COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 10.04.1995
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JOINT RESEARCH CENTRE

1994 ANNUAL REPORT

(Presented by the Commission)

PREAMBLE

Following

- Article 4 of the Council Decision of 29 April 1992, adopting specific research programmes to be implemented by the Joint Research Centre for the European Economic Community (92/273/EEC) during the period 1992–1994,

- Article 4 of the Council Decision of 29 April 1992, adopting specific research programmes to be implemented by the Joint Research Centre for the European Atomic Energy Community (92/274/Euratom) during the period 1992–1994,

- Article 5 of the Council Decision of 29 April 1992, adopting a supplementary research programme to be implemented by the Joint Research Centre for the European Atomic Energy Community (92/275/Euratom) during the period 1992–1995;

it is foreseen that an annual report on the execution of the programme will be transmitted by the Commission to the Council, the European Parliament and the Economic and Social Committee.

The enclosed document constitutes the third of these reports and concerns the year 1994.

It is accompanied by the observations of the Board of Governors.

OBSERVATIONS OF THE BOARD OF GOVERNORS ON THE JRC ANNUAL REPORT 1994 [1]

Introduction

The Board of Governors, as requested by the Council decisions on the JRC specific programmes, provides every year its observations on the Annual Report drawn up by the JRC Management and adopted by the Commission.

The Board first of all notes that 1994 was a particularly important year for the JRC. It was the last year of the 1992-1994 programme, and the Board when approving the 1994 Workprogramme early in the year, ascertained the fulfilment of the objectives for that programme. At the same time 1994 became the transitional year towards a new more competitive approach for the JRC for 1995 onwards. The first signal of this was found in the Council Common Position on the Fourth Framework Programme on Community Activities of Research, Technological Development and Demonstration 1994-1998 of December 1993. The chief concern of the Board was not only that the JRC itself be prepared to meet the new challenges, but in particular that the Commission, the Council and the European Parliament in a timely way would create new boundary conditions, by suitable amendments to rules and regulations, allowing the JRC to operate under the new conditions. The Board met at an extraordinary meeting in early February 1994 to review this new situation. It has been a concern for the Board throughout the year.

JRC Work in 1994

The Board notes with satisfaction that JRC scientific-technical work - as witnessed by the Annual Report - has progressed with a good pace leading to a number of significant achievements. Some of these have attracted public attention, such as the verification at the Institute for Transuranium Elements of illicit nuclear materials performed as support to the Commission EURATOM Safeguards Directorate of DG XVII. Cooperation both with national and international organisations has been intensified, one example being the European Tracer Experiment to test the behaviour of atmospheric models for emergency response. A typical example of the JRC, here the Environment Institute, being invited to lead Europe-wide large-scale experiments encompassing numerous laboratories and national and international (IAEA, WMO) authorities. In agreement with a strategy defined by the Board in 1990, a growing proportion of the JRC activities are devoted to scientific-technical support to Community policies in response to requests from the Commission services responsible for these policies. This accounted for almost a quarter of the total JRC work in 1994. Novel activities were witnessed - amongst others - by the inauguration in October 1994 of the European Centre for Validation of Alternative Methods (alternative to animal experiments) established in Ispra to support Community regulatory work in the area upon initiative of DG XI.

It was a promising sign that during the year the JRC were able to considerably increase its volume of new contracts for work for third parties, even in an environment where the competition is getting stiffer.

1994 saw the installation of the Institute for Prospective Technological Studies at its Seville (Spain) location. The Board will follow with interest the Institute developments in this new environment, which may well lead to an intensified Mediterranean Area collaboration for the JRC.

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1. The Observations of the Board of Governors accompanying the Annual Report are requested in the Council Decisions 92/273/EEC, 92/274/Euratom, 92/275/Euratom of 29 April 1992 on the JRC Specific Research Programmes 1992-1994 for the EEC and the EAEC and the supplementary programme (HFR Reactor) 1992-1995 for the EAEC. The Council Resolution 92/C 118/03 of 29 April 1992 stipulates that the Annual report shall provide information on all categories of activities of the JRC.

A wider JRC collaboration came into existence in 1994 through the EEA Agreement. Austria, Iceland, Finland, Norway and Sweden participated fully in the JRC programmes for the EEC, and the Board was guided in its work by participation of representatives from all five countries.

Finally, from the 1994 work, the Board notes with considerable satisfaction the growing number of scientific fellows under the Human Capital and Mobility Programme and other schemes. This, together with arrangements for scientific visitors and seconded national experts, is judged of significant value for the scientific vitality of the Centre and a consolidation of the collaboration with national research in the Member States and participating countries.

JRC towards the Future

As already mentioned, the JRC has embarked on its transition towards a more competitive existence as has been advocated for some time by the Board and now decided by the Council, the European Parliament and the Commission. The Board pledges to support the Commission and the JRC management in this not uncomplicated endeavour. To this end the Board notes with satisfaction the re-emphasis of its role, as given by the Commission decision of 14th November 1994 on its terms of reference.

Besides the formal decisions on the future of the JRC, the evaluations of the Centre in 1993 and 1994 - on the initiative of the Board - by Visiting Groups and the overall analysis of Sir Hermann Bondi, FRS will serve as guidance for the Board.

There are issues of more immediate concern such as the assistance with the selection of candidates for the several Directors' posts, which have or will shortly fall vacant. Several other tasks are still ahead of the Board and the JRC including the finalisation of an on-going definition of a long-term strategy for the Centre.

Acknowledgements

The Board acknowledges with gratitude its contact during the year with Professor A. Ruberti, Member of the European Commission and his efforts in securing a proper place for the JRC as an instrument for the Community research and technological development policy.

At the same time the Board expresses appreciation for the devotion of the Director General, his Directors and the entire JRC staff to its work and their courage in facing the considerable future challenges for the Centre.

Brussels, February 1995

JOINT RESEARCH CENTRE

1994 ANNUAL REPORT

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Report of the Commission

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THE JOINT RESEARCH CENTRE

The Joint Research Centre is a European scientific and technical research centre established by the Commission of the European Communities, with headquarters in Brussels. Five separate sites, located in Belgium, Germany, Italy, the Netherlands and Spain, house eight different institutes, each with its own focus of expertise.

These institutes are:

IRMM	The Institute for Reference Materials and Measurements (Geel)
ITU	The Institute for Transuranium Elements (Karlsruhe)
IAM	The Institute for Advanced Materials (Petten & Ispra)
ISEI	The Institute for Systems Engineering and Informatics (Ispra)
EI	The Environment Institute (Ispra)
IRSA	The Institute for Remote Sensing Applications (Ispra)
IST	The Institute for Safety Technology (Ispra)
IPTS	The Institute for Prospective Technological Studies (Seville)

The statutory staff of the JRC was 1 845 at the end of 1994. To this number one must add 354 scientists who were active in the Centre and were paid by the JRC under various hosting schemes.

The global financial appropriations available to the JRC in 1994 were around 300 Mioecu, taking into account a contribution of 11 Mioecu, from the EEA/EFTA Member States.

This Annual Report intends to give a general overview of JRC activities in 1994.

Readers may find more details in the Annual Reports of the eight institutes. The JRC also publishes numerous scientific reports, presents papers in conferences and in scientific journals, and organises workshops, seminars and conferences to disseminate its scientific achievements.

These documents may be obtained from

Public Relations and Publications
CEC – Joint Research Centre
I – 21020 Ispra (VA) Italy
Phone : + 39 332 78 91 80
Fax : + 39 332 78 58 18

1. THE JRC IN 1994

In the period 1992-1994, as in previous programme periods, the Joint Research Centre (JRC) has executed research programmes for the EEC (European Economic Community) and the EAEC (European Atomic Energy Community) respectively, as approved by the Council. Moreover, the JRC has provided scientific and technical support for various Community policies as requested by the Commission Directorates General responsible for these policies and has made its scientific competence and experimental installations available to public or private bodies in return for payment (Work for Third Parties).

During 1994, the last year of the 1992-1994 JRC Specific Programmes, adopted by the Council on 29 April 1992, contributions were made to the objectives of the 3rd Framework Programme under the lines of Industrial and Materials Technologies, Measurement and Testing, Environment, Nuclear Fission Safety, Controlled Thermonuclear Fusion and Human Capital and Mobility. About 66% of the JRC Budget was used in 1994 to implement these programmes.

The Agreement on the European Economic Area (EEA) entered into force on 1 January 1994 and the EEA/EFTA countries have participated since then in the JRC Specific Programmes for the EEC.

The JRC has benefited from its multi–disciplinarity, its role as a neutral organisation forming part of the services of the European Commission and the many collaborations it has developed with research organisations in the Member States, as well as wider collaborations under various agreements with third countries. Much attention has been paid by the JRC Board of Governors to ensuring respect for the principle of subsidiarity.

About 23% of the 1994 JRC Budget went into work undertaken as scientific and technological support for the Commissions' services and much attention has been paid to applying the customer/contractor principle. Almost all major operations were covered during the year by an inter–DG multiannual contract, a Council Decision or a Commission Decision, and the rest were carried out on a one–off basis in response to requests from Commission Directorates General. New initiatives, conceived in 1993, were taken with the inauguration of the European Centre for Validation of Alternative Testing Methods (ECVAM) and the signature of a memorandum of understanding between DG XI and the JRC, for the European Reference Laboratory of Air Pollution (ERLAP).

Contractual work performed for third parties continued and the JRC strengthened its marketing efforts both at institute and at central level. As a result, the volume of new contracts substantially increased during the year, with all the institutes being involved in the execution of third party work.

The JRC's fifth site, at Seville in Spain, was opened on 1 September 1994; it houses the Institute for Prospective Technological Studies, following an agreement between the Kingdom of Spain and the Communities signed on 15 April 1994.

The Fourth Framework Programme on Community activities of Research, Technological Development and Demonstration (1994-1998) and the Euratom Framework Programme (1994–1998) were approved and the role of the Joint Research Centre has been reoriented, by the Council Conclusions of 26 April 1994 (OJ N° C 126/1 dated 7.5.1994), towards a more competitive approach.

The two specific programmes for the work for the EC and for the EAEC, to be carried out by the JRC during the period 1995-1998, were approved by the Council on 15 December 1994.

1.1. Council Decisions relating to Joint Research Centre activities

On 26 April 1994, the Council reaffirmed its resolution of 29 April 1992 on the JRC, and in particular :

- the Community character of the JRC and its role in the achievement of the objectives of the Union,

- the need for the JRC to pursue and reinforce its move towards a more competitive approach on the basis of a genuine customer/contractor relationship.

The Council underlined the need for the JRC to progressively enter the competitive area, generally in networks with other laboratories; this transition towards a more competitive approach should be introduced gradually and progressively during the period 1995 to 1998.

The Commission, in the course of 1994, acted to facilitate the new orientation :

- in adopting new rules for the participation of European organisations in the activities of the 1995-1998 Framework programme, allowing the JRC to participate, on a same basis with other laboratories, in these activities ; these rules have been adopted by the Council;

- in proposing the needed amendments to the financial regulations, which are presently under discussion at the Budgetary Authority, Council and the European Parliament;

- in adopting the needed reorganisation of the JRC, in strengthening the role of the Board of Governors, reinforcing the link with the shared cost activities and creating a Scientific and Industrial Advisory Group;

- by creating an Internal JRC task force in order to help the JRC scientific units to answer effectively the calls for tender of the shared cost and other competitive activities;

- by requesting the Secretariat General of the Commission to organise the competitive support activities which will have to be launched under the responsibility of the various Directorates General of the Commission.

The two specific programmes for the work for the EC and for the EAEC, to be carried out by the JRC during the period 1995-1998, were approved by the Council on 15 December 1994.

1.2. Evaluation of JRC scientific activities

Visiting groups, made up of scientists and science managers external to the European Commission and chosen for their knowledge in the specific fields of the JRC institutes, were constituted in 1993, on the recommendation of the Board of Governors, to carry out an independent evaluation of the JRC's scientific activities.

Nine of these groups, of 4 to 6 persons each, visited the institutes in late 1993 and in 1994. They had discussions with scientific and managerial staff, and their reports were then gathered and analysed by Sir Hermann Bondi, FRS (Fellow of the Royal Society).

Sir Hermann Bondi discussed their findings and observations with the Board of Governors, in line with the Council Decision on the JRC Specific Programmes of 29 April 1992.

It was generally recognised that the development of the JRC's activities had been continuous and positive. The institution of visiting groups has led to establishing valuable new connections, has provided constructive advice to the respective institutes and seems to have been a successful approach to assessing JRC activities.

Broad similarities between the nine reports were observed : the overall scientific standards of the work were praised; the JRC's support activities for Commission programmes were judged to be good and improving, but further development is still attainable.

It was generally recognised that the stimulus of having to gain work on a competitive level would have very positive results. But a change of attitude, or even of culture, will be necessary — indeed for some institutes quite considerable change — and will require sustained determination. On the other hand, the rapid growth of external links, thanks to grantholding students and visiting scientists as well as through networking, was universally applauded and further extension in this direction is recommended.

The JRC management analysed all specific recommendations made by the visiting groups, and approved their implementation wherever they were compatible with existing regulations.

The Board of Governors made its own observations which, together with the visiting groups' evaluation reports, were transmitted by the Commission, to the Council and the Parliament, in accordance with the requirements laid down in the Council Decisions on the JRC Specific Research Programmes for 1992–1994.

1.3. Entry into force of the EEA Agreement

Following the entry into force of the EEA Agreement on 1 January 1994, the EEA/EFTA countries have started participating in all aspects of the JRC's EEC programmes. Scientific collaboration has been particularly focussed on areas of specific interest to these countries, such as photovoltaic systems for alpine regions, an extension to EFTA countries of the project on the monitoring of land resources, a project on coastal monitoring for the Baltic region, an extension of the application of tracer techniques for global change (cooperation with the Austrian laboratory at Seibersdorf), as well as the development of methods for risk prevention, in collaboration with the National Rescue Services Board of Sweden.

Nationals from the EEA/EFTA countries have participated in the work both at committee level and in the institutes, as grantholders, visiting scientists and seconded national experts. Finally, representatives of the EEA/EFTA countries have joined the Board of Governors.

1.4. Specific research programmes

The major task of the JRC in 1994 was to contribute to the implementation of the EC's 3rd Framework Programme in its last year of existence. This contribution accounted for 66% of the JRC budget, and was carried out, in particular, through activities included in the following specific programmes:

- The Industrial and Materials Technologies programme encompassed research on advanced materials executed by the Institute for Advanced Materials (IAM), and on the working environment, executed by the Institute for Safety Technology (IST), the Institute for Systems Engineering and Informatics (ISEI) and by the Environment Institute (EI).

The work performed on materials for extreme environments was continued, with emphasis on high temperature corrosion (up to 1400^{0}C), creep and fatigue properties on new metallic materials (superalloys, intermetallics) and Si_3N_4-SiC based ceramics and composites.

Significant progress was made in the field of interfaces in materials in four main areas: carbon fibre reinforced silicon nitride ceramics, plasma ion nitriding, semiconductor gas sensors, and cubic boron nitride films.

In the field of hard coatings, nano-crystalline (B, Ti)Nitride films of considerable hardness and good wear resistance were developed. They are interesting candidates for applications such as high speed machining, since they are much more stable than other protective films at high temperatures.

The European-based networks on aged materials (AMES), the behaviour of critical industrial components (NESC) and the validation of inspection methods (ENIQ) became well established. More

than 40 different organisations from all over the world were involved in these networks. The first project of NESC, involving all disciplines related to structural integrity, is already in full operation. Within ENIQ there was a growing consensus on a European methodology for inspection qualification of non-destructive techniques. A first large project on validation of surveillance practice and mitigation methods was ready to be set up in AMES.

In the domain of the working environment (see also further, in the Environment Protection programme), the determination of trace metals in the European population in general and under working conditions was continued; the study of metal toxicity at low level exposure was also continued. Early fault diagnosis tools were also investigated, through a methodology for the diagnosis of industrial processes based on statistical analysis applied to the start-up/shut-down of industrial plants.

- **The Measurement and Testing** programme encompassed research projects on measurements and reference materials, carried out by the Institute for Reference Materials and Measurements (IRMM), and research projects on reference methods for non-nuclear energies (photovoltaic systems) and the assessment of the reliability of structures, executed by the Institute for Systems Engineering and Informatics (ISEI) and by the Institute for Safety Technology (IST).

The IRMM confirmed its worldwide reputation by accurately measuring neutron-interaction data and by preparing relevant reference materials, contributing thus to numerous fields of application.

Among others, isotope abundance measurements and atomic weight determinations were performed with extreme accuracy.

A prior commitment to the Community Bureau of Reference (BCR) was extended, and special reference materials relevant for biological and environmental studies were prepared, tested and characterised.

At the ISEI, activities dealt with structural diagnostics by optical and volumetric techniques. Achievements were made in the utilisation of pulsed holographic interferometry and the characterisation of stone materials by an electronic speckle pattern interferometer. Acoustic emission techniques were used to assess the quality of bonding and a methodology was developed for laser holographic interferometric techniques for measuring damage accumulation in materials.

Other activities regarded pre-normative research on photovoltaic systems at the ESTI (European Solar Test Installation), namely the development of a flash radiometer, the annealing of thin-film silicon amorphous modules, after light-soaking and tests of safety standards for commercial modules.

- **The Environment Protection** programme consisted of research projects executed by the Environment Institute (EI) on atmospheric pollution, and on soil, water and waste pollution. It also encompassed applications of remote sensing techniques, executed by the Institute for Remote Sensing Applications (IRSA), and research activities on industrial hazards executed by the Institute for Safety Technology (IST) and by the Institute for Systems Engineering and Informatics (ISEI).

On atmospheric pollution, the results of the preliminary measuring campaign on the Biogenic Emission in the Mediterranean Area (BEMA) project showed biogenic emissions to be two to three times higher than those in temperate ecosystems. This feature has been further investigated in the course of the 1994 BEMA campaign, held once more at the Castelporziano (Rome) test site. The results will be available in early 1995.

The preparation of ETEX, the "European Tracer Experiment" designed to test the behaviour of atmospheric models for emergency response, is continuing. Various countries contributed equipment and techniques, which made it possible to widen the field experiment.

By a collaboration agreement with the "World Meteorological Organisation" (WMO), a "World Data Centre for Aerosols" (WDCA) was created, to collect and exchange information obtained through a large number of monitoring stations around the world. WDCA is a part of the "Global Atmospheric Watch" (GAW) system, set up by WMO to monitor the evolution of the global atmosphere.

All the information available on the environmental contamination caused by the Chernobyl accident is being collected and merged in form of an atlas, in collaboration with all European countries, including eastern and central European countries, Russia, Belarus and Ukraine. The project will be carried out using modern computer technologies. Exchange of scientists and training were important aspects of the project, which will be completed in 1996, ten years after the accident.
Activities at EI related to pollution by trace metal exposure and its health effects were mentioned above. A mechanistic understanding of metal toxicity at a low level exposure is being developed.

In the framework of indoor air pollution, the adsorption–desorption of several volatile organic compounds (VOC) on furniture surfaces (carpet, wall covering, etc.) has been investigated: a new model with two adsorption compartments has been developed and successfully tested.

Field and laboratory studies continued in the areas of pollutant–soil–water interaction and toxin production associated with algal growth, in relation to environmental factors. The application and development of advanced analytical techniques for pollutant detection in various environmental matrices have been pursued through collaborative studies and intercalibration exercises with European laboratories. Two mobile analytical laboratories have been designed and put into operation within the framework of the EUREKA project EU 674.

At IRSA, the work scale went from local to global; considerable emphasis was put on scientific issues grouped under the generic heading of "Global Change". It embraced work on global vegetation dynamics, global patterns of fire activity in vegetation, sea surface temperatures and marine primary productivity.

The Institute is the counterpart of the European Space Agency (ESA) for the application of earth observation data. They work together on a number of collaborative projects. For example, the first phase of a three year ESA - EC project to produce maps of tropical forest distribution was brought to a successful end. The use of remote sensing techniques resulted in the most up–to–date information currently available on the state of the world's tropical forests.

Likewise, for the marine environment, a joint project with ESA for the processing of ocean colour and sea surface temperature data, and the distribution of this information to a wide range of European institutes, was successfully concluded; work has begun on a similar initiative related to data from a new generation of Earth observation sensors.

1994 also saw the Institute take a lead role in a major new initiative with the ESA, the European Earth Observation System. It is designed to improve and promote the use of Earth observation data throughout Europe, and involves a collaboration with national space agencies and several Earth observation communities throughout the ESA, the European Union and the EEA/EFTA Member States. As a contribution to the European Earth Observation System, the JRC with its three institutes, IRSA, ISEI and EI, is developing the CEO–Centre for Earth Observation – a decentralised European data management and information system which will provide value added data services.

At IST, modelling work on dense vapour cloud dispersion in the framework of STEP shared-cost actions concentrated on the development of the shallow layer model and on the validation of the 3-dimension code ADREA-HF and the one-dimensional shallow layer computer model.

The development of a two-dimension computer code for the numerical simulation of reactive gas flows has been completed. Assessment calculations are under way for the study of deflagration and detonation phenomena in industrial environments.

- **The Nuclear Fission Safety** programme encompassed a number of research activities ranging from reactor safety executed by the Institute for Safety Technology (IST), to research activities on nuclear safeguards and fissile materials management, executed by the Institute for Safety Technology and the Institute for Systems Engineering and Informatics (ISEI), and to research activities on nuclear fuels and actinides executed by the Institute for Transuranium Elements (ITU).

After the execution of the first Phebus FP test in December 1993 at Cadarache (F), preliminary analysis of the results was started at Ispra and Cadarache, with contributions from all partners in this international project. The second test with irradiated fuel is planned for 1995. A new version of the European Source Term Evaluation Research (ESTER) code package developed by the Institute in

collaboration with the European partners for the evaluation of the source term, has been released to the partners for testing and validation.

At Ispra the construction of the STORM facility (Simplified Tests On Resuspension Mechanisms) for large scale studies of aerosol deposition and re–suspension has been completed.

The experimental programme on in–vessel melt quenching phenomena, performed in the Fuel Melting and Release Oven (FARO) and the small–scale steam explosion (KROTOS) facilities available at Ispra, saw important progress. The first successful tests with 150 kg of molten material were carried out in FARO and a small-scale test programme, executed in KROTOS with real material, focused on steam explosion investigation.

In the field of basic actinide research, theoretical studies of magnetic-optical properties made a major contribution to the understanding of the unusually high Kerr effect observed in some actinide compounds. The superconductivity transition temperature of americium was found to increase strongly with pressure.

In the basic investigations to improve the safety of nuclear fuels, emphasis was placed on a better understanding of the structural changes occurring in the cold part of LWR fuel at high burnup, i.e. the RIM effect.

Nuclear safeguards activity on surveillance dealt with active vision techniques and computer assisted reviewing of surveillance images.

- **The Fusion Technology and Safety** programme is executed by the Institute for Safety Technology (IST), the Institute for Systems Engineering and Informatics (ISEI), and the Institute for Advanced Materials (IAM).

The principal activities concerning the European Tritium Handling Experimental Laboratory (ETHEL) involved the preparation of two experimental circuits for commissioning with hydrogen/deuterium and the installation of new services to improve future operational and maintenance activities. The laboratory's Tritium Rework Unit was at the detailed design stage. The on-going cold commissioning should lead to active operations with tritium, starting in 1995.

The world-wide development of fusion technology was concentrated on the design of the International Thermonuclear Experimental Reactor (ITER). The IAM contributed to this effort by supporting ITER's technological needs for the selection and characterisation of materials. In parallel, IAM also participated in the European longer term programme for the development of low activation materials.

In the area of thermonuclear fusion, computer simulation and experimental validation of remote handling procedures were pursued, together with post-accidental thermal transient analyses for design guidelines and assessment for the ITER (International Thermonuclear Experimental Reactor).

- **The Human Capital and Mobility** programme of the JRC continued with increased activities in 1994 and covered all Institutes. It offered individual research fellowships to interested scientists, participation in Networks with other research organisations and access to large scale facilities projects. The Board of Governors of the JRC approved during 1994, 96 individual fellowships at post–doctoral level, 7 networks involving JRC participation, two institutional fellowships in association with universities, and JRC participation in one large scale facility.

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Progress made in the execution of these programmes is reported in more detail in Chapter 2, dedicated to the activities of the JRC institutes.

1.5. Scientific and Technical Support for Community policies

JRC scientific and technical (S/T) expertise is available to other Directorates General of the Commission for support in the formulation and implementation of Community policies.

The JRC support can take several different forms:

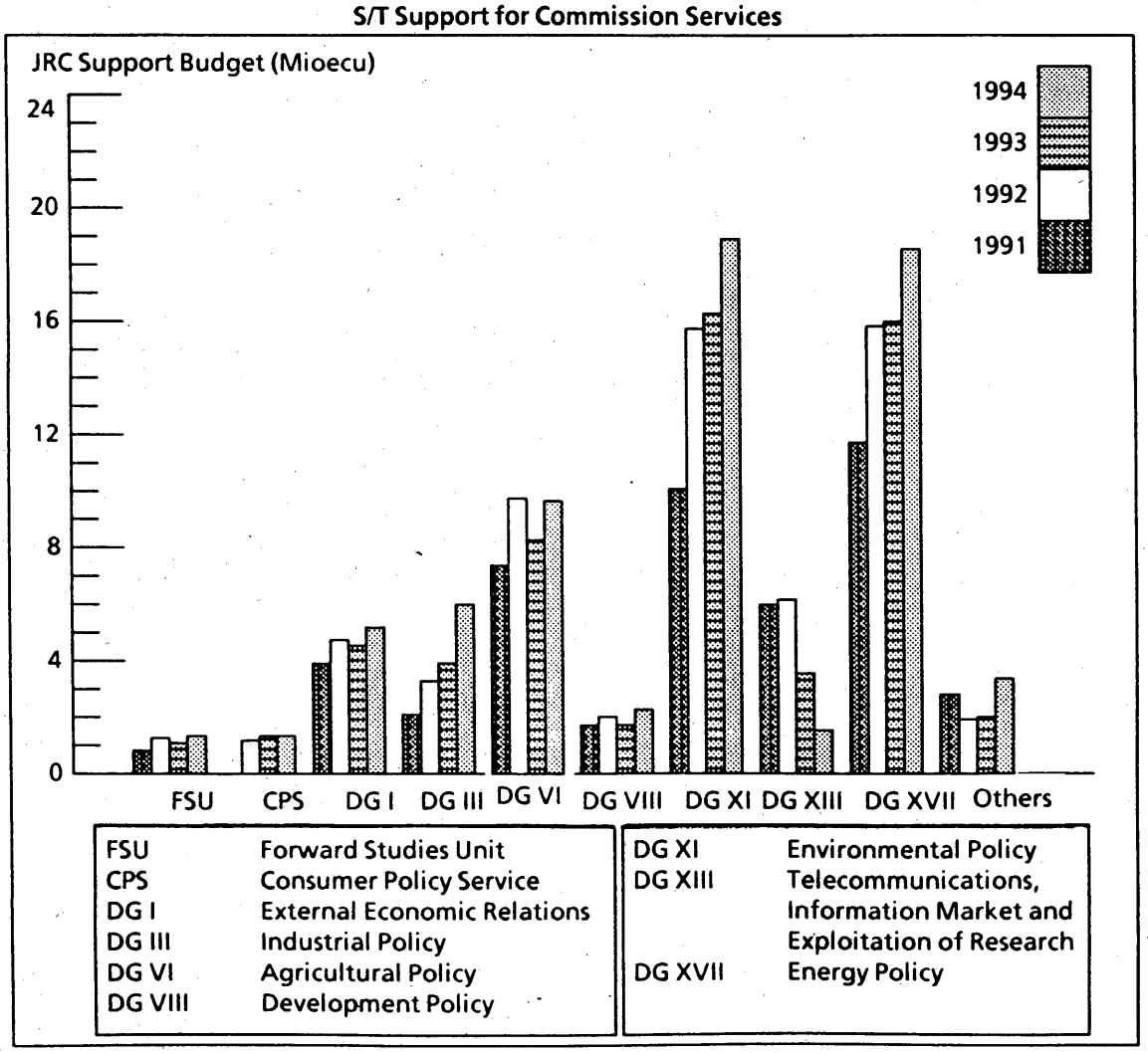
- laboratory work or theoretical studies drawing on the scientific competence or experimental facilities of the JRC;
- scientific and technical work for implementing EC legislation or S/T assistance with drafting of new legislation;
- scientific assistance in the management of projects or contracts,

In 1994, JRC scientific and technical support accounted for 23% of the JRC budget. Figure 1 shows how this support was divided between the various Community policies. An effective customer/contractor relationship, as well as a degree of continuity and long-term planning, were among the priorities. Furthermore, major long-term agreements have been consolidated by decisions of the Commission, which have been communicated to the Council and to the European Parliament. The main sectors concerned were environment, energy and agriculture.

About 83% of all operations were covered during the year by an inter-DG multi-annual contract, a Council Decision or a Commission Decision, with the rest carried out in response to urgent requests from Commission Directorates General.

Figure 1

S/T Support for Commission Services



• **JRC support for Environmental policy**, which accounts for 27.8% of the scientific and technical support budget, provides DG XI with scientific and technical assistance in the implementation of legislation on chemical pollutants, atmospheric pollution, water quality, chemical waste, industrial risks and major accidents. This work is part of the EC Action Programme in the field of the Environment and includes the following actions:

- atmospheric pollution support, concerning the implementation of EC Directives 80/779 and 85/203/EEC on air quality (SO_2, NO_2), and Directive 92/72/EEC (ozone, modelling studies). A memorandum of understanding between DG XI and the JRC for the setting-up and operation of the European Reference Laboratory of Air Pollution (ERLAP) was signed on 11 July 1994;

- preparatory work for the "European Tracer Experiment" (ETEX), to test the validity of atmospheric models for emergency response by using artificial released tracers. Initiated in 1992 to support DG XI activities on radiation protection, the experiment is progressing well, with more than twenty countries participating;

- assistance with the management of information on environmental contamination from the Chernobyl accident, which is being collected and merged in the form of an atlas. This project is being developed in collaboration with all European countries, including central European countries, along with Russia, Belarus and Ukraine;

- data collection by the European Chemicals Bureau (ECB), as stipulated by Council Regulation 793/93 on the risk assessment of existing chemicals. The database IUCLID (International Unified Chemicals Information Database, former EUCLID) became operational;

- the inauguration of the European Centre for the Validation of Alternative Methods (ECVAM) on 17 October 1994. It is currently establishing information services and is organising a series of workshops, task forces and symposia in order to support interlaboratory prevalidation and formal validation of non-animal tests and testing strategies;

- the establishment of a Major Accident Bureau at the Joint Research Centre (JRC), dedicated to the carrying out of scientific and technical activities related to the implementation of Community legislation (Directive 82/501/EEC) dealing with the control of major accident hazards. A memorandum of understanding between DG XI and the JRC was signed in January 1994.

• **JRC support for Energy policy** (DG XVII) accounts for 27.3% of the scientific and technical support budget.

Most of the work undertaken deals with the following tasks:

- training of inspectors, harmonisation of in-service nuclear safeguards inspection practices, providing state of the art equipment and reference analyses of nuclear materials samples;.

- design of on-site laboratories for safeguards analysis at reprocessing plants such as Sellafield and La Hague; routine analysis of nuclear materials samples;

- contribution to long-term energy scenarios, including the evolution of the nuclear energy industry;

- contributions to energy conservation and to the rational use of energy in small and medium size industries, buildings and transport systems;

- monitoring of photovoltaic and solar thermal demonstration projects.

• **JRC support for the Common Agricultural Policy**, which accounts for 14.2% of the scientific and technical support budget, covers mainly the following research areas:

- application of remote sensing to agricultural statistics with the aim of developing and demonstrating, up to semi–operational level, methodologies integrating remote sensing data into the collection of statistics for the monitoring of crop acreage and agricultural production in the EC (Council Decision of 26 September 1988);

- assistance in establishing registers of inventory control systems in agriculture, using either airborne or spaceborne remote sensing techniques;

- in the framework of the European Office for Wine, Alcohol and Spirit Drinks, identification of the origin of alcohol in wines and spirits and implementation of the Nuclear Magnetic Resonance (NMR) and Isotope Ratio Mass Spectra.

Further information on JRC scientific and technical support activities for the Commission's services may be found in Chapter 2.

1.6. Work for third parties

The customers of the Joint Research Centre

The JRC has offered its scientific expertise to external customers since 1988, and has attracted orders worth more than 83 Mioecu over the seven years since this activity was initiated.

During the first period (1988-1991) in which the JRC offered its scientific expertise to third parties, a total order book (adjusted for cancellations) of 43.85 Mioecu was registered.

Table 1
JRC execution of third party work (Mioecu) ordered during the period 1988-1991

Years	1988-1992	1988-1993	1988-1994
Initial Order book	45.64	45.64	45.64
Cancellation	1.45	1.79	1.79
Actual order Book	44.19	43.85	43.85
Amounts invoiced	25.43	29.49	32.74
Payments received	23.38	27.87	31.30

At the end of 1994, 72% of the work contracted for in 1988–1991 has been carried out and invoiced, and payments received totalled 31.3 Mioecu. Work on the remaining 28% is continuing and will, in some cases, extend up to the year 2000.

Over the period 1992-1994, the total volume of orders received by the JRC from external customers amounts to 39 Mioecu, of which the total of new orders received in 1994, reached 18 Mioecu. At the end of 1994, 59% of work contracted for in 1992-1994, has been carried out and invoiced, worth a total of 23 Mioecu (see Fig. 3). The rest will be carried out in 1995 and later. Payments received correspond closely the amounts invoiced.

Industry remains the most important JRC customer, with 57% of orders. Research organisations account for 21%.

The nuclear sector remains the predominant field of activity, with about 75% of the contracts. Other sectors – including the environment – amount for just over 25% of total orders received by the JRC and currently being carried out.

Figure 2

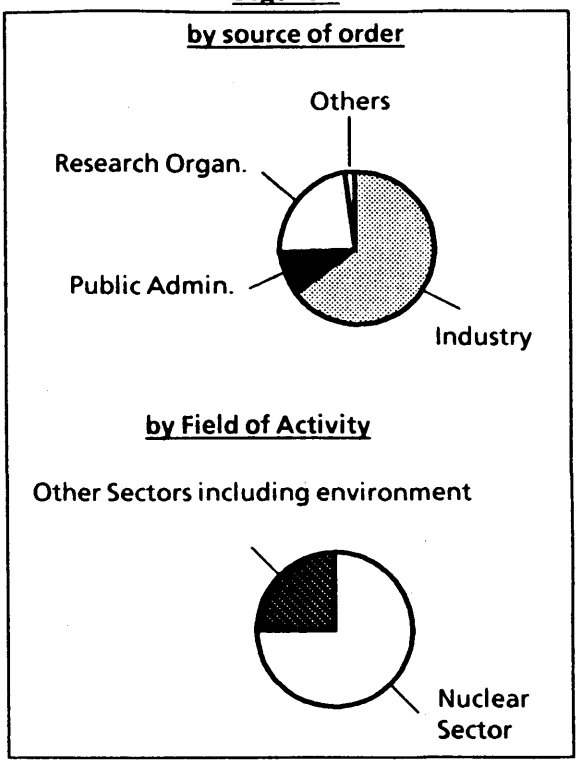
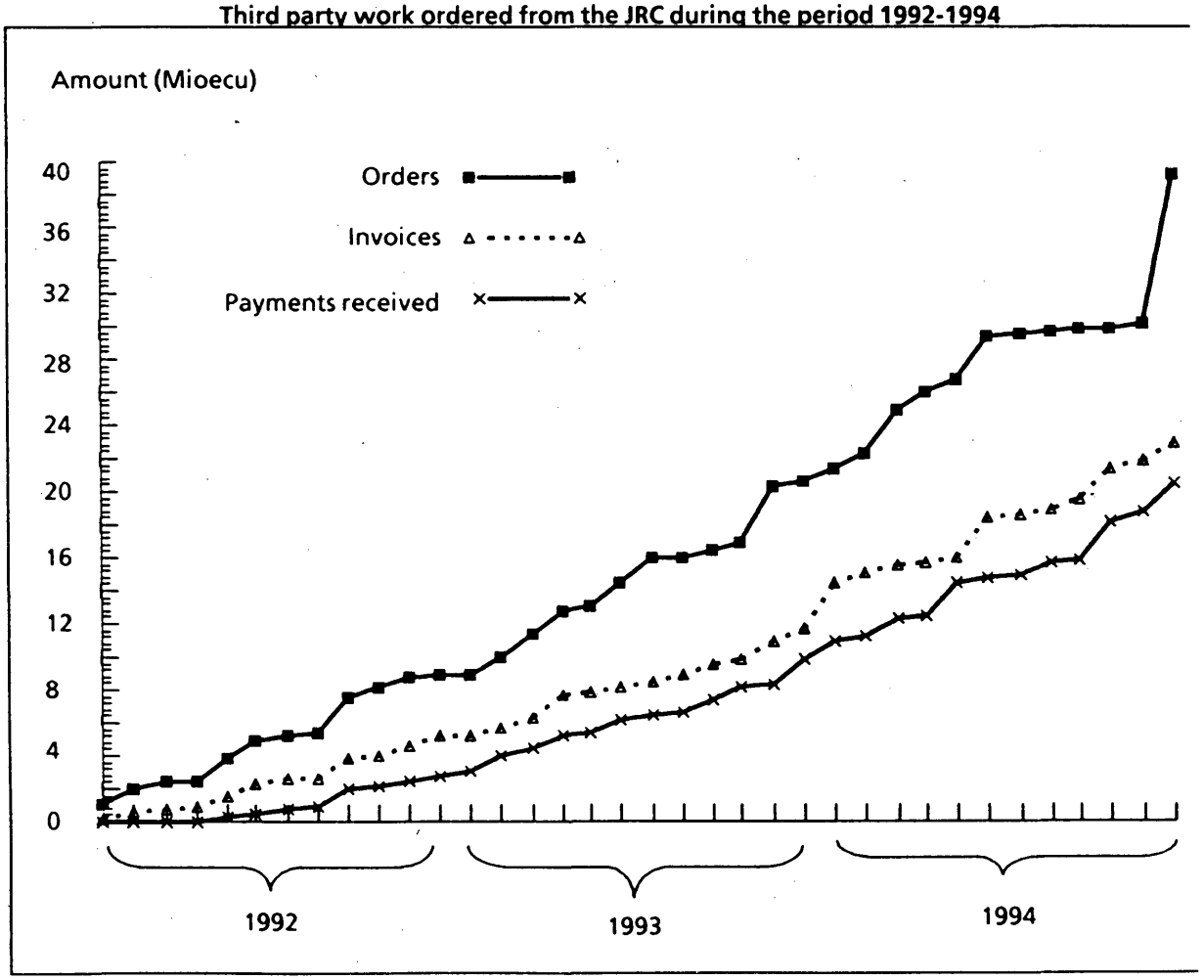


Figure 3

Third party work ordered from the JRC during the period 1992-1994



A trend already noticeable in 1993, the public sector's increasing need for scientific expertise in the field of environmental management, is gathering momentum. Projects involving the JRC in the study of air, water and soil pollution and in the management of industrial and urban waste have progressed well; environment related activities now account for 20% in volume of the orders being carried out by the JRC, particularly in Ispra, and could grow further.

The Institute for Advanced Materials is far ahead of the other JRC Institutes in the winning of contracts for third party work but, for the first time a very important contract has been earned by the JRC institutes housed at the Ispra site.

1.7. Cooperation with national research organisations

A part of the JRC's cooperation is of an informal nature, resting on the wide range of contacts individual staff members have built during their professional careers or their participation in international networks and working groups.

Non–core research staff, such as grantholders, seconded national experts and visiting scientists contribute more contacts with their previous institutions. This kind of informal permeation of information among researchers who may have widely different scientific backgrounds, but who work on related problems, has an invaluable "cross–fertilisation" value for breeding ideas and finding new practical solutions.

On a more structured basis, the JRC cooperates with national research organisations within the European Union and the associated EFTA countries through bilateral and multilateral agreements, Human Capital and Mobility networks and Eureka projects.

Bilateral cooperation is generally focused on highly specialised fields, where the sharing of scientific expertise enhances the scientific qualitities of both partners. There are 87 bilateral cooperation agreements in force, as of 1994.

In multilateral cooperation, the subjects under study are usually broader than in bilateral ones. The number of partners may vary from 2 to 20 or even more, in extreme cases up to 70. 49 multilateral cooperation agreements are now operational, involving nearly 600 partners.

Fig. 4 gives the distribution (in numbers of agreements, large and small) of both bilateral and multilateral cooperation agreements among the JRC's institutes.

The Human Capital and Mobility (HCM) Programme, with its networks with other research organisations, is another suitable framework for cooperation. The JRC participates in 20 HCM Networks (see Fig. 5). Postgraduate and post–doctoral grantholders provide a multiplicity of contacts with their former universities and are a good source of information.

The JRC also participates in five Eureka projects (see Fig. 5)[2].

2. The EUREKA initiative was set-up to raise, through closer cooperation among enterprises and research institutes in the field of advanced technologies, the productivity and competitiveness of Europe's industries and national economies on the world market, and hence strengthen the basis for lasting prosperity and employment. It involves 20 countries, plus the European Commission.

Figure 4
bilateral and multilateral cooperation

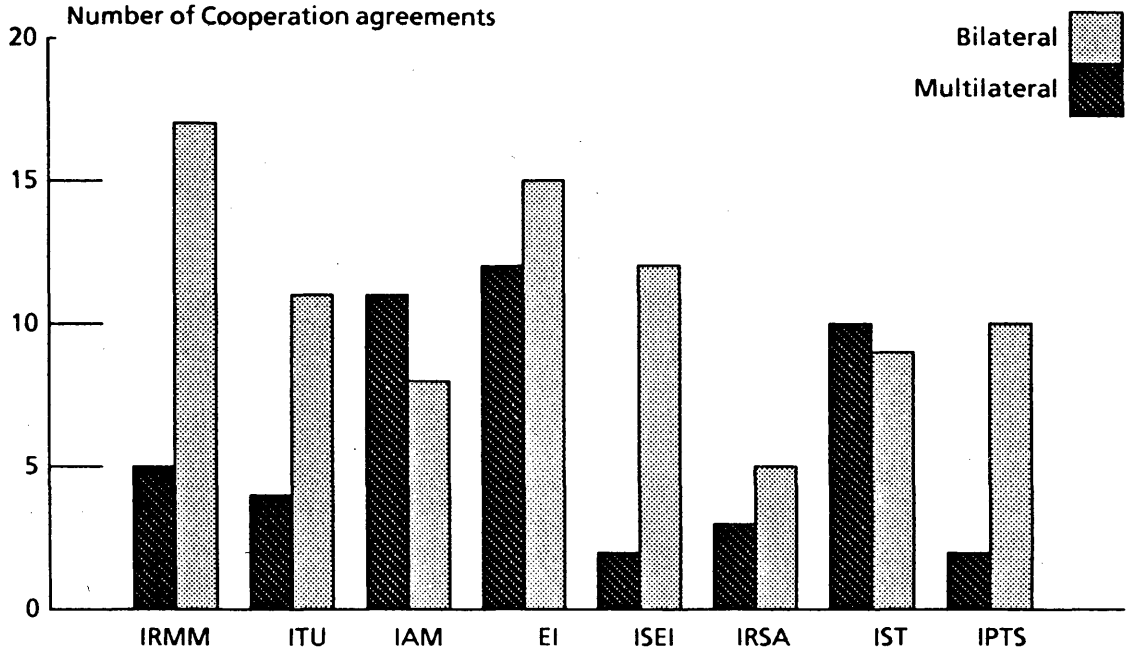
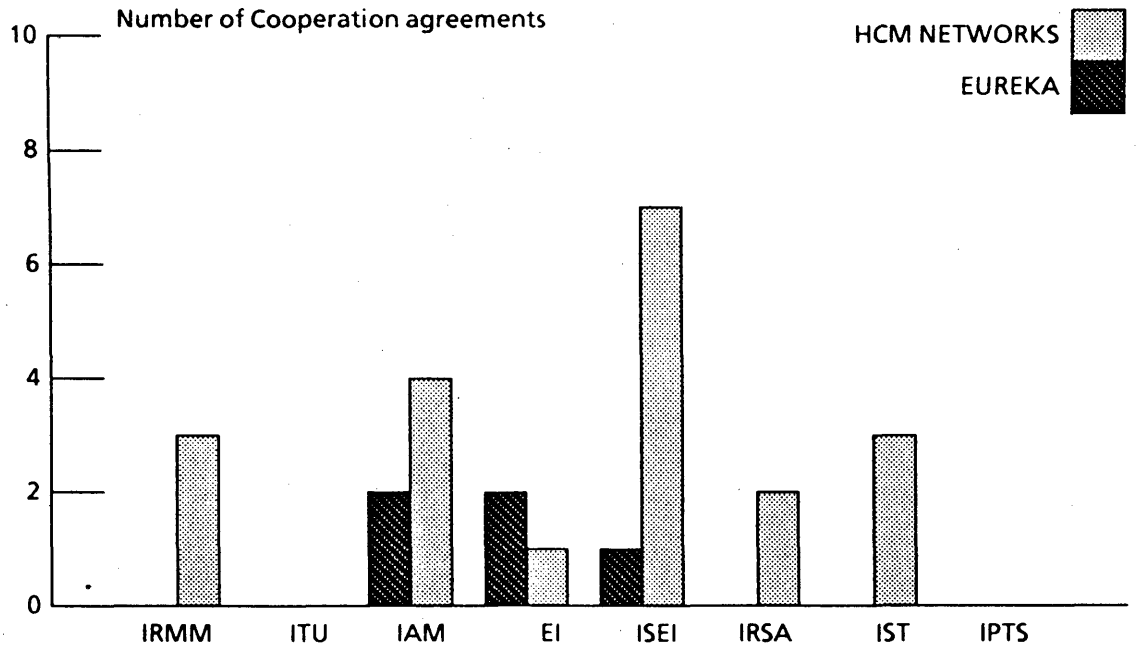


Figure 5
HCM and Eureka cooperation



- CEFIR (Ceramic European Fibre Research, EU 658), an initiative aimed at the production of European high temperature resistant ceramic fibres, where a novel methodology for the engineering of fibre and composite interface has been developed (see par. 2.3 below);

- IPACERC (Induction Plasma Assisted CVD of Erosion Resistant Coatings) a project aimed at the development of Plasma Assisted Chemical Vapour Deposition Reactor of Erosion resistant coatings. This application will be used for helicopter turbines.

- FORMENTOR (EU 19), concerned with the development of expert systems to support decision making in hazardous situations, where a first version of a coherent methodology has been developed (see par. 2.4 below), for a real time operator decision support system;

- EUROTRAC (EU 7), with the TRACT (Transport of Air Pollutants over Complex Terrain) sub-project which uses artificial tracers for assessing the transport of atmospheric pollutants in the Alpine region, where data related to previous experiments have been assembled in a data base, which is now available for predictive model verification; and the LACTOZ (Laboratory Studies of Chemistry related to Tropospheric Ozone) sub-project which evaluates, by laboratory experiments, the chemical and photochemical transformation of atmospheric pollutants, where cooperation with the University of Kiel and with the University of Milan has led to interesting results (see par. 2.5 below);

- EUROENVIRON (EU 330), with the TRACY (Toxic Metals in Human Tissues and Fluids) project (EU 618), which aims to develop a Member State data base for toxic materials in human tissue and fluids, and the mobile analysis laboratory project (EU 674) aimed at developing a mobile analytical laboratory for the in–field analysis of water, waste and soil and where an interlaboratory exercise is near completion (see par. 2.5 below).

1.8. International cooperation

- Cooperation on nuclear safeguards R&D

The Commission of the European Communities approved in July 1994 the agreement renewing the longstanding Cooperation Agreement between the United States Department Of Energy and the European Atomic Energy Community, which was concluded for the first time in January 1982.

The Council has been informed about this development, in accordance with Article 101, paragraph 3, of the EURATOM Treaty, and the Agreement was signed on 6 January 1995. This renewal of the agreement will allow the pursuit of fruitful collaboration with several US laboratories in nuclear safeguards R& D.

Cooperation in the same field progressed very well with the Japanese Atomic Energy Research Institute (JAERI), in accordance with the agreement signed between the Commission and JAERI in May 1990.

Work performed under a contractual agreement with the Kohplin Radium Institute in St. Petersburg, concerned with the performance assessment of on–site automated sampling equipment for nuclear safeguards on a nuclear fuel reprocessing facility, progressed according to plans.

- Cooperation on nuclear reactor safety with the US Nuclear Regulatory Commission (USNRC)

Work performed under a contractual agreement for cooperation in nuclear safety research, focussed on severe accidents, also progressed according to plan (see 2.7. below)

- Cooperation in remote sensing Earth Observation techniques with China.

First discussions took place on the setting up of a cooperation plan in the field of Earth observation techniques for the monitoring of the state of the environment in China.

1.9. Ispra site renovation

Ispra, in northern Italy, is the largest of all five JRC sites. It was handed over to the European Atomic Energy Community (EURATOM) in 1960–62 and gradually developed in the 1960s as a technology–oriented, nuclear "big science" research and development centre, meant to accommodate a staff of 4 000. The nuclear programme orientation has, meanwhile, undergone significant change and Ispra now hosts a total of 2 185, including non–permanent staff, visitors and students.

On the one hand, the availability of inexpensive energy at the time accounts for the centre being built in a rather spread-out fashion, with some disregard for the ecological and economic aspects of energy efficiency. On the other hand, non–nuclear research at Ispra gradually evolved after 1973 towards issues of "safety" and "environment", and is likely to focus further on "soft" research such as environment and life sciences. This type of activity requires different kinds of buildings and infrastructural services, such as smaller laboratories and more offices used for data processing.

The JRC management has now seized the opportunity provided by having to renovate installations and to erect some new ones in order to try and turn Ispra into an ecologically designed centre by concentrating all future constructions within a more densely built, more restricted zone, expecting to realise sizable energy savings as well as a recovery by nature in the non–built areas. It is intended to make it a model for the transformation of an existing, older research centre into an ecologically efficient one. The fact that Ispra houses both the JRC's Environment Institute and research on alternative energy is a further incentive for the operation.

Plans for an ECO–Centre at Ispra were suggested in 1991, started in 1992 and progressed in 1993 towards a fully fledged masterplan for the whole site and its energy balance. This masterplan is now available and includes all aspects of infrastructure adjusting, building construction and nature recovery. The phased transformation ends up being a more demanding task than the designing of a "green" centre from scratch.

All future buildings will be concentrated in a particular zone in the northern end of the site, with a fivefold more intense use of ground.

The implementation of the plan has started and is progressing: the south facade (780 m^2) of the ELSA (European Laboratory for Structural Assessment) experimental hall has been cladded with solar panels. Four surviving buildings are being refitted to reduce energy use; three new ones are now in the planning phase for construction in 1995/96.

1.10. Publications, workshops and seminars

- **Publications and patents**

In 1994 the JRC published 951 papers. Table 2 gives the distribution of these publications among the JRC institutes.

The detailed list of JRC publications is published each year in the "Publications Bulletin". The last issue, No 14/ISSN0254–3133, published in March 1994, lists JRC publications in 1993.
In 1994, 30 JRC patents were also granted. These are also listed in the bulletin.

Table 2

JRC publications by JRC institute in 1994

Institute	EUR Reports	Conference Papers	Articles	Total
Directorate General	1	-	2	**3**
Institute for Reference Materials and Measurements	5	78	38	**121**
Institute for Transuranium Elements	2	77	33	**112**
Institute for Advanced Materials	24	111	49	**184**
Institute for Systems Engineering and Informatics	22	105	17	**144**
Environment Institute	16	68	34	**118**
Institute for Remote Sensing Applications	14	111	14	**139**
Institute for Safety Technology	15	90	10	**115**
Institute for Prospective Technological Studies	4	6	5	**15**
Total	**103**	**646**	**202**	**951**

- **Conferences, workshops and seminars**

In 1994, the JRC organised 5 conferences, about 200 international workshops and meetings, and 60 visits to the various sites. The resulting total of 7 700 visitors demonstrates that the Centre is constantly widening its horizons within the international scientific community.

A selection of these activities is given in the following list.

Conferences

8-10 March	PISC /Project for the Integrity of Steel Components – JRC Petten
1-2 June	4th International Symposium on Food and Cosmetics – JRC Ispra
13-14 September	Quantitative Structure – Activity Relationships (QSAR) in Environmental Sciences – JRC Ispra

Workshops-Meetings

1-2 February	2nd meeting of the Steering Commettee of the Pathfinder Phase of the Centre for Earth Observation (CEO) – JRC Ispra
21 February	Biogenic Emission in the Mediterranean Area – JRC Ispra
16-19 April	"Journées des Actinides" – JRC Karlsruhe
28-29 June	Working Group on "Targets and Fuels" – JRC Karlsruhe
4-6 October	Quality Assurance in Analytical Chemistry – JRC Geel
12 October	Handling/Analysis of vagabonding Nuclear Material" initiated by the Federal Ministry of the Environment - JRC Karlsruhe

2. ACTIVITIES OF THE JRC INSTITUTES IN 1994

This chapter outlines the activities of the institutes of the JRC during 1994.

2.1. The Institute for Reference Materials and Measurements (IRMM)

The IRMM is dedicated to the promotion of European standards and the harmonisation of reference materials and methodologies. The Institute contributed to the Framework Programme Line "Measurement and Testing" by executing its specific programme under the heading "Reference Materials and Measurements". Its work continued to cover nuclear as well as non-nuclear aspects and to contribute to fundamental studies as well as to applied research. It is engaged in support activities related mainly to nuclear safeguards at the request of the Directorate General for External Relations (DG I), in support of the International Atomic Agency (IAEA) and of the Directorate General for Energy (Euratom Safeguards Directorate, DG XVII). It also provides services and reference materials to various customers from the EU Member States.

- **Reference Materials and Measurements**

The task of IRMM is to contribute to an improvement of harmonisation and standardisation in analytical measurements. To this end, available efforts were directed towards :

- the preparation, characterisation and certification of high quality reference materials facilitating the establishment of a co-ordinated analytical measurement system at the European level;

- the application of measurement expertise and refined analytical techniques to well selected non-nuclear issues.

The high quality reference materials prepared are used for the calibration of analytical equipment at all stages of the nuclear fuel cycle and in various non-nuclear fields, with the aim of improving the reliability of measurements in chemistry and physics. Samples for nuclear data measurements have been prepared and characterised (in particular, a new series of ^{10}B and ^{6}LiF reference deposits).

The certification procedures for rhodium, titanium and new AlCo alloys for reactor neutron dosimetry are proceeding well. For non-nuclear reference materials, further improvement in automation of production processes has led to higher productivity and quality.

Progress has been made in the study of the electrochemical behaviour of metallothioneins and related molecules. Trace metal analyses of materials from the marine environment were continued.

The Regular European Interlaboratory Measurement Evaluation Programme (REIMEP) activity continued, and mixed uranium-plutonium oxide pellets have been certified for their uranium and plutonium content.

The Ultra Clean Chemical Laboratory is being used for the production of extremely pure acids. The International Measurements Evaluation Programme (IMEP), which is a collaborative effort involving many laboratories in the Member States, has attracted the interest of official laboratories from states within the Danube river basin for participation in an IMEP intercomparison campaign on measurements of trace elements in water.

Measurements of isotopic composition of noble gases and of light elements, using their gaseous fluorides compounds, are progressing.

Measurements of neutron induced reactions continued very successfully , as a result of requests from users in the fields of fission and fusion technologies :

- total cross sections of ^{10}B were measured at the Linac and the Van de Graaff accelerators, in the framework of cooperation initiated by the Nuclear Science Committee of the Nuclear Energy Agency (NEA);

- very high energy resolution measurements of total cross sections of iron and aluminium were carried out, in response to a special interest, expressed by the NEA Working Party on Evaluation Cooperation;

- in collaboration with the Kernforschungszentrum, Karlsruhe, neutron capture cross sections of ^{138}Ba and ^{208}Pb have been measured;

- high accuracy total and capture cross sections of ^{237}Np have been determined in collaboration with the CEA (Commissariat à l'Energie Atomique)

The Linac was operational in the first half of 1994 only; since then, it has been undergoing a complete refurbishment.

Radionuclide standardisation work has been performed on extended area sources of ^{41}Ca and ^{56}Co. Two low energy X-ray standards, each with a set of different fluorescence layers, have been produced and are available for utilisation.

Measurements of low radioactivity levels continued in collaboration with the Max-Planck-Institut, Heidelberg and the underground laboratory of SCK/CEN, Mol.

- **Community and external services**

The IRMM continued to carry out safeguards verification measurements in response to requests from the Euratom Safeguards Directorate of DG XVII as part of a quality control programme co-ordinated by the Institute for all ECSAM (European Commission's Safeguards Analytical Measurements) laboratories. In particular, results of analytical measurements on mixed uranium-plutonium oxide pellets were evaluated.

A chromatographic method for the identification and quantification of hair dye precursors and couplers has been developed in support of the Consumer Protection Service. An informative data bank on safety of products has been designed and almost completed.

Work in support of the Directorate General for Agriculture has concentrated on the production of ewe-curd reference materials and on the preparation of milk powder spiked with dioxines and furanes.

Several large scale productions of reference materials have been realised, such as four sediments for the Measurement and Testing Programme (former BCR), curd and milkpowder for DG VI, and trout and Antarctic sediments for external customers.

2.2. The Institute for Transuranium Elements (ITU)

The ITU has expertise and unique equipment for property studies on nuclear fuel materials. It carries out, within the Nuclear Fission Safety programme, research on the safety of actinides in the nuclear fuel cycle. It also contributes to research on fuel behaviour under accident conditions, characterisation of nuclear waste forms, and exploratory research. It provides scientific and technical support for nuclear safeguards upon request from the Directorates General for External Relations (DG I) and for Energy (DG XVII). In addition, the ITU is engaged in a number of contracts at the request of various customers.

- **Safety of actinides in the nuclear fuel cycle**

– High burnup light water reactor fuel

In order to understand better the physical properties of high burnup uranium oxide fuel, work continued on both simulated fuels (SIMFUEL) and actual reactor irradiated fuel. In particular, the relation between the oxygen potential and the oxygen-to-metal ratio of the fuel was studied. For the first time, the buffer effect of the oxidation of molybdenum fission products on fuel oxidation could be confirmed.

Further ion implantation work extended the database of parameters for production of the fuel structure at the periphery (rim-effect). The radiation damage work was extended to very high energy uranium implants. For the first time, fission tracks could be seen in UO_2 produced by double fission.

– Fuel for transmutation studies and partitioning of actinides

In a new activity, radiation damage is being studied on materials (e.g. spinel $MgAl_2O_4$) for transmutation of minor actinides. First results were obtained on phase changes and swelling occurring due to the impact of fission products in such matrices.

The extension of the Minor Actinides (MA) laboratory was carried on, with the development of powder preparation equipment based on the sol-gel process, and the design of a new fabrication chain for the preparation of fuel pins containing minor actinides.

The work on partitioning of actinides from waste solutions was continued with genuine high level waste. Potential extractants were tested in batteries of centrifugal contactors.

Preparatory work was done on fuel targets for the transmutation of minor actinides (mainly Am-241, Am-243 and Cm) in a fast reactor. This project is being carried out in cooperation with CEA (France), ECN (Netherlands) and KfK(Germany).

– High temperature studies of UO_2

With the objective of establishing a unified microscopic model encompassing many thermophysical properties, high temperature studies on uranium oxide were pursued using, among others, analysis of calorimetric data previously obtained at ITU.

The laser flash device for measurement of the thermal diffusivity of irradiated fuel was tested with several standard samples and with semitransparent materials presenting particular difficulties. The apparatus constructed at ITU exhibits outstanding performance, thanks to the very sophisticated optical and mechanical alignment system.

Annealing tests of irradiated fuel in contact with reactor structural materials have been carried out at temperatures up to 1600° C, using mostly a lightly reducing atmosphere. The results show only slight increases of nuclide releases as compared to experiments without such structural materials.

– Basic actinide research

Study of the physical and structural properties of the heavy-fermion superconductor UPd_2Al_3, and its isostructural compounds $NpPd_2Al_3$ and $NpNi_2Al_3$, was continued, including solid solutions between the first two compounds with two different Np/U ratios.

Experimental effort was also concentrated (Mößbauer study, structural and electrical properties) on the uranium and neptunium compounds of the $AuCu_3$ structure type. All of the uranium compounds exhibit anomalous compression without any structural change, which is not the case for the neptunium compounds. The origin of this phenomenon could indicate pressure-induced electron transfer in uranium. Other interesting effects of pressure observed were the enhancement of

superconductivity in americium and strong changes of the magnetic ordering temperatures in some uranium, neptunium and plutonium compounds.

Theoretical work on the optical and magnetic properties of actinide materials was continued. In particular, a newly developed programme for calculating circular dichroism was applied to various compounds, e.g. Uranium Sulphide. The pressure dependences of the Curie temperatures of Cm and Gd were calculated and compared.

– Fuel behavior under accident conditions

The fission gas release of cladded high burnup UO_2 pellets with a central hole annealed under He/3% H_2 atmosphere was studied using thermal ramps, simulating the thermal behaviour during a LOss of Coolant Accident (LOCA). The first results indicate that the release is correlated with the temperature rise.

New improvements of the TRANSURANUS code have been implemented, and statistical analysis in the form of numerical noise analysis was included.

A new model TUBRNP (TRANSURANUS BuRNUp) has been developed to predict the radial power density distribution as a function of burnup, together with the radial profile of uranium and plutonium isotopes.

In order to study the consequences of an accidental rupture of the cladding of fast breeder oxide fuel containing americium or neptunium, sodium compatibility tests on such fuels were carried out under laboratory conditions.

- **Characterisation of radioactive waste**

Further specimens of irradiated UO_2 were leached under highly oxidising conditions. The influence of granite (reducing conditions) on the leaching of spent fuel was also investigated.

The corrosion of UO_2 and UO_2 spent fuel in various media has been studied using electrochemical techniques. Due to their high resistivity, the samples are subject to pitting attack at grain boundaries or inclusions. The more heterogeneous irradiated materials suffer higher (~ 50x) corrosion than non-irradiated UO_2.

- **Community services**

The design for the on-site laboratory at Sellafield was continued, with two milestones for the laboratory installation : the "Hazards of Operation" study and the "Precommissioning Safety Report" were accepted by the plant operator. A quality control scheme in accordance with ISO 9001 (EU 29000) was introduced, using outside consultants .

About 500 chemical analyses of safeguards samples were performed in 1994 for the Euratom Safeguards Directorate in Luxembourg.

A portable compact K-edge absorptiometer for U solutions and a neutron-gamma counter for Pu oxide samples were built for use by inspectors. A hybrid K-edge apparatus, installed at La Hague for routine measurements of input samples, was maintained and used for routine inspection measurements by Institute staff.

Also, in support of DG XVII, the inductively coupled plasma mass spectrometer technique has been combined with a high pressure liquid separation column for the on-line measurement of actinides and fission products, and with a laser for ablation of fuel or other highly radioactive material. A very sensitive glow-discharge mass-spectrometer has been installed in a glovebox and calibrated for a wide range of materials.

During 1994, a series of receipts, the so-called "vagabonding" nuclear materials, has been analysed. These materials were analysed under the terms of an agreement between Germany and the

European Commission, in particular the Euratom Safeguards Directorate in Luxembourg. The samples have varied considerably, from uranium-containing powders to fresh fuel pellets and to plutonium containing materials.

- **Work for third parties**

A breakthrough was achieved in the preparation of α-emitting agents for a new radio-immuno-therapy. The chemical separation scheme for Ac-225 from U-233/Th-229 feed, based on sorption on titanium phosphate followed by cation exchange, was brought to a routine stage. First charges of Ac-225 were shipped to the USA, where clinical studies are being performed.

The fabrication of actinide-bearing multicomponent alloys, to be used as targets for irradiation, was successfully finished.

Contractual work also included the study of dissolution residues from high burnup fuels, and the characterisation of spent nuclear fuels. These contracts started in 1994.

In the Institute's hot cells, major work on the assessment of commercial fuel and cladding performance was continued under contract with the nuclear industry. Non destructive testing of 125 fuel rods and post test analysis of samples from the first run of the PHEBUS project were also carried out as third party work.

The total volume of third party work performed in 1994 amounted to about 2.5 Mioecu.

- **Exploratory research**

With the conversion to low enriched uranium for material test reactors, in order to support non-proliferation objectives, an increase in uranium loading is important. The feasibility of manufacturing a new high density (7 g U/cm3) material test reactor fuel based on uranium nitride has been demonstrated. Compatibility studies proved that there is no metallurgical interaction between uranium nitride and Al below 500°C.

The acoustic agglomeration rate of aerosols has been shown to depend linearly on the applied acoustic power. This result has important implications for acoustic agglomeration models and for the design of effective agglomeration cavities.

2.3. The Institute for Advanced Materials (IAM)

With sites at both Petten and Ispra, the IAM carries out the specific programme on Advanced Materials and exploits and operates the High Flux Reactor for the Dutch and German authorities. The Institute is engaged in pre-normative research related to standards and codes, and in work on a contractual basis for industry. During 1994 the Institute concentrated its efforts on the research areas of materials and measurements, reliability and life extension, materials for extreme environments, surface modification technology, measurement and validation methodologies for materials and structure, and fusion materials.

- **Materials and measurements**

Activities were primarily focused on the qualification and characterisation of metallic and ceramic materials and components for application in industrial service. Several approaches were investigated, such as life assessment, threshold limits, performance, failure behaviour, etc. by modelling and experimental validation, in order to establish and develop a design and operating code.

The scientific scope ranged from the simulation of "extreme" industrial environments, often tailored to specific technologies or the development of complex, unique testing facilities, to the interpretation of the materials' behaviour at the microstructural and submicrostructural level. The qualification of advanced commercial materials was supported by the development of novel next-

generation materials, particularly in the field of composites and in surface engineering. All activities were associated with relevant producer and end-user European industries.

- **Reliability and life extension**

Emphasis was placed on the combined mechanical performance and corrosion resistance of advanced materials in service simulating environments, the development of life predictive procedures and the input for codes of practice for industrial applications in the three following fields: metallic alloys, ceramics and composite ceramics, and sub-critical components.

- **Materials for extreme environments**

The R&D work contributed to the safety, reliability, efficiency and environmental friendliness of industrial installations. In particular, work was performed on high temperature corrosion, chemical-mechanical properties of high temperature alloys, characterisation of intermetallics and refractory alloys and ceramics and composites. It included the development of unique test equipment, the promotion of testing standards and the generation of a materials property data base on advanced materials operating at high temperatures in corrosive environments.

- **Surface modification technology**

IAM offers a wide ranging competence in surface coating and engineering, deployed at both Petten and Ispra. Major activities include low pressure and atmospheric plasma spraying of thermal barrier coating systems, chemical vapour deposition of hard and ultra-hard wear resistant coatings, physical vapour deposition of hard coatings for engineering and biomedical applications, process development, modelling and in-situ diagnostic feedback for intelligent processing, laser and high energy beam surface treatments. Surface engineering for next-generation materials included ceramic-matrix joining, interfacial engineering in fibre composites, the fabrication of coatings by colloidal processing, and surface degradation in industrial metal processing by Marangoni convection.

- **Measurement and validation methodologies for materials and structures**

Pre-normative activities were continued with the development and improvement of methods for the measurement, testing and detection of properties of metallic, ceramic and composite materials, including the validation of these methods as a pre-normative input to the subsequent development, improvement or optimisation of codes and standards by European standards institutions.

In the area of materials information and data management the work on the High Temperature Materials Databank (HTM-DB) was continued with emphasis on the incorporation of spin-off improvements into the HTM-DB from an aluminium alloy databank for the European car industry, promotion of the HTM-DB as the standard data base in Europe for alloy properties, and cooperation with the European Collaborative Creep Committee (a BRITE/EURAM activity).

- **Fusion technology and safety**

Through experimental research, the development of the understanding and the determination of properties of materials relevant to future thermonuclear fusion applications, namely low activation materials, was continued. Experimental support to the NET/ITER data base (Next European Torus/International Thermonuclear Experimental Reactor), and a contribution to the long term European Fusion Programme, featured prominently. All these activities were carried out in the framework of the programme monitored and agreed upon by the Fusion Technology Steering Committee.

- **High Flux Reactor (HFR)**

The High Flux Reactor at Petten was operated during 270 days at full power, and the irradiation capacity was used at a level close to the technical limits. The Boron Neutron Capture Therapy facility was commissioned and now awaits a decision of the medical partners on clinical trials of patients. Furthermore, it has strengthened its leading position in supplying the European radio-pharmaceutical industry with radioisotopes.

- **Community services**

Support activities were performed for DGIII, on standards for advanced ceramics and Non Destructive Testing (NDT) standards for pressure vessels. This latter activity made it possible to exploit the Project for the Integrity of Steel Components (PISC) results for direct use by CEN/CENELEC (the European Standardization Committee/European Committee for Electric Standardization) in order to develop and orient activities of the networks AMES (Aged Materials Expertises and Studies), NESC (European Network for Evaluating Steel Components), and ENIQ (European Network for Inspection Qualification). These networks back up the policies and actions of European Commission Directorates XI and XVII, which have responsibility for reactor safety and energy matters.

Projects developed by the networks in the area of regulation included:

- comparison of national requirements and industrial practices in relation to the integrity of structural components, with emphasis on materials ageing, inspection effectiveness and structural integrity assessment methodologies;

- support for the development of a harmonised approach to steel embrittlement evaluation and mitigation methods;

- support for the harmonisation of inspection qualification procedures, through performance demonstration.

- **Work for third parties**

Work for third parties continued, with a volume of contracts comparable to the previous year. Contracts were obtained from the energy sector for materials development and materials performance assessment. The HFR was utilised for the production of radioisotopes for medical and industrial applications and for the irradiation of structural materials.

- **Exploratory research**

The following three projects were carried out : (a) engineering of fibre-matrix interfaces in ceramic composites by nanocrystalline processing, (b) measurement of localised stress fields at dissimilar material interfaces by neutron scattering, and (c) direct measurement of adhesion in films and coatings by a laser pulse induced spallation technique.

2.4. The Institute for Systems Engineering and Informatics (ISEI)

The ISEI contributes to the specific research programmes on Working Environment, Measurement and Testing, Environment, Nuclear Fission Safety and Fusion. It carries out several activities in Support of the Community Policies and is engaged in Exploratory Research and in Third Party Work.

- **Working Environment**

The field studies of cognitive ergonomics (the analysis of reasoning and decision making processes in work places), applied to the domain of air traffic control, for the study of complex working conditions, have led to the development of an operative model of "stress". This model aims at improving the design of interfaces and communications between operators and of means of control. The studies of safety at work have been applied to the domain of airplane-pilot interaction and have resulted in a method for the identification of the root causes of human error. Moreover, a new

cockpit resource management approach has been designed for the introduction of cognitive aspects in pilot training. The methodology of process statistical diagnostics (the diagnosis of industrial processes based on statistical analysis) has been applied to start-up/shut-down of industrial plants, which are typical complex, non-linear processes. This methodology will contribute to the development of tools for early fault diagnosis.

- **Measurement and Testing,**

Field tests to investigate the state of conservation of old Italian paintings with a portable new instrument based on laser interferometry, called Electronic Speckle Pattern Interferometer (ESPI), have been successful. A multiple ESPI system has been developed and tested, and a new procedure for mechanical characterisation of stone materials has been setup. Contacts with industries are going on with a view to marketing the system. A coherence-radar system for surface profilometry of industrial components has been developed, implemented and successfully tested. This system would be used for dimensional control of high precision small industrial components of the order of 10-20 cm. A series of comparative tests, performed by various manufacturers and research laboratories, on the use of acoustic emission in real time qualification for the quality control of glued joints during the glue polymerisation process for aeronautics, has been completed with positive results. An acoustic ultrasonic technique is being applied in collaboration with industry to the quality control of glued joints after the polymerisation period.

Pre-normative research in photovoltaic systems was concluded with the final verification of the fast sampling flash radiometer. This system makes possible spectral irradiance measurements of very short (1ms) light pulses, and a patent was requested. Emphasis was put on the implementation of a quality assurance system following the ISO 9003 standard, and on the participation in the first phase of a world-wide calibration of reference solar cells, which would lead to a world photovoltaic reference scale recognised by national standard bodies. The experience gained in previous years with the technology of amorphous-silicon thin-film modules has been transferred to the Ecocentre ELSA-facade, as part of a harmonised cost-benefit analysis of rational risk of loss of energy in existing buildings. Work on system identification for energy savings in buildings was continued.

- **Environment**

New decision support models for environmental management were developed, taking into account both qualitative and quantitative information, and addressing the problem of various types of uncertainties. These models are being applied in third party work for the Sicily Region in the areas of pollution control in urban areas and of water resources management. The computer programme TRIM (Transportation Risk Management) was enhanced, with the development of an accident data base based on worldwide public sources. Geographical Information Systems (GIS) and spatial analysis technique in decision support systems for environmental management have been applied to real case studies, e.g water management problems in Ireland and Italy and management of a natural park in Belgium. The Multi Criteria Decision Aid (MCDA) technique coupled with GIS and generic algorithms has been applied to solve the problem of generating alternatives in site facilities for toxic waste treatment.

In the area of remote sensing techniques, the "Pathfinder Phase" of the CEO–Centre for Earth Observation aimed at preparing the "Design and Implementation Phase", has been started. A number of studies on the survey of present infrastructure status in Europe and on the requirements of users of satellite data, have been launched. A workshop on European data networks and user information services was organised at the end of 1994 in collaboration with the European Space Agency.

Dedicated systems for the visualisation and animation of scientific data were developed.

- **Nuclear Safeguards, Nuclear Fission Safety and Fusion**

In the area of safeguards, the navigation of a remotely guided vehicle was applied to the detection of unforeseen obstacles; this development was based on ultrasonic data and a neural network. Techniques for remote monitoring over public networks dealing with storage, encryption and

transmission of safeguards data were investigated. In the Laboratory for Surveillance and Containment (LaSCo), investigations were pursued on integration of video surveillance with other sensors for the safeguarding of nuclear material storage areas. The first experimental tasks were conducted in the TAME (Tank Measurement Laboratory), in order to investigate precision measurements on liquid content.

In the area of reactor safety, the development of a set of integrated software tools for the safety management of nuclear power plants was pursued. This set of tools, based on the STARS (Software Tools for the Analysis of Reliability and Safety) structure and regularly updated PSA (Probabilistic Safety Assessment) concept, was successfully applied to the analysis of the auxiliary feedwater system of the Grohnde power plant. A collaboration with TüV Süd-West (Technischer Überwachung-Verein) was undertaken, to validate the STARS fault tree analyser. Applications of dynamic reliability for investigating man-machine interface, and studies of human factors in PSA, have been made in order to improve the evaluation of operator error probability in accident sequences. The development of advanced models for knowledge extraction from reliability data bases and estimation of reliability parameters has continued. The pressurised thermal shock experimental activity, in the context of nuclear fission safety, has been concluded. A review and a summary of the results obtained during the 3rd Framework Programme in the field of plant ageing is being published.

In the area of thermonuclear fusion, computer simulation and experimental validation of remote handling procedures have been pursued in the ROBERTINO facility, as a contribution to the design of the blanket handling device for ITER (International Thermonuclear Experimental Reactor). Post-accidental thermal transient analyses for design guidelines and assessment have been carried out for the ITER design and for the study of Safety and Environmental Assessment of Fusion Power (SEAFP). A contribution to the assessment of the dynamic structural integrity of the vacuum vessel of ITER and of the blanket structures of SEAFP, in case of a plasma disruption, has been undertaken.

- **Community services**

A system for designing information verification of complex nuclear facilities, based on image processing, was developed by the JRC and installed at the International Atomic Energy Agency (IAEA). Several training courses were organised for IAEA inspectors in the field of volume and mass determination and surveillance in tanks and sealing techniques. Environmental tests on video equipment for inspectors have been conducted (for DG I).

Work on safety critical computer systems began with collection of existing information, preparation of the Safecomp'95 conference and the drawing-up of a workplan for the 1995-1998 programme. The implementation of the 3D image synthesis software in the new parallel computer CONCERTO was completed (for DG III).

The pilot implantation in Ispra of a European Coordination Centre for Aircraft Incident Reporting Systems (EEC-AIRS) was almost completed, and will be operational in 1995 (for DG VII).

The activities on the "Seveso Directive" were reinforced to implement a Major Accident Hazards Bureau. The Bureau's tasks are : the operation of the Major Accident Reporting System; the operation of the Community documentation centre on Industrial Risk and the scientific/technical coordination of technical working groups for drafting guidance notes on various issues arising from the directives. In particular, significant progress has been made towards guidance notes for safety reports and safety management systems. Guidelines for the information of the public were published as a Euratom report. Assistance work in the field of biotechnology was pursued, and comparison of activities on environmental impact assessments in Member States was initiated (in support of DG XI).

Valorisation activities included holographic compression techniques for image synthesis, ultra high sensitivity interferometric sensors, tagging/sealing applications (in support of DG XIII).

Review stations of recorded surveillance images, based on a cyclic image buffer, were developed for computer assisted review. A system for the identification of fuel element numbers, using pattern recognition, was designed (in support of DG XVII/EURATOM Safeguards Directorate).

European demonstration project proposals in the area of photovoltaics, heating, building, transport and industry sectors (THERMIE programme) were appraised. Assistance was extended to ALTENER and SAFE programme activities, in the area of a rational use of energy in buildings and industry (in support of DG XVII).

Work continued on operation and development of the authoring system for the documentation antifraud project and for the computer-aided management of parliamentary petitions (support for the General Secretariat).

Neural networks tools were implemented for statistical applications such as typology of European regions and foreign trade statistics (in support of EUROSTAT).

- **Work for third parties**

Calibration of photovoltaic cells and quality testing of modules continued to be major sources of income. Other activities concerned environmental management studies requested by regional administrations and sealing systems fabrication for nuclear safeguards.

- **Exploratory research**

Exploratory activities dealt with, among others, the analysis of local optical correlation decay, numerical stereophotogrammetry, advanced visualisation of dynamic data, and the propagation of solitons.

2.5. The Environment Institute (EI)

The Environment Institute, based at Ispra, contributed to the Environment Protection programme and the Working Environment subprogramme. In particular EI activities have concerned the implementation of three programmes, namely a participation in the Global Change Research; the Technologies and Engineering for the Environment and - to a lesser extent - the Working Environment. A steadily increasing part of the Institute's effort has been devoted to scientific/technical support for Community policies, special consideration having obviously been given to the Directorate General for Environment, Nuclear Safety and Civil Protection (DG XI).

- **Environmental chemicals**

Studies within the framework of indoor air pollution have been continued using both small and walk-in (Indoortron) exposure chambers. In particular, the adsorption/desorption process for several Volatile Organic Compounds (VOC) has been investigated on furniture surfaces (carpets, wall coverings), entailing the development and successful testing of a new two-absorption compartments mathematical model.

Field and laboratory studies on pollutant-soil-water interaction, as well as on toxin production associated with algal blooms in relation to environmental factors, have been pursued in order to investigate the transformation and fate of pollutants in the soil. Collaborative studies and intercomparative analytical campaigns between European laboratories have been launched, with a view to the development and application of advanced techniques for pollutant detection in various matrices. Two mobile analytical laboratories have been made operational, within the framework of the EUREKA project EU 674. Contributions were made to the implementation of new techniques and in-site applications.

- **Atmospheric Pollution – Global Change**

The second experimental campaign for the assessment of Biogenic Emission in the Mediterranean Area (BEMA project) has been carried out in Castelporziano (Rome). The main purpose of the

campaign was to further elucidate the quite large monoterpene emissions from the sclerophyllous Mediterranean oak, despite the lack of monoterpenes in the leaves or bark, which had been observed in the preceeding 1993 BEMA campaign. The final results will be available in early 1995.

Within the framework of the European research project LABVOC, the troposphere oxidation process of the biogenic dimethyl sulphide, which is an important source of particles in marine air, has been further investigated through laboratory experiments. Major uncertainties in the present understanding of the process, and future research needs, have been identified by means of a sensitivity and uncertainty analysis.

Within the framework of the International Geosphere-Biosphere Programme (IGBP) the Aerosol Characterisation Experiment (ACE-2) has been proposed with a view to evaluating the impact of anthropogenic aerosols on global change. This field experiment has been scheduled for 1997.

A World Data Centre for Aerosols (WDCA) was created, resulting from collaboration with the World Meteorological Organisation. The Centre will collect and exchange information and data from monitoring stations all over the world, as part of the Global Atmospheric Watch (GAW) system for the monitoring of the evolution of the global atmosphere.

Several interlaboratory exercises, with the participation of laboratories in the Member States, have been organised, and are being evaluated to assess analytical errors in water analysis.

Soil interlaboratory comparison has been launched and the preparatory campaign at Brembate (Bergamo, Italy) has been planned.

- **European Chemicals Bureau (ECB)**

The first phase of data collection on risk assessment of existing chemicals (Council Regulation 793/93) has been completed. More than 7 000 data sets from industrial and commercial companies have been loaded in IUCLID (International Unified Chemicals Information Database) and installed at the competent authorities in the Member States and at the OECD. Several meetings with national experts have been organised to deal with "Classification and Labelling", "Notification of New Chemicals", "Risk Assessment of Existing Chemicals" and "Export/Import Control of Certain Dangerous Chemicals".

- **European Centre for Validation of Alternative Testing Methods (ECVAM)**

The European Centre for Validation of Alternative Testing Methods (ECVAM) was inaugurated on 17 October 1994. The establishment of information services has already started, and the Centre has organised a series of workshops, task forces and symposia. Interlaboratory prevalidation and formal validation studies are being supported. In practice, ECVAM is involved in the development and validation of non-animal tests and testing strategies.

- **Working Environment**

Activity dealing with trace metal exposure and health effect has been primarily focussed on the qualitative determination of trace metals in the European population in both general and working conditions, and on metal toxicity at low level exposure.

- **Community services**

A memorandum of understanding between DG XI and the JRC for the setting-up and operation of the European Reference Laboratory for Air Pollution (ERLAP) was signed on 11 July 1994. ERLAP – an extension of the former Central Laboratory for Air Pollution – is intended to support the action of DG XI as far as ambient air quality is concerned, and to participate in monitoring programmes such as EMEP (European Monitoring and Evaluation Programme).

Preparatory work for ETEX (European Tracer Experiment) continued. ETEX was designed to test the behaviour of atmospheric models for emergency response. The field experiment, which was

scheduled to be performed at the end of the year, was enlarged in scope and application through the contribution of equipments and techniques from various countries.

All the available information on environmental contamination from the Chernobyl accident is being collected and merged in form of an atlas. The project, benefitting from modern computer technology, is being developed in collaboration with all European countries – including central European countries, Russia, Belarus and Ukraine – and is planned to conclude in 1996, ten years after the accident.

Work on the data bank on pharmaceuticals (ECPHIN) has been pursued in support of DG III; new action was undertaken, aimed at developing an intercommunication network for the ECPHIN system. A prototype is being tested with the users.

Further work has been performed within the framework of the "European Office for Wine, Alcohol and Spirit Drinks", to identify the origin of alcohol in wines and spirits, and to implement the Nuclear Magnetic Resonance (NMR) and Isotope Ratio Mass Spectra (IRMS) fingerprint data bank.

- **Work for third parties**

In the context of work for third parties, further progress has been made in activities carried out for the Lombard Region, aimed at control of air pollution monitoring stations, throughout the region.

The contract with Ente Flumendosa in Sardinia continued, with analytical work on water and sediments for the detection of several pollutants, using advanced analytical techniques such as graphite-furnace atomic absorption spectrometry and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).

A new contract with the Sicily Region is being finalised, to cover activities in the fields of air pollution, water pollution and the control of the general population for trace metal content in body fluids.

- **Exploratory research**

Exploratory research at EI dealt with three projects, namely : the use of surface enhanced Raman scattering for the characterisation of aerosols; the development of a tracer technique for gold; the setting up of a laser photofragmentation technique for the study of heterogeneous reactions of sulphur compounds in the troposphere.

2.6. The Institute for Remote Sensing Applications (IRSA)

Located at Ispra, the IRSA implements the programme on the applications of remote sensing. The Institute, through the use of satellite Earth observation data, provides key scientific support for agricultural statistics at the request of the Directorate General for Agriculture (DG VI) and the European Statistical Office (EUROSTAT). It also provides scientific and technical support at the request of the Directorates General for External Relations (DG I), Development (DG VIII), and Environment, Nuclear Safety and Civil Protection (DG XI).

Within the programme on the Application of Remote Sensing Techniques, the IRSA has undertaken work on a number of themes related to the monitoring of the environment and to global change.

- **Environmental monitoring in Europe and the Centre for Earth Observation**

New techniques for obtaining specific information on the condition of the European environment are being developed. These are based on the use of satellite imagery and geographic information systems.

The Forest Information from Remote Sensing (FIRS) programme consolidated its planning phase, and the first steps towards a uniform European forest information system were taken.

The first pilot studies of a new initiative, the Coastal Ecosystem Monitoring project, were successfully started. They will embrace initiatives such as sediment transport and coastal erosion.

Land degradation monitoring tests concentrated on soil erosion and wildfire damage at Spanish and Greek test sites. These were complemented by the first experiments concerning hydrological modelling for water resource management.

The pathfinder phase of the Centre for Earth Observation (CEO) project, aiming at preparing the "Design and Implementation Phase" has been started in conjunction with a steering committee of the Member States. IRSA established a CEO project committee which began activities to survey and understand the present infrastructure status, etablish user requirements, and produce cost estimates, with the goal of producing a final plan for the design and implementation phase.

- **Global change**

The IRSA continued to develop satellite data processing techniques to derive relevant information from Earth observation data, contributing thus to the worldwide effort to understand and predict changes in the global environment.

The processing of a ten-year data set for the African continent was completed. These data were used for continental-scale land cover classification, and to generate a unique view of wildfire patterns for the continent. These results are used for global change research in the framework of two International Geosphere Biosphere Programme activities, the Data and Information System and the International Global Atmospheric Chemistry (IGAC) project respectively.

Complementary work in the marine environments of the biosphere saw the establishment of networks of applications projects to use the archives of processed ocean colour and sea surface temperature data. Significant progress was made in linking Earth observation data sets into bio-optical models, for a prediction of the ocean's net primary productivity.

- **Advanced techniques of Earth observation**

The European Microwave Signature Laboratory (EMSL) began the experiment plan coordinated by the International Advisory Committee. The EMSL also responded to ad hoc requests for experimentation concerning detection of dangerous objects.

Laboratory measurements using the Optical Goniometer, supported by field observations, made significant progress towards extraction of precise geophysical measurements, particularly relating to spectral signatures of biochemicals in vegetation reflectance spectra. Such measurements will be vital for interpretation of data from future space instruments.

Development of workstations for automatic marine oil spill detection and for the monitoring of shipping traffic, using satellite and airborne Synthetic Aperture Radar (SAR) systems, neared completion. These will be tested as an aid to coastguard activities in Europe.

SAR data from the European Remote Sensing Satellite Nr 1 (ERS-1) were also used for mapping and monitoring of temperate forests in Europe and tropical forests in South America and West Africa.

- **Community services**

The pilot project for the application of remote sensing to agricultural statistics increased its operational capabilities. Regular bulletins of crop statistics and information on crop conditions are being routinely published. These are forwarded to DG VI and EUROSTAT. The national statistical services of some Member States are implementing the agricultural project's methodology. The work has also been extended to new geographical regions, including the Maghreb and the Czech Republic, where the remote sensing methods were found to be equally effective.

The Fire in Global Environmental Monitoring programme (FIRE) contributed to the establishment of a new IGAC project to look at the effect of savanna fires on atmospheric chemistry. Field work in

central Africa and Madagascar, aimed at constructing operational fire monitoring systems, in support of DG VIII, was carried out and confirmed the effectiveness of fire detection from satellite. This information may be used for the protection of forest reserves and national parks.

New methods for land cover map update and revision from satellite data were developed in support of DG XI. The Ocean Colour Techniques for Observation, Processing and Utilisation Systems (OCTOPUS) programme has been developed with ESA and other European partners in preparation for the upcoming Sea viewing wide Field of view Sensor (SeaWiFS) space mission.

- **External services**

The TRopical Ecosystem Environmental observation by Satellite (TREES) project (a joint project with ESA, the European Space Agency) completed the first worldwide tropical forest inventory from satellite data, and began detailed planning for a second project phase concentrating on forest condition monitoring, to develop an alarm system for detection of major areas of tropical deforestation.

The European Airborne Remote Sensing Capability (EARSEC), a joint project with ESA, consolidated its instrument development and testing programme. Optical and microwave sensors will be available in 1995, to be used in airborne experimental campaigns throughout Europe.

Third party work for water resource monitoring and management in the Mediterranean continued, and new work focusing on environmental monitoring for Sicily began.

The Institute also became involved in the VEGETATION programme developed by France, Belgium, Italy, Sweden and the European Commission. This will manage the development of the new operational vegetation monitoring space-borne instrument. The data will be used for mapping surface parameters, such as surface roughness, and for use in operational crop production forecasting.

- **Exporatory research**

Finally, exploratory research subjects ranged from development of a knowledge-based system for crop acreage estimation using ERS-1 SAR data, through detection of malaria, to development of virtual reality systems for remote sensing.

2.7. The Institute for Safety Technology (IST)

The IST contributes to the Measurement and Testing, the Nuclear Fission Safety and Fusion and to the Environment programmes. It is also engaged in several support activities at the request of the Commission's services, mainly in the field of nuclear safeguards for the Directorates General for External Relations (DG I) and Energy (DG XVII).

- **Reactor safety**

The Institute contributes to the research on Light Water Reactor (LWR) severe accidents. The work focussed on two areas of concern, which were the study of the interaction of molten corium with the coolant and reactor structures and the evaluation of the quantity and quality of radioactive products (source term) which would be released into the environment in the case of an accident.

In the first area, the tests in the FARO (Fuel Melting And Release Oven) and KROTOS,(Small Scale Steam Explosion) facilities continued to deliver important results, which are under discussion and are being used by the European and US partners to better understand the fundamental mechanisms of molten fuel-coolant interaction (melt quenching, steam explosion) and to validate computer models. The first full-scale tests in FARO (with 150 Kg of molten material) have been performed. It was possible to make a first evaluation of the effect, on the quenching process, of the presence of zirconium metal in the molten corium.

The COMETA (Core Melt Thermal-hydraulic Analysis) code already developed has been successfully

used to analyse the FARO tests. In KROTOS, a series of tests with uranium oxide in water allowed a clear comparison with results obtained using simulant materials (e.g. aluminium oxide) which exhibit very different behaviour.

In the second study area, source term, work focussed on completing the construction of STORM, a large scale plant which will be used to investigate aerosol re-suspension in the primary system and its role on source term. In addition, the development of the ESTER source term code package and the analysis of the first Phebus FP in-pile test performed in December 1993 continued in close cooperation with all the partners in this international research project.

- **Nuclear safeguards**

A specific R&D programme is being executed at the JRC to provide technical tools for control of fissile materials, to comply with EC requirements in the framework of the EURATOM Treaty and the Non Proliferation Treaty.

The activities of Non-Destructive Assay (NDA) are performed at the PERformance LAboratory (PERLA) and of mass-volume determination in the TAnk MEasurement (TAME) laboratory.

Studies on neutron multiplication and hardware developments have been carried out in the field of plutonium monitoring. Thermal (infrared) video systems were tested, to check their applicability to plutonium monitoring, with positive results.

- **Waste management**

Actinide monitoring activities were concentrated on the development of active and passive systems for checking uranium and plutonium in waste packages.

An industrial scale Pu control system was constructed for 200 l drums, and was successfully tested in industrial environments. Several industries have shown particular interest in the exploitation of such a system. A U-measurement system for small samples (about 1 dm^3) was under construction for supply to an industrial customer.

- **Fusion technology**

The principal activities regarding the European Tritium Handling Experimental Laboratory (ETHEL) involved the preparation of two experimental circuits for commissioning with hydrogen/deuterium and installation of new services to improve the laboratory's future operational and maintenance activities. A third test is in the preparation phase, while the laboratory's Tritium Rework Unit is at the detailed design stage. The on-going commissioning will lead to active operations with tritium in ETHEL in 1995, and will permit the start of large scale experiments for ITER (International Thermonuclear Experimental Reactor).

By reallocating laboratory space available in one of the ESSOR (Essai Orgel-organique Eau Lourde) hot cell areas, a low inventory tritium laboratory was put into operation in 1994, so that hot tests could be performed on the memory effects of tritium in zeolites and in in-building structures, in support of the work of ITER. A special inquiry performed for the latter concerned tritium tracking in a fusion reactor.

- **Industrial hazards**

The FIRES facility was modified and prepared for studies on polymerisation reactions, in cooperation with the chemical industry. Development of advanced methodologies has been continued, for the determination of reactor conditions, process optimisation and control.

In close cooperation with industry, validation of the computer package RELIEF (design venting system code) has been continued. A personal computer version of this code, with a sophisticated user interface, has been completed. A venting test series in the new test facilities DRACULA (large-scale venting) and COLUMBUS (venting of long horizontal vessels) has been started. A general computer

module for the numerical simulation of transient two-phase flow has been developed, and work is continuing on the development of a 3-D version of the code, also including reacting flow capabilities.

Modelling work on dense vapour cloud dispersion continued in the framework of STEP (Science and Technology for Environmental Protection) Shared-Cost Actions. The development of a 2-D computer code for the numerical simulation of reactive gas flows has been completed. Assessment calculations are under way for the study of deflagration and detonation phenomena in industrial environments. Future developments will focus on the extension to 3-D flow conditions.

- **Measurement and Testing**

Pseudo-dynamic tests on large-scale models of civil engineering structures are being performed at the ELSA reaction-wall facility, as part of a project of prenormative research in support of Eurocode No. 8, the provisional European standard for the design of civil engineering structures in seismic areas. This activity is performed within a scientific network involving 19 European laboratories under the Commission's Human Capital and Mobility programme. The overall aim of the prenormative research is to enlarge, through analytical and experimental studies, the current field of application of Eurocode No. 8 and to improve its reliability.

As part of this collaborative research, a full-scale 4-storey reinforced concrete structure was tested at the ELSA reaction wall under severe earthquake loadings. This experimental campaign provided unique experimental data for the validation of computer simulation models and for the calibration of damage indicators to be used in the safety assessment of reinforced concrete structures.

Pseudo-dynamic tests were also performed on large-scale models of irregular bridges using the so-called substructuring technique. The ELSA team has also contributed to the COST-C1 project, the European concerted action on the semi-rigid behaviour of civil engineering connections.

The Large Dynamic Test Facility (LDTF) was used to investigate the dynamic characteristics of materials and structural components, mainly at the request of industry in Europe and Japan. A group of users of LDTF, including sponsoring industrial partners, has been formed under the "Large Installations" chapter of the Human Capital and Mobility programme.

- **Community services**

The Institute for Safety Technology has continued to provide a scientific and technical support to the EURATOM Safeguards Directorate (ESD) and to the IAEA (through DG I) in the field of nuclear safeguards. More than 10 training courses and calibration exercises have been organised in PERLA to meet the Commission policy in nuclear fuel fabrication facilities. A seminar with 20 Russian experts has also been organised in PERLA (PERformance LAboratory for safeguards), to support the ESD in its cooperation with the Russian Federation.

An unattended/integrated active neutron monitoring system (UMS) utilising surveillance tools, has been designed and initiated (in collaboration with ISEI) with the aim of providing ESD with a modern device capable of monitoring in unattended mode, the total output of fuel assemblies produced in a Low Enriched Uranium (LEU) fuel fabrication plant. The device will be tested and installed in 1995.

Field measurement results collected by ESD need to be organised in upgraded data base facilities to facilitate performance assessment, long term evaluation, training and procedure setup. IST is providing the data base systems, which are being implemented and linked to a network.

- **Work for third parties**

Contracts with European and non-European research organisations and industries, such as "Ente Nazionale per l'Energia Elettrica" (ENEL), "Energia Nucleare ed Energie Alternative" (ENEA), "United States Nuclear Regulatory Commission" (USNRC), Otomelara, Kawajyu, Mitsubishi and others, continued in 1994.

The Institute has performed studies and experiments in facilities referred to below, both in the nuclear and non-nuclear fields.

The USNRC is partly funding the large scale facility FARO and the small scale facility KROTOS for fuel-coolant-interaction experiments in the case of a severe accident in an LWR.

The detailed design and the operation of the STORM facility for studies on aerosol deposition-resupension, and research on innovative advanced small reactors using nuclear safety codes, are carried out on behalf of ENEL.

The Large Dynamic Test Facility (LTDF) is being used mainly for studies of dynamic material properties in collaboration with Japanese partners.

2.8. The Institute for Prospective Technological Studies (IPTS)

The IPTS performs both a technology watch function and scientific and technological studies, at the request of the services of the Commission, mainly in the fields of the environment, energy and transport, with particular attention to industrial innovation.

- **Science and Technology Observatory**

As part of the development of ESTO (European Science and Technology Observatory), the preparation of an information system on current research involved the implementation of an intelligent interface aimed at providing a more user-friendly system. Progress was made in this field, and first results are expected early in 1995. Prototype S/T Observatory work has been initiated in the field of "Environmental Technologies". The approach chosen involves the development and use of a specialised multifunctional information treatment system, aimed at the early detection of S/T breakthroughs. Initial trials were undertaken for the conception of typical Observatory outputs such as alert reports, newsletters and strategic studies . Other modules of ESTO are being prepared : e.g. "Advanced Materials" and "Future Energy Technologies".

- **Community service**

Activities in support of the Forward Studies Unit of the Commission concerned industrial and environmental problems, including global change aspects. Work related to business and the environment focussed on the analysis of two micro-economic case studies. The first, related to end-of-pipe technologies, concerned flue gas desulphurisation by a Japanese company; the second, related to process technology, concerned waste minimisation and water utilisation by a British chemical company. A seminar on Business and Environment was organised in Seville in February 1994 and the proceedings were edited and are being published in a book. Work on the development of green indicators, as well as studies concerning science policy, technology innovation and interaction with job creation and sustainability, were carried out. Finally, a study on biotechnology risk assessment was completed, including analysis of the Japanese approach to biotechnology regulation and a review of problems created by genetically manipulated organisms. The survey of global change research and policy continued in 1994, in order to update the scientific assessment of these issues and to serve as a basis or a reference for the definition and/or evaluation of Community and international policy response .

As a follow-up to the studies on the Competitiveness of European Space Industries made in support of DG III, an analysis was performed of the various consolidation options such as economies of scale and functional gains .

In the field of environmental protection, a study of the techniques for environmental policy evaluation was performed following a request from the Forward Studies Unit of DG III and DG XI and with the collaboration of DG II. A catalogue of techniques was prepared, including a guide to the selection of the most appropriate method in each specific case. Two other projects were carried out in support of DG XI. The first concerned the prospective technological aspects of plastics recycling up to 2010, including chemical and mechanical recycling and incineration. The second dealt with the development of an observatory and watch function in the field of the Best Available Technologies (BAT) which will contribute to the assessment of technologies which are candidate for future BATs.

Work in support of DG XVII involved the review and assessment of energy technologies which may become available in the long term (year 2020 and beyond).

After the completion, in 1993, of a study on fuel cell technologies, the final report was published in April 1994. Technologies for CO_2 separation, storage and/or sequestration were reviewed: two workshops were held in January and an interim and a final report on CO_2 storage were produced. Photovoltaic energy and nuclear fission energy were also reviewed, and work is continuing on assessing their long-term prospects.

- **External service**

Under contract with a national space organisation, a study concerning "Space markets and elements for a space policy" was performed and the final report was made available in January 1994.

Similarly, with a European firm, a study on regional profiles in RTD activities for Spain was performed, and the final report made available in August 1994.

3. HUMAN RESOURCES

3.1. Staff policy

The JRC authorised statutory staff ceiling amounts to 2 080, including both scientific-technical and administrative staff.

JRC statutory personnel is governed by EC staff regulations. For many years, the JRC has not recruited staff as officials. Scientific/technical temporary agents are recruited under a five year contract, which is renewable; after two terms the contract becomes of undetermined duration. Administrative temporary agents are directly recruited under a contract of undetermined duration.

Table 3 gives the distribution of the JRC officials and temporary agents present at the JRC on 31 December 1994, by Directorates and Institutes. In the course of 1994, as of December, 88 people belonging to these two categories had left the JRC and 58 had been recruited.

Table 3

Distribution of Statutory Staff as of December 1994

Institutes	Staff
Directorate General	21
Programmes Directorate	12
Resources Coordination - Scientific & Technical Support	387
Institute for Reference Materials and Measurements	173
Institute for Transuranium Elements	198
Institute for Advanced Materials	259
Institute for Systems Engineering and Informatics	199
Environment Institute	196
Institute for Remote Sensing Applications	91
Institute for Safety Technology	278
Institute for Prospective Technological Studies	25
JRC Seconded Staff	8
Total	**1 845**

The difference between the authorised ceiling in statutory staff and the staff effectively present at the JRC can be explained as follows:

- posts for statutory staff, in agreement with the Council and the Parliament, have been deliberately kept vacant, in order to save personnel credits, to allow hiring of visiting scientists, seconded experts and other scientific grant holders falling outside the Human Capital and Mobility Programme conditions;

- the remainder of the difference corresponds to the necessary margin of flexibility required to allow for movement of staff during the year.

3.2. Visiting scientists, seconded experts and scientific fellows

Numerous scientists, besides the statutory staff, are active in the JRC, under various hosting schemes:

- the JRC hosts senior scientists for one year or sometimes two years, as visiting scientists;
- experts from national organisations may be seconded to the JRC, to participate in selected scientific work;
- the JRC trains researchers, through a programme of fellowships, granted to postgraduate students preparing a doctorate;
- the JRC participates in the Human Capital and Mobility (HCM) programme, and hosts post-doctoral scientists under this programme.

Table 4 shows where these people worked in the various JRC institutes.

It is also worthwhile mentioning that, thanks to the Human Capital and Mobility programme, the number of post-doctoral scientists present at the JRC increased from 13 in 1992 to 91 in 1993 and to 197 in 1994 ; furthermore, there are about 40 scientists from third countries working at the JRC on a grant, within the framework of a Commission agreement with their countries or with the IAEA. Besides the above mentioned scientists, several senior scientists and about 150 trainees are working at the JRC with no cost to the EC budget, in general for a short period of time.

Table 4

Visiting scientists, seconded experts, grant holders (situation as of December 1994)

Institutes	Visiting scientists	Seconded experts	Post-doctoral scientists	Post-graduate students	Total
Institute for Reference Materials and Measurements	3	1	19	15	**38**
Institute for Transuranium Elements	-	-	21	12	**33**
Institute for Advanced Materials	3	-	44	10	**57**
Institute for Systems Engineering and Informatics	6	2	35	14	**57**
Environment Institute	4	3	22	34	**63**
Institute for Remote Sensing Applications	6	5	25	14	**50**
Institute for Safety Technology	4	2	24	13	**43**
Institute for Prospective Technological Studies	1	-	7	5	**13**
Total	**27**	**13**	**197**	**117**	**354**

4. FINANCES

The commitment credits fixed by the budgetary authority for the execution by the JRC of the specific research programmes and S/t support activities for the Commission for 1994 are as follows :

-	Specific research programmes	189.38	Mioecu
-	S/t support for the Commission	68.79	Mioecu
	Total	258.17	Mioecu

Other resources for HFR operation and third party work are :

-	HFR Reactor	18.97	Mioecu	(Supplementary programme)
-	Work for third parties	12.65	Mioecu	(Budgetary advance)
	Total	31.62	Mioecu	

Furthermore, there was a contribution of 11.15 Mioecu from the EEA/EFTA countries to the specific programmes for the EEC. The total amount of available credits was therefore 300.94 Mioecu.

Details of 1994 commitments are given in Table 5 which covers specific research programmes, exploratory research, S/T support to the Commission and work for third parties (HFR Reactor and others).

The advance in the budget of reimbursable credits for the execution of work for third parties has been committed only to the level of 8.79 Mioecu; the unused credits of this advance, amounting to 3.86 Mioecu, have been reimbursed by cancellation.

For exploratory research, the budget initially foresaw 1.45 Mioecu (including the EEA/EFTA contribution); appropriations have been provided during the year by transfers from the programme lines, within the ceiling set by Council Decisions and the Financial Regulations.

Table 5

Commitments for Programme Execution 1994 including the EEA/EFTA contribution
(Rounded figures, MioEcu)

	Personnel	Other Expenditures	Total	Budget 1994
Specific Research Programmes				
Industrial and Materials Technology	17,70	8,83	26,53	29,14
Measurement and Testing	19,99	13,29	33,28	34,71
Environment	30,84	19,54	50,38	52,64
Human Capital and Mobility	-	11,74	11,74	11,80
Nuclear Fission Safety	26,26	26,92	53,18	57,16
Controlled Thermonuclear Fusion	8,51	6,07	14,58	13,63
Exploratory Research	5,80	4,69	10,49 *	1,45
Subtotal	**109,10**	**91,08**	**200,18**	**200,53**
S/T Support to the Commission	37,99	31,96	69,95	68,79
Subtotal	**147,09**	**123,04**	**270,13**	**269,32**
Others				
HFR Reactor	4,93	12,17	17,10	18,97 **
Work for Third Parties (Advance: reimbursable credits)	4,59	4,20 ***	8,79 ****	12,65
Subtotal	**9,52**	**16,37**	**25,89**	**31,62**
Total	**156,61**	**139,41**	**296,02**	**300,94**

*) As explained on the preceding page this was made available by the initial budget figure and transfers from the other programme lines.

**) HFR foreseen resources.

***) Specific credits, paid by the contractors in order to perform the work, are not included in these figures; they amount to 2.81 Mioecu.
The total volume of contractual work performed in 1994 amounts thus to11,60Mioecu.

****) The advance in the budget of reimbursable credits for the execution of work for third parties has been committed only to the level of 8,79 Mioecu; the unused credits of this advance, amounting to 3.86 Mioecu have been reimbursed by cancellation.

ANNEX A

LIST OF TABLES AND FIGURES

ANNEX B

JOINT RESEARCH CENTRE

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ALTENER	Specific actions for greater penetration for renewable energy sources
BCR	Bureau Communautaire de Référence
BRITE-EURAM	Basic Research in Industrial Technologies for Europe/European Research on Advanced Materials
CEA	Commissariat à l'Energie Atomique
CEN	Comité Européen de Normalisation
DG	Directorate General
EAEC	European Atomic Energy Community
ECN	Energie Centrum Nederland
ELSA	European Laboratory for Structural Assessment
ESA	European Space Agency
ESD	Euratom Safeguards Directorate
ESTER	European Source Term Research Code
ETHEL	European Tritium Handling Experimental Laboratory
EURATOM	European Atomic Energy Community
EUREKA	European Research Coordination Agency
EUROENVIRON	EUREKA Environmental Umbrella Project
EUROSTAT	European Statistical Office
EUROTRAC	European Experiment on Transport and Transformation of Environmentally Relevant Trace Constituents in the Troposphere (EUREKA project)
FARO	Experimental Facility for Fuel Melting
FORMENTOR	EUREKA project to develop expert system to help decision in hazardous situations (complex man made systems)
HCM	Human Capital and Mobility
HFR	High Flux Reactor (Petten Site)
IAEA	International Atomic Energy Agency
ISO	International Standards Organisation
KFK	Kernforschungszentrum Karlsruhe
OECD	Organisation for Economic Cooperation and Development
PHEBUS	French In-Pile Programme (Severe Fuel Damage)
SAR	Synthetic Aperture Radar
SAFE	Specific actions for vigorous energy efficiency/Action déterminée en faveur d'une plus grande efficacité énergétique
SCK/CEN	Studiecentrum voor Kernenergie/Centre d'Etudes Nucléaires
STARS	Software Tools for Analysis of Reliability and Safety
THERMIE	Technologies Européennes pour la Maîtrise de l'Energie

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