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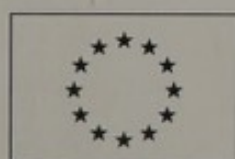
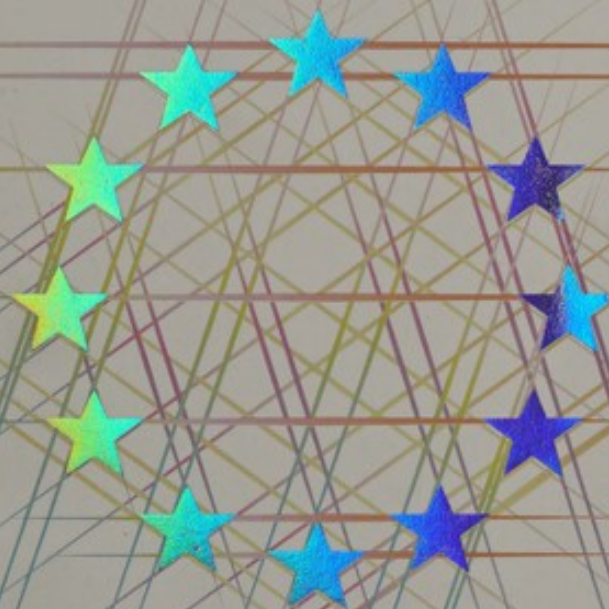
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# JRC93



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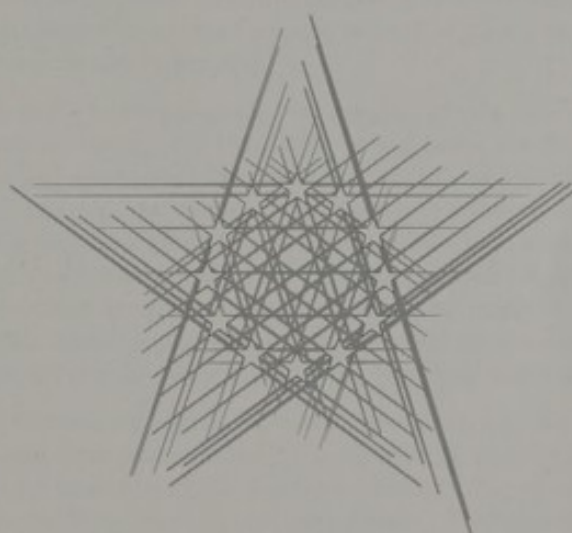
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# JRC93



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## FOREWORD

The Joint Research Centre (JRC) forms an integral part of the European Community's development within the scientific research field. Its multiple activities are at the disposal of the Community as a whole and are conducted in close collaboration with research laboratories and industry in the Member States. These activities include assistance given to the Commission itself, by the provision of services of a specific scientific and technical nature. These services aid the Commission in carrying out the broad spectrum of Community policies for which it has responsibility.

During 1993, the Council of the European Union and the European Parliament, on the occasion of the discussions held on the 4th Framework Programme of Community activities in the field of research, technological development and demonstration, considered new ways in which the JRC could be more closely integrated into the European network of science and technology, than had been the case in the past.

In addition to this forward planning, throughout 1993 the JRC continued the work already set out for the 1992-1994 period under the 3rd Framework Programme and was assisted and advised in this task by its Board of Governors. Emphasis was also put on rationalisation of resources and increasing the overall performance of the Centre. Cooperations with national laboratories and the creation of networks was stepped up, which helped to facilitate the Centre's closer integration within the European scientific community. Progress with regard to new cooperations between the participating EEA/EFTA countries and the JRC's Institutes was also made and is continuing.

Support to Community policies was further developed, with the Commission entrusting long term actions to the JRC. An example of this type of support action was the formation of the European Chemicals Bureau and the European Office for Wine, Alcohol and Spirit Drinks. Furthermore, substantial support was offered to the other services of the Commission in various fields, ranging from agriculture to environmental protection and energy, while respecting the subsidiarity principle.

An evaluation of the outcome, quality and adequacy of the work performed by all of the JRC's Institutes was begun during 1993, with the setting up of independent Visiting Groups and their inspection will continue in 1994 also.

The complete activities of the JRC and its achievements during 1993 are presented in this Annual Report, accompanied by the observations of the JRC Board of Governors. The report bears witness to the many ways in which the JRC fulfills the role given it by the Community and to the progress achieved in developing its scientific and technical competences for the future.

My gratitude is expressed to the Board of Governors for all their help and advice throughout the year and to the Director General, the Directors and the entire staff of the Joint Research Centre for the quality of their work and their contribution to the Centre's success.

A. Ruberti

Member of the Commission

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.

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 forthcoming 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 realises 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 in 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

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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 European Commission, with headquarters in Brussels. Four sites in Belgium, Germany, Italy and the Netherlands house eight different institutes, each with its own focus of expertise.

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

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Materials  
and  
Measurements

Institute  
for  
Systems  
Engineering  
and  
Informatics

Safety  
Technology  
Institute



## 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 JRC financial resources in 1993 amounted to 264 MioEcu and their repartition among the JRC activities is given in the figure opposite.

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. 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. 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.

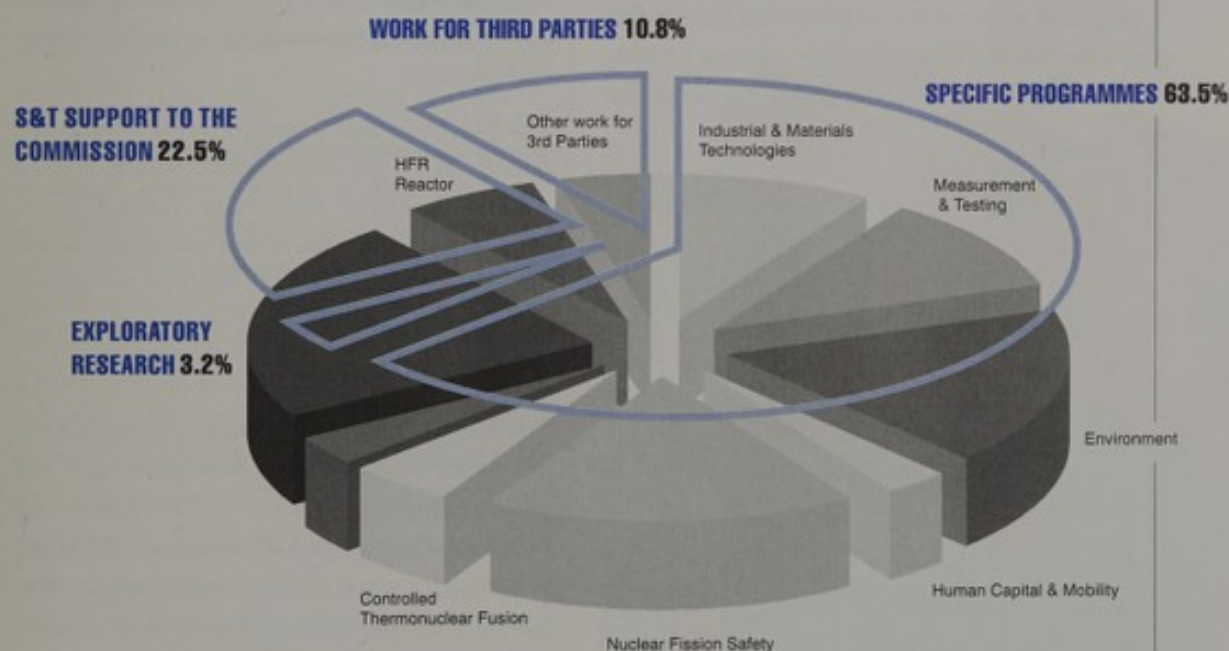
Contractual work performed for external third parties continued to be of a high quality and executed with speed, and the JRC strengthened its marketing efforts both at institute and central level. The volume of new contracts reached a higher level than in the previous year.

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.





## Specific Research Programmes

*The predominant task of the JRC is still its contribution to the implementation of the Framework Programme which accounted for 63.5% 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 (AMES, ENIQ and NESQ) - in which IAM acts as reference laboratory - were launched to integrate European efforts on inspection procedure qualification for heavy duty structural components.

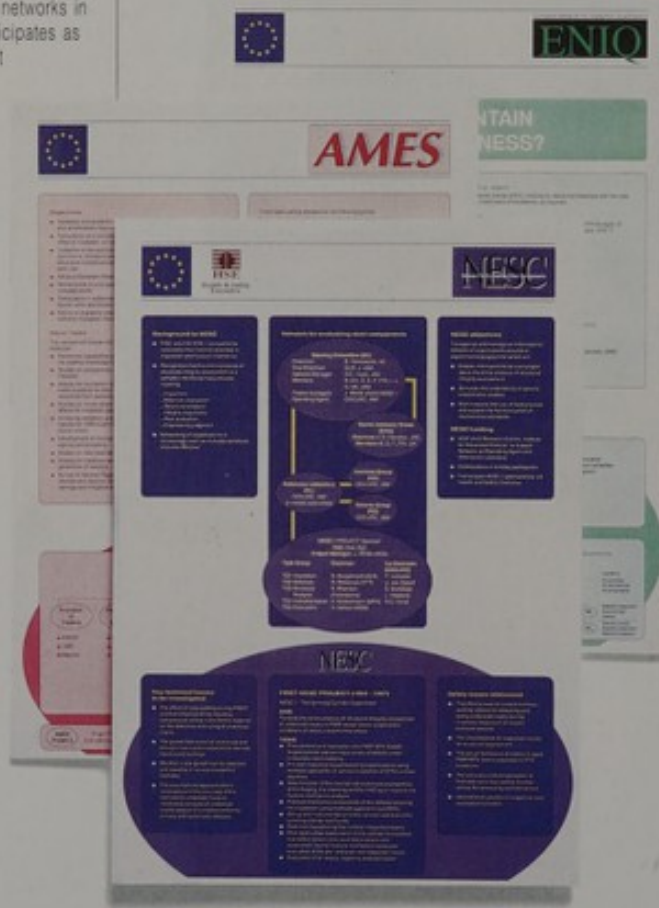
The research on Working Environment at ISEI was focused on models and methods for human error assessment in avionics, air traffic control and chemical industries.

The EI activity was mainly directed towards the assessment of the toxicological impact of trace metals on general and occupational exposed populations. Experiments were started with a new chamber called INDOORTON to test indoor pollution.

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.

European research networks in which the IAM participates as the operating agent





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) of the IST investigated the behaviour of materials and structures to dynamic loading for the design of civil engineering structures in seismic areas, in collaboration with the European Association of Structural Mechanics Laboratories. At the ISEI, a new procedure has been developed for testing the light induced degradation of thin film amorphous silicon modules (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).

The Environment Institute continued its research on atmospheric pollution and global change; these activities were aimed at elucidating the potential contribution of vegetation emission to tropospheric ozone, understanding and modelling the chemistry of sulphur compounds in marine troposphere and the aerosol formation processes, and assessing the transport of air pollutants over complex terrains.

These have been complemented by air laboratory studies focussed on tropospheric oxidation of biogenic and anthropogenic emissions, and on the



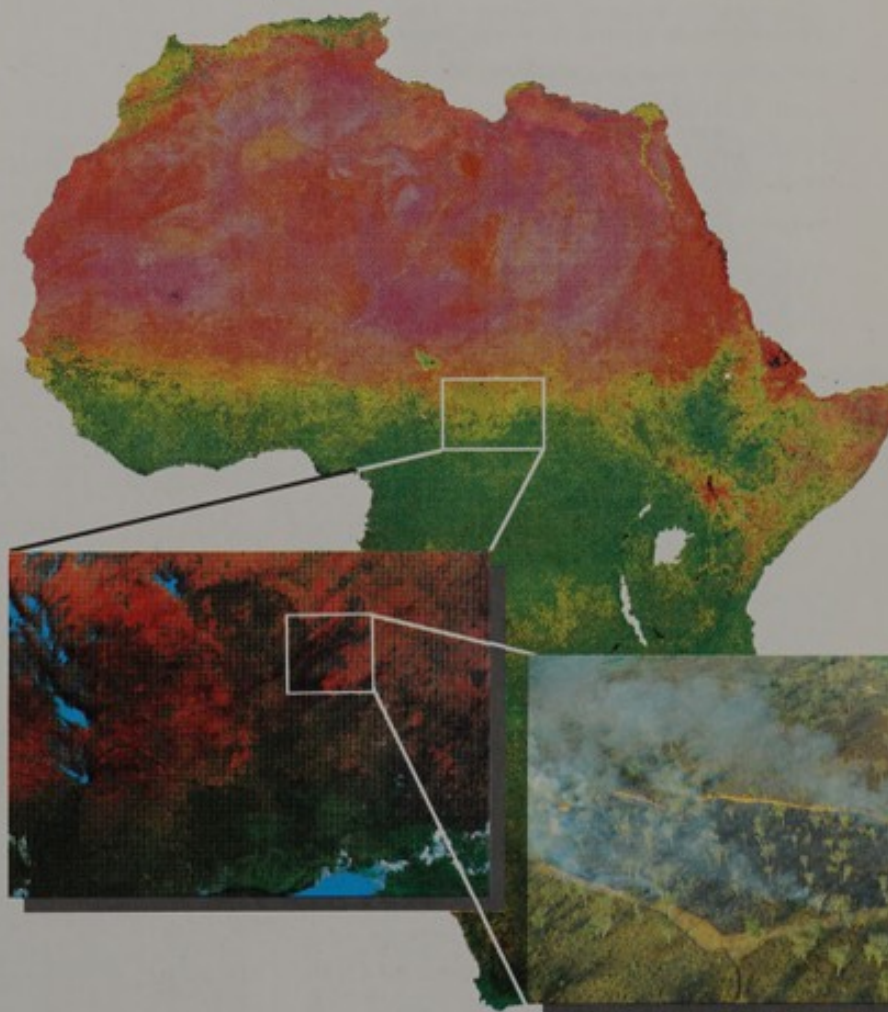
Parts of the JRC cuvette system to measure biogenic emissions of trace gases from oak/pine branches during the BEMA Campaign (June 93 Rome).

Remote sensing of Biomass Burning activity at continental, regional and local levels in the Savannah - forest transition zone of Africa (FIRE project).

characterisation of photochemical oxidants occurring in the course of surface ozone episodes.

In addition, the coordination role has been played by EI both in the experimental campaign of the BEMA project (Biogenic Emission in the Mediterranean Area) involving the participation of 12 national laboratories, and in a measurement campaign across the North-Atlantic as part of an international study on aerosols and climate.

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 has been calibrated and 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 ISEI, the IRSA and the EI examined the setting-up of a Centre for Earth Observation (CEO), whose objective would be to provide an efficient decentralised network for the full exploitation of the earth observation data.

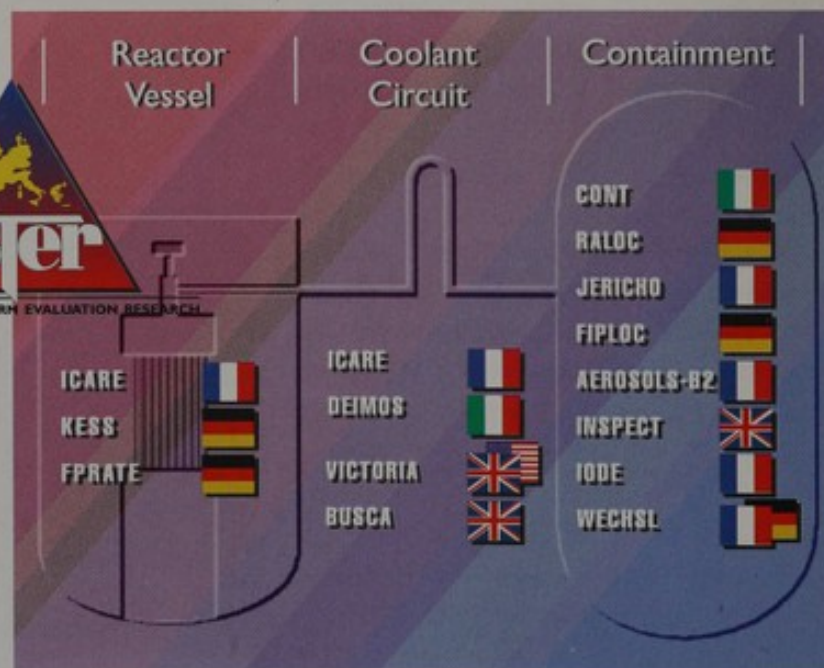
At the IST, the Facility for Investigating Runaway Events Safety (FIRES) has been operating for the study of aromatic nitrations. Studies have been performed to develop and apply to FIRES advanced methodologies for determining safety conditions, process optimisation, process control and early warning 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



IRSA's Optical Goniometer - a facility which measures the Bidirectional Reflectance Distribution Function of various targets of interest for remote sensing.

International codes used by the ESTER group



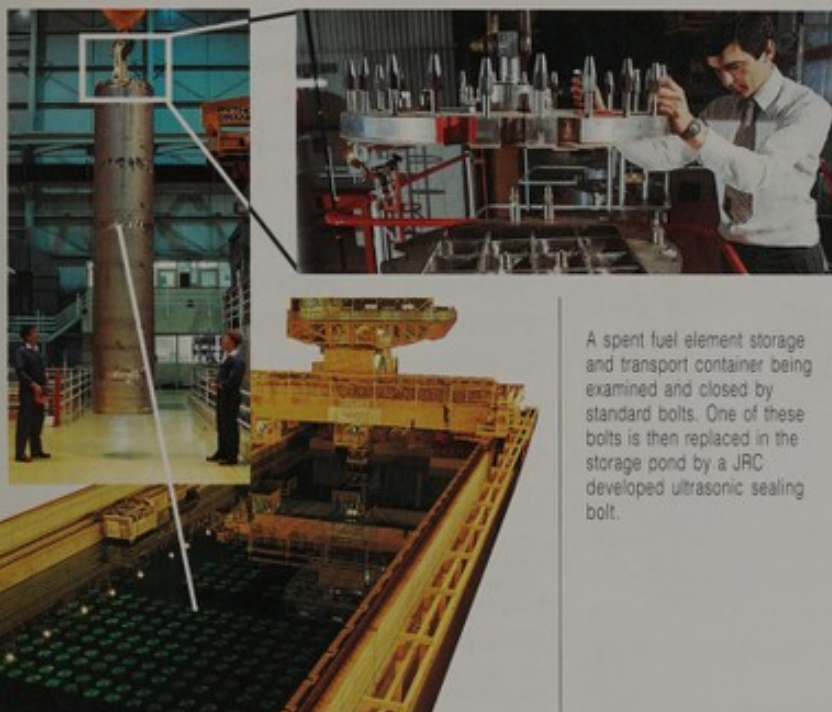
safeguards and fissile materials management, executed by the Institute for Safety Technology and the Institute for Systems Engineering and Informatics (ISEI), and to research activities on nuclear fuels and actinides executed by the Institute for Transuranium Elements (ITU).

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.

In collaboration with many European institutions, the IST continued the development of the European Source Term Research (ESTER) computer code package which 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





A spent fuel element storage and transport container being examined and closed by standard bolts. One of these bolts is then replaced in the storage pond by a JRC developed ultrasonic sealing bolt.

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 by 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.

#### FELLOWSHIP OPPORTUNITIES JOINT RESEARCH CENTRE

*Progress made in the execution of these programmes is reported in more detail in the Chapter dedicated to the activities of the JRC Institutes*





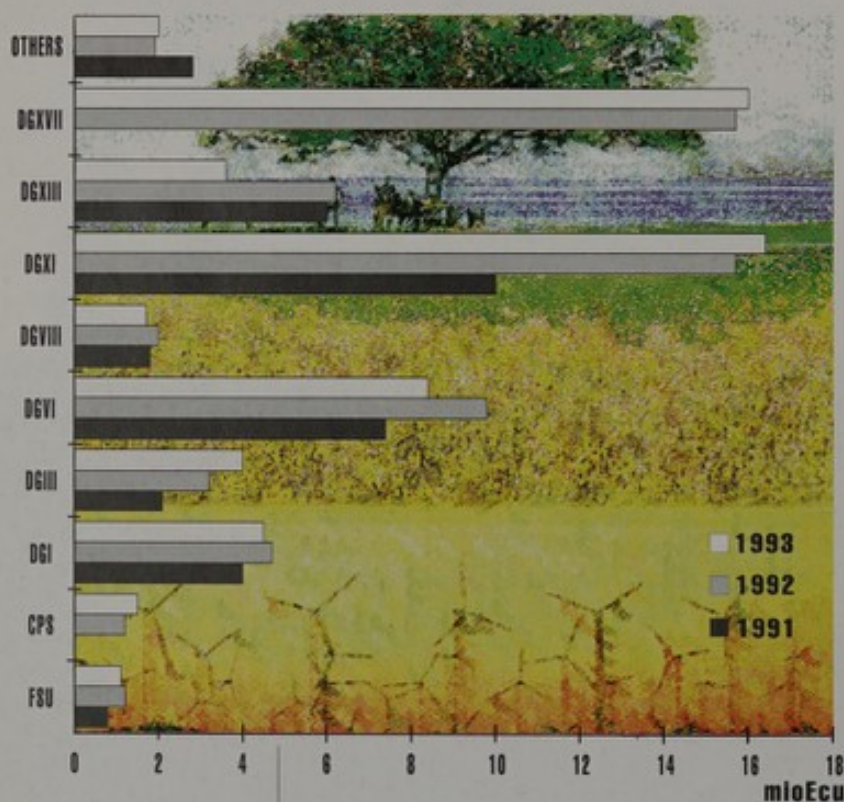
## JRC S&T Support to Community Policies

*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.*

In 1993, the JRC scientific and technical support accounted for 22.5 % of the JRC budget, at the same level as in 1992. The figure below shows European the main sectors concerned were Environment, Energy and Agriculture. Much attention has been paid to provide an effective customer/contractor relationship, as well as a degree of continuity and long-term planning. 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.

Support to the Commission 1993:

FSU Forward Studies Unit  
CPS Consumer Policy Service  
DGI External Relations  
DGIII Industrial Policy  
DGVII Agricultural Policy  
DG VIII Development Policy  
DG XI Environment Policy  
DG XIII Telecommunications,  
Information Market and  
Exploitation of Research  
DG XVII Energy Policy



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

- implementation of EC Directives 80/779 and 85/203/EEC on air quality (SO<sub>2</sub>, NO<sub>2</sub>, photochemical oxidants);
- establishment of the European Reference Laboratory of Air Pollution (ERLAP);

### WASTE MANAGEMENT SUPPORT

- preparation of the European Waste Catalogue (Directive 91/156/EEC) with the co-ordination of a group of independent experts;

### RADIATION PROTECTION SUPPORT

- setting up of the "European Tracer Experiment" (ETEX) to test the validity of atmospheric models, with more than twenty countries participating; the first experiment is foreseen in 1994;

### MAJOR ACCIDENTS SUPPORT

- implementation of EC Directive 82/501/EEC on the accident hazards connected with the industrial activities involving dangerous chemicals;
- investigation of hazards of certain industrial activities such as processing and storage installations for hazardous chemicals.

### CHEMICALS CONTROL SUPPORT

- 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.

Another initiative includes the development of the European Centre for Validation of Alternative Testing Methods (alternative to vivisection).



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 nuclear safeguards 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:

- development and demonstration of 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);
- establishment of 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 (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 the chapter dedicated to the activities of the JRC Institutes.*





## Work for Third Parties

*Besides the operation of the HFR reactor, at the request of the German and the Dutch governments, the JRC has been offering its scientific expertise to other external customers since 1988, totalling a volume of orders of more than 60 Mioecu during the last six years since this activity was initiated.*

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.

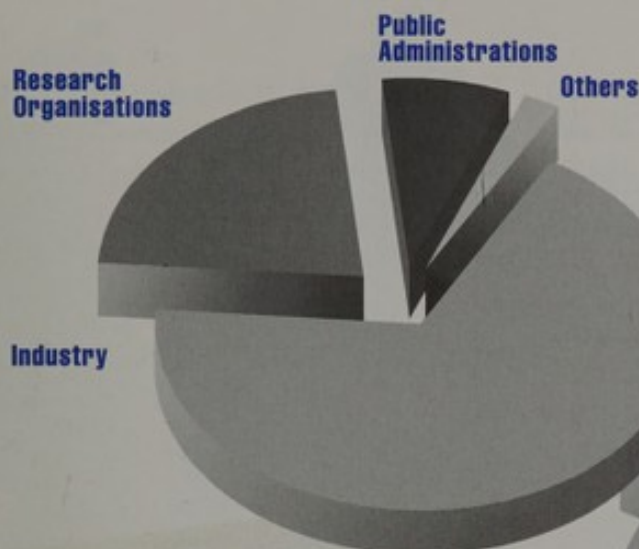
Environment related contracts now being executed at the JRC account for 9% of the total orders executed in 1993, which is an increase of 25% compared with the past year.

The total volume of new orders received in 1993 by the JRC reached the level of 11.7 Mioecu; the evolution of the order book in 1992 and 1993 is given in the bar chart opposite.

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

As in 1992, two Institutes, namely the Institute for Advanced Materials and the Institute for Transuranium Elements are far ahead of 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.





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

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

The bar chart below describes the evolution of Third Party Work orders during the period 1992 - 1993

INSTITUTE FOR SYSTEMS ENGINEERING AND INFORMATICS

**ESTI**

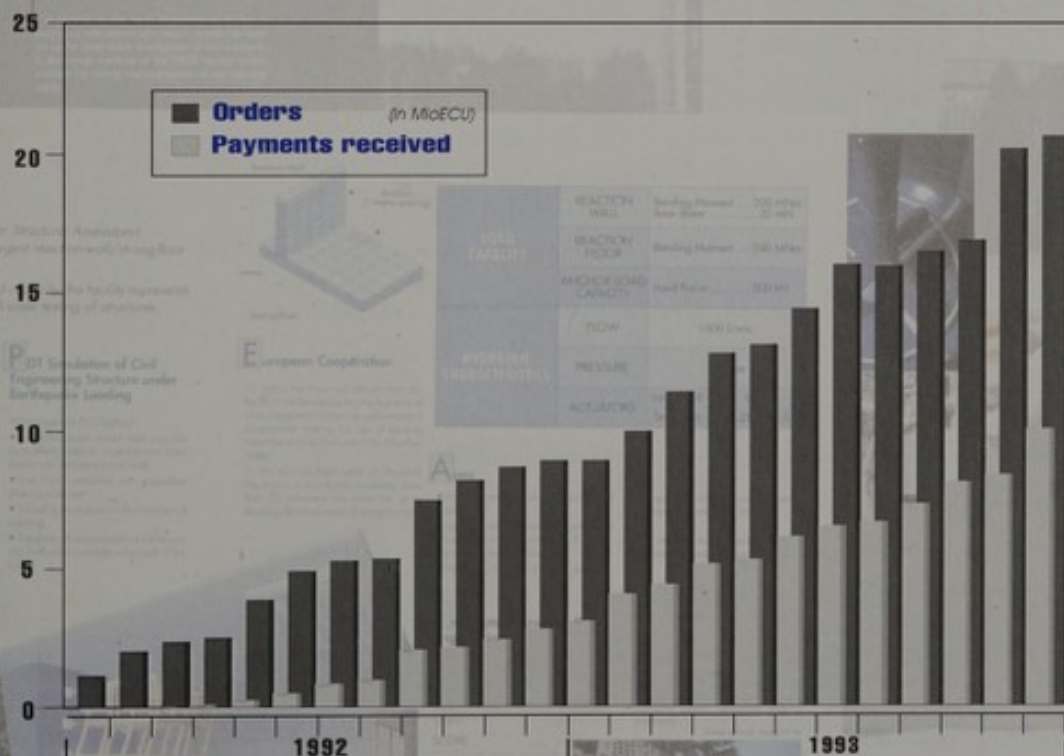
PHOTOVOLTAIC QUALIFICATION TESTING SERVICES

Activities:

every related to the different photovoltaic energy cells, modules and to the solution of problems.

Photovoltaic Modules Qualification and Performance Testing

This process with our facilities, in addition, involves tests to stringent levels designed to test their suitability for all applications considered. The tests comprise temperature cycling, which simulates the day/night stress, high temperature/high humidity stress, resistance to impacts both as hail and man-made stress. An exposure to ultraviolet radiation simulates the radiation dose of many years. The electrical output is tested as well as the module's reaction to simulated full-sun loading, which occurs during events of single cell from full action, whereas previous module is not used in the production of



REACTOR WALL	Reactor Wall	200 mPa
	Reactor Wall	200 mPa
REACTOR FLOOR	Reactor Floor	200 mPa
	Reactor Floor	200 mPa
ANCHOR LOAD CAPACITY	Anchor Load Capacity	200 mPa
	Anchor Load Capacity	200 mPa
FLOW	Flow	200 mPa
	Flow	200 mPa
PRESSURE	Pressure	200 mPa
	Pressure	200 mPa
ACTUATORS	Actuators	200 mPa
	Actuators	200 mPa

REACTOR WALL	Reactor Wall	200 mPa
	Reactor Wall	200 mPa
REACTOR FLOOR	Reactor Floor	200 mPa
	Reactor Floor	200 mPa
ANCHOR LOAD CAPACITY	Anchor Load Capacity	200 mPa
	Anchor Load Capacity	200 mPa
FLOW	Flow	200 mPa
	Flow	200 mPa
PRESSURE	Pressure	200 mPa
	Pressure	200 mPa
ACTUATORS	Actuators	200 mPa
	Actuators	200 mPa

MAJOR UNKNOWN

- Modes of damage failure propagation
- Energy absorption
- Marginal damage



## 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<sup>1</sup> projects.*

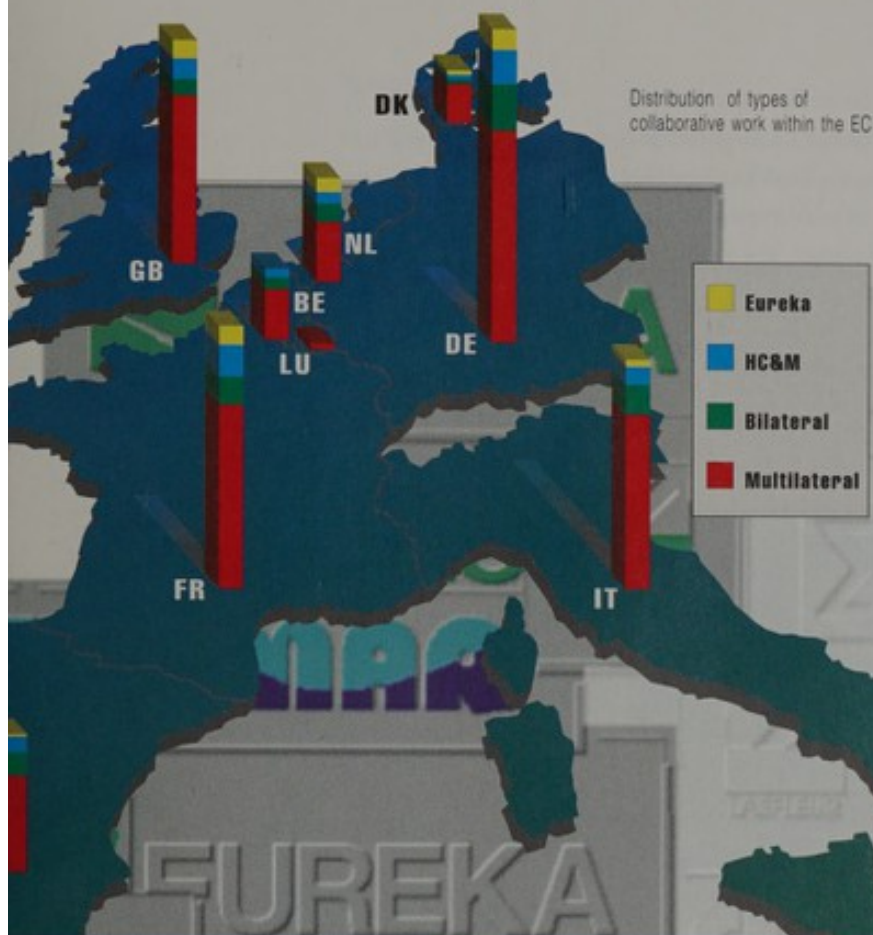
More than 100 bilateral cooperations and 60 multilateral cooperations are today in force with national organisations. These cooperations allow to increase the scientific knowledge and excellence of the partners. The bilateral cooperations are generally focused to highly specialised fields whereas multilateral ones, whose number of partners is generally comprised between 2 and 20 (up to 70 in extreme cases), concern broader subjects. The JRC is also participating in eleven Human Capital and Mobility Networks (HCM) and in five EUREKA projects. A list of the most important cooperations is given in the table opposite. All these cooperations are open to new prospective participants who want to join and benefit from them in bringing their additional scientific expertise.

The JRC is also participating in five EUREKA (European Cooperation on Advanced Technology) 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;
- 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 for real time operator decision support systems;

- 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.

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 European Commission.



- 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;

- VISIMAR (Visualisation and Simulation of Marine Environmental Processes, EU 495), to monitor the marine environment in producing an animation system showing the dynamic behaviour of geophysical processes has been concluded.

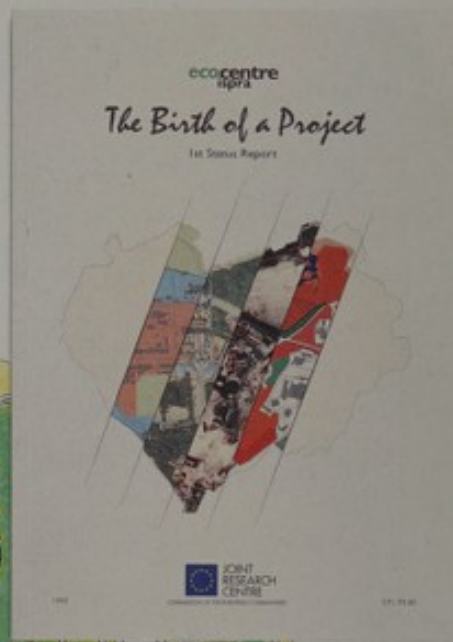
Institute	Research Area	Observations
IRMM	<ul style="list-style-type: none"> <li>Reference Nuclear Materials Measurements</li> <li>Reference Measurements for Chemical Analysis</li> <li>Polluting Trace element determination in the environment</li> </ul>	<ul style="list-style-type: none"> <li>REIMEP collaborative effort involving more than 30 laboratories</li> <li>IMEP: collaborative effort involving up to 65 laboratories</li> <li>Envirotrace: an HCM network involving 15 laboratories</li> </ul>
ITU	<ul style="list-style-type: none"> <li>Basic Actinide Research</li> <li>Partitioning and transmutation of long lived actinides in order to mitigate their long term hazards</li> </ul>	<ul style="list-style-type: none"> <li>Bilateral cooperation with interested universities and research institutes</li> <li>Network with interested research institutes</li> </ul>
IAM	<ul style="list-style-type: none"> <li>High temperature ceramic fibres for ceramic-matrix composite materials</li> <li>Prenormative research on advanced materials</li> <li>Non destructive inspection techniques for reliability assessment of mechanical structures</li> <li>Development of reliable ceramic components for advanced gas turbines</li> </ul>	<ul style="list-style-type: none"> <li>Research networks with universities and research institutes</li> <li>VAMAS</li> <li>PISC longstanding multinational cooperation system expanded to embrace 3 new networks:               <ul style="list-style-type: none"> <li>NESC: Network for Evaluating Steel Components</li> <li>ENIQ: European Network for Inspection Qualification</li> <li>AMES: European Action group on aged reactor materials and components.</li> </ul> </li> <li>HCM network involving 5 European Laboratories</li> </ul>
ISEI	<ul style="list-style-type: none"> <li>Semi-autonomous Monitoring and Robotics Technology (SMART)</li> <li>Interactive image synthesis and processing on Innovative Computer Architectures</li> <li>Diagnostics and Reliability of Innovative Materials and Structures for Transportation Applications</li> </ul>	<ul style="list-style-type: none"> <li>HCM network involving 13 European organisations</li> <li>HCM network involving 8 European laboratories</li> <li>HCM network involving 8 European partners</li> </ul>
EI	<ul style="list-style-type: none"> <li>Intercalibration and development of measurement methods for air pollution monitoring</li> </ul>	<ul style="list-style-type: none"> <li>Major collaborative effort in intercalibration and development of measurement methods with all interested European laboratories</li> </ul>
IRSA	<ul style="list-style-type: none"> <li>International forest investigation</li> <li>Agricultural statistics</li> <li>Monitoring of Common Agricultural Policies</li> </ul>	<ul style="list-style-type: none"> <li>Existing cooperation with ESA and four national institutes</li> <li>Contractual activities in network</li> <li>Contractual activities in network</li> </ul>
IST	<ul style="list-style-type: none"> <li>Structural mechanics (earthquake engineering research), operation of the ELSA facility</li> <li>Prenormative research in support to Eurocode No 8</li> <li>Reactor Safety: Severe accidents</li> </ul>	<ul style="list-style-type: none"> <li>Existing European association of structural mechanics laboratories (30 European laboratories)</li> <li>HCM network involving 19 European organisations</li> <li>Cooperation with 16 European laboratories contributing to the Phebus PF programme, cooperation with 8 organisations involved in the FARO projects</li> </ul>
IST/ISEI/ITU	<ul style="list-style-type: none"> <li>Nuclear Safeguards</li> </ul>	<ul style="list-style-type: none"> <li>ESARDA longstanding formal cooperation with all interested European research Institutes</li> </ul>



## Ispira site renovation

The plans for an ECOCentre at the Ispira 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.

Computerised simulation of the photovoltaic modules in place on the south face of the ELSA building situated alongside the area under consideration for ECOcentre redevelopment. (ECOcentre Status Report cover far right).



## Publications and Eurocourses

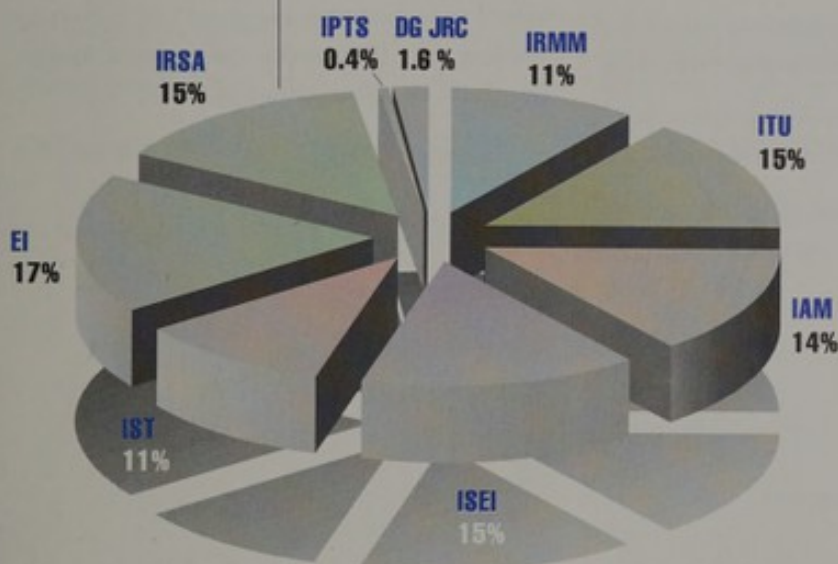
JRC PUBLICATIONS & EUROCOURSES

### Publications - Patents

In 1993 the JRC published 1016 papers. The following pie chart gives the distribution of these publications among the JRC Institutes.

The detailed list of JRC publications is made available 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.

Publications statistics by Institute



### Eurocourses - Other Workshops and Seminars

The JRC organised 8 Eurocourses with 90 guest lecturers from EC Member States, USA, Canada and Japan, 40 experts from the JRC Institutes and various Directorates General of the Commission, and 316 participants coming from industry, public administration, universities and research organisations from the EC Member States and from 20 non-EC countries.

The courses encompassed topics within environment, remote sensing, nuclear safety, materials sciences and civil protection.

Three other one-week courses were organised for the European Association for Environmental Man-

agement Education in the frame of the programme of the European Master in Environmental Management established by the Commission in 1991.

Furthermore, the JRC organised 8 large international conferences and 87 workshops and seminars to discuss their activities with scientists of other organisations and to disseminate the results of their work. This represented a total of 5000 visitors to the Centre during 1993.

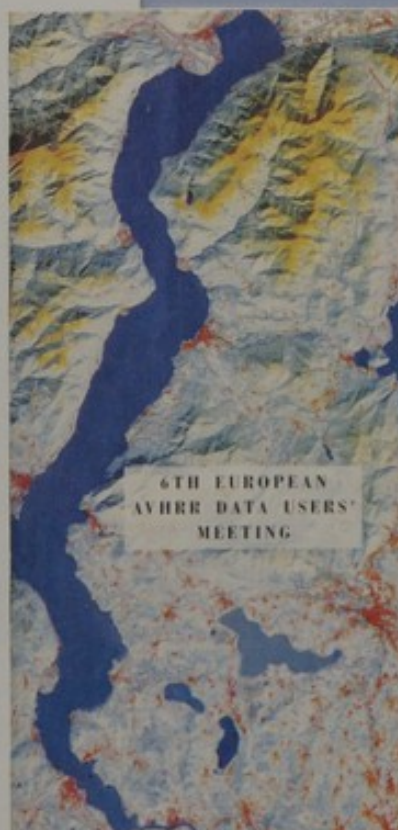
### LE PROJET MARS BILAN ET PERSPECTIVES

Villa Carlotta • Belgique • Luc Maggiori • Italie  
17 & 18 Novembre 1993

### THE MARS PROJECT OVERVIEW AND PERSPECTIVES

Villa Carlotta • Belgique • Luc Maggiori • Italy

### International Conference on NATURAL RISK AND CIVIL PROTECTION





## Human Resources

The JRC statutory staff comprising officials and temporary agents, including both scientific-technical and administrative staff, amounted to 1875 agents by the end of December 1993.

During 1993, 80 agents left the JRC and 54 people were recruited.

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

- senior scientists hosted for one or sometimes two years as visiting scientists;
- experts from national organisations seconded to the JRC to participate in selected scientific work;
- postgraduate students preparing a doctor degree trained through a programme of fellowships;
- post-doctoral scientists under the Human Capital and Mobility (HCM) Programme.

The pie-chart gives the repartition of the 217 scientists who were working at the JRC under these four schemes.

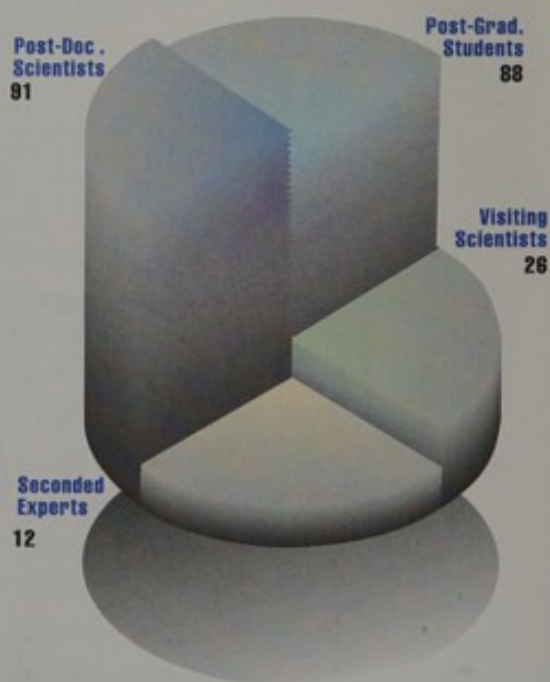
It is also worthwhile mentioning that thanks to the Human Capital and Mobility Programme, the number of Post-doctoral scientists present at the JRC increased from 13 to 91; furthermore, there are about 18 scientists from third countries working at the JRC on a grant in the framework of a Commission agreement 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.

In total, 2230 persons were thus active in the JRC, in 1993.

Some of the many young people who have taken advantage of the various hosting schemes are pictured here at the JRC-Ispra



Classification of the visiting scientists, seconded experts and grant holders in 1993



## Finances

JRC

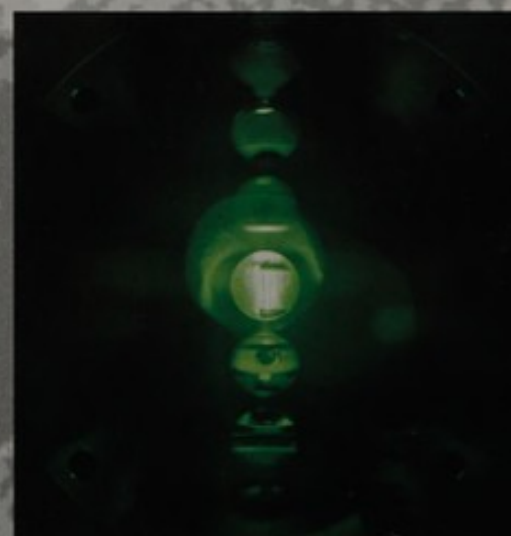
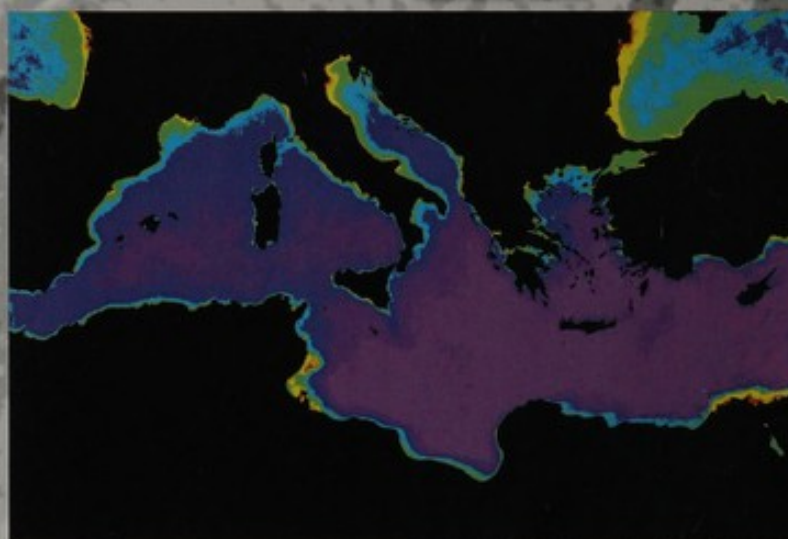
The JRC financial resources in 1993 amounted to 264 mioEcu; these resources are stemming from the EC budget, for the execution of the specific programmes and of the S/T support activities for the Commission, from contributions from the German and the Dutch Governments for the operation of the HFR, and from the JRC customers for the execution of work at their requests.

The budget (commitment credits) executed by the JRC in 1993, is given in the table below.

Commitments for the execution of the JRC activities in 1993 (rounded figures, mioEcu)

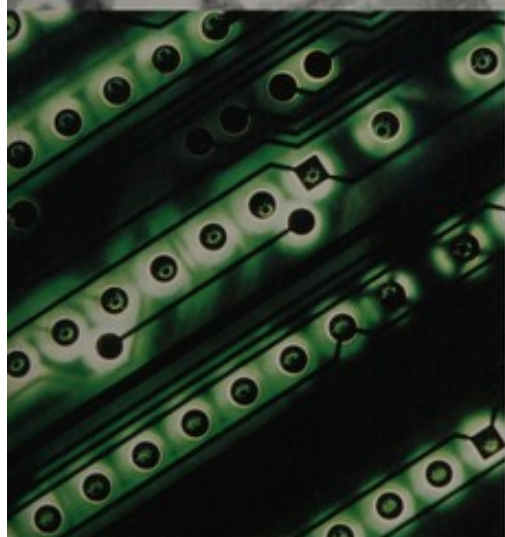
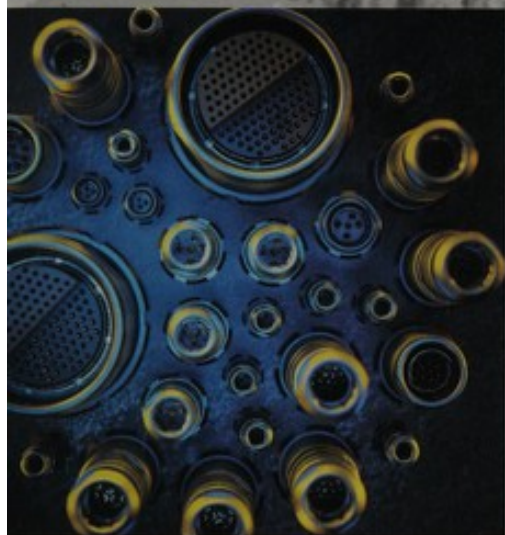
Specific Research Programmes	mioEcu	mioEcu
Industrial and Materials Technologies	24.9	
Measurement and Testing	28.3	
Environment	47.0	
Human Capital and Mobility	7.7	
Nuclear Fission Safety	46.2	
Controlled Thermonuclear Fusion	13.5	
<i>Subtotal</i>		167.6
Exploratory Research	8.6	
<i>Subtotal</i>		8.6
S&T Support to the Commission	59.4	
<i>Subtotal</i>		59.4
Work for Third Parties		
HFR Reactor	16.9	
Work for other Third Parties	11.5	
<i>Subtotal</i>		28.4
<b>Total</b>		<b>264.0</b>







# ACTIVITIES OF THE JRC INSTITUTES IN 1993



## The Institute for Reference Materials and Measurements

*The IRMM is dedicated to the promotion of European standards and the harmonisation of reference materials and methodologies. The Institute contributed to the Framework Programme Line "Measurement and Testing" by executing its specific programme under the heading "Reference Materials and Measurements". The character of its work continued to favour non-nuclear aspects and to move from fundamental studies to applied research. 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 work executed at IRMM is to contribute to improved harmonisation and standardisation in analytical measurements. To this end available skills were oriented :

- to prepare, characterise and certify high quality reference materials enabling the establishment of a coordinated analytical measurement system on European level and
- to apply the measurements expertise and the refined analytical techniques to appropriate non-nuclear issues.

The IRMM is providing high quality reference materials for the calibration of analytical equipment in all stages of the nuclear cycle and in various fields of non-nuclear issues, with the aim of improving

the reliability of measurements in chemistry and physics. Samples for nuclear data measurements have been prepared and characterised such as new  $^{10}\text{B}$  and  $^6\text{LiF}$  reference deposits.

Various reference materials were prepared, characterized 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). Upon request from the Measurement and Testing programme (former BCR) several special reference materials 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 uranium plutonium oxide pellets and solutions of spent nuclear fuel, synthetic input and plutonium nitrate; recently, the International Atomic Energy Agency (IAEA) has proposed to include REIMEP into its quality analysis scheme.

The Ultra Clean Chemical Laboratory now operational is used for the determination of very low concentration trace elements in a variety of materials. Interlaboratory rounds with up to 70 partners on trace elements in natural and synthetic water as well as one 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.

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  $^{235}\text{U}$  and on the total cross-section of  $^{10}\text{B}$ ;
- analysis of total cross-section of  $^{58}\text{Ni}$  and  $^{60}\text{Ni}$ ;
- the cross-section for neutron inelastic scattering from  $^{238}\text{U}$  and from palladium isotopes (fission products) are being investigated.

As for fusion technology, high resolution total cross-section measurements on natural iron have been performed.

An intercomparison of the standardisation of thin  $^{235}\text{U}$  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 new Germanium detector, installed at 225 m depth in the HADES (High Activity Disposal Experimental Site) underground laboratory of the SCK/CEN, Mol, Belgium. Its underground location allows a considerable reduction of the background from cosmic rays and neutron activation.

### Community and External Services

The IRMM continued the preparation of a series of reference materials 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 (quality control programme coordinated 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 the origin of some products or pollutants, has been developed and applied to sulphur in fossil fuels (responsible for  $\text{SO}_2$  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 support of the Consumer Protection Service, lead analyses have been performed in different hair products.

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

## The Institute for Transuranium Elements

*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 lifetime limitation of current Light Water Reactor (LWR) fuels, with emphasis on the analysis of the formation of structural defects at the fuel rod surface at high burn-up ("rim effect").

Work on deactivation of actinides (long-life radioactive wastes) by transmutation 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 transmuting 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 a special compound (trialkyl-phosphine oxide) in processes including centrifugal extraction.

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

An experiment for investigating the transport mechanisms of large nuclear aerosol particles (in particular,  $\text{UO}_2$  particles) in ducts and chimneys was carried out. Experimental and theoretical studies focused on the complete determination of heat capacity data of  $\text{UO}_2$  in the pre-melting region.

Technological advances concerned the construction of a laser flash machine for diffusivity measurements on irradiated fuel samples and the calibration of a shielded Knudsen cell for vaporisation experiments with irradiated fuel samples.

### Reactor Safety

Mathematical codes for reactor safety studies have been 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  $\text{UO}_2$  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 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  $\text{NpSb}$  and of  $\text{UFe}_2\text{Al}_4$  for structural investigations.

Mössbauer measurements on  $\text{NpX}_3$  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 nuclear safeguards 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. The final specifications for the Sellafield laboratory were issued. The equipment for non-destructive analysis has been tested and installed.

Illegally imported nuclear material discovered in the Member States was found 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  $\text{ZrO}_2$  and  $\text{UO}_2$ , 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  $600^\circ\text{C}$ . The results are being evaluated in view of the development of new fuels for Materials Test Reactors.



## Institute for Advanced Materials

*The IAM executes the specific programme on Advanced Materials and exploits and operates the High Flux Reactor for the Dutch and German authorities. It is engaged in pre-normative research related to standards and codes, and in work on a contractual basis for industry. During 1993, it 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

Coating technology was the subject of a large part of activities. European research networks actively promoted within the growing field of surface engineering focused their attention on 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, expertise has been gained in the application of controlled coating layers onto ceramic fibres coupled with a novel composite fabrication process.

A chemical technique has been developed for producing nanocrystalline ceramic coatings (e.g. alumina and yttria on ceria-stabilized zirconia). A new precipitation technique was developed for the production of large amounts of ceramic powder of composition difficult to obtain by other means.

Laser surface melting was found to 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. Multilayer coatings of porous titanium and hydroxyapatite on titanium alloy substrates were characterised structurally and mechanically in view of orthopedic applications for femoral and knee prosthesis. The wear rate and the friction coefficients of titanium and CoCrMo alloys as articulating components against polyethylene were determined.

The Networks (AMES, ENIQ and NESQ) launched to integrate European efforts on inspection procedure qualification for heavy duty structural components concentrated on materials rejuvenation, integration of fracture mechanics and on inspection, involve the management of projects aiming at codes, standards and industrial practice improvement. They support activities within DG III, DG XI and DG XVII.

Corrosion studies have been performed on newly developed advanced metallic materials having potential for gas turbine applications in order to determine why industrial corrosion found in practice is underestimated by laboratory studies in simulated environments.

Unique facilities were developed to study the behaviour of materials 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 mechanical behaviour of ceramic composite materials (e.g. bi-directionally reinforced ceramic composites) in hot corrosive environments.

Work on SiC/SiC material, which is potentially applicable to fusion reactors, showed that European industrial SiC/SiC material will satisfy low activation criteria. However, ceramic breeder materials were found to be reactive in high temperature tests, towards the SiO<sub>2</sub> 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 were 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.

#### 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 has resulted in equipment improvements (e.g. high temperature radiant furnace, laser extensometer, advanced pyrometer), which are being transferred into commercial 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, and for the production of radioisotopes (medical and industrial applications) or for the nuclear irradiation of structural materials in the HFR.



## The Institute for Systems Engineering and Informatics

*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 was centred on experimental and field research in the working environment of air traffic control to evaluate stress factors. Studies on safety at work focused on analysis of human-machine interactions, in transport systems for improving human reliability. A fault detection method for chemical processes has been developed.

### Measurement and Testing

The development of a portable interferometer based on electronic speckle pattern analysis to be used for real time measurements of microdeformations was completed.

A new optical method for stone surface diagnostics was tested and successfully applied to the chemical degradation of surfaces such as in the case of monuments exposed to air pollution.

The development of standards for the application of acoustic emissions to aeronautic materials was pursued.

A new model, proposed in the previous years, to assess high cycle fatigue damage in metallic structures has been validated for the case of stationary fatigue cycling. This model is exploited for a better evaluation of life expectancy of means of transportation.

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 mod-

ules were performed. Work to integrate large area façade modules in new facilities was continued as well as the contribution to standards organisations, namely International Electrotechnical Commission and Deutsches Komitee für Elektrotechnik.

### Environment

In the area of industrial risk, the application of decision support systems to the management of hazardous wastes has been pursued. A first experiment with multi-media decision support systems has been made together with studies for the integration of geographic information system. Plant safety and reliability studies have been 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.

Fission reactor safety studies proceeded via the development of expert systems to support plant safety and reliability management. Experiments on the pressurised thermal shock test rig were completed, to evaluate the safety margins of the primary piping of a reactor.

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 by combined computer simulation and experimental validation.

Electromagnetic forces occurring in blanket attachment locks of the Next European Tokamak Reactor 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 the Sellafield plant of BNFL and volume tests in mini-TAME (in support of DG I on nuclear safeguards for IAEA).

The new parallel computer (CS-I Concerto) developed in the frame of an Esprit project has been installed and its performances for image processing and synthesis has been evaluated.

The design of a European Coordination Centre for Aircraft Incident Reporting Systems (ECC-AIRS) was completed and the implementation of a pilot system was started (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 (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 were implemented such as the realisation of video surveillance systems for computer aided recording and reviewing, the production of sealing bolts and the development of transport and training computerised information archives (in support of DG XVII).

European demonstration project proposals in the area of photovoltaics, heating, building, 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.

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

For Third Party Work, calibration, certification and assistance tests were performed on new photovoltaic devices in ESTI (European Solar Test Installation).

#### Exploratory Research

Exploratory research mainly concerned neural networks for teleoperated vehicles, surface sensors and propagation of solitons.



*The EI activity is essentially focussed on the Environment Protection Programme and, to much lesser extent, on the Working Environment Subprogramme. A relevant part of the Institute effort is spent on the scientific and technical support to various Commission's services main emphasis being given to that provided to the Directorate General for Environment Nuclear Safety and Civil Protection (DG XI).*

### **Atmospheric Pollution**

Biosphere-atmosphere interaction studies have concerned the potential contribution of vegetation emissions in the Mediterranean basin to tropospheric ozone formation and consequently to global change. The EI has coordinated the European project on the Biogenic Emissions in the Mediterranean Area (BEMA), the first experimental campaign of which - performed in May/June 1993 near Rome with the participation of 12 national laboratories - was focused on the estimation of volatile organic compounds (VOC) fluxes.

Laboratory and field studies on the chemistry of sulphur compounds in the marine troposphere and the modelling of their conversion into particles as well as of the impact of the aerosol formation on the radiative properties of the atmosphere have been extended. Experimental data gathered in the course of a cruise across the North-Atlantic have been exploited to assess the role of natural and anthropogenic sulphur.

A data base has been assembled from the experimental data collected in the atmosphere tracer campaigns (1989-1991 and 1992) to assist modellers for the verification of air transport models within the framework of the EUREKA programme

TRACT/TRANSALP (Transport of Air Pollutant over Complex Terrains/Transalpine Transport of Air Pollutants).

In the field of air chemistry studies focus has been maintained on the tropospheric oxidation mechanisms of biogenically and anthropogenically emitted compounds, on the nighttime chemistry and on the role of selected nitrogen species in the generation of toxic compounds. The analysis of trends and episodes of tropospheric ozone in the Alpine region is complemented with the characterisation of photochemical compounds occurring in these circumstances.

### **Soil and Water Pollution: Waste**

The models developed from laboratory studies on the spreading of containments in terrestrial and aquatic ecosystems have been verified in field. The transport behaviour of selenium in the course of field migration experiments has been investigated by means of non invasive spectroscopic measurements at the soil/water interface.

The handbook dealing with dioxin detection and with environmental monitoring and therapies to counteract intoxications connected with mycotoxins development in the course of algal blooms, has been updated.

### **European Chemicals Bureau (ECB)**

The ECB which has been established within the EI since January 1st 1993, is supporting 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) has been made operational and a number of harmonised electronic data-set discs from chemical industry and from importers has been processed and registered.

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

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

The now formally created 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.

#### **Working Environment**

The systematic collection and critical evaluation of data on trace metals in human tissues and body fluids in view of deriving reference values has been continued within the framework of the EUREKA EUROENVIRON project (TRACY subproject).

#### **Community and External Services**

Within the framework of the technical and scientific support to DG XI focussed on air pollution issues, an air quality monitoring campaign has been performed in Brussels in close collaboration with DG XI and municipal environmental authorities.

The second intercomparison exercise for nitrogen dioxide measurement specially addressed to south-European countries - has been organised and performed.

EI has coordinated the weekly air sampling in some EMEP (European Monitoring and Evaluation Programme) stations located in the Mediterranean basin, for the monitoring of volatile organic compounds.

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.

The development and the management of databanks on radiological contamination of the environment and occupational exposure of nuclear plants operators have been continued.

A coding/decoding software for rapid exchange of information within EU in case of radiological emergencies (ECURIE - Radiological Information Exchange System) has been prepared.

In support to DG III, a CD-ROM of the first version of the EU databank on pharmaceutical products (ECPHIN) has been made available.

Work performed for DG VI related to the control of wine (sugaring, watering, databank) by Nuclear Magnetic Resonance methodologies has led to the creation of "The European Office for Wine, Alcohol and Spirit Drinks".



## The Institute for Remote Sensing Applications

*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).*

### Environmental Monitoring in Europe

New initiatives have emerged in the field of integrated ecological mapping:

- the development of a new project on European forest mapping and monitoring, entitled Forest Information from Remote Sensing with particular emphasis on forest ecosystems;
- the development of operational methodologies for the mapping and the monitoring of land degradation in Mediterranean regions. These are 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.

Examples of this work include :

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

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 development of advanced techniques of earth observation continued. In particular, polarimetric radar data collected from airborne campaigns have been used to obtain a better understanding of forests and their evolution.

In addition, two European Remote Sensing Satellite No.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;
- the evaluation of 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 was completed in 1993. A Call for Experiments for use of the laboratory 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 which explores the performance of high spectral resolution data (laboratory, field and airborne data) in order to derive geophysical parameters relevant to forestry and agriculture.

#### Community Services

Work continued on the assessment of the marine productivity of the upwelling area off the North West African coast, starting from satellite derived sea surface temperature and ocean colour data. 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 bi-weekly facsimiles showing the current estimate of areas under crop were forwarded to DG VI and EUROSTAT.

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. From this work, a new project entitled "Fire in Global and Environmental Monitoring" has been developed to map and monitor fire events on a continental or sub-continental basis (in support of DG VIII).

The Ocean Colour European Archive Network, 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 Colour Scanner satellite data. Linked to this, a new programme, the Ocean Colour Techniques for Observation, Processing and Utilisation System project, for the utilisation of data from the Sea-viewing Wide field of view sensor (SeaWiFS) has been initiated with the European Space Agency. Work was also undertaken to investigate the use of remote sensing in the revision of the Coordination of Informatics on the Environment Land Cover map (in support of DG XI).

#### External Services

The Tropical Ecosystem Environmental Observations by Satellites (TREES) project (a joint project with ESA) has established a first inventory of tropical forest cover.

For the European Airborne Remote Sensing Capability (EARSEC), a joint project with ESA, work progressed satisfactorily in three directions: 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.

A Third Party Work contract has been initiated 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.



## The Institute for Safety Technology

*The IST contributes to the Measurement and Testing, the Nuclear Fission Safety and Fusion, and to the Environment Programmes. It 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 Policy (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.

On 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. The ESTER computer code package will be applied to the post-test analysis of the first Phebus-FP tests.

### Fusion Technology

Verification and testing of safety relevant systems 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.

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.

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.

### Measurement and Testing

A 4-storey reinforced concrete structure has been constructed and tested at the ELSA reaction wall under simulated severe earthquake loading. In parallel, a large-scale model of a bridge was tested using the so-called substructuring technique, allowing physical testing of a complex structure to be limited 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. This activity performed within a scientific network under the Human Capital and Mobility programme, aims to enlarge the current application field and to improve the reliability of EUROCODE 8, the provisional European standards for the design of civil engineering structures in seismic areas.

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 work focused on the assessment, improvement and harmonisation of safety methodologies.

The Facility for Investigating Runaway Events Safely (FIRES) was operated 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 Depressurisation, Relief and Containment Using Large Apparatus venting facility, and commissioning of the venting of long horizontal vessels facility is expected to start by the end of the year. Experimental data and design methodologies based on the previous 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 Economic 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 application 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, which is a large scale multitank laboratory fully operational since 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.



## The Institute for Prospective Technological Studies

*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, 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 survey of global change research and policy 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 Best Available Technologies developments" (BAT). A contribution concerning steel coil coating technology will serve as a prototype for further BAT exercises. Concerning the evaluation of environmental projects and programmes, another study 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).

Work in support of the DG for Energy involved the review and assessment of energy technologies which may become available in the long term (year 2020 and beyond). Three technologies were initially taken into consideration:

**fuel cells technology** : a first study 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 expected investment/operating costs, the areas of application, the impact on the environment, etc.;

**technologies for CO<sub>2</sub> separation, storage and/or sequestration** : these technologies could become "a must" for preventing the increase of atmospheric CO<sub>2</sub> concentration, as a result of fossil fuel combustion. The emphasis was placed upon studying the technological and economic parameters controlling the accession of these technologies to the market;

**nuclear fission reactor and fuel cycle data** : a preliminary survey of the state of the art of fuel fabrication and recycling, and of prospects for improvements in the reprocessing plants has been carried out.



# Joint Research Centre

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### Programmes Directorate

#### Brussels

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Safety engineer

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2. Interinstitutional relations
3. General planning
4. Marketing
5. Space Applications

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2. Analytical accountancy &  
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3. Contracts
4. Infrastructure, Ispra site
5. Radiation Protection, Ispra site
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7. Central workshop, Ispra
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9. Documentation
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