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JOINT RESEARCH CENTRE
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FOREWORD

The Joint Research Centre (JRC) is the corporate research laboratory of the European Commission. Its eight multidisciplinary institutes, each with its own focus of expertise bring their independent scientific and technical support to the formulation and implementation of European policies. They also perform scientific research and technology development for national agencies, universities and corporate clients from Union Member States as well as from other countries.

The JRC has the potential to do even more to serve a European Union that is both growing and changing. It is one of my priorities to see that the 4th Framework programme of European Community activities in the field of research and technological development and demonstration, which calls for a new competitive approach for the JRC, induces an innovative and dynamic response.

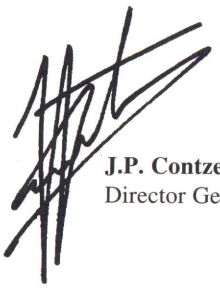
During 1994, the majority of the JRC's activities covered the framework research programme and the scientific and technical support to the Commission. In this respect, the JRC's work contributed to improving the environment and public safety, mainly through support to EU legislation but also through such projects as the "Advanced Mobile Analytical Laboratory", a Eureka project. The latter combines recent sophisticated analytical techniques with the capacity for fast intervention on polluted sites. The European Reference Laboratory of Air Pollution is another valuable 1994 achievement.

The JRC increased its multidisciplinarity with the start of the European Centre for Validation of Alternative Methods which has the ultimate objective of progressing towards total replacement of current animal testing.

The installation of the Institute for Prospective Technological Studies at Seville has also widened the geographical base of the Centre.

Among the JRC's objectives, the most important overall is its contribution to strengthening the scientific and technological base of European industry. This is vital for increased international competitiveness. And it means the JRC should be closer to the market. It must gear its high standard of scientific excellence to technological excellence in European industry. The FORMENTOR, a Eureka project achieved in 1994 is an example of such a contribution. This project developed a real time advisory system built into the control systems of complex plants increases safety, and also productivity, as it reduces production costs.

I would like to express my gratitude to the Board of Governors, for their advice and guidance during the year, and my appreciations to the Directors and the staff of the JRC for their high standard work, and I am confident of their response to the challenge of meeting Europe's competitive needs.



J.P. Contzen
Director General

OBSERVATIONS OF THE BOARD OF GOVERNORS ON THE JRC ANNUAL REPORT 1994

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

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

JRC Work in 1994

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

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

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

Finally, from the 1994 work, the Board notes with considerable satisfaction the growing number of scientific fellows under the Human Capital and Mobility Programme and other schemes.

This, together with arrangements for scientific visitors and seconded national experts, is judged of significant value for the scientific vitality of the Centre and a consolidation of the collaboration with national research in the Member States and participating countries.

JRC towards the Future

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

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

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

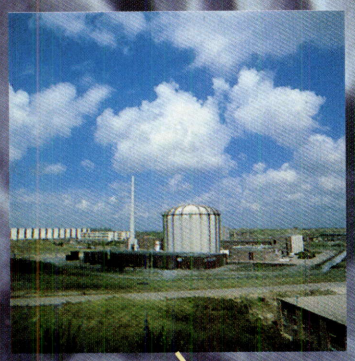
Acknowledgements

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

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

Brussels, February 1995

CONTENTS



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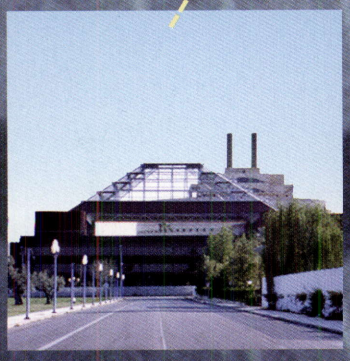
Geel

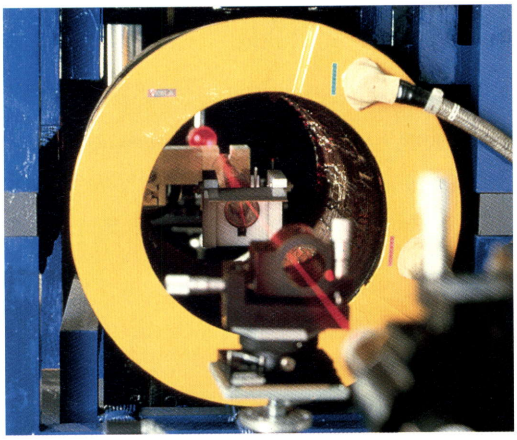
Karlsruhe

Ispra



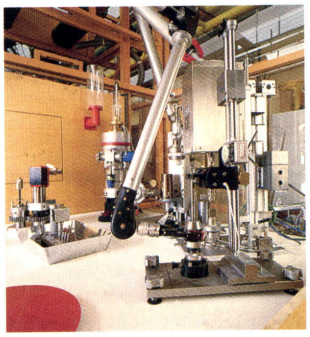
Seville

THE JOINT RESEARCH CENTRE



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

GEEL (B)	**IRMM**	The Institute for Reference Materials and Measurements
KARLSRUHE (D)	**ITU**	The Institute for Transuranium Elements
PETTEN (NL)	**IAM**	The Institute for Advanced Materials
ISPRA (I)	**IAM**	The Institute for Advanced Materials
	ISEI	The Institute for Systems Engineering and Informatics
	EI	The Environment Institute
	IRSA	The Institute for Remote Sensing Applications
	IST	The Institute for Safety Technology
SEVILLE (E)	**IPTS**	The Institute for Prospective Technological Studies



The statutory staff of the JRC was 1845 at the end of 1994. To this number one must add 354 scientists who were active in the Centre and were paid by the JRC under various hosting schemes.

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

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

Readers may find more details in the Annual Reports of the eight institutes. The JRC also publishes numerous scientific reports, presents papers in conferences and in scientific journals, and organises workshops, seminars and conferences to disseminate its scientific achievements. A contact address can be found on page 48 of the report.

THE JRC IN 1994

In the period 1992-1994, the Joint Research Centre (JRC) executed research programmes for the EEC (European Economic Community) and for the EAEC (European Atomic Energy Community) respectively, as approved by the Council.

Moreover, the JRC provided scientific and technical support for various Community policies as requested by the Commission Directorates General responsible for these policies and made its scientific competence and experimental installations available to public or private bodies in return for payment.

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

The Agreement on the European Economic Area (EEA) entered into force on 1 January 1994; the EEA/EFTA countries have participated since then in the JRC specific programmes for the EEC and representatives of these countries have joined the Board of Governors.

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

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

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

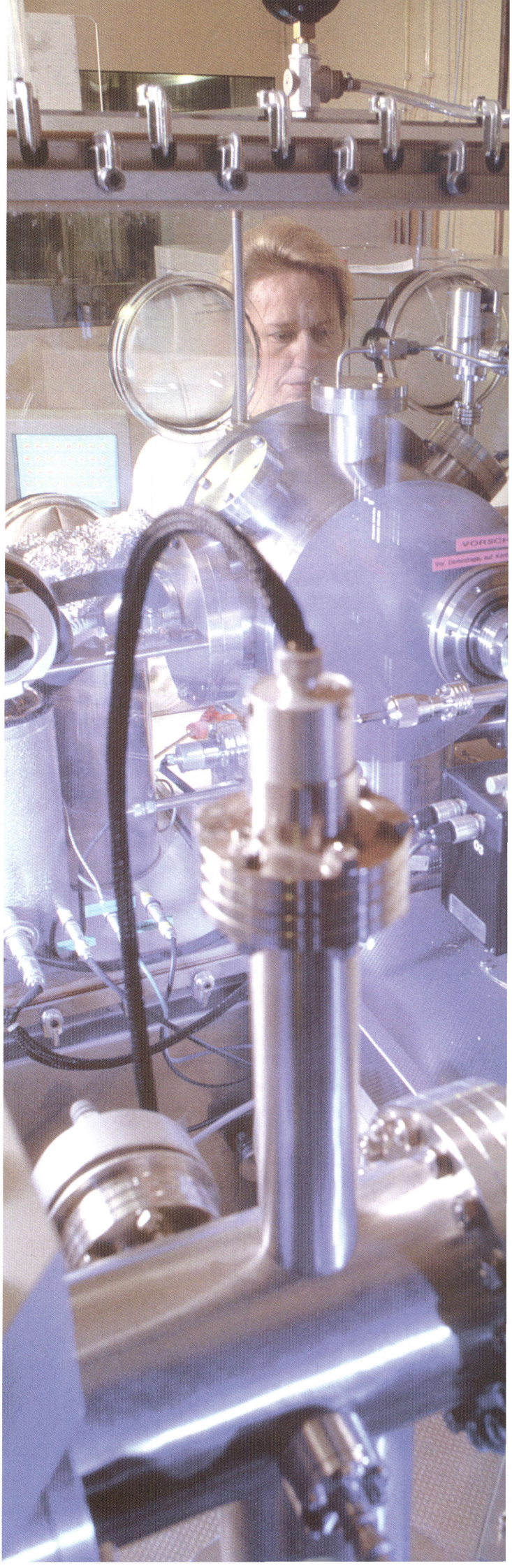
The JRC's fifth site, at Seville in Spain, was opened on 1 September 1994; it houses the

Institute for Prospective Technological Studies, following an agreement between the Kingdom of Spain and the Communities signed on 15 April 1994.

Nine Visiting groups, made up of scientists and science managers external to the European Commission were constituted in 1993, to carry out an independent evaluation of the JRC's scientific activities. Broad similarities between their reports were observed: it was generally recognised that the development of the JRC's activities had been continuous and positive. All specific recommendations were implemented or are under implementation in sofar they are compatible with the existing regulations.

The Fourth Framework Programme on Community activities of Research, Technological Development and Demonstration (1994-1998) and the Euratom Framework Programme (1994-1998) were approved and the role of the Joint Research Centre has been reoriented, by the Council Conclusions of 26 April 1994 (OJ N° C 126/1 dated 7.5.1994), towards a more competitive approach. The Council, European Parliament and the Commission acted to facilitate this orientation mainly in adopting new rules, allowing the JRC to participate with other European organisations in the Shared Cost Actions of the 1995-1998 Framework Programme.

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



SPECIFIC RESEARCH PROGRAMMES

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

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

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

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

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

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

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

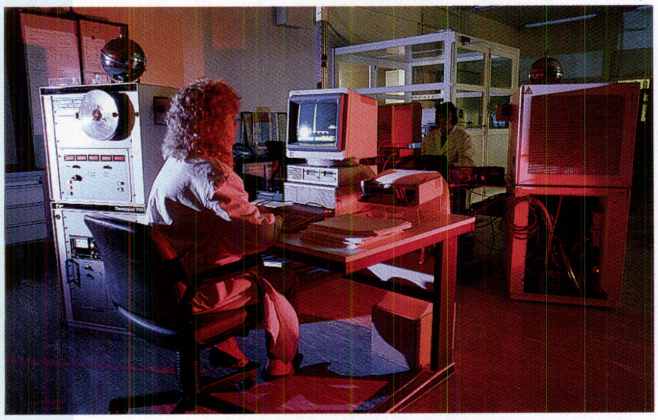
- **The Measurement and Testing** programme encompassed research projects on measurements and reference materials, carried out by the Institute for Reference Materials and Measurements (IRMM), and research projects on reference methods for non-nuclear energies (photovoltaic systems) and the assessment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

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

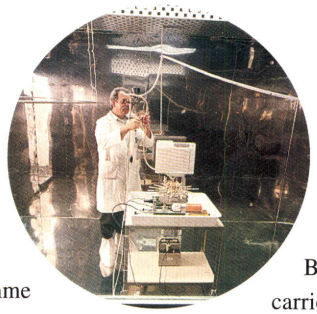
Among others, isotope abundance measurements and atomic weight determinations were performed with extreme accuracy.

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

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



damage accumulation in materials. Other activities regarded pre-normative research on photovoltaic systems at the ESTI (European Solar Test Installation).



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

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

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

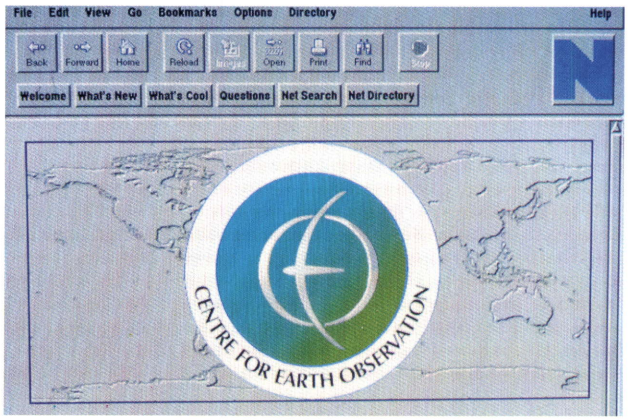
By a collaboration agreement with the World Meteorological Organisation (WMO), a World Data Centre for Aerosols (WDCA) was created, to collect and exchange information obtained through a large number of monitoring stations around the world. WDCA is a part of the Global Atmospheric Watch (GAW) system,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

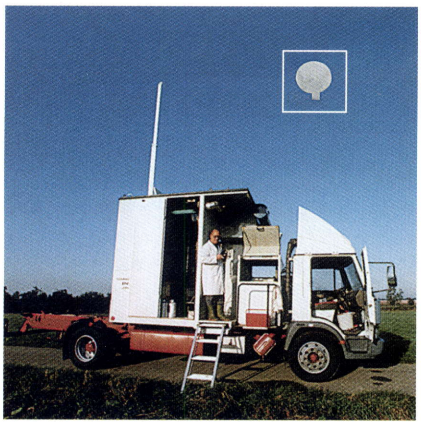
All the information available on the environmental contamination caused by the Chernobyl accident is being collected and merged in form of an atlas, in collaboration with all European countries, including eastern and central European countries, Russia, Belarus and Ukraine. The project will be carried out using modern information technologies. Exchange and training of scientists were important aspects of the project, which will be completed in 1996, ten years after the accident.

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

Field and laboratory studies continued in the areas of pollutant-soil-water interaction. Advanced analytical techniques for pollutant detection in various environmental conditions have been developed with several European laboratories. Two mobile analytical laboratories have started operation within the framework of the EUREKA project EU 674.

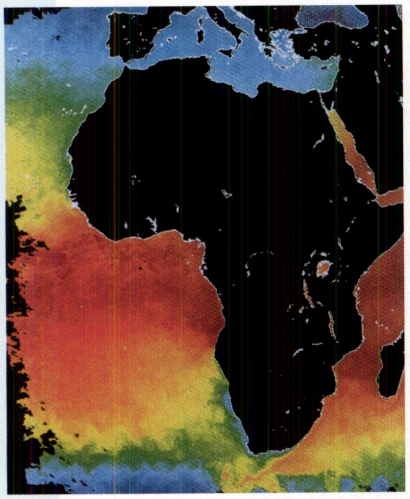
At IRSA, the work scale went from local to global; considerable emphasis was put on scientific issues grouped under the generic heading of "Global Change". It embraced work on global vegetation dynamics, global patterns of fire activity in vegetation, sea surface temperatures and marine primary productivity.





THE CEO WWW HOME PAGE

The Centre for Earth Observation (CEO) established a home page on the World Wide Web. This server provides Europe's scientists an opportunity to contribute information concerning their projects to the CEO, and helps them to find new sources of relevant information. The server provides a full multi media environment with audio, visual and animation as well as access to major Earth Observation data bases world wide. Some 50 scientists make on average 600 different requests for documents, images and other information from this server every day.



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

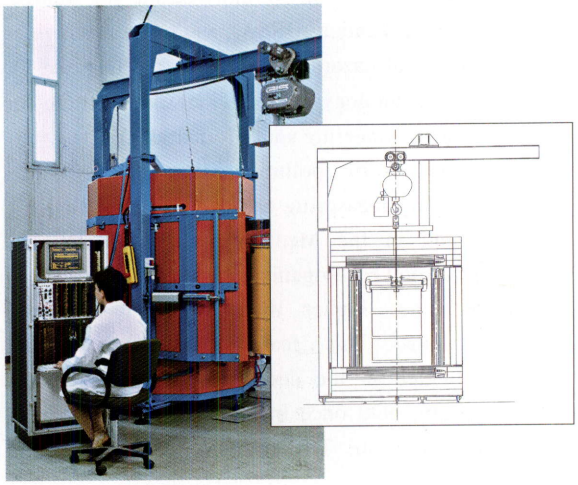
Likewise, for the marine environment, a joint project with ESA for the processing of ocean colour and sea surface temperature data, and the distribution of this information to a wide range of European institutes, was successfully concluded; work has begun on a similar initiative related to data from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

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

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

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

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



DRUM MONITOR FOR PLUTONIUM CONTAMINATED WASTE PACKAGES

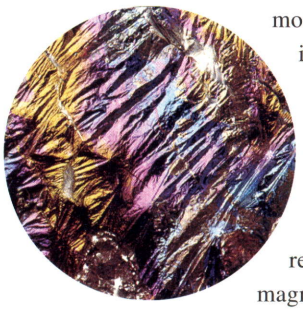
A waste barrel monitor for the assay of plutonium in radioactive waste has been designed, constructed and tested at the Institute for Safety Technology (IST).
The monitor performs an absolute determination of the total mass of plutonium embedded in the waste matrix. The assay principle of drum monitor is the detection of emitted neutrons from spontaneous fission of the fertile Pu isotopes. The detected neutrons are transformed into a signal pulse train which is recorded and analysed immediately following each measurement. The monitor thus finds applications both for control of low level radioactive waste prior to transport and storage, and for nuclear material balance in nuclear facilities.
The design of the new monitor is based on years of experiences from measurements with simulated waste at JRC Ispra and from measurement campaigns in nuclear facilities. This new monitor is adapted to an industrial environment (easy operation even with very heavy waste drums) having a higher performance than the earlier pilot version. Attention was also paid to operator requirements for safe handling of standard radioactive waste containers. The picture shows the drum monitor in its final configuration.
A series of measurement campaigns at nuclear facilities throughout Europe is currently taking place partly co-organised by the Euratom Safeguards Directorate. Negotiations are under way to allow exploitation of the drum monitor technology by third parties.

activities on nuclear fuels and actinides executed by the Institute for Transuranium Elements (ITU).

After the execution of the first Phebus FP test in December 1993 at Cadarache (F), preliminary analysis of the results was started, with contributions from all partners in this international project. The second test with irradiated fuel is planned for 1995.

A new version of the European Source Term Evaluation Research (ESTER) code package has been released to the European partners for final validation.

The construction of the STORM facility (Simplified Tests On Resuspension Mechanisms) for large scale studies of aerosol deposition and resuspension has been completed.



The first successful test with 150 kg of molten material has been performed in the Fuel Melting and Release Oven (FARO) and a small-scale steam explosion experiment executed in the KROTOS facility, saw important progress.

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

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

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

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

The principal activities concerning the European Tritium Handling Experimental Laboratory (ETHEL) involved the preparation of two experimental circuits for commissioning with hydrogen/ deuterium and the installation of new services to improve future operational and maintenance activities. The ongoing cold commissioning should lead to active operations with tritium, starting in 1995.

The IAM contributed to the ITER's technological needs in supporting the selection and characterisation of fusion materials. It also participated in the European longer term programme in developing low activation materials.

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

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

Scientific and Technical Support for Community Policies

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

The JRC support can take several different forms:

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

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

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

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

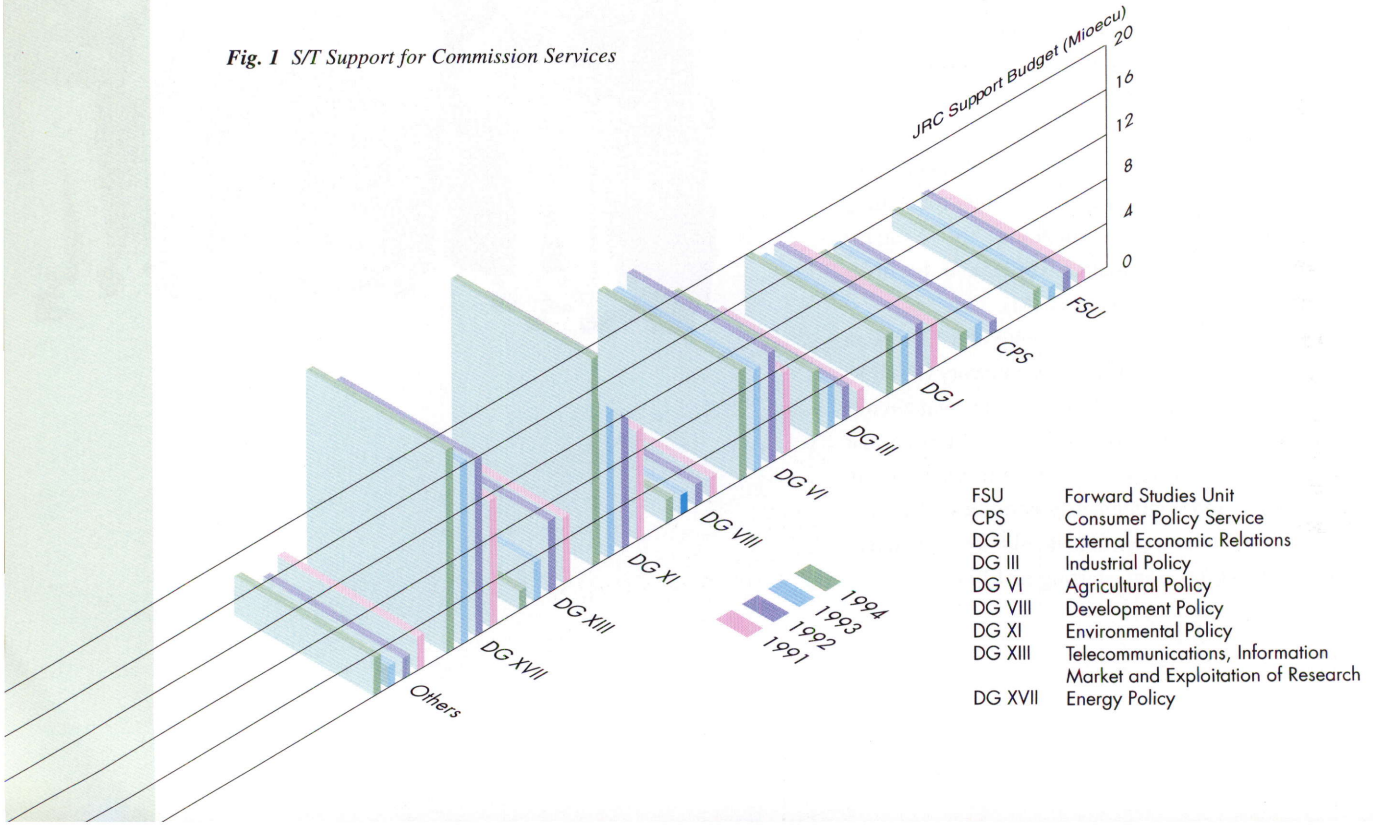
– atmospheric pollution support, concerning the implementation of EC Directives 80/779 and 85/203/EEC on air quality (SO_2, NO_2), and Directive 92/72/EEC (ozone). A memorandum of understanding between DG XI and the JRC for the setting-up and operation of the European Reference Laboratory of Air Pollution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

– preparatory work for the European Tracer Experiment (ETEX), to test the validity of atmospheric models for emergency response by using artificial released tracers.

Initiated in 1992 to support DG XI activities on radiation protection, the experiment is progressing well, with more than twenty countries participating;

– assistance with the management of information on environmental contamination from the

Fig. 1 S/T Support for Commission Services



Chernobyl accident, which is being collected and merged in the form of an atlas. This project is being developed in collaboration with all European countries, including central European countries, along with Russia, Belarus and Ukraine;

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

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

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

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

Most of the work undertaken deals with the following tasks:

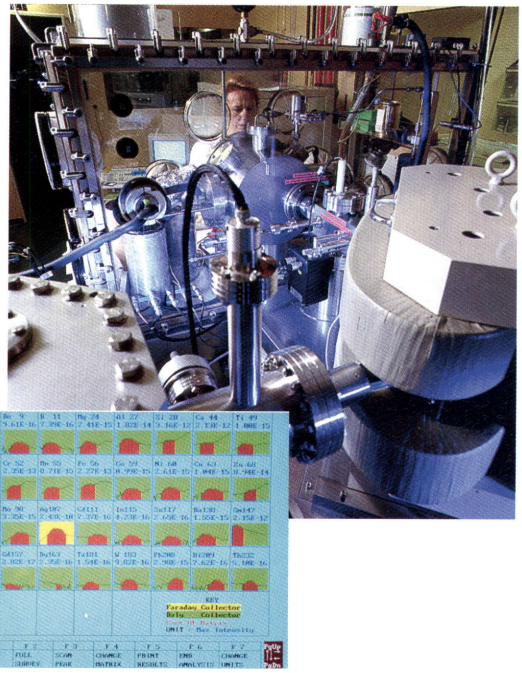
– training of inspectors, harmonisation of in-service nuclear safeguards inspection practices, providing state of the art equipment and reference analyses of nuclear materials samples including vagabonding materials;

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

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

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

– monitoring of photovoltaic and solar thermal demonstration projects.



ANALYSIS OF VAGABONDING NUCLEAR MATERIALS

The scientific and technical assistance of the Institute for Transuranium Elements in the area of analysis and characterisation of nuclear materials seized by German authorities reached a culmination point during 1994. The number of samples transported to and analysed in the Institute was higher than in previous years.

The work carried out by the Institute can be considered as an example on how the facilities and expertise of the Joint Research Centre can be of use to authorities/institutions in Member States of the European Union. One of the key pieces of equipment for the determination of the origin of the nuclear materials was the Glow Discharge Mass Spectrometer, which can detect traces of impurities down to a level of 10^{-10} (100 parts per trillion).

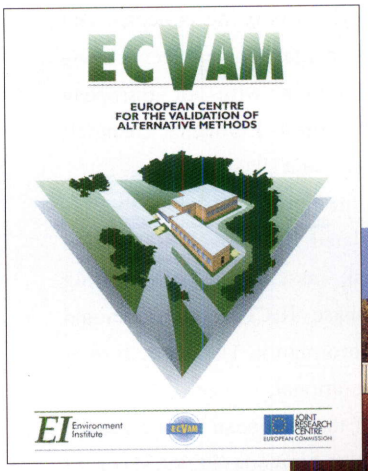
● **JRC support for the Common Agricultural Policy,** which accounts for 14.2% of the scientific and technical support budget, covers mainly the following research areas:

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

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

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

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



A EUROPEAN CENTRE FOR THE VALIDATION OF ALTERNATIVE METHODS (ECVAM)

A European Centre for the Validation of Alternative Methods (ECVAM), has been set up by the Commission in order to coordinate the validation of alternative test methods at the Union level; to act as a focal point for the exchange of information on the development of alternative test methods; to set up, maintain and manage a data base on alternative procedures; and to promote dialogue among legislators, industries, biomedical scientists, consumer organisations and animal welfare groups, with a view to the development, validation and international recognition of alternative test methods.

1994 saw the official opening of the new ECVAM building, which was immediately followed by the first ECVAM Symposium, on practical aspects of the validation of alternative methods. ECVAM organised eleven workshops during 1994, at which experts reviewed the state of the art and recommended the best ways forward with regard to replacing animal tests in testing vaccines, hormones and cosmetics. ECVAM scientists were also involved in pre-validation studies or validation studies on alternatives in testing for eye irritation, for phototoxicity and for tumour promotion.

The customers of the Joint Research Centre

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

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

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

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

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

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

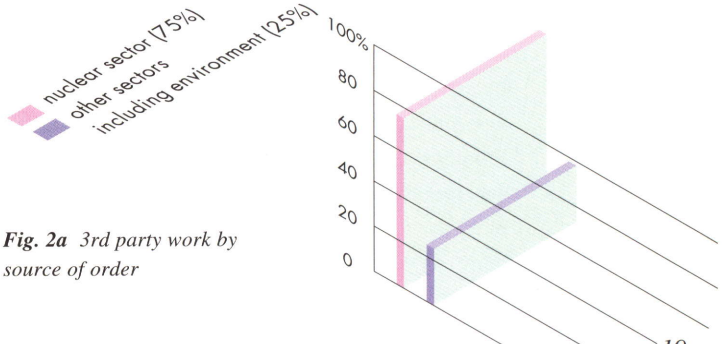


Fig. 2a *3rd party work by source of order*

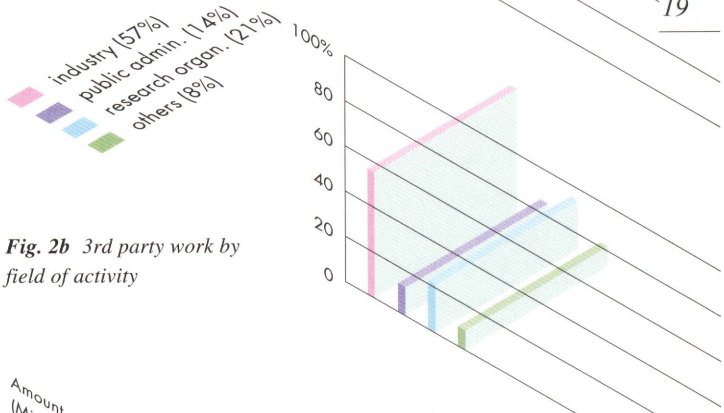
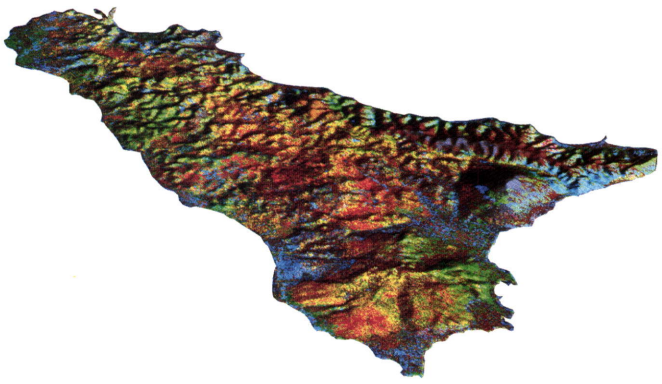


Fig. 2b *3rd party work by field of activity*



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

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

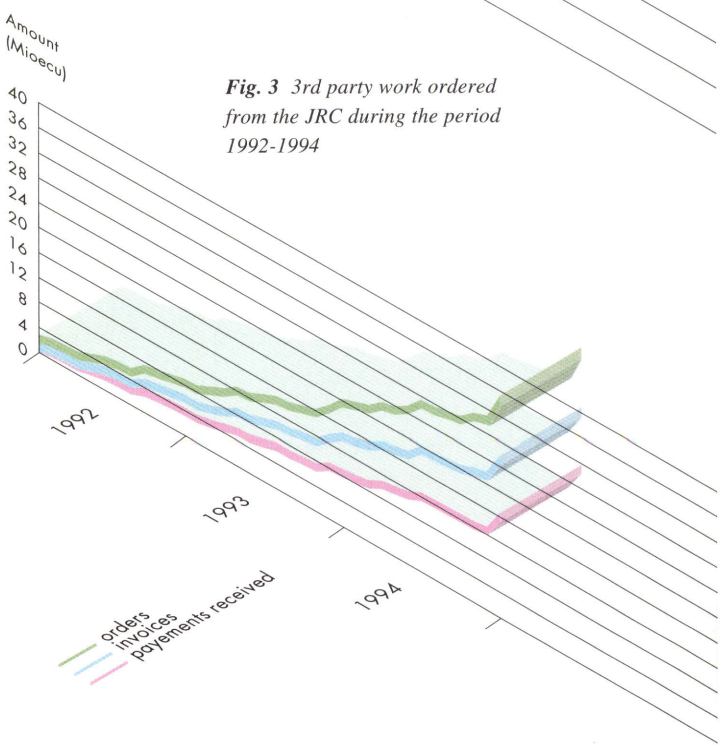


Fig. 3 *3rd party work ordered from the JRC during the period 1992-1994*

Cooperation with National Research Organisations

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

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

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

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

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

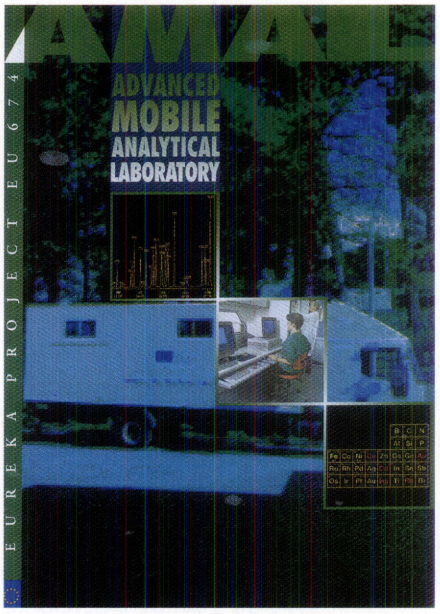
The Human Capital and Mobility (HCM) Programme, with its networks with other research organisations, is another suitable framework for cooperation. The JRC participates in 20 HCM Networks (see Fig. 5). Postgraduate and post-doctoral grantholders provide a multiplicity of contacts with their former universities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

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

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

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

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



AMAL: ADVANCED MOBILE ANALYTICAL LABORATORY

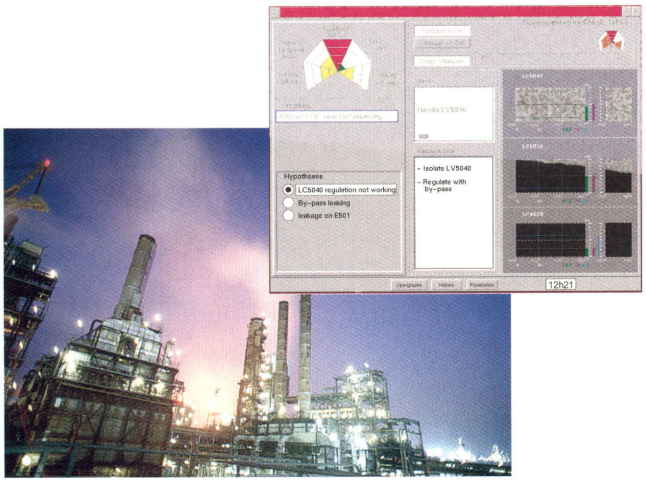
The Environment Institute of the Joint Research Centre is coordinating the EU674 project within the framework of the EUREKA umbrella EUROENVIRON, which concerns the development of an "Advanced Mobile Analytical Laboratory" (AMAL) designed for "in-field" sampling and analysis of waste, soil and water. This Laboratory combines the latest in analytical techniques with sophisticated new methods of sample collection, sample handling and data transfer, thus providing a system which is faster, safer, more accurate and more standardized than anything currently available.

AMAL consists of four vehicles equipped to fulfill the purpose of the project. The contribution of the Environment Institute to the project comprises construction and outfitting of two Mobile Units: one for sample preparation, provided with hoods and working surfaces, acting as mobile chemical laboratory, the second for instrumental analysis, housing advanced techniques.

One of the main challenges has been to adapt analytical techniques to field conditions, which means making sure that they can stand shocks, vibrations and temperature swings. A major field trial in October 1994 on a heavily polluted site near Leipzig (Germany) demonstrated AMAL fully operational. The final stage of the project will be to find commercial customers, such as local authorities or industrial sites.

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

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



FORMENTOR, A REAL-TIME ADVISORY SYSTEM FOR OPERATORS OF COMPLEX PLANTS

FORMENTOR was developed within the framework of the EUREKA initiative, the partners being Cap Gemini Innovation, Aerospatiale Protection Systemes and DNV. The industrial phase of the FORMENTOR project has been completed. It provides plant operators with information on the real-time necessary to make a series of decisions as to the appropriate actions to take when faced with major plant perturbations. As such, FORMENTOR helps avoid all sorts of losses in abnormal situations, whether production losses, the effect on the environment or danger to human life and health. Main achievements in 1994 have been a pilot industrial application in collaboration with British Petroleum and a full-scale industrial application for supervising a refinery unit operated by TOTAL.

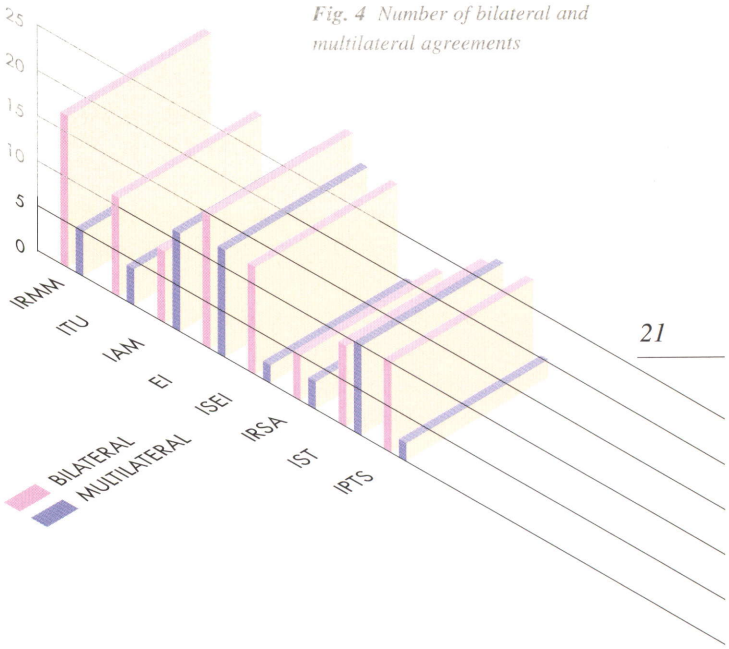


Fig. 4 Number of bilateral and multilateral agreements

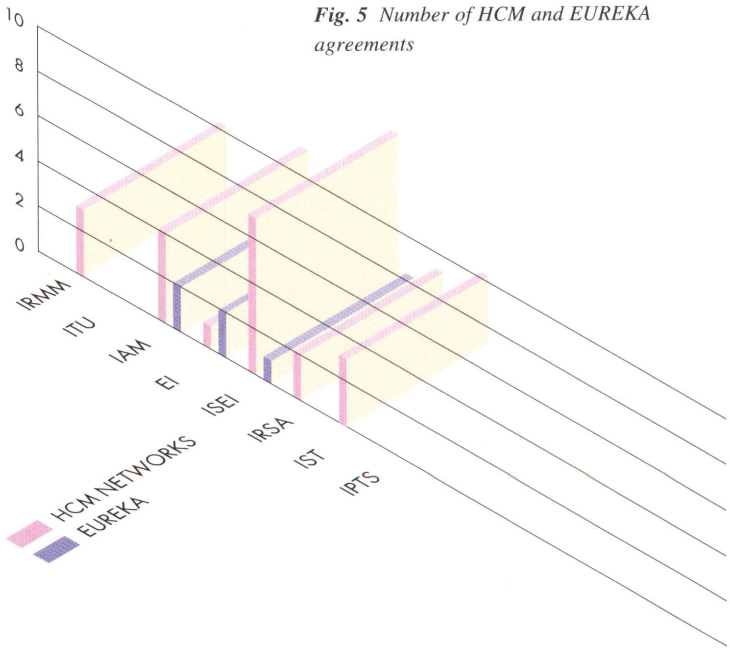


***Fig. 5** Number of HCM and EUREKA agreements*

INTERNATIONAL COOPERATION

● **Cooperation on nuclear safeguards R&D**

The Commission of the European Communities approved in July 1994 the agreement renewing the longstanding Cooperation Agreement between the United States Department Of Energy and the European Atomic Energy Community, which was concluded for the first time in January 1982. This renewal of the agreement was signed on 6 January 1995. It will allow the pursuit of fruitful collaboration with several US laboratories in nuclear safeguards R&D.

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

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

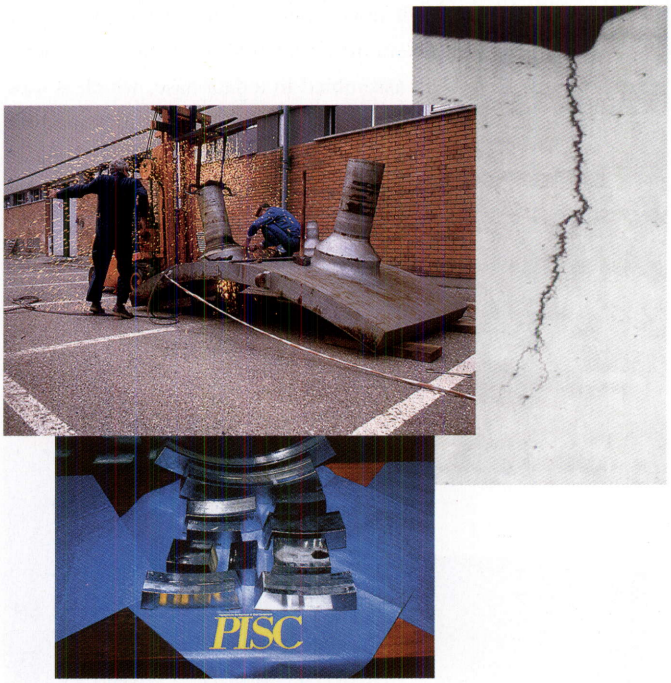
Furthermore, in cooperation with MINATOM and GOSATOMNADZOR of the Russian Federation, the JRC made the feasibility study of a training centre to be established at Obninsk.

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

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

● **Cooperation in remote sensing Earth Observation techniques with China.**

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



COMPLETION OF PISC PROGRAMME WITH CONSEQUENT IMPROVEMENTS IN PLANT INSPECTION PROCEDURES

Starting in 1974, several studies of Non Destructive Test effectiveness and reliability in the nuclear industry were initiated in a number of the EC and OECD member states. One of the most important, extensive and thorough of these studies was PISC. Several literature surveys made by national institutions and international organisations have shown that the PISC conclusions are supported by other work.

This programme showed that generally neither the effectiveness nor the reliability of inspection procedures were sufficiently evaluated at that time.

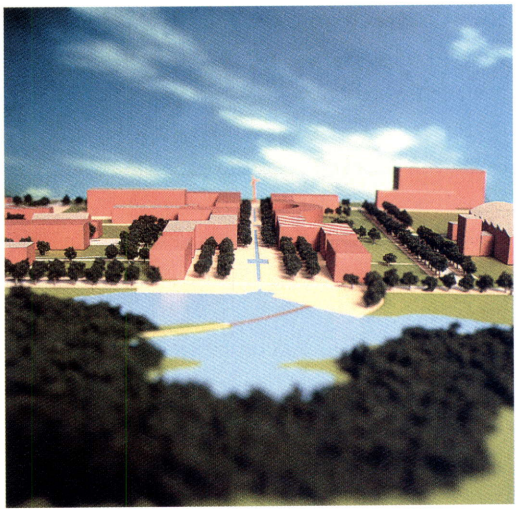
At present, it seems that inspection of many pressure components could be effective and reliable. The effectiveness and reliability of these inspections will depend very much on the way in which they will be qualified and PISC II contributed significantly to the development of qualification schemes and in particular to the performance demonstration of inspection procedures.

The experimental work of PISC III, managed by JRC as operating agent, now ended and, with it, the funding of the PISC programme. However, the evaluation and use of PISC data generated by the different Round Robin Tests will certainly continue for several years as well as the cooperation spirit which characterized these 20 years of NDE effectiveness evaluation.

Ispra Site Renovation

Plans for an ECO-Centre at Ispra were suggested in 1991, started in 1992 and progressed in 1993 towards a fully fledged masterplan for the whole site and its energy balance. This masterplan is now available and includes all aspects of infrastructure adjusting, building construction and nature recovery. All future buildings will be concentrated in a particular zone in the northern end of the site, with a fivefold more intense use of ground.

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



Publications, Workshops and Seminars

Publications and patents

In 1994 the JRC published 1141 papers. Fig. 6 gives the distribution of these publications among the JRC institutes.

The detailed list of JRC publications is published each year in the "Publications Bulletin". The last issue, No 14/ISSN0254-3133, published in March 1994, lists JRC publications in 1993.

In 1994, 30 JRC patents were also granted. These are also listed in the bulletin.

Conferences, workshops and seminars

In 1994, the JRC organised 5 conferences, about 200 international workshops and meetings, and 60 visits to the various sites. The resulting total of 7700 visitors demonstrates that the Centre is constantly widening its horizons within the international scientific community.

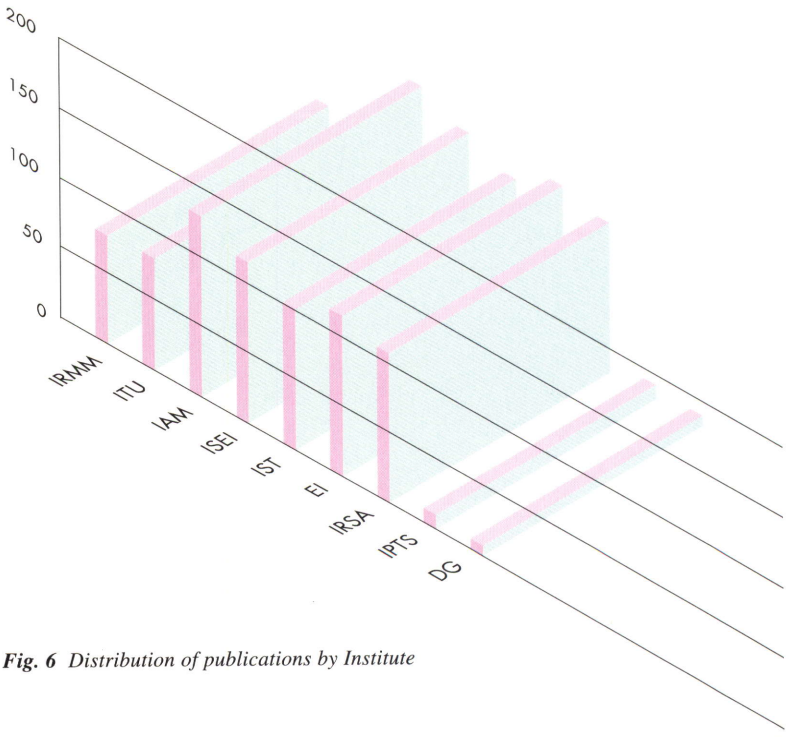


Fig. 6 *Distribution of publications by Institute*

HUMAN RESOURCES

The JRC statutory staff comprising officials and temporary agents, including both scientific-technical and administrative staff, amounted to 1845 agents by the end of December 1994. During 1994, 88 agents left the JRC and 58 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 for a doctorate degree trained through a programme of fellowships;
- post-doctoral scientists under the Human Capital and Mobility (HCM) Programme.

Fig. 7 gives the repartition of the 354 scientists which were working at the JRC according to 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 in 1992 to 91 in 1993 and to 197 in 1994; furthermore, there are about 40 scientists from third countries working at the JRC on a grant, within the framework of a Commission agreement with their countries or with the IAEA. Besides the above mentioned scientists, several senior scientists and about 150 trainees are working at the JRC with no cost to the EC budget, in general for a short period of time.

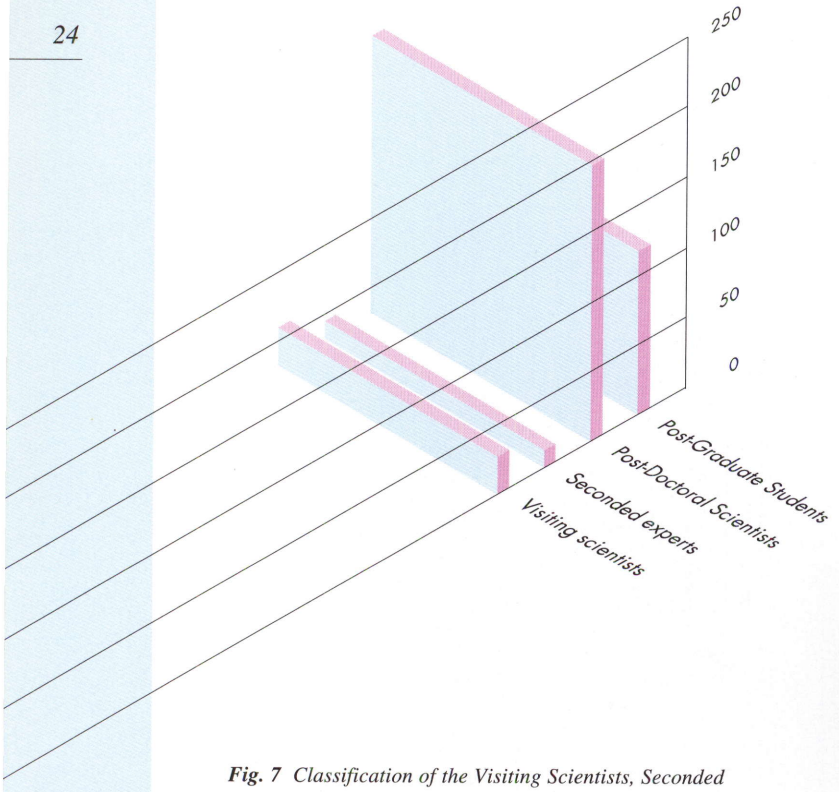
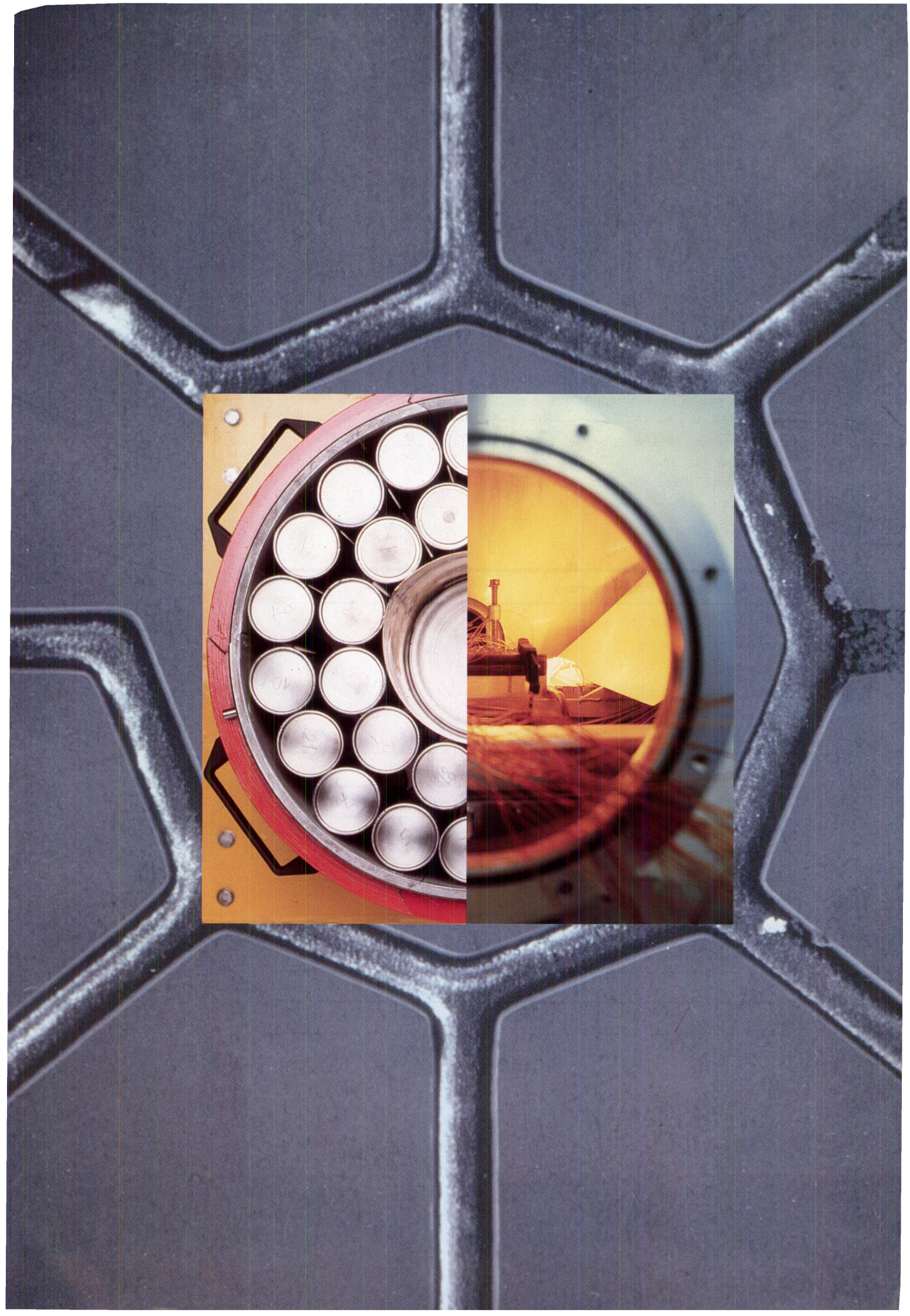


Fig. 7 *Classification of the Visiting Scientists, Seconded Experts and Grantholders in 1994*

The budget (commitments credits) executed by the JRC in 1994, is given in the table below.
The JRC financial resources in 1994 amounted to 300 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 Government for the operation of the HFR, and from the JRC customers for the execution of work at their requests.

Specific Research Programmes		
Industrial and Materials Technology	26.5	
Measurement and Testing	33.3	
Environment	50.4	
Human Capital and Mobility	11.7	
Nuclear Fission Safety	53.2	
Controlled Thermonuclear Fusion	14.6	
Exploratory Research	10.5	
Subtotal		**200.2**
S/T Support to the Commission	69.9	
Subtotal		**69.9**
Work for third parties		
HFR Reactor	17.1	
Work for other Third Parties	11.6	
Subtotal		**28.7**
Total		**298.8**

All figures Mioecu



ACTIVITIES OF THE JRC INSTITUTES

IRMM	The Institute for Reference Materials and Measurements
ITU	The Institute for Transuranium Elements
IAM	The Institute for Advanced Materials
ISEI	The Institute for Systems Engineering and Informatics
EI	Tne Environment Institute
IRSA	The Institute for Remote Sensing Applications
IST	The Institute for Safety Technology
IPTS	The Institute for Prospective Technological Studies

THE INSTITUTE FOR REFERENCE MATERIALS AND MEASUREMENTS (IRMM)

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

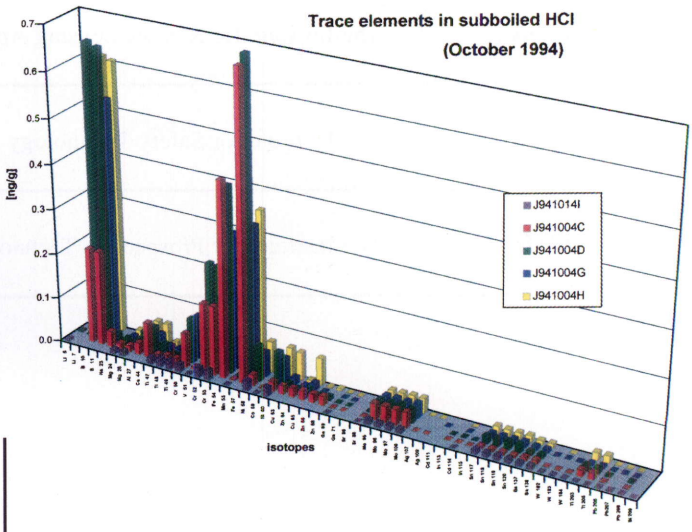
Reference Materials and Measurements

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

- The preparation, characterisation and certification of high quality reference materials facilitating the establishment of a co-ordinated analytical measurement system at the European level;
- The application of measurement expertise and refined analytical techniques to well selected non-nuclear issues.

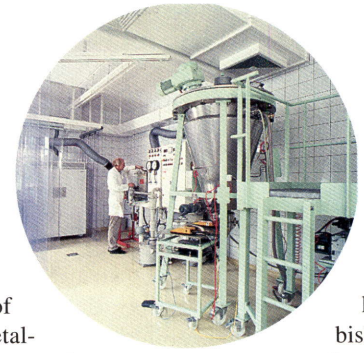
The high quality reference materials prepared are used for the calibration of analytical equipment at all stages of the nuclear fuel cycle and in various non-nuclear fields, with the aim of improving the reliability of measurements in chemistry and physics. Samples for nuclear data measurements have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

The certification procedures for rhodium, titanium and new AlCo alloys for reactor neutron dosimetry are proceeding well. For non-nuclear reference materials, further improvement in automation of



THE ULTRA CLEAN CHEMICAL LABORATORY (UCCL): OPERATION CHARACTERISTICS AND ACHIEVEMENTS

After one year of operation the air purity of the UCCL has been carefully checked and evaluated. Measurements of the number of residual particles in air have been performed at the workbenches and at various zones within the controlled laboratory areas. The use of the High Efficiency Particulate Air (HEPA) filters above the workplaces turned out to be very efficient. The acid sub-boiling and the water sub-boiling installations mounted in one part of the UCCL are continuously producing high purity acids (HF, HCl, H_2SO_4, HNO_3) and water. The UCCL was used for the determination of Li, B, Fe and U trace impurities in the produced acids.



production processes has led to higher productivity and quality.
Progress has been made in the study of the electrochemical behaviour of metallothioneins and related molecules. Trace metal analyses of materials from the marine environment were continued.
The Regular European Interlaboratory Measurement Evaluation Programme (REIMEP) activity continued, and mixed uranium-plutonium oxide pellets have been certified for their uranium and plutonium content.
The Ultra Clean Chemical Laboratory is being used for the production of extremely pure acids. The International Measurements Evaluation Programme (IMEP), which is a collaborative effort involving many laboratories in the Member States, has attracted the interest of official laboratories from states within the Danube river basin for participation in an IMEP intercomparison campaign on measurements of trace elements in water.
Measurements of isotopic composition of noble gases and of light elements, using their gaseous fluorides compounds, are progressing.
Measurements of neutron induced reactions continued very successfully, as a result of requests from users in the fields of fission and fusion technologies:
- total cross sections of ^{10}B were measured at the Linac and the Van de Graaff accelerators, in the framework of cooperation initiated by the Nuclear Science Committee of the Nuclear Energy Agency (NEA);
- very high energy resolution measurements of total cross sections of iron and aluminium were carried out, in response to a special interest, expressed by the NEA Working Party on Evaluation Cooperation;
- in collaboration with the Kernforschungszentrum, Karlsruhe, neutron capture cross sections of ^{138}Ba and ^{208}Pb have been measured;
- high accuracy total and capture cross sections of ^{237}Np have been determined in collaboration with the CEA (Commissariat à l'Energie Atomique).

The Linac was operational in the first half of 1994 only; since then, it has been undergoing a complete refurbishment.
Radionuclide standardisation work has been performed on extended area sources of ^{41}Ca and ^{56}Co. Two low energy X-ray standards, each with a set of different fluorescence layers, have been produced and are available for utilisation.
Measurements of low radioactivity levels continued in collaboration with the Max-Planck-Institut, Heidelberg and the underground laboratory of SCK/CEN, Mol.

Community and external services

The IRMM continued to carry out safeguards verification measurements in response to requests from the Euratom Safeguards Directorate of DG XVII as part of a quality control programme co-ordinated by the Institute for all ECSAM (European Commission's Safeguards Analytical Measurements) laboratories. In particular, results of analytical measurements on mixed uranium-plutonium oxide pellets were evaluated.
A chromatographic method for the identification and quantification of hair dye precursors and couplers has been developed in support of the Consumer Protection Service. An informative data bank on safety of products has been designed and almost completed.
Work in support of the Directorate General for Agriculture (DG VI) has concentrated on the production of ewe-curd reference materials and on the preparation of milk powder spiked with dioxines and furanes.
Several large scale productions of reference materials have been realised, such as four sediments for the Measurement and Testing Programme (former BCR), curd and milkpowder for DG VI, and trout and Antarctic sediments for external customers.

THE INSTITUTE FOR TRANSURANIUM ELEMENTS (ITU)

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

Safety of actinides in the nuclear fuel cycle

• High burnup light water reactor fuel

Work continued on both simulated fuels and actual reactor irradiated fuel in order to better understand the properties of high burnup uranium oxide fuel; for the first time, the buffer effect of the oxidation of molybdenum fission products on fuel oxidation could be confirmed.

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

• Fuel for transmutation studies and partitioning of actinides

A radiation damage study has been initiated on matrix materials (e.g. spinel $MgAl_2O_4$) for transmutation of minor actinides; phase changes and swelling occurring due to the impact of fission products in such materials were observed.

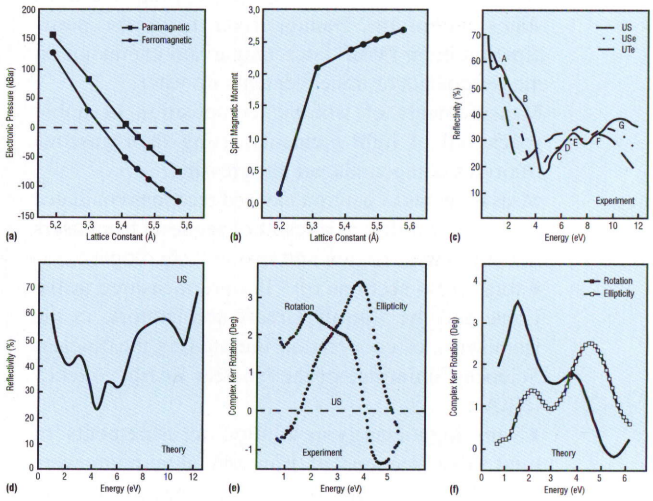
The extension of the Minor Actinides (MA) laboratory was carried on, with the development of powder preparation equipment based on the sol-gel process, and with the design of a new fabrication chain for the preparation of fuel pins containing minor actinides. The work on partitioning of actinides from waste solutions was continued; potential extractants were tested on centrifugal contactors. In cooperation with CEA (France), ECN (Netherlands) and KfK (Germany) fuel targets were prepared for the transmutation of minor actinides (mainly Am-241, Am-243 and Cm).

• High temperature studies of UO_2

High temperature studies on uranium oxide were pursued using, a.o the analysis of calorimetric data previously obtained at ITU in order to establish a unified microscopic model encompassing many thermophysical properties.

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

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



SEVEN EXPERIMENTS, ONE THEORY

The actinide compound uranium sulphide is one of the most studied materials and exhibits a wide variety of interesting properties. For example, at low temperature it is a ferromagnet (like iron or cobalt) and (unlike most ferromagnets) exhibits enormous magnetic anisotropy. Experiments using neutrons have determined the individual components making up the magnetism, and the specific magneto-optical properties have been measured parameters of importance in any possible application, for example in mobile telephones, walkmans and other recording devices. These experiments, and many others, have been published for some years, but their theoretical understanding was lacking.

This has now been accomplished; the only input into this theory is the atomic numbers of the elements and the crystal structure, in this case cubic face centered. Some of the results, and the comparison with experiment, are shown in the figure.

• **Basic actinide research**

Study of the physical and structural properties of the heavy-fermion superconductor UPd_2Al_3, and its isostructural compounds $NpPd_2Al_3$ and $NpNi_2Al_3$, was continued.

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

Theoretical work on the optical and magnetic properties of actinide materials was continued.

• **Fuel behaviour under accident conditions**

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

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

Characterisation of radioactive waste

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

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

Community services

The ITU activities are mainly oriented in support of DG XVII - Euratom Safeguards Directorate and to a lesser extend to DG I.

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

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

The inductively coupled plasma mass spectrometer technique has been combined with a high pressure liquid separation column for the on-line measurement of actinides and fission products, and with a laser for ablation of fuel or other highly radioactive material.

A very sensitive glow-discharge mass-spectrometer has been installed in a glovebox and calibrated for a wide range of materials.

About 500 chemical analyses of safeguards samples were performed; moreover several illicit (so-called vagabonding) materials, have been analysed; the samples have varied considerably, from uranium-containing powders to fresh fuel pellets and to plutonium containing materials.

Work for third parties

The chemical separation scheme for Ac-225 from U-233/Th-229 feed, based on sorption on titanium phosphate followed by cation exchange, was brought to a routine stage. First charges of Ac-225 were shipped to the USA, where clinical studies are being performed.

Actinide-bearing multicomponent alloys, to be used as targets for irradiation, were elaborated.

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

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

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

Exploratory research

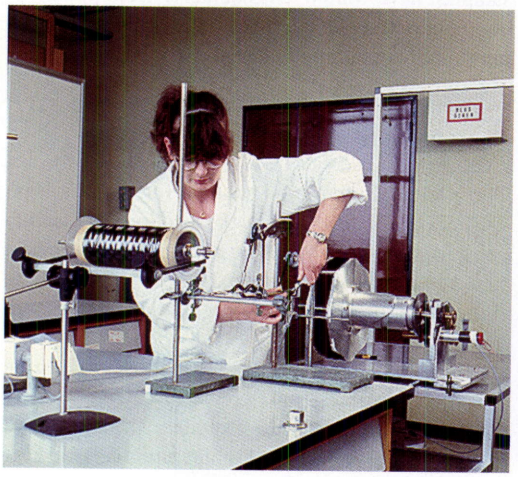
The feasibility of manufacturing a new high density (7 g U/cm^3) material test reactor fuel based on uranium nitride has been demonstrated.

Compatibility studies proved that there is no metallurgical interaction between uranium nitride and Al below 500°C.

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

THE INSTITUTE FOR ADVANCED MATERIALS (IAM)

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



APPLICATION OF THIN CERAMIC COATINGS ON HIGH MODULUS CARBON FIBRES TO INCREASE STRENGTH OF COMPOSITE MATERIALS

The objective of this work is to explore innovative solutions for the engineering of interfaces and fabrication of ceramic matrix composites (CMC). The current liquid infiltration of woven fibres with ceramic or ceramic precursor materials offers a low cost versatile processing route for the fabrication of ceramic composite components. However, these current processing routes limit ultimate composite properties. The innovative solution of infiltration of powders under electrophoretic potential generates more uniform and higher densities and reduces macrodefect population in the densified ceramic. The results obtained by this technique have shown significant improvement in the process of producing CMCs and also in their properties. One patent proposal was already accepted and two patent proposals are in process.

Materials and measurements

Activities were primarily focused on the qualification and characterisation of metallic and ceramic materials and components for application in industrial service. Several approaches were investigated, such as life assessment, threshold limits, performance, failure behaviour, etc. by modelling and experimental validation, in order to establish and develop a design and operating code. The scientific scope ranged from the simulation of "extreme" industrial environments, often tailored to specific technologies or the development of complex, unique testing facilities, to the interpretation of the materials' behaviour at the microstructural and submicrostructural level. The qualification of advanced commercial materials was supported by the development of novel next-generation materials, particularly in the field of composites and in surface engineering. All activities were associated with relevant producer and end-user European industries.

Reliability and life extension

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

Materials for extreme environments

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

Surface modification technology

IAM offers a wide ranging competence in surface coating and engineering, deployed at both Petten and Ispra. Major activities include low pressure and atmospheric plasma spraying of thermal barrier coating systems, chemical vapour deposition of hard and ultra-hard wear resistant coatings, physical vapour deposition of hard coatings for engineering and biomedical applications, process development,

modelling and in-situ diagnostic feedback for intelligent processing, laser and high energy beam surface treatments. Surface engineering for next-generation materials included ceramic-matrix joining, interfacial engineering in fibre composites, the fabrication of coatings by colloidal processing, and surface degradation in industrial metal processing by Marangoni convection.

Measurement and validation methodologies for materials and structures

Pre-normative activities were continued with the development and improvement of methods for the measurement, testing and detection of properties of metallic, ceramic and composite materials, including the validation of these methods as a pre-normative input to the subsequent development, improvement or optimisation of codes and standards by European standards institutions.
In the area of materials information and data management the work on the High Temperature Materials Databank (HTM-DB) was continued with emphasis on the incorporation of spin-off improvements into the HTM-DB from an aluminium alloy databank for the European car industry, promotion of the HTM-DB as the standard data base in Europe for alloy properties, and cooperation with the European Collaborative Creep Committee (a BRITE/EURAM activity).

Fusion technology and safety

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

High Flux Reactor (HFR)

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

Community services

Support activities were performed for DG III, on standards for advanced ceramics and Non Destructive Testing (NDT) standards for pressure vessels. This latter activity made it possible to exploit the Project for the Integrity of Steel Components (PISC) results for direct use by CEN/CENELEC (the European Standardisation Committee/European Committee for Electric Standardisation) in order to develop and orient activities of the networks AMES (Aged Materials Expertises and Studies), NESC (European Network for Evaluating Steel Components), and ENIQ (European Network for Inspection Qualification). These networks back up the policies and actions of European Commission Directorates XI and XVII, which have responsibility for nuclear safety and energy matters.
Projects developed by the networks in the area of regulation included:
- comparison of national requirements and industrial practices in relation to the integrity of structural components, with emphasis on materials ageing, inspection effectiveness and structural integrity assessment methodologies;
- support for the development of a harmonised approach to steel embrittlement evaluation and mitigation methods;
- support for the harmonisation of inspection qualification procedures, through performance demonstration.

Work for third parties

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

Exploratory research

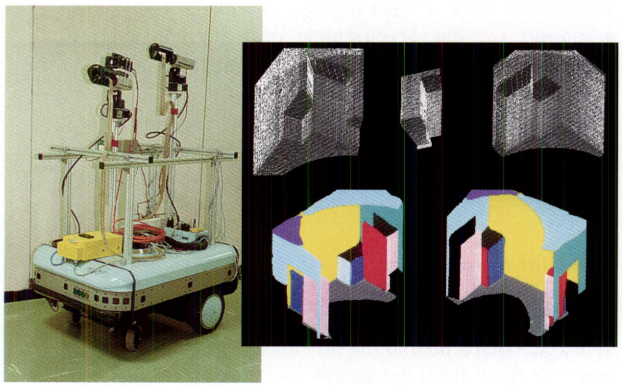
The following three projects were carried out: (a) engineering of fibre-matrix interfaces in ceramic composites by nanocrystalline processing, (b) measurement of localised stress fields at dissimilar material interfaces by neutron scattering, and (c) direct measurement of adhesion in films and coatings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

THE INSTITUTE FOR SYSTEMS ENGINEERING AND INFORMATICS (ISEI)

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

Working Environment

Cognitive ergonomics (analysis of reasoning and decision making processes in work places) were applied to air traffic control for the study of complex working conditions. Field studies led to developing an operative model aimed at better designing interfaces and communications between operators and means of control. Safety at work studies were applied to airplane-pilot interaction and resulted in a method for identifying the root causes of human error. A new cockpit resource management approach was designed for pilot training. Process statistical diagnostics were applied to the start-up/shut-down of industrial plants, which are typically complex, non-linear processes. This methodology will help developing tools for early fault diagnosis.



SENSOR-BASED NAVIGATION IN MOBILE ROBOTICS

A key aspect to the implementation of a mobile robot for the surveillance of hazardous areas is the quality of its navigation module, i.e., the comfort an operator has in guiding the system, the capability to deal with unforeseen obstacles, and the ability to improve its performance over time. To achieve this goal, the robot must rely upon data coming directly from on-board sensors. Learning capabilities allow the robot to enhance the quality of sensory data and acquire efficient navigation strategies.

Measurement and Testing

A new, portable instrument called the Electronic Speckle Pattern Interferometer (ESPI), based on laser interferometry, was successfully tested to investigate the state of conservation of old Italian paintings. A procedure for mechanical characterisation of stone materials thanks to a multiple ESPI system has been displayed to industries with a view to marketing the system. A coherence-radar system for surface profilometry (to be used as a high precision dimensional control of small industrial components) was also developed and successfully tested. Acoustic techniques are being developed, in collaboration with industry, for the quality control of glued joints.

In photovoltaic systems, pre-normative research resulted in a final check on the fast sampling flash radiometer, for spectral irradiance measurement of very short (1ms) light pulses. A patent was requested. Emphasis was put on setting up a quality assurance system following the ISO 9003 standard, and on participating to the first phase of a world-wide calibration of reference solar cells, which would lead to a world photovoltaic reference scale recognised by national standard bodies. The technology gained on amorphous-silicon thin-film modules was used on the Ecocentre ELSA-facade. System identification for energy savings in buildings was continued.

Environment

New decision support models for environmental management were developed. They are being applied for pollution control in urban areas and water resources management. An accident data base based on worldwide public sources was added to the software TRIM (Transportation Risk Management). Geographical Information Systems (GIS) and spatial analysis techniques in decision support systems for environmental management were applied to real case studies, e.g. management of water in Ireland and Italy and of a natural park in Belgium. The Multi Criteria Decision Aid (MCDA) technique coupled with GIS and generic algorithms was applied to generating alternatives in site facilities for toxic waste treatment.

ISEI contributed to the CEO (Centre for Earth Observation) project, see p. 38, where a survey of the present infrastructure in Europe and of the requirements of satellite data users has been launched. A workshop on European data networks and user information services was organised at the end of 1994, in collaboration with the European Space Agency.

Nuclear Safeguards, Nuclear Fission Safety and Fusion

Safeguards: A remotely guided vehicle was able to detect unforeseen obstacles thanks to ultrasonic data and a neural network. Techniques for remote monitoring dealing with storage, encryption and transmission of safeguards data were investigated. In the LaSCo (Laboratory for Surveillance and Containment), attempts were made to integrate video surveillance with other sensors for safeguarding nuclear material storage areas. First experiments were made in the TAME (Tank Measurement lab) to investigate precision measurements on liquid content.
Reactor safety: The development of integrated software tools for the safety management of nuclear power plants was pursued. This set of tools, based on the STARS (Software Tools for the Analysis of Reliability and Safety) structure and regularly updated PSA (Probabilistic Safety Assessment) concept, was successfully applied to the analysis of the auxiliary feedwater system of the Grohnde power plant. A collaboration with TüV Süd-West (Technischer Überwachung-Verein) was undertaken, to validate the STARS fault tree analyser. Investigations were made to better evaluate operator error probability in accident sequences. Advanced models for knowledge extraction from reliability data bases and estimation of reliability parameters were further developed. The pressurised thermal shock experimental activity, in the context of nuclear fission safety, has been concluded. A review of plant ageing results obtained during the 3rd Framework Programme is being published.
Thermonuclear fusion: Computer simulation and experimental validation of remote handling procedures went on in the ROBERTINO facility, to help design the blanket handling device for ITER (International Thermonuclear Experimental Reactor). Post-accidental thermal transient analyses for design guidelines and assessment were carried out for ITER and for SEAFP (Safety and Environmental Assessment of Fusion Power). The dynamic structural integrity of ITER's vacuum vessel and of SEAFP's blanket structures in case of a plasma disruption is being assessed.

Community services

A system, based on image processing, developed by the JRC for designing information verification of complex nuclear facilities was installed at the International Atomic Energy Agency (IAEA). Training courses were organised for IAEA inspectors on volume and mass determination, surveillance in tanks and sealing techniques. Video equipment for inspectors was tested.

Work on safety critical computer systems began with a collection of existing information, to prepare the Safecomp'95 conference and to draw up a workplan for 1995-1998. A 3D image synthesis software in the computer CONCERTO was completed for DG III.
A pilot Coordination Centre for Aircraft Incident Reporting Systems (EEC-AIRS) is being completed and will be operational in 1995 (DG VII).
A Major Accident Hazards Bureau will be in charge of operating the Major Accident Reporting System, the Community documentation centre on Industrial Risk and the scientific/technical coordination of technical working groups, for drafting guidance notes on issues arising from the Seveso directives. Guidance notes for safety reports and safety management systems have significantly progressed. Guidelines for public information were published.
Assistance work in biotechnology was pursued, and activities on environmental impact assessment in Member States are being compared (DG XI).
Valorisation activities included holographic compression techniques for image synthesis, ultra high sensitivity interferometric sensors and tagging/sealing applications (DG XIII).
Review stations of recorded surveillance images, based on a cyclic image buffer, were developed for computer assisted review. A system for identifying fuel element numbers using pattern recognition was designed (DG XVII/EURATOM Safeguards Directorate).
European demonstration project proposals in the areas of photovoltaics, heating, building, transport and industry sectors (THERMIE programme) were appraised. Assistance was extended to ALTENER and SAFE programme activities, in the area of a rational use of energy in buildings and industry (DG XVII).
Work continued on informatics systems for antifraud projects and on the computer-aided management of parliamentary petitions (General Secretariat).
Neural networks tools were implemented for statistical applications (EUROSTAT).

Work for third parties

Calibration of photovoltaic cells and quality testing of modules still are major sources of income. Other activities include environmental management studies for regional administrations, and sealing systems fabrication for nuclear safeguards.

Exploratory research

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

THE ENVIRONMENT INSTITUTE (EI)

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

Environmental chemicals

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

Field and laboratory studies on pollutant-soil-water interaction, as well as on toxin production associated with algal blooms in relation to environmental factors, have been pursued in order to investigate the transformation and fate of pollutants in the soil.

Collaborative studies and intercomparative analytical campaigns between European laboratories have been launched for the development and application of advanced pollutant detection techniques in various matrices. Two mobile analytical laboratories are now operational, within the framework of the EUREKA project EU 674. Contributions were made to the implementation of new techniques and on-site applications.

Atmospheric Pollution - Global Change

The second experimental campaign for the assessment of Biogenic Emission in the Mediterranean Area (BEMA project) has been carried out in Castelporziano (Rome). The main purpose of the campaign was to further elucidate the quite large monoterpene emissions from the sclerophyllous Mediterranean oak, despite the lack of monoterpenes in the leaves or bark, which had been observed in the preceeding 1993 BEMA campaign. The final results will be available in early 1995.

Within the European research project LABVOC, the troposphere oxidation process of the biogenic dimethyl sulphide - an important source of particles in marine air - has been further investigated in the laboratory. A sensitivity and uncertainty analysis has pointed to major uncertainties in the present understanding of the process, and to future research needs.

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

This field experiment has been scheduled for 1997.

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

Several interlaboratory exercises have been organised, with laboratories in the Member States to assess analytical errors in water analysis.

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

European Chemicals Bureau (ECB)

The first phase of data collection on risk assessment of existing chemicals (Council Regulation 793/93) has been completed. More than 7000 data sets from industrial and commercial companies have been loaded in IUCLID (International Unified Chemicals Information Database) and installed at the competent authorities in the Member States and at the OECD. Meetings with national experts were organised to deal with "Classification and Labelling", "Notification of New Chemicals", "Risk Assessment of Existing Chemicals" and "Export/Import Control of Certain Dangerous Chemicals".

European Centre for Validation of Alternative Testing Methods (ECVAM)

The European Centre for Validation of Alternative Testing Methods (ECVAM) is involved in the development and validation of non-animal tests and testing strategies; it was inaugurated on 17 October 1994. Information services are getting established and the Centre has organised a series of workshops, task forces and symposia. Interlaboratory prevalidation and formal validation studies are in progress.

Working Environment

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

Community services

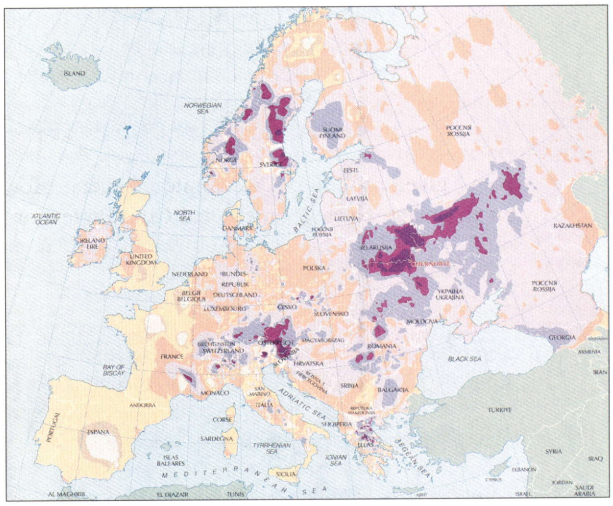
A memorandum of understanding between DG XI and the JRC for the setting-up and operation of the European Reference Laboratory for Air Pollution (ERLAP) was signed on 11 July 1994. ERLAP - an extension of the former Central Laboratory for Air Pollution - is intended to support the action of DG XI on ambient air quality, and to participate in monitoring programmes such as EMEP (European Monitoring and Evaluation Programme).
Preparatory work for ETEX (European Tracer Experiment) continued. ETEX was designed to test the behaviour of atmospheric models for emergency response. The field experiment, which was scheduled to be performed at the end of the year, was enlarged in scope and application through the contribution of equipments and techniques from various countries.
All the available information on environmental contamination from the Chernobyl accident is being collected and merged in form of an atlas. The project, using modern informatics technology, is being developed in collaboration with all European countries - including central and eastern European countries, Russia, Belarus and Ukraine - and is planned to terminate in 1996, ten years after the accident.
Work on ECPHIN, the data bank on pharmaceuticals, has been pursued in support of DG III; a new intercommunication network for the ECPHIN system is being developed.
Further work is going on at the "European Office for Wine, Alcohol and Spirit Drinks", to identify the origin of alcohol in wines and spirits, and to implement the Nuclear Magnetic Resonance (NMR) and Isotope Ratio Mass Spectra (IRMS) fingerprint data bank.

Work for third parties

Further progress was made in activities carried out for the Lombard Region, aimed at control of air pollution monitoring stations, throughout the region.
The contract with Ente Flumendosa in Sardinia continued, with analytical work on water and sediments for the detection of several pollutants, using advanced analytical techniques such as graphite-furnace atomic absorption spectrometry and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).
A new contract with the Sicily Region was signed, to deal with air pollution, water pollution and the control of the general population for trace metal content in body fluids.

Exploratory research

Three projects are being tackled: the use of surface enhanced Raman scattering for the characterisation of aerosols; the development of a tracer technique for gold; the setting up of a laser photo-fragmentation technique for the study of heterogeneous reactions of sulphur compounds in the troposphere.



ETEX, A EUROPEAN TRACER EXPERIMENT: THE ACHIEVEMENT OF THE IN-FIELD CAMPAIGN

ETEX (European Tracer EXperiment) is an atmospheric tracer experiment carried out in Europe, but open to non-European countries, aimed at evaluating the capability and timeliness of atmospheric models to forecast quantitatively the evolution of a pollutant cloud over distances in the order of a thousand kilometres or more and travel times in the order of three days. This is important for testing public emergency plans and warning systems in cases of major accidents.
The project plan was essentially to release an appropriate amount of an atmospheric tracer from a location in Europe, unknown to the participants, informing them of the location and characteristics of the release only when the operation was under way. Two tracer releases were made from the release site (Monterfil, Brittany; France) on 23 October and 14 November 1994. A total of 12,000 air samples have been collected at ground and by aircraft and transferred to JRC-Ispra for analysis. In both experiments, results were received within six hours from the notification of the release sent from 24 participating institutions in 20 countries.
ETEX is co-sponsored by the European Commission, the World Meteorological Organisation and the International Atomic Energy Agency. The project is managed by the JRC-Environment Institute at Ispra. The following countries are participating:
Austria, Belgium, Bulgaria, Canada, Czech Rep., Denmark, Finland, France, Germany, Hungary, Israel, Italy, Japan, Norway, Poland, Romania, Russia, Slovak Rep., Sweden, Switzerland, the Netherlands, United Kingdom, USA.

THE INSTITUTE FOR REMOTE SENSING APPLICATIONS (IRSA)

Located at Ispra, the IRSA implements the programme on the applications of remote sensing. The Institute, through the use of satellite Earth observation data, provides key scientific support for agricultural statistics at the request of the Directorate General for Agriculture (DG VI) and the European Statistical Office (EUROSTAT). It also provides scientific and technical support at the request of the Directorates General for External Relations (DG I), Development (DG VIII), and Environment, Nuclear Safety and Civil Protection (DG XI).
Within the programme on the Application of Remote Sensing Techniques, the IRSA has undertaken work on a number of themes related to the monitoring of the environment and to global change.

Environmental monitoring in Europe and the Centre for Earth Observation

New techniques for obtaining specific information on the condition of the European environment are being developed. These are based on the use of satellite imagery and geographic information systems.
The Forest Information from Remote Sensing (FIRS) programme consolidated its planning phase, and the first steps towards a uniform European forest information system were taken.
The first pilot studies of a new initiative, the Coastal Ecosystem Monitoring project, were successfully started. They will embrace initiatives such as sediment transport and coastal erosion.
Land degradation monitoring tests concentrated on soil erosion and wildfire damage at Spanish and Greek test sites. These were complemented by the first experiments concerning hydrological modelling for water resource management.
The pathfinder phase of the Centre for Earth Observation (CEO) project, aiming at preparing the "Design and Implementation Phase" has been started in conjunction with a steering committee of the Member States set up by the Board of Governors. Under their guidance IRSA established a CEO project committee which began activities to survey and understand the present infrastructure status, establish user requirements, and produce cost estimates, with the goal of producing a final plan for the design and implementation phase.

Global change

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

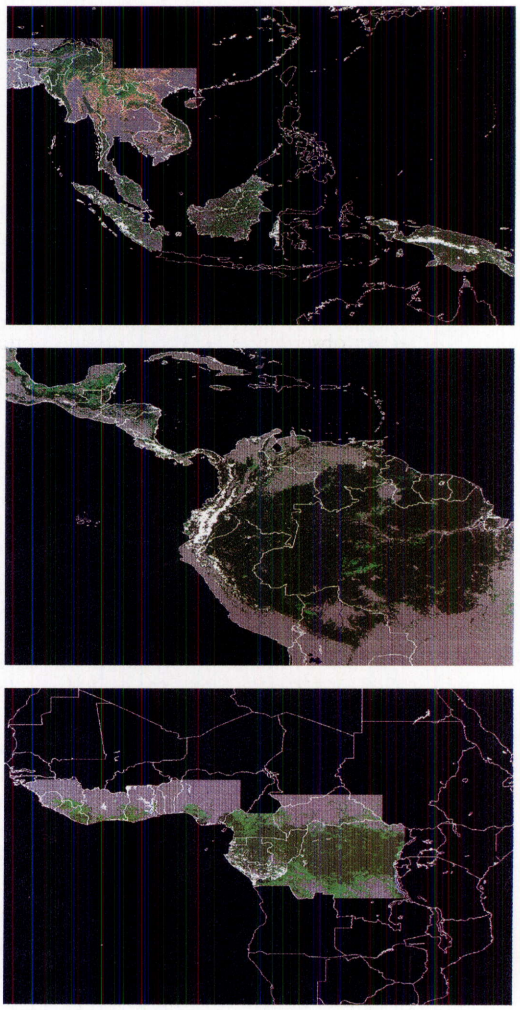


IMAGE IS A NEW FOREST / NON-FOREST MAP OF THE WORLD

1994 saw the completion of a new and outstanding data set describing the World's Tropical Forests. The first "wall to wall" data set and derived map will provide a baseline for global tropical forest monitoring and deforestation studies.
This is the culmination of three years of data collection, prototyping, methodological development and analysis.
The work has been performed in collaboration with experts and institutions across Europe and the tropical countries.
A full validation exercise, has been conducted using high resolution imagery from the Landsat , SPOT and ERS-1 satellites.

The processing of a ten-year data set for the African continent was completed. These data were used for continental-scale land cover classification, and to generate a unique view of wildfire patterns for the continent. These results are used for global change research in the framework of two International Geosphere Biosphere Programme activities, the Data and Information System and the International Global Atmospheric Chemistry (IGAC) project respectively.
Complementary work in the marine environments of the biosphere saw the establishment of networks of applications projects to use the archives of processed ocean colour and sea surface temperature data. Significant progress was made in linking Earth observation data sets into bio-optical models, for a prediction of the ocean's net primary productivity.

Advanced techniques of Earth observation

The European Microwave Signature Laboratory (EMSL) began the experiment plan coordinated by the International Advisory Committee. The EMSL also responded to ad hoc requests for experimentation concerning detection of dangerous objects.
Laboratory measurements using the Optical Goniometer, supported by field observations, made significant progress towards extraction of precise geophysical measurements, particularly relating to spectral signatures of biochemicals in vegetation reflectance spectra. Such measurements will be vital for interpretation of data from future space instruments.
Development of workstations for automatic marine oil spill detection and for the monitoring of shipping traffic, using satellite and airborne Synthetic Aperture Radar (SAR) systems, neared completion. These will be tested as an aid to coastguard activities in Europe.
SAR data from the European Remote Sensing Satellite No. 1 (ERS-1) were also used for mapping and monitoring of temperate forests in Europe and tropical forests in South America and West Africa.

Community services

The pilot project for the application of remote sensing to agricultural statistics increased its operational capabilities. Regular bulletins of crop statistics and information on crop conditions are being routinely published. These are forwarded to DG VI and EUROSTAT. The national statistical services of some Member States are implementing the agricultural project's methodology. The work has also been extended to new geographical regions, including the Maghreb and the Czech Republic, where the remote sensing methods were found to be equally effective.
The Fire in Global Environmental Monitoring programme (FIRE) contributed to the establishment of a new IGAC project to look at the effect of savanna fires on atmospheric chemistry. Field work in central Africa and Madagascar, aimed at constructing operational fire monitoring systems, in support of DG VIII, was carried out and confirmed the effectiveness of fire detection from satellite. This information may be used for the protection of forest reserves and national parks.
New methods for land cover map update and revision from satellite data were developed in support of DG XI. The Ocean Colour Techniques for Observation, Processing and Utilisation Systems (OCTOPUS) programme has been developed with ESA and other European partners in preparation for the upcoming Sea viewing Wide Field of view Sensor (SeaWiFS) space mission.

External services

The TRopical Ecosystem Environmental observation by Satellite (TREES) project (a joint project with ESA, the European Space Agency) completed the first worldwide tropical forest inventory from satellite data, and began detailed planning for a second project phase concentrating on forest condition monitoring, to develop an alarm system for detection of major areas of tropical deforestation.
The European Airborne Remote SEnsing Capability (EARSEC), a joint project with ESA, consolidated its instrument development and testing programme. Optical and microwave sensors will be available in 1995, to be used in airborne experimental campaigns throughout Europe.
Third party work for water resource monitoring and management in the Mediterranean continued, and new work focusing on environmental monitoring for Sicily began.
The Institute also became involved in the VEGETATION programme developed by France, Belgium, Italy, Sweden and the European Commission. This will manage the development of the new operational vegetation monitoring space-borne instrument. The data will be used for mapping surface parameters, such as surface roughness, and for use in operational crop production forecasting.

Exploratory research

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

THE INSTITUTE FOR SAFETY TECHNOLOGY (IST)

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

Reactor safety

The Institute contributed to research on Light Water Reactor (LWR) severe accidents. The work focussed on the study of the interaction of molten corium with the coolant and reactor structures and on the evaluation of the quantity and quality of radioactive products (source term) which would be released in the case of an accident.
In the first area, the tests in the FARO (Fuel Melting And Release Oven) and KROTOS, (Small Scale Steam Explosion) facilities delivered important results, which are being discussed by the European and US partners to better understand the fundamental mechanisms of molten fuel-coolant interaction (melt quenching, steam explosion) and to validate computer models. The first full-scale tests in FARO (with 150 kg of molten material) have been performed. A first evaluation was made of the effect, on the quenching process, of the presence of zirconium metal in the molten corium.
The COMETA (COre MElt Thermal-hydraulic Analysis) code already developed has been successfully used to analyse the FARO tests. In KROTOS, a series of tests with uranium oxide in water allowed a clear comparison with results obtained using simulant materials (e.g. aluminium oxide) which exhibit very different behaviour.
In the second area, source term, work focussed on completing the construction of STORM, a large scale facility designed to investigate aerosol re-suspension in the primary system and its role on source term. In addition, the development of the ESTER source term code package and the analysis of the first Phebus FP in-pile test performed in December 1993 continued in close cooperation with the partners in this international project.

Nuclear safeguards

The activities of Non-Destructive Assay (NDA) are performed at the PERformance LAboratory (PERLA); those of mass-volume determination in the TAnk MEasurement (TAME) laboratory.
Studies on neutron multiplication and hardware developments have been carried out in the field of plutonium monitoring. Thermal (infrared) video systems were tested, to check their applicability to plutonium monitoring, with positive results.

Waste management

Actinide monitoring activities focused on developing active and passive systems for checking uranium and plutonium in waste packages.
An industrial scale plutonium control system for 200 l drums was successfully tested in industrial environments. Several organisations have shown interest in exploiting such a system. A uranium measurement system for small samples (about 1 dm^3) was built for an industrial customer.

Fusion technology

European Tritium Handling Experimental Laboratory (ETHEL): two experimental circuits were prepared for commissioning with hydrogen/deuterium and new services installed to improve the laboratory's future operational and maintenance activities. A third test is in preparation, while the laboratory's Tritium Rework Unit is at the detailed design stage. Active operations with tritium in ETHEL should start in 1995, and will allow large scale experiments for ITER (International Thermonuclear Experimental Reactor).
A low inventory tritium laboratory was put into operation in 1994, so that hot tests could be performed on the memory effects of tritium in zeolites and in in-building structures, in support of the work of ITER. A special inquiry performed for the latter concerned tritium tracking in a fusion reactor.

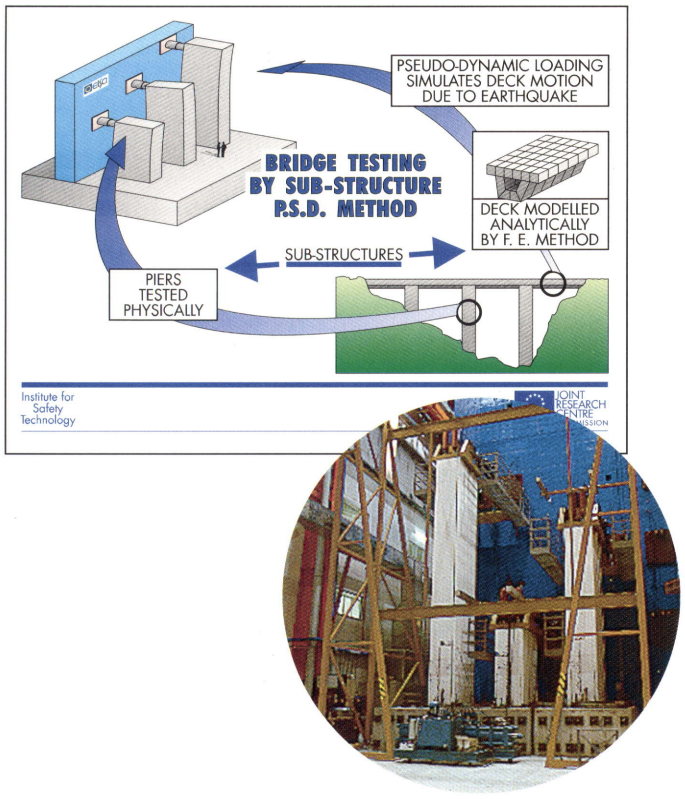
Industrial hazards

The FIRES facility was modified and prepared for studies on polymerisation reactions, in cooperation with the chemical industry. Advanced methodologies were further developed to determine reactor conditions, process optimisation and control.
In close cooperation with industry, validation of the computer package RELIEF (design venting system code) has been continued. A personal computer version of this code, with a sophisticated user interface, has been completed. A venting test series in the new test facilities DRACULA (large-scale venting) and COLUMBUS (venting of long horizontal vessels) has been started. A general computer module for the numerical simulation of transient two-phase flow has been developed, and work is continuing on the development of a 3-D version of the code, also including reacting flow capabilities.

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

Measurement and testing

Pseudo-dynamic tests on large-scale models of civil engineering structures are being performed at the ELSA reaction-wall facility, as part of a project of prenormative research in support of Eurocode No. 8, for the design of civil engineering structures in seismic areas. This activity is performed within a scientific network involving 19 European laboratories under the Commission's Human Capital and Mobility programme. The overall aim of the prenormative research is to enlarge, through analytical and experimental studies, the current field of application of Eurocode No. 8 and to improve its reliability. A fullscale 4-storey reinforced concrete structure was tested at the ELSA reaction wall under severe earthquake loadings. This experimental campaign provided unique experimental data for the validation of computer simulation models and for the calibration of damage indicators to be used in the safety assessment of reinforced concrete structures.
Pseudo-dynamic tests were also performed on large-scale models of irregular bridges using the so-called substructuring technique. The ELSA team also contributed to the European concerted action on the semi-rigid behaviour of civil engineering connections.



LARGE-SCALE PSEUDODYNAMIC TESTS ON HIGHLY IRREGULAR BRIDGES IN THE ELSA LABORATORY

A scientific network involving 18 research organisations in the European Union and the JRC ELSA laboratory jointly execute a programme of pre-normative research in support of Eurocode No. 8 (EC8) for the design of structures in seismic areas. As part of the above programme of pre-normative research, pseudo-dynamic tests on highly irregular bridges were performed in the ELSA reaction-wall facility during the year 1994. The testing programme included pseudo-dynamic tests on six complete bridges. The bridges have 3 piers with height ranging from 7 to 21 meters and identical cross sections (rectangular hollow section with 400 mm thickness) and a continuous deck (200 m long). The bridges are representative of typical multi-span continuous-deck motorway bridges.
Despite the potential of the pseudodynamic technique, direct testing of very large civil engineering structures like bridges would be impossible due to the size of the model (which would actually be bigger than the laboratory itself) and the number of degrees of freedom to be controlled. It is, however, possible to extend the field of application of the method, at least when the behaviour of a part of the structure is well known, by introducing a substructuring technique. With such a technique, only the part of a large and complex structure (here the bridge piers) which is expected to suffer severe damage is physically tested, the remainder (the bridge deck in the present case) being simulated by a finite element computer code running in parallel with the pseudodynamic test.

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

Community services

The Institute for Safety Technology has continued to provide a scientific and technical support to the EURATOM Safeguards Directorate (ESD) and to the IAEA (through DG I) in the field of nuclear safeguards. More than 10 training courses and calibration exercises have been organised in PERLA (PERformance LAboratory for safeguards) for Nuclear Safeguards Inspectors; a seminar with 20 Russian experts has also been organised in PERLA, to support the ESD in its cooperation with the Russian Federation.
An unattended/integrated active neutron monitoring system (UMS) utilising surveillance tools, has been designed and initiated (in collaboration with ISEI) with the aim of providing ESD with a modern device capable of monitoring in unattended mode, the total output of fuel assemblies produced in a Low Enriched Uranium (LEU) fuel fabrication plant. The device will be tested and installed in 1995.
Field measurement results collected by ESD need to be organised in upgraded data base facilities to facilitate performance assessment, long term evaluation, training and procedure setup. IST is providing the data base systems, which are being implemented and linked to a network.

Work for third parties

Contracts with European and non-European research organisations and industries, continued in 1994. The Institute has performed studies and experiments in the nuclear and non-nuclear fields.
The United States Nuclear Regulatory Commission (USNRC) is partly funding the large scale facility FARO and the small scale facility KROTOS for fuel-coolant-interaction experiments.
The detailed design and the operation of the STORM facility for studies on aerosol deposition-resuspension, and research on innovative advanced small reactors using nuclear safety codes, are carried out on behalf of the "Ente Nazionale per l'Energia Elettrica" (ENEL).
The Large Dynamic Test Facility (LTDF) is being used mainly for studies of dynamic material properties in collaboration with European or Japanese partners.

THE INSTITUTE FOR PROSPECTIVE TECHNOLOGICAL STUDIES (IPTS)

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

Science and Technology Observatory

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

Community service

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

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

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

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

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

External service

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

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

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