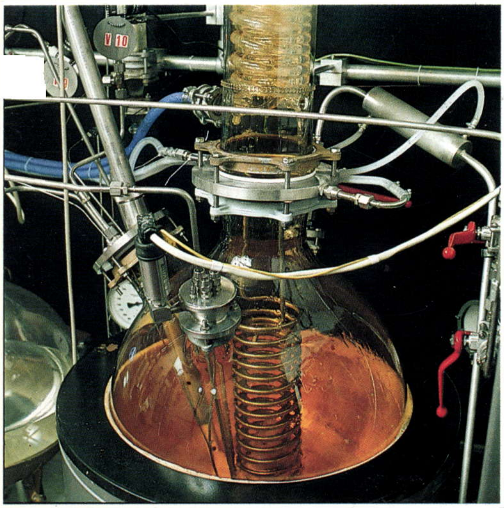
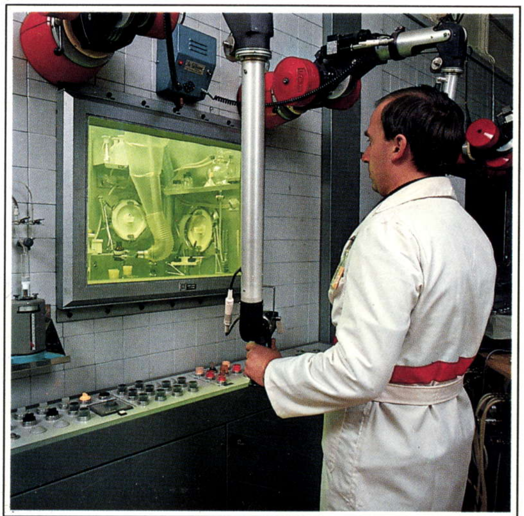
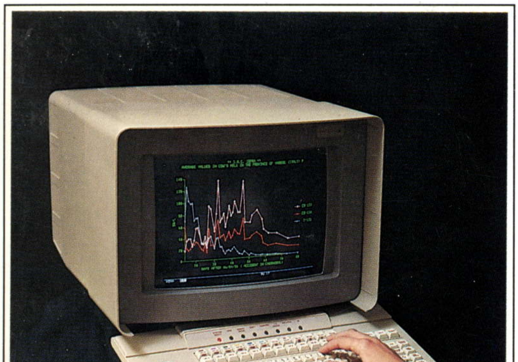
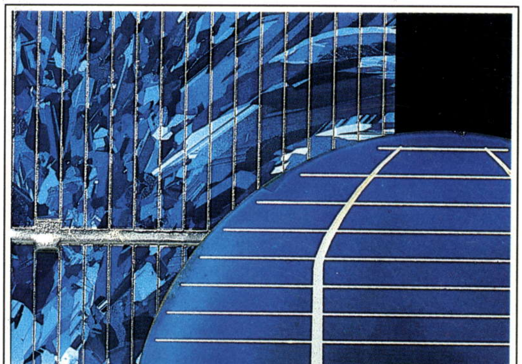
# JOINT RESEARCH CENTRE

## ANNUAL REPORT 1986









COMMISSION OF THE
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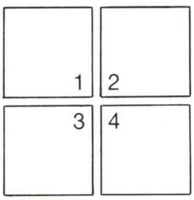
Cover illustrations




EUR 10937

# JOINT RESEARCH CENTRE

## ANNUAL REPORT 1986

COMMISSION OF THE
EUROPEAN COMMUNITIES

# Foreword

This 1986 annual report for the Joint Research Centre (JRC) of the Commission of the European Communities is being published, for the first time, in a version intended for a wide diffusion in order to increase general public awareness of the scientific activities of the Community's own Research Centre.

The brochure highlights the JRC's main themes of research as they are carried out in its four establishments located at Geel (Belgium), Ispra (Italy), Karlsruhe (Federal Republic of Germany) and Petten (Netherlands); these themes are linked with the implementation of several Community policies which constitue the essential motivation for such research. The brochure focuses in more detail on the 1986 achievements of the four establishments.

1986 was a particularly significant year for the JRC: numerous milestones were reached thanks to the team effort of our scientists, and of our administrative staff. The year was also marked by the initiation of an in-depth reflection on the future role of the JRC.

This reexamination of our mandate for the future began with a thorough evaluation of JRC activities. Findings were presented as a Communication from the Commission in March 1986 and subsequently discussed in Council, Parliament and the Economic and Social Committee.

Furthermore, in response to proposals made by the Council, the Commission decided to set up a Panel of Senior Industrialists to examine from an industrial point of view the future mission of the JRC. The Panel's report was delivered in late 1986; its recommendations constitute an important input to the current process leading to the proposal of the Commission for a new outlook on the JRC.

Future JRC activities will continue to support the Commission's implementations of Community policies, focusing on well identified scientific needs in a few selected areas; they will also be opened to work contracted out by public and private organizations, thereby ensuring a closer involvement of the JRC in the evolving industrial context of the Community. Public awareness about the JRC's scientific activities will undoubtedly contribute to the achievement of such goals.

K.-H. NARJES
Vice-President

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# Introduction

The Joint Research Centre (JRC) carries out "in-house" scientific and technical research programmes as an integral part of the Community's overall policy for research and technological development; it provides a public service for the benefit of the Community and the implementation of its policies.The JRC consists of four research establishments located at Geel (B), Petten (NL), Karlsruhe (F. R.of Germany) and Ispra (I), with headquarters in Brussels.

Established under the EURATOM Treaty, the JRC was originally concerned with research into civil applications of nuclear energy. In the early 1970's Community R&D policy began to expand into other fields, and the JRC's activities were extended to areas such as non-nuclear energy, and environmental protection.

More recently, major Community R&D programmes were launched with a distinctly industrial orientation: ESPRIT (Information Technologies), BRITE (Industrial Technologies), BAP (Biotechnology) and RACE (Telecommunications). Under the Single European Act of 1986, which calls for a strengthening of the scientific and technological basis of European industry, this trend will continue.

The JRC's own research programmes follow the trend and are geared more and more to industrial needs and objectives; furthermore, great care is being devoted to orient JRC activities according to the demand of well identified customers, in order to ensure the greatest relevance of this research.

The 1986 activities were focused - as foreseen in the 1984-1987 JRC multiannual programme - on research into industrial technologies, energy (nuclear and non-nuclear) and environmental protection.

The JRC also provides scientific and technical support for other services of the Commission in the formulation and the implementation of Community policies for which they are responsible (e.g. energy policy, industrial policy, environmental policy, customs union).

The JRC also contributes to the development of the scientific knowledge and techniques necessary to permit standardisation bodies and regulatory authorities to fix norms and standards on a rational and neutral basis. This is an important element in the Community's efforts to unify its internal market.

Projects undertaken by the JRC reflect the collective concerns of all twelve Community countries, and are independent of national interests. The JRC also plays a federating role as the focal point for work performed in the laboratories of the twelve Member States, and several outside the Community.

The total number of people employed by the JRC is 2260, including administrative and back-up staff as well as scientists and technicians; in 1986 expenditure was around 200 Mecus.

Ispra (I) is the largest of the four establishments, employing three-quarters of the JRC staff. It carries out research in the key areas of nuclear fission safety, nuclear fusion, non-nuclear energy, environmental protection, applications of satellite remote sensing, industrial hazards and materials.

Karlsruhe (F.R. Germany) houses the Institute for Transuranium Elements, a highly specialized laboratory which carries out research into plutonium and other actinides (radioactive substances which are produced mainly in nuclear reactors), and the safety of nuclear fuels.

Petten (NL) specializes in studies on advanced materials at high temperatures and is the site of the High Flux Reactor which is used to test the behaviour of materials under irradiation. It is one of the busiest materials testing reactors in the world.

Geel (B) is the Central Bureau for Nuclear Measurements. It carries out precision measurements and prepares reference materials for the nuclear energy industry. Available techniques are also used for non-nuclear reference materials.

# THE ISPRA ESTABLISHMENT

# Environment

The protection of the environment and the safety of European citizens have been growing concerns of the European Community. Great emphasis is placed on providing scientific support for the implementation of the Community's environmental policy; most of these research activities are undertaken at the specific request of the Commission's services or governmental institutions. In 1986, as the Community was preparing for European Year of the Environment (1987), the Ispra Establishment of the JRC conducted research in three areas: environmental protection, land and sea surveillance using remote sensing techniques, and industrial hazards.

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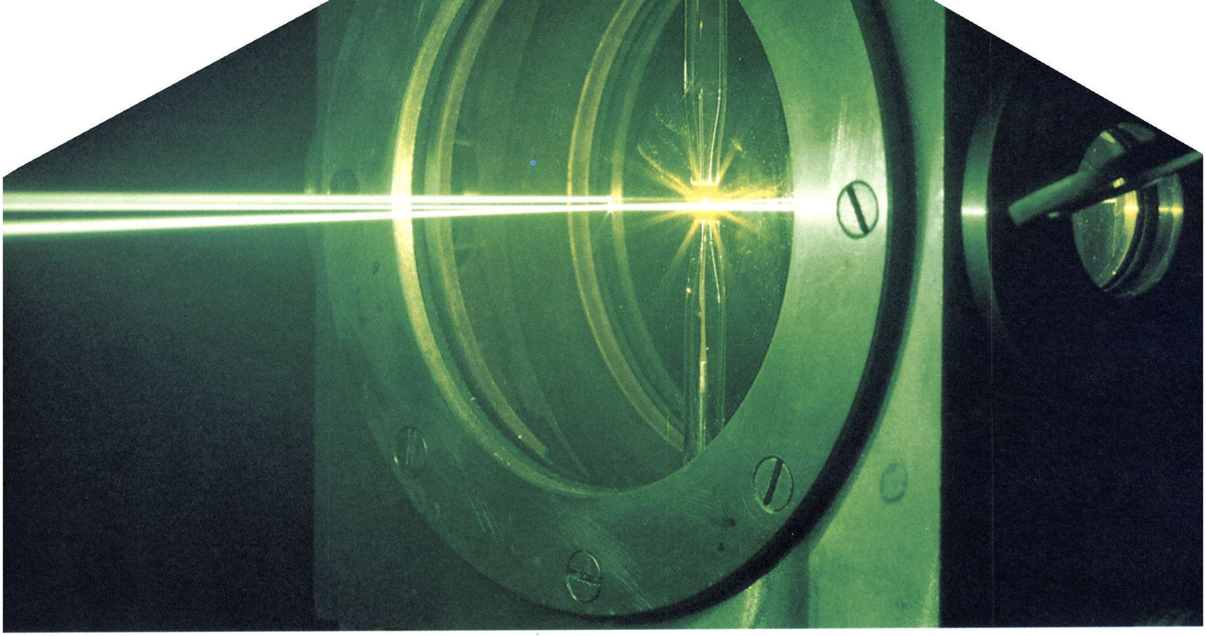

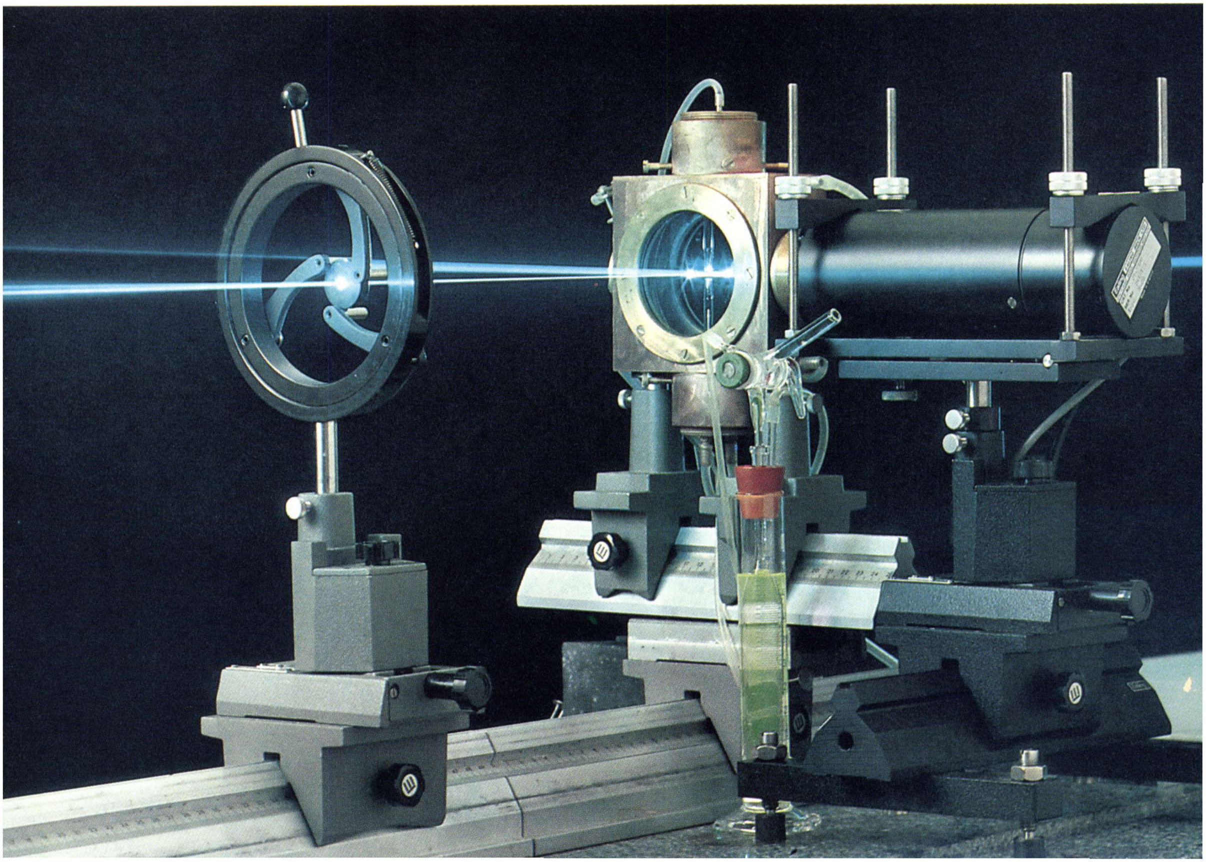

# Environmental Protection

Research aimed at improving the protection of the environment has focused on three aspects: environmental chemicals, atmospheric pollution and trace metal pollution.

Throughout 1986, a substantial improvement in the development of ECDIN, the Environmental Chemicals Data Information Network on chemical products which may interact unfavourably with the environment, was achieved by extending and updating the data coverage of the files. In total, about 50 000 new or revised data have been added. At present ECDIN, which is publicly available from a commercial firm Datacentralen in Copenhagen as an on-line service, has about 300 users (40% chemical industry, 35% libraries and information services, 25% governmental and local authorities, research institutes). The European Inventory of Existing Chemical Substances (EINECS), which is a special register within ECDIN, allows a legal distinction to be made between "old" and "new" chemicals; it was completed in 1986. This is a very important achievement for the application of Community legislation governing the production, labelling and transport of dangerous chemicals.

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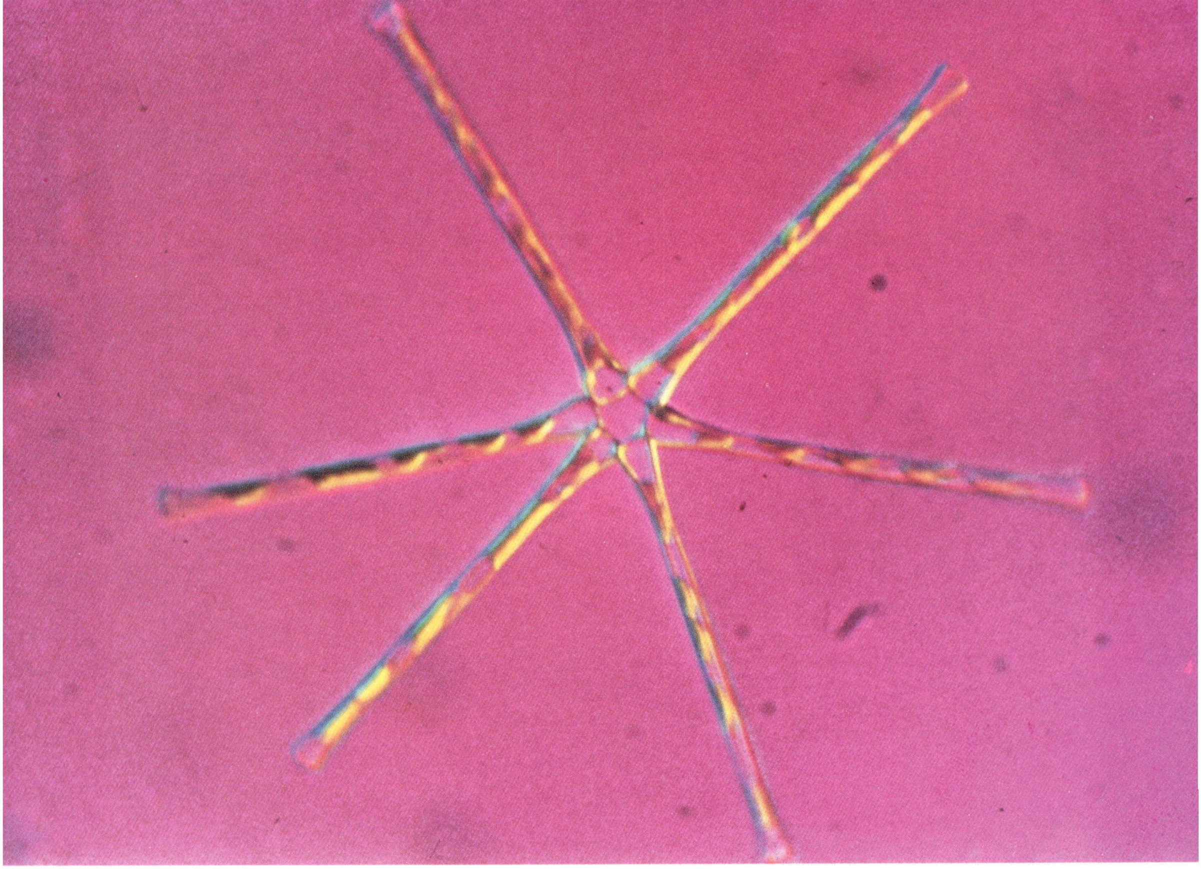
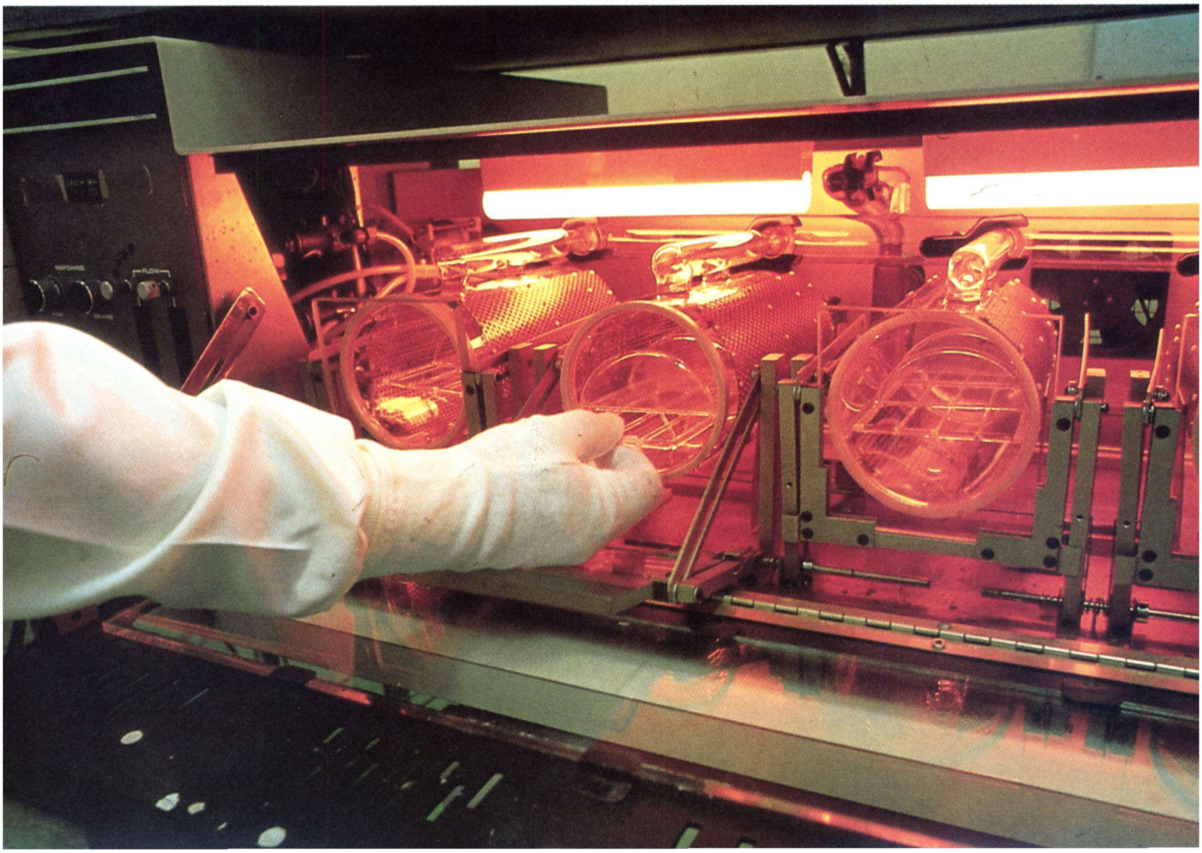
The surveillance of the indoor air quality is growing in importance because of the socio-economic trend towards an increased time spent in offices, at home as well as in recreational buildings. JRC initiated an Indoor Air Quality project, linking several national laboratories in the twelve Community Member States, with JRC Ispra as the central coordinator; a preliminary laboratory intercomparison exercise was completed and the launching of joint European projects is foreseen. At the request of the European Parliament, indoor air quality levels were measured in the European Parliament offices and during a Strasbourg plenary session; they were found acceptable.

The emission of volatile organic solvents by a variety of consumer products has also been tested, and their significance as a source of indoor pollution has been established.

The major pollutants of the atmosphere are the combustion gases from coal and oil burned in thermal power stations; sulphur dioxide is a major component of these gases. These pollutants are considered the main cause of acid rain. In 1986, the Central Laboratory for Air Pollution set up for the implementation of the EC Directive on limits for sulphur dioxide, completed its measurements in the Member States. An extended measurements programme based on the daily sampling and analysis of atmospheric suspended particulates and their precipitation was also run continuously at Ispra. All this work is part of a programme on the evaluation and monitoring of European pollution.





Ispra's mobile laboratory for the remote sensing of atmospheric pollutants was re-equipped with better instruments; another mobile unit was designed for the release of perfluorocarbon into the atmosphere, a special tracer used to study atmospheric diffusion and transport. The technique should allow the tracer to be detected up to 200 Km away. Ispra is also preparing a joint project with the research centre at Wurenlingen (Switzerland), which will investigate the Italian/Swiss alpine transport of atmospheric tracers.

The Ispra Mark 13 A process for power-plant flue-gas desulphurisation was developed as a spin-off from energy research on hydrogen; it entered a new phase in 1986 with the decision to build and operate a pilot plant at an Italian refinery. The engineering work was completed, and the unit is expected to be in use by the end of 1987, treating an hourly through-put of 32,000 m3. Laboratory work is also under way to develop a process which will combine desulphurisation with the removal of nitrogen oxides. If successful, this process could be used industrially to clean the exhaust gas of thermal power plants.

Progress is also being made with the research into trace metals pollution. Laboratory work on the effects of trace metals on living organisms in fresh water showed that a continuous introduction of trace metals is more dangerous to plankton than a single accidental discharge of the same total quantity.

The use of a radio-labelling technique has allowed the investigation of the passage of trace metals from ash (produced when hard coal and lignite are burned) into the soil, and thereby to the human body. A dynamic model for the transfer of chromium suggests an increase in the amounts found in human tissues for a population living within 5 Km of the ash deposit. Such results are important for safety authorities at all levels.

The "Athens lead experiment" aimed at assessing the impact of lead in car exhaust gas on human blood continued in 1986. Preliminary results show a substantial decrease of lead in blood following the reduction of lead in gasoline from 0.4 to 0.2 grammes per litre of gasoline.


** J.R.C. ISPRA **
AVERAGE VALUES IN COW'S MILK IN THE PROVINCE OF VARESE (ITALY)
BQ/L
CS-137
CS-134
I-131
DAYS AFTER 86/04/26 ( ACCIDENT IN CHERNOBYL)

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VIETATO
L'ACCESSO

# Remote Sensing Techniques

Observation of the Earth by satellite-borne sensors constitutes a powerful means of collecting data on agriculture, land-use, marine pollution and coastal phenomena in an economic and global way.

In recent years, JRC Ispra has built up a considerable expertise in the use of remote sensing techniques; these activities are now mostly oriented towards applications for the benefit of various environmental protection agencies, African governmental organizations, as well as the Commission's own services.

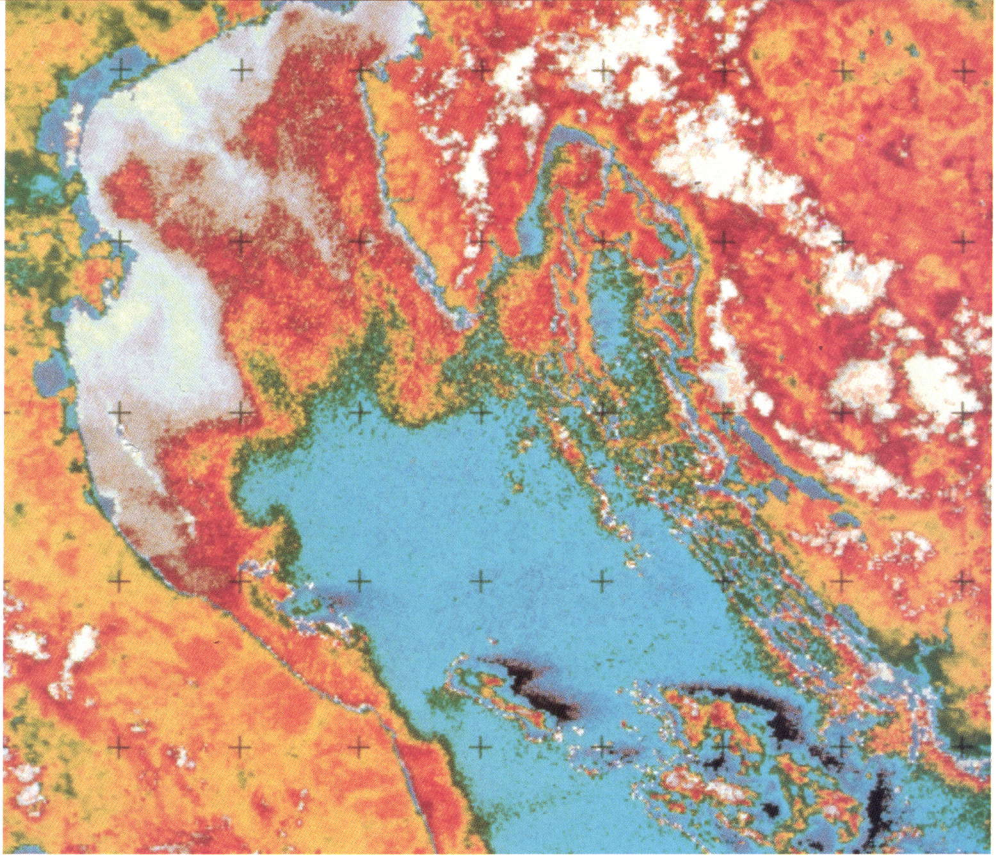
A new campaign on agricultural data acquisition took place in 1986 in cooperation with the European Space Agency and national laboratories. Known as AGRISAR 86, it covered agricultural sites in five different European countries. The data collected is now being evaluated together with the results of previous data-acquisition campaigns. The final objective of these activities is to help improve the European agriculture statistics for which a new programme was started at the request of the European Statistical Office and of the Directorate General for Agriculture.

The JOLIBA project which monitors natural renewable resources in the Sahelian countries of Africa was extended. The aim is to develop methodologies for the surveillance of rain-fed crop production and river flood prediction, using the "Landsat" and "SPOT" satellite data. JRC Ispra has also assumed the technical coordination of eight remote sensing projects on the desertification of the Sahelian countries carried out by European national laboratories. The aim of these activities is to demonstrate how space remote sensing techniques could contribute to an agricultural monitoring system and lead to a better regional assessment of food production in Africa.

Throughout 1986, results were being analysed from the Archimede II exercise on the remote sensing of hydrocarbons at the surface of the sea in the German Bight. Much of this work is still in progress,the surveillance of hydrocarbon pollution at sea.

Work also continued on the gathering and analysis of data on the coastal transport of pollution, especially in the Northern Adriatic basin. Campaigns conducted in 1986 led to a better understanding of the relationship between total suspended matter (one of the parameters accessible to remote sensing) and the presence of heavy metals.

A study of the West African upwelling area for the Fishery Research Institute of Morocco produced data for chlorophyll-like pigment concentrations, sea surface temperature distributions and fish capture. The evaluation of these data is in progress.



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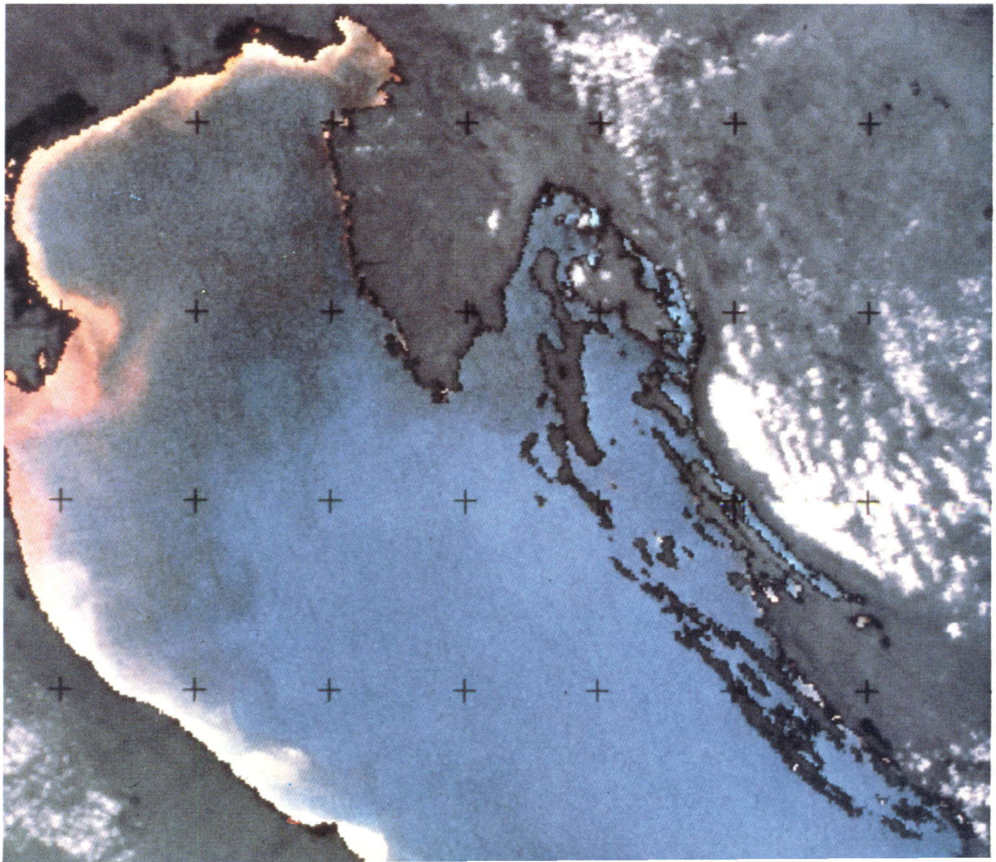

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# Industrial Hazards

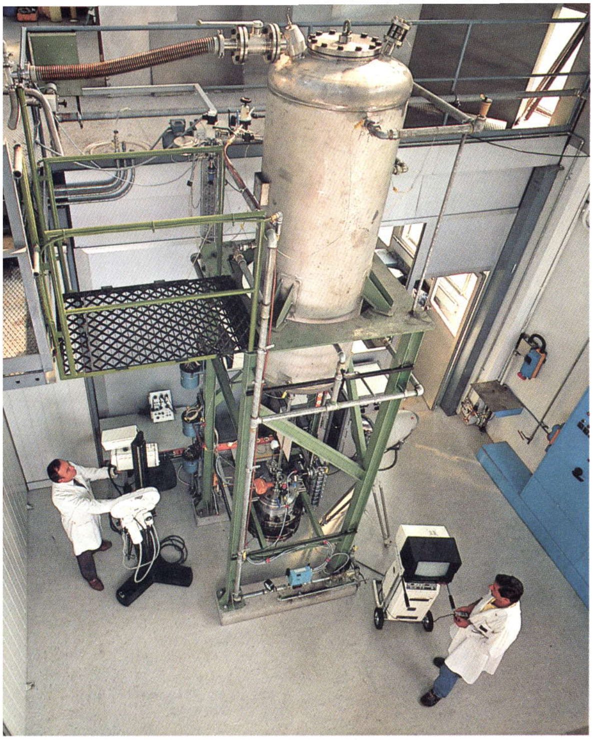
Research into industrial hazards represents the emergence of a new field of expertise at the Ispra Establishment. Disasters such as those at Flixborough, Seveso, Bhopal and elsewhere have drawn the public's attention to the threat to public health and to the environment which results from sudden catastrophic events. Public authorities at all levels are seeking greater control over major hazardous industrial undertakings, and are looking to science to help them in this task.

Research in this area is potentially a very large field, covering system reliability, structure reliability, human-system interactions, decision theory, understanding of explosion mechanisms, behaviour of materials, atmospheric diffusion of poisonous substances, emergency simulation and planning.

In 1986, JRC Ispra launched a new activity in accident prevention by putting forward the criteria, objectives and content for a safety case analysis of a chosen "benchmark" industrial plant. The analysis itself is being performed in collaboration, with national research institutes such as TNO (NL), TUV (F.R. Germany), GRS (F.R. Germany), HSE (UK), RIS (DK), ENEA (I) and major industrial companies under a shared cost programme; the European Safety and Reliability Association will be involved.

Other developments included completion of the informatic structure of the data-bank for the Major Accident Reporting System (MARS) to support the implementation of the EC Council Directive on Major Accident Hazards of certain industrial activities, and of an integrated software system to support the management of riks involving hazardous substances. A project was begun with the Dutch Ministry responsible for environmental affairs to assess this system for the production, transportation and use of chlorine.

In the field of accident management and control, Ispra ran two workshops on the chemical and thermodynamic behaviour of runaway reactions. As a result, work has begun into the setting up of a Facility for Investigating Runaway Events Safety (FIRES), including a chemical reactor. The JRC research project in this field will be coordinated by a European Contact Group on Runaway Reactions which will include industrial companies, national research institutes and universities.



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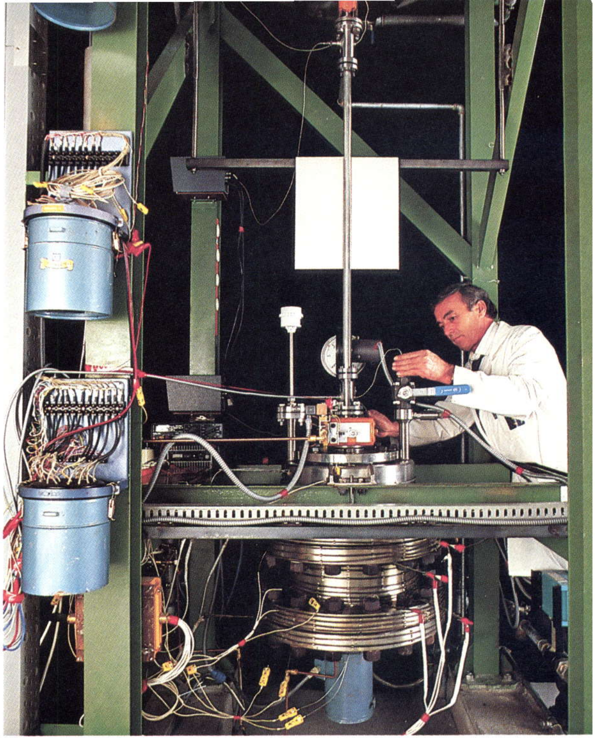

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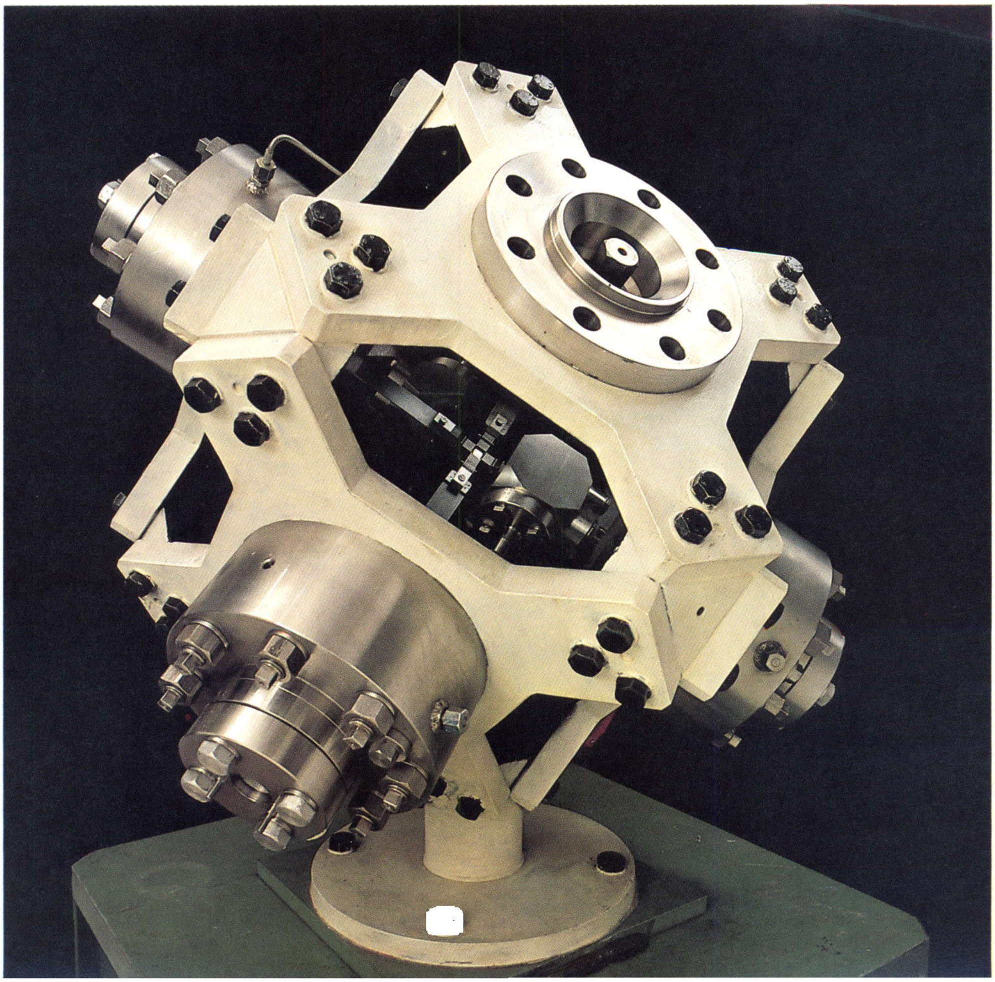

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# Solar Energy

Solar energy systems have great potential from an energy supply viewpoint, especially in Mediterranean countries. But the practical realization of this potential requires validated measurements of performance and durability. JRC Ispra plays an important role in the development of European technologies for the use of solar energy through its European Solar Test Installations (ESTI). It has test facilities for both photovoltaic and thermal solar devices. In 1986, ESTI had thirteen industrial users.

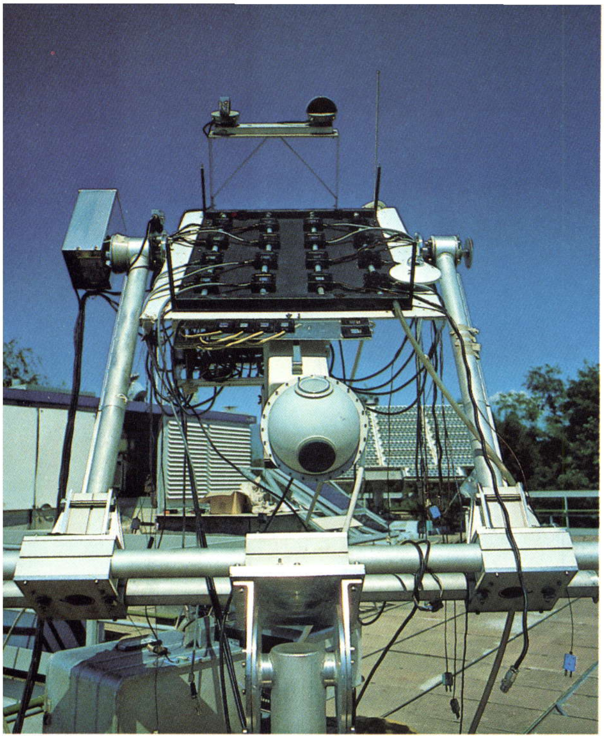
Ispra continued to participate actively in the worldwide standard writing activities of the International Electrotechnical Commission, including the experimental validation of specific procedures, the calibration of photovoltaic devices and the monitoring of photovoltaic plants.

Work in the field of thermal conversion was actively continued with the development of methods for the performance prediction and the durability evaluation of solar thermal systems. This activity is mainly carried out within the European Solar Collector and Systems Testing Group,which is managed and financed by the JRC. This Group, composed of 22 national laboratories, has been progressing actively with new participants from Spain and Portugal. Results are based on experimental and theoretical work carried out within the respective laboratories and the JRC test facilities. The International Standards Organization has chosen the JRC as technical expert for the formulation of standards for solar-thermal collectors.

The results from the European Solar Collector and Systems Testing Group (which comprises practically all national laboratories for thermal solar testing, as well as Ispra) is a striking example of what a concerted prenormative activity at the European level can accomplish.

JRC Ispra also runs a research programme aimed at improving energy conservation in households (about 35 % of total Community energy consumption), based on energy audit techniques. In 1986, JRC Ispra completed and tested two solar passive test cells which will be considered references for similar installations planned in Member States. The JRC solar laboratory was converted to a hybrid solar active/passive building in order to assist in the validation of performance prediction methods. Emphasis is being put on solar passive testing because of its potential impact on energy conservation in buildings and the need for adequate standards for solar architecture.

Using a JRC patent for the downward transfer of heat without a pump, a small solar plant for heating process water was built in a textile plant in Italy.



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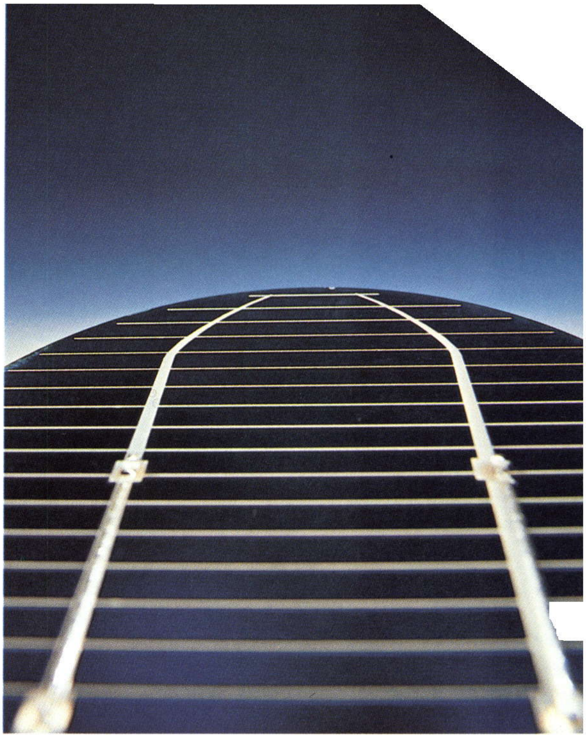

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# Nuclear Fusion

Controlled thermonuclear fusion offers the long-term possibility of a new form of energy. JRC research in this field is part of the European Fusion Programme which covers all the fusion work carried out in the laboratories of Member States, together with those in Sweden and Switzerland.

The ultimate aim of the programme is the joint acquisition of the scientific and technological knowledge needed to build fusion power plants. Research is concentrated on the most promising approach which uses the magnetic confinement of a high temperature plasma in which the fusion reaction occurs.

The first stage is the demonstration of the scientific feasibility of fusion which will be achieved during this decade by the operation of JET (the Joint European Torus at Culham in the UK) and similar devices in the US and Japan.

The second stage is a demonstration of the technical feasibility which will require the construction of an experimental reactor, the Next European Torus (NET), in order to test different technical components for a future commercial demonstration reactor (DEMO).

The NET team at Garching (F. R. of Germany) has already begun the conceptual design work for the second stage machine, with important contributions being made by the JRC. Ispra was involved in studies which led to the design of the reactor's mechanical configuration, the remote handling system and components inside the machine's vacuum chamber (first wall and tritium breeding blanket). A facility was constructed to investigate the thermal-mechanical behaviour of the first wall of NET under pulsed operating conditions, and preliminary tests were performed.

Experimental data obtained at Ispra also contributed to design work on the so-called blanket technology (based on liquid mixtures of lithium and lead) which will be used to "breed" the tritium needed for the fusion reaction itself. The high flux reactor at JRC Petten was used for the neutron irradiation of lithium-lead at temperatures relevant to NET in order to measure tritium production and its diffusion through the steel container.

Research into the structural materials needed for NET was also conducted at Ispra and Petten. This dealt mainly with the investigation of different steels which may be used for the walls and blanket structures in both NET and DEMO.

Ispra is involved in risk assessment for thermonuclear fusion. The neutron-induced radioactivity in structural and breeder materials was evaluated. The amount of constituents and impurities which can be tolerated in order to enable a shallow land burial of the materials, after use in a fusion reactor, was assessed. Safety evaluations were performed; the scenario of a loss of coolant accident was analysed in order to assess the need for an emergency cooling system.

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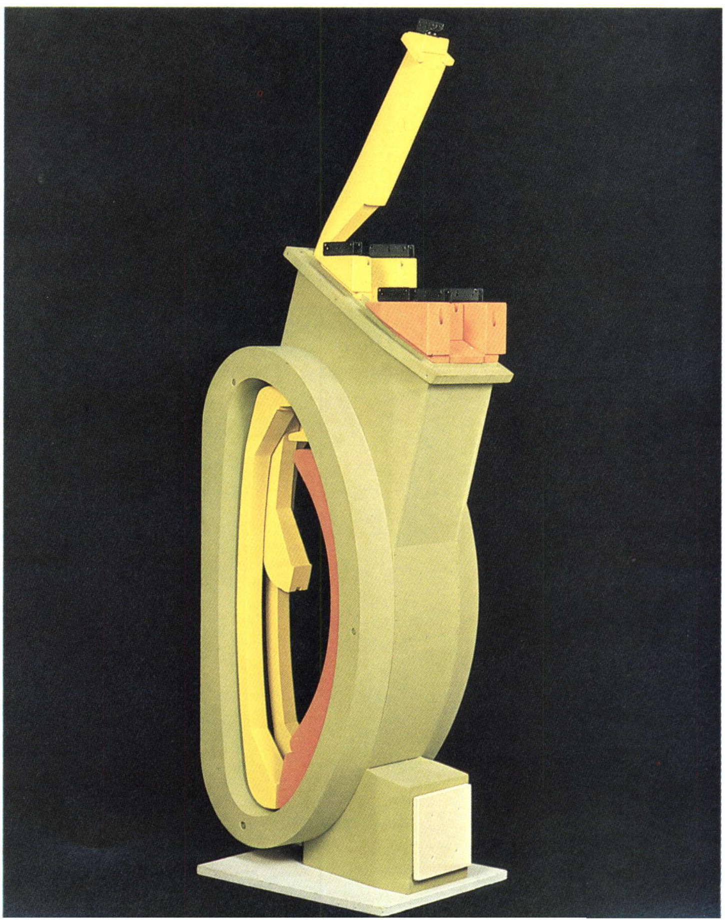

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Experiments to simulate plasma disruption with an electron beam were also used to investigate the effects of the presence of helium in the first wall material during the disruption. It was shown that the precipitation of helium causes cracks and material losses. New experimental data on the interaction between lithium-lead and water have been obtained, and an experimental facility to investigate the effects of a rupture in the blanket coolant tube is under construction.

The computer code developed to evaluate the environmental effects of tritium dispersion in the atmosphere was used to support tritium release experiments performed in France.

Early in the year, twenty-one firms presented nine offers for the preliminary design study of the laboratory named ETHEL (European Tritium Handling Laboratory), which will be mainly devoted to the safety aspects of tritium handling in fusion plants. Four offers were selected for the execution, within a six-month period, of parallel studies including the design and cost evaluation of the laboratory. At the end of the study, a contractor was chosen for the next phase, namely the detailed design and construction of a laboratory at Ispra.

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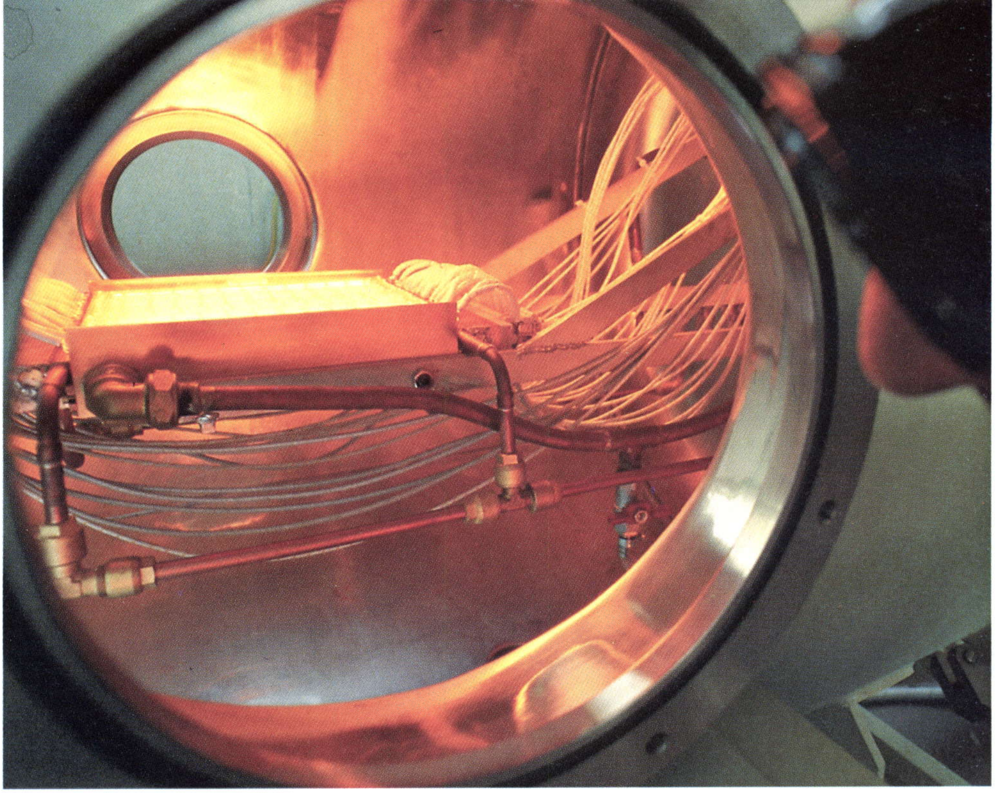

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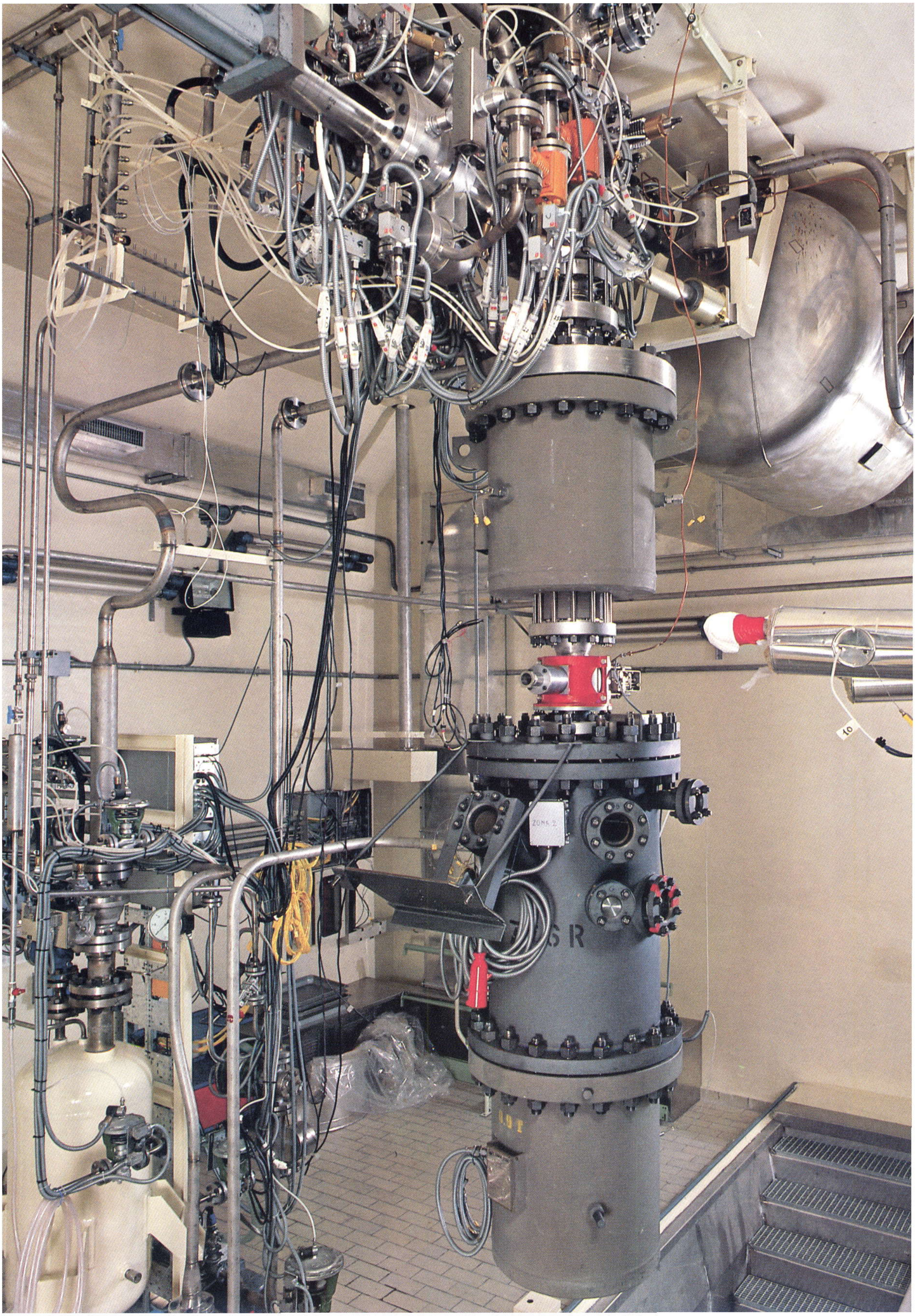
# Nuclear Fission

Nuclear-fission energy is one of the principal means of reducing, in the foreseeable future, the Community's dependance on petroleum through a diversification of energy sources. Consequently, the continuation of a safe nuclear programme is an essential aspect of European energy policy.

Community research is oriented towards the safety aspects of nuclear fission. It covers research on the safety of both light-water reactors (LWR) and liquid-metal-cooled fast breeders (LMFBR), on the management of radioactive waste, and on the safeguarding and management of fissile materials; this is implemented at Ispra. Research on nuclear fuels and the actinide elements is carried out at Karlsruhe. Additional research into reactor safety is done through shared-cost contracts with research institutes in Member States.

Outside the programme execution, a particular event merits special mention. The nuclear establishments, in collaboration with the appropriate national laboratories, maintain a routine observation of the atmospheric radioactivity in and around the establishments of the JRC. The Radioprotection Division in Ispra was the first to measure indications of the passage of the radioactive cloud from the Chernobyl disaster over Northern Italy. An intensified measurement campaign with reporting to the Italian authorities and the Commission was immediately initiated and the experience gained here gave rise to the formulation of a new project on radiation monitoring and evaluation for the JRC programme modification for 1987.



# Reactor Safety

JRC activities on reactor safety cover accident prevention and mitigation for both Light Water Reactors (LWR) and Liquid Metal Fast Breeder Reactors (LMFBR).

Research into accident prevention is aimed at improving the design and construction of reactor components and systems in order to increase their operational reliability, thereby increasing the safety of nuclear power plants. It also includes inspection methodologies and procedures for early detection of structural defects, and methods to predict the life expectancy of reactor components.

Accident mitigation studies are directed towards a better understanding of the phenomena which occur during the course of an accident with a view to mitigate the consequences. It includes the development of models to simulate the various stages of a reactor accident. Several types of accident are considered: those involving a temporary loss of coolant which does not endanger the reactor core, and hypothetical accidents where damage to the core and a release of fission products may occur.

For the reliability and risk evaluation of LWRs an important achievement has been the creation of a viable information system on all aspects of reactor operation. In 1986 the two most important data banks which are part of the European Reliability Data System (ERDS) were almost completed. These are the Component Event Data Bank (CEDB) which assembles data on reactor component failures, and the Abnormal Occurrence Reporting System (AORS) which systematically collects and classifies the information from national abnormal occurrence reports. These systems have already made some interesting analysis possible, and were of great help during the analysis of the Chernobyl disaster in identifying some issues of relevance for Western reactors.

For several years, JRC Ispra has been coordinating benchmark exercises aimed at comparing the different procedures and methods used by national organizations in applying probabilistic risk analysis techniques. In 1986 new computer codes for reliability analysis were completed; they are now available for Member States. A new exercise to model human errors during test and maintenance operations, and during an hypothetical accident began in 1986 with the participation of national organizations.


JRC-PURIST
AXIS CONTROL
PISC
MANUAL AXIS CONTROLS
COMPUTER
WATER CIRCUIT
FAN UNIT
SERVO POWER AMPS
POWER SUPPLIES
FAN UNIT

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The Project for the Inspection of Steel Components (PISC) assesses procedures and techniques used for the inspection of nuclear reactor structures (particularly the vessel and pipings). It is jointly sponsored by the OECD/NEA and the European Community, with approximately 50 % of the resources provided by the Commission; the remaining 50 % comes from non-EC countries through inspections and materials, and the OECD/NEA provides secretarial support. The results of PISC II were analysed in 1986, confirming that techniques exist which enable safe inspections to be performed. An important result of PISC II was the announced modification of the ASME, section XI code. The improvement and industrialization of these techniques will be covered in PISC III which began in 1986.

Another important LWR safety research activity, performed in collaboration with several European organizations, is aimed at the prediction of the residual life of primary components of nuclear reactors. Fatigue testing was carried out on a 1:5 scale model reactor as part of a programme to develop ways of predicting the lifetime of reactor pressure vessels and related components. Work also began on a pressurized thermal shock experiment to study crack behaviour in the critical zones of a pressure vessel.

LOBI, the large experimental facility located at Ispra, was used to investigate the thermohydraulic behaviour of reactor during loss of coolant accident. Several tests were successfully performed in 1986, providing experimental data used to validate computer codes which are widely used in Europe. National research teams are associated with this work through shared cost contracts.

Ispra also participated in LACE, the international programme organized by the US Electric Power Research Institute to investigate aerosol behaviour in LWR containment buildings in the event of a serious accident. Related experiments on the revolatilization and resuspension of fission products in containment buildings were also begun through shared-cost contracts.

The research on LMFBR safety is directed to provide experimental data and to develop models for the analysis of very low probability accidents involving partial or total core damage. The specially built FARO facility began with tests aimed at obtaining a controlled release of molten uranium dioxide into the test area. This will be used to investigate phenomena such as fuel fragmentation, fuel jet perforation, fuel plugging and freezing.

The Post-Accident Heat Removal (PAHR) experiment aims at assessing the coolability of a layer of uranium dioxide and steel particles in sodium which could be deposited on reactor structures if the core of a fast-breeder reactor were to melt. In 1986, in-pile tests were successfully carried out, within a shared cost action, at Mol (Belgium). The European Accident Code which describe the initiation phase of a whole-core accident, has been released to the Member States in its first version.

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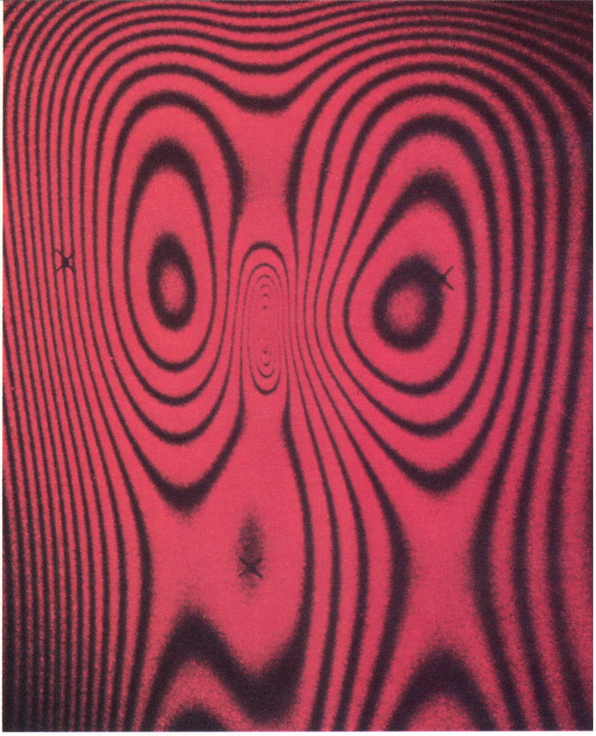

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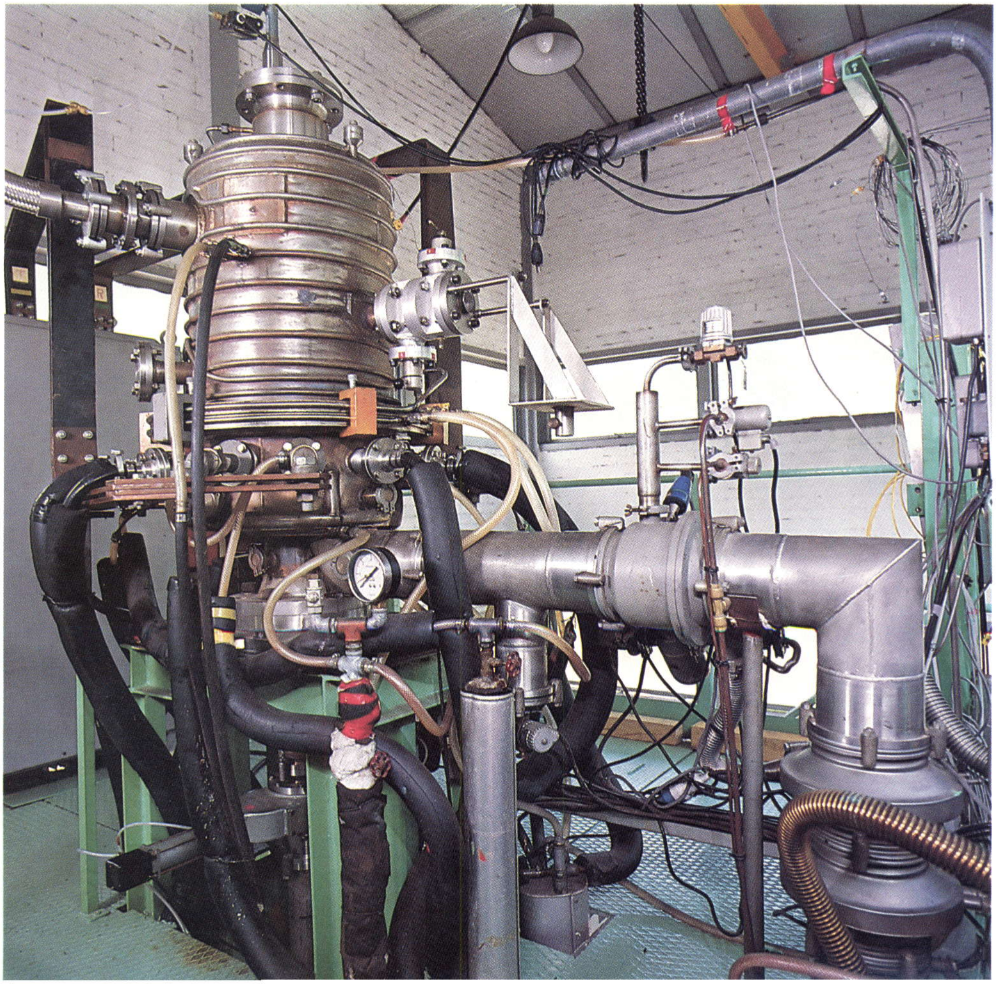

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# Radioactive Waste Management

The future of nuclear power and its acceptance by the general public depends, among other things, on the development of satisfactory methods for the management and final disposal of radioactive waste produced in the nuclear fuel cycle.

At Ispra, research is conducted into several aspects of the waste management problem, and in 1986, the final preparations were being made to the PETRA facility which will be able to prepare and handle several types of nuclear waste, and contribute to the optimization of waste management procedures. PETRA is due to become fully operational in 1987, and a users group composed of experts from Member States was set up to plan its work programme.

Radioactive waste generated in the nuclear fuel cycle will need to be disposed of in repositories mined into carefully chosen geological formations. Research is needed in order to analyse the safety of these repositories and Ispra's scientific resources in this field are mainly dedicated to such studies.

In 1986 studies were made to improve the quality of the safety assessment of such geological repositories; for example, the possible release of neptunium from waste containers and its migration through the geosphere was studied in specially designed experimental facilities. This contributed to the validation of the mathematical models needed for safety assessment by safety and regulatory authorities.

The disposal of radioactive waste in deep oceanic sediments could be a possible alternative to storage in continental geological formations. Within the NEA (OECD) Seabed Working Group, Ispra participated in studies on the experimental penetration of deep oceanic sediments, and the related hole closure process. A data transmission experiment from 30 m inside the sediments at 5400 m water depth and then via satellite to land was successfully completed.

# Nuclear Safeguards

The safeguarding of nuclear materials is a prerequisite for nuclear energy. In the European Community, nuclear materials safeguards are implemented by the EURATOM Safeguards Inspectorate of the Commission, based in Luxemburg; worldwide, these safeguards are implemented by the International Atomic Energy Agency (IAEA).

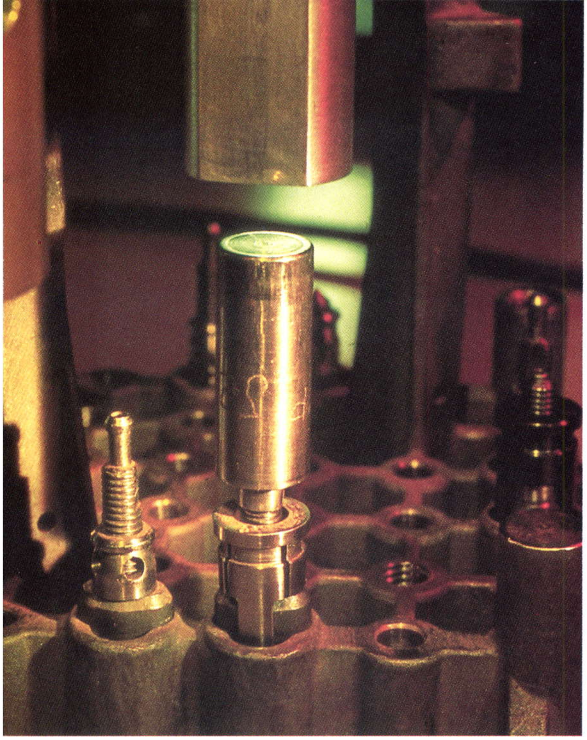
The scope of the JRC programme is to provide the scientific and technical support needed for an efficient implementation of these nuclear safeguards.

In 1986 the "Pre-Perla" plutonium handling laboratory was inaugurated at Ispra by the Commission's Vice President Narjes. This facility is designed for the performance assessment of instruments needed for industrial measurements of fissile materials, and for the training of nuclear safeguards inspectors.

A fully automatic optical surveillance system was demonstrated for the first time in a nuclear material storage area. The system is based on image transmission via optical fibres and image processing to detect abnormal occurences in nuclear materials handling. It is now up to the Safeguards Authorities to decide upon the routine utilization of this system for the surveillance of industrial nuclear facilities.

A study was carried out for the development of a laser disc archive to collect and compose images of the brass seals used on containers for nuclear materials.

Work was also completed on the application of statistical accountancy to data supplied by industrial plant operators. The information is stored in a large computerized safeguards data base which is now installed at the headquarters of the IAEA.



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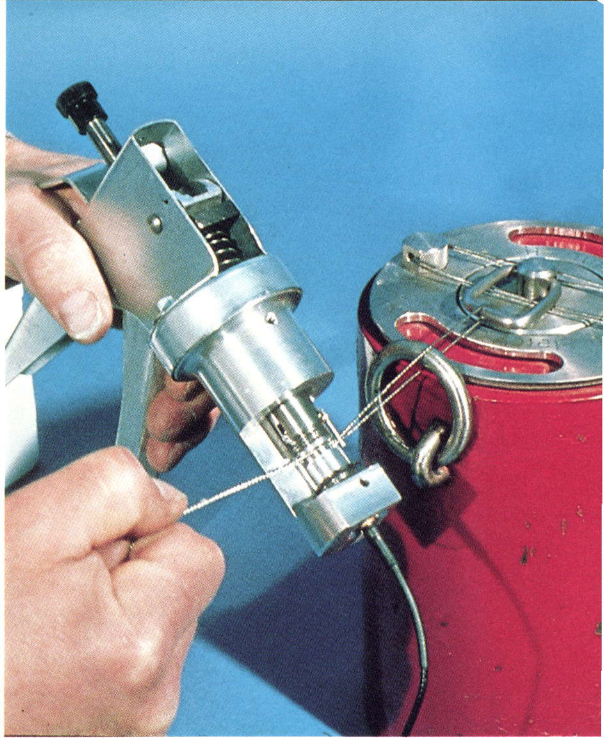

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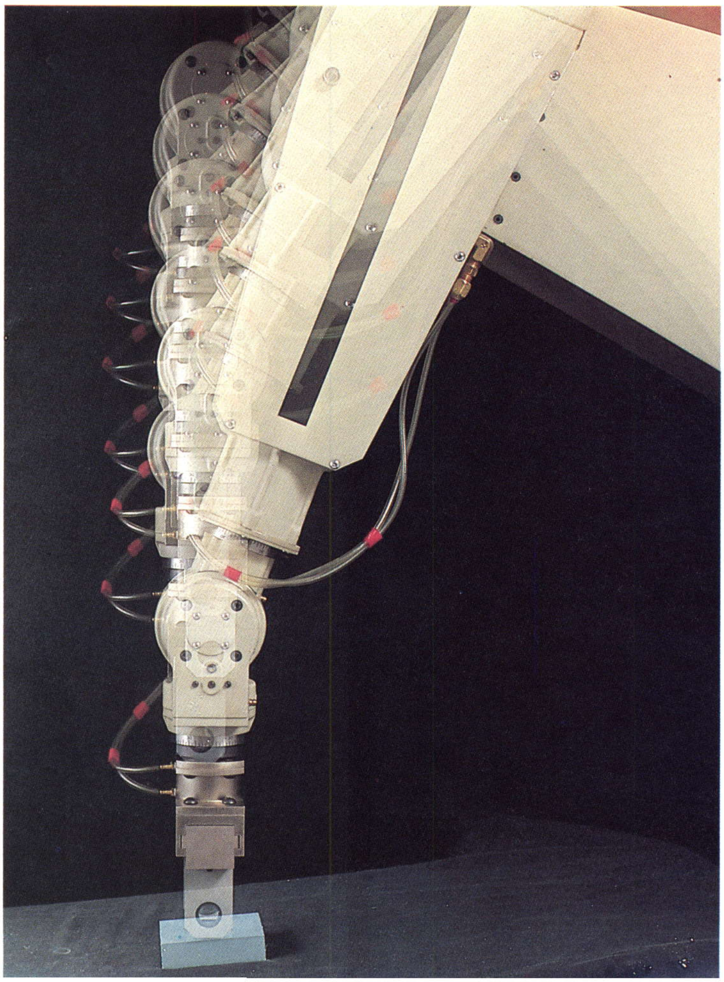

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# THE KARLSRUHE ESTABLISHMENT

# Nuclear Fuels and Actinides

JRC Karlsruhe is the European Institute for Transuranium Elements which carries out research into the development and improvement of nuclear fuels, safety aspects of the nuclear fuel cycle, and basic research on the actinide elements.

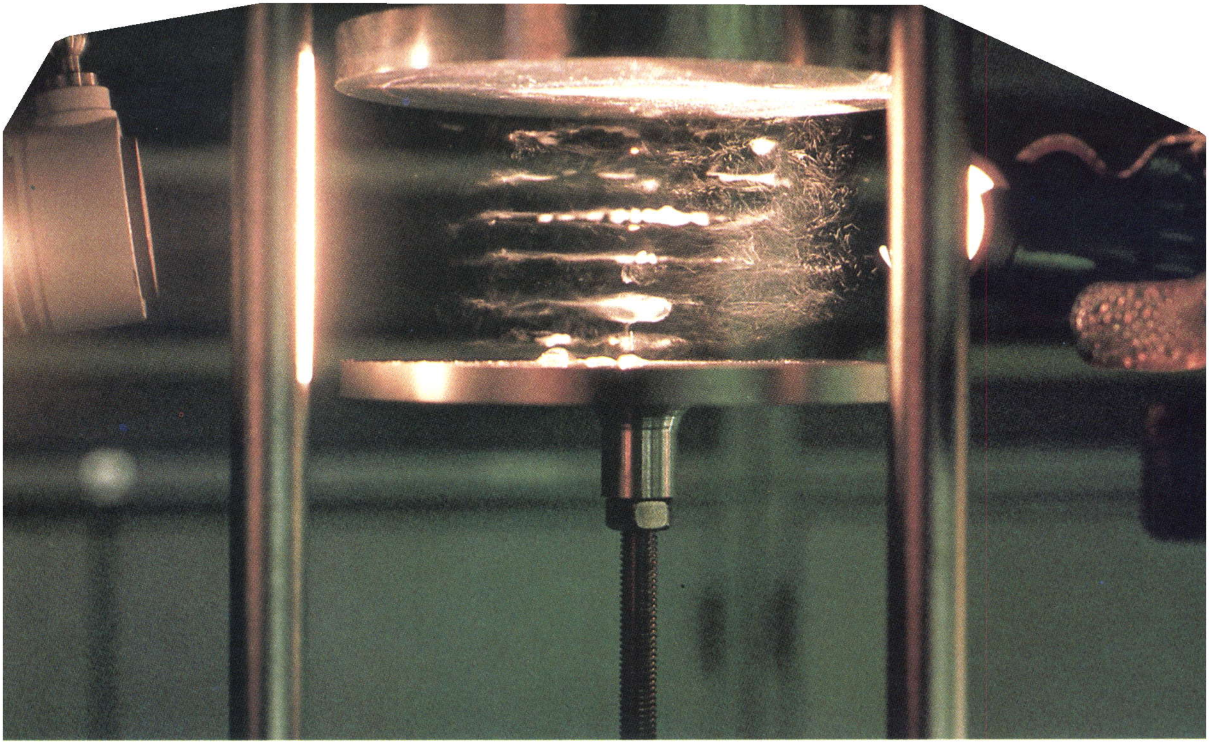
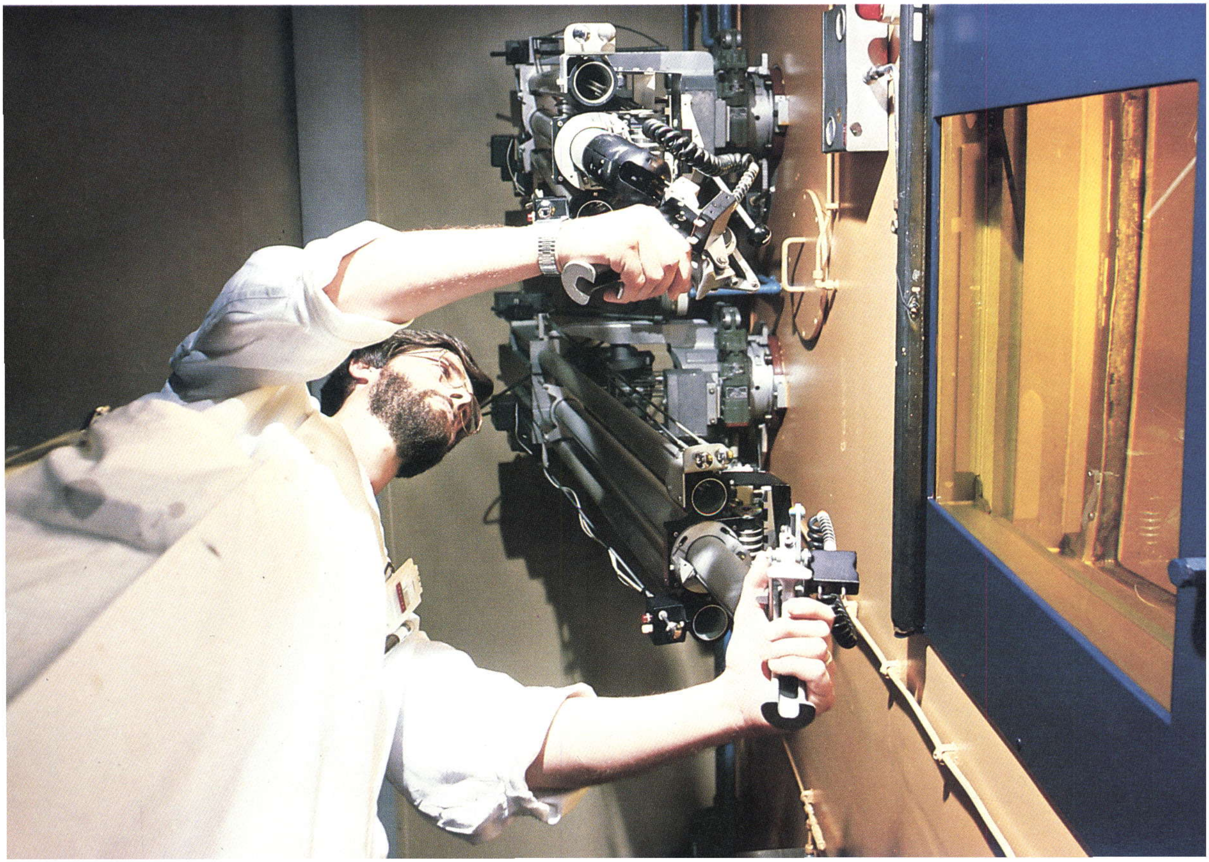
A key project at Karlsruhe is the research into the safe use of fuels for fast breeder reactors. In 1986 this was pursued by studies on advanced fuels: characterization of nitride fuel, fuel property measurements, the preparation of irradiation experiments, and fuel pin modelling studies. The collection of data on the properties of nitride continued and a preliminary version of a fuel swelling model was established.

It was also pursued by measuring the very high temperature properties of nuclear materials in a new laser autoclave. Equation of state studies were completed in 1986, establishing agreement between the measured and calculated partial pressures over liquid uranium dioxide up to 5000 K (degrees Kelvin).

Experimental activity on the behaviour of oxide fuels and fission products (under conditions of severe fuel damage) was concentrated on an analysis of three types of LWR fuel in the as-irradiated state and after slow transients. The development of a mechanistic fission product behaviour code (FUTURE) was also completed in 1986. A steady state and transient integral fuel rod performance code (TRANSURANUS) was also validated for base and transient irradiations of value for nuclear industry and safety authorities.

Karlsruhe carries out various experimental and theoretical studies on the formation of actinides in reactors. In 1986 ten different actinide oxides were irradiated in the Karlsruhe fast flux test reactor and the results analysed. Fuel pins containing neptunium and americium were prepared for a joint irradiation with the French Atomic Energy authorities.

Studies into the formation, characterization and trapping of plutonium-bearing aerosols were also carried out. A computer code was developed to describe three dimensional flow fields and the variation of aerosol particle concentration with time and space. More than fifty full scale "glove box" fire experiments were performed in a fire chamber equipped with instruments to measure the concentrations of airborne contaminants and examine the mechanisms of their dispersion. The scavenging of nuclear aerosols by acoustic waves showed particularly promising results. This could have important consequences for the safe handling of nuclear fuels.

# THE GEEL ESTABLISHMENT

# Nuclear Measurements and Reference Materials

The Central Bureau of Nuclear Measurements (CBNM) at Geel plays an important role in the development of the Community's nuclear energy industry, particularly through its contribution to the harmonization of nuclear measurements and reference materials. Its work has now been extended to include reference materials and measuring techniques in non-nuclear fields in support of the Community Bureau of Reference Programme and as part of the effort to enlarge the research into industrial technologies.

Nuclear measurements are carried out mostly according to the needs expressed by international bodies such as the IAEA and the OECD-NEA, but are also at the request of national institutions.

In 1986, the fission cross-section of 235-Uranium, the number of fission-neutrons emitted for each neutron absorbed in 235-Uranium, and the capture cross-section for 238-Uranium, were determined in the subthermal neutron energy region. The fission cross-section of 243-Americium was also measured in the neutron energy range 100 eV to 10 MeV, providing a significant addition to the knowledge of this cross-section.



Important measurements were also carried out on neutron emission cross-sections in order to provide data for neutron transport calculations for the design of the lithium blanket needed to breed tritium in fusion reactors.

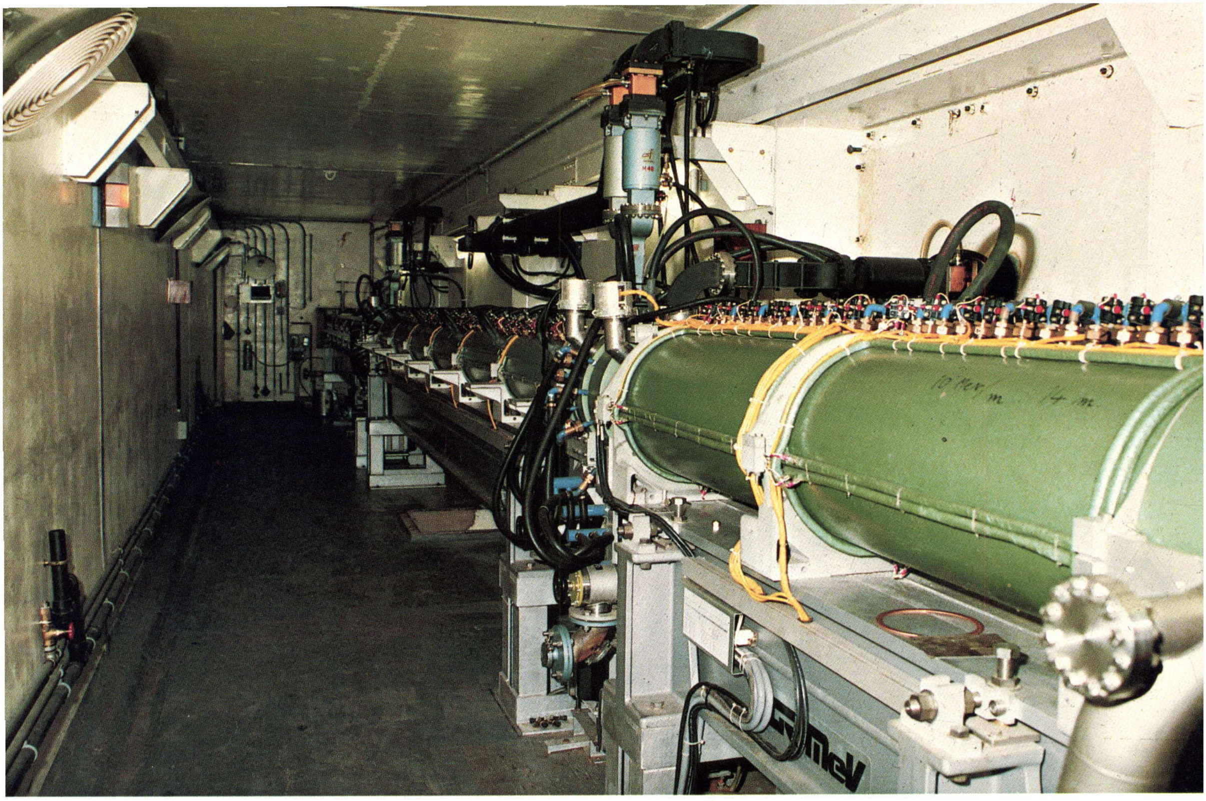
Progress was made in the preparation of reference materials of uranium minerals, and pilot samples of plutonium dioxide for isotopic abundance measurements were completed for distribution to interested laboratories.

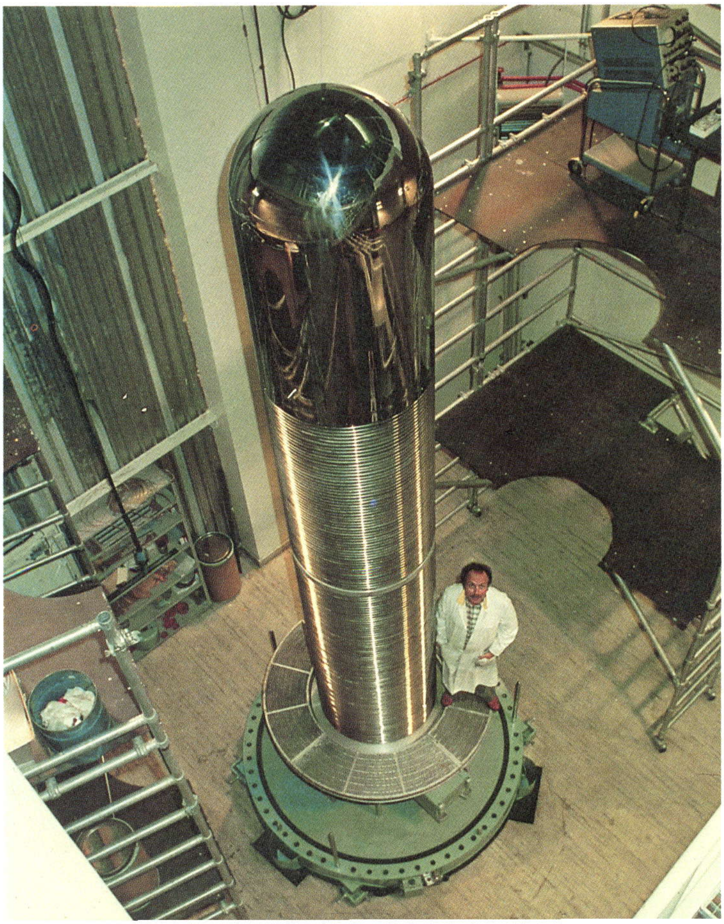
Numerous reference materials, special targets and samples were sold to many customers, in 1986.

The CBNM also initiated a Regular European Interlaboratory Measurement Evaluation Programme related to actinide measurements. Support to the Euratom Safeguards Inspectorate was continued.

Outside the nuclear field, Geel carried out a measurement of the thickness of a commercially prepared gold layer on a nickel support by determining the absorption of the nickel X-ray radiations. This will serve as thickness reference material in the electronics industry.

Throughout 1986, Geel increased the amount of work it does in support of the CBR by preparing reference materials for a wide variety of customers. A new building devoted to the preparation and handling of non-nuclear reference materials was completed.





# THE PETTEN ESTABLISHMENT

# The High Flux Reactor (HFR)

In 1986, which marked the 25th anniversary of the HFR, routine reactor operation and maintenance was normal but reactor availability decreased slightly due to a delay in the replacement of primary heat exchangers.

The overall reactor occupation showed a significant increase from 54% to 75% of its theoretical maximum (practical limit is about 85 %). A large number of irradiation experiments were carried out successfully contributing to R&D work in the participating Member States (F.R. of Germany and the Netherlands), the JRC and third parties from inside and outside the Community in important areas.

Individual projects included safety aspects of nuclear fission, materials for nuclear fusion, neutron activation analysis for geological and environmental studies, neutron beam research, radio-isotope production and non-destructive testing by neutron radiography.

# High Temperature Materials (HTM)

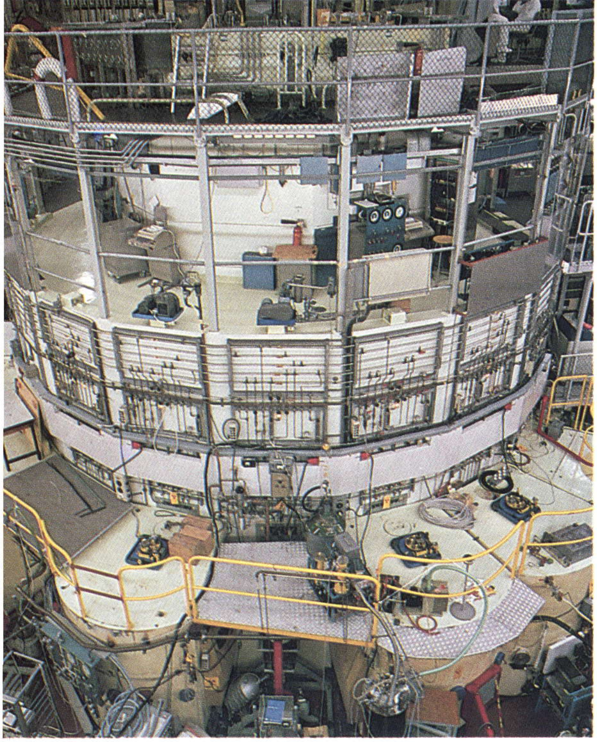
This programme addresses the growing demand for advanced materials for high temperature applications in the European Community. The programme is generic in nature, in order to benefit a range of technologies peculiar to several industries such as transport, chemical, energy, etc. It consists of five projects (Steels and Alloys, Sub-components, Engineering Ceramics, HTM Data Bank and HTM Information Centre).

One of the most important developments of 1986 was the validation of predictive models for the multiaxial creep behaviour of steel alloy tubes under complex mechanical loading and corrosive attack at high temperatures.

Several material damage mechanisms which limit the service life of industrial plant components operating at high temperatures were also established quantitatively: high temperature crack growth, the influence of carburisation on creep deformation, and coating/substrate interface damage caused by thermal cycling.

The threshold between acceptable and catastrophic corrosion in simulated coal conversion environments was established and validated by in-plant testing.

The high temperature materials (HTM) data bank was enlarged by research data from COST programmes on gas turbines and power plant technologies. This work concentrated on creep and fatigue properties. In addition the High Temperature Information Centre organized scientific meetings for materials specialists and compiled inventories of HTM activities in Europe. It commissioned studies to identify current developments in materials technology and future research needs.



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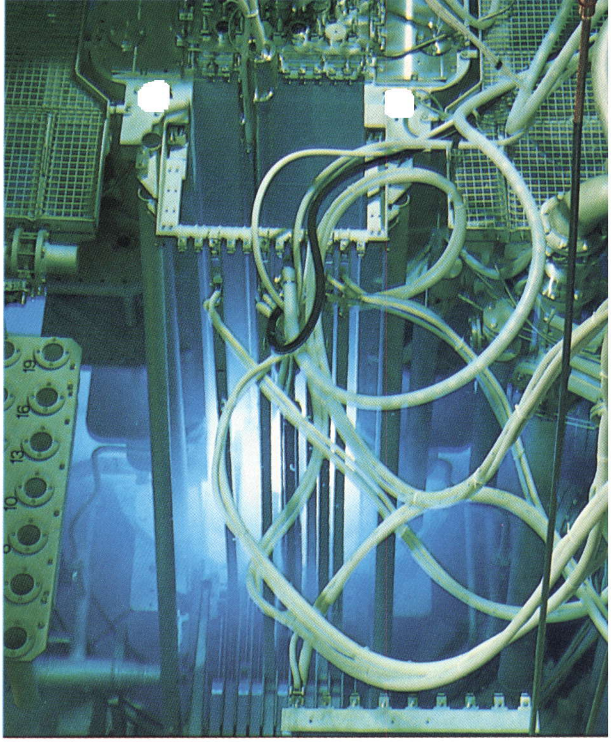

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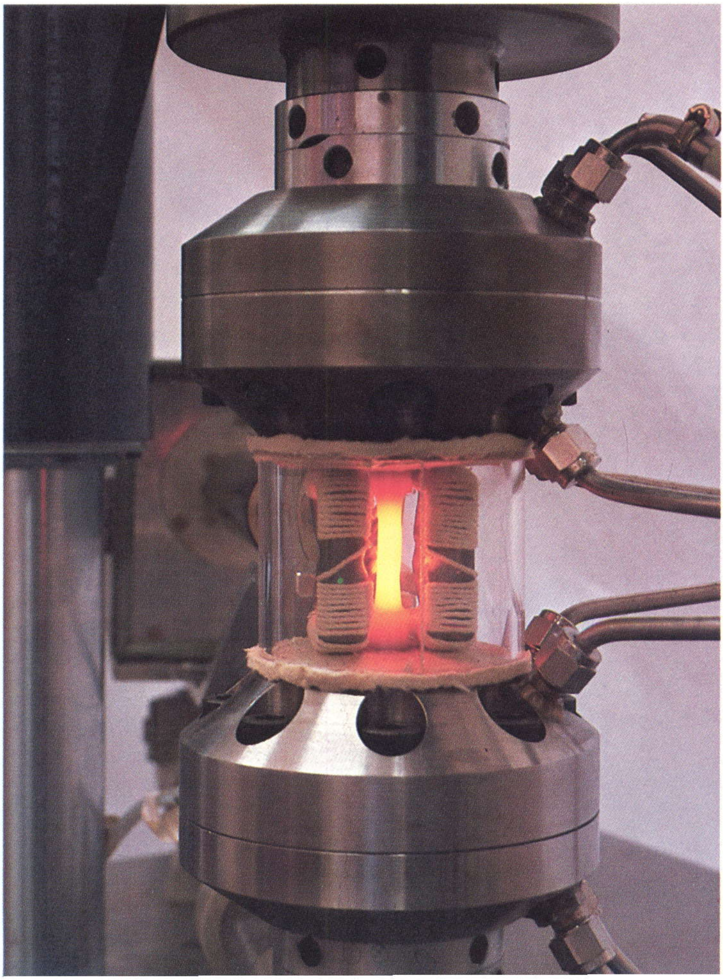

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