the Biology Group Ispra research programme.

33. Measures used by the Commission for the purpose of implementing Research Programmes. CEC document XII/120/83-EN.

APPENDIX 3

THE QUESTIONNAIRE

The communications addressed to contractors concerning the questionnaire and the questionnaire itself are reproduced on the following pages.

COMMISSION
OF THE
EUROPEAN COMMUNITIES

Directorate-General
for Science, Research and Development
Joint Research Centre

Brussels - 1. XII. 1982

26252

Dear Sir,

Postperformance evaluation of the European Community's Radiation Protection Programme 1976-1980

Since several years now, the Commission of the European Communities has been proceeding to postperformance evaluations of its R&D programmes. One of the programmes being evaluated presently is the 1976-1980 Radiation Protection Research Programme.

The evaluation is carried out by a team of independent external experts, chaired by Professor W.K.Sinclair, the President of the National Council on Radiation Protection and Measurements, USA. These experts have the Commission's full confidence and have been given a free hand to consult wherever and whatever they consider necessary for performing their work efficiently.

The team has been invited to assess:

- the scientific and technical achievements of the Radiation Protection Programme;
- the social and economic impact of the Programme;
- the contribution of the Programme to Community objectives;
- the effectiveness of the Programme management and of the utilisation of resources.

During its first meeting the team found that - in order to get as complete a picture as possible of the overall situation in the short time available and in particular of the problems which have been encountered during the period 1976-1980 - the views of those directly involved in the research work, i.e. the contractors, were a precious source of information. It therefore decided to take these views by means of a questionnaire.

Enclosed you will find this questionnaire which we would like you to complete as far as possible. Your answers serve solely the purpose of the evaluation. The results of the inquiry will be treated on a strictly confidential basis by the evaluation team. For those parts of the summarized feedback information to be included in the final evaluation report, no reference will be made to specific contracts or contractors.

For convenience one questionnaire has been sent out for each R&D contract. If you were responsible for several contracts you are free to group your answers into one single questionnaire. In this case please don't forget to list all the contract references covered in the identification section.

./.

Provisional address Rue de la Loi 200 B-1049 Brussels — Telephone 235 1111 — Telegraphic address "COMEUR Brussels"
Telex. "COMEU B 21877"

The evaluation team entrusted one of its members, Professor A.Wambersie, with the task of analysing and summarizing the information. Therefore we invite you to return, before 15 December 1982, the completed questionnaire directly to the following address:

Professor Dr. André Wambersie
Clinique St.Luc
RENT 5469
Avenue Hippocrate, 62
B-1200 Brussels

As the Commission attaches great importance to the present evaluation - the Radiation Protection Programme is now running for more than twenty years - your active cooperation in completing the questionnaire and in any other contacts you may have with the members of the team would be greatly appreciated.

Thanking you for your collaboration,

Yours sincerely

p. P.FASELLA
DIRECTOR GENERAL
for Science, Research and Development
Joint Research Centre

Enclosure: Questionnaire for contractors (abbreviations used: EC = European Community; CEC = Commission of the European Communities).

COMMISSION
OF THE
EUROPEAN COMMUNITIES

Directorate-General
for Science Research and Development
Joint Research Centre

The Director-General

Brussels 14. 1. 1983

01097

Dear Sir,

Postperformance evaluation of the Community's Radiation Protection Programme 1976-1980 - Contractor questionnaire

A few weeks ago a contractor questionnaire was sent out by the Commission of the European Communities on behalf of the independent external expert panel evaluating the Community's Radiation Protection Programme in order to take the views of the contractors, which the panel considers as a precious source of information. We have been told by Professor Wambersie - the panel member who has been entrusted with the task of analysing and summarizing the feedback information - that on 12 January 1983 he had not yet received a reply from you.

Enclosed you will find another copy in case that for any reason you did not receive the first one. May we ask you to complete in the next few days the questionnaire as far as possible and to send it back directly to the following address:

Professor Dr.André Wambersie
Clinique St.Luc
RENT 5469
Avenue Hippocrate, 62
B-1200 Brussels

The deadline which has been fixed by the panel is 31 January 1983.

Thanking you again for your collaboration.

Yours sincerely

P. P.FASELLA
DIRECTOR GENERAL
for Science, Research and Development
Joint Research Centre

Enclosure: Questionnaire for contractors with accompanying letter dated 1 December 1982.

Provisional address Rue de la Loi 200 B 1049 Brussels - Telephone 235 11 11 - Telegraphic address 'COMEUR Brussels'
Telex 'COMEU B 21877'

EVALUATION OF THE COMMUNITY'S RADIATION PROTECTION PROGRAMME 1976-1980

Questionnaire for contractors

Notes:

1. In order to save time the evaluation panel decided to send out this questionnaire in the English language only.

   However, if it is more convenient for you to present your answers in any other Community language you are free to do so.

   Feedback information will be handled on a strictly confidential basis by the evaluators.

2. The evaluation panel entrusted one of its members, Professor A. Wambersie, with the task of analysing and summarizing feedback information. Please return therefore the completed questionnaire directly to this expert:

Notes:

1. Afin du gagner du temps le groupe d'évaluation a décidé d'envoyer le questionnaire en version anglaise seulement. Si toutefois vous préférez donner vos réponses dans une autre langue de la Communauté vous êtes invité à le faire.

   Toutes les informations transmises par les contractants seront traitées sur une base strictement confidentielle par les évaluateurs.

2. Le groupe d'évaluation a confié la tâche d'analyser et de résumer les informations transmises par les contractants à un de ses membres, à savoir: le professeur A.WAMBERSIE. Veuillez donc renvoyer le questionnaire dûment rempli directement à cet expert:

Professor A.WAMBERSIE
Clinique St.Luc
RENT 5469
Avenue Hippocrate, 62
B-1200 BRUXELLES

Evaluation of the EC Radiation Protection Programme 1976 - 1980: Questionnaire for Contractors

Identification section:

- contract reference no(s) .....
- type of institution (university, research establishment, industry, other) .....
- country .....

What was the number and age of Phd scientists involved in your contract(s) .....
.....

PART A: Questions related to R&D development

Questions	Answers
1. In the period 1976-1980 did the Community's Radiation Protection Programme:	a)
- create	☐
- maintain	☐
- develop	☐
the research capacity of your organisation in the field?	
2. During that period to what extent did the CEC financial support effectively increase the available R&D funds i.e.	
Did your organisation:	a)
- make available additional funds (or additional national funds) in response to the CEC's decision to support your research proposal?	☐
- maintain the national contribution at the level which would have been reached in the absence of a favourable CEC decision?	☐
- reduce the national funds as a result of the CEC financial support?	☐
Please give your estimated size of the effect if possible.	

(a) Please tick boxes as appropriate.

PART B: Programme related questions	
I. Scientific/technical aspects	Answers
1. What was the motivation of your research proposal?	
2. (a) Did your work proceed according to schedule with regard to timing and nature/quality of the results? (b) Did you meet any special difficulties of whatever nature? (c) If yes, what were the consequences of these difficulties on the conduct of the R&D work?	a) yes ☐ no ☐ a) yes ☐ no ☐
3. To what extent do you consider that the objectives of your research – either originally set or subsequently modified – have been reached?	
4. Did you benefit from the CEC support other than financially? Please explain.	a) yes ☐ no ☐

a) Tick boxes as appropriate.

II. Potential applications and spin-off of research results	Answers
1. In the field of Radiation Protection what do you consider to have been the main applications/benefits of your research results?	
2. What kind of people/institutions are most likely to use your results? Can you name examples of such people/institutions?	
3. In fields other than Radiation Protection were or are there any benefits/applications of your results? Please indicate what you think the main ones were or are?	
4. What kind of people/institutions are most likely to use the applications specified under question B-II-3? Can you name examples of such people/institutions?	

III. Programme Management	Answers
1. Was/were the contract(s) let in a timely manner? If not, what do you consider to have been the reasons: - Delayed answer from the Commission? - Delays in obtaining funding for the overall programme - Any other reason? What were the consequences of any delays on the execution of your work?	
2. Was your work followed/reviewed by the CEC during the definition and the execution phases of your contract(s): (a) What interactions did you have: - discussions with CEC management staff; - site visits (by CEC staff or delegated experts); - contractor meetings; - seminars/symposia/conferences; - progress and final report requirements; - others? Please specify. (b) Did these interactions affect the content and the conduct of your research work? Please explain.	a) a) yes no

a) Tick boxes as appropriate

(c) Do you consider these interactions to have been useful for your research and how would you see it possible to improve them? (d) Did the CEC staff react to your satisfaction to any special requests from your side or to difficulties you mentioned?	
3. What is your opinion concerning the early circulation/dissemination of information and overall programme results among the contractors involved in the Radiation Protection Programme	
4. What is your opinion on the management in general of your contract(s) - including both scientific and contractual/administrative aspects - by the CEC? Are there specific points that should be improved?	

IV. Financial aspects	Answers
1. Do you have any comments on the financial policy of the CEC?	

V. National/international cooperation – Information transfer	Answers
1. (a) Is(are) your contract(s) with the CEC: – of a bilateral nature (CEC and your institute) – of a multilateral nature (CEC, yours and other institutes) (b) Would you see advantages in broader multilateral arrangements? Please explain.	a) a) yes ☐ no ☐
2. (a) In the frame of your research contract(s) did you establish new contacts with: + other CEC – contractors in your country? + research staff, specialists or organisations in other EC Member States (enhancement of international cooperation)? (b) Were these contacts intensive or of a more superficial nature?	
3. Did the CEC contract(s) allow you to establish professional contacts across national borders beyond those established in the frame of this (these) contract(s)?	

a) Tick boxes as appropriate.

VI. Programmatic aspects	Answers
1. Taking into account the widespread presence of ionising radiation in many fields of human activity: (a) Do you consider that your national R&D programme should cover all the aspects and problem areas related to radiation protection? (b) To what extent do you consider that you can rely on the results and know-how acquired through R&D work carried out by CEC contractors in other countries? (c) Do you consider that the CEC programme should be fully comprehensive with respect to Radiation Protection Research?	
2. Did you or do you have contacts with any of the research establishments of the CEC Joint Research Centre (Geel, Ispra, Karlsruhe, Petten)?	

VII. Socio-economic impact of R&D results

1. The CEC is interested in the evaluation of the socio-economic impact of the Radiation Protection Research Programme. Do you have any comments to make on present and possible future socio-economic effects?

VIII. Any other comments or suggestions for improvement of the programme

1. Please write down here any other comments or suggestions you may have, of a general or specific nature, related to any aspect of the programme.

APPENDIX 4
ANALYSIS OF QUESTIONNAIRE RESPONSES

In order to try to canvass as wide a range of views as possible the Panel sent out the questionnaire of Appendix 3 to all people who were contractors in the 1976-1980 Radiation Protection Programme.

A copy of the questionnaire (there were two versions, one in English and one in French) is in appendix 3 together with the communications that accompanied it. The numbering system used in this analysis follows that of the questionnaire.

In all, 103 questionnaire returns were received covering 111 contracts, a response rate of 78 per cent by of the deadline. Ten others were received thereafter but were not included in the analysis.

The responses were distributed as follows:

BY SECTOR		BY COUNTRY	
Dosimetry	21	Netherlands	12
Environment	16	France	16
Short-term effects	14	Germany	14
Late Somatic effects	20	U.K.	21
Genetic effects	30	Ireland	4
Risk evaluation	2	Denmark	7
		Belgium	12
		Italy	13
		ICRP and ICRU	2
		International co-operative groups	2

Forty of those replying classified themselves as universities, fifty-eight as research establishments, one as industry and four as some other category.

Not all questions were answered by all contractors and sometimes more than one answer was given by a contractor replying for more than one contract. Thus the total number of answers to each question varies.

A summary of the responses follows:

QUESTIONS	ANSWERS AND COMMENTS	
Part A.1		
In the period 1976-80 did the Community's Radiation Protection Programme:	create	10
	maintain	39
	develop	59
- create - maintain - develop the research capacity of your organisation in your field?	A significant majority of the contractors indicated that the CEC funding either created or developed their research capacity in this field. This pattern held across all sectors and was most marked in "genetic effects" and "environment."	

Part A.2

To what extent did the CEC financial support effectively increase the available R & D funds, i.e. did your organisation
- make available additional funds?
- maintain the national contribution?
- reduce the national funds?

Please give your estimated size of the effect.

more funds	41
same funds	55
reduced funds	3

Patterns were similar by sector and country, although all three "reduced funds" answers came from the U.K. There were very few attempts to estimate the size of the effects.

Part B. I.1

What was the motivation of your research proposal?

Answers here invariably gave some particular scientific explanation and cannot readily be summarized. Nor were the answers particularly helpful.

I. 2a

Did your work proceed according to schedule?

Yes	82
No	20

The high level of "yes" answers held across all sectors and countries. Particularly high were "Dosimetry" with 19/20 and "Genetic Effects" with 26/29 "yes" replies. All twelve of the Dutch replies said "yes."

I. 2(b)

Did you meet any special difficulties?

Replies were not useful because of the variation in the interpretation of the question.

I. 2(c)

What were the consequences?

Similar comments to 2(b) apply.

I. 3

To what extent do you consider that the objectives of your research have been reached?

Replies were coded from 1 total failure to 5 complete success. The resulting distribution was as follows:

1	2	3	4	5
0	5	28	31	31

The weighted average of this distribution is 3.9. Replies from all sectors, particularly dosimetry, reflected that contractors felt that they had achieved most of their objectives during the course of the programme. There were no significant differences between

I. 3 (continued)

countries. The very high level of achievement reported suggests that the level of risk-taking in the programme is rather low.

I. 4

Did you benefit from CEC support other than financially? Please explain.

Yes	88
No	15

20/21 replies in the dosimetry sector were positive, while the late somatic effects sector was more negative with only 14/20 "yes" answers. All 12 Dutch replies were positive as were all 16 French replies. In the explanations given the following were mentioned the indicated number of times:

Improved contacts with other researchers	58
Increased collaboration with other scientists and institutions	16
Improved perception of the quality of one's work in one's own country	5
Widening views of participants	3

Part B. II.

Potential applications and spin-off research result.

These questions were included to generate information for the socio-economic evaluation. The answers have therefore been absorbed in that part of the report. Some of the answers given have been shown numerically as if they were given in answer to question VII. 1.

Part B. III.1

Was the contract let in a timely manner? If not, what do you consider to have been the reason? Delayed answers from the Commission? Delays in obtaining funding for the overall programme?

Yes	73
No	23

24% represents a significant level of complaint. It rose to 50% in the "genetics" sector and 7/13 Italians said "no." By contrast, all of the Dutch responded positively. 11 contractors considered the reason to be delay in obtaining an answer from the Commission, while 14 felt that the problem was delay in funding the whole programme.

Any other reasons?

What were the consequences of any delays on the execution of your work?

There were very few replies to the "consequences" question.

III. 2(a)

What interaction did you have during the definition and execution phases of your contract?

- discussions with CEC management staff
- site visits (by CEC staff or delegated experts)
-contractors meetings
- seminar/symposia/conferences
- progress and final report requirements
- others and please specify

The following numbers of contractors reported "yes" in each category:

Discussions	62
site visits	42
contractor meetings	83
seminars, etc.	72
report requirements	79
other specific meetings with collaborating labs.	9
people with no contacts	0

This pattern was similar both by country and by sector.

III. 2(b)

Did these interactions affect the content and conduct of your research work? Please explain.

Yes	74
No	24

The pattern was broadly similar across sectors but the late somatic effects sector was less affected than the others, probably because EULEP provided an alternative forum and perhaps also because of the long term nature of the research. There were very few explanations.

III. 2(c)

Did you consider these interactions to have been useful for your research and how would you see it possible to improve them?

Useful:	Yes	87
	No	3

18 contractors mentioned that if meetings were more specialised they would be more useful.

III. 2(d)

Did the CEC staff react to your satisfaction to any special requests from your side or to difficulties you mentioned?

Yes	69
No	2

III. 3

What is your opinion concerning the early circulation/dissemination of information and overall programme results among the contractors involved in the Radiation Protection Programme?

Most replies indicated whether the dissemination was good, bad or indifferent in the contractors' judgement. Replies were therefore scaled from 1 = very poor to 5 = very good. Answers were distributed as follows:

III. 3 (continued)

1	2	2	4	5
0	9	36	31	9

Weighted average: 3.5
The patterns were very similar by country and by sector.

III. 4
What is your opinion of the management in general of your contract - including both scientific and contractual or administrative aspects - by the CEC.
Are there specific points that should be improved?

Again, replies were rated on a scale of 1 to 5 with 1 = very poor and 5 = very good. The results were:

1	2	3	4	5
0	10	29	33	19

Weighted average: 3.7
Very few specific suggestions were made for improvements.

Part B. IV. 1
Do you have any comments on the financial policy of the CEC?

The following comments were made. The frequency is also indicated.

% of CEC funding is about right	2
% of CEC funding is too small	15
too much money goes to large labs	7
Money is poorly distributed between countries	4
CEC should co-ordinate finance between labs	2
Too much money goes to small labs	2
More flexibility is required in CEC funding rules, e.g. to allow the purchase of capital equipment on CEC money	8
Research is funded under the wrong programme	1

Part B. V. 1(a) and 1(b)
These questions concerned the relative merits of bilateral and multilateral arrangements.

Although replies were collected to these questions we believe them to be unhelpful because of wide variations in their interpretation between contractors. This is reinforced by the fact that the number of contractors replying that they had a multilateral contract was known to be wrong.

V. 2(a)
In the frame of your research contracts did you establish new contacts with:
- other CEC contractors in your country

Replies were as follows:

Other CEC contractors	45

V. 2(a) [continued]
- research staff or organisations in other CEC Member States

CEC researchers in other countries 81
Patterns were similar across sectors and countries.

V. 2(b)
Were these contacts intensive or of a more superficial nature?

Replies were scaled from 1 = very superficial to 5 = close collaboration. The results were as follows:

1	2	3	4	5
4	18	27	27	6

Weighted average = 3.2

V. 3
Did the CEC contract allow you to establish professional contacts across national borders beyond those established in the frame of this contract?

Yes 64
No 29
Sector and country patterns were similar to the overall pattern.

Part B. VI. 1(a)
Do you consider that your national R & D programme should cover all the aspects and problem areas related to radiation protection?

Yes 20
No 67
There was no difference between sectors, but France provided 7 and U.K. 8 of the "yes" answers. All 12 Dutch replies were "no."

VI. 1(b)
To what extent do you consider that you can rely on the results and know-how acquired through R & D work carried out by CEC contractors in other countries?

Replies were scaled from 1 = "not at all" to 5 = "completely and without reservation." The numerical distribution of the answers was as follows:

1	2	3	4	5
0	2	21	39	17

Weighted average score: 3.9 which was much the same both by sector and country and reflects a fairly high degree of confidence.

VI. 1(c)
Do you consider the CEC programme should be fully comprehensive with respect to Radiation Protection Research?

Yes 49
No 34
The proportion of British and French saying "yes" was again higher than the average, 74% against an average of 59%. By contrast only 18% of the Dutch said "yes." Taken with 1(a) a picture emerges with the French and British being very keen on comprehensive programmes and the Dutch not at all keen.

VI. 2

Did you or do you have contacts with any of the research establishments of the CEC Joint Research Centre (Geel, Ispra, Karlsruhe, Petten)?

Yes	54
No	48
Geel	13
Ispra	26
Karlsruhe	21
Petten	8

Some people said "yes" without specifying which centre, which is why the numbers do not tally. The U.K. and Denmark had noticeably fewer contacts with the Centre, probably reflecting their relative newness in the Community in the 1976-80 period.

Part B. VII. 1

The CEC is interested in the evaluation of the socio-economic impact of the Radiation Protection Research Programme. Do you have any comment to make on present and possible future socio-economic effects.

Some replies which were given to questions II 1-4 are recorded here. The answers given, with their frequencies were:

Contribution to the development of European co-operation	1
Contribution to education and training	3
Formulation of safety standards and protection for workers and for the general population	10
Improved medical treatment in the case of exposure	1
Spin-off improvements in other fields - safety standards	3
Commercial or industrial spin-offs	1
Medical spin-offs	12
Prevention of duplication of research efforts	1
Dispelling ignorance and misunderstanding by public of nuclear power	8
Allowing development of nuclear energy by reducing uncertainty.	8

Part B. VIII. 1

Please write down here any other comments or suggestions you may have, of a general nature, related to any aspect of the programme.

Relatively few contractors said anything under this heading. The replies received and their frequency are set out below:

There should be better feedback on reasons for refusal of submissions for funds.	2
More effort should be made by the Commission to disseminate scientific information.	3

Part B. VIII. 1 (continued)

The CEC fills a very important gap in research funds. 3
Co-operation on research should be extended outside the CEC. 3
CEC research policy is too conservative because of long delays in decision-making. 2
CEC research policy is too conservative because it is largely reactive to requests for funds. 1
Closer and more detailed evaluation of progress reports of contracts is required. 1
Members of advisory committees should not also be contractors. 1

Recommendations on the presentation of questions in future questionnaires

Part B I.1 This question asked "what was the motivation of your research proposal." The answers given invariably specified some esoteric scientific reason and gave no clue to whether the underlying motive had been to obtain funds, to utilise contacts etc. This question should probably not be included in future unless backed up by interviews.

Part B I. 2(b) & 2(c) These questions asked the contractor if he met any special difficulties and what the consequences were. Examples of difficulties and examples of consequences should be given and contractors invited to tick the appropriate boxes. The latter would, of course, include an "other please specify" box.

Part B I.3 Contractors should be invited to tick one box a scale of 1 = total failure to 5 = complete success.

Part B I.4 Although the answers to this question were very useful, they would have been even more so if those who said "no", they did not benefit other than financially, explained why they gave that answer. The question should therefore specify that both "yes" and "no" require an explanation. As it was only those who said "yes" gave one.

Part B III.3 Some people answered on the lines that early dissemination of information etc "was a good thing," which is like stating you are in favour of virtue. What was wanted were views on how well dissemination etc was carried out. The question should therefore be rewritten and answers invited on a scale of 1 = dissemination etc very bad to 5 = dissemination etc very good.

Part B III.4 This question should offer a scale from 1 = management very bad to 5 = management very good, thus avoiding the need for interpretation on the part of the questionnaire analysts.

Part B V. 1(a) & 1(b) The answers to these questions were of no value because what constituted a multilateral or bilateral contract was not precisely specified. This should be corrected in future. For 1(b) the question should ask if the contractor would have liked a different arrangement in his contract.

Part B V. 2(b) Contractors should be offered a scale of 1 = very superficial to 5 = close collaboration to avoid subsequent interpretation of the answers by the analysts.

Part B V.3 The word "allow" is ambiguous. A better terminology would be "Did the CEC contract lead you to establish...".

Part B VI. 1(b) Contractors should be offered a scale from 1 = "not at all" to 5 = "completely and without reservation" to avoid the necessity of interpretation by the analysts.

Part B VI.2 boxes relating to each centre location should be offered for contractors to tick if they have had contacts at that place.

APPENDIX 5

INTERVIEWS AND VISITS

Interviews and visits were held to amplify documented material and thus to assist in the overall evaluation of the programme. Some of these, such as the interview of the ACPM chairman, had unique importance in improving the understanding of the Panel of the procedures and indeed some of the philosophy of the management of this multinational programme. Other interviews were used to supplement the detailed information and to help confirm or deny impressions of the sector evaluations.

Visits included a brief visit by some members of the Panel to the Biology Group at Ispra and by three members of the Panel to a study group on Accident Consequence Modeling, which took place in Brussels on a day in February 1983, following one of the Evaluation Panel meetings.

1. Special Interviews

(a) Interview of Prof. Dr. W. Gössner, ACPM Chairman, December 13, 1982

The interview started with a historical outline of the ACPM structure and function, from its origin in 1961 as a scientific advisory committee in Biology with members serving in their personal capacity, to the restructuring in 1969 which created the present ACPM composed by experts designated by national governments, to the integration of this ACPM on Biology and Health Protection into a wider system of ACPM's, which took place in 1977.

In parallel with strengthening of the representation, a widening of the scope of ACPM functions took place. At present, these functions may be summarized as follows: to assist CEC with elaboration of programme proposals, through a procedure of consultations and discussions culminating in a formal document of approval; selection of the research proposed by national laboratories to implement an approved program; review of the programme progress; establishment of closer links and integration with national research and development activities.

Professor Gössner outlined the composition of the ACPM, both in terms of nationalities and of specialities of the various members and described the methods of work established within the Committee in connection with the various functions. Much of this information is contained in Chapter 3 of this report on management of the programme and procedures.

In respect to the programming functions, Professor Gössner reviewed the procedure to arrive at the formulation of a new programme and the difficulties created by the need to decide on a programme greatly in advance of its execution, to allow for the time of approval by higher political bodies. It was apparent from this description that there has been a steady improvement of these procedures and that the formulation of a new programme involves ample consultations of experts from various countries and fields to arrive at a broad-based and sufficiently wide proposal. The present procedure is regarded by the interviewee as adequate to identify new areas of prospective activity. Professor Gössner also believes that a procedure leading to a decision about a future programme a year before the end of the previous one has resulted

in the elimination of inconveniences which disrupted the continuity of research activities in the past. The Panel concurred with this opinion and while endorsing the present practices recommends an important expansion in the procedure for establishing the Programme Proposal, as noted elsewhere.

As to the selection of research proposals, the Panel asked the interviewee to elaborate specifically on the criteria and procedures for examination of new proposals and it is satisfied that the main criteria guiding the ACPM in the selection are the scientific value of the proposals, their congruence with the general programme, the qualifications and expertise of the scientists and the value of the proposal at the Community rather than at the national level.

In the field of management and progress monitoring, the elements of flexibility and the means to readjust the programme to allow for new ideas and research were the main points discussed. Other points touched upon the merit and desirability of large coordinating groups such as EULEP vis-a-vis the functions of the CEC services and of the ACPM itself. It was concluded that when each party keeps to the respective functions, such scientific coordinating groups are very beneficial for the efficient execution of the programme.

Of special interest to the Panel members was the part of the interview in which Professor Gössner elaborated on the problems facing the ACPM in view of its numerous and important functions. In his opinion the most important challenge now facing the ACPM is that of strengthening its scientific function and to widen the expertise available within it to cover all aspects of the programme.

Professor Gössner expressed satisfaction about the climate of collaboration, understanding and constructive criticism within the ACPM about the establishment of the Evaluation Panel, he stated that any suggestion in the field of management will be seriously considered in view of increasing the efficiency of the ACPM. Any suggestion of a scientific nature will similarly be discussed for possible inclusion into the new five-year programme 1985-1989 presently under consideration.

(b) Interview of J.F. Duplan as Chairman of EULEP, December 13, 1982. The interview was in one sense, an interview of a sector D contract (201-76-1-BioC) but had wider significance in that it dealt specifically with the organization and function of a surrogate cooperative coordinating group spawned by the CEC programme to enhance the work in late effects.

The EULEP contract was examined in detail and the Panel was informed at the interview of its Chairman, Dr. J.F. Duplan that EULEP began as a research-supporting body, but has gradually re-oriented to be a research-coordinating agency. The Panel considers this shift to be valuable because it will result in a clearer distinction between the funding role of the CEC and the scientific role of EULEP. EULEP can be (and has been) instrumental in bringing about rapid changes in the programme, such as in promoting an interest in prenatal effects of irradiation. The organization, functions and procedures governing the life of EULEP were described to the Panel. The main functions are: coordination of research activities and standardization of techniques

(dosimetry, pathology), provision of scientific services from one to another member laboratory, training of scientists in advanced areas of late effects research (virology, molecular biology), organization of scientific meetings and symposia, support of travel for scientific exchanges. International collaboration is a prerequisite in order to obtain money from EULEP.

The main drive behind EULEP appears to be the genuine interest of the scientists and their institutes in the objectives of EULEP. Considering the money that the CEC is investing in the contract, the Panel was favourably impressed by the results achieved. It was noted that the functions of the EULEP could not easily be taken over by the CEC staff because they are understaffed and overburdened. There are distinct advantages also in scientists coordinating themselves according to their own needs. The Panel is satisfied that, as long as the main function of EULEP remains in coordination, there is no overlapping of functions with CEC administration. This appears to be the desire of EULEP, which regards itself as an independent scientific group. Note that supporting material relating to this contract appears in Appendix 2, #25.

2. Interviews of Sector Contractors

(a) Sector D - Late Effects

(i) Contract No. 242-76-7 BIO, dealing with comparative studies on various populations of radiation-induced leukemia viruses, was investigated in depth. A separate interview was held on December 13, 1982 with the research head Dr. J.F. Duplan. The interview was particularly helpful to place the scientific questions in an appropriate perspective, which was not immediately apparent from the reports submitted. It became evident that the original purpose of the proposal was to study the relationships between two different carcinogenic viruses but in fact most of the work went to show differences rather than similarities. Although the final achievements were, in a sense, opposite to the original goals, the Panel was satisfied that the programme has been scientifically successful. The specific role of CEC's support in this case was to enable the contracting laboratory and a collaborating institution, to develop biochemical, molecular-biological and virological aspects of the work that would otherwise have not been possible. It was stated that the CEC support was also important in obtaining additional local funds. There was full satisfaction expressed at the way the administration of the contract was carried out and no obvious suggestions for improvement. The Panel believes that the work is relevant to the CEC Radiation Protection Programme, in the general sense that it deals with mechanisms of radiation-induced leukemogenesis. The impression that the Panel gained from examining this contract was a favourable one. However, this was a contract in which the final report for the 5 year period did not do justice to the work performed. Supporting material concerning this contract appears in Appendix 2, #27.

(ii) Another contract No. 218-76-1 led by Professor W. Gössner was examined and a separate interview was held on December 13, 1982 with its project leader. This is a very early contract in the CEC programme and it developed out of an interest in bone carcinogenesis by internal emitters. Bone tumors have the advantages of a low species specificity,

easiness of early detection and low spontaneous incidence. To the original research on animals, epidemiological studies on humans treated with Peteosthor were added; more recently, virological aspects of bone tumor induction were developed together with research on the effects of physical variables (radionuclides with different half-lives, fractionation) and of biological variables (sex, age, strain). An increase in tumor induction by protraction in the case of alpha emitters is considered to be an important finding of this work. The Panel noted that the contract had been scientifically productive and that the various parts of the original proposal were fairly well covered in the publications, with the exception of effects in utero and of synergistic effects, which were proposed but apparently not pursued. Technical considerations, in addition to the higher priority given to virological research, accounted for this fact. At the time of the contract, about 40% of the laboratory work was funded on CEC money; at present this has fallen to 30%. There was complete satisfaction in the way the CEC services were managing the contract. It was thought that the best way to ensure smooth running was for the CEC staff to show interest and monitor progress from a distance without trying to interfere with the conduct of the work. The Panel concluded that the mechanisms of carcinogenesis were obviously the main interest of the group but the results produced were of a scientifically high standard and very valuable in the general context of the CEC programme. Supporting materials relating to this contract appear in Appendix 2, #26.

(b) Sector E - Genetic Effects.

The evaluation team invited two contractors to extended interviews, Professor F.H. Sobels and B. Bridges, on January 17, 1983.

(i) Professor Sobels of Leiden University was invited both because he leads a large group of scientists with many projects as part of the CEC Radiation Protection Programme (15 projects in 1976-80) and because he has had long experience with the way the programme has developed and how it is administered.

The work of the group led by Professor Sobels is a large operation, and its many projects may be viewed as an integrated effort in basic radiation genetics, but directed towards problems of immediate interest to radiation protection. An important aspect of the studies was the application of the so called parallelogram method for quantification of human radiation risks. This model has had setbacks, since tests of predictability of somatic vs germ cell damage and in vivo vs in vitro exposures did not hold from one animal species to another as far as chromosomal damage goes. Work is continuing utilizing other end points. The hypothesis was an attractive one and the model has been useful but it is very important that its limitations have been determined.

On the other hand, studies on the principles underlying the doubling dose method seem to indicate that this method may be better suited than was formerly believed. More recent work however - with mutation induction via transposons - appears to indicate new and unexpected mechanisms. Thus, the final answer is not yet in hand, and the work will continue.

Of direct interest for radiation protection has been e.g. the work with neutrons, which indicate that in spite of the ion density of high

LET tracks, induced chromosomal translocations do not constitute a recessive lethal more often than is seen after induction by X-rays.

The main benefit of the Radiation Protection Programme - beyond the factual financial support - is judged by Professor Sobels to be the scientifically integrating and stimulating work atmosphere to be found in the sector on genetic effects.

Problems were formerly encountered, in particular in some of the smaller labs, during the transition time between two research program periods, but appear to have been overcome lately. Professor Sobels had never had any difficulties with the programme management, which he ascribed to the CEC itself and also to being able to have in his department a sufficient clerical force to cope with all details of contract and financial administration. Some smaller laboratories do not have the advantage of clerical or administrative help. The Panel noted that these smaller laboratories especially hoped that administrative procedures would be kept to a minimum. Supporting documents, Appendix 2, #28.

(ii) Professor Bryn Bridges, of Sussex University, leads a MRC research laboratory of intermediate size, and has three projects with the Radiation Protection Programme, associated in a cooperative effort with research groups in Rotterdam, Rijswijk and Leiden. The projects are primarily oriented towards studies of mechanisms of induction of radiation damage in humans.

For this purpose, the group has collected a large number of tissue specimens from cases of genetically determined diseases proven or suspected of being cancer prone, including also hereditary neurological diseases. In analogy with what has been done in microbial genetics, it is hoped that this collection of mutant cells may yield clues of repair pathways in humans.

At present, a four-fold difference in D_0 has been observed between fibroblast lines, but no enzymatic step had been identified up to 1980. So far, straight biochemical methods have been used, but it is expected that cloning techniques now under development will allow complementation studies with yeast mutants with known repair defects, and a new level of analysis and insight seems possible.

Epidemiological evidence of cancer proneness in relatives of patients with ataxia telangiectasia may indicate heterozygote susceptibility. More recently a defect in DNA ligase activity has been identified in one of the radiation sensitive strains. If this proves to be a general feature of cancer prone conditions, radiation sensitive individuals may be identified and special protection standards may be of relevance, e.g. avoidance of occupational radiation work, special precautions during radiation therapy, etc.

Professor Bridges introduced in 1973 the concept of "radiation equivalent" for chemical toxins. He believes today that this concept should be limited to risk norm descriptions for individual substances and situations, and that attempts to create a general unit of exposure are futile.

Professor Bridges expressed strongly his satisfaction with the mutual collaboration organized through the Radiation Protection

Programme with other tissue culture laboratories. The interaction had proved flexible and multifaceted, and highly stimulating. Prof. Dr. Bridges had one complaint concerning the required accounting of a scientists time which he believed was too detailed. This turned out, however, not to be a requirement of the CEC but rather a local imposition.

The CEC has agreed to support 39% of the work, but the contract now in reality covers only about 20%, because the input into the project has grown thanks to support from other (MRC) sources. Supporting documents, Appendix 2, #29.

The impression gained by the Panel through these interviews is supported by the information contained in the answers to the questionnaire. There appears to be in the Sector on Genetic Effects; a mutually stimulating working atmosphere within the sector; a conscious orientation of the work in relation to radiation protection relevance; a close and fruitful relationship between basic biology and genetics and the methodologies and approaches used; and, finally, a highly helpful and creative function fulfilled by the project programme.

(c) Sector F - Evaluation of Radiation Risks

The Panel interviewed Mr. G. Uzzan of the CEA, Fontenay-aux-Roses (Contract 099-76-1, PSA F) on January 17, 1983.

M. Uzzan explained that the prime purpose of the single research contract in Sector F was to develop methodologies for assessing individual and collective doses of radiation in man during both normal operations and accidents, for assessing the consequent damage in man, and for assessing the socio-economic effects of such exposures.

The main aim initially was to assess the existing state of knowledge to see if answers to the relevant questions were available. This involved undertaking literature searches and summarising information. If the information base was fairly good an attempt was made to use it directly to generate guidance, if necessary doing small amounts of original work to make this possible. Some of the rather basic work done under a sub-contract in project 2 was justified because it was intended to provide models of detrimental effects for use in risk assessment.

Mr. Uzzan explained that by far the largest effort had been made in Project 1, concerned with assessing individual and collective dose, and that Project 3 took the least effort. He agreed that Project 3 had not been executed entirely satisfactorily and that aspects of work carried out in relevant research areas in other countries had been neglected.

In answer to a question concerning the relationship of research under this programme with research under the "Plutonium Recycling in Light Water Reactor's" programme, Mr. Uzzan stated that the joint report by CEA/NRPB entitled "Methodology for Evaluating the Radiological Consequences of Radioactive Effluents Released in Normal Operations" had drawn on several parts of the work done under the Radiation Protection Programme. In particular he mentioned the work on uptake of radionuclides by vegetation, on washout coefficients for iodine, and the MESOS model of atmospheric dispersion.

Mr. Uzzan agreed that the number of papers published in refereed journals as a consequence of the programme was rather low, but stressed the value of conferences and reports. He also agreed that the final report was very late, over two years after the end of the contract. This he explained was due to problems in getting sub-contractors to produce their reports in time.

As a footnote to the interview, Commission staff were asked why a contract of association had been chosen for this sector. The reply was that closer contacts between contractor and sub-contractor were advantageous and enabled the CEC to keep closer control of the work.

Supporting documents are in Appendix 2, #30.

3. Interviews of CEC Radiation Protection Programme Personnel

(a) Programme Personnel.

Interviews or addresses took place for information purposes. Mr. F. Van Hoeck addressed the panel on the overall role and functions of the CEC programmme at its first meeting October 4th and the details are available in the minutes. He also responded to questions regarding the interview of Mr. Uzzan and attended some of the Panel meetings.

Dr. H.G. Ebert addressed the Panel specifically on the management procedures of the CEC on December 14 and again on the Publication and Meeting Policies of the CEC on January 18th. Dr. Ebert also attended most of the meetings of the Panel and responded to questions and provided information at all stages.

The Panel was also addressed at its December meeting by the Programme Managers on Dr. Ebert's staff. Dr. Ebert himself for Dosimetry and its Interpretation, Dr. Myttenaere for Behaviour and Control of Radionuclides in the Environment, Dr. Gerber for Short Term Effects, Dr. Gerber for Late Somatic Effects, Dr. De Nettancourt for Genetic Effects (January meeting), Dr. Sinnaeve for Evaluation of Risks, and Dr. Schibilla for Medical exposures. These addresses, the questions that followed and the written material helped especially to provide descriptions of the sector programmes and to place their status in perspective on the contemporary scientific scene.

(b) Biology Group at Ispra.

Dr. M. Devreux was interviewed on January 17 and conducted the tour of the Ispra Laboratory on October 4th. His comments and enlightened description of the work of the Biology Group at Ispra helped greatly in formulating an understanding of the circumstances and progress there and thus contributed to the description of the programme in Chapter 2 and its evaluation in Chapter 6. Supporting documents include items 31 and 32 of Appendix 2.

4. Other Interviews

Mr. Hurst for Mr. de Sadeleer, Head of the Contracts Division of D.G. XII February 22, 1983.

Mr. Hurst indicated the role of the contracts administration branch of D.G. XII in implementing the contract, which begins after the contracts have been decided upon, but must now be updated individually with the respective laboratories. A document labeled XII/120/83-EN

"Measures used by the Commission for the purpose of implementing Research Programmes," (Appendix 2, #33) was provided and it details all the procedures. All contractors are treated alike, and the Panel noted that "juste retour" has never entered into it at any phase, at ACPM, with the contractors or with CEC or the Council. CEC has paid 20% initially and thereafter on invoices each 6 months. The latter will change to 12 months because payment is being tied to the progress reports, (scientific and financial). CEC does not have a requirement for scientists time reporting, they do not buy equipment but provide for depreciation, and patents are generally shared by CEC and the national contractor. There seemed to be no special problems in the administrations of the contracts.

Mr. Gabolde Head of the Internal Affairs Coordination Division of DG XII met with the Panel on February 22 to describe the background of the framework programme which is designed to provide a strategy for all scientific and technical activities of the Commission. A document (see Appendix 2, document 24) describes the framework programme. The aims are to (1) provide a conceptual tool for choosing scientific objectives, (2) provide a programming tool to measure and separate activities at the national, international and community level, (3) provide a financial forecasting tool. The overall aim seems to be to use research programmes more effectively to meet the needs of the Community, and to emphasize and expand those programmes that serve the community needs best. In the future each research programme, like the Radiation Protection Programme, will have to indicate in what way it serves a variety of community objectives by testing on a matrix with objectives on one side (vertical) and of the programme on the other (horizontal). One overall objective is to raise the investment of the CEC in research to 4% of the total CEC budget, the present investment being 2.5-2.6%. These additional commitments will benefit those research programmes that serve Community purposes best as judged by the framework programme. Presumably all of this means that CEC believes research is cost effective, an important and indeed vital judgement for the future of the Community.

It was noted in the course of these discussions that basic research is not considered either the aim or the province of the CEC. The CEC has specific interactions with the European Science Foundation which conducts basic research in Europe. Nevertheless, it was recognized that even in the relatively applied research programmes of the CEC a basic component is important to provide the necessary background for the field and to ensure the calibre of the investigators needed for the successful prosecution of the programme.

Mr. Boggio Head of the Research Evaluation Service of D.G. XII made a presentation at the first meeting of the Panel on the experiences of the CEC with respect to evaluations and the conference it had held. This was important information for the orientation of the Panel. Both he and Mr. Matthieu, of the Research Evaluation Service of D.G. XII who has acted as secretary to the Panel, provided much information and perspective from time to time on CEC procedures and policies. Mr. Matthieu attended all meetings full-time and was a constant help on all the details of the Panel's work.

5. Study group

Three members of the Panel, Bresson, Oftedal and Sinclair attended during the morning only on February 23, the study group on Accident Consequence Modeling organized by J. Sinnaeve of CEC staff as part of the programme of Sector F. The purpose of attendance by the Panel members was to see how the study group procedure worked. This was the first meeting of this group which included about 25 people, about half of whom were investigators on two contracts, one with NRPB and one with KFK (Karlsruhe). NRPB personnel, led by Dr. N. Kelley, presented an overview and some details of their proposed work on the contract for the next two years. KFK personnel (led by Dr. S. Vogt) presented their plans also. The function of the study group is for the other members of the group to comment, question and critique the plans, which they did ! The study group is to meet again at the end of a year, examine progress, consider further elements of the programme, fill in gaps, etc. and finally to meet again at the end of the two years, comment on what has been done and critique a report on the subject to be prepared by NRPB and KFK.

This seemed to be an excellent plan, those invited seemed knowledgeable in the field and asked many questions about complex terrain modeling and the like, source terms for the entire fuel cycle and so on. Contacts with work in the USA are being developed and work there is well known. The impressions from this limited visit to a study group, as a mechanism for bringing a given subject area into sharp focus and moving it forward while utilizing effectively much of the talent available in the Community, were very favourable.

It should be noted that the members of the Panel are generally familiar with CEC symposia and all have attended a number of these over the years. Some are also familiar intimately with the work of EULEP or CENDOS etc. also.

European Communities — Commission

EUR 8648 — Evaluation of the European Community's radiation protection research programme (1976-80)

W. K. Sinclair, R. L. Akehurst, G. Bresson, E. Oberhausen, P. Oftedal, G. Silini, A. Wambersie

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The evaluation of the Community's radiation protection R & D programme, which is the subject of this report, forms part of the Commission's efforts to submit its research and development programmes to an external evaluation.

The task of conducting a critical review of the radiation protection research and development programme 1976-80, was entrusted to a panel of seven external independent experts appointed by the Commission. The panel focused on the assessment of the scientific and technical achievements during the period 1976-80, the evaluation of the effectiveness of the programme management and of the utilization of the resources as well as the assessment of the socio-economic impact of the programme and the elaboration of recommendations for future orientation of research.

The report summarizes the discussions and conclusions of the evaluation panel.

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