

COMMISSION OF THE EUROPEAN COMMUNITIES

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JOINT RESEARCH CENTRE

1993 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 second of these reports and concerns the year 1993.

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

OBSERVATIONS OF THE BOARD OF GOVERNORS ON THE JRC ANNUAL REPORT 1993¹

The Board notes that the Annual Report of the JRC provides information on all categories of activities, and that it is a well-prepared and usefully structured document.

Rationalisation of Resources

The Annual Report of the JRC reflects much of the work on which the Board has been concentrating throughout the year including improvements to the internal efficiency of the Centre. Although there are still various administrative measures and infrastructural adaptations to be implemented, the rationalisation of resources, mainly at the Ispra site, has been efficiently continued. Similarly, the Board has followed the plans for an ECO-Centre at Ispra.

Human Capital and Mobility

The Human Capital and Mobility Programme is a vital contribution to integrating the JRC in the European Scientific Community. It has been successfully launched as far as grantholders, networks with national partners and use of large-scale installations by teams from the Member States are concerned. Important emphasis has been placed on increasing the number of grantholders and selecting candidates relative to the appropriateness of their qualifications. In conjunction, a balanced geographical distribution has also been achieved.

Cooperation with National Research Organisations

The Board has closely followed the Centre's cooperation with National Laboratories and the setting up of research networks. The quality of their research and the methods coordinating their activities across Europe have been a main concern for the Board and a subject of intensive study throughout the year. The Board strongly emphasises that the JRC should collaborate with institutes in all Member States - and in the future from the participating EFTA countries. The large number of cooperations described in the Report bears witness to the Centre's understanding of true collaboration, which is also vital for the future.

Global Change and its impact on Earth and Environment is amongst the new research areas in the field of environment. The Board has encouraged the Commission initiative on a European Network for Research in Global Change (ENRICH) to which the JRC should also contribute.

The Centre for Earth Observation (CEO) falls within the same network initiative and should encourage and enable the use of Earth observation data for the benefit of society at large. It was conceived in collaboration with the European Space Agency (ESA) and the Board devoted most of its meeting in June 1993 to discussions regarding the outcome of the feasibility study. The next phase - the pathfinder phase - is now in progress and the Board will follow this closely, emphasising particularly that the project be geared towards the needs of the users.

Scientific and Technical Support

The Board has noted the development of the scientific-technical support for Community policies requested by other Directorates General of the Commission. In this connection, it is with satisfaction that the Board has seen the Commission entrusting further long-term structured actions to the JRC.

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.

These include the European Chemicals Bureau and the European Office for Wine, Alcohol and Spirit Drinks, while the European Centre for Alternative Methods (alternative to vivisections) initiated its work during the year. These are examples of the Commission benefitting from the scientific and technical competences of the JRC in areas requiring the intervention of its own laboratory.

Evaluation of JRC Activities

The current 1992-1994 programme passed its mid-term during the year. To this end with a view to better evaluating the outcome, quality and adequacy of the work, the Board has set up a system of independent visiting groups to inspect each of the JRC institutes. In late 1993 the Board acknowledged the reports from the evaluations of the High-Flux Reactor at Petten, the Institute for Prospective Technological Studies, and the Institute for Systems Engineering and Informatics. Further evaluations of the other JRC institutes are forth-coming and the reports will be subject to the Board's consideration during 1994.

The Role of the JRC in the Community

The Board has devoted much time and effort to the forward planning of the Centre, but 1993 has been particularly concentrated on this matter. The Board has discussed the role of the JRC in the Fourth Framework Programme of Community activities in research, technological development and demonstration, proposed by the Commission last summer, at all its meetings. An initial step in the decision process (European Parliament Opinion, Council Common Position) has now been reached. The Board, like the Commission, is keen to ensure a continuing position for the JRC as an integral part of the Community R&D system, but do realize that new ways to this end may be necessary. The Board has expressed its willingness to assist the Commission in the adaptations necessary for the future.

In this respect the Board expresses with pleasure its gratitude to Professor Antonio RUBERTI, Commissioner for Research and to Professor Claude DESAMA, Chairman of the European Parliament Committee on Energy, Research and Technology for their discussions and valuable help to the Board for identifying the future role of the JRC.

In summary, the Board acknowledges the continuous dedication and efficient work performed during the year by the Director General, the Directors and indeed the entire staff of the Joint Research Centre, and recognises their demonstrated will to embark on new orientations and changes from the past. The future will offer many new challenges to the JRC.

During 1993, the Board, comprised of representatives of the 12 Member Countries, has been working closely with Observers from the EFTA countries in preparation for the Agreement on the European Economic Area (EEA) and wishes to acknowledge their valuable contributions. The Board welcomes the Agreement of the European Economic Area entering into force on 1 January 1994 and looks forward to the strengthened collaboration with the participating EFTA countries.

Brussels, January 1994

JOINT RESEARCH CENTRE

1993 ANNUAL REPORT

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Report of the Commission

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THE JOINT RESEARCH CENTRE

The Joint Research Centre of the European Communities is a European scientific and technical research centre established by the Commission of the European Communities, with headquarters in Brussels. Four sites in Belgium, Germany, Italy and the Netherlands 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 (Ispra)

This Annual Report intends to give a general overview of JRC life in 1993.

Furthermore, readers may find more details in the Annual Reports of the eight Institutes. Finally, as in the past, the JRC 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
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1. JRC LIFE IN 1993

1993 saw the Joint Research Centre (JRC) passing the mid-term of the activities set out by the Council Resolution and Council Decisions adopted on 29 April 1992 for the 1992-1994 period. As expected, the Centre was fully engaged in the pursuit of its assigned activities and at the same time, in a dynamic planning for the future.

The JRC continued its contribution to the 3rd Framework Programme via the lines of Industrial and Materials Technologies, Measurement and Testing, Environment, Nuclear Fission Safety, Controlled Thermo-Nuclear Fusion and Human Capital and Mobility.

The JRC has a strong tradition of executing projects of a multidisciplinary nature. This was reflected in the subject areas of most of the Institutes with the aim of meeting the needs of the Community as a whole, its Institutions and Member States. All eight Institutes continued their activities within the context of specific programmes, scientific and technological support for the Commission, contractual work for external third parties and exploratory research.

The neutral and independent role of the JRC was underlined, research of pre-normative character was emphasised as was the true European nature of its scientific-technical activities. Much attention has been paid by the JRC Board of Governors to ensure proper response to the subsidiarity principle and to foster increasing significant collaboration with national research in the Member States. Plans were drawn up for a possible coming collaboration with the EFTA Countries. Europe-wide or international collaboration continued under schemes like EUREKA and EC agreements with several countries around the world. Thanks to its capabilities and its involvement in the formulation and implementation of Community policies, the JRC assumed the role of a neutral and independent tool.

Work undertaken as scientific and technological support for the Commission continued and much attention has been paid to applying the customer/contractor principle. Practically all major operations were covered during the year by an Inter-DG (Directorate General) multiannual contract, a Council decision or a Commission decision, and the remaining part was executed in response to more precise requests from Commission Directorates General. New initiatives included the European Centre for Validation of Alternative Testing Methods (alternative to vivisection) and the European Chemicals Bureau both for the Directorate General for Environment, Nuclear Safety and Civil Protection and new work in the nuclear safeguards area for the Directorate General for Energy.

Contractual work performed for external third parties continued to be of a high quality and executed with speed, and the JRC strengthened its marketing efforts both at institute and central level. The volume of new contracts reached a higher level than in the previous year.

The many exploratory research projects gave stimuli for possible new work orientations and added to the scientific vitality of the JRC.

Early planning of the JRC's contribution to the 4th Framework Programme on Community activities in research and technological development was started; the scientific and technical objectives and contents of programmes were defined in cooperation with the JRC Board of Governors.

The Commission issued its proposal on the 4th Framework Programme on Community activities of Research, Technological Development and Demonstration (1994-1998) and various accompanying documents.

1.1 Specific Research Programmes

The predominant task of the JRC is still its contribution to the implementation of the Framework Programme which accounted for 65% of the JRC Budget. It contributed to the objectives of the 3rd Framework Programme by the execution of 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).

European research networks were actively promoted by the IAM within the growing field of surface engineering. Research work covered hard surfacing for the wear resistance, fibre coatings for composite interface engineering and biocompatible coatings for prostheses. The Advanced Coating Centre, a joint venture with the Netherlands Energy Foundation (ECN), became fully operational in 1993.

A methodology for the engineering of composite interface structures has been established in the frame of the EUREKA-CEFIR project; a technique for producing nanocrystalline ceramic coatings has been developed.

Three Networks were launched to integrate European efforts on inspection procedure qualification for heavy duty structural components; these networks in which the IAM acts as the Operating Agent and the Reference Laboratory are:

- AMES: European Network on Reactor Pressure Vessel Embrittlement and Annealing;
- ENIQ: European Network of Inspection Validation or Verification;
- NESC: Network for the Evaluation of Steel Components.

The research on Working Environment at ISEI was focused on models and methods for human error assessment in avionics, air traffic control and chemical industries. Models have been validated by field research and by analysis of recorded accidents and incidents.

The EI activity on Trace Metals Exposure and Health Effects was mainly directed towards the assessment of the toxicological impact of trace metals on general and occupational exposed populations. Experiments with a new walk-in environmental test chamber for indoor pollution and exposure studies (INDOORTRON) were started.

- **The Measurement and Testing** programme encompassed research projects on measurements and reference materials, executed by the Institute for Reference Materials and Measurements (IRMM), and research projects on reference methods for non-nuclear energies 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).

IRMM continued the elaboration of reference materials, as in the past. In collaboration with national institutes, the value of the Avogadro constant has been redetermined to a precision of 10⁻⁷, which promises application for redefinition of the international standards.

Nuclear data continued to be measured; measurements of very low contaminations in various materials have been performed in the Ultra Clean Chemical Laboratory and with a new detection device installed in an underground facility of the SCK/CEN, Mol; interlaboratory measurements have been performed to analyse trace elements in water and in human serum within the International Measurement Evaluation Programme (IMEP).

The European Laboratory for Structural Assessment (ELSA) continued its experimental and modelling activities in collaboration with the European Association of Structural Mechanics Laboratories which comprises around 30 laboratories from the Member States. The main objective is prenormative research for an improved understanding of the nonlinear response of materials and structures to dynamic loading for the design of civil engineering structures in seismic areas. At the ISEI, prenormative research was pursued with the development of a new test procedure for thin photovoltaic films.

- **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).

At the Environment Institute, the activity on "Biogenic Emissions in the Mediterranean Area" (BEMA) was continued as a contribution to the global change programme by setting up the concept for a European 4-year project. The JRC acted as a project coordinator of a first measuring campaign performed in May 1993 with the interdisciplinary cooperation of 12 laboratories from various European countries, .

The EI coordinated the European participation in an international experimental study on aerosols and climate. Data from a scientific campaign across the North Atlantic was analysed and showed the influence of continental pollution on the aerosol and cloud systems of the remote North Atlantic ocean.

In the frame of global change study the IRSA developed remote sensing based approaches to study the terrestrial and marine biospheres with particular emphasis on changes in vegetation distribution (e.g. biomass burning) and regional and temporal variations of sea surface temperature and biological activity.

Advanced techniques for remote sensing were evaluated; high spectral resolution sensors have been shown to provide information on specific elements of interest such as lignin and moisture content, which cannot currently be obtained with existing sensors. Microwave remote sensing techniques were also evaluated for forestry and agricultural applications; these provide possible means to acquire data independent of prevailing weather conditions.

The EMSL (European Microwave Signature Laboratory) facility will be used in an experimental programme devoted to undertake spectral signature research in preparation for future spaceborne observations. This programme has been defined on the basis of recommendations and requests emanating from interested research institutes across Europe.

Methodologies (neural networks, expert systems and spectral mixture modelling) are being developed to monitor vegetation and environmental conditions in several parts of Europe, with particular emphasis on ecosystem mapping, land degradation and desertification.

The setting-up of a Centre of Earth Observation (CEO) has been examined by the ISEI, the IRSA and the EI; the main objective of the Centre is to provide an efficient decentralised network for the full exploitation of the earth observation data including those obtained by spaceborne sensors.

At the Institute for Safety Technology research on Industrial Hazards continued. The Facility for Investigating Runaway Events Safety (FIRES) aimed at studying the safety of batch chemical reactors has been operating for the study of aromatic nitrations. Studies have been performed to develop and apply to FIRES advanced methodologies for determining safety conditions, process optimisation, process control and early warning detection of runaway initiation.

- **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).

The IST continued its contribution to the study of severe accident phenomena in nuclear power plants with the participation in the international PHEBUS programme at CEA Cadarache and with the execution of the FARO (experimental facility for fuel melting) test programme at Ispra, simulating severe accidents in the core of nuclear reactors.

The development of the European Source Term Research (ESTER) computer code package continued in collaboration with many European Institutions; it is designed to become the European best estimate code for the calculation of Source Term in severe accident scenarios.

The Institute for Transuranium Elements (ITU) contributed to the study of safety of nuclear fuels, and especially to the effect of high burn-up on fuel and cladding integrity. Particular attention was paid to structural changes occurring at the fuel surface and to the influence of fission products on the fuel thermal conductivity. Studies concerning the safety and transmutation of actinides were continued in cooperation with several European Laboratories.

Nuclear Safeguards research continued at ISEI-ITU and IST; a mobile robot for remote verification and an active video detection system were developed. On-site sealing techniques have been pursued; ultrasonic sealing and identification techniques have been patented.

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

Verification and testing of the safety relevant systems in the European Tritium Handling Experimental Laboratory (ETHEL) continued during 1993 with the aim of obtaining the operational licence for Nuclear Testing in 1994. Cooperation between the IST (ETHEL) and the Kernforschungszentrum Karlsruhe (KFK) Tritium Laboratory Karlsruhe (TLK) facility is progressing.

Various computer packages were developed by the ISEI to model physical phenomena within a reactor and a facility to simulate remote handling procedures has been built.

- **The Human Capital and Mobility programme** of the JRC continued with increased activities in 1993 and covered all Institutes. It offered individual research fellowships to interested scientists, participation to Networks with other research organisations and Access to Large Scale Facilities projects. The Board of Governors of the JRC approved during 1993, 200 individual fellowships on a post-doctoral level, 11 networks involving a JRC participation and 3 projects on Access to Large Scale Facilities of the JRC.

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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.

1.2 JRC S/T Support to Community Policies

The JRC scientific and technical 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 competences or experimental facilities of the JRC;
- scientific and technical work for implementing EC legislation or S/T support to drafting new legislation;
- scientific assistance in the management of projects or contracts,

In 1993, the JRC scientific and technical support accounted for 22 % of the JRC budget, at the same level as in 1992. Figure 1 shows how this support was divided amongst the various Community policies.

During the year, a number of multi-annual agreements have been signed by the Director General of the JRC with other Directorates General in order to provide an effective customer/contractor relationship, as well as a degree of continuity and long-term planning. 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.

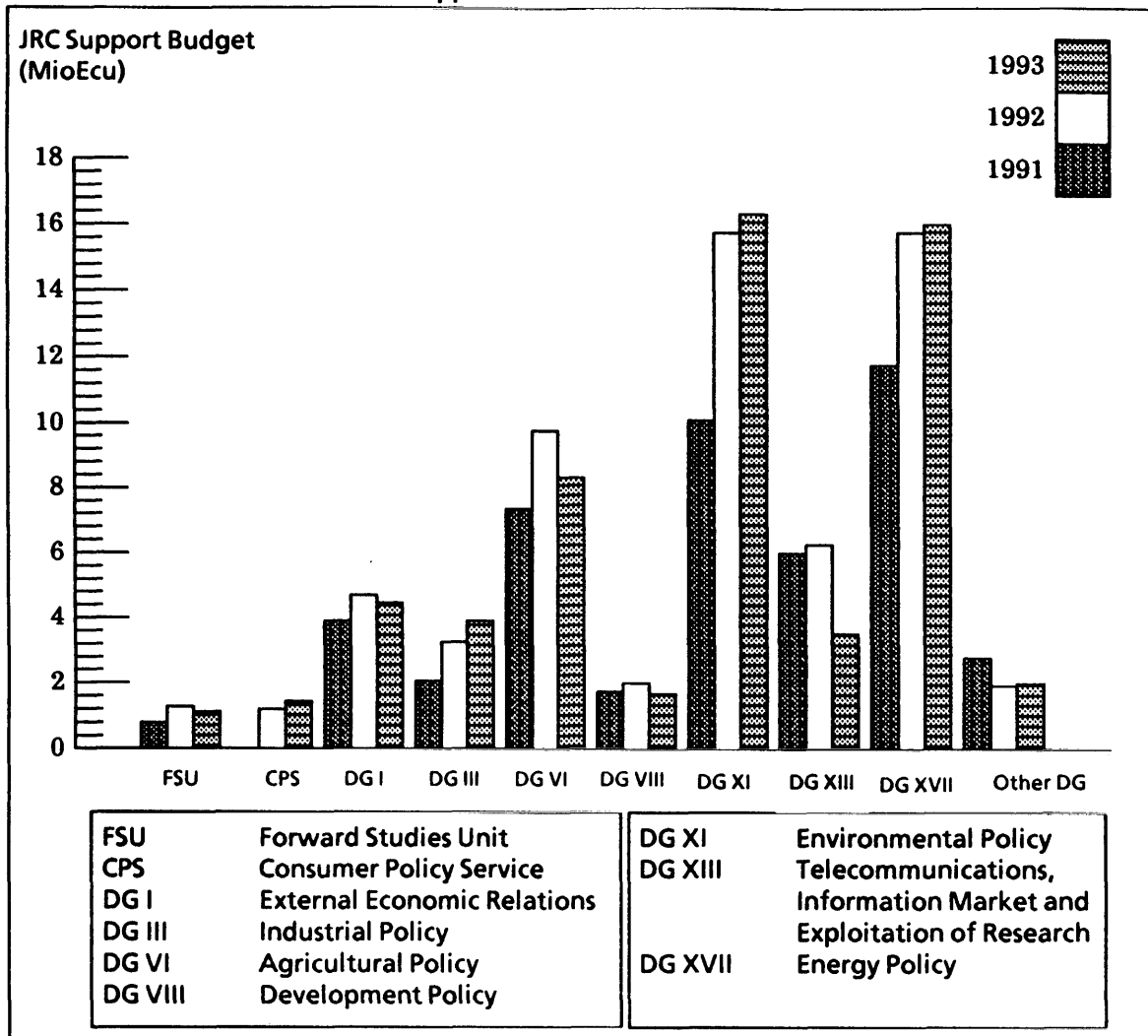
Practically around 83% of all operations were covered during the year by an Inter-DG multi-annual contract, a Council Decision or a Commission Decision, with the remaining part executed in response to more urgent requests from Commission Directorates General.

● **JRC support for the 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 concerns the implementation of EC Directives 80/779 and 85/203/EEC on air quality (SO₂, NO₂, photochemical oxidants); work for the establishment of the European Reference Laboratory of Air Pollution (ERLAB) has considerably progressed and the Communication of the Commission to the Council and the Parliament will be issued shortly;
- support in the management of waste is provided with the co-ordination of a group of independent experts for the preparation of the European Waste Catalogue (Directive 91/156/EEC);
- setting up of 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, and it should be operational for the first experiment in 1994;
- work on major accidents supports the implementation of EC Directive 82/501/EEC and the investigation of hazards of certain industrial activities such as processing and storage installations for hazardous chemicals;
- establishment of the European Chemicals Bureau within the EI since January 1st, 1993, with the task of carrying out and coordinating the scientific/technical work for the implementation of EC legislation for the control of chemicals in continuation of similar work performed by the EI for DG XI since several years.

Figure 1

S/T Support to Commission Services



- **JRC support for Energy policy (DG XVII) accounts for 27.2% of the scientific and technical support budget.**

Most of the work undertaken deals with the following tasks:

- training of inspectors, harmonisation of in service inspection practices providing state of the art equipment and reference analyses of nuclear materials samples;
- operation of on-site laboratories for safeguards analysis at reprocessing plants such as Sellafield and La Hague;
- contribution to long-term energy scenarios, including the evolution of nuclear energy industry;
- contributions to energy conservation and to 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 to develop and demonstrate, up to the 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 26.9.1988);
- support to applications in establishing registers of inventory control systems in agriculture, using either airborne or spaceborne remote sensing techniques;
- creation of the European Office for wine, alcohol and spirit drinks was communicated by the Commission to the Council and the European Parliament (COM(93) 360 final, 16 September 1993).

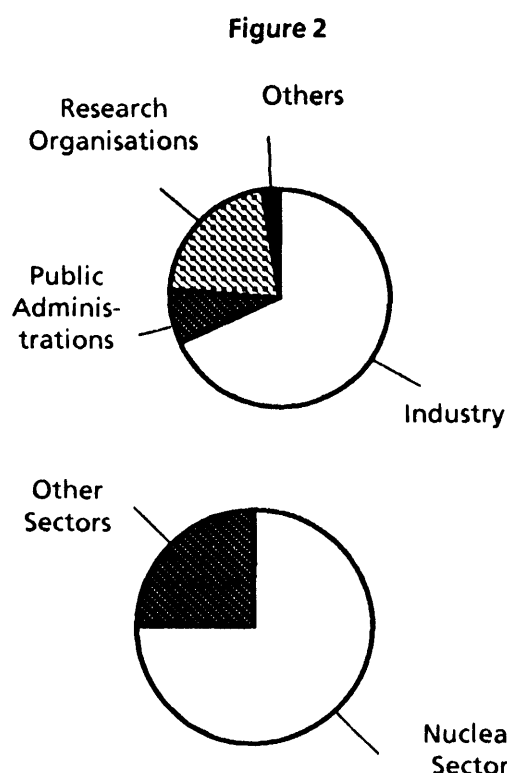
Further information on the JRC Scientific and Technical support activities to the Commission's services may be found in Chapter 2.

1.3 JRC Work for Third Parties

The customers of the Joint Research Centre

The JRC is offering its scientific expertise to external customers since 1988, totalling a volume of orders of more than 60 Mioecu during the last six years since this activity was initiated.

Industry remains by far its most important customer, with 68% of the orders received by the JRC and being still today under execution while research organisations and public administrations account for 22% and 8% respectively. Others cover the remaining 2% [Fig. 2].



The nuclear sector remains also the predominant client of the JRC expertise, while other sectors amount globally just over 25% of the total orders received by the JRC and being now executed.

The public sector, with its increasing needs for expertise in the area of environmental management, is emerging as a customer of the JRC for projects involving the study of air, water and soil pollution and the management of industrial and urban waste.

Environment related contracts being now executed at the JRC account for 9% of the total orders executed in 1993, which is an increase of 25% compared with the past year.

The total volume of new orders received in 1993 by the JRC reached the level of 11.7 Mioecu.

The volume of new orders received in 1993 is 30% higher than that received in 1992.

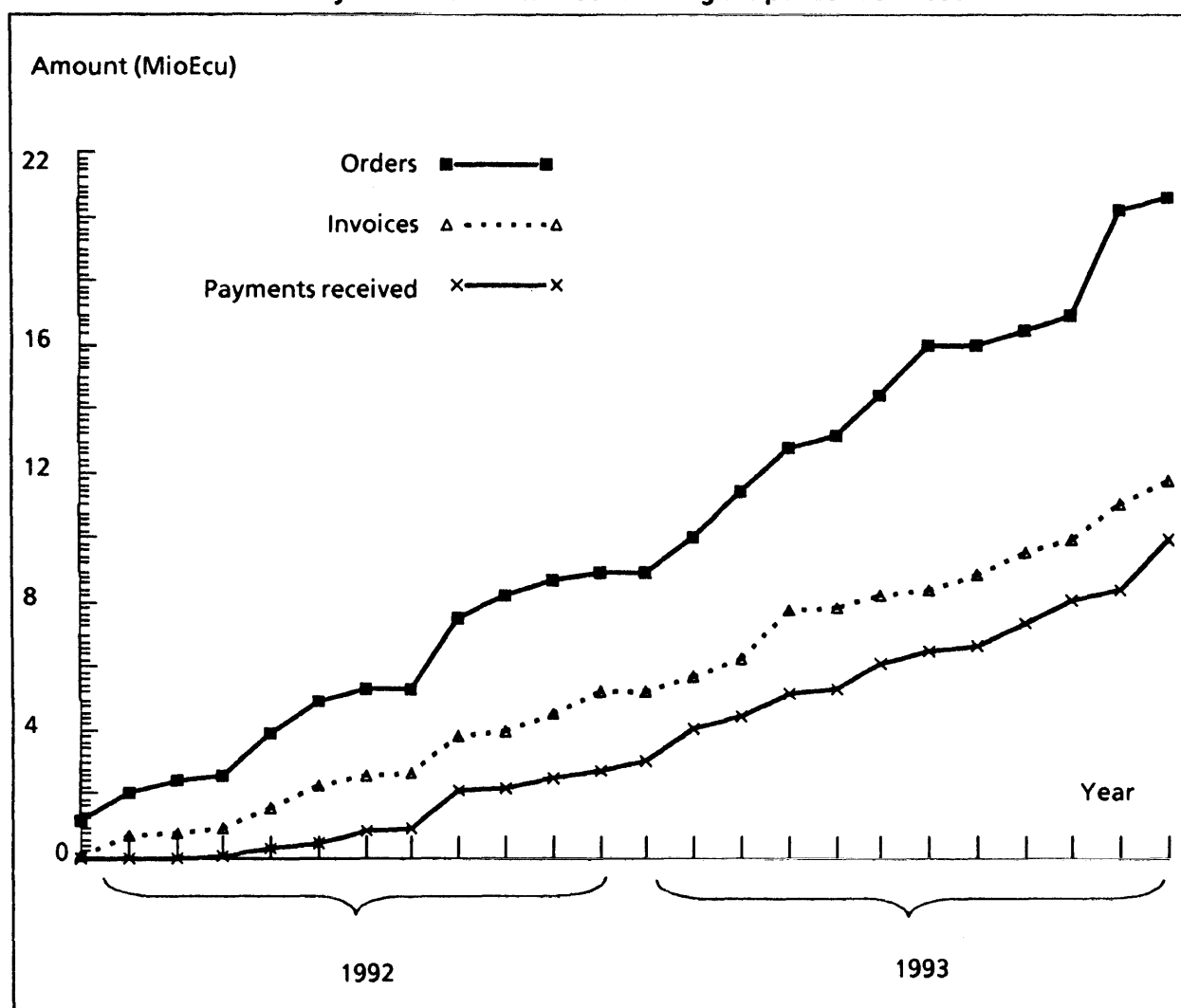
Fig. 3 details the evolution of orders, invoices and payments for third party work contracted during the period 1992-1993.

During this period, the total volume of invoices reached [10 Mioecu], which means that roughly half of the orders received in 1992-1993 have been completed during these two years, while the other half will be executed in 1994 and later on.

Payments received are following closely the amounts invoiced.

Figure 3

Third Party Work ordered to the JRC during the period 1992-1993



As in 1992, two Institutes, namely the Institute for Advanced Materials and the Institute for Transuranium Elements are far ahead the other JRC Institutes in the winning of contracts for Third Party Work.; The Institute for Safety Technology acknowledged the biggest increase in earning contracts for Third Party Work since the volume of its orders doubled in 1993 in comparison with 1992.

The evolution of the execution of work ordered during the period 1988-1991 is proceeding smoothly but will further extend over the next years.

Table 1 shows, by period, the evolution of the execution of the Third Party Work ordered during the years 1988-1991.

Table 1
JRC Execution of Third Parties Work (Mioecu) ordered during the period 1988-1991

Year	1988-1991	1988-1992	1988-1993
Initial Order book	45.64	45.64	45.64
Cancellation	---	1.45	1.79
Actual order Book	45.64	44.19	43.85
Amounts invoiced	17.83	25.43	29.18
Payments received	15.33	23.38	27.74

The volume of contracts signed during that period totalled 45.64 Mioecu, now adjusted to 43.85 Mioecu following cancellations or modifications of a few contracts.

End 1993, the invoices issued for work on the contracts totalled 29.18 Mioecu; 66% of the work ordered was thus executed at that time. The corresponding payments received totalled 27.74 Mioecu.

The execution of the remaining work on the 1988-1991 contracts will continue, as foreseen in the contracts, during the coming years, and in a few cases up to 2000.

1.4 JRC Cooperation with National Research Organisations

The JRC is cooperating with national organisations through various schemes : bilateral cooperations, multilateral cooperations, Human Capital and Mobility Networks, and Eureka projects.

Bilateral cooperations between the JRC Institutes and national organisations within the Member States of the European Community are numerous, roughly more than 100 bilateral cooperations are today in force; they are generally focused to highly specialised fields where the JRC is sharing its scientific expertise with other research organisations in order to increase the scientific excellence of both partners.

Around 60 multilateral cooperations between the JRC institutes and national organisations are operational. The number of partners of those collaborations is generally comprised between two and 20 partners but in an extreme case, up to 70 laboratories are participating. The subject of collaboration is, generally, broader than in the bilateral co-operations and its goal is to enhance the collective scientific knowledge of the partners. Therefore, this kind of cooperation has an important Community significance. Figure 4 is giving the distribution of these bilateral and multilateral collaborations among the JRC Institutes.

The JRC is also participating in eleven Human Capital and Mobility Networks (HCM). The distribution of these cooperations among the JRC Institutes is given on Figure 5 while Table 2 lists the most important bilateral and multilateral collaborations.

All these cooperations are open to new prospective participants who want to join and benefit from them in bringing their additional scientific expertise.

Figure 4
JRC bilateral and multilateral Cooperations

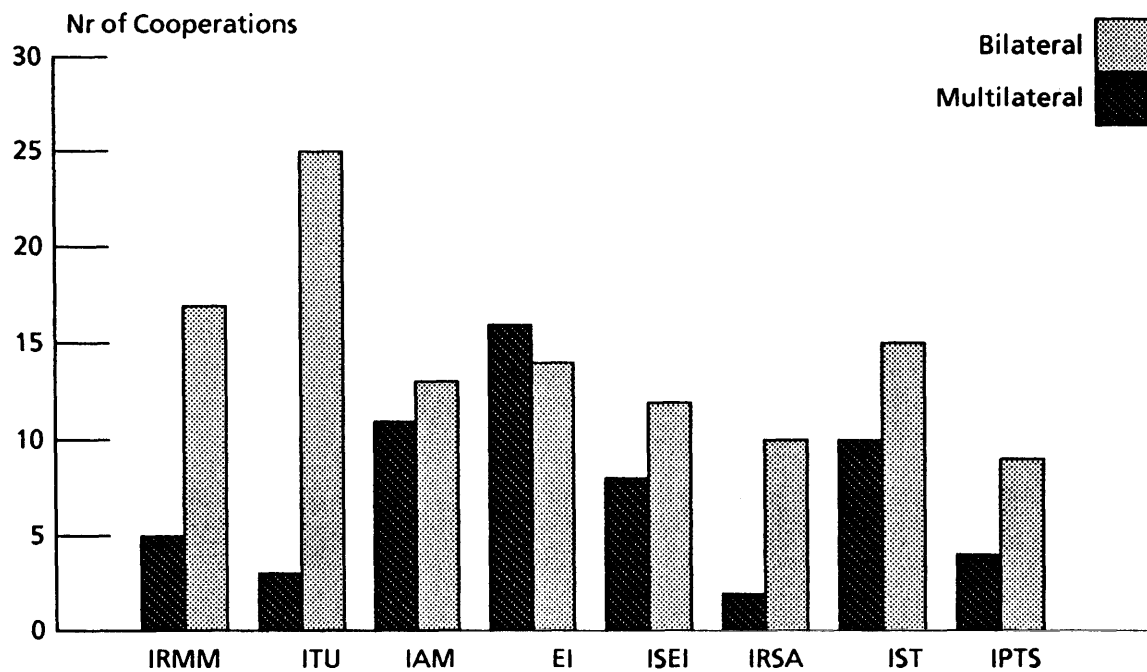


Figure 5
JRC HCM and Eureka Cooperations

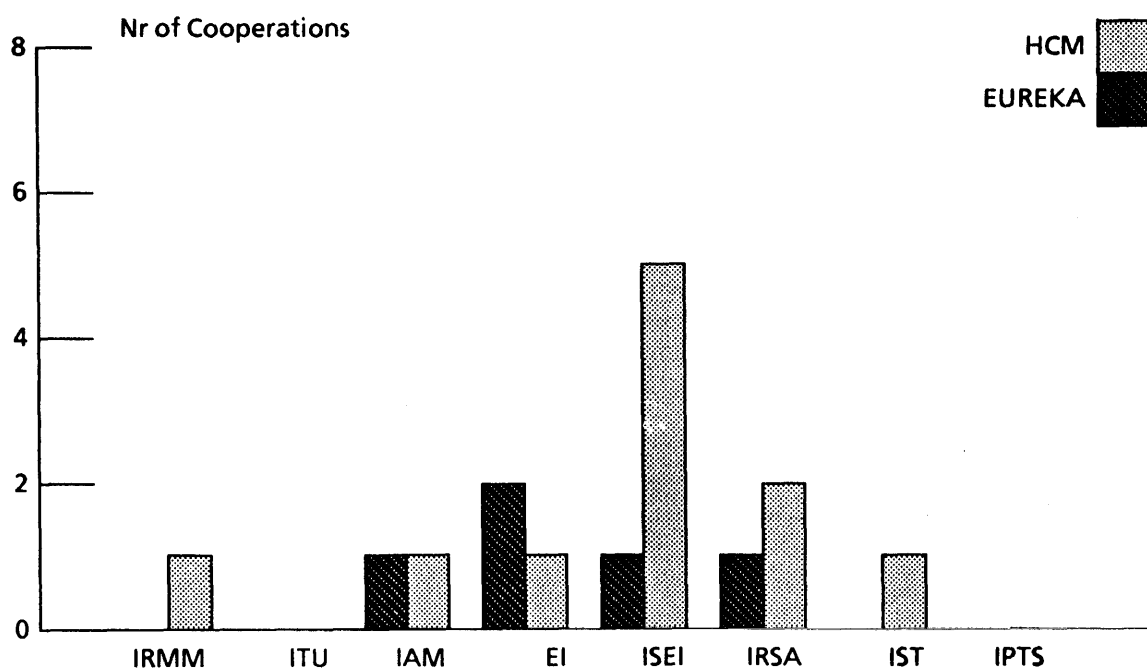


Table 2

Most important research areas where the JRC is animating a significant cooperation throughout the EC

Institute	Research Areas	Observations
IRMM	<ul style="list-style-type: none"> - Reference Nuclear Materials Measurements - Reference Measurements for Chemical Analysis - Polluting Trace element determination in the environment; 	<ul style="list-style-type: none"> - REIMEP collaborative effort involving more than 30 laboratories - IMEP : collaborative effort involving up to 65 laboratories - Envirotrace: an HCM network involving 15 laboratories
ITU	<ul style="list-style-type: none"> - Basic Actinide Research - Partitioning and transmutation of long lived actinides in order to mitigate their long term hazards 	<ul style="list-style-type: none"> - Bilateral cooperation with interested universities and research institutes - Network with interested research institutes
IAM	<ul style="list-style-type: none"> - High temperature ceramic fibres for ceramic-matrix composite materials - Prenormative research on advanced materials - Non destructive inspection techniques for reliability assessment of mechanical structures - Development of reliable ceramic components for advanced gas turbines 	<ul style="list-style-type: none"> - Research networks with universities and research institutes - VAMAS - PISC longstanding multinational cooperation system expanded to embrace 3 new Networks: NESG : Network for Evaluating Steel Components ENIQ : European Network for Inspection Qualification AMES : European Action group on aged reactor materials and components. - HCM network involving 5 European Laboratories
ISEI	<ul style="list-style-type: none"> - Semi-autonomous Monitoring and Robotics Technology (SMART) - Interactive image synthesis and processing on Innovative Computer Architectures - Diagnostics and Reliability of Innovative Materials and Structures for Transportation Applications 	<ul style="list-style-type: none"> - HCM network involving 13 European organisations - HCM network involving 8 European laboratories - HCM network involving 8 European partners
EI	<ul style="list-style-type: none"> - Intercalibration and development of measurement methods for air pollution monitoring 	<ul style="list-style-type: none"> - Major collaborative effort in intercalibration and development of measurement methods with all interested European laboratories
IRSA	<ul style="list-style-type: none"> - International forest investigation - Agricultural statistics - Monitoring of Common Agricultural Policies 	<ul style="list-style-type: none"> - Existing cooperation with ESA and four national institutes - Contractual activities in network - Contractual activities in network
IST	<ul style="list-style-type: none"> - Structural mechanics (earthquake engineering research), operation of the ELSA facility - Prenormative research in support to Eurocode N° 8 - Reactor Safety : Severe accidents 	<ul style="list-style-type: none"> - Existing European Association of Structural Mechanics Laboratories (30 European laboratories) - HCM network involving 19 European organisations - Cooperation with 16 European Laboratories contributing to the Phebus PF programme, cooperation with 8 organisations involved in the FARO projects
IST/ISEI/ITU	<ul style="list-style-type: none"> - Nuclear Safeguards 	<ul style="list-style-type: none"> - ESARDA longstanding formal cooperation with all interested European research Institutes

The JRC is also participating in five EUREKA (European Cooperation on Advanced Technology)¹ projects :

- CEFIR (Ceramic European Fibre Research, EU 658), an initiative aiming 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 IAM);
- FORMENTOR (EU 19), related to 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), for real time operator decision support system;
- EUROTRAC (EU 7), with the TRACT (Transport of Air Pollutants over Complex Terrain) sub-project that 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 that evaluates, by laboratory experiments, the chemical and photochemical transformation of atmospheric pollutants where cooperation with the University of Keel and with the University of Milano has led to interesting results (see par. 2.5);
- EUROENVIRON (EU 330), with the TRACY (Toxic Metals in Human Tissues and Fluids) project (EU 618) which aims to develop a state base for toxic materials in human tissue and fluids and the mobile analysis laboratory project (EU 674) aiming at developing a mobile analytical laboratory for the in-field analysis of water, waste and soil and where an interlaboratory exercise has been launched (see par. 2.5);
- VISIMAR (Visualisation and Simulation of Marine Environmental Processes, EU 495), to monitor the marine environment has been concluded in producing an animation system showing the dynamic behaviour of geophysical processes (see par. 2.6).

1.5. Ispra site renovation

The plans for an ECO-Centre at the Ispra site are progressing towards a fully fledged masterplan for the site and its energy balance. First accomplishments include a survey by infrared measurements of energy losses from buildings, the on-going retrofitting of several buildings and the detailed plans for installation of solar panels on the south façade of the ELSA (European Laboratory for Structural Assessment) experimental hall foreseen to be installed in 1994.

1. 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 Commission of the European Communities.

1.6. Publications and Eurocourses

- **Publications - Patents**

In 1993 the JRC published 884 papers. The following Table 3 gives the distribution of these publications among the JRC Institutes.

Table 3

Distribution of JRC Publications among JRC Institutes in 1993

Institutes	EUR Reports	Conference Papers	Articles	Total
Directorate General	6	5		11
Institute for Reference Materials and Measurements	6	60	28	94
Institute for Transuranium Elements	2	109	33	144
Institute for Advanced Material	13	79	63	155
Institute for Systems Engineering and Informatics	18	82	20	120
Environment Institute	14	94	19	127
Institute for Remote Sensing Applications	9	98	21	128
Institute for Safety Technology	31	63	6	100
Institute for Prospective Technological Studies	1	4		5
Total	100	594	190	884

The detailed list of JRC publications is published each year in the "Publications Bulletin". The last issue, No 13/ISSN0254-3133, published in April 1993, gives the list of JRC publications in 1992. In 1993, 26 JRC patents were also granted.

- **Eurocourses - Other Workshops and Seminars**

The JRC organised 8 Eurocourses with 90 guest lecturers from EC Member States, USA, Canada and Japan and 40 experts from the JRC Institutes and various Directorates General of the Commission.

The courses encompassed topics within environment, remote sensing, nuclear safety, materials sciences and civil protection. They were attended by 316 participants coming from industry, public administration, universities and research organisations from the EC-Member States and from 20 non EC countries.

Three other one-week courses were organised for the European Association for Environmental Management Education in the frame of the programme of the European Master in Environmental Management established by the Commission in 1991.

Furthermore, the JRC Institutes organised various workshops and seminars to discuss their activities with scientists of other organisations and to disseminate the results of their work.

2. ACTIVITIES OF THE JRC INSTITUTES IN 1993

This chapter outlines the activities of the Institutes of the JRC during 1993.

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

The IRMM, the former Central Bureau for Nuclear Measurements (CBNM), located in Geel (Belgium), is dedicated to the promotion of European standards and the harmonization 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". The character of its work continued to favour non-nuclear aspects and to move from fundamental studies to applied research, without, however, disregarding the commitments defined in the Treaty of Rome. It is engaged in support activities related mainly to nuclear safeguards at the requests of the Directorate General for External Relations (DG I) in support to the International Atomic Energy Agency (IAEA) and to the Directorate General for Energy (Euratom Safeguards Directorate, DG XVII). It also provides services and reference materials to various customers from the EC Member States.

- **Reference Materials and Measurements**

The IRMM is providing high quality reference materials for the calibration of analytical equipment in all stages of the nuclear fuel cycle and in various fields of non-nuclear issues, with the aim of improving the reliability of measurements in chemistry and physics. Special targets and samples for nuclear data measurements have been prepared and characterised such as new ^{10}B and ^6LiF reference deposits.

Various reference materials were prepared, characterised and certified. Productivity and quality in the preparation of biological, environmental and food reference materials were improved as well as the control of their elaboration (humidity, particle size, homogeneity and contamination). Several special reference materials for BCR were certified, such as orange juice (sugar, amino-acids), pig liver (vitamins), fly ash (dioxines) or soils (phenols, cyanides). Analytical work on metallo-proteins and heavy metal traces of environmental or bio-medical importance also continued.

The Regular European Interlaboratory Measurement Evaluation Programme (REIMEP) activity continued with various Interlaboratory Measurement on Mixed Oxide pellets and solutions of spent fuel, synthetic input and plutonium nitrate; furthermore, the International Atomic Energy Agency (IAEA) has proposed to include REIMEP into its quality analysis scheme.

The now operational Ultra Clean Chemical Laboratory will be used for the determination of very low concentration trace elements in a variety of materials. The interlaboratory rounds with up to 70 partners on trace elements in natural and synthetic water as well as that on iron in human serum have been concluded within the International Measurement Evaluation Programme (IMEP).

Determinations of the silicon molar mass to improve the accuracy of the Avogadro Number were performed for German, Italian and Japanese partners. Nearly absolute isotopic measurements on several gases and amount measurements on gravimetrically prepared gas mixtures were conducted applying procedures developed in the Avogadro project.

A set of rules of "Good Practice" have been worked out to enable accurate worldwide traceability of chemical measurements.

In the field of fission technology, neutron measurements continued to be carried out on basic cross-sections:

- experiments on the fission cross-section of ^{235}U relative to the neutron-proton scattering (in the neutron energy range from 0.3 to 2 MeV) and on the total cross-section of ^{10}B (in the neutron energy range from 100 eV to about 10 MeV);
- analysis of total cross-sections of ^{58}Ni and ^{60}Ni up to 800 keV neutron energy which has been included in the Nuclear Energy Agency (NEA) Data Bank and in the ongoing evaluation for the Joint European File; measurements of the radiative capture cross-sections as well as the capture γ -ray spectra of ^{58}Ni have been started;
- the cross-sections for neutron inelastic scattering from ^{238}U and from palladium isotopes (fission products) are being investigated. The alpha and triton yield (important for tritium build-up in fuel elements) from ternary fission of ^{235}U in the resonance region, as well as fragment mass- and energy distributions for the spontaneous fission of ^{242}Pu , ^{244}Pu and for neutron induced fission of ^{243}Am were investigated.

As for fusion technology, high resolution total cross-section measurements on natural iron have been performed. Data relevant to the prediction of gas production, in particular the $^{58}\text{Ni}(n,\alpha)$ cross-section relative to $^{27}\text{Al}(n,\alpha)$ as standard, are being measured.

An intercomparison of the standardisation of thin ^{233}U layers involving also the US National Institute of Standards and Technology (NIST) was finalised.

Measurements of very low contaminations in various materials, e.g. environmental samples, have been performed using a shielded 100 cm³ HP (High Purity) Ge detector. This detection system was installed at 225 m depth in the HADES (High Activity Disposal Experimental Site) underground laboratory of the SCK/CEN, Mol. The purpose of this was to reduce considerably the background from cosmic rays and neutron activation.

In the programme on radiation physics, optical transition radiation was used for energy and divergence measurements of the electron beam with on-line display of the beam parameters.

At the 7MV Van de Graaff nuclear reaction analysis was applied for the stoichiometric analysis of μm thick boron-nitride films via simultaneous recording of boron and nitrogen (α,p) reactions. Analysis of oxygen diffusion in implanted stainless steel continued. Structural work for the generation of a $^{15}\text{N}^+$ beam for hydrogen profiling experiments will be finalised.

● Community and External Services

The IRMM continued the preparation of a series of solid spikes for safeguards measurements which were supplied to the IAEA. It also executed safeguards verification measurements according to the requests of the Euratom Safeguards Directorate of DG XVII. This is the quality control programme co-ordinated by the Institute for all ECSAM (European Commission's Safeguards Analytical Measurements) laboratories. In particular, results of the analytical measurements on mixed uranium plutonium oxide pellets, plutonium nitrate solution, spent fuel and synthetic input solutions were collected for evaluation.

The isotopic fingerprint method which allows the identification of origin of some products or pollutants, has been developed and applied to sulphur in fossil fuels (responsible for SO_2 emissions during combustion leading to environmental pollution) and to carbon, oxygen and nitrogen in food and drugs, to prevent fraudulent actions.

Activities have been initiated on the development of means for legislative controls (DG III) by providing suitable certified reference materials.

In the frame of support of the Consumer Protection Service, test measurements have been executed by performing lead analyses in different hair products.

Work in support to the Directorate General for Agriculture has been started: test production of ewe-curd reference materials, freeze-drying procedure of lemon juice and preparation of milk powder spiked with dioxines and furanes.

2.2. The Institute for Transuranium Elements (ITU)

The ITU has expertise and unique equipment for property studies on nuclear fuel materials. It executes, within the Nuclear Fission Safety Programme, research on the safety of actinides in the nuclear fuel cycle. It also contributes to research on reactor safety and on the management of radioactive waste. It provides scientific and technical support of 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 important contracts at the request of the nuclear industry.

- **Safety of Actinides in the Nuclear Fuel Cycle**

The ITU concentrated its efforts to assess the limits of safe operation of nuclear fuels. The study on the limitation of the lifetime of current Light Water Reactor (LWR) fuels put emphasis on the formation of structural defects at the fuel rod surface at high burn-up ("rim effect").

Work on transmutation of actinides was continued. In a collaboration with CEA, EdF, ECN and KFK, the major part of studies focused on the transmutation of Tc-99, I-129, and minor actinides in an inert matrix in view of irradiations in PHENIX, HFR, and OSIRIS. An irradiation experiment to study possibilities of transmuted technetium in the Petten reactor was started. Moreover, a new "Minor Actinides" laboratory, conceived in view of preparing and testing fuel for new transmutation experiments, has been designed. Separation of actinides has been experienced with trialkyl-phosphine oxide in processes including centrifugal extraction.

An experiment for investigating the transport mechanisms of large nuclear aerosol particles (in particular, UO₂ particles) in ducts and chimneys was carried out. The agglomeration of fine dust particles in a turbulent flow field was studied in detail.

Experimental studies on the high temperature phase transitions in UO₂ were performed in order to complete existing heat capacity data in the pre-melting region. A thermodynamic model for electronic and atomic point defect contributions to the heat capacity of UO₂ has been designed and validated.

A laser flash machine for diffusivity measurements on irradiated fuel samples was constructed and a shielded Knudsen cell for vaporisation experiments with irradiated fuel samples was calibrated.

Studies concerning the safety of actinides were pursued in collaboration with more than 50 national research institutions in the world.

- **Reactor Safety**

Mathematical codes for reactor safety studies have been further developed and applied in view of the planned PHEBUS fission gas release experiments. Ultrasonic thermometers for in-pile centre line temperature measurements have been installed and tested.

- **Characterisation of Radioactive Waste**

Work in the field of nuclear waste characterisation concentrated on the study of effects which determine the long term stability of spent fuel in various environments. Leach tests were and will be carried out in autoclaves with: 1) irradiated UO₂ powder; 2) segments of irradiated fuel rods with pre-formed defects; 3) mixed oxide fuel irradiated to a burn-up of 50 GWd/t (in preparation).

The effect of radiation damage and of the oxidation state on the leaching behaviour of simulated high burn-up fuel was further investigated. Models describing the interaction of steam and water with spent fuel were extended to leaching and oxidation.

Efforts were made to clarify the oxidation of fission product containing fuel and to establish relations between oxygen potential and oxygen to metal ratio for various burn-ups.

Newly developed equipment has been used for the non-destructive analysis of irradiated fuel rods by passive neutron interrogation.

- **Basic Studies on Actinides**

Different classes of neptunium and plutonium compounds were prepared (mostly in the form of single crystals), characterised and encapsulated for basic physical property studies. Special efforts were made to produce large single crystals of NpSb and of UF_8Al_4 for structural investigations.

Mössbauer measurements on NpX_3 compounds were performed under pressure in order to elucidate the electronic structure of these compounds. A new facility for measuring the specific heat of actinides at low temperatures underwent testing. Attempts were made to clarify factors which influence permanent magnetism in rare earth-transition metal systems, and a theory of the Curie temperatures of localized systems was developed. Electronic and structural investigations were carried out with synchrotron radiation from European and US sources.

- **Community and External Services**

The analysis of samples taken by inspectors at different nuclear installations within the European Community continued to be achieved upon request by the EURATOM Safeguards Directorate (ESD). An expert system for quality assurance was further developed and tested. Preparations for the installation and operation of analytical safeguards laboratories at the site of large reprocessing plants continued. New methods for the separation of input samples and for gravimetric analysis have been developed. The final specifications for the Sellafield laboratory were issued. The equipment for non-destructive analysis (n-gamma coincidence analysis, K-edge densitometry) has been tested and installed. New staff has been recruited and is being trained for the on-site laboratory in La Hague and Sellafield.

In 1993, illegally imported nuclear material was discovered in the Member States and submitted to ITU for analysis which proved it to be of low significance.

External contract work deals with the fabrication of minor actinide containing fuel, the characterisation of uranium dioxide irradiated to high burn-up in power plants, the analysis of chemical interactions between ZrO_2 and UO_2 , and a study of mechanical properties of Light Water Reactor fuel. Third party contract work increased during 1993 and now constitutes about 5% of the budget of the Institute.

- **Exploratory Research**

UN powders, UN-Al powder blends, and sintered UN-Al discs were prepared and characterised. Compatibility tests were performed at temperatures up to 600°C. The results are being evaluated in view of the development of new fuels for Materials Test Reactors.

2.3 The Institute for Advanced Materials (IAM)

With sites at both Petten and Ispra, the IAM executes 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 1993 the Institute concentrated its effort on the research areas of surface modification technology, reliability and life extension, materials for extreme environments, and fusion materials.

● **Materials and Measurements**

European research networks were actively promoted within the growing field of surface engineering. Research work covered hard surfacing for wear resistance, fibre coatings for composite interface engineering and biocompatible coatings for prostheses. The Advanced Coating Centre, a joint venture with the Energie Centrum Nederland (ECN), became fully operational in 1993 and initiated bilateral actions for the development of new coatings and coating processes technology. Its range of facilities include plasma and thermal spraying, and thermal and plasma assisted chemical vapour deposition techniques.

In the frame of the EUREKA-CEFIR project on Ceramic Fibre Research, a methodology for the engineering of composite interface structures has been established by application of controlled coating layers onto ceramic fibres coupled with a novel composite fabrication process.

A chemical technique for producing nanocrystalline ceramic coatings has been developed. 10 - 25 nm thick coatings of alumina and yttria were produced on ceria-stabilized zirconia. An emulsion precipitation technique was developed for the production of large amounts of ceramic powder of composition difficult to obtain by other means.

Laser surface melting can improve the fatigue life of stainless steel at least as much as high quality electropolishing. The substitution of gold alloys in dental prostheses by plasma sprayed titanium glass ceramic layers was studied. The adhesion of glazed films deposited on titanium or on an intermediate layer was determined by pull-off and shear tests. Low pressure plasma spray, multilayer coatings of porous titanium and hydroxyapatite on titanium alloy substrates for orthopedic applications, in particular for femoral and knee prosthesis, were characterised structurally and mechanically. The wear rate and the friction coefficients of titanium and CoCrMo alloys as articulating components against polyethylene were determined.

Three Networks were launched to integrate European efforts on inspection procedure qualification for heavy duty structural components - on materials rejuvenation, on integration of fracture mechanics and on inspection. These networks in which the IAM acts as the Operating Agent and Reference Laboratory are:

AMES: European Network on Reactor Pressure Vessel Embrittlement and Annealing;

ENIQ: European Network of Inspection Validation or Verification;

NESC: Network for the Evaluation of Steel Components.

These European initiatives officially launched in 1993, involve the management of projects aiming at codes, standards and industrial practice improvement. They support activities within DG III, DG XI and DG XVII.

Characterisation of chemical/mechanical properties of newly developed advanced metallic materials having potential for gas turbine applications has been performed under long term exposure at high temperatures. Corrosion studies have been targeted at determining the reason why industrial corrosion found in practice is underestimated by laboratory studies in simulated environments.

Unique facilities were developed to allow creep crack growth to be measured on either compact tension test-pieces or notched components under the combined conditions of stress and very high

hydrogen pressure such as those occurring in the petrochemical industry. A model predicting the creep behaviour of steels for steam raising plant has been established and verified.

An ultra high temperature facility was built for testing the high temperature mechanical behaviour of ceramic composite materials (e.g. bi-directionally reinforced ceramic composites) in corrosive environments.

Work on SiC/SiC material, which is potentially applicable to fusion reactors, showed that European industrial SiC/SiC material produced by chemical vapour infiltration will satisfy low activation criteria. However, ceramic breeder materials were found to be reactive in high temperature tests, towards the SiO₂ content of SiC/SiC composites. The thermal fatigue lives of first wall components, manufactured with welded and brazed segments, were found to be a factor 5 below that estimated using nuclear codes. In contrast, components with cracks produced by plasma disruption simulation with electron beams have shown to have fatigue lives at least one order of magnitude more than that foreseen by fracture mechanics.

- **High Flux Reactor**

The High Flux Reactor (HFR) at Petten was operated at close to 100% of the scheduled operation time and the irradiation capacity was used to about 60%.

The topical sectors of utilised capacity remained largely unchanged with respect to 1992, i.e. 40% for materials and fuel irradiations for fission reactors and for fusion applications, 30% for radioisotope production mainly for medical applications, 12% for exploratory R&D dealing with Boron Neutron Capture Therapy; neutron radiography, activation analysis and silicon doping at low scale absorbed the remaining irradiation capacity.

- **Community and External Services**

A considerable effort was invested in the performance characterisation of new and/or improved mechanical testing methods for advanced materials. This prenormative research has also resulted in improvements to equipment such as prototypes of a high temperature radiant furnace, of a laser extensometer, and of an advanced pyrometer. These improvements are now being transferred into commercially available products.

The IAM was strongly involved in an interlaboratory prestandardisation testing programme on advanced ceramics/composites/coatings. European workshops on standardisation of test methodologies for ceramics corrosion and mechanical testing were also organised.

A study on the corrosive degradation of automobile catalyst systems enabled improvements in the catalyst/washcoat/support system to be formulated. Technical advice was provided to DG XI (Environment) and DG III (Industry), in the formulation of Commission directives on ceramic catalyst supports and ceramics standards.

Third party contract work increased during 1993 and now constitutes about 10% of the budget of the Institute. Contracts were obtained from the energy sector for materials development. Contracts for the High Flux Reactor related to the production of radioisotopes, used in medical and industrial applications, and for the nuclear irradiation of structural materials.

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

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

- **Working Environment**

The activity on cognitive ergonomics and organisational factors was centred on experimental and field research in the working environment of air traffic control. Studies on new technologies for safety at work were focused on analysis of human-machine interactions, modelling of integrated control in complex domains, research on human reliability and development of simulation models of human supervisory control. Identification and diagnostics of real industrial processes has been carried out by the computer code TREE, previously developed.

- **Measurement and Testing,**

In the area of reliability modelling of structures, the development of a portable electronic speckle pattern interferometer was completed. The optical method for stone surface diagnostics during salt crystallisation was tested and the development of standards for the application of acoustic emissions to aeronautic materials was pursued. Improvement of the interferometry technique by pulsed laser and tests of two high sensitivity interferometric sensors for weak gradient temperature measurements, were also carried out.

The new methodology previously developed to assess high cycle fatigue damage in metallic structures was tested for deterministic loading conditions.

Prenormative research in photovoltaic systems was pursued with the development of a fast, sampling flash radiometer and of thin film reliability test procedures. Annealing tests of light induced degradation on thin film large area amorphous silicon modules were performed. Work to integrate large area facade modules in new facilities was continued as well as the contribution to standards organisations, namely International Electrotechnical Commission and Deutsches Komite für Elektrotechnik.

- **Environment**

In the area of industrial risk, the application of decision support systems to the management of hazardous wastes has been pursued and a first experiment with multi-media decision support systems has been made together with studies for integration of geographic information system with decision support techniques. Plant safety and reliability studies have been also pursued, with the participation to TOMHID, a STEP (Science and Technology for Environmental Protection) project for the identification and screening of hazards in socio-technical systems, and to FORMENTOR, a EUREKA project aiming to develop real time operator decision support systems for on-line use in the control of complex hazardous plants. Applications of the STARS (Software Tools for the Analysis of Reliability and Safety) integrated software system to specific cases have also been performed. Finally, a new activity on safety critical computer systems has started.

In the area of remote sensing techniques, the feasibility phase of the Centre for Earth Observation (CEO) was completed and the pathfinder phase started.

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

In the area of safeguards and fissile materials management, a mobile robot for remote verification in storage areas and an active video vision system triggered by scene change detection were developed. Thermal, humidity and mechanical tests were performed in the Laboratory for Surveillance and Containment (LaSCo) as well as sensor studies and investigation on integrated systems of video surveillance with other sensors. Development and on-site applications of sealing techniques have been pursued. An international patent on ultrasonic sealing and identification bolts has been deposited. Needs for the TANK MEasurement laboratory (TAME) were specified and data for nuclear power plants and materials, including those from Former Soviet Union, have been collected.

Fission reactor safety studies proceeded by application of the living Probabilistic Safety Assessment (PSA) technique in complex plant reliability and safety models, as the STARS computer system, and by implementation of the DYLAM-TRETA code package for reliability assessment by dynamic event tree techniques. Experiments on the pressurised thermal shock test rig were completed. The knowledge

based system (BOSS - Backtracking and Overviewing for Structural Safety) was linked with that for data acquisition from the monitored structures and material damage data storage.

In the area of thermonuclear fusion, the work in support of the design of a blanket handling device for the Next Step (NET/ITER - Next European Torus/International Thermonuclear Experimental Reactor) machine was pursued in the ROBERTINO facility by combined computer simulation and experimental validation on 1/3 mock-ups.

Electromagnetic forces occurring in blanket attachment locks of the Next Step in case of plasma disruption were calculated and validation tests of damping effects on magnetically induced vibrations started. Envelope post-accidental temperature, transient analysis for the Next Step and for a power reactor, as well as classification studies of activated wastes were also carried out.

- **Community and External Services**

Image processing and laser range finder were applied for design information verification, thermal mechanical tests for containment and surveillance, installation of ultrasonic sealing-bolts in Sellafield plant of BNFL and volume tests in mini-TAME (in support of DG I on nuclear safeguards for IAEA).

The new parallel computer CONCERTO was implemented and a software for remote sensing applications (SPACE) was tested (in support of DG III).

The pilot of an European coordination centre for aircraft incident reporting systems was developed (in support of DG VII).

The Community Documentation Centre on Industrial Risk (CDCIR) and that for biotechnology safety and regulation (BIOSAFE) were operated. The work on the civil protection pilot information system was completed. Assistance on nuclear safety started (in support of DG XI).

Studies also concerned the area of holograms synthesis, interferometry, tagging / sealing and solar techniques (in support of DG XIII for valorisation of European research and for technology transfer).

Several works as the realisation of video surveillance systems for computer aided recording and reviewing (CAVIS/CARES), the production of sealing bolts and the development of transport and training computerised information archives were implemented (in support of DG XVII).

European demonstration project proposals in the area of photovoltaics, thermal, buildings, transport and industry sectors were appraised (in support of DG XVII on solar energy and energy savings).

The ISEI continued to assist the General Secretariat of the Commission for operation and development of the authoring system of the documentation antifraud project and for the computer-aided management of parliamentary petitions.

Connectionist tools were implemented for statistical applications such as typology of European regions or time series of foreign trade statistics (in support of EUROSTAT).

For Third Party Work, calibration and certification tests as well as assistance tests on new photovoltaic devices were performed in ESTI (European Solar Test Installation) under contract with various organisations. Contracts were also won in the areas of risk assessment and nuclear safeguards, in particular in that of sealing bolts.

- **Exploratory Research**

Exploratory research was dealing with various subjects as neural networks for teleoperated vehicles, surface sensors and propagation of solitons.

2.5. The Environment Institute (EI)

The EI is based at Ispra, its activity being essentially focused on the Environment Protection Programme and on the Working Environment Subprogramme. The Institute's scientific and technical effort is also dedicated to support different Commission's services, such as the Directorate General for Environment, Nuclear Safety and Civil Protection (DG XI).

- **Environmental Chemicals**

The European Collaborative Action (ECA) "Indoor Air Quality and its Impact on Man", gathering experts from laboratories in 14 European countries, has continued to review indoor air quality issues and to develop guidance for indoor investigations and the achievement of "healthy" buildings. Particular attention has been paid to the characterisation and the evaluation of sources of organic indoor pollution.

A third updated compact disc version of the ECDIN (Environmental Chemical Data and Information Network) databank on environmental chemicals has been made available.

- **Atmospheric Pollution**

The work in the field of atmosphere-biosphere interactions has concerned the potential contribution of vegetation emissions in the Mediterranean basin to the tropospheric ozone formation and to the global change. The JRC also acted as a coordinator of an European project on Biogenic Emissions in the Mediterranean Area (BEMA). A preliminary measuring campaign in May/June 93 at Castel Porziano near Rome has been joined by 12 scientific laboratories from different European countries. The measurements have been focused on the estimation of VOC (Volatile Organic Compounds) fluxes from selected ecosystems including the comparison of enclosure- and micrometeorological-methods.

The European IGAC (International Global Atmospheric Chemistry) Project Office (EIPO) has been established at Ispra to coordinate European participation in IGAC and to promote links with the CEC Environment Programme.

Laboratory, field and modelling studies of the chemistry of sulphur products in the marine troposphere, of their conversion into particles and the impact of the aerosol formation on the radiative properties of the atmosphere have been pursued and extended. Data collected during a campaign across the North-Atlantic in autumn 1992, have been analysed in order to assess the role of natural and anthropogenic sulphur in the area covered.

The plans for an Aerosol Characterisation Experiment (ACE-2) in the North-Atlantic were accepted as an International (Europe-USA) experiment within the IGAC Project.

The data collected in the atmospheric tracer campaigns carried out in 1989-1991 and 1992 (in Baden-Württemberg) under the EUREKA programme TRACT/TRANSALP (Transport of Air Pollutants over Complex Terrain/Transalpine Transport of Air Pollutants) have been assembled in a data base, which is available to the TRACT modellers for model verification.

Laboratory studies of the tropospheric oxidation mechanisms of biogenic and anthropogenic emissions have been continued in the frame of the Joint CEC/EUROTRAC LACTOZ project. Focus has been maintained on the nighttime chemistry and the role of the nitrate radical, NO_3 . Further insight into the mechanism of alkene (isoprene) - NO_3 reactions leading to epoxide formation, has been gained in collaboration with the University of Kiel. The generation of toxic nitro-compounds in the reaction of aromatics (methylarenes) with NO_3 has been evaluated in a cooperative research with the University of Milano.

The EI has contributed, together with four European laboratories active in LACTOZ, to a joint project aiming at the development of a large outdoor smog chamber. This tool will significantly enlarge the

range of experimental facilities at the disposal of European researchers for studies of kinetics and mechanisms of atmospheric reactions.

The analysis of trends and episodes of tropospheric ozone in the Alpine region has continued. Peroxyacetylnitrate (PAN) is now regularly measured, simultaneously with the ozone level, to characterise the photochemical components appearing in surface ozone episodes.

- **Soil and Water Pollution; Waste**

The field scale verification of laboratory-derived models of contaminants spreading in terrestrial and aquatic systems has progressed in cooperation with the "Universidad Politécnica de Cataluna" in Barcelona. The validity of the ground water tracing with ⁷⁹Br has been demonstrated.

Non invasive spectroscopic measurements at soil/water interface by means of X-ray synchrotron radiation have been used for investigating the transport behaviour of Se in field migration experiments.

The handbook on toxin detection, environmental monitoring and therapies to counteract intoxications connected with mycotoxins development in algal blooms, has been updated.

A number of interlaboratory exercises with the participation of laboratories of the Member Countries have been organised to assess analytical errors in water analysis.

In the frame of the EUROENVIRON Project, the EU-674 subproject (mobile analytical laboratory) has progressed steadily. Soil interlaboratory comparison has been launched and the preparatory campaign at Brembate (Bergamo - Italy) has been defined.

- **European Chemical Bureau (ECB)**

The ECB which is established within the EI since January 1st 1993 (Communication from the Commission to the Council and the European Parliament, O.J. C1, January 5, 1993), is carrying out the scientific and technical work for the implementation of EC legislation for the control of chemicals, i.e.: classification and labelling of dangerous substances, notification of new substances, testing methods, existing chemicals, export/import control, etc.

The European Chemicals Inventory Database (EUCLID) database has been made operational and a number of Harmonized Electronic Data-set discs from chemical industry and from importers has been processed and registered.

Some 15 meetings of experts of the Member Countries have been organised and hosted to deal with the above issues.

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

The ECVAM has been formally created by a Commission decision and a communication to the Council and European Parliament, SEC (91) 1794. The ECVAM is providing a support for DG XI in relation to all aspects of Directive 86/609/EEC on the protection of animals used for laboratory experiments. Work focused on the development, pre-validation, formal validation and scientific and regulatory acceptability of non-animal procedures and tests, test batteries and testing strategies, as replacements for the currently accepted animal procedures and tests.

- **Working Environment**

Within the framework of the EUROENVIRON project, the TRACT subproject (EUROENVIRON EU/618) continued the systematic collection and critical evaluation of the published information concerning trace metals in human tissues and fluids for the derivation of "reference values". Work is done in cooperation with the International Commission on Occupational Health and the International Union for Pure and Applied Chemistry.

- **Community and External Services**

- Organisation and execution, by means of the calibration bench of the JRC Ispra Central Laboratory of Air Pollution, of the second intercomparison exercise for nitrogen dioxide (NO₂) measuring procedures, especially addressed to laboratories of South-European countries;
- coordination of the weekly air sampling in some EMEP (European Monitoring and Evaluation Programme) stations located in the Mediterranean basin for the control of VOC;
- implementation of a campaign of air quality in Brussels in close collaboration with DG XI/A3 and Municipal Environmental Authorities;
- development and management of data banks on radiological contamination of the environment and occupational exposure of nuclear plants operators;
- preparation on CD-ROM (Compact Disk Read-Only-Memory) of a first pilot version of the EC databank on pharmaceutical products (ECPHIN) in support of DG III;
- preparation of coding/decoding software for rapid exchange of information within the EC in case of radiological emergency (ECURIE - Radiological Information Exchange System).

The European Atmospheric Tracer Experiment (ETEX), aimed at evaluating the quality of atmospheric models when used in emergency conditions, met an unexpected success of participation, with 23 countries participating to the first dry run, held in spring 1993.

Work performed for DG VI (since 1987), concerning the NMR control of wine (sugaring, watering, data bank, etc.), has led to the creation of "The European Office for wine, alcohol and spirit drinks".

2.6. The Institute for Remote Sensing Applications (IRSA)

Located at Ispra, the IRSA executes the programme on the Application of Remote Sensing Techniques. The Institute provides a major scientific support for the utilisation of remote sensing data in 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**

The Collaborative Programme for the development of remote sensing techniques to monitor less favoured areas of the European Community has been transformed into a project on integrated ecological mapping. This has resulted in a number of new initiatives:

- the development of a new project on European forest ecosystems, entitled Forest Information from Remote Sensing (FIRS);
- the development of operational methodologies for the mapping and the monitoring of land degradation in Mediterranean regions using data from satellite and airborne sensors, including high resolution imaging spectrometers. This work, inspired from a previous project undertaken in southern France on land use mapping, is currently being tested over sites in Greece and Spain.

In support of these activities, data interpretation was carried out by newly developed techniques including neural networks, expert systems, integrated geographical information systems and automatic image segmentation.

- **Global Change**

As a contribution to the worldwide effort to understand and predict changes in the global environment, the IRSA has continued to develop techniques to derive relevant information from earth observation data.

Continental scale data sets for Africa and Asia have been collected and processed in order to evaluate continental scale vegetation processes on a multi-temporal basis. The results were used as input into climate models. New techniques have been developed to derive information from these data. In this respect, a new vegetation index, the Global Environmental Monitoring Index (GEMI), has been developed.

Global change research has also considered the marine environment. Particular emphasis has been given to the development of techniques to measure sea surface temperature and primary productivity via ocean colour and to assimilate these data in numerical models

- **Advanced Techniques of Earth Observation**

The evaluation and promotion of advanced techniques of earth observation have continued. Polarimetric radar data collected from airborne campaigns have been analysed and correlated with high spectral resolution optical data, with the objective of the campaigns being to obtain a better understanding of forests and their evolution.

In addition, two ERS-1 (European Remote Sensing Satellite Nr 1) projects are being undertaken :

- the International Forest Investigation project which is evaluating the potential of satellite borne Synthetic Aperture Radar (SAR) data to map and monitor forests;
- an ERS-1 Pilot Project which is evaluating the capability of the SAR data to provide information on European agriculture in terms of surface and yield.

The calibration of the European Microwave Signature Laboratory (EMSL), a facility for measuring the signatures of a range of natural and man-made targets, was completed in 1993. In addition, a Call for Experiments was distributed to European laboratories and an experiment plan formed, overseen by an Advisory Committee of internationally recognised experts.

Finally, a new programme has been initiated that explores the performance of high spectral resolution data in order to derive geophysical parameters, with particular reference to forestry and agriculture applications. This will use laboratory, field and airborne data as input.

- **Community Services**

Work continued on the observation of the upwelling area off the North West African coast. Data from a sea truth collection campaign undertaken in 1992, as well as satellite derived sea surface temperature and ocean colour data were analysed to assess the marine productivity in this area. These data are being used to validate the ongoing work on the derivation of chlorophyll maps from satellite data and the modelling of the hydrodynamics of the upwelling area (in support of DG I).

In the pilot project for the application of remote sensing to agricultural statistics, Action 2 (monitoring the condition of vegetation on a continental scale using low spatial resolution satellite data) has concentrated on the routine processing of satellite data. Action 4 (rapid estimates of change in acreages and potential yield) has taken into account 53 sites across Europe, from which biweekly facsimiles showing the current estimate of areas under crop are forwarded to DG VI and EUROSTAT.

The work for the "Fond Européen d'Orientation et de Garantie Agricole" (FEOGA) of DG VI has concentrated on the establishment of olive tree, vineyard and citrus registers.

Techniques were developed to monitor and characterise vegetation patterns, and particularly biomass burning, at continental scales. This was supported by a field campaign in southern Guinea and the collection and processing of continental scale earth observation data sets. From this work, a new project entitled "Fire In Global and Environmental Monitoring (FIRE)" has been developed to map and to monitor fire events on a continental or sub-continental basis (in support of DG VIII).

The Ocean Colour European Archive Network (OCEAN), a joint project with the European Space Agency (ESA), has prepared all facilities and tools required for the processing and archival of the Coastal Zone Color Scanner satellite data. In addition, an Application Development Programme for the exploitation of the data, incorporating more than 30 European laboratories, has been initiated. Linked to this, a new programme, the Ocean Colour Techniques for Observation, Processing and Utilisation System (OCTOPUS) project, for the utilisation of data from the Sea viewing Wide field of view Sensor (SeaWifs) has been initiated with ESA. Work was also undertaken to investigate the use of remote sensing in the revision of the CORINE (Coordination of Informatics on the Environment) land cover map using computer aided interpretation, plus semi-automatic and automatic updating techniques (in support of DG XI).

- **External Services**

The Tropical Ecosystem Environmental Observations by Satellites (TREES) project (a joint project with ESA) has established a base line inventory of tropical forest cover using data from the Advanced Very High Resolution Radiometer (AVHRR) sensor. In addition, the first data from the ERS-1 SAR have been received and are being evaluated.

For the European Airborne Remote Sensing Capability (EARSEC - a joint project with ESA), work progressed satisfactorily. This included contracts for the development of an advanced airborne imaging spectrometer, the improvement of an existing airborne SAR and the development of systems for the processing of both the SAR and spectrometer data, amongst others.

A Third Party Work contract was won from a French organisation to establish a network of Mediterranean regions for the timely monitoring of available water resources, including the creation within each region of Water Resources Monitoring Units.

The EUREKA/EUROMAR project VISIMAR (Visualisation and Simulation of Marine Environment Processes) has produced an animation system that shows the dynamic behaviour of geophysical processes as derived from remote sensing and mathematical modelling data. The project entered its final phase and was concluded in 1993.

2.7. The Institute for Safety Technology (IST)

Located at Ispra, the IST contributes to the Measurement and Testing, the Nuclear Fission Safety and Fusion, and to the Environment Programmes. The Institute is engaged in several support activities at the request of 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 study of severe accident phenomena, an area where public perception of risk is high and international cooperation is important, has been the subject of activities related to the FARO and the joint CEA/JRC Phebus Fission Products programmes.

Concerning FARO, tests simulating on a large scale, in-vessel phenomena during severe accidents have been carried out on molten fuel quenching in water, after an extensive facility modification.

In relation to Phebus-FP, the preparations for the first test, involving fuel melting and release of fission products in a simulated reactor containment, have been completed with the collaboration of the CEA in the following order: introduction of new shroud parameters and other design modifications, execution of analytical recalculations, production of the final test protocol, post-test examination, and the test itself performed in 1993.

The IST continued, in collaboration with many European institutions, the development of the ESTER (European Source Term Research) computer code package; it is designed to become the European best estimate code for the calculation of source term in severe accident scenarios. ESTER will be applied to the post-test analysis of the first Phebus-FP tests.

- **Fusion Technology**

Verification and testing of safety relevant system in the European Tritium Handling Laboratory (ETHEL) has continued under the supervision of the Italian Regulatory Authority (ENEA/DISP), in the perspective of the Nuclear Testing in 1994.

The assembly of two experimental loops in ETHEL glove-boxes, the testing of their components and systems, and the acquirement and the assembly of components for another experimental loop have been achieved in view of Tritium research activity.

Preparatory research activities using hydrogen and deuterium have also continued.

The cooperation between the IST (ETHEL facility) and the German Kernforschungszentrum, Karlsruhe, (KFK) (TLK facility) continued and a third workshop has been organised to discuss progress achieved on preparatory research activities for their respective facilities.

The EURATOM Safeguards Directorate and the joint ETHEL/TLK task force pursued discussions on the elaboration of a common tritium control methodology specifically applicable within these two civil tritium facilities.

- **Working Environment**

The Ventilation and Pollutant Transport Modelling project has progressed via the refinement of the computer code TRAFU (e.g. introduction of a transport equation for the computation of product concentration, modification of the turbulence model mainly related to the discrete representation of the boundary conditions, etc.).

- **Measurement and Testing**

The new reaction wall facility (ELSA) is being used for prenormative research in support of EUROCODE 8, the provisional European standards for the design of civil engineering structures in seismic areas. This activity performed within a scientific network under the Human Capital and Mobility programme, aims to enlarge the current field of application of EUROCODE 8 and improve its reliability. A 4-storey reinforced concrete structure has been constructed and tested at the ELSA reaction wall under simulated severe earthquake loading. In parallel, preparatory work has been performed to test a large-scale model of an irregular bridge using the so-called substructuring technique. This technique allows to limit physical testing of a complex structure to its critical parts (i.e. those which are expected to undergo severe deformations), the rest of the structure being modelled by a computer code running in parallel with the experiment.

As a part of the ongoing research in collaboration with the European Association of Structural Mechanics Laboratories, a large steel/concrete composite structure designed according to EUROCODE 8 will be tested in 1994 with the view of comparing its actual behaviour against the intended design behaviour. The ELSA team has also contributed to the COST C1 project, the European Concerted Action on Control of semi-rigid behaviour, of civil engineering structural connections.

- **Industrial Hazards**

The focus of this work was on the assessment, improvement and harmonisation of safety methodologies.

The Facility for Investigating Runaway Events Safely (FIRES) was operated to study the safety of batch aromatic nitrations in order to develop advanced methodologies for the determination of safety conditions, process optimisation, process control and early warning detection of runaway initiation.

Commissioning tests are now underway on the new large-scale DRACULA (Depressurisation, Relief and Containment Using Large Apparatus) venting facility, and commissioning of the COLUMBUS facility (venting of long horizontal vessels) is expected to start by the end of the year. Experimental data and design methodologies based on the previous MPMC (Multi-Phase Multi-Component) facility have contributed to the work of a number of international working groups (ISO Technical Committee 185, DIERS/Design Institute for Emergency Relief Systems and DECHEMA "Deutsche Gesellschaft für chemisches Apparatewesen, chemische Technik und Biotechnologie, e.V.").

The emergency pressure relief computer package RELIEF is ready for use and validation against experiments. A model describing the runaway/venting of high pressure (supercritical) catalyst bed reactors has been completed.

In the field of dense gas dispersion, a three-dimensional computer code is under validation, the extension of the one-dimensional shallow layer model into two-dimensions being under progress.

A two-dimensional computer code for the numerical simulation of combustion and explosion processes, currently under development, showed a high resolution prediction capability.

- **Community and External Services**

The IST has continued to provide a scientific and technical support to the Directorate General for External Relations (IAEA) and the EURATOM Safeguards Directorate (ESD) in the field of nuclear safeguards.

An intense programme of training courses and calibration exercises has been performed in PERLA to meet and satisfy the Commission policy related to nuclear safeguards in fuel fabrication facilities.

Instruments for Non Destructive Analysis techniques and related data evaluation methods have been developed and tested for being applied by IAEA inspectors.

Development of industrial size volume calibration and measurement techniques for reprocessing plants in support of the Euratom Safeguards Directorate has also continued at the TANK MEasurement (TAME) Laboratory. TAME, which is a large scale multitank laboratory, has become fully operational in 1993. Studies on the accurate bulk volume measurement have been performed in the key points of typical reprocessing facilities where such measurements are usually made for the fissile material balance/accountancy purposes.

- **Exploratory Research Activities**

Several activities covered long-term environmental problems like radioactive waste management, iron production using hydrogen, and atmospheric circulation models.

2.8. The Institute for Prospective Technological Studies (IPTS)

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

Work on the development of ESTO (European Science & Technology Observatory) aims at the realisation of an information system on current-research in Europe. Data collected in the 1992 survey from sources of information on R&D projects were analysed and made compatible with the Commission's recommended standard, CERIF. User requirements and a feasibility study concerning the implementation of an intelligent interface for this information system were completed.

Following the study on the Competitiveness of European Space Industries, the IPTS worked out a study on future Space Markets whose scope was :

- to describe space markets according to a number of criteria: competitiveness, transition, potential captive markets;
- to provide, for each class of application, an estimation of the current size of the market and its potential for growth;
- to evaluate the competitive position of the European Space Industry.

The second phase of a study initiated in 1991, concerning the Electrification of the European High Speed Train Network, was completed. The scope was :

- to perform in-depth evaluations of the relative merits of three competing electrification systems;
- to execute techno-economic modelling of the future growth of international traffic throughout Europe;
- to forecast demand for high-speed rolling stock in different regions (in support of DG for Industry).

Activities in support of the Forward Studies Unit of the Commission concerned industrial and environmental problems, including global change aspects. Work related to market-based approaches for environmental protection focused on least-cost solutions for achieving environmental quality targets, and on barriers to business acceptance of market-based instruments. The report "The Environmental Business", reviewing the activities of the Institute in this field over the last three years (case studies, employment impacts, market-based instruments), was completed and issued. The survey of global change research and policy began in 1991, and continued in 1993 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 response policies.

In the field of environmental protection, the IPTS has also made a proposal for the establishment of an "Observatory in BAT developments" (BAT-Best Available Technologies). A contribution concerning steel coil coating technology will serve as a prototype for further BAT exercises. A standardised annex on prospective technologies in all other BAT technical notes is being considered. Concerning the evaluation of environmental projects and programmes, another study based on an extensive literature review, complemented by interviews with experts and attendance at specialised conferences and workshops, has resulted in a catalogue of the various methods and techniques currently applied in the evaluation of environmental effects, together with a preliminary assessment of the strengths and weaknesses of each approach (in support of DG for Environment, Nuclear Safety and Civil Protection).

As a contribution to the study of long-term energy scenarios, work in support of the DG for Energy involved the review and the assessment of energy technologies which may become available in the long term (year 2020 and beyond). Three technologies were initially taken into consideration:

- the first study on the evolution of fuel cells technology which was completed in September 1993, has allowed the definition of many criteria of interest: the specifications of the prevailing system configurations, the approximate dates for their commercial availability, the operational parameters, the expected investment/operating costs, the areas of application, the impact on the environment, etc.;
- the second study aimed to identify the current status and the possible evolution, on a mid-term horizon (year 2020), of technologies for CO₂ separation, storage and/or sequestration. These technologies could become "a must" for preventing the increase of atmospheric CO₂ concentration, as a result of fossil fuel combustion, if the greenhouse effect is confirmed as a severe threat to the Earth's climate. The emphasis was placed upon forecasting the possible future range of the technological and economic parameters (efficiency, energy intensity, investment and operating costs, etc.) controlling the accession of these technologies to the energy technology market, as inputs to energy scenarios;
- the third study dealt with nuclear fission reactor and fuel cycle data. A preliminary survey of the state of the art of the fuel fabrication and recycling, and of prospects for improvements in the reprocessing plants has been carried out in order to set a background for the introduction of advanced reactors into the nuclear energy system.

Numerous seminars or workshops, involving the participation of external experts, were organised during 1993 in connection with the above studies.

3. HUMAN RESOURCES

3.1. Staff Policy

The JRC authorised statutory staff ceiling amounts to 2080, including both scientific-technical and administrative staff.

JRC statutory personnel is governed by the 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 4 gives the distribution of the JRC officials and temporary agents present at the JRC on 31 December 1993, by Directorates and Institutes. Until December 1993, 80 people of these two categories left the JRC and 54 people were recruited.

Table 4

Distribution of Statutory Staff

Location	Staff
<i>Directorate General</i>	21
<i>Programmes Directorate</i>	18
<i>Resources Coordination - Scientific & Technical Support</i>	397
<i>Institute for Reference Materials and Measurements</i>	170
<i>Institute for Transuranium Elements</i>	192
<i>Institute for Advanced Materials</i>	261
<i>Institute for Systems Engineering and Informatics</i>	213
<i>Environment Institute</i>	196
<i>Institute for Remote Sensing Applications</i>	91
<i>Institute for Safety Technology</i>	292
<i>Institute for Prospective Technological Studies</i>	16
<i>JRC Seconded Staff</i>	8
Total	1875

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 remaining part of the difference corresponds to the necessary margin of flexibility ($\pm 6\%$) 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 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 doctor degree;
- the JRC participates in the Human Capital and Mobility (HCM) Programme and hosts post-doctoral scientists under this programme.

Table 5 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 to 91; furthermore, there are about 18 scientists from third countries working at the JRC on a grant in the framework of a Commission agreement with their countries or with the IAEA. Besides the above mentioned scientists, several senior scientists and about 120 trainees are working at the JRC with no cost to the EC budget, in general for a short period of time.

Table 5

Visiting Scientists, Seconded Experts , Grant Holders on 31 December 1993

Institutes	Visiting scientists	Seconded experts	Post-Doctoral Scientists	Post-Graduate Students	Total
<i>Institute for Reference Materials and Measurements</i>	2	1	9	9	21
<i>Institute for Transuranium Elements</i>	-	-	8	3	11
<i>Institute for Advanced Materials</i>	3	-	24	20	47
<i>Institute for Systems Engineering and Informatics</i>	5	3	12	13	33
<i>Environment Institute</i>	6	3	9	17	35
<i>Institute for Remote Sensing Applications</i>	8	2	12	9	31
<i>Institute for Safety Technology</i>	-	2	13	12	27
<i>Institute for Prospective Technological Studies</i>	2	1	4	5	12
Total	26	12	91	88	217

Furthermore the Directorate General has one seconded expert bringing thus the total to 218.

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 to the Commission for 1993 are as follows :

-	Specific Research Programmes	177.3	MioEcu
-	S/T Support to the Commission	62.1	MioEcu
	Total	239.4	MioEcu

Other resources for HFR operation and third party work are :

-	HFR Reactor	18.5	MioEcu (Supplementary programme)
-	Work for Third Parties	14.1	MioEcu (Budgetary advance)
	Total	32.6	MioEcu

The total amount of the available credits is therefore 272.0 MioEcu.

Details about 1993 commitments are given in Table 6 covering 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 8.11 MioEcu because the amount of orders for such activities did not reach the original target; the unused credits of this advance, of 6.0 MioEcu have been reimbursed to the budget by cancellation.

For exploratory research the budget initially foresaw pm; appropriations have been provided during the year by transfers from the programme lines within the ceiling set by the Council Decisions, and the Financial Regulations.

Table 6

Commitments for Programme Execution 1993
(Rounded figures, MioEcu)

	Personnel	Other Expenditures	Total	Budget 1993
Specific Research Programmes				
Industrial and Materials Technology	17.41	7.52	24.93	25.42
Measurement and Testing	18.09	10.21	28.30	30.04
Environment	31.48	15.57	47.05	48.93
Human Capital and Mobility	0.15	7.54	7.69	8.23
Nuclear Fission Safety	27.63	18.55	46.18	50.93
Controlled Thermonuclear Fusion	8.54	4.91	13.45	13.71
Exploratory Research	5.46	3.10	8.56	pm
Subtotal	108.76	67.40	176.16	177.26
S/T Support to the Commission	33.92	25.44	59.36	62.12
Subtotal	33.92	25.44	59.36	62.12
Others				
HFR Reactor	5.90	11.02	16.92	18.51*
Work for Third Parties (Advance: reimbursable credits)	4.44	3.67 **	8.11***	14.14
Subtotal	10.34	14.69	25.03	32.65
Total	153.02	107.53	260.55	272.03

*) HFR foreseen resources.

**) Specific credits, paid by the contractors in order to perform the work are not included in these figures; they amount to 3.36 Mioecu.
The total volume of contractual work performed in 1993 amounts thus to 11.47 Mioecu.

***) The advance in the budget of reimbursable credits for the execution of work for Third Parties has been committed only to the level of 8.11 Mioecu because the amount of orders for such activities did not reach the original target; the unused credits of this advance, of 6 Mioecu have been reimbursed to the budget by cancellation.

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JOINT RESEARCH CENTRE

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

BCR	Bureau Communautaire de Référence
CEA	Commissariat à l'Energie Atomique
CEN	Comité Européen de Normalisation
DG	Directorate General
DYLAM-TRETA	Dynamic Logical Analytical Methodology-Transient Response Thermal-Hydraulic Analysis
EAEC	European Atomic Energy Community
ECN	Energie Centrum Nederland
EdF	Electricité de France
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
FIRES	Facility for Investigating Runaway Events Safely
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	Kerforschungszentrum Karlsruhe
LACTOZ	Laboratory Studies of Chemistry Related to Tropospheric Ozone
NMR	Nuclear Magnetic Resonance
PERLA	Performance and Training Laboratory (Nuclear Safeguards)
PHEBUS	French In-Pile Programme (Severe Fuel Damage)
PHENIX	French Prototype Fast Reactor
SAR	Synthetic Aperture Radar
SCK/CEN	Studiecentrum voor Kernenergie/Centre d'Etudes Nucléaires
STARS	Software Tools for Analysis of Reliability and Safety

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