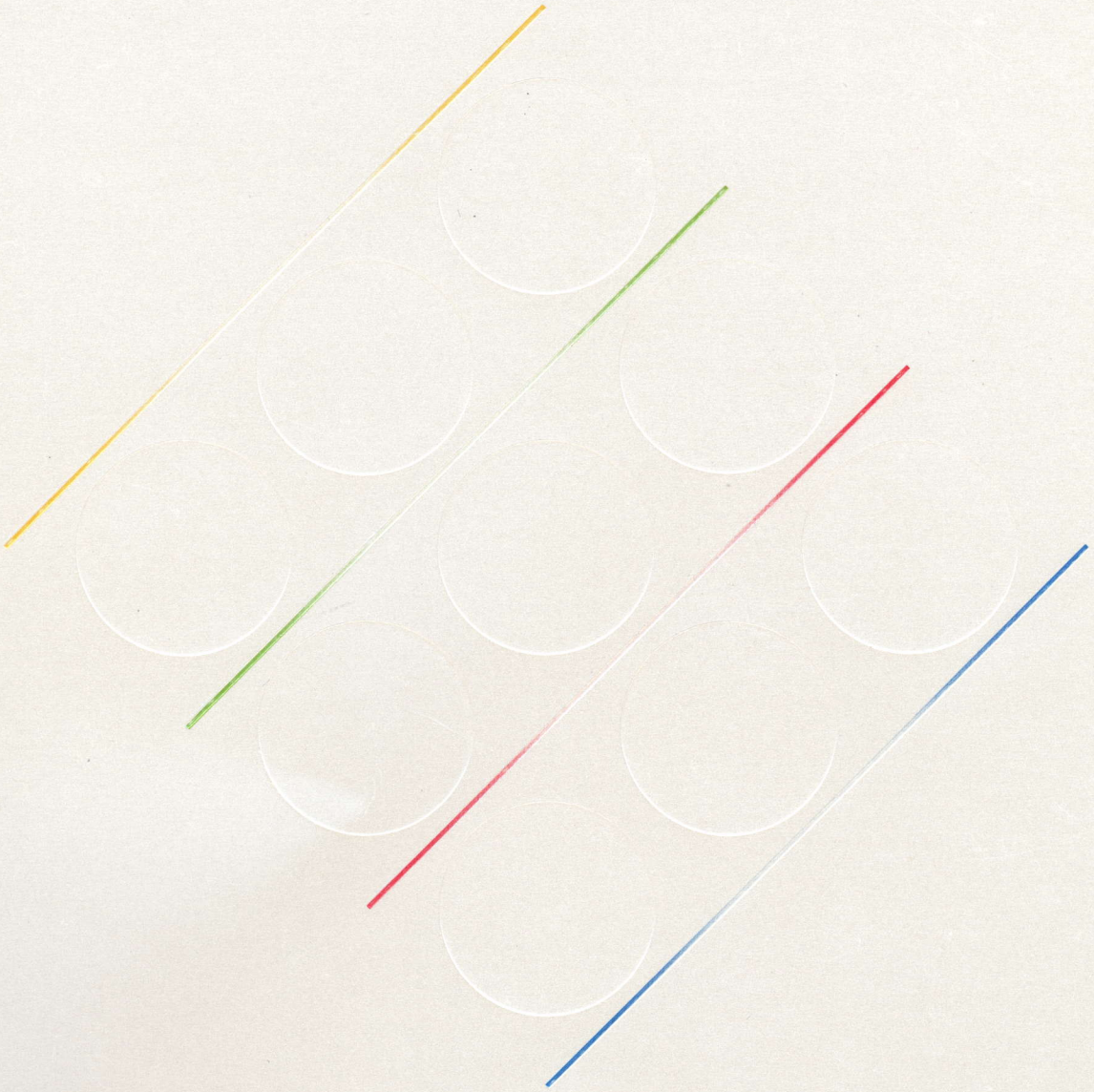
Commission of the European Communities



# JOINT·RESEARCH·CENTRE

# ANNUAL REPORT

# 1 · 9 · 8 · 8

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## Foreword

1988 marked the opening of a new era for the Joint Research Centre. Within the European Communities, this was the first year of a new four year research programme which runs through 1991, the eve of the opening of Europe's internal market. In October 1987, the Commission of the European Communities proposed a new orientation for the JRC. It has been asked to play a significant role in Europe's future and in the establishment of the internal market by supporting the improvement of European industrial competitiveness, the improvement of safety, and the protection of the environment. This 1988 Annual Report shows successful steps already taken by the JRC in this direction, and indicates the trend of the JRC towards fulfilling its role in the future of Europe.

Early in 1988, the JRC was reorganised into nine independent Institutes to derive full benefit from its expertise and facilities. These Institutes help to reorient the JRC as it carries out its many activities within the primary role of providing the Commission of the European Communities with its own scientific and technological research.

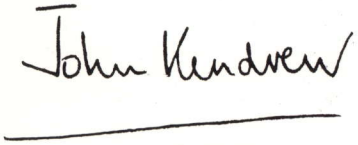
As in previous years, the majority of the JRC's research focused on activities outlined in the framework research programme of the Communities. In addition, the JRC has responded to increasing requests for direct technical support to the General Directorates of the Commission. Support to the Commission is an important JRC activity that may increase in the coming years.

The JRC has been given a new task of working for clients outside the Commission, such as national agencies, universities and private enterprises. This is designed to strengthen communication betwenn the JRC and the Communities, and to increase its support of European industry. The JRC, has moved quickly in response to the directive to seek outside clients. It successfully reached its initial goals in this area, while working to maintain the delicate balance between fulfillment of institutional tasks, and execution of work for external parties.

In addition, 1988 has marked the launching of a programme of exploratory research, to open important new areas of endeavour, and to maintain high levels of scientific competence for Europe's future.

To succeed in a rapidly evolving European Community, the JRC must work with increasing autonomy and flexibility to carry out the necessary management and fiscal changes its new orientation requires. The Community Institutions should devote further attention to the issues of flexibility and autonomy where progress has still to be made.

The Board of Governors notes with satisfaction the substantial progress made by the JRC in 1988, and looks forward to the challenges of the future.



**Sir John Kendrew**
Chairman of the Board of Governors

## Corrigenda

| | |
|---|---|
| Page 79 | Table 4: Total 9100 *should read* **950.0** |
| Page 83 | Table A1: for pubblications *read* **publications** |
| Page 93 | *under* Institute for Safety Technology *include the omitted Division:* **Nuclear Fuel Cycle Heinz DWORSCHAK** |
| | *under* Institute for Prospective Technological Studies, for Carlo RINALDI *read* **Carlo RINALDINI** |
| Page 100 | Ispra Site telex number *given as* 3800058 EURI *should read* **380058 EURI** |
| | Petten Site telex number *given as* 5721 REACP *should read* **57211 REACP** |

# CONTENTS

# 1988: A DECISIVE YEAR

The year 1988 was characterized by decisions which constitute a profound and penetrating reform of the Joint Research Centre (JRC). The proposals formulated by the Commission back in October 1987 in the communication "A New Outlook for the Joint Research Centre" were met during 1988 by resounding agreement both from the Council and the European Parliament. The formal decisions on the research programmes for the 1988-1991 period were made by the Council on 14th October 1988, thus rather late during the year. Following advice from the Board of Governors of the JRC it was possible however to initiate the new activities of the JRC earlier in the year without prejudging the final attitude and decisions of the Parliament and Council.

In general, this led to satisfactory execution of the work in 1988 as shown throughout the present report. Various investments in new scientific equipment and installations were delayed however until the final decisions on the JRC programmes had been made; the same applied to the implementation of some elements of the new personnel policy as well as the realization of the new internal structure of the Centre. Consequently, the full effect of the reform of the JRC may only be noted during 1989, but initial lessons can already be drawn from the new shape of the JRC, as described below, and throughout the present report.

The decision-making process determining the new pace and setting of the JRC was characterized in 1988 by a lively interaction between the Community Institutions. Indeed, it was the first time that decisions concerning the JRC had been taken since the adoption of the Single European Act. The relatively short length of the overall decision process witnesses the dynamism with which the Community Institutions responded to the Commission's proposal for a new JRC.

The JRC is now engaged in four main types of activity as described in the Council Resolution of 29 June 1988:

- **specific research programmes** - the mainstream of the JRC activities in the past will be reduced to 74% of the total JRC activities over the 4 years;
- **exploratory research** - a new feature to ensure future scientific vitality will represent 5% of the JRC specific research programmes;
- **scientific and technical support for the Commission** - a task already carried out in the past, will be significantly increased to represent 12% of the JRC activities;
- **and work for external third parties** - again a new task, should represent 14% of the global JRC activities.

The specific research programmes are concentrated on the topics of

- modernisation of industrial structures,
- enhancement of safety, prevention and mitigation of accidents, and
- surveillance and protection of the environment.

In these areas a genuine need is seen for the JRC to contribute to the objectives of the Framework Programme for Community activities in research and technological development. However, this does not mean that the work by the JRC is performed in isolation. On the contrary, an important objective of the JRC is to develop practical and significant initiatives to reinforce collaboration with the research centres and laboratories of all Member States, thereby assuming the role of catalyst of European scientific integration. In 1987 several

new initiatives had been taken towards this ambitious horizontal objective of the Centre encompassing all tasks of the JRC, and throughout the following chapters many references will be found to practical implementations in the form of collaborative programme arrangements and joint ventures. This sets a pace for the future, when the JRC, capitalizing on further contacts established in 1988, will develop fully the concept of associated laboratories.

Throughout the 1988-1991 period the JRC will evolve dynamically. In order to make resources available for some of the newer tasks, those for the specific research programmes will gradually decrease. The specific research programme on Radiation Evaluation and Monitoring was terminated as planned at the end of 1988, whereas relevant activities will continue as requested by the Directorate-General of the Commission responsible for nuclear safety.

Indeed, the reconfirmation of the JRC task of scientific and technological support for the Commission was met in 1988 by a dynamic response from the customer Directorates-General of the Commission responsible for the various Community policies to which the JRC provides its support. This response was demonstrated by demands for work exceeding the resources available.

Demand for the JRC's services in support of the Commission was highlighted by the signing of several multiannual agreements between the major customer Directorates-General and the JRC calling for work in the areas of environmental protection, applications of remote sensing techniques to agriculture, radiation protection and non-nuclear energies. Other major support areas comprise safeguards, chemical analyses and foodstuff investigations for the benefit of the relevant Directorates-General, and applications of remote sensing techniques for the development policy. All in all, the scientific and technological support for the Commission is a task for which the potential demand goes beyond the financial target set for 1988-1991.

The new task of exploratory research was guided by the Board of Governors and purposely given a relatively modest start in 1988; while up to 5% of the specific research programme resources are available for this task, only 3.4% of the 1988 programme budget was solicited. The task of exploratory research is a cornerstone of determining the scientific future of the JRC. It is of paramount importance that the limited resources for this task be spent in the most efficient way. The JRC and the Board of Governors continue to consider new directions for exploratory research. The projects initiated in 1988 witness the scientific potential of the JRC and the vitality of its scientific staff, and were the subject of an initial evaluation by the Board of Governors in early 1989.

Obviously, the new tasks of the JRC will have to be developed gradually over the 1988-1991 four-year period, and this applies notably to work for external private and public bodies. In addition to the ongoing exploitation of the High Flux Reactor (HFR) for the Dutch and German governments (supplementary research programme), a good start was made on work for external bodies. In a highly competitive market the JRC in the first year of this new task signed contracts and agreements which promise revenue in 1988-1991 of almost 30% of the target for that period. During this start-up phase, the revenue paid in 1988 was around 2 Mecu. Customers comprise European industries as well as public and private bodies within or outside the Community countries. Main work areas so far are in the field of the environment, advanced materials and nuclear safety. As agreed, the Council received at the end of 1988 a propo-

sal for consolidating the legal basis for the EEC related third party work. The time ahead calls for increased marketing efforts by the JRC, adjustment of intellectual property regulations adapted to the needs of customers, and increased innovation.

Considerable reflections at the managerial level during 1988 led to the formation in early November of a new internal structure for the JRC, and the designation of senior staff for the new units created. The JRC now comprises nine scientific Institutes spread over the four sites as illustrated in the new organisation chart for the JRC given in the annex to the present report.

The Institutes each have well-defined scientific/technical specific domains and execute their relevant shares of the JRC tasks under the responsibility of the Director-General in Brussels, who with his senior advisors is supported by a Directorate of Programmes in Brussels and a Directorate of Administration for the JRC in Ispra. The emerging scope of the Institutes and their fields of work are highlighted throughout this report.

Hand in hand with the objective of reinforced collaboration with national laboratories and research centres is the implementation of the new staff policy highlighted in the Commission's 1987 communication "A New Outlook for the JRC", and confirmed by several decisions made during 1988. A leading theme is mobility for scientific vitality. To this end, the JRC budget for 1988 onwards has been restructured to facilitate the influx of young research fellows (grantholders), senior visiting scientists, and staff seconded from national public and private bodies. For the latter categories more flexible regulations have been set up during 1988; already there are promising signs of their effects, a trend expected to accelerate in coming years. This also applies to new measures of time-limited contracts for a number of well-defined posts for statutory staff as scientific/technical temporary agents. The full implementation of these measures awaits the availability of posts which are expected to be liberated in 1989 upon decision by the Council and Parliament on proposed regulations for termination-of-service measures (early retirement) for officials.

With regard to the committee structure around the JRC, new modalities were approved during 1988. The Commission decided on new terms of reference for the Board of Governors thus confirming the central role of this committee in the life of the JRC and the relations between the Member States of the Community and the JRC. It is the wish of the Commission to further emphasize the scope of the Board of Governors by giving it appropriate possibilities to advise on the adaptation of specific research programmes to the evolving needs of the Community. A proposal on this matter will be submitted to the Council in early 1989. Increased contacts between the European Parliament and the Board of Governors, as exemplified by the presence of the Chairman of the Board at one of the meetings of the Committee on Energy, Research and Technology of the Parliament, should be further developed in the future.

The newly created scientific Institutes of the JRC should be properly advised on scientific matters by Institute Advisory Committees, which will be set up in 1989. Finally, the JRC and the Board of Governors are maintaining the proper dialogue with the relevant Advisory Committees on Management and Coordination and with the committees exercising a similar role at present or in the future. This is of particular importance to ensure coherence between Community shared-cost action programmes and JRC programmes in the same subject areas.

Above all, the committee structure around the JRC is an instrument to ensure and stimulate the interaction between research and technological developments in the Member States and in the JRC. This is a concern where all levels of contact are of paramount importance for the Centre and its developments.

All in all, 1988 was perhaps the most dynamic year ever experienced in the lifetime of the Joint Research Centre. Formally, the Centre has 30 years on its records, and in October 1988 it celebrated the 25th anniversary of the Institute for Transuranium Elements in Karlsruhe. The many vital decisions taken during the year required immediate implementation, including new structures which had to be set up for the execution of the new tasks. A good start was made during 1988, and the prospects for the future are highly promising.

Throughout the year the Commission was wisely advised by the Board of Governors, which guided the Director-General and his senior staff in setting the JRC's new pace in the service of the Community. The Commission and the Director-General gratefully acknowledge the support received from the Board of Governors and from the other Community Institutions, the advice received from many quarters, the interest in collaboration demonstrated by numerous national public and private bodies, and last but not least, the courage and enthusiasm of the staff of the JRC facing the new challenges.

JRC ANNUAL REPORT 1988

# MAIN ACHIEVEMENTS AND MILESTONES

# JRC SPECIFIC RESEARCH PROGRAMMES

This chapter outlines the major achievements of the JRC, as it executes its four main functions:

- Specific research programmes on a multiannual basis
- Support activities at the request of other Commission services
- Work under contract for third parties
- Exploratory research to open new avenues and to maintain scientific excellence.

The JRC specific research programmes are concentrated mainly on three major topics : the modernisation of industrial sectors, the enhancement of safety, prevention and mitigation of accidents and the surveillance and protection of the environment. Other studies are related to information technologies and electronics and to prospective technology assessment.

## Central Bureau for Nuclear Measurements

The Central Bureau for Nuclear Measurements (CBNM) at Geel has the important role of promoting European standards and contributing to the harmonization of reference methodologies and materials. The CBNM executes the programme on Nuclear Measurements and Reference Materials.

GELINA, the Geel electron linear accelerator, has been used mainly (for 81%) with short burst-widths (<1 ns) for high resolution neutron production. It was also used with large burst-widths (2000 ns) for low energy neutron work and for transition radiation studies. The CN-7 MV Van de Graaff has been used mainly for neutron data measurements and additionally for neutron irradiations in radiobiological studies. The central computer was mainly used for batch processing and interactive work for the analysis of experimental data.

### Nuclear measurements

Nuclear measurements have been carried out on the basis of the needs collated by international organizations such as IAEA, NEA and BIPM; some are performed at the request of national Institutions. These measurements are related to:

**Nuclear Data for Standards,** such as the new determination of the fission neutron spectrum of $^{252}Cf$, and the alpha-particle emission probabilities of $^{237}Np$.

**Nuclear Data for Fission Technology,** such as the latest fission cross-section measurements at the Very Cold Neutron Source at the Laue-Langevin Institute (ILL) and the final $\eta$ (the number of fission neutrons emitted per neutron absorbed) measurements for $^{235}U$, performed also at ILL, Grenoble.

**Nuclear Data for Fusion Technology** where further measurements were made of the neutron emission cross-section of $^{9}Be$ at the request of the Fusion Programme.

**Radionuclide Metrology** where low energy X-ray standard sources were prepared with emission rates between $10^3$ and $10^5$/s and an uncertainty of 3%.

**Metrology of Neutron Fluence and Dose** where absorbed doses were determined in the course of neutron irradiations for the Radiobiology Department of SCK/CEN, Mol. Results on the two-spheres technique to measure neutron fluence at energies of 2.5 MeV and 14.7 MeV were communicated to BIPM.

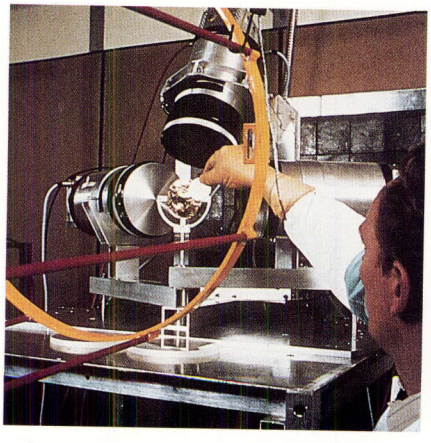


Figure 1: Experimental set-up for neutron interaction measurements at GELINA

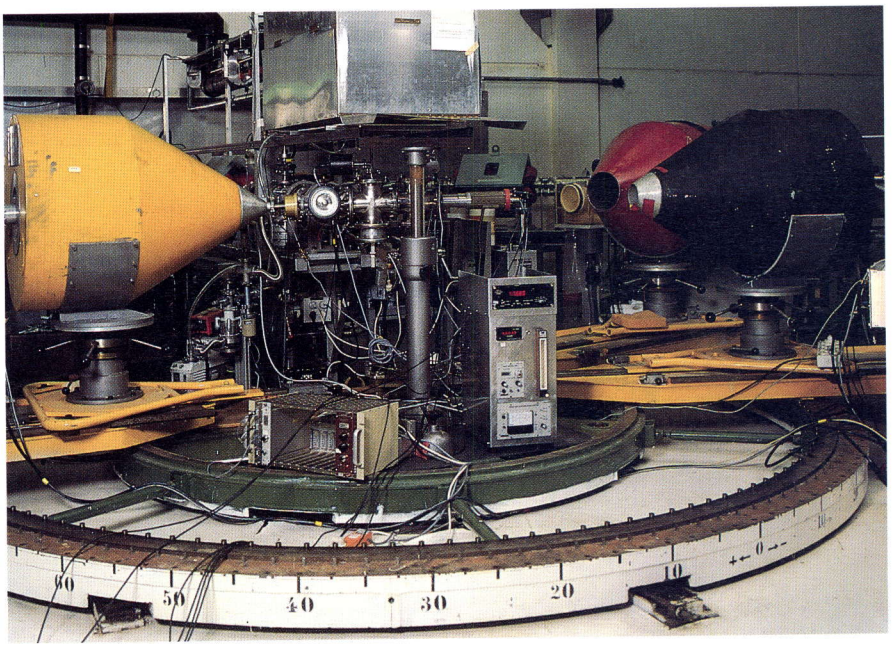


Figure 2: Turntable of the detector system at a beam line of the 7 MV Van de Graaff Accelerator

## Reference Materials

High quality nuclear reference materials have been prepared, characterized and certified at CBNM; they are used to guarantee European independence in the fields of commercial transactions and nuclear safeguards. Scientific competence in nuclear measurements and in refined analytical techniques is made available for quality control programmes in the nuclear and the non-nuclear fields. Most important achievements are:

**Actinide Reference Materials:** the characterization of three uranium ore and mineral reference materials (EC-NRM 113, 114, 116) was finalized; the characterization of EC-NRM 210, a batch of pure $PuO_2$, was continued. Five uranium isotope reference materials (EC-NRM 183-187) are ready for certification.

Figure 3: Preparation of specimens for routine contamination monitoring

Various uranium and plutonium isotope synthetic mixtures were prepared for mass-spectrometric calibrations, as well as a new $^{235}U$ spike material for use as a tracer.

**Reactor Neutron Dosimetry Reference Materials:** Nickel (EC-NRM 521) was certified, $^{238}UO_2$ is close to certification. Progress was made for other materials (niobium foil and wire, rhodium foil and Al-Co alloy).

Further progress was made in **Aerosol and Surface Reference Materials** as well as in a more accurate measurement of the **Atomic Weight of Silicon** as part of an international effort to redetermine the Avogadro Number.

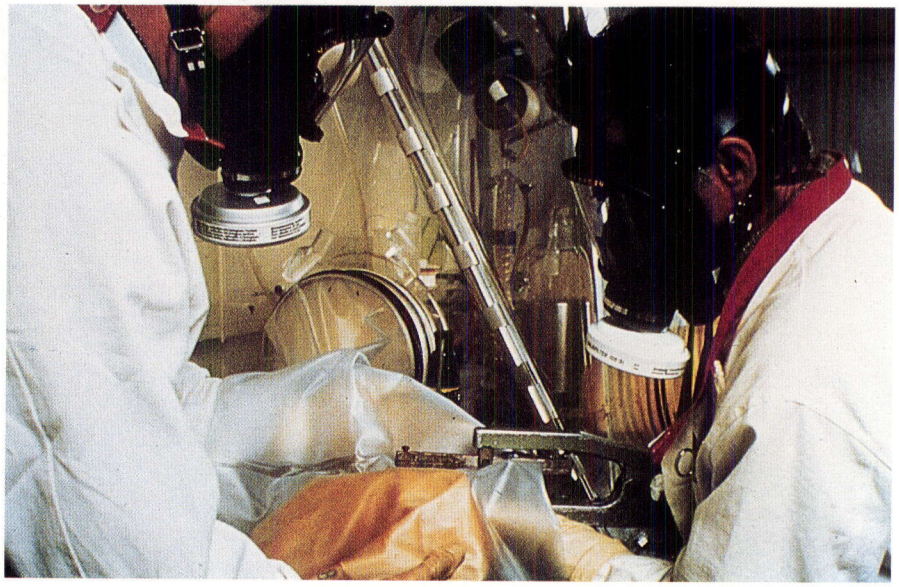


Figure 4: Working at a glove box in the course of preparing nuclear reference materials

## The Institute for Transuranium Elements

The Institute for Transuranium Elements at Karlsruhe executes the programme on nuclear fuels and actinide research. The aim is to contribute to the safety of the nuclear fuel cycle.

Studies on the **Safety of Fuel Applications** deal with understanding the behaviour of light water reactor fuel and fission products during normal and abnormal reactor conditions as well as with the improvement of operating capabilities of advanced fuels. In this context, high burn-up $UO_2$ fuel was annealed in hot cells up to its melting point in order to investigate fission gas migration and release mechanisms. Relevant data on fuel properties and fuel behaviour under transient in-pile conditions are being collected in a data bank, which is constantly updated. These data were analysed and used to validate fuel pin codes in accompanying modelling activities. The TRANSURANUS code was incorporated into the European Accident Code (EAC) at JRC Ispra.

The microstructure of debris originating from the molten core and from the outer crust of the Three Mile Island reactor was analysed, its content in volatile fission products was determined and the maximum temperatures to which the material was exposed were estimated. Efforts to investigate properties of non-irradiated fuels under accident conditions, i.e. at temperatures up to 4000K, were continued.

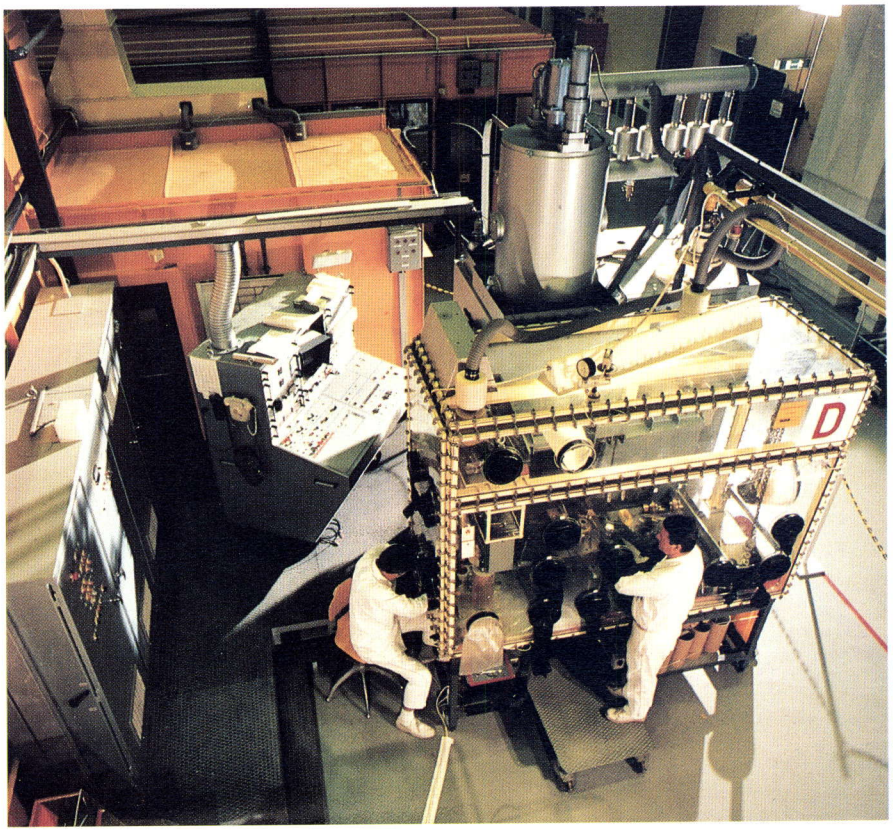


Figure 5: Electron beam welding facility for fuel rod preparation

Three nitride fuel pins were irradiated in the Petten high-flux reactor; post-irradiation analysis of these pins revealed marked structural differences due to differences in fabrication procedure. This opens up possibilities for preparing fuel pellets with a "tailored" structure.

Studies on the **Safety of the Fuel Cycle and its Effect on the Environment** concerned in-pile actinide formation and assessment of scenarios arising from the accumulation of minor actinides (i.e. Np, Am, Cm) by assuming their transmutation in fast reactors or in special minor actinide burners.

Nuclear aerosol studies in 1988 were aimed at a better understanding of the release and dispersion of dust particles during fires in nuclear facilities; studies demonstrated that not more than 2% of the contaminant particles were sufficiently stable to escape to the chimney.

In the search for alternative reprocessing schemes, the Institute is investigating the possibility of destroying ammonium ions (which may give rise to safety problems during reprocessing) in nitride solutions of dissolved fuels as well as extracting and further purifying of actinides from reprocessing waste streams.

In **Actinide Research,** the effort in 1988 has focussed on the systematic preparation of single crystals of actinide compounds with identical simple crystal structures and the preparation of new compounds with potentially interesting properties for both fundamental and applied materials science. Progress was made in understanding how the electronic structure of the original components is modified when actinide elements are alloyed with transition metals.

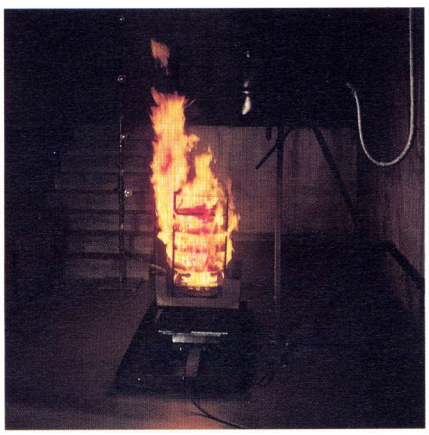


Figure 6: Fire experiment studies with dispersion of radioactive aerosol from burning plexiglass

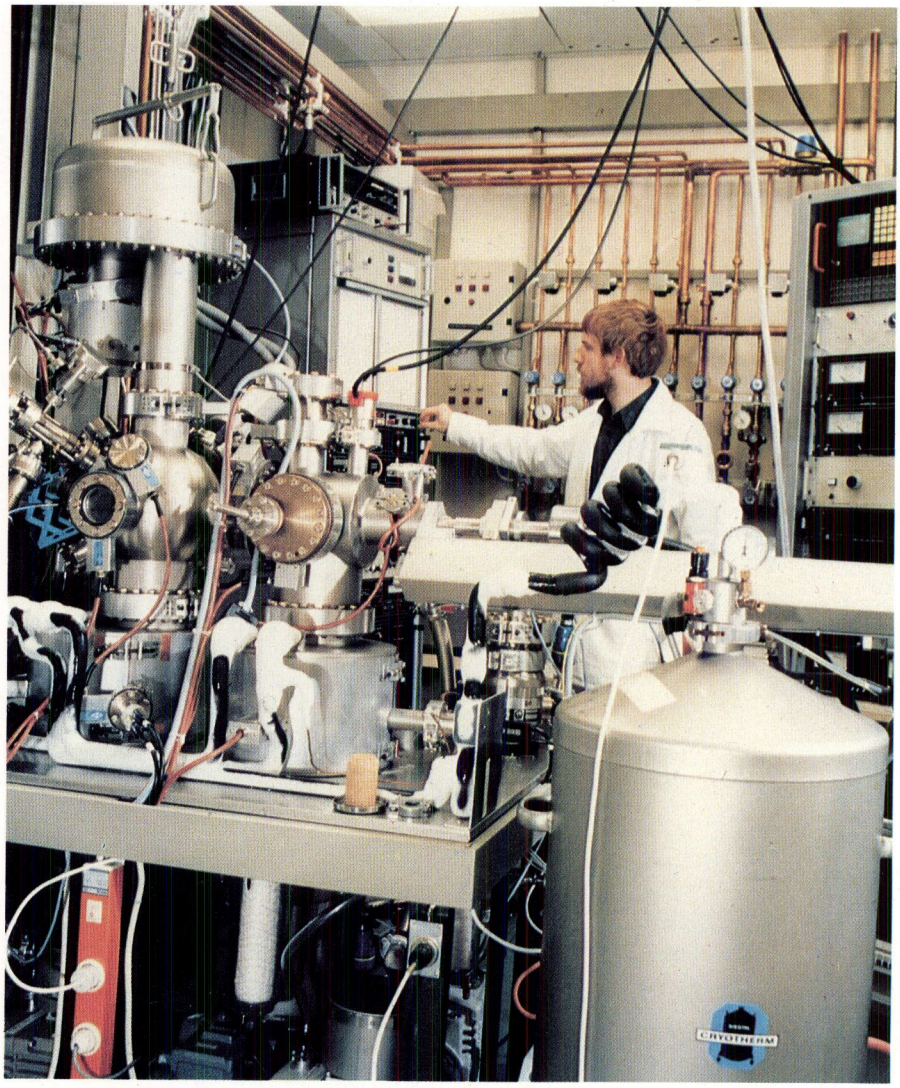


Figure 7: Close-up XPS/UPS installation (photoelectron spectroscopy with actinides)

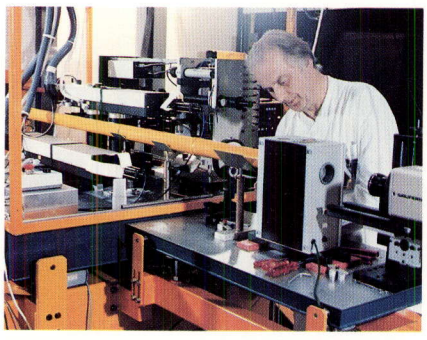


Figure 8: Laser and pyrometer for thermophysical property measurements at very high temperatures

Band structure calculations performed at JRC Karlsruhe predict certain unusual neutron scattering features which were confirmed experimentally in an interlaboratory effort on single crystals of $UFe_2$ and $PuFe_2$ prepared at the Institute.

As part of development of a general model for catalytic effects, the formation of hydrogen from ethane in the presence of various substrates containing uranium and/or nickel was studied experimentally by correlating chemical reactivities with the electronic structure of the reactants. Measurements of x-ray diffraction, x-ray absorption and optical reflectivity under extremely high pressures (up to 500 kbar) were performed to elucidate the electronic structures of simple actinide compounds with elements from the fifth and the sixth columns of the Periodic Table.

Work to establish an **Actinides Information Centre was continued by implementing a retrieval system for computer-stored bibliographical references on actinides.**

# The Institute for Advanced Materials

The Institute for Advanced Materials executes the programme on advanced materials which is carried out largely at Petten and partly at Ispra in five operation units : Materials Characterisation, Materials Processing, Functional Materials, Materials Performance and Reliability, and Non-Destructive Evaluation and Testing (The last two of these units are also contributing to the realisation of programmes in the nuclear area).

1988 was the first year of the programme on Advanced Materials. Particular attention was paid to close coordination between the two sites of the Institute, in order to benefit from the complementarity of facilities and staff expertise. During the year, there began a shift in the balance of the materials activities, from predominantly characterisation studies to materials innovation and the engineering and design of improved properties through processing and surface modification. In this connection, an important development has been the introduction of a unique integrated facility for combined ion beam and laser beam treatment of metals and ceramics, for which the plant has been completely defined and preparatory studies, theoretical analyses and tests have already been undertaken.

The salient features of progress in the research programme are summarised below:

- in connection with **corrosion** studies, it has now been established that carefully formulated pre-oxidisation treatments can improve remarkably the corrosion resistance of commercial ferritic and austenitic steels during exposure to highly sulphidising service atmospheres. An instrumental development, the Glancing Angle Diffractometer, has been upgraded to allow analysis of structure and strains in both thin films and corroded steel samples;

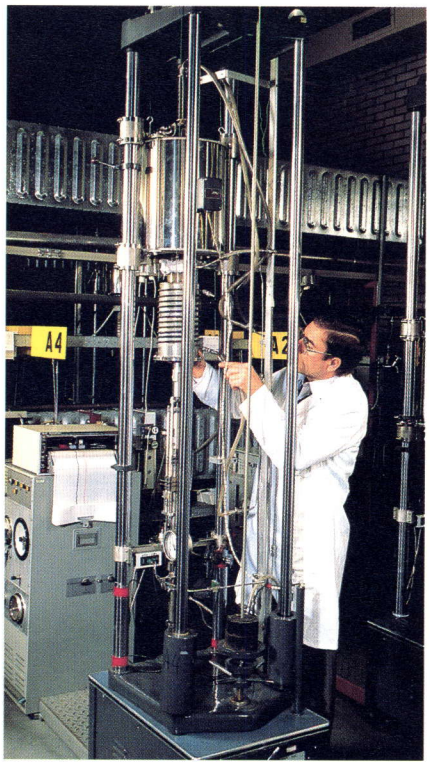



Figure 9: Creep test assemblage for corrosive environment

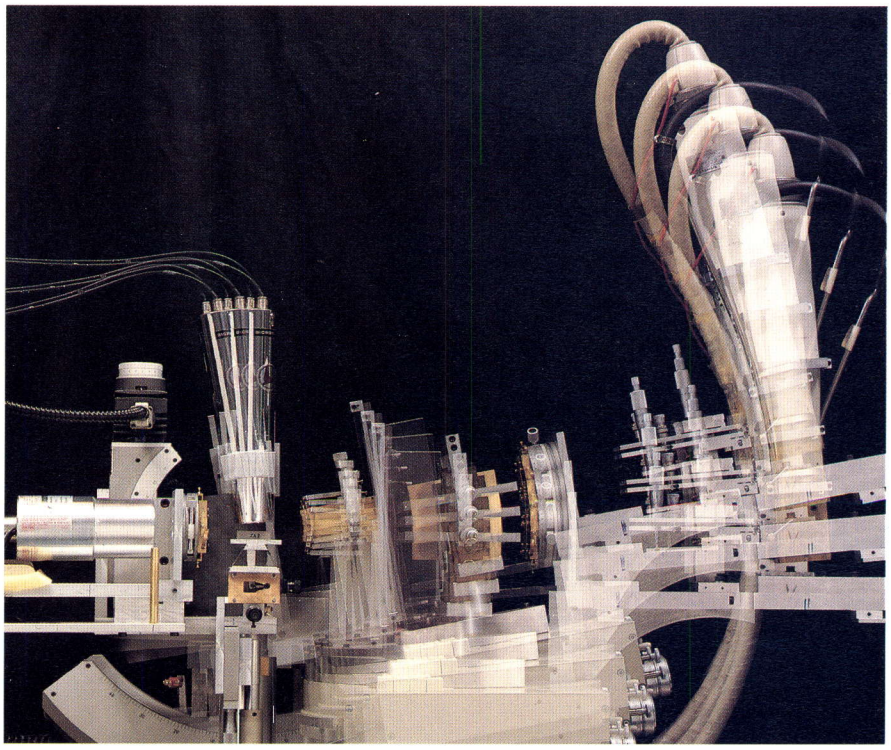


Figure 10: The prototype X-ray Glancing Angle Diffractometer, illustrating motion of the source arm, i.e. X-ray tube, monochromator and collimation systems


Figure 11: Autoclaves for high temperature corrosion studies

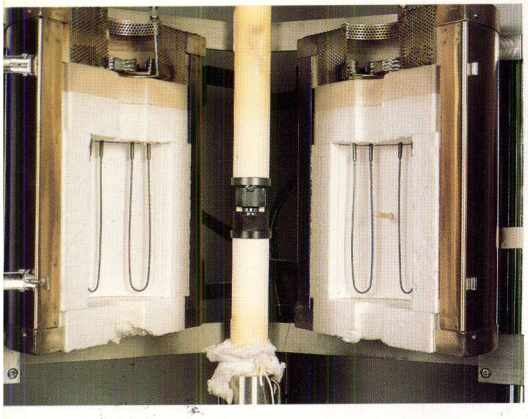


Figure 12: View of a 4 point bend test rig used for fracture mechanics studies at high temperature in ceramics

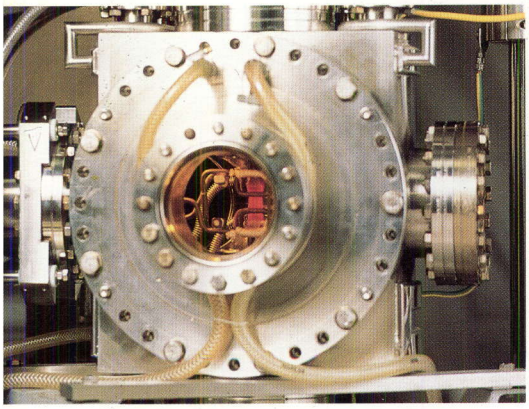


Figure 13: Fatigue testing chamber for research into the interaction between mechanical properties and environmental attack

- an ''interest club'' of electric utilities has been set up to develop and exploit an expert system for the **assessment of the residual** life of headers in electricity generating plants;
- the importance of intergranular chemical composition for the **high temperature corrosion resistance** of silicon nitride in simulated industrial environments has been highlighted;
- the **Materials Data Bank** has been widely presented to European user groups within the framework of the DG XIII Materials Databanks Demonstrator Programme. As part of its future orientations in computer aided engineering and processing, an on-line link has been made between the Data Bank and programmes for structural mechanics finite element analysis;
- in the **surface engineering** field, the conditions for producing metastable alloy solid solutions by ion beam mixing have been established; in addition, a comparative evaluation has been made of hard titanium carbide coatings produced by ion beam deposition and by r.f. magnetron plasma sputtering;
- as part of a growing effort in **Non-Destructive Evaluation techniques** on materials such as composites and ceramics, changes in velocity of ultrasonic sonds have been detected and measured in test samples undergoing creep; the aim is to develop this technique in order to measure the amount of damage during service performance;
- **materials test and standardisation methods** are being actively developed: here we report on a new technique for measuring the creep crack growth of machined defects in multi-axially stressed tubular components and a method for producing ideal macrocracks in ceramics for crack growth measurements under four-point bending;

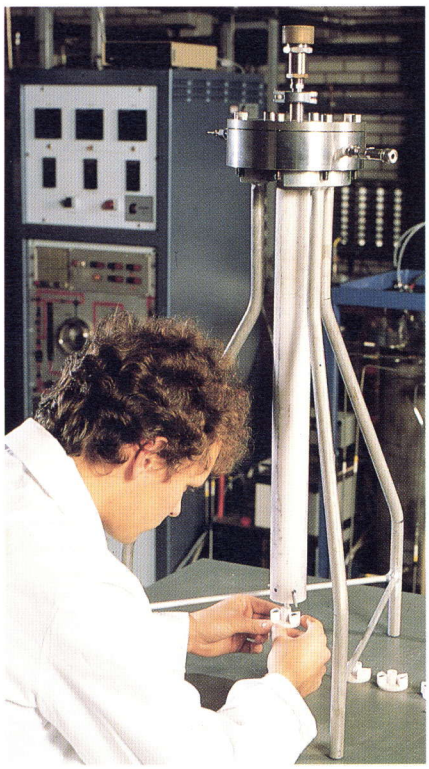


Figure 14: Assembly of test specimen on a corrosion autoclave

In parallel with the materials technology activities, the basic understanding of alloy and ceramic structure and properties at the atomistic level has been broached through the exploitation of new investigative techniques and large scale facilities, such as synchrotron radiation and cold neutron sources. In this connection, an Understanding has been signed between the JRC and a group of Italian University Departments in solid state physics in order to encourage cooperative projects in areas such as High Tc Superconductivity, sensor materials, and the sintering of ceramics. This activity is also supported by the Institute's Cyclotron which is making significant contribution to the study of radiation damage in fusion materials and is supporting material surface modification studies as well as a number of other fields such as biomedical radioisotope production.

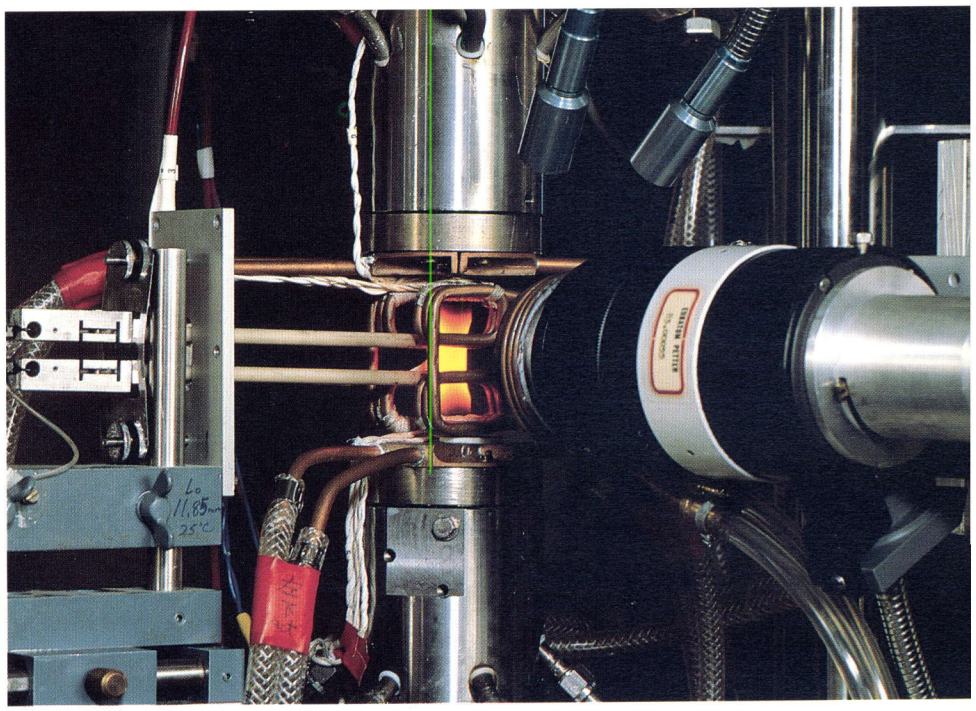


Figure 15: View of an experimental set-up for the optical measurement of fatigue crack lengths at elevated test temperatures

The Institute contributed to several international events on future developments in materials for advanced technologies; various meetings have been organised to publicise new research developments, including the Conference on "Metal/Ceramic Joining", the Conference on "Trace Element Effects in Oxidation", the EC/Yugoslavia bilateral Conference on Materials, and Round Table Discussions on "European Standards for Ceramics" and "Standards for Materials Data Banks".

## The Institute for the Environment

The Institute for the Environment at Ispra executes the programmes on Environmental Protection, Radioactivity Environmental Monitoring and Radioactive Waste Management.

### Environmental Protection

Research progress in the area of Environmental Chemicals, Air Pollution, Water Quality, Chemical Wastes and Food and Drug Analysis is reported below. The new research areas of the European Monitoring Network, Environmental Studies in the Mediterranean Basin and Genetically Engineered Substances are in the preparation stage.

#### Environmental Chemicals

New data on use and consumption patterns, legislation, carcinogenicity and human health effects have been introduced in the ECDIN (Environmental Chemicals Data Information Network) data bank on environmental chemicals. EINECS (European Inventory of Existing Chemical Substances) is now publicly available on-line. New and more user friendly access strategies for ECDIN are being tested in a pilot study.

Figure 16: Portable instrumentation for field investigations of indoor air quality. From left to right - above: 1) adsorption/reaction cartridge and metering pump for the air sampling of aldehydes; 2) same for volatile organic compounds (VOC); 3) portable chromatograph for tracer gas measurements; below: 4) bag and gas syringe for tracer gas sampling; 5) photoionization detector for the measurement of total VOC; 6) temperature and humidity meter; 7) monitor for respirable particulate matter.

In the framework of the concerted action "Indoor Air Quality and its Impact on Man" a summary report on radon pollution has been published and draft summary reports on $NO_2$ and formaldehyde have been prepared. Three draft guidelines: "Complaints on air quality in buildings - a practical guide", "Sampling strategy in chemical indoor air analysis" and "Formaldehyde emission from wood based materials: guideline for the determination of steady state concentrations in test chambers" have been compiled. Research activities were focussed on the validation of methods for the characterization of emissions of

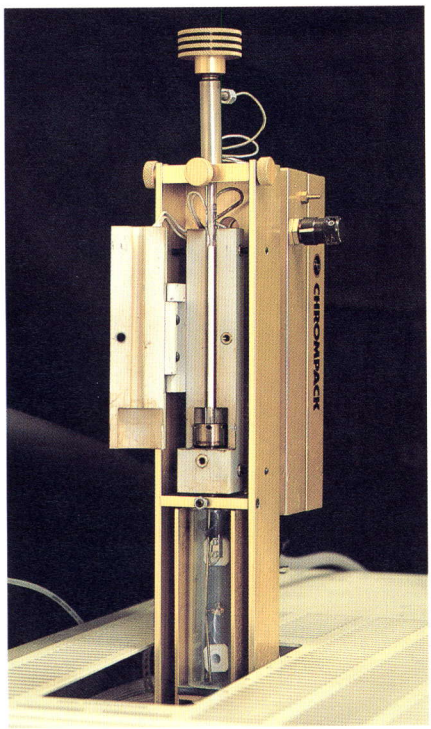



Figure 17: Thermal desorption cold trap injector for the introduction of VOC samples into the gas chromatograph

volatile organic compounds from materials and products used indoors. Experiments with building materials showed a large variation in time dependence for these emissions and demonstrated the need to develop models which allow a simple description of the emission.Participation in an international round robin test revealed the need for further standardization of the chamber test method. In view of the continuing request for field surveys of indoor air quality in buildings of the European Parliament a new strategy for such surveys has been developed.

New results on the in-vitro metabolic pathways of dimethylarsenic acid, arsenocholine and arsenobetaine in animal and human blood were obtained. These As-compounds do not interact with the biochemical blood compounds, which explains their low toxicity. A study on Vanadium transport through the placenta and milk to fetal and newborn rats showed that Vanadium is able to pass the placental barrier and is metabolized in the fetus. The baseline study for the definition of reference levels of trace metals in human lung tissues has been completed. For most elements narrow concentration ranges were obtained. In total 48 elements were determined for 13 regionally scattered samples. Regarding blood and urine reference values are now available for 39 elements. A study on the biological monitoring of Co, Ta, W and Cr in blood fluids, broncho-alveolar lavage, pubic hair and toenails suggests their use as bio-indicators for workers exposed to hard metal dusts.

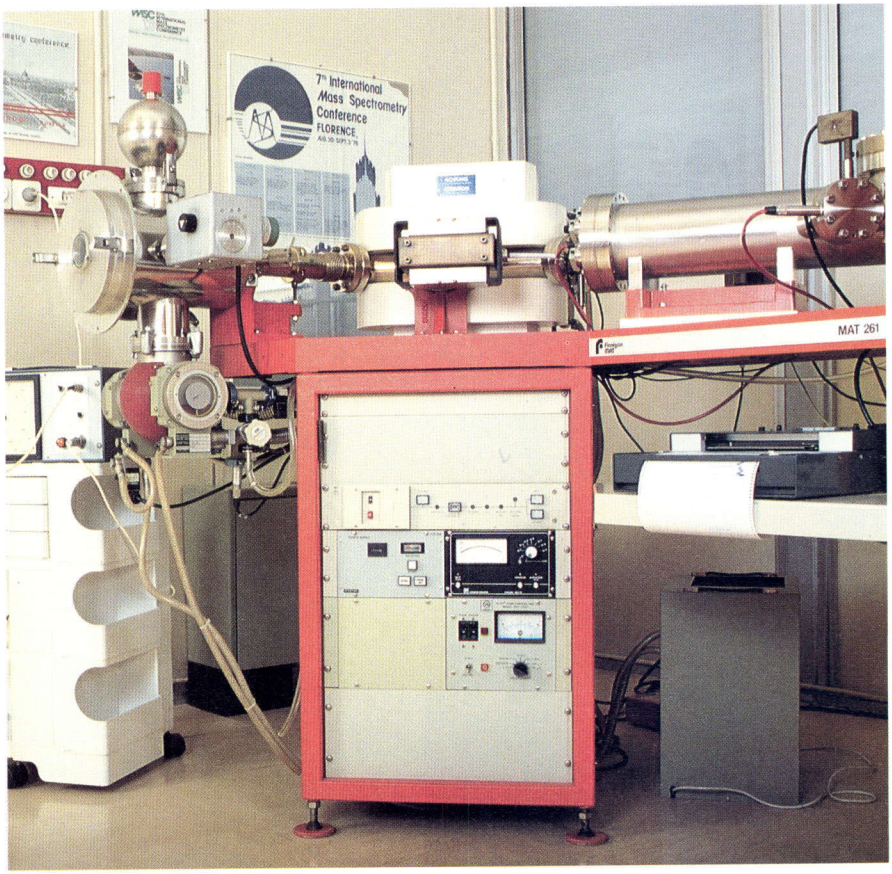



Figure 18: Variable multicollector mass spectrometer for isotope ratio determination and precise inorganic measurements

## Air Pollution

The role of biogenic emissions (e.g. terpenes) in the dry deposition processes of $O_3$,/$NO_2$/$SO_2$ mixtures on forest trees was further investigated. With increasing humidity the $SO_2$ oxidation yield and the subsequent $H_2SO_4$ formation decreases in the ß-pinene/$O_3$/$SO_2$ system. Addition of $NO_2$ to the system causes higher terpene conversion but lower $SO_2$ oxidation rates. To contribute to the understanding of the role that $NO_3$ radicals play in the night-time chemistry of atmospheric pollutants, the reaction products of $NO_3$ and alkenes were identified by comparison with the infrared spectra of synthesized reference compounds as a mixture of unsubstituted carbonyl-, nitroxyl-, hydroxyl compounds and dinitrates. The rate constant of the reaction between $NO_3$ and $NO_2$ leading to NO formation has been determined by use of diode laser and Fourier transform infrared spectroscopy. A part of these studies represents the JRC contribution to the COST 611, EUROTRAC EUREKA project.

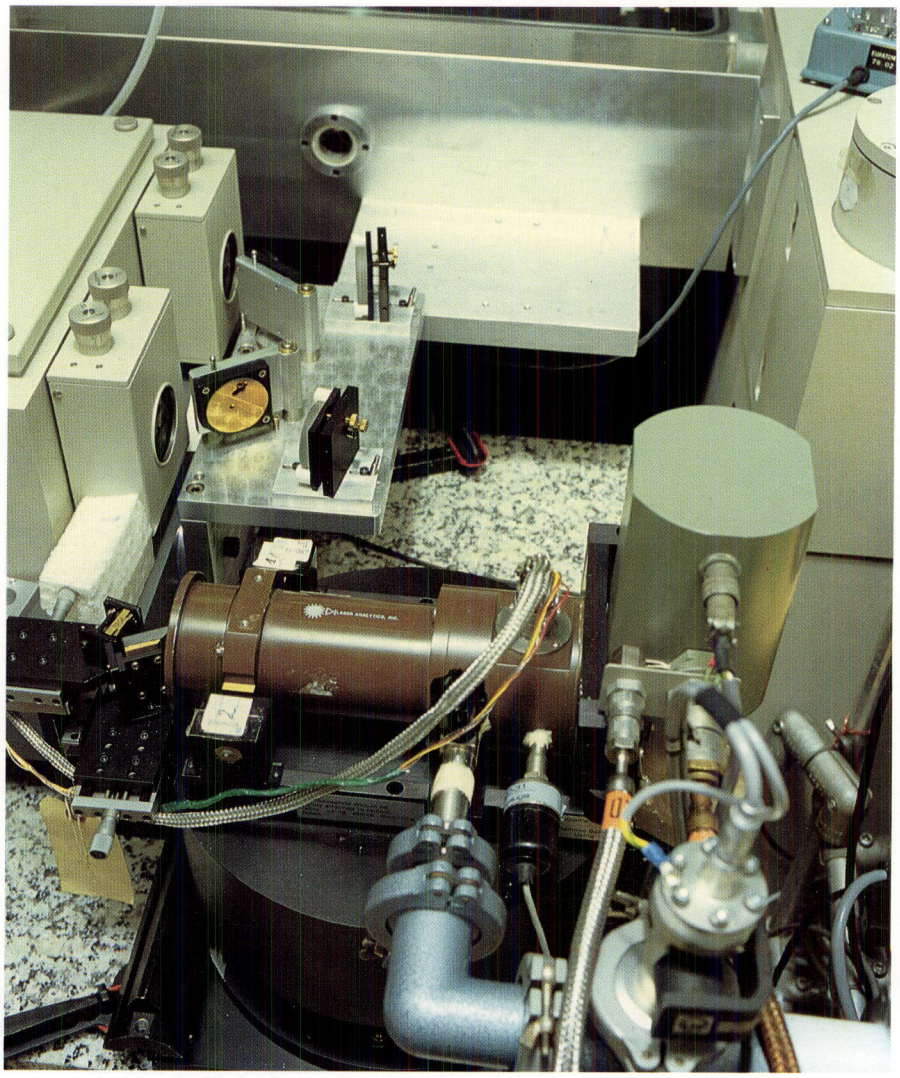
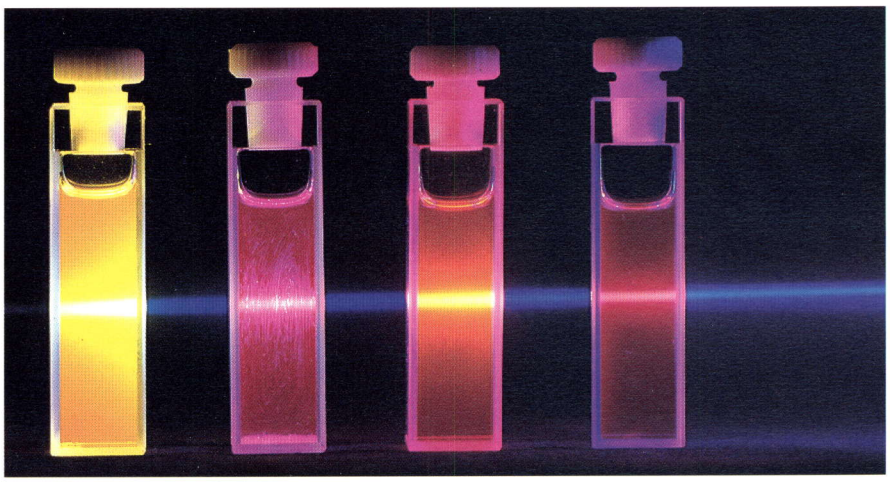


Figure 19: Tunable diode laser (TDL) spectrometer input to the 480 L reaction chamber (via the vacuum tight window at the top left of the picture)

Figure 20: Molecular fluorescence in liquids excited by a blue He-Cd laser. Different colours reveal different substances. The laser beam is attenuated by the strong absorption occurring in the solutions.



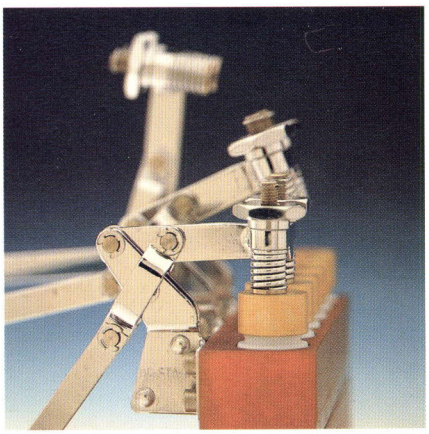


Figure 21: View of a spring-loaded closing system of a high pressure container used for the solubilization of acidic sediment environments

The construction of the pilot plant for the ISPRA MARK 13A desulphurisation process at the SARAS refinery, Sarroch (Sardinia) was delayed till September 1988 and followed by the start-up of the plant. For the combined desulphurisation/denoxing process substantial progress was made on the electrolytic reduction of nitrogen oxides.

Perfluorocarbon tracer experiments were performed to study atmospheric dispersion in a complex lake-mountain area. In collaboration with the air quality laboratory of the Ticino Canton the formation of tropospheric ozone in the prealpine region was investigated.

To interpret the air quality data of the Athens campaign (September 1987) the wind field over the complex greater Athens area was described by a numerical model.

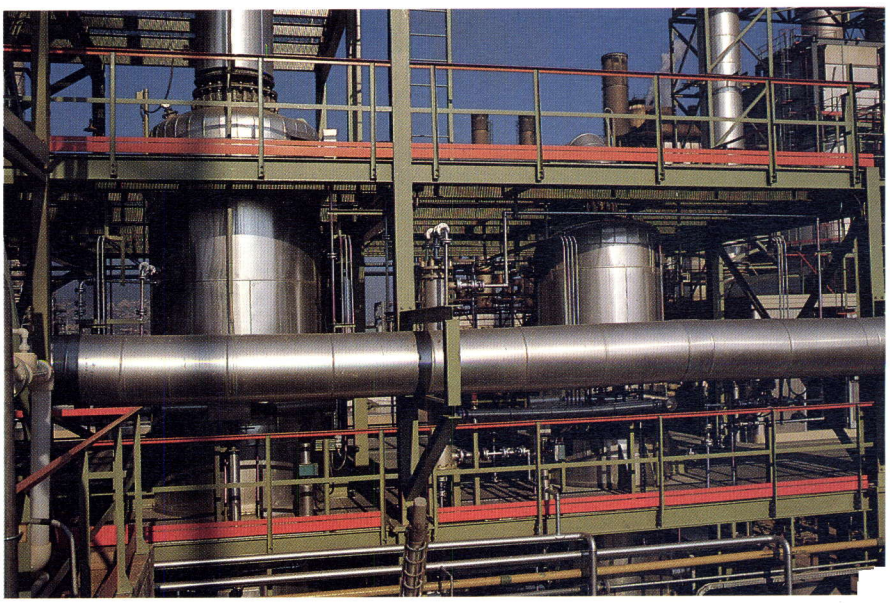


Figure 22: Pre and final concentrator of the Ispra Mark 13A Flue Gas Desulphurisation Plant in Sardinia

Figure 23: The tracer team, alongside the mobile laboratory for 'in field' release, sampling and analysis of atmospheric tracers

## Water Quality

Ecotoxicological studies at Lake Comabbio confirmed that artificial oxygenation prevents periodic mass mortality of fish, increases the trophic level, and modifies the repartition of trace metals (e.g. Cu, Cd, Zn, Ni) between water and sediments. The participation of the Institute in the lake recovery project on Lake Orta continued with trace metal inventories and pollutant mapping and studies on horizontal and vertical metal transport. Mathematical models describing thermo-hydrodynamics, nutrient mass balance and sediment evolution have been validated and calibrated with a view to predictive applications.


Figure 24: The flight of the MAFALDA (Multi-Analysis Floating Apparatus for Limnological Data Assessment). Used for research studies on Lake Maggiore over the last 3 years, the MAFALDA was recently transported to nearby Lake Orta where it will participate in monitoring a cleaning operation of the lake.

## Chemical Wastes

Experiments on inorganic waste analysis, soil characterization, waste leaching chemistry and diffusion of inorganic and organic pollutants in porous soil media were carried out to support a dynamic model for the computation of pollutant migration. A procedure for the extraction, clean-up and detection of polyhalogenated aromatic compounds was developed and applied to soil, milk and liver samples. For reference purposes highly toxic compounds like PCD, PCDDs and PCDFs can now be synthesized.

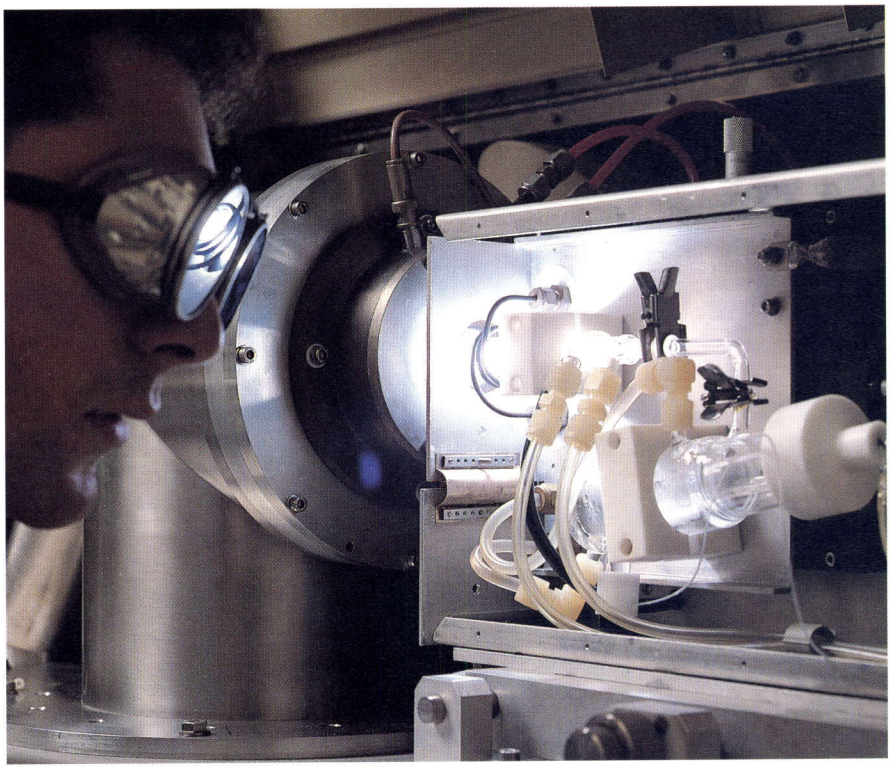


Figure 25: View of the plasma source of the ICP mass spectrometry used for inorganic ultra trace (ppt level) element determination

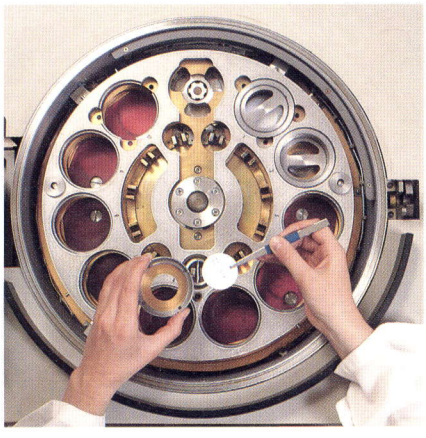


Figure 26: Preparation of the sample holder for X-ray fluorescence measurements

A risk assessment methodology for human exposure to polyhalogenated aromatic compounds, based on toxicity equivalent factors, was applied to the practical case of an urban incinerator.

The Chemical Emergency Management (ChEM) decision support system has been applied to the case of electrical equipment containing polychlorinated biphenyls; suggestions for prevention and emergency responses in case of accidents have been prepared.

## Food & Drug Analysis

The basic instrumentation for a food laboratory was commissioned in order to implement this new research area. A new (500 MHz) Nuclear Magnetic Resonance Spectrometer instrument has been installed and will be mainly devoted to wine analysis.


Figure 27: A graphical output from the data bank on radioactivity in the EC environment

## Radioactivity Environmental Monitoring

The data bank on radioactivity in the E.C. environment after the Chernobyl accident has been supplemented with data of the 1984-1986 period, obtained from national Authorities in fulfilment of art. 35-36 of the Euratom Treaty. The bank will form the basis of the periodical reports issued by the Commission on radioactivity measurements in the European Community, and will be open to public enquiries.

The bank will provide an unique opportunity to verify the environmental distribution models developed in the past, essentially on the basis of fall-out studies and laboratory tracer experiments. A major exercise of that nature is being jointly organized by CEC, IAEA and WMO on the verification of mesoscale air transfer models, which are of major importance in nuclear emergencies.

A complementary experimental activity on sampling techniques for airborne radioactivity has been started; open to international cooperation, it is based on the exploitation of two facilities:

a) a 100 $M^3$ environmental chamber to test and compare equipment for measurement of airborne radioactivity;

b) a 15 meter high rain tower, where the wash-out processes for the various airborne radionuclides can be studied.

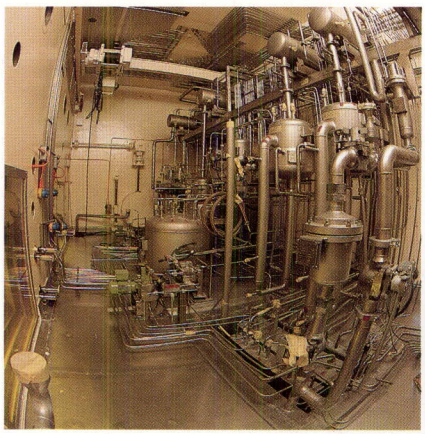


Figure 28: A fish-eye view of the equipment inside one of the PETRA hot cells

## Radioactive waste management

The construction of the PETRA facility at Ispra has been terminated in 1988, with the successful performance of the components and system functional tests. PETRA reproduces at a fully active pre-industrial scale the chemical operations related to spent fuel reprocessing, including vitrification of highly radioactive waste. PETRA is expected to start hot operations at the end of 1989.

Figure 29: PETRA is controlled by a computerised process control system which assures maximum safety.

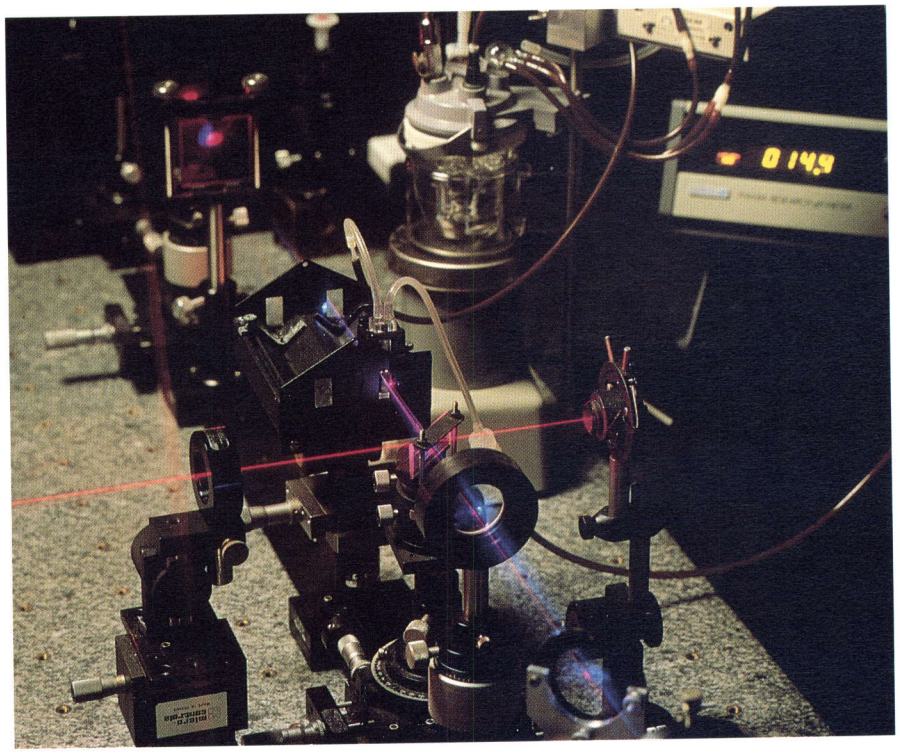
Figure 30: Neutron counting techniques have been developed to monitor the actinide content in solid waste, non destructively.

The kind of experiments to be performed in the short and medium term on irradiated fuel materials has been discussed and defined with the national organisations forming the PETRA Users Group. They take into account both the necessities deriving from the licensing procedure and the items of common interest for the member countries.

A high sensitivity-high accuracy instrument for non-destructive monitoring of plutonium in nuclear waste has been constructed; based on passive neutron counting, it has been especially designed for transportability and use in nuclear installations. A measuring campaign has been successfully carried out at the Casaccia ENEA Centre; a demonstration of this instrument to the European Parliament took place at Strasbourg on 13 April 1988.

A set of fully active vitrified waste samples, prepared at Ispra in cooperation with ENEA (Italy), has been characterized at the Transuranium Institute.

Figure 31: Laser spectroscopy allows the study of chemical forms of actinides in water at extremely low levels.



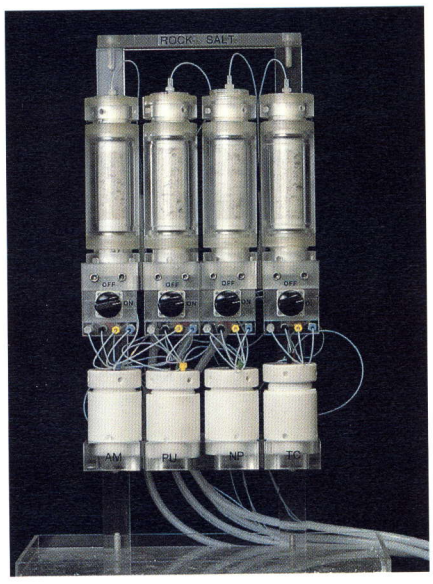



Figure 32: The interaction of radionuclides with salt in partially closed salt galleries is simulated by laboratory column experiments.

Among the measurements, gamma scanning, leaching tests, and optical and electron microscopy before and after leaching were performed.

The European PAGIS (Performance Assessment of Geological Isolation Systems) project, involving all major national laboratories of the EC, under joint coordination of the shared-cost action programme and the JRC, was completed at the end of 1988. The safety assessment codes developed by JRC Ispra have been successfully integrated in PAGIS; they deal specifically with probabilistic risk assessment and sensitivity-uncertainty analysis. The final reports will appear in early 1989. These codes are being expanded for application to fractured geological media, in collaboration with CIEMAT-ENRESA, Spain.

## The Institute for Remote Sensing Applications

The Institute for Remote Sensing Applications executes the programme on the Application of Remote Sensing Techniques.

### Monitoring of Land Resources and their use.

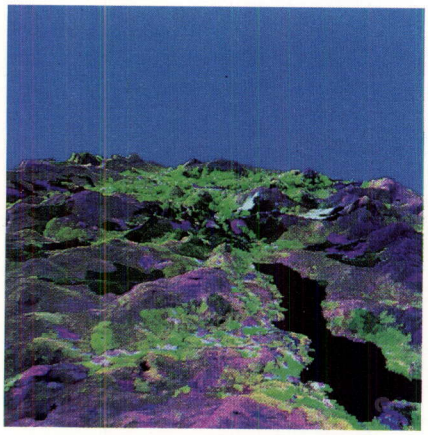


Figure 33: 3-D view of the Snowdonia National Park with an indication of the proposed reservoir for cooling water

The Ardèche experiment concerned an inventory and mapping of soil occupation (agriculture and forestry) over the department (560.000 ha), by automatic classification methods using Thematic Mapper (TM) data (30 m. resolution). This implied multitemporal processing using 3-4 TM images over the vegetation cycle and led to the development of two packages for radiometric and geometric corrections. Work on radiometric corrections of TM time series scenes led to the development of an experimental system which extracts the necessary scene dependent physical values from the image itself (e.g. clear water, radiance and scene histogram minima). An operational use of this method is envisaged after further testing.

Figure 34: To achieve maximum quality for the geometric registration of several images to a common mapping system, digital elevation data must be included in a correction algorithm. This elevation model was used to produce the 3-D projection of satellite data of the Ardèche region in France.

### Monitoring of the Marine Environment

In the area of sea pollution surveillance (Archimede Project) a small exercise was performed in April in the North Sea. Microwave radiometers (participation of the Deutsche Forschung und Versuchanstalt für Luft and Raumfahrt and Rijkswaterstaat) succeeded in discriminating between oils and biogenic films,

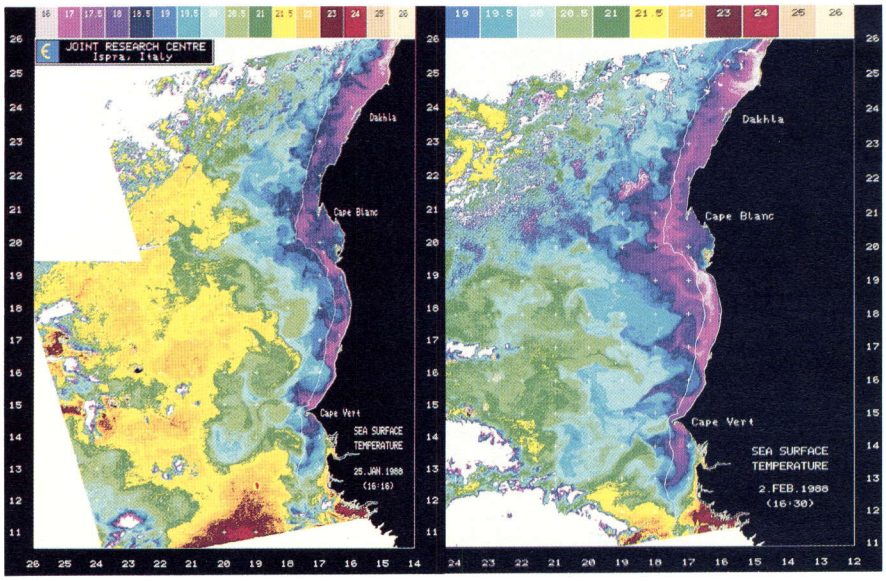



Figure 35: For a temporal description of the upwelling phenomena along the north-west African coast, further sea surface temperatures were produced. The two images, from 25 January and 2 February 1988 give an example of the strong changes in the temperature pattern in the sea surface and demonstrate the unique possibilities of satellites to observe such large areas.

showing details never observed before. Studies in coastal pollution dynamics resulted in a number of achievements, these include refinements for the Thematic Mapper (TM) data analysis resulting in the interpretation of a set of TM scenes of the Gulf of Naples which yielded maps of chlorophyll and total suspended sediment concentrations as well as of surface temperature.

A feasibility study of an instrument capable of accurately determining the angular and/or spectral distribution of solar radiance both in air and water was completed.

In collaboration with the Maroccan Authorities, upwelling studies and processing of bi-monthly sea surface temperature maps were continued, using simultaneously acquired CZCS and AVHRR images. The oceanography of the upwelling area was described using the collected data sets.


Figure 36: A typical image produced from sideways looking radar using microwave sensors operating at long wave lengths. The sideways looking mode enhances the topography and target height.

## Advanced Technology

### Microwave Remote Sensing Activity.

This is a new project for the Institute. One of the main objectives is the design and construction of a microwave signature laboratory which will be available both for direct JRC research as well as for use by EC member countries. A feasibility study has been carried out by an industrial consortium and a design plan for the laboratory proposed. Work was started with the European Space Agency on a plan to promote the concept of a European Airborne Remote Sensing Facility. The idea has been well received by the European user community as well as by European National Space Agencies.

### Laserfluorosensor activity.

Although the Time Resolved Lidar Fluorosensor will only arrive in June 1989, a mobile laboratory has been prepared to receive the instrument in order to perform ''in field'' tests and measurements. The main effort has therefore been devoted to setting up the laboratory simulation facility.

# The Institute for Safety Technology

The Institute for Safety Technology, at Ispra, executes the programme on Reference Methods, Reliability and Structures, Nuclear Reactor Safety and Industrial Hazards.

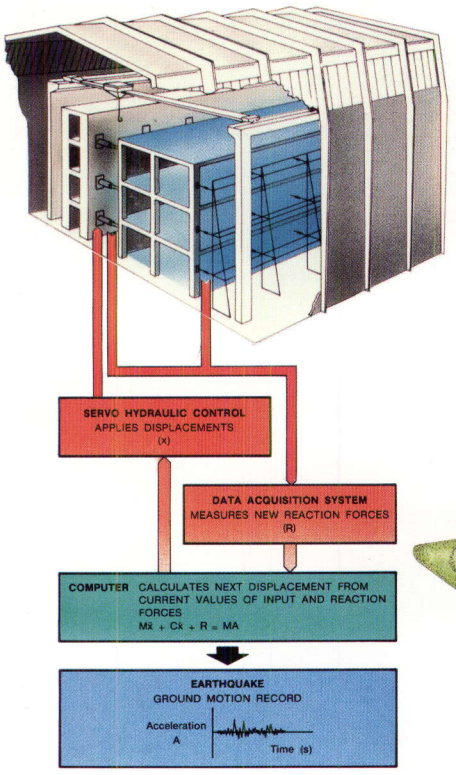
## Reference Methods, Reliability and Structures

### Reaction Wall Project

The design study of the reaction-wall facility was started in January 1988. Phase I of the study was completed in July 1988 and included the production of a general layout of the laboratory, the optimization and structural design of the reaction wall/strong floor system and a preliminary cost evaluation of the facility. Phase II, the final phase of the design study, was begun on August 24, 1988, and will be completed by the end of May, 1989.

An analysis was also started of the problems posed by the implementation and operation of the pseudodynamic test method (PDTM). A new implicit method is being developed which has considerable potential for reducing the actuator control and error propagation problems encountered in the currently used explicit implementations of the PDTM.

Continuous progress has been achieved in the development, in collaboration with CEA, of the PLEXIS-3D dynamic finite element code for coupled fluid/structure problems.



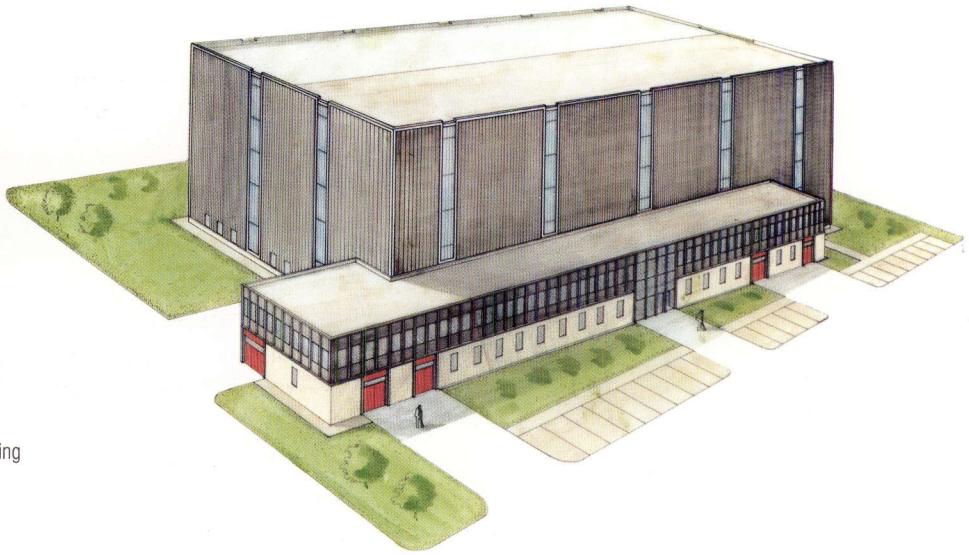



Figure 37: Pseudo-dynamic testing of civil engineering structure using a reaction wall (above). An artist's impression of the proposed Structural Mechanics Laboratory which will house the new reaction wall (right).

### Reliability Modelling of Structures

The fatigue cycling test at room temperature of Vessel No. 1 (1:5 scale) has exceeded the level of 500.000 cycles.

The prediction of fatigue crack growth and of time to failure is progressively improved by using in service inspection data.

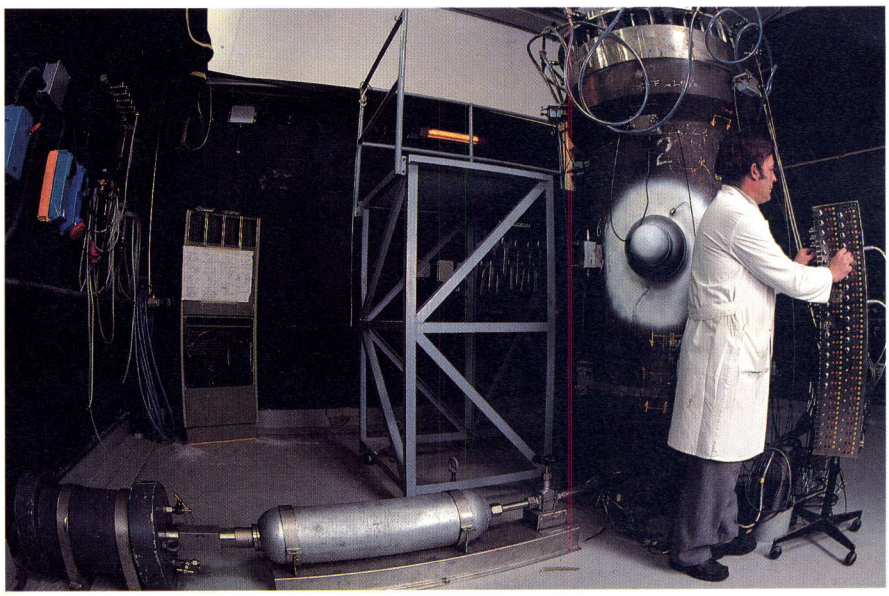


Figure 38: Computer controlled test rig for fatigue tests on 1/5th scale models of pressure vessels

It could be shown that the propagation of cracks has been rather heavily conditioned by the presence of cladding residual stresses and that sensible predictions of crack growth are possible taking into account the incremental values rather than the absolute crack dimensions.

### Pressurized Thermal Shock

This work is carried out in collaboration with Material Prüf Anstalt (MPA) - Stuttgart. The thermal cycling has been started including temperature data collection in 146 locations. A knowledge-based system has been prepared to manage the experimentation.

## Reactor Safety

Several studies already under way in the previous period, in particular studies concentrating on the analysis of severe accidents, were continued.

Part of the Shared Cost Action contracts launched in the previous period were still under way and new actions were started in the Source Term area.

Main achievements in 1988 are reported hereafter.

### Reliability and Risk Evaluation

The component Event Data Bank has become operational after successful conclusion of the pilot phase carried out in cooperation with data suppliers. Development of tools for the data analysis has been continued in view of a possible future participation in the World Association of Nuclear Operators.The cognitive modelling of the operator has been further developed in the area of man-machine interaction. In the field of Probabilistic Safety Analysis, the international benchmark exercise on Event Sequence has been started.

## PISC (Project for the Integrity of Structural Components)

Considerable progress has been made in the PISC III actions which are jointly sponsored by the OECD and the CEC and in which JRC is operating agent as well as reference laboratory for the analysis of results. These actions were: 1) inspection of real contaminated reactor structure pieces carried out in the hot laboratories at Ispra; 2) automated inspections on a full scale vessel at MPA Stuttgart; 3) organization of a round robin exercise to test the inspection capabilities on complex geometries, like nozzles and safe-ends; 4) validation of mathematical models of ultrasonic equipment response; 5) exercises to test the inspection reliability. All these activities were performed in collaboration with a large number of organizations in Europe, the US and Japan.

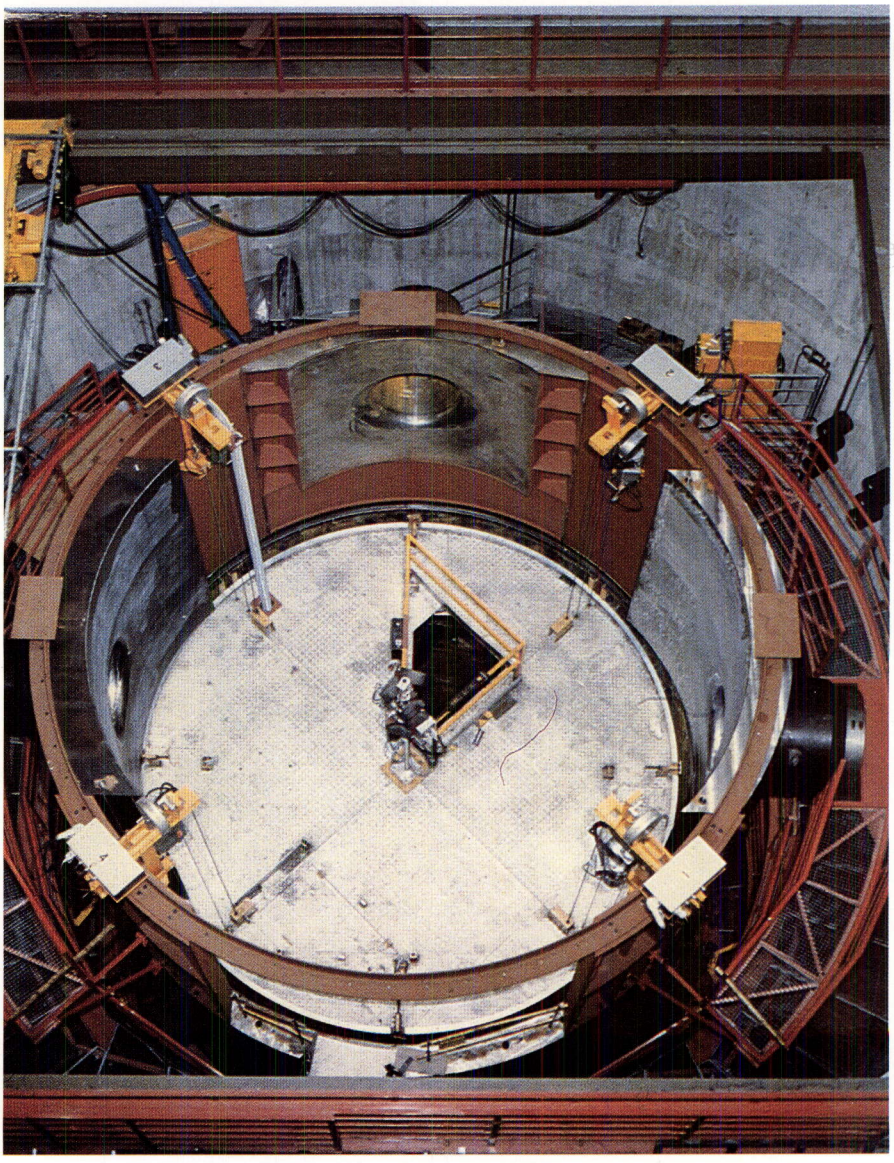


Figure 39: Full scale vessel at MPA Stuttgart : View of the PWR Nozzles Supporting Ring

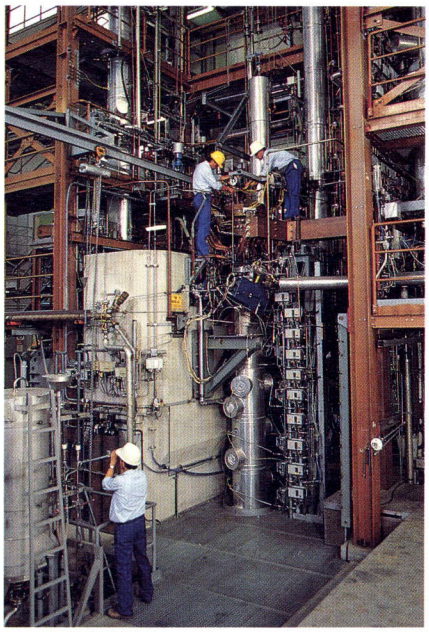


Figure 40: The LOBI experimental facility used for integral tests on loss of coolant accidents in Light Water Reactors

## Abnormal Behaviour of Reactor Cooling Systems and Accident Modelling

In this research area three main projects are included:

- **LOBI**, which is a large experimental facility for the investigation of thermo-hydraulic behaviour of reactor cooling systems during transient or loss-of-coolant accidents in a pressurized water reactor. Four tests were executed and analysed in 1988. A number of Member State organisations participated in the selection and precalculation of tests. The test results have been extensively used for validation/improvement of the US RELAP5/MOD$_2$ code and the European codes ATHLET (FRG) and CATHARE (F);
- **FARO** is an experimental plant where up to 100 kg of $UO_2$ can be melted for the study of fuel jet penetration and fragmentation in the coolant (sodium) of structure response to fuel jet impact, of fuel freezing and plugging in channels and subassemblies. The plant is now used for studies of interest for severe accident analysis in LMFBRs.

  In 1988 the tests with the TERMOS test sections have been successfully started : for the first time,a test involving the interaction of 100 kg of $UO_2$ with liquid sodium has been executed, providing new data on melt penetration in sodium, the pressure field generated and $UO_2$ debris settlement.

  Research and tests have also continued to increase the reliability of the temperature measurement in the molten $UO_2$ pool applying ultrasonic techniques.
  For a better qualification of the melt delivery from the FARO furnace to the test sections, simulant tests with water jets have been executed, providing interesting information on the release phenomena.

  A preliminary study has been started to investigate the possible use of the FARO facility for the study of phenomena related to LWR severe accidents.

Figure 41: Microgram from a part of a solidified $UO_2$ block after melting in the FARO furnace.

- **EAC**, which is a system code for the analysis of the initiation phase of low probability whole core accidents in LMFBRs. In 1988 considerable progress has been made in the development of the EAC2 version by coupling the TRANSURANUS pin behaviour model to the EAC informatics and to the CFEM boiling model. The MDYN fuel model has been improved in the area of fuel flow regimes and through the introduction of a third fluid. The CAMDYN in-pin fuel model and the LAKU fission gas behaviour model were completed. These activities were executed with substantial support from JRC-Karlsruhe. Validation of both models with a few CABRI experiments has been undertaken successfully.

## Source Term

The contract between the JRC and the Commissariat à l'Energie Atomique (France) specifying the JRC participation in the in-pile Phebus Fission Product Programme (FP) was signed on 12 July 1988. The JRC is directly involved in the project funding and work through a team detached on site and a team at Ispra participating in analysis work. In 1988 a number of Shared Cost Actions in support of the preparation of Phebus FP have been concluded: the results are giving an essential contribution to defining the test matrix, the experimental circuit dimensioning and the instrumentation plan.
New Shared Cost Actions contracts have been launched in 1988 on advanced instrumentation (in relation to Phebus FP), on Fission Product chemistry and on model and code development.

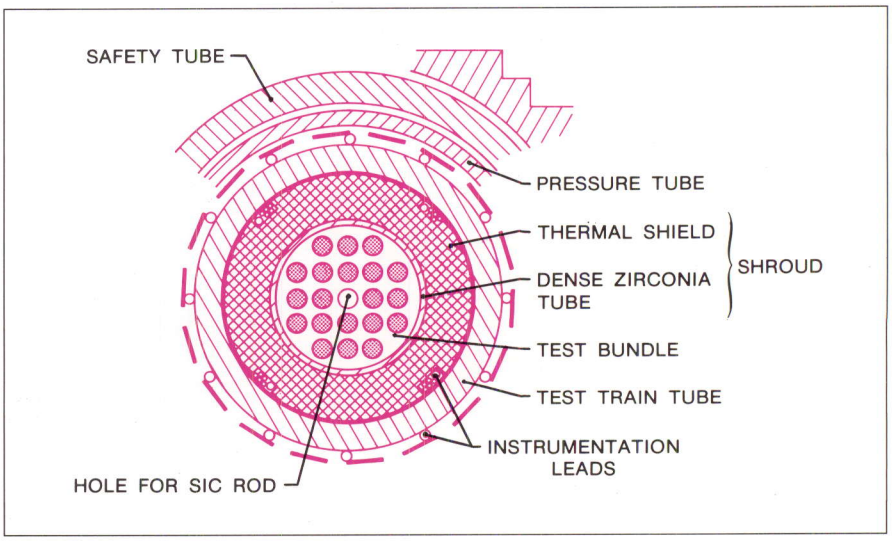



Figure 42: Cross section of the lower part of the PHEBUS FP Test Stringer

## PAHR in-pile

This activity will be completed in the 1988/1991 period with the execution of three in-pile tests in the BR2 reactor at Mol (B). In 1988 a series of tests has been performed at Ispra to set up a more accurate and reliable particulate bed filling procedure. The second in-pile test is in preparation: its particle bed has been prepared and characterized following the new procedure which will allow an easier interpretation of the test and validation of models and codes.

Figure 43: The Ispra Risk Management Support System is hosted on a SUN computer. Displayed here are the results from a risk assessment exercise in the Netherlands.

## Industrial Hazards

In the context of Systems Safety and Reliability studies 20 organisations from 10 Member States have completed the bench mark exercise on major hazard analysis. It consisted in the identification of hazards and in the assessment of risk contours around an ammonia storage connected to a sea terminal.

In parallel JRC started the development of DOMINO, a software package suited to perform analysis of incident scenarios characterised by propagation of failures among different facilities because of fire or explosion events.

The Ispra Risk Management Support (IRIMS) has been implemented on a SUN computer together with a first version of a new transportation risk model called TRIM.

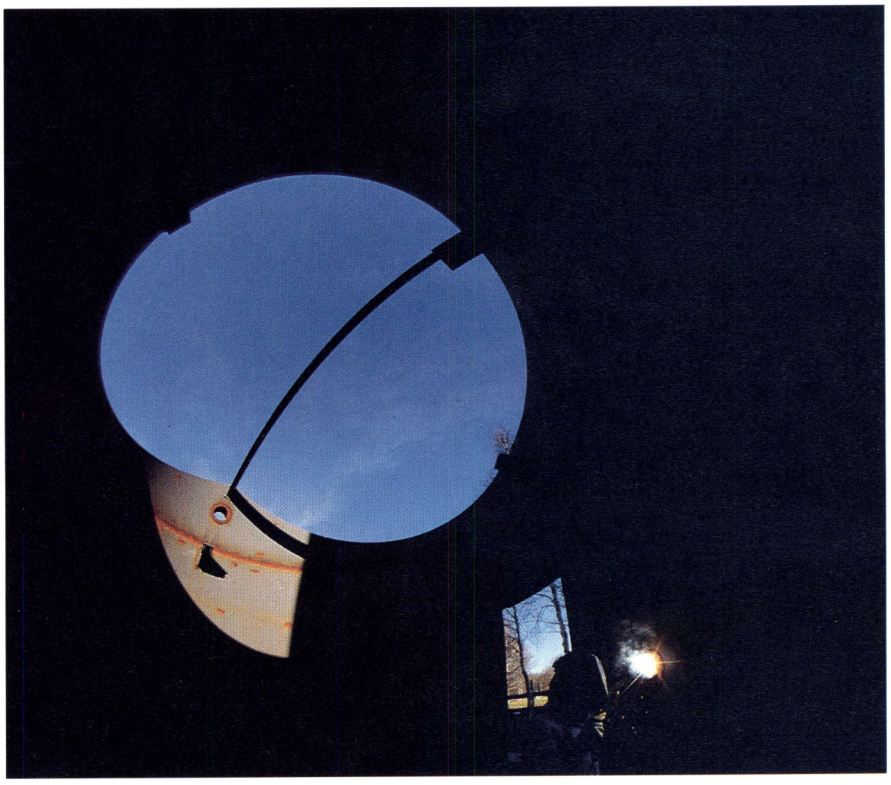


Figure 44: A view from the inside of the FIRES bunker undergoing construction. The bunker will eventually house the 100 l chemical reactor.

For the analysis of off-normal behaviour of chemical reactors (runaway reactions) the construction of the FIRES facility whose central part is a 100 litre capacity standard chemical reactor has been actively pursued. The experimental capabilities have been increased by purchasing a fully automated small-scale (2 litres) reactor. The first version of FISIM ( FIres SIMulator) has been completed and test cases for validation, which include neutralisation, oxidation of sodium thiosulphate and toluene nitration reactions, have been performed. The theoretical kinetic studies have been continued, concentrating on toluene nitration by mixed acid and on suspension polymerization of methyl methacrylate reactions. The first version of the mathematical model of these two kinetic schemes allows the prediction of the performance of the FIRES venting system

for different onset pressures. In addition, the effects of severe accidents in the FIRES facility leading to reactor rupture and the containment vessel capabilities have been investigated.

Within the runaway reactions project the Multiphase - Multicomponent Fluid Flow Test Facility produced results on flow regimes as they change with the physical properties of fluids. Flow patterns so far not reported in the literature were observed and analysed. The modelling work concentrates on verifying the codes DEERS and SAFIRE using experimental data.

## The Institute for Systems Engineering

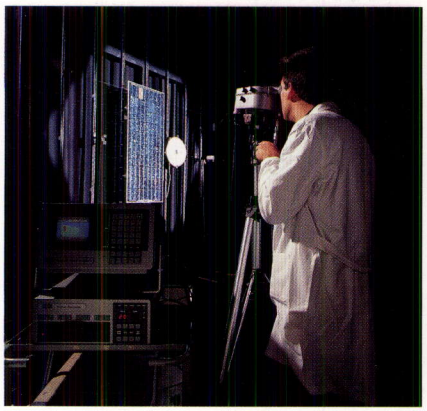
The Institute for Systems Engineering at Ispra executes the programmes on Reference Methods for Non Nuclear Energies, on Safeguards and Fissile Materials Management, and on Fusion Technology and Safety.

### Reference Methods for Non Nuclear Energies

The programme on Reference Methods for Non Nuclear Energies has been focussed on performance evaluation and devices, implementation of certification procedures for industrial solar energy (photovoltaic/thermal) using the ESTI (European Solar Test Installation) facilities at Ispra, and on standardization of procedures for energy auditing.

The main achievements concern photovoltaic (PV) modules and passive solar system modelling and testing procedures; they are:

- Implementation of test procedures and development of measurement and qualification standards for PV modules within the International Electrotechnical Commission;



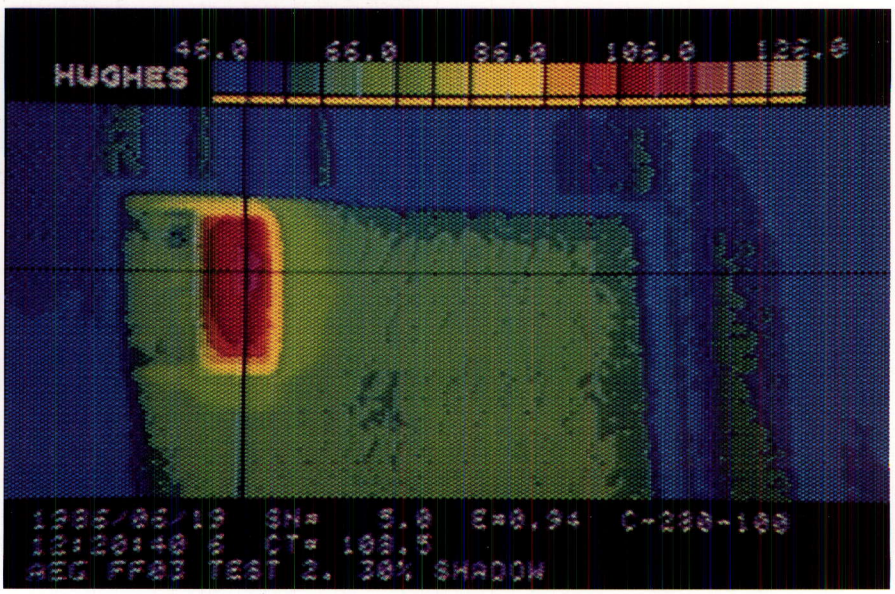



Figure 45: Thermal imaging equipment for Hot SPOT failure tests on photovoltaic modules (above). Observation of an Hot SPOT on the video display (right). The local heating observed occurs under certain shadow conditions (e.g. dirt) and can destroy a module if the manufacturer does not take the necessary precautions.

- upgrading of measurement and calibration techniques in ESTI using laser scanning for light induced current measurement and hot spot failure analysis of photovoltaic cells;
- setting up of a collaborative programme between JRC, CEA CADARACHE (France) and CIEMAT (Spain) on the degradation assessment of amorphous silicon cells;
- completion of a long term weathering experiment (5 year duration) with solar collectors in rural and industrial sites, and comparison of realistic corrosion damage with accelerated corrosion experiments carried out in the ESTI laboratories;

Figure 46: Testing of solar passive and active components on the Ispra Site

- development of a 3-dimensional model for thermal computation in building design and energy audits;
- development, in collaboration with LNETI (Portugal) and Ecole des Mines (France) of an input-output method for the evaluation of solar system performance. The method has been adopted by ISOP;
- a methodology for the evaluation of the performance of solar passive buildings has been applied to the JRC Solar Laboratory with a view to collaboration with Mediterranean countries.

Figure 47: Measuring indoor thermal comfort in the Ispra Solar Passive Laboratory

## Safeguards and Fissile Materials Management

The programme on Safeguards and Fissile Materials Management is centered on the development of new safeguards techniques for both present and future nuclear fuel cycles.The activity is performed in cooperation with the major R&D organisations in the field within the Community (ESARDA association) and in the USA. Important milestones in 1988 are:

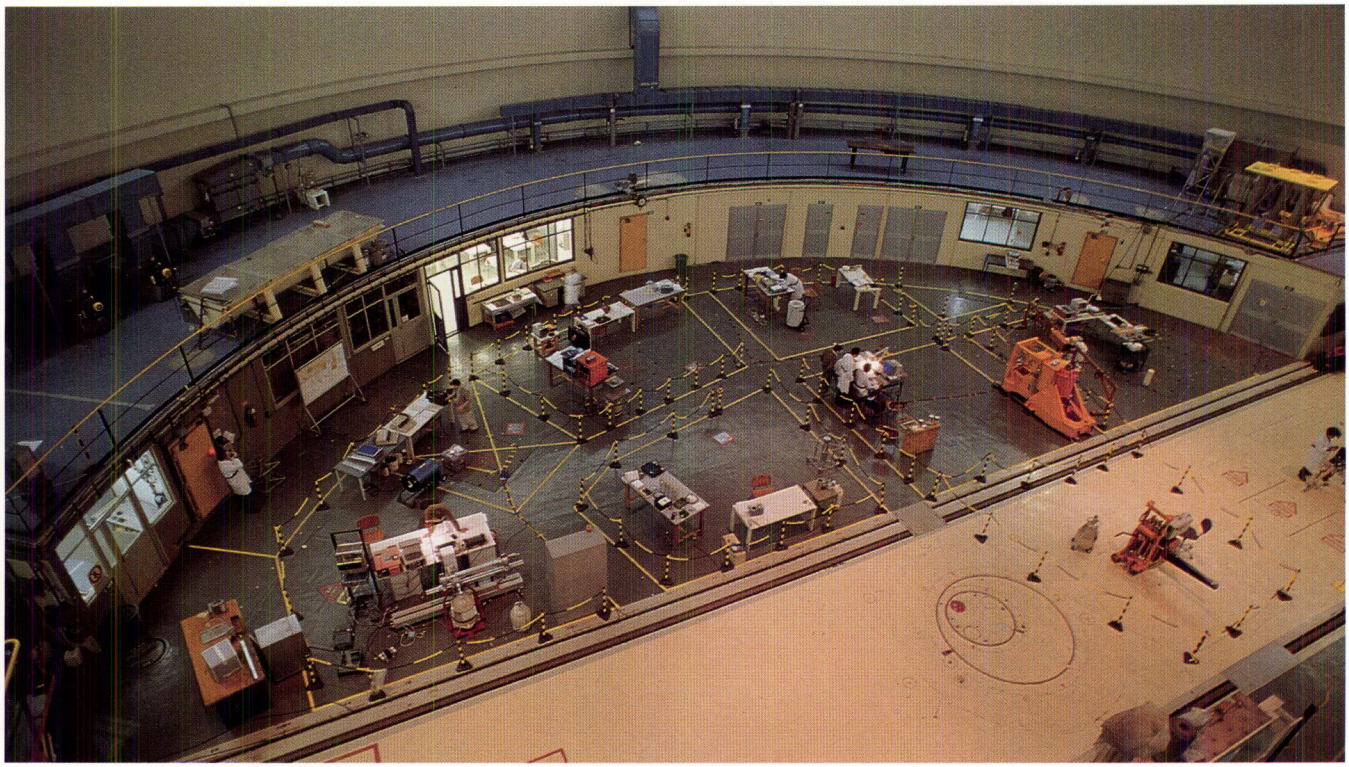


Figure 48: Operative since 1987, the Pre-PERLA (PERformance LAboratory) facility is employed in calibration and training exercises for Euratom and IAEA inspectors

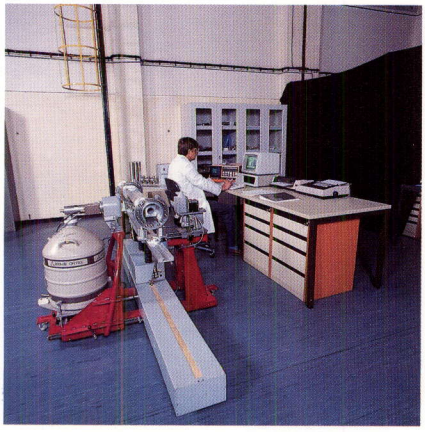


Figure 49: The Material Testing Reactor (MTR) Scanner is a device used to monitor fuel elements

- Initial measurements on large samples of plutonium in the Pre-Perla laboratory with the most recently developed non-destructive techniques available at the EURATOM and IAEA safeguards inspectorates;
- the execution of a Physical Inventory Verification (PIV) exercise of enriched Uranium by teams of safeguard inspectors again in Pre-Perla;
- a series of training courses for DCS inspectors on methods and instruments based on the various non-destructive measurement techniques, like active and passive neutron interrogation and gamma spectrometry;
- an extraction procedure based on TBP has been developed at Karlsruhe, taking advantage of the use of analytical robots, in order to speed up separation of Uranium and Plutonium for subsequent mass spectrometric analysis;
- installation at Sandia National Laboratories, USA, of an experimental set up originally developed at JRC, Ispra, for the reading of ultrasonic signatures on seals of plutonium containing fuel assemblies;
- development of an engineered prototype of a laser system for the surveillance of nuclear spent fuel pools. Two laser beams scan a plane above the water and the system detects any object penetration in the area under surveillance (up to 25 m);
- design of an interactive system for the simulation of nuclear facilities, using the characteristics of a typical plutonium fuel fabrication plant. The simulator aims to evaluate the performance of nuclear materials accountancy measures.

## Fusion Technology and Safety

The programme on Fusion Technology and Safety is implemented at the Ispra and Petten sites; it is fully integrated with the work carried out by the European Associated Laboratories in the framework of the European Fusion Programme 1985-1989. The following steps were taken in 1988.

- design of in-vessel components for the ITER-first phase design;
- assessment of the electromechanical effects on in-vessel structures (plasma facing components and supporting systems) of NET due to plasma disruptions;

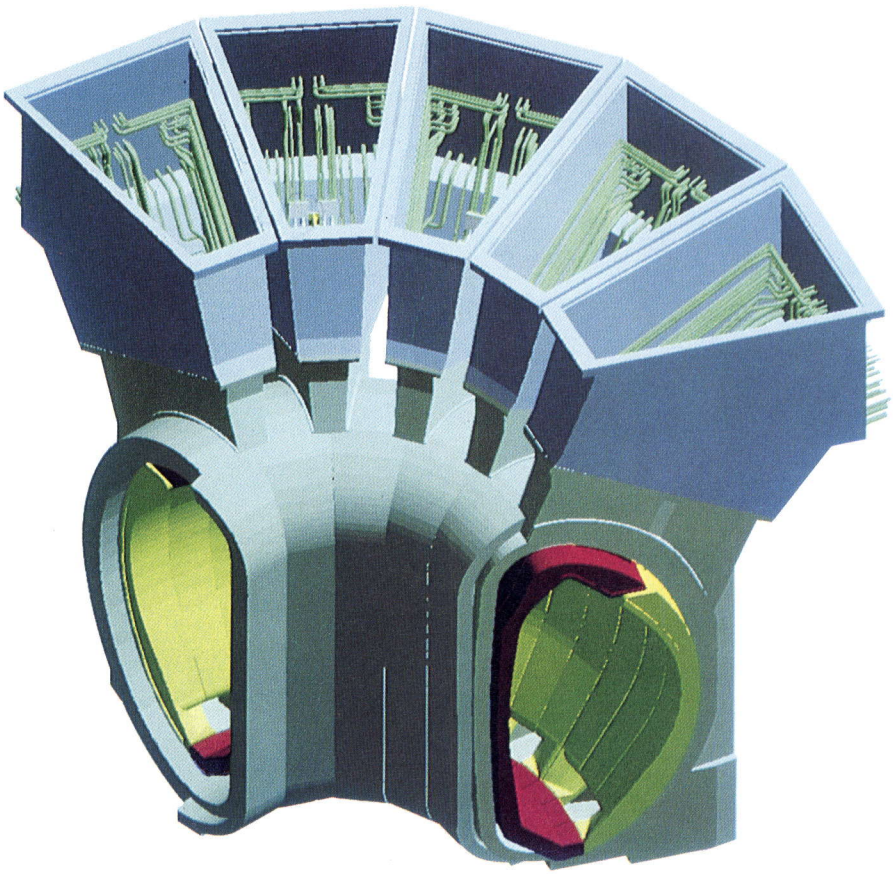


Figure 50: Computer model of a section of the NET (Next European Torus) design for studies of systems integration, assembly-disassembly and maintenance by remote handling

Figure 51: Breeding material ($Li_{17}Pb$) after simulation of a steam generator accident in a fusion reactor liquid metal blanket

- development of a model of melting and evaporation of the surface of a first wall under plasma disruption, based on simulation experiments using electron guns;
- completion of the post-irradiation examination of AISI-316 and Mn-Cr steels irradiated in HFR at 10 dpa and of the analysis of the first irradiation tests on Pb-17Li samples;
- execution of several tests of Pb-17Li/water interaction in the large scale facility, showing that the governing phenomena are water-jet break-up and mixing;

- validation with in-field experiments of atmospheric transport and diffusion codes to evaluate the environmental impact of tritium releases;
- authorization from ENEA-DISP for the construction of the Tritium Handling Laboratory (ETHEL) up to the inactive commissioning of the laboratory has been obtained. Ground preparation and construction of the building were started in October 1988. Most of the other subsystems have been ordered. Some of them are in an advanced stage of construction, like the large caisson on the glove boxes. The liquid and gaseous waste storage and buffer tanks have already been delivered to the Ispra site.

## Centre for Information Technologies and Electronics

The Centre for Information Technologies and Electronics and the Institute for Prospective Technological Studies mainly perform support activities for the JRC and for other services of the Commission; an increasing share of their activities will be dedicated to work for external customers.

This centre will consist of two units:

1. computing division, operating like a service company, available to in-house or external customers;
2. a scientific division, in charge of advanced applications of Information Technologies, Telecommunications and Electronics.

Figure 52: View of the mainframe computing system from the operators' control room

### Computing Division

During 1988, the Computing Division has taken many steps to upgrade the computing facilities, to develop the networks and to provide better services to other institutes and administrative units. The main results are:

- orders have been placed to replace the current, saturated, AMDAHL 5860 (20 Mips) with a more powerful general purpose AMDAHL machine (44 Mips) complemented by a Computing Surface machine based on transputers; for scientific purposes the addition of a mini-super is planned in the first half of 1989. A connection to an external CRAY X-MP, under service bureau agreements, will be maintained, as appropriate;
- the DUAL backbone network, after years of development, has been installed in the Ispra research campus. Fully conforming to OSI standards, it provides transparent high speed communication over a fibre optic ring between the Ethernet Local Area Networks installed in the buildings of the Ispra site. It also provides bridges to other proprietary networks and access to the international networks under X25;
- office automation systems have been improved and experimental solutions have been tested to interconnect the management information systems of the four JRC sites;
- data base development and server functions have been supplied to the following projects: ERDS, AORS, OUSR (reactor safety); MARS, CHEM (industrial risk); REM (radio-protection) and HTM (materials);

## Division for Advanced Applications of Information Technologies and Electronics

- This Division participates in the development of Information Services, intelligent accounting systems and decision support systems for the specific research programme on Nuclear Safeguards and Fissile Materials

Figure 53: The computer vision system for reviewing images obtained during optical surveillance. The pictures are grabbed by the TV camera, processed by the computer and displayed on the TV monitor.

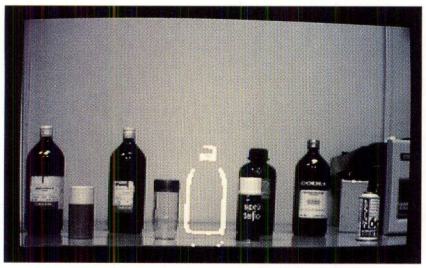


Figure 54: A computer vision system demonstrates here a scene modification (missing object is shown by white contour lines) during a surveillance of fissile materials stored in a cell.

Management. Statistics, fuzzy sets, real-time simulators and artificial intelligence are combined in these products. An expert system has been delivered to the International Atomic Energy Agency; it produces results comparable to the performance of top human experts in the Agency;

- intelligent vision systems for containment and surveillance have also been developed for the Nuclear Safeguards research programme, and delivered to the inspectors of the Euratom Nuclear Safeguards directorate. These products might have far-ranging commercial applications for monitoring and safety purposes in industrial plants, banks and the public service;
- specific application integrated chips have been designed at the request of customers, and produced by commercial silicon manufacturers;
- the signal processing, data acquisition and process control capabilities of this division are used for the continuing development of the instrumentation and data handling of experimental facilities related to the Reactor Safety specific research programme.

Figure 55: A computer vision system used for the verification of metal seals in safeguards containment shows here an image of an E-metal seal with soldering traces and scratches. The white frame, representing the zone to be stored on disk, is used for adjusting TV camera and seal support.

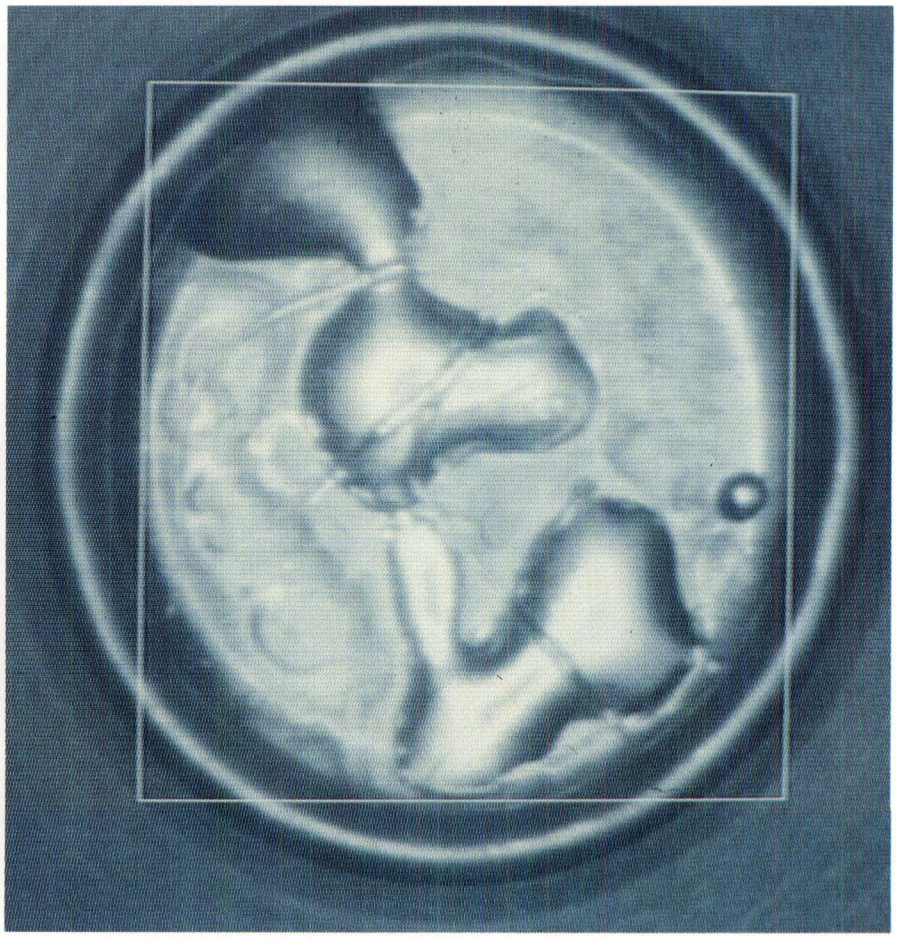


Figure 56: Four examples of metal seals with randomly distributed taps and scratches used in containment procedures in safeguards

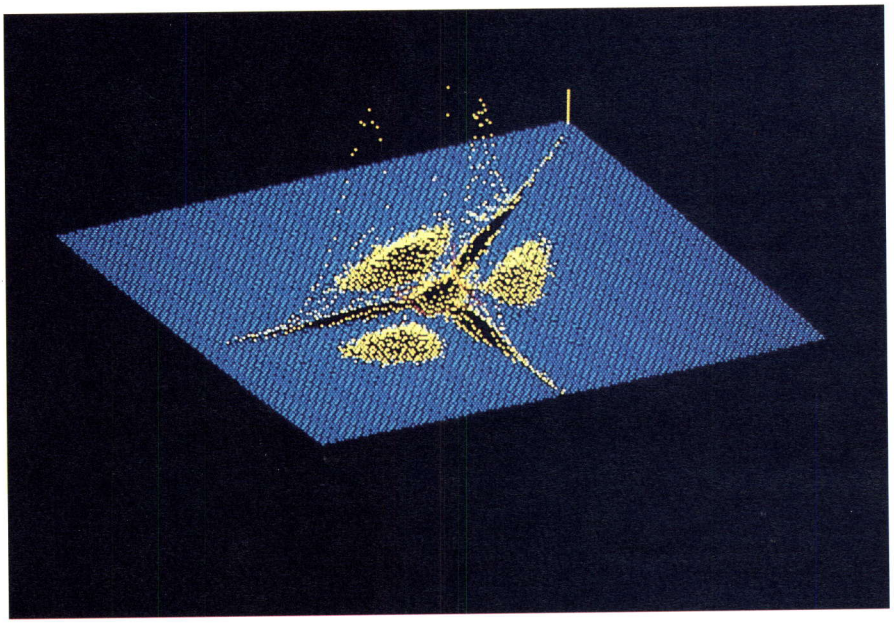


Figure 57: The spectrum of a multidimensional analysis of the neutrons and gamma rays in the Spontaneous Fusion (SF) of $^{252}Cf$ with a three detectors configuration

## Institute for Prospective Technological Studies

Only preparatory work has been performed during 1988 by this new Institute; four main lines have been followed:

- contributing to the definition by DG XII (General-Directorate Science, Research and Development), of the new CEC programme proposal to the Council, called MONITOR; this proposal encompasses: early warning in science and technology, strategic assessment, evaluation of programmes, and long term forecasting;

  The Institute should play an important role in early warning in science and technology and in strategic assessment.
- contributing to the formulation of future DG XII initiatives, concerning aeronautic industries and space;
- contributing to the creation of the European Research Association for Flow, Turbulence and Combustion (ERCOFTAC);
- participating in two restricted brainstorming sessions and seminars on advanced communication (Ste Croix) and telecommunications (Santander).

# JRC EXPLORATORY RESEARCH

## Research prospects

The Board of Governors approved a number of exploratory research projects at its meeting of 9th June 1988, and the necessary transfer of funds was duly made as a charge upon the resources of the specific research programmes

**Acoustic Aerosol Scavenging** (TUI, Karlsruhe). Aerosol agglomeration studies were performed in experimental chambers (volumes of 5, 15, and 170 $m^3$), using electro-acoustic transducers at a frequency of 21 kHz. Test aerosols included carbon black produced by burning rubber and a white chemical fog. Quantitative measurements of the mass rate of condensation versus acoustic power were made. A volume of 15 $m^3$ was cleared of a dense, black aerosol in 15 minutes using 1 kW of acoustic power. Extrapolation of the data supports a proposal for the large scale scavenging of hazardous aerosols.

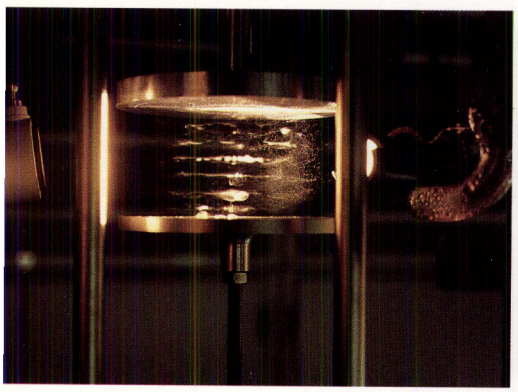


Figure 58: Coagulation of a water aerosol by an ultrasonic field

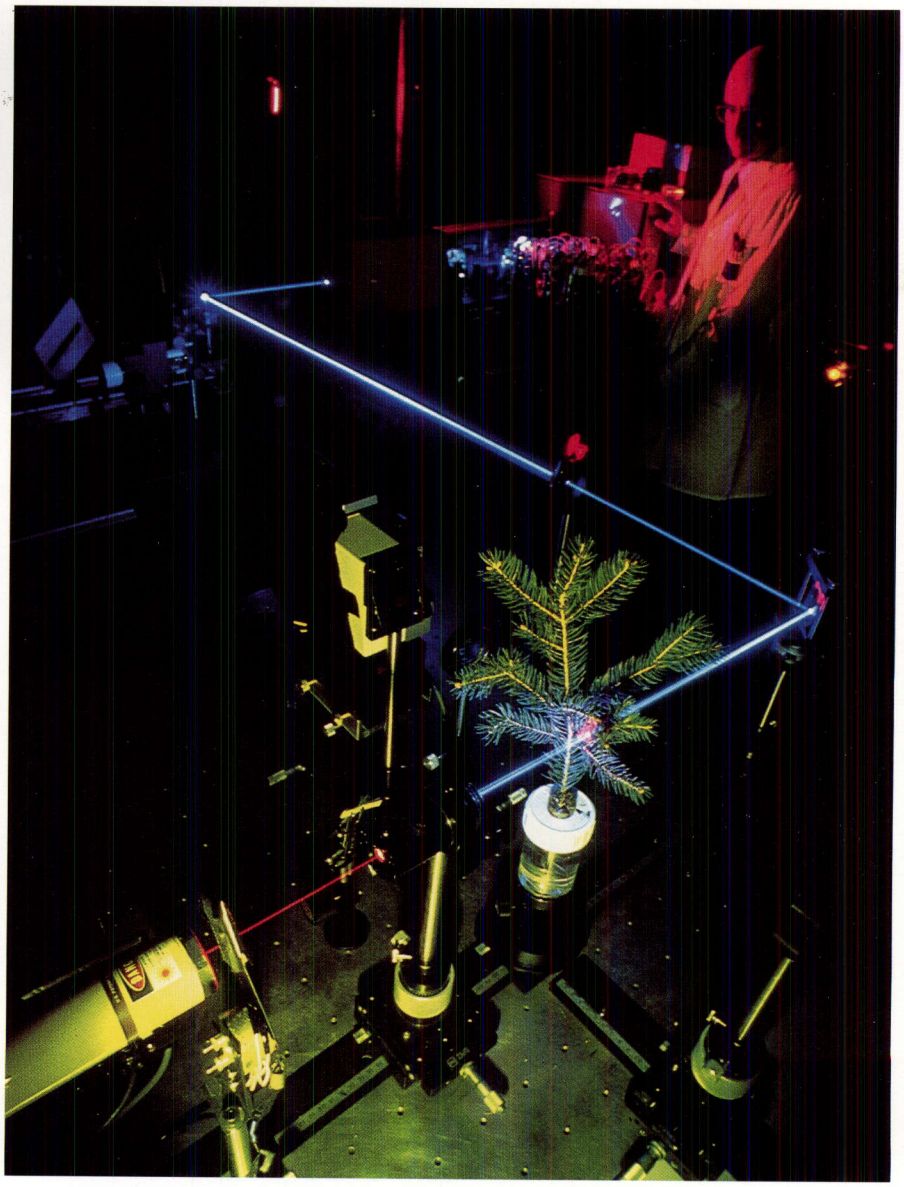


Figure 59: In vivo laser-executed chlorophyll fluorescence investigated as a suitable tool for early plant stress identification

**Application of Laser spectroscopy** to the characterisation of living green matter (Remote Sensing, Ispra). In a photosynthetic system the light energy absorbed by a large array of antenna pigment is trapped for times between tens and hundreds of picoseconds by the reaction centres of Photosystem I and Photosystem II. The ensuing energy transfer processes are investigated by time-resolved fluorescence. Results for green leaves show a strong dependence on reabsorption phenomena which rules out using the spectral shape to characterise the state of vegetation. The very strong stress produced by the application of herbicides does alter the shape significantly, but such conditions do not exist in nature.
The reabsorption phenomena do not affect the decay times of chlorophyll fluorescence and experiments showed that strong stress conditions (application of Photosystem II herbicides) as well as natural degradation (senescence) can be distinguished. The results lend confidence to the expectation that time decay measurements on green vegetation in known physiological states will lead to the successful design of infield remote sensing instrumentation.

**Image Processing and Synthesis for Diagnostics.** (Systems Engineering, Ispra). Images obtained by various techniques, holograms, x-ray films, electron micrographs and so on contain observations of great interest for structural analysis, but the processing and retrieval of information from them encounter some difficulties. Results have been obtained on the production of laser holograms without use of a reference beam (multi-evolutive speckle method now being patented); on the digitalisation of high-density x-ray negatives; on the implementation of automated interference fringe detection and the corresponding coding computer programmes.

Figure 60: Laser interferogram of a pipe interior, obtained by optical fibres

Figure 61: VICOR Image Processing: studies of crack growth by analysing high density X-ray negatives. These negatives are digitized using a high efficiency in-house negatoscope and then stored on high speed hard disks. The system has zooming capabilities up to 60 times enlargement.

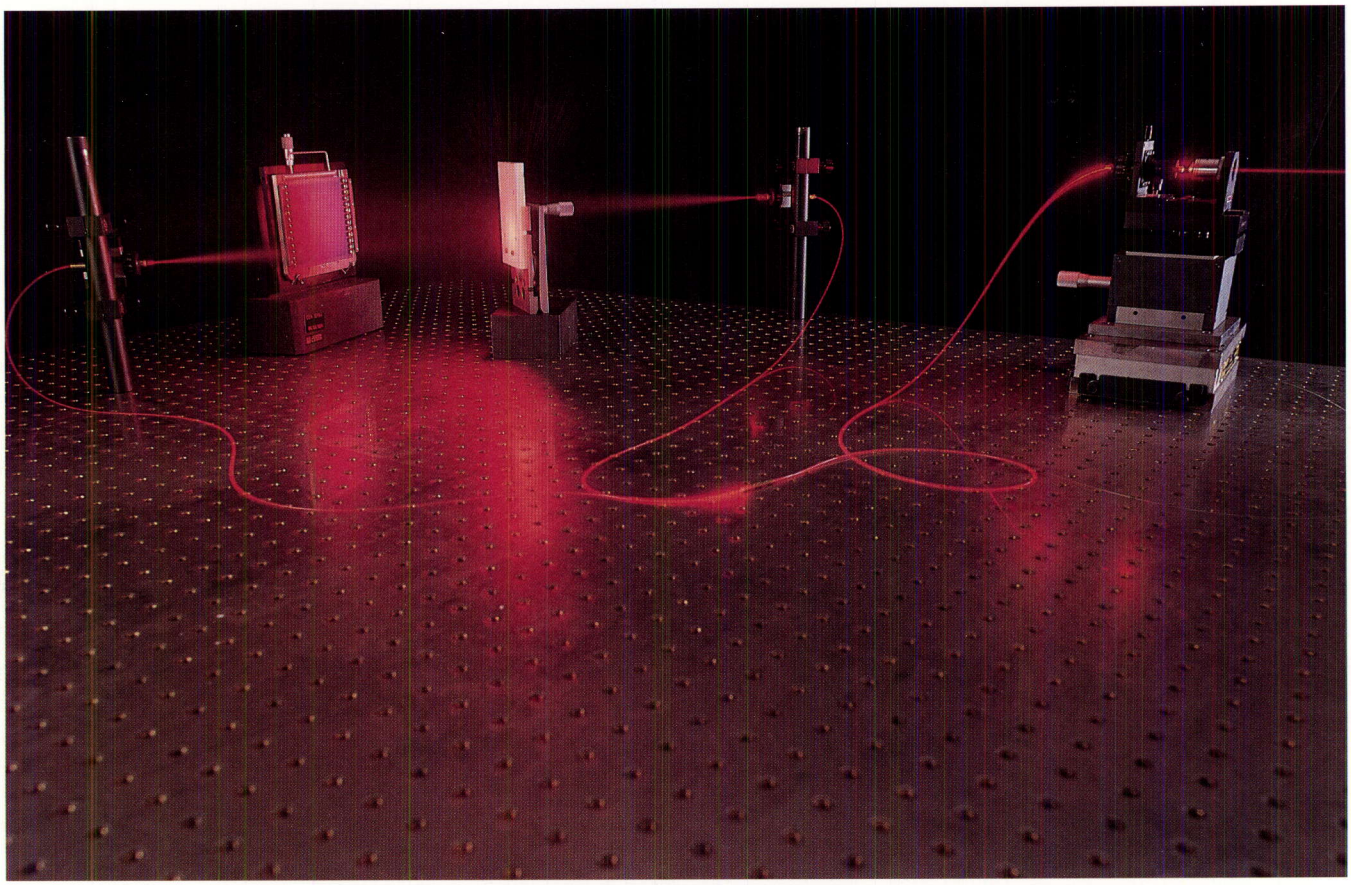


Figure 62: Use of optical fibres for laser holographic interferometry

**Advanced Damage Modelling** (Systems Engineering, Ispra). Experiments have shown that the thermal response of specimens under monotonic loading, even in the elastic regions, depends on the level of damage already undergone by the material field. The thermal field measurement allowed the discrimination of different levels of creep damage. Acoustic emission signals examined by non-linear adaptive filters also show promise for strain analysis and the continuous monitoring of loaded structures.

**Development of Sensors** (Systems Engineering, Ispra). A prototype optical fibre sensor was developed and used for laser holographic interferometry in inaccessible regions such as the interiors of pipes. The potential use of light squeezing techniques, prompted by the successful work mentioned above, has been investigated. Experimental feasibility studies have been designed.

**Decisions Context Modelling** (Systems Engineering, Ispra). The main features of the decisions in risk situations have been identified. The self-referential character of the context has been highlighted and guidelines for empirical research on risk communication have been produced.

Four communications have been issued entitled:

- Safety control and new paradigms in systems science;
- non-random propagation of risks along organisational channels;

- reflection on communicating about high-risk technologies;
- risk communication and the paradigm of paradox.

**H/D Extraction, Purification and Separation** (Safety Technology, Ispra). Two substrates have been used in the gas-chromatograph, namely Na-Mordenite and Na-70% Ca Mordenite. For the Na-Mordenite data were taken on:

- the retention times and resolution factors of $H_2$ and $D_2$ in the temperature range from - 100°C to -135°C;
- the separation factor for mixtures as a function of the throughput;
- the adsorption of $H_2$ and $D_2$ at liquid nitrogen temperature.

The strong adsorption of hydrogen isotopes observed is encouraging for the separation from helium in the future ETHEL programme. Even better performance was observed for Na-70% Ca Mordenite, provided a detailed conditioning procedure is respected so that complete reversibility is obtained.

**Non-destructive Plutonium Waste Monitor** (Safety Technology, Ispra). Several recent demonstrations of the Ispra monitor for plutonium residues in radioactive waste cans support the urgent need for this exploratory action. Steps already completed involve,

- development of a theory for dead time correction for the neutron signal pulse train;
- development of the algorithms for the dead time correction of the factorial moments up to third order, and experimental testing of the formula;
- specification of the hardware for final testing, including the simulated waste barrels and $PuO_2$ sources in the range of 1 g to 1 mg.

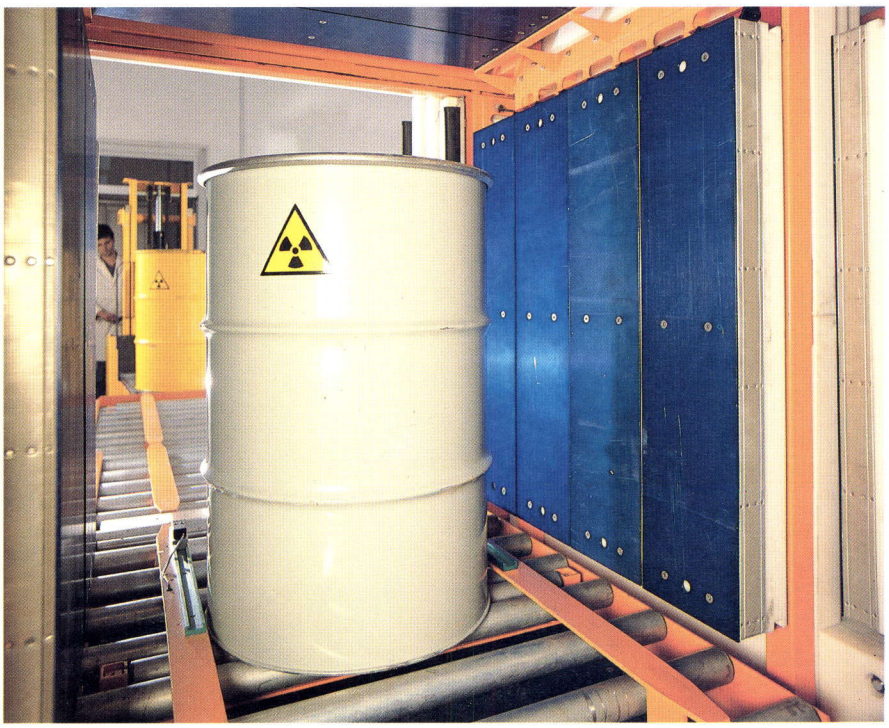
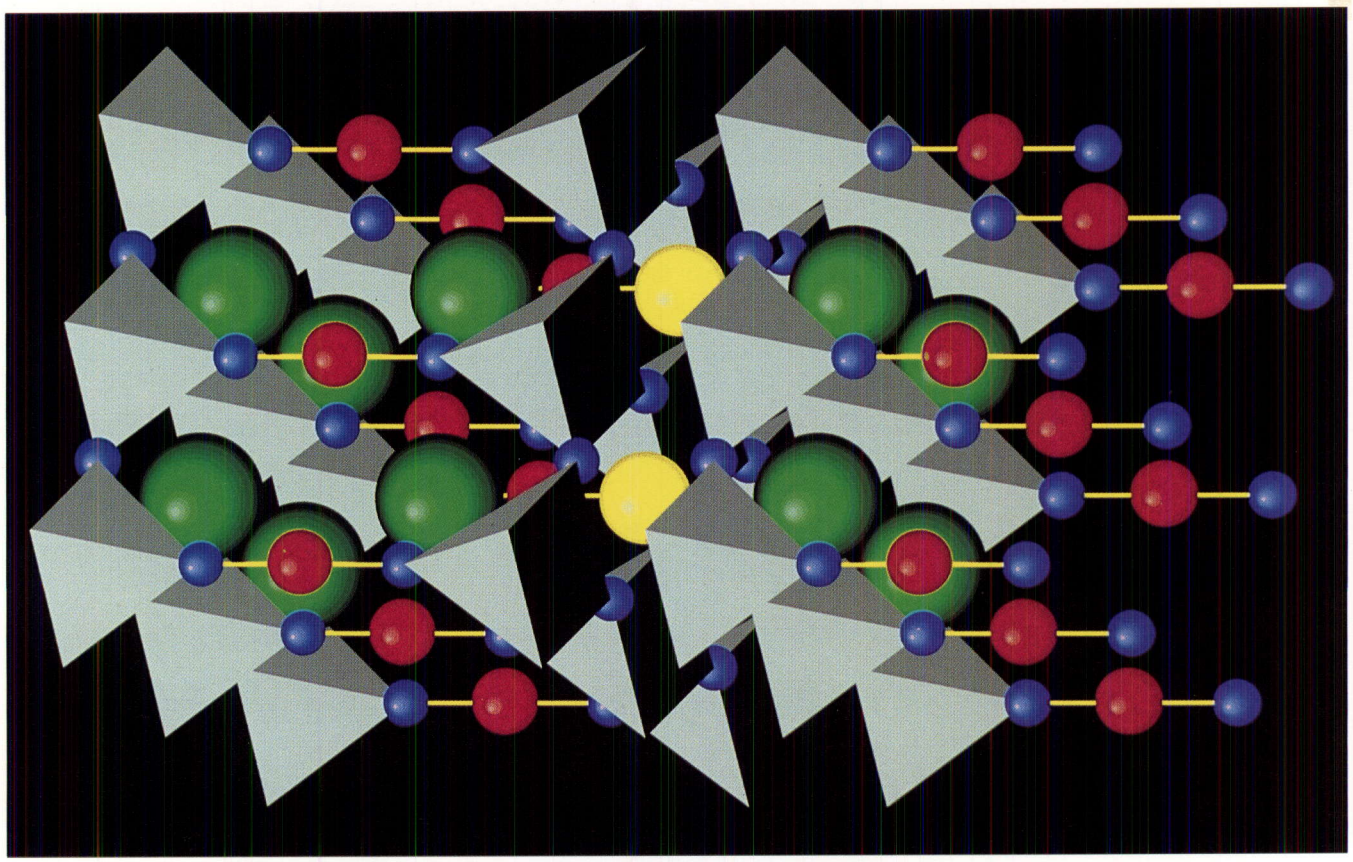


Figure 63: An interior view of the inspection chamber of the non-destructive plutonium waste monitoring system developed at Ispra

**Neural Networks Application** (Centre for Information Technologies and Electronics, Ispra). In-depth discussions have been held with University and industrial laboratories participating in BRAIN (DG XII) and ESPRIT (DG XIII) projects on Artificial Neuron Networks (ANS). Planning of ANS actions on problem solving, learnability, massive parallel computing and industrial applications. Initial application of optimisation theory to the design and evaluation of neural architectures and to learning algorithms.

**Investigations on High Tc Super-Conductors** (Advanced Materials). The objective of the work done is to develop high performance, stable compounds. Two publications concern the EMF (oxygen potential) measurements on the perovskite compounds, $YBa_2Cu_30_{6.5+x}$. One publication concerns the x-ray crystal lographic structure studies of Bi compounds and one publication treats the Li/Cu0 system as precursors of layered copper super-conductors.



Figre 64: A steric representation of the superconductor $YBa_2Cu_3O_7$ structure showing the planar planes. Yellow - yttrium; green - barium; red - copper; blue - oxygen.

**Micro-hydrodynamics of Laser Melted Metallic Pools** (Advanced Materials). A two-dimensional transient computer model for convective heat transfer and surface tension gradient (Marangoni) driven flows has been developed and the computed shapes compared with observations. A link has been made with the VAMAS activity on fusion welding.

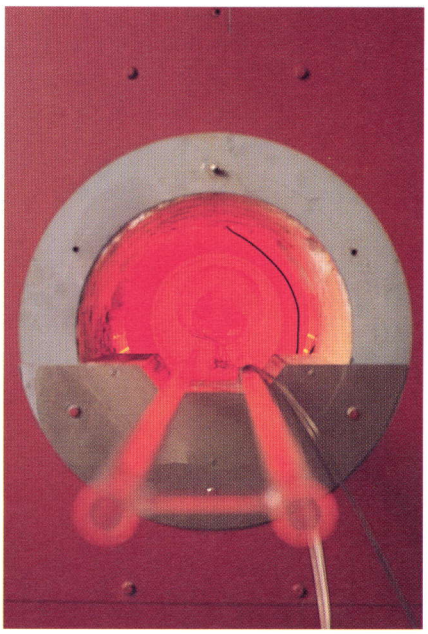


Figure 65: High temperature high precision gas controlled heat pipe furnace for industrial applications

**Modelling of Natural Convection with Turbulence** (Safety Technology, Ispra). Two-dimensional and three-dimensional algorithms were developed and tested for flow in the laminar regimes including liquid-solid phase change.

The introduction of a turbulent regime into the modified CONDIF code was studied in which Industrial partners, CISE and ENEL, are showing increasing interest.

**Analysis of Chemical Processes in Operational and Accident Conditions** (Safety Technology, Ispra). Work has resulted in the development of a robust and generally applicable algorithm for the description of transient two-phase flows. It is conceived so as to anchor its further extension to more complex flow conditions where more phases/components are involved and where chemical reactions intervene. A review of existing and projected modelling strategies for transient, multi-phase flows has been completed.

**Multi-phase Flow Measurements** (Safety Technology, Ispra). The nuclear magnetic resonance (NMR) flow measurement software for the CXP spectrometer was developed to cope with oil-water-gas mixtures. An engineering design for an oil-water-gas loop was made and a market search for components was launched (a report is in preparation).

**Heat-Pipe Simulation Models** (Safety Technology, Ispra). Heat-pipes are designed using models which predict the heat transfer coefficients and the dry-out limits. This year the completed studies concern 2-dimensional modelling of the boiling limit of porous heat-pipe wicks and this result was reported to the ASME Heat Transfer Conference, Texas (1988). The mechanism evoked received confirmation from observations on hot spots in a potassium heat-pipe and the boiling limit of sintered aluminium structures.

**Study of Transition Radiation** (CBNM, Geel). Transition radiation is generated when a relativistic electron beam traverses a stack of thin metallic foils. Optical transition radiation was recorded from several single foil radiations after preparation of the electron and radiation beam lines.

**Isotopic Abundance Measurements** (CBNM, Geel). Isotope abundance measurements were made on iron and gallium. For iron a suitable compound accepting enriched isotopes was found and for gallium the first atomic weight was discovered. Determinations were completed.

**Isotoped Dilution Mass Spectrometry** (CBNM, Geel). Certification of Rye Grass, Beech Leaves and Spruce Needles was made using IDMS for boron. For rubidium the spike reference material IRM--18 was prepared and characterised. It permits measurement of rubidium concentration in human blood and serum with an accuracy better than 1%.

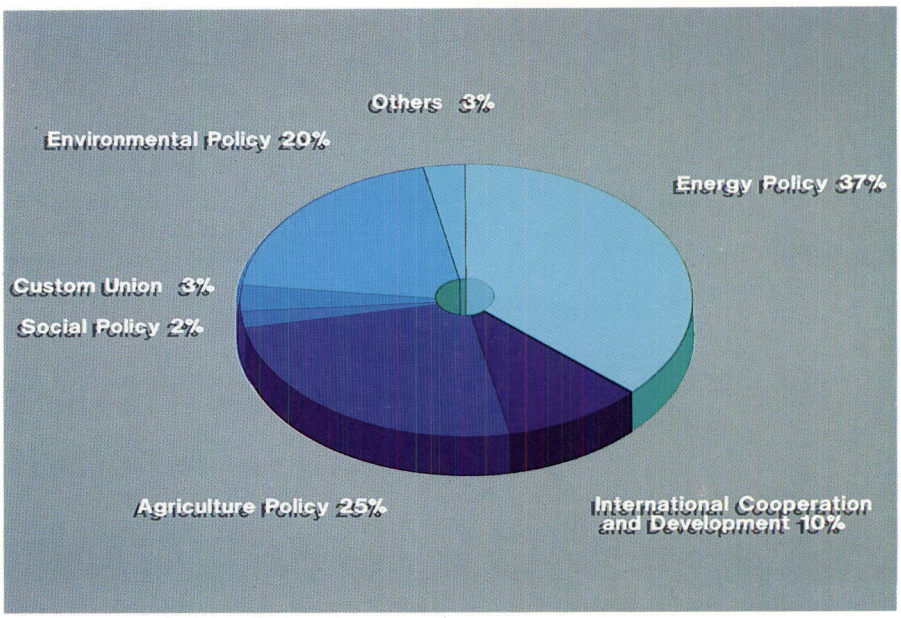
# JRC SUPPORT TO COMMUNITY POLICIES

JRC scientific and technical expertise is made available to various Commission departments for the formulation and implementation of Community policies. This support covers several types of activity:

- theoretical studies or laboratory work;
- assistance in the management of research projects or contracts;
- scientific and technical expertise and preparation of elements for Council directives or recommendations.

During 1988 support to Community policies accounted for 10% of the JRC budget, an increase from 3% in 1987; this share is expected to increase further in the future. An illustration of the distribution of this support to the various Community policies is given in Figure 66.

Figure 66: Distribution of support to the Community policies in 1988




## Support to Cooperation and Mutual Assistance in Case of Disaster

Centre for Information Technologies and Electronics

This activity in support to the General Secretariat was continued, with a larger commitment than in 1987. Two areas received particular attention:

- use of information technology to improve information exchange between Member Countries;
- use of satellite communications from the field in case of emergency

## JRC Support for Industrial Policy

Environment and Systems Engineering

The World Shipbuilding Data Bank set up at JRC was regularly updated. Concerning the directives 88/379/EEC on classification, packing and labelling of dangerous substances, tables of data were prepared including nomenclature, classification and EEC, CAS and ECDIN numbers. Work on fertilizers concerned analytical procedures of secondary nutrient elements and oligoelements.

## JRC Support for Social Policy

### Biological Monitoring and Occupational Exposure to Chemicals (Environment)

Four basic texts on monographs concerning aromatic amines, aromatic nitro compounds, carbamate pesticides and Nickel were prepared by international experts;

A data profile and the outline of the information system on industrial toxicology have been designed and submitted to DG V for approval; data on the carcenogenicity of selected chemicals (IARC list) will be included.

### Renal Insufficiences and Trace Metals (Environment)

Sources of metal contamination were studied: a ''radiorelease test'' was developed to study metal contamination from dialysis equipment. The studies on Trace Metal imbalance in body tissues have continued: considerable progress has been made in this area by neutron activation analysis (NAA) including cyclic NAA.

Figure 67: Neutron Activation Analysis of human tissues: sample preparation for neutron irradiation in the ultra clean laboratory

## JRC Support for the Common Agricultural Policy

### Laboratory for food analysis (Environment)

The new nuclear magnetic resonance spectrometer was installed and brought up to specification for proton, deuterium and carbon channels. Measurements using carbon-13 have started, to determine the alcohol content of wine and alcoholic beverages.

Figure 68: The new 300 MHz Nuclear Magnetic Resonance Spectrometer. Measurements taken of the deuterium/hydrogen ratio in the different sites of ethanol, derived from wine or other alcoholic beverages, permit the determination of its history and origin.

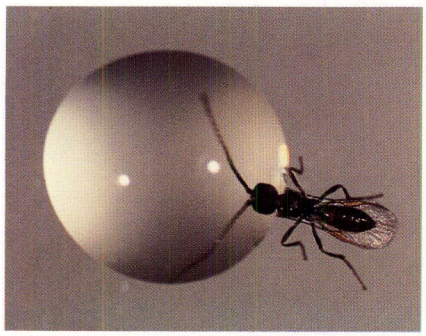


Figure 69: An important naturally occurring endoparasitoid of aphides (*Aphidius ervi* Hal.), is now being reared in quantity in laboratories for eventual release into the agricultural environment in support of integrated plant protection.

### Scientific support to the management of integrated plant protection (Environment)

Scientific support was provided in relation to contracts, meetings and publications. Four scientific meetings took place in Lisbon, Catania, Tølløse and Udine. A congress, "Parasitis 88", took place in Barcelona.

### Application of remote sensing to agricultural statistics (Remote Sensing)

This project consists of seven actions, the first four making up the major themes and the latter three being in support of these main actions; only the first four actions made much progress in 1988.

### Regional inventories

Five contiguous areas (20,000 sq km) in Europe were selected as test sites. Contractors have collected ground data related to these areas and have compared them with high-resolution satellite data taken at the same time.

The results of the first year's ground surveys have been presented recently.

### Vegetation conditions and yield indicators

Contractors have been engaged to demonstrate the application of low-resolution satellite data for the monitoring of crop development and early warning of unusual growth conditions. Software is being developed, in collaboration with the European Space Agency, to make raw satellite data more useful for agricultural applications.

### Models of yield prediction

Tenders were received for a data base containing historical information on crops, climate and agro-meteorology; the objective is to improve the statistical prediction of the yield for Europe. The first results of these studies are expected in the summer of 1989.

### Rapid estimates of changes in acreages and potential yield

An activity has just been started to obtain rapid estimates of changes in acreage and potential yield. The objective is the installation of a system in which high resolution satellite data are received at a dedicated station, rapidly processed, assessed and delivered to Brussels within a few days after the satellite passage.

## JRC Support for Environmental Policy

JRC is providing DG XI with technical assistance and supporting implementation of EC-directives in the field of Chemicals, Atmospheric Pollution, Water Quality, Chemical Waste and Major Accidents.

### Chemicals (Environment)

The final master version of EINECS (European Inventory of Existing Chemical Substances, an essential part of the 79/83 EEC directive on the labelling and transport of dangerous substances) is now established. To facilitate a future systematic evaluation of existing chemicals at the Community level, based on the EINECS inventory, a pilot study has been carried out with the aim of structuring the inventory according to chemical composition. At the same time, a list of 500 chemicals has been prepared which is based on production figures from the ECDIN data bank and now represents the ''Commission List'' of high production chemicals in the Community.A work on ''chemical characterization'' of European soils started with the sampling and analysis of six representative soils.

Figure 70: Various precipitation collectors at the JRC EMEP Station

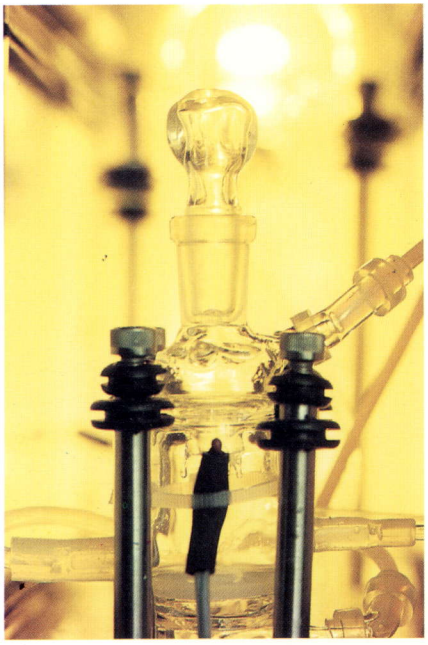


Figure 71: Reaction cell of a low range $SO_2$ monitor (< 2 ppb)

### Atmospheric Pollution (Environment)

The Central Laboratory for Air Pollution Measurements, set up for the implementation of the EC 80/779 directive on limits and guide values for $SO_2$ and suspended particulates, continued its mission with the check of 29 national field measuring stations. The first quality assurance programme referring to the harmonisation of various measuring methods existing in Member States was approved in an EC expert meeting in March 1988. The JR-EMEP station operated continuously under the Long RANGE Transboundary Air Pollution Convention. The implementation of total hydrocarbon measurements has been tested in the laboratory.

### Water Quality (Environment)

Four supporting projects have been agreed with DG XI and related study contracts have been concluded with external laboratories including: preparation of ecotoxicological reports for two pesticides; review of water quality standards; review of sources of heavy metals (B, As, Mo, Ni, Zn, Cu, Cr) and effect of water oxygenation on the distribution of heavy metals (Cu, Cd, Zn, Ni).

### Chemical Waste (Environment)

A fast method for screening PCBs at 50 ppm level in oil and other environmental samples is under investigation.
At the same time a new isomer specific HRGC-ECD method, to be used as a reference laboratory method, has been successfully developed. This method has also been tested in two international interlaboratory comparisons on sludge and oil reference materials.

Figure 72: Analysis of toxic PCBs in oil by dual-column high resolution gas chromatography

### Major Accidents Reporting System (Safety Technology)

The accidents reported by the National Authorities were stored in this data bank for easy retrieval. They were analysed and discussed with the Authorities in order to improve preventive measures.
Work on comparison of national practices for safety reports, emergency planning and risks communication has been promoted as the basis for harmonization of national guidelines towards a common safety policy.

## JRC Support for Development Policy

### Monitoring of vegetation in tropical and subtropical areas: crop production, watershed conditions and tropical deforestation (Remote Sensing).

An operational image analysis system was installed to allow the rapid processing of the AVHRR data obtained from the Maspalomas receiving station. Three main themes, related to the study of vegetation dynamics are investigated: the evaluation of rainfed crop production in sub-sahelian countries, the assessment of environmental conditions in the Upper Niger watershed and the dynamics of tropical deforestation.

The themes investigated during this reporting year all bear some relevance to the study of "global change". The scale adopted in the analysis is indeed mainly oriented toward regional to subcontinental assessments. In addition, the phenomena under observation, such as primary productivity, tropical deforestation and biomass burning, are major parameters in the evaluation of climatic impact upon the biosphere. Conversely, some of the changes being observed have a direct impact on climatic parameters and atmospheric chemistry of large areas.

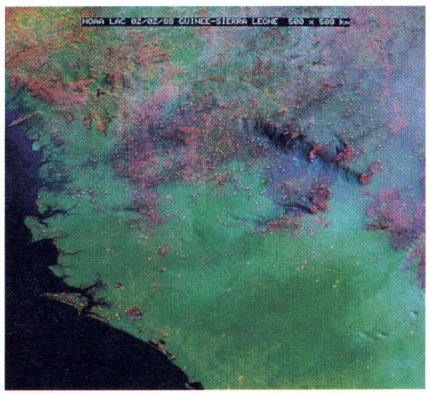


Figure 73: It is now recognised that fire is one of the main agents of environmental degradation in tropical and subtropical areas (right). In addition bush fires have a direct impact on atmospheric chemistry. NOAA-AVHRR images are currently being used in the study of fire distribution in West Africa (above).

Figure 74: A member of the ESTI team during on-site measurements of a photovoltaic installation in the Alps (altitude 2610 m)

## JRC Support for Energy Policy

### Rational use of energy and new energies (Systems Engineering)

JRC Ispra collects and disseminates technical information and provides technical advice to the Community Energy Bus Programme. Three data bases concerning the rational use of energy in small and medium size industries were put in operation.

Assistance was provided concerning demonstration projects in the field of project selections, monitoring campaigns, data analysis and systems hardware testing.

Inspections and on-site measurements were carried out at 5 photovoltaic (PV) installation sites. Results from monitoring 15 PV projects were analysed. The progress of new projects has been followed and the entries in the SESAME data bank updated correspondingly. The activities of the European Working Group on PV-Plant Monitoring and the issuing of a PV Monitoring Newsletter have been continued. For solar thermal projects a telemonitoring system for centralized acquisition of data is being developed.

For energy saving projects a study of their likely replicability has been set up.

**Safeguards** (Systems Engineering, Centre for Information Technologies and Electronics, Transuranium Elements, CBNM)

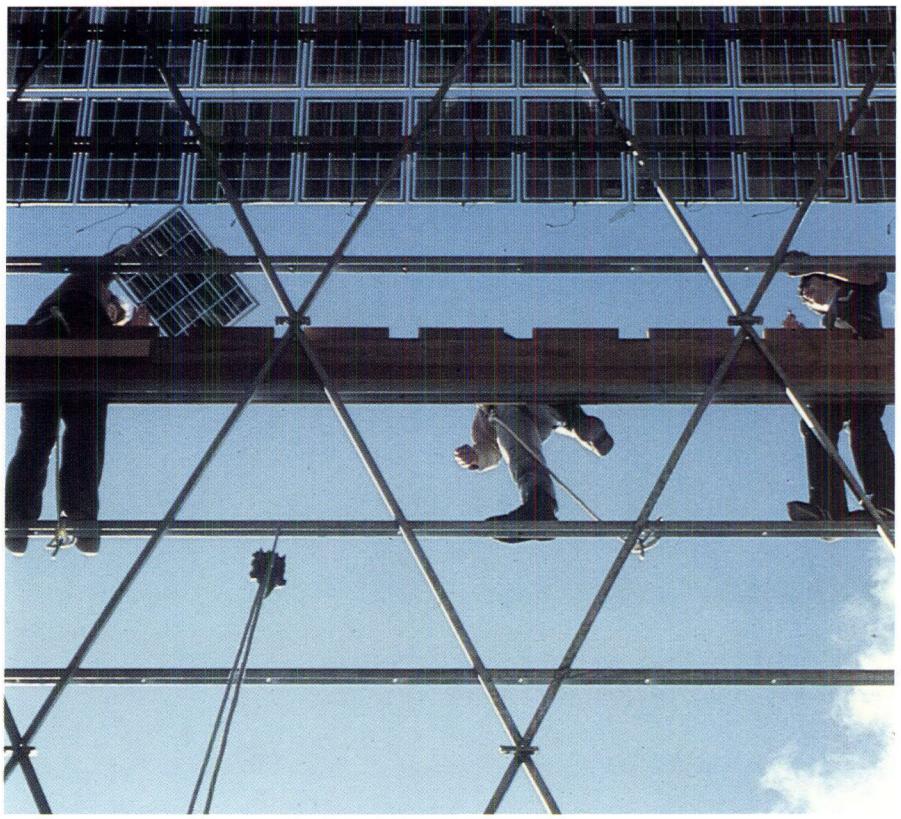


Figure 75: Photovoltaic modules mounted on the roof of a dairy farm near Cork, Ireland

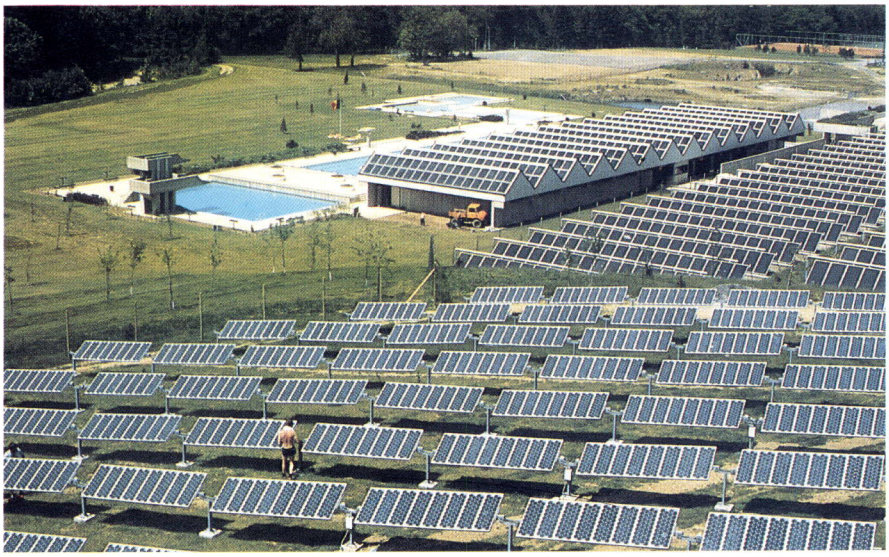


Figure 76: Solar-thermal panels heat a swimming pool in Chevetogne, Belgium, while its electric supply is provided by photovoltaic modules.

The main achievements in the activities in support to the Safeguards Inspectorate are as follows:

- a computer-aided video surveillance system was developed and laboratory tested; it is being delivered to the Luxembourg Inspectorate headquarters;
- technical support in the field of safeguards information systems was initiated; in particular, a material accountancy data evaluation system (MADES) was developed and installed on the computer at headquarters;
- the analytical support to the Safeguards Directorate was continued (ECSAM activity). In addition, certain analytical techniques were further developed (a robotic installation was coupled to an expert system) and a data link to Luxembourg has been installed and the necessary software written;
- A number of training courses for inspectors and a physical inventory verification exercise were held on non-destructive essay methods.

## JRC Support to the Customs Union

### Environment and Safety Technologies

Technical assistance was given for the implementation of the E.C. Regulation 2340/86 concerning chemical and biological substances.
Expertise was provided on orcoacid sulpho-rhodamine G; it consisted of the identification of the chemical component and the certification of European suppliers.
Refractory sands to prepare moulds for non-ferrous metals, organic samples and catalysts were investigated and several samples of starch were analysed by polarimetry and enzymatic methods.

Advice was given on the technical-scientific characteristics of possibly duty-free imported instruments, and technical assistance was also given for discussion at the Court of Justice.

# JRC WORK FOR THIRD PARTIES

Work for third parties will constitute in the future a growing source of revenue for the JRC.Target values are given in the next table.

**Table 1:** Target value for Work for Third Parties (Mioecu)

| Year | 1988 | 1989 | 1990 | 1991 | Total |
|---|---|---|---|---|---|
| HFR | 17.2 | 19.4 | 20.1 | 21.3 | 78 |
| Other third party work | 2.9 | 14.6 | 15.9 | 18.6 | 52 |
| TOTAL | 20.1 | 34 | 36 | 39.9 | 130 |

To achieve such ambitious goals, in 1988 the JRC launched an aggressive policy towards the commercialisation of its services and a healthy response throughout most of the JRC Institutes has been given to this urgent requirement to attract contracts for the European industry. Already today, the total signed contractual work for third parties (outside HFR) amounts to more than 4.5 Mioecu*), but revenues paid for such activities in 1988 are still modest and around 2 Mioecu. Early results may be summarized as follows:

## Exploitation of the High Flux Reactor

Institute for Advanced Materials, Petten

During 1988, the reactor operated well and according to schedule. Routine maintenance and modification activities, including the first in-service inspection after the vessel replacement, were carried out in the main stop periods in March and July/August. As a measure to prolong HFR operation in view of potential fuel supply delays, reactor power was lowered and the cycle length was reduced.

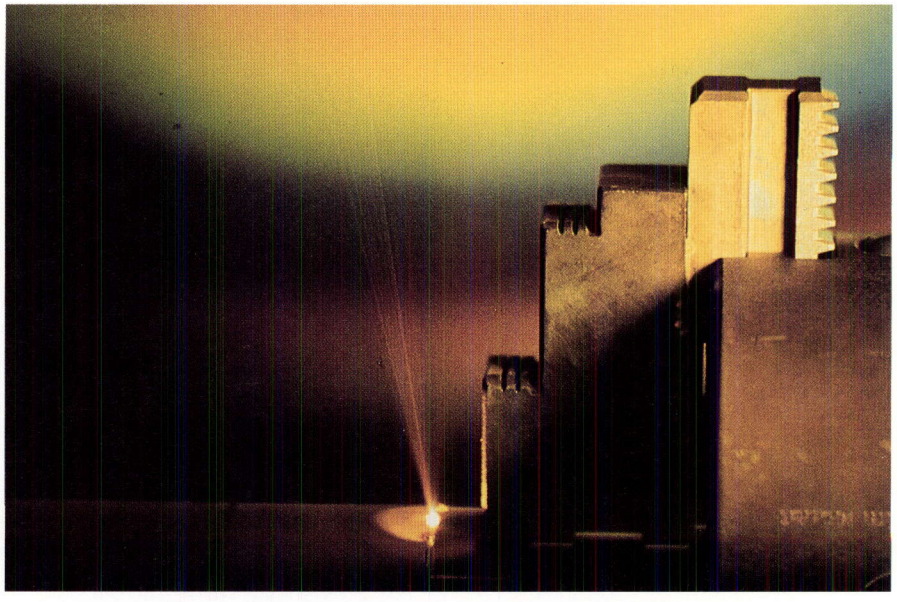


Figure 77: Electron beam welding of test components for irradiation in the HFR Petten

*) Total envisaged revenues of signed and contractual work expected at present is in the order of 15 Mioecu over four to five years.

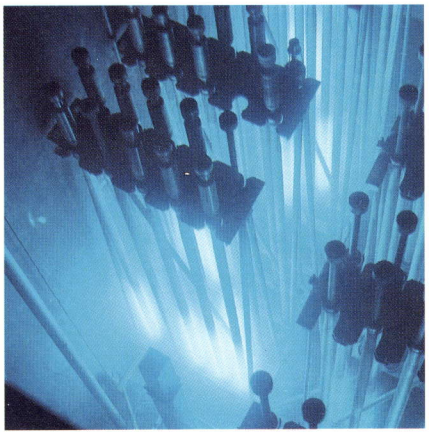


Figure 78: The Cherenkov effect can be clearly seen in the view of the reactor pool at the HFR Petten

The test programme comprised steady-state and transient tests of fuels for LWRs, HTRs and LMFPRs; radiation damage investigations, including radiation enhanced creep of graphite and steels for application in fission and fusion reactors; the extensive use of beam tubes for nuclear physics and solid state physics programmes, and radioisotope production for medical and other uses.

Activities to up-grade, modernise and improve equipment and techniques were successfully conducted. Important developments include LWR fuel rod testing facilities, a control system for swept HTR fuel experiments and design work for in-pile biaxial creep experiments.

The neutron radiography facilities are now well equipped for industrial applications. A market study and active promotion including a demonstration of the method led to promising contacts. A new field of utilisation for the HFR is the neutron capture therapy method to treat special types of cancer. A cooperative group comprising JRC Petten, ECN and the Dutch Cancer Institute has begun a design study for a clinical facility. Support from the Commission's Medical Research Programme also contributes to progress in this field.

## Nuclear Measurements

The Central Bureau for Nuclear Measurements has concluded several work for third parties:
More than 200 special samples and targets (thin deposits, foils, pellets, pure metal wire or alloy pieces) were prepared, characterized and delivered to customers in industries, national organisations or Universities;
Various materials were prepared for the next test rounds within the Regular European Measurement Evaluation Programme (REIMEP): $UO_2$ powder, $UO_2$ pellets, uranyl nitrate, Pu nitrate, MOX pellets, synthetic input solution and spent fuel input solutions;
Two series of irradiations were performed at a Van de Graaff beam line, on request by the SCK/CEN Mol, for radiobiological studies on mice;

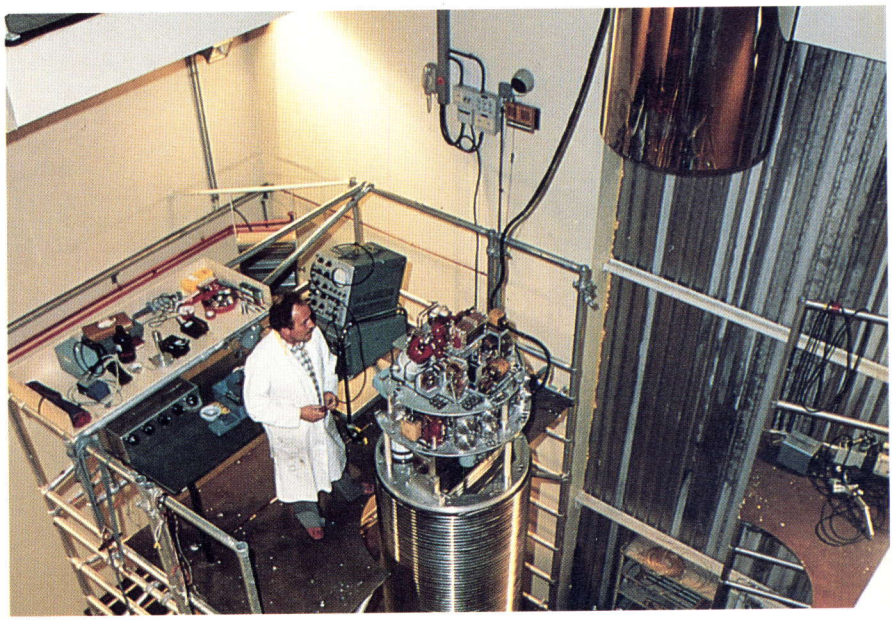


Figure 79: The 3.7 MV Van de Graaff accelerator at the CBNM used for nuclear measurements and the assay of trace elements

Four test barrels of sealed waste from NIRAS (Nationale Instelling voor Radioactief Afval en Splijtstoffen) were measured by $\alpha$-ray spectrometry and finally a test quality assurance programme was performed for ionization chamber measurements of $^{57}Co$ with 11 participants from Belgian hospitals.

## Transuranium Elements

The Institute for Transuranium Elements concluded various contracts in 1988:

Eight unirradiated rods with uranium-plutonium mixed carbide fuel rod are being conditioned and transformed by heat treatment into oxide for further processing;
Fuel solutions are being analysed for Am, Cm, and Np content;
Ten samples of mixed oxide fuel, taken from different radial positions of irradiated fast breeder reactor fuel pins, are being analysed electrochemically for their oxygen potential;
The oxygen potential of $UO_2$ doped with $Gd_2O_3$ will be measured in a specially designed electrolytic cell;
The formation and composition of residues appearing during dissolution of uranium oxide fuel irradiated in LWR will be investigated;
Chevron-notched short-rod type indentation measurements are being performed with 10 samples of $Y_2O_3$ and MgO in order to determine their mechanical strength;
The content of sodium tetraborate of low activity samples from the boric acid reservoir of several power stations is being determined;
Preparatory work for the fabrication of alloys containing Np and Am and the thermophysical and thermodynamic investigation of these materials in view of their use as fuel for the transmutation of minor actinides is on schedule;
Non-destructive analysis, destructive investigation, burn-up determination, oxygen potential measurements and annealing experiments will be performed with Pu-enriched LWR fuel samples;
and a feasibility study for the determination of the Pu content of un-irradiated MOX fuel samples using an interrogation technique with an $^{192}Ir$ source has been performed in 1988.

Total revenues in 1988 of the Institute of Transuranium Elements in work for third parties amount to 500.000 Ecus.

## Advanced Materials

The Institute of Advanced Materials has signed in 1988 about 20 contracts spread throughout the research functions of the Institute. The contracts amount to more than 1 Mecu. The average value of a contract is thus small (about 50.000 Ecu) and some contracts were indeed much smaller than this. The acceptance of small contracts during this build-up phase has been encouraged by management in order to develop a "track record" in this type of R&D and also to help introduce the new attitude throughout the Institute. There are already signs that this is having the desired effect, with certain firms expressing an interest for further work.

Certain contracts show that, as expected, industry is taking advantage of specialised JRC facilities for tests and services. However, a growing proportion of the contracts are being attracted, under highly competitive circumstances, by JRC scientific competences which are unique in some fields, as in the study of the performance of turbine blades in thermal fatigue conditions for the aeronautical industry, or the corrosion resistance of new ceramics in aggressive atmospheric conditions. This is the type of interaction with industry which is being fostered.

In addition to the bilateral contracts with industry, R&D network schemes are being pursued. Examples include a Club of potential users of a ceramic materials data bank; a Club for developing Sensor Materials, and a Consortium of four leading European laboratories to offer R&D services in materials characterisation and performance to industry.

## Environment

The following work for Third Parties was conducted by the Institute for the Environment

### Environmental Protection

Within the Framework of the Agreement between JRC and the Italian Ministry for the Environment, proposals have been submitted for funding in the field of toxic wastes, risk analysis and pollution abatement and reclamation plans for the Po river basin.

### Nuclear Waste

Two contracts have been signed with ENRESA, Spain, in the field of radioactive waste management. They aim to increase the Spanish capabilities in safety assessment and related experimental research, by developing a version of the JRC safety assessment code LISA especially tailored for the Spanish geological situation, and by studying the decommissioned uranium mine at El Berrocal as a natural analogue for actinide migration from a waste storage site.

The contracts cover a period of three years and envisage the detachment of three Spanish scientists at JRC Ispra.

## Safety Technology

The following work for Third Parties was conducted by the Institute for Safety Technology.

### Decontamination and nuclear measurements

Tests were performed for chemical decontamination of mechanical components from power stations and for incineration of low activity resins. Both activities were executed in close cooperation with the contractor.

One contract was related to the measurement of emitting material from waste drums, using measuring techniques developed by JRC.

### Calculation models and codes

Two small contracts were concluded to develop fluid mechanics codes.

### Thermohydraulic experiments

The LOBI facility was sponsored by BMFT from the beginning and continues to receive support to perform the last tests which are specified by BMFT alone, but the results of which are available to all Member States.

## Systems Engineering

The following work for Third Parties were conducted by the Institute for Systems Engineering.

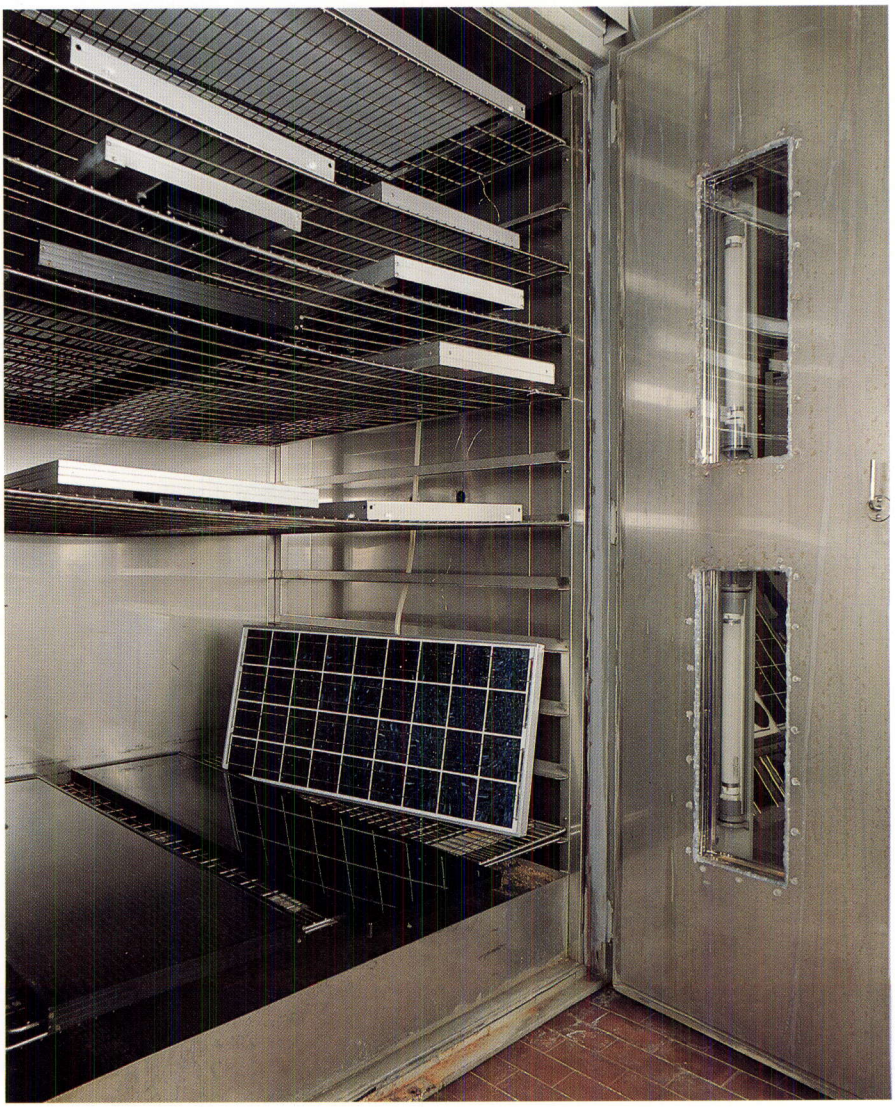


Figure 80: An interior view of ESTI : High temperature/ high humidity climatic chamber where photovoltaic modules are exposed to an accelerated life-time stress. This test is one out of 15 which a module has to pass successfully before it is certified according to our specification EUR 502

### Qualification of photovoltaic modules on ESTI

Issuing of qualification certificates and performance measurements of photovoltaic modules on ESTI installations. In 1988, nine different types of modules involving monocrystalline, polycristalline and amorphous silicon cells, from European, American and Japanese firms have been certified according to procedure 502, a procedure which in great part has been developed at JRC.

### Energy analysis of regional building stock

A contract has been passed with Regione Lombardia for the development and application of energy analysis of regional building stock with the aim of identifying and testing procedures of certification of building energy performance. During the period, a regional data base utilizing the DMBS/ADABAS has been developed and is being implemented to assess analysis techniques of various energy conservation measures. A monitoring campaign of 4 apartment buildings in the Varese area has been initiated to investigate energy parameter identification techniques.

### Risk of transportation of dangerous nature

JRC is carrying out this work as a subcontractor of the University of Pisa as part of the CNR's Strategic Project ''Transport''. The three year project has been started with an analysis of the potential accident scenarios based on records of roads and railway accidents.

### BRITE Project P.124 - Subcontract by SNEA

The work is just started. JRC has been asked to define the architecture of an expert system to improve the inspection capabilities for industrial pression vessels and off-shore platforms.

### CAD/CAE applications in support to SME

Finite Element Method Analysis work and support for CAD training has been contracted to JRC by a manufacturer of car subassemblies. This type of work is expected to be extended to other Small and Medium Enterprises.

### Design of the cooling system for IGNITOR

A consultancy contract for the conceptual design of the cooling system of IGNITOR has been contracted to JRC by Tecnomare Brown Boveri.

## Information Technologies and Electronics

**The Centre for Information Technologies and Electronics** has submitted a number of proposals, in cooperation with industrial consortia, to the ESPRIT II competition; two of them have been selected: ARCHON (with KRUPP ATLAS) and KWICK (with BULL).

JRC ANNUAL REPORT 1988

# LARGE INSTALLATIONS

# LARGE INSTALLATIONS

## Operation of Large Installations

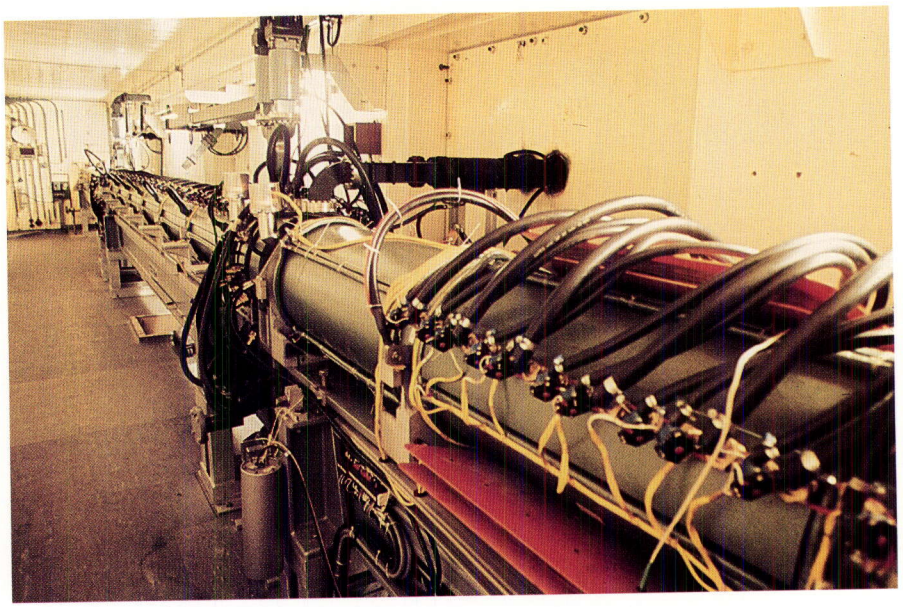


Figure 81: A view of part of the Geel Electron Linear Accelerator (GELINA) used for physics experiments

### GEEL

#### ACCELERATORS

Gelina, the Geel electron linear accelerator, was operated for nearly 3000h at approximately its full capacity, 75% of the available machine time (operation for 4 days around the clock, for 40 working weeks). The Gelina has been used for physics experiments, mainly (81%) for short burst-high resolution neutron production.

The 7 MV Van de Graaff accelerator was also operated at nearly full capacity for approximately 2500h, with occasional shift work. Its operation has been dedicated to neutron experiments and to neutron irradiation for radiobiology studies. In addition, the same team operated the 3.5 MV Van de Graaff for 30% of its available time for Particle-Induced X Ray Emission (PIXE) and Rutherford backscattering experiments. This equipment is being upgraded to improve its spatial resolution (microbeam).

### ISPRA

#### LOBI (LWR of Normal Behaviour Investigation)

LOBI is a large test loop for the study of off-normal behaviour in light water primary cooling circuits.

4 LOBI experiments have been performed during the first half of 1988:

| | |
|---|---|
| 1. Test BL-16: (19.3.1988) | Specified by GRS (Gesellschaft für Reaktor Sicherheit) (D) O.4% Break in Cold Leg |
| 2. Test BL-03: (15.4.1988) | Specified by JRC Steam Generator Heat Loss |

3. Test A1-93 (30.4.1988) — Specified by GRS (D) 2% Break in Cold Leg
4. Test A1-94: (25.3.1988) — Specified by GRS (D) 4% Break in Cold Leg

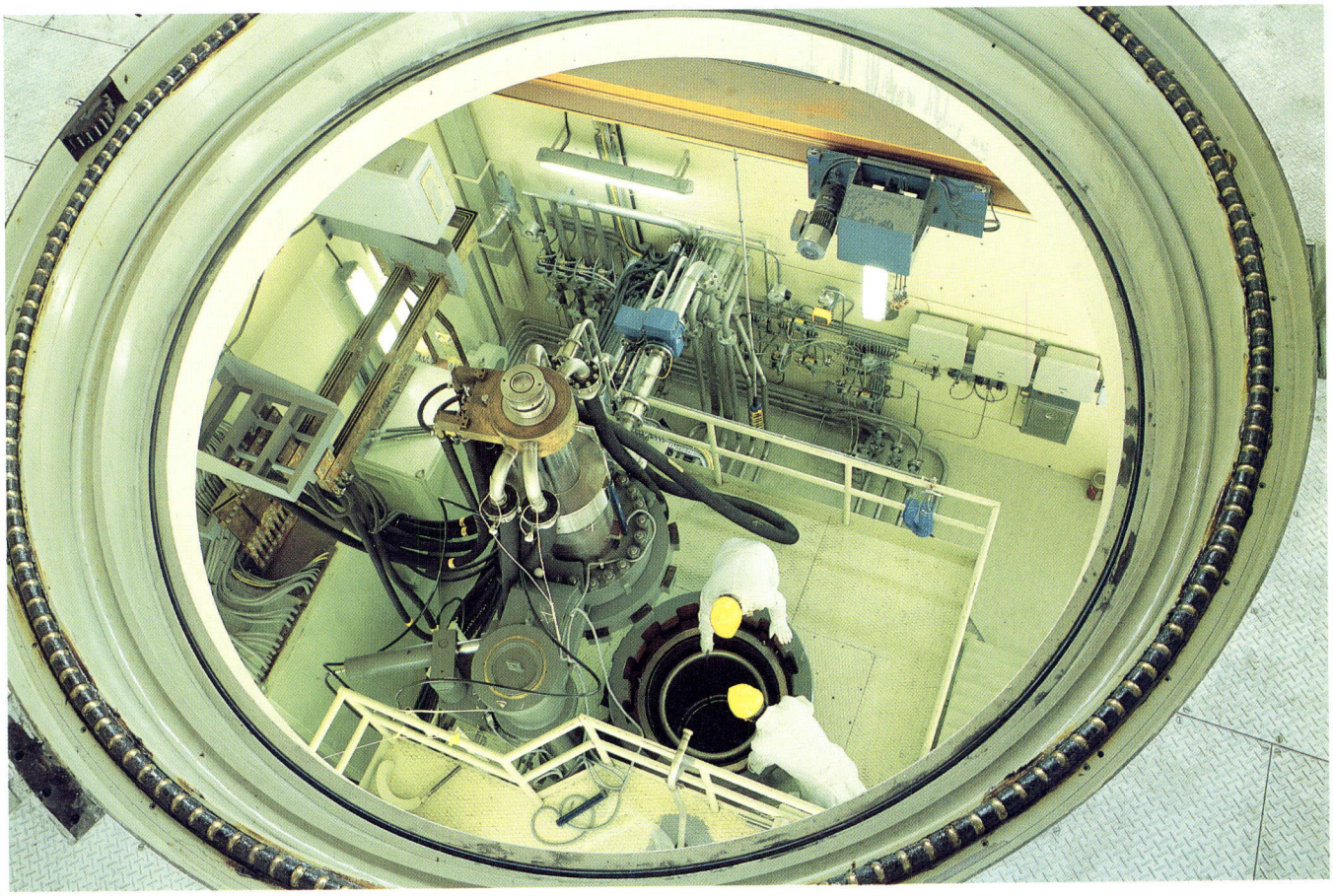
During the execution of the 5th LOBI test on 22.6.1988 the heater rod bundle failed. The installation of the new heater rod bundle took the second part of 1988 and the experiment restarted in February 1989.

## FARO (Experiment Facility for Fuel Melting)

FARO is a multipurpose facility to investigate post accident heat removal and interactions between fuel and coolant in nuclear reactors.

In 1988 the first large sodium -$UO_2$ interaction test has been performed using 100 kg of $UO_2$ at about 3000°C and 150 $dm^3$ of Na at 400°C. This test and others similar to be carried out fulfill one of the principal requirements for which this installation was built, i.e. to investigate whether violent explosions occur when using large masses of $UO_2$ in a interaction test. A preliminary analysis of results shows the importance of sodium temperature for the formation of $UO_2$ debris and allows us to estimate the penetration depth of $UO_2$ jets in sodium.

Figure 82: A 'birds-eye' view of the FARO facility showing preparational work on the $UO_2$ melting furnace



In addition, two molten pool experiments have been performed in the furnace to characterise the temperature and geometry of the $UO_2$ molten pool.

The success in running these experiments suggests the use of this installation to solve accident management problems for Light Water Reactors. Feasibility studies were started and results are being discussed with Member States.

## LDTF (Large Dynamic Test Facility)

The Large Dynamic Test Facility (LDTF) has unique features for testing under realistic geometrical and loading conditions the influence of weldings and defects in materials on the dynamic behaviour of structures.
In 1988 tests were conducted on the effects of welded joints showing the overall ductile behaviour of specimens. Experiments were also performed on structures with large cross sections to check crack instability criteria derived from tests on small specimens.
Finally tests were conducted at 350 and 550°C to measure high temperature behaviour of steels.

During 1988, 40% of the maximum LDTF operation time was used. This facility is thus available for other applications and for external customers.

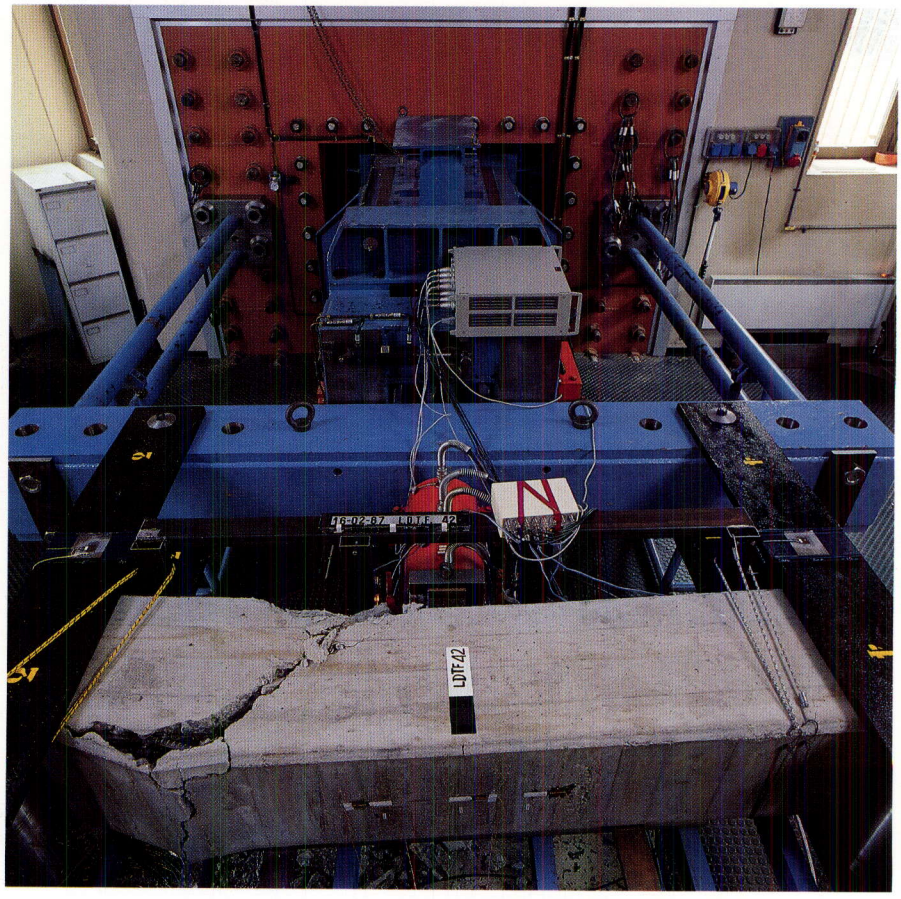



Figure 83: The Large Dynamic Test Facility (LDTF) in the process of testing a reinforced concrete beam

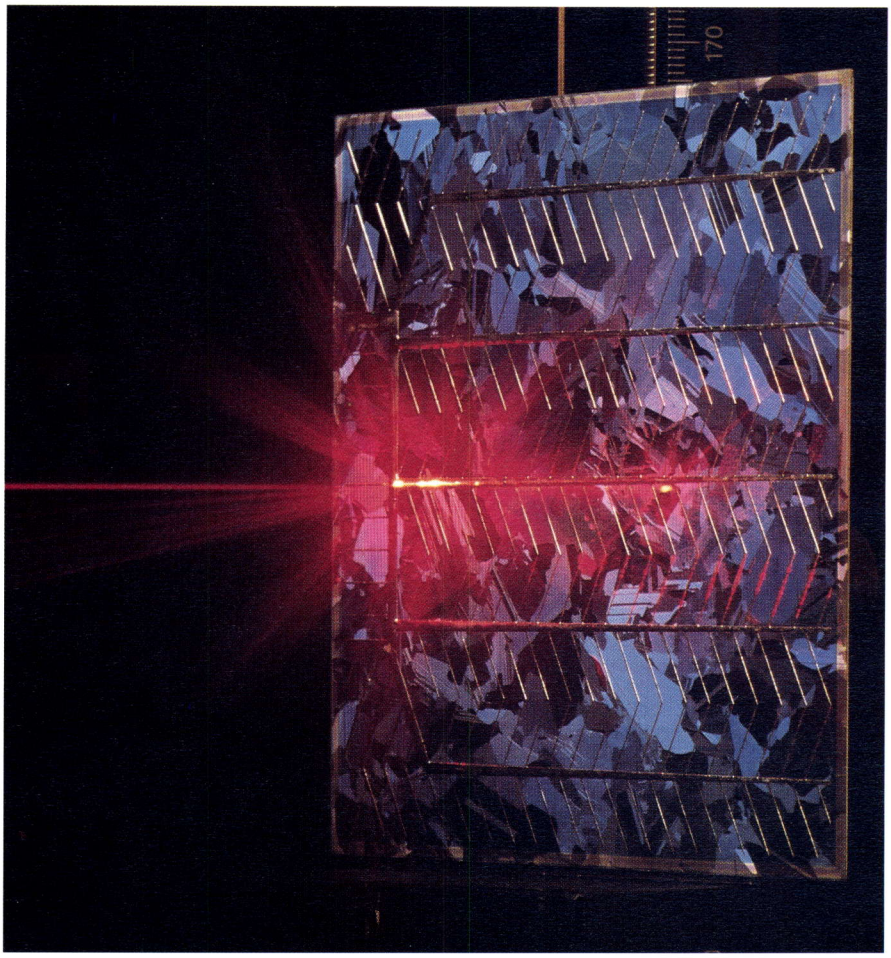


Figure 84: Laser scanning is under development as a new diagnostic tool for photovoltaic cells

## ESTI (European Solar Test Installation)

The ESTI facility is used to develop test procedures for photovoltaic devices; in 1988, the work consisted of certification and calibration of photovoltaic modules and sensors according to procedures EUR 101 and 502 which involve both performance and qualification tests

Output in 1988:

- calibration of 64 radiation sensors
- performance testing of 105 modules from 10 different companies of 5 countries (Third Party Work)
- issue of 10 complete certification documents.

## MAINFRAME COMPUTER

The Centre is equipped with a large mainframe computer backed up by extensive auxiliary equipment and highly developed networks linking computers and terminals at the Centre and with access to public data transmission networks.

During 1988 the mainframe computer was used 80% by scientific technical applications, 14% by administration and 6% by other users, notably outside customers. It was available 24 hours per day and used to capacity. Following a call for tender, the mainframe was replaced in December 1988, increasing its capacity by a factor 2.2 to 2.4 with new features for the operating system migrating towards UNIX.

Figure 85: Automated tape cartridge library containing 1200 Gigabytes of archival data with robot-controlled access plus 'juke box' optical disk archive (worm) with 300 Gigabytes of data

## CYCLOTRON

The Cyclotron has been operated on a one and two shift basis and also around the clock, according to the requirements of the experimental programme. In 1988, the net effective time for experimental irradiations has been around 1.600 hours, although the Cyclotron operated for nearly 2.000 hours.

The breakdown between the major categories of experiments amounts to

| | |
|---|---|
| Fusion Materials | 85% |
| Environmental Trace Analysis | 9% |
| Third Party Contracts | 6% |

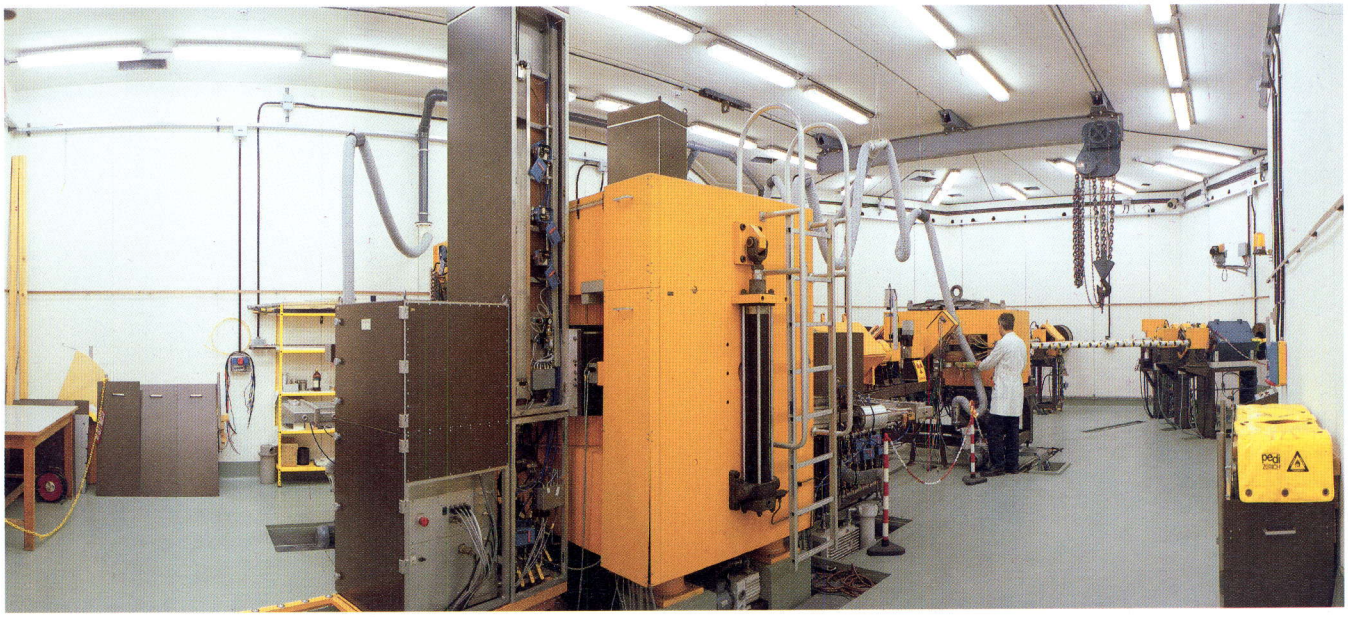


Figure 86: The cyclotron and switching magnet in the cyclotron shielded cell

# PETTEN

## HIGH FLUX REACTOR

The High Flux Reactor was operated in 1988 for 240 days, and the average occupation of the irradiation positions in HFR has been 77%. The break-down into the various categories of irradiation experiments is as follows:

| | | | |
|---|---|---|---|
| LWR | 4% | Radionuclide production | 14% |
| LBR | 10% | Nuclear Physics | 10% |
| HTR | 12% | Solid State Physics | 8% |
| Fusion | 29% | Miscellaneous | 13% |

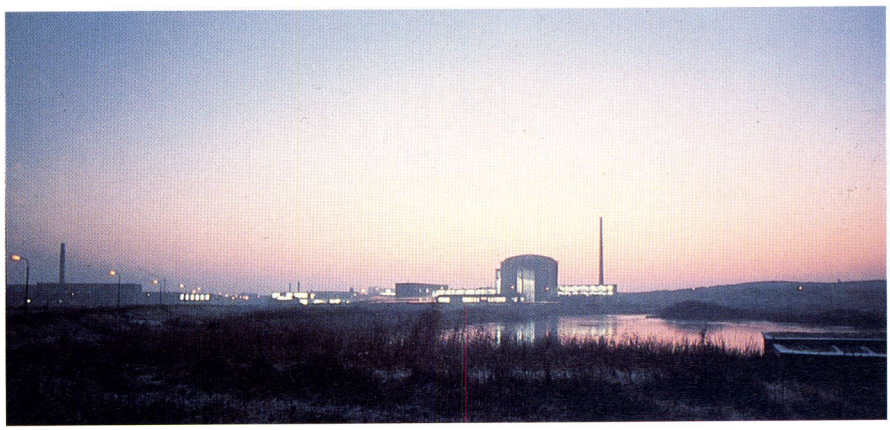


Figure 87: View of the JRC Petten, in Holland, which houses the High Flux Reactor (HFR)

## Construction of new installations

### PETRA
(Facility for Treatment of Radioactive Waste)

The construction of the PETRA facility at Ispra was terminated in 1988, with the successful performance of the components and systems functional tests.

Figure 88: Completing work inside one of the PETRA experimental cells

### PERLA
(Performance and Training Laboratory - Nuclear Safeguards)

The civil engineering work of the Perla facility was completed in 1988 and the further equipping of the laboratory will continue in 1989. Meanwhile the Pre-Perla laboratory has operated fully for the development of non-destructive techniques, the execution of a physical inventory verification exercise by teams of safeguards inspectors and for training courses for inspectors.

Figure 89: Reception of the plutonium standard samples at the PERLA facility

## ETHEL

(European Tritium Handling Experimental Laboratory)

The authorization from ENEA-DISP for the construction of the Tritium Handling Laboratory (ETHEL) up to the inactive commissioning of the laboratory has been obtained. Ground preparation and construction of the building were started in October.
Most of the other subsystems have been ordered. Some of them are in an advanced stage of construction, like the large caisson on the glove boxes. The liquid and gaseous waste storage and buffer tanks have already been delivered to the Ispra site.

## REACTION WALL

The design study of the reaction-wall facility was started in January 1988. Phase I of the study was completed in July 1988 and included the production of a general layout of the laboratory, the optimization and structural design of the reaction wall/strong floor system and a preliminary cost evaluation of the facility. Phase II, the final phase of the design study, was begun in August 24, 1988, and will be completed by the end of May, 1989.

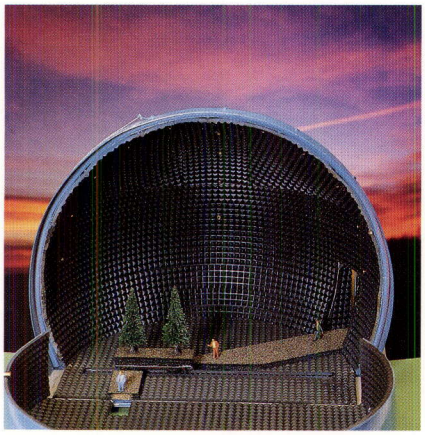


Figure 90: A model of the proposed microwave signature laboratory incorporating a coherent polarimetric scatterometer (1-40 GHz). The laboratory will permit the detailed analysis of the mechanisms of microwave scattering.

## THE MICROWAVE SIGNATURE LABORATORY

The European remote sensing user community expressed, on several occasions, the urgent need for an "open" European Signature Laboratory (EUSIL). Since such a facility is beyond the scope of national groups, the JRC took the initiative to install one at Ispra. After finishing a detailed design study, undertaken by a leading European company, the implementation phase was started by the end of 1988. It will be continued throughout the year 1989. The first experiments are planned to take place in the early summer of 1990.

## THE LASER AND ION BEAM FACILITY

A special attribution of investment appropriation by the European Parliament in 1987, made possible the realization at the JRC of a unique facility for the synthesis of new materials, including the engineering of their surfaces. In 1988, the design of the integrated "Laser foundry", has been frozen, taking into account the existence of associated ancillary equipment and laboratory services available at the Ispra site. The 2 Mioecu funds provided for the Facility have been committed, for the Ion Implantation System, the two Laser Surface Treatment Stations, the Scanning Surface Analysis System and the Plasma Surface Deposition Unit.

The Facility as a whole will be operational early in 1989.

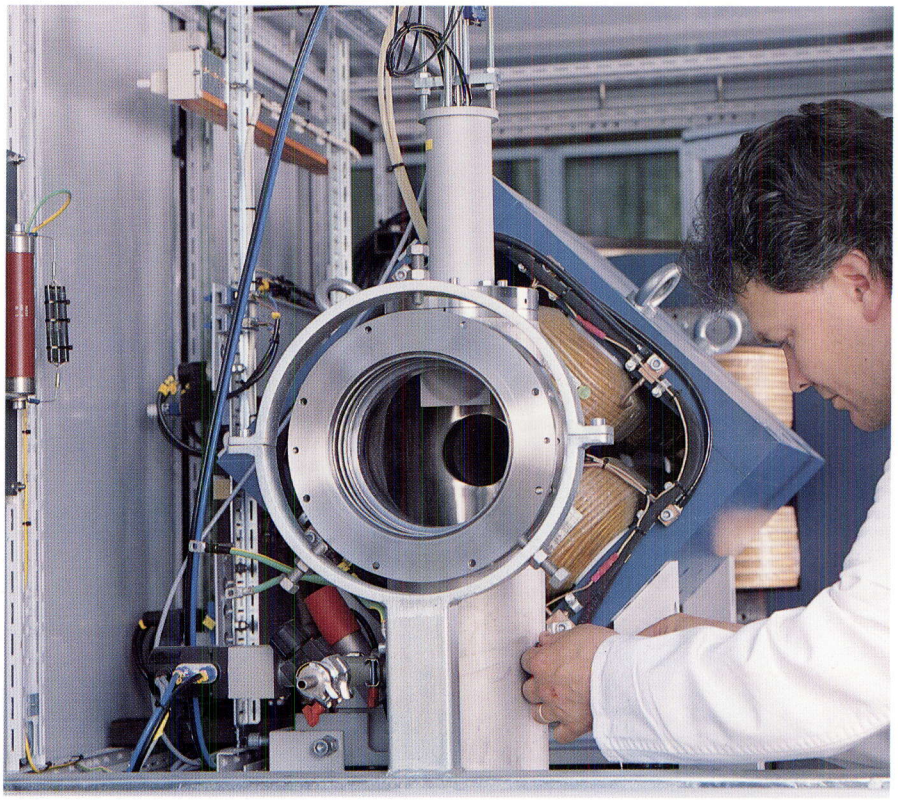


Figure 91: A detail of the beam line which forms a part of the heavy ion implanter, a new facility recently installed at the JRC Ispra for advanced materials studies.

JRC ANNUAL REPORT 1988

# HUMAN AND FINANCIAL RESOURCES

# RESTRUCTURATION AND STAFF POLICY

## Restructuration: New Organigramme

The structure of the JRC has been modified drastically in order to face the challenge of its new tasks.

These modifications take into account the recommendations expressed by the Senior Industrialists Panel which suggest establishing a clear separation between the programme management and the management of resources. This leads to greater administrative, financial and scientific autonomy for the new units, which are to be well identified and given more responsibility.

The realization of these new principles has led to the creation of eight scientific institutes and a Centre for Information Technologies. In addition to the nine scientific units a Directorate for Administration for the whole JRC (located at Ispra) has been defined. Its task will be to give the necessary support to the units located at Ispra and direct assistance to the General Directorate for matters concerning the nine newly created units. Furthermore a Programme Directorate has been created in Brussels for strategic planning purposes and to provide scientific coordination.

The detailed organigramme is given in Annex C.

## Staff Policy

The JRC authorized staff amounts to 2180, including both the scientific-technical and the administrative categories.

Employees are governed by the staff regulations for employees of the European Communities. For many years the JRC has only recruited staff as temporary agents; at present 53% of the total staff are temporary agents and 47% are officials in the scientific-technical and administrative categories.

During 1988, 118 agents left the JRC, 45 people have been recruited as temporary agents and 4 people were transferred in from other services of the Commission. The administrative staff has been reduced by transferring 80 agents with their posts to the General Administration of the Commission.

A new staff policy has been defined within the framework of the existing staff regulations.

The current policy of recruiting temporary agents has been continued. For the scientific-technical agents the need for possible contract prolongation is assessed at the end of the period (up to five years). Furthermore, for specific tasks, scientists and technicians will be recruited on the basis of three year non-renewable contracts.

These measures have been taken to increase the scientific vitality and flexiblity of the JRC; to the same end, more flexible regulations for scientific visitors and secondment of scientific-technical staff from national, public and private bodies have been introduced. These new regulations together with those for grant holders (young research fellows) have already been put into use; they have stimulated an increased flow of people from these categories into the JRC.

A final measure with respect to staff policy consists of a proposal for termination of service for 100 officials. This regulation is before the Council and the Parliament. A decision is expected early in 1989 and the regulation should take effect during that year.

## Visiting Scientists and Scientific Fellows

The JRC trains high-level specialists through a programme of fellowships, which is applicable to three different categories of candidates:

— undergraduate students;

— postgraduate students preparing a master's or a doctor's degree

— post-doctoral fellows.

Fellows are given a grant lasting from one to three years.

Table 2 shows where these fellows worked in the various JRC sites during 1988.

**Table 2:** Fellows by place of work and by categories

| | Ispra | Karlsruhe | Petten | Geel | Total |
|---|---|---|---|---|---|
| Post-doctoral fellows | 9 | 3 | 4 | 8 | 24 |
| Postgraduates | 88 | 7 | 16 | 0 | 111 |
| Undergraduates | 69 | 5 | 4 | 15 | 93 |
| Total | 116 | 15 | 24 | 23 | 228 |

Besides this type of fellowship, the JRC hosts visiting scientists, mostly professors on sabbatical leave and senior scientists; they are appointed for one year. 58 visiting scientists (Ispra 40, Geel 13, Karlsruhe 4, Petten 1) resided in the JRC in 1988.

The visiting scientists and scientific fellows total 286 individuals.

# FINANCES

## Expenditures committed in 1988

The commitment credits fixed by the Budgetary Authority for the execution by the JRC of the Specific Research Programmes and of the S/T Support Activities to the Commission, are as follows:

| | |
|---|---|
| — Specific Research Programmes | 183.5 Mioecus |
| — S/T Support to the Commission | 21.6.Mioecus |
| Total | 205.1 Mioecus |

Other resources for the operation of HFR and for work for third parties are:

| | |
|---|---|
| — HFR Reactor | 17.2 Mioecus (Supplementary programme) |
| — Work for Third Parties | 2.9 Mioecus (Estimation) |
| | 20.1 Mioecus |

The total amount of the credits available is therefore 225.2 MioEcus.

Details about 1988 commitments are given in the two following tables according to the Specific Research programmes, Exploratory Research, S/T Support to the Commission and Work for Third Parties (HFR Reactor and others).

**Table 3:** Commitments for programme execution 1988 (Rounded figures, Mioecu)

| | Personnel | Other Expenditures | Total | 1988 Budget |
|---|---|---|---|---|
| Specific research programmes | 106.4 | 67.0 | 173.4 | 183.5 |
| Exploratory Research | 2.3 | 2.3 | 4.6 | |
| Subtotal | 108.8 | 69.3 | 178.1 | 183.5 |
| S/T Support to the Commission | 10.9 | 12.4 | 23.3 | 21.6 |
| Subtotal | 10.9 | 12.4 | 23.3 | 21.6 |
| Work for Third Parties | | | | |
| HFR Reactor | 4.9 | 10.8 | 15.7 | 17.2 |
| Others | 0.2 | 2.5 | 2.7 | 2.9* |
| Subtotal | 5.1 | 13.3 | 18.4 | 20.1 |
| Total | 124.8 | 95.0 | 219.8 | 225.2 |

*) Estimate, out of budget.

The difference between available credits and commitments is 5.4 Mioecus of which 4 Mioecus were transferred during the budgetary exercise to other parts of the budget.

The unused credits are related mainly to underspending of personnel credits (recruitment was postponed until the content of the 1988/1991 programme was

decided) with, in addition, about 0.9 Mioecus for the Reaction Wall. The later amount should be transferred on 1989 and the Commission has been asked to authorise this.

Table 4 shows a projection of the expenditures expected during the four years of the current Programme.

Furthermore, a sum of 1 Mioecus has been added by the Budgetary Authorities in 1989 for ''Research activities of Community interest''; this sum will be fully committed to contractual work to be performed by European industry.

**Table 4:** Annual and Total expenditures 1988 - 1991 (Rounded figures, Mioecu)

| | Commitments in 1988 | Budget 1989 | Projection 1990 | Projection 1991 | Total |
|---|---|---|---|---|---|
| Personnel Credits | 124.8 | 132.0 | 135.5 | 142.7 | 535.0 |
| Subtotal | 124.8 | 132 | 135.5 | 142.7 | 535.0 |
| Specific research programmes | 67.0 | 70.4* | 67.8 | 63.5 | 268.7 |
| Exploratory Research | 2.3 | 2.7 | 3.9 | 3.4 | 12.3 |
| Subtotal | 69.3 | 73.1 | 71.7 | 66.9 | 281.0 |
| S/T Support to the Commission | 12.4 | 14.8 | 17.6 | 13.8 | 58.6 |
| Subtotal | 12.4 | 14.8 | 17.6 | 13.8 | 58.6 |
| Work for Third Parties | | | | | |
| HFR Reactor | 10.8 | 13.8 | 14.3** | 16.6 | 55.5 |
| Others | 2.5 | 5.7 | 5.8 | 5.9 | 19.9 |
| Subtotal | 13.3 | 19.5 | 20.1 | 22.5 | 75.4 |
| Total | 219.8 | 239.4 | 244.9 | 245.9 | 9100 |

*) Including the transfer of 0.9 Mioecu related to the Reaction Wall
**) Of which 2.6 Mioecu = contribution in kind from ECN

# ANNEXES

ANNEX A

# PUBLICATIONS, EURO COURSES, APPLICATION OF RESULTS, AND FAIRS

## Publications

In 1988 the JRC published 734 papers. The following Table gives the distribution of these publications between research programmes

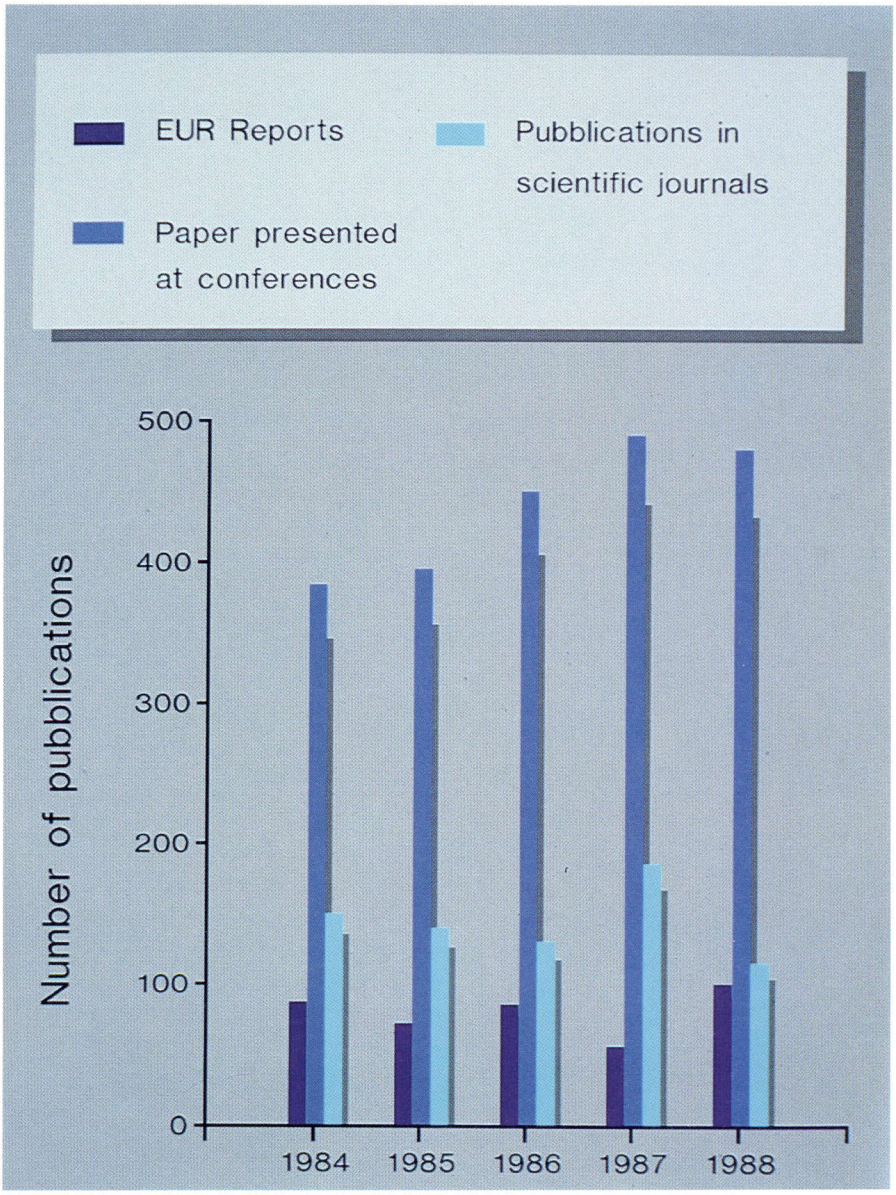
**Table A1:** Distribution of JRC publications between research programmes in 1988

| | EUR Reports | Conference papers | Public. in scientific journals | Total |
|---|---|---|---|---|
| Nuclear Measurements and Reference Materials | 4 | 26 | 26 | 56 |
| Materials | 5 | 29 | 10 | 44 |
| Fusion Technology and Safety | 8 | 46 | 8 | 62 |
| Reactor Safety | 6 | 57 | 12 | 75 |
| Radioactive Waste Management | 17 | 20 | 16 | 53 |
| Safeguards and Fissile Materials Management | 4 | 16 | 3 | 23 |
| Nuclear Fuels and Actinide Research | 9 | 85 | 36 | 130 |
| Testing of Solar Energy Systems | 12 | 19 | 3 | 34 |
| Environmental Protection | 17 | 72 | 29 | 118 |
| Application of Remote Sensing techniques | 4 | 31 | 7 | 42 |
| Industrial Hazards | 4 | 20 | 1 | 25 |
| Radioactive Environmental Monitoring | 2 | 2 | | 4 |
| Operation of the HFR Reactor | 1 | 9 | 2 | 12 |
| Miscellaneous | 9 | 36 | 11 | 56 |
| TOTAL | 102 | 468 | 164 | 734 |

The development of these publications during the last five years is illustrated in Fig. A1.

The detailed list of JRC publications is printed each year in the "Publications Bulletin"; the last issue number 8 (ISSN-0254-3133) printed in June 1988 gives the list of JRC publications in 1987.

**Figure A1:** Development of JRC publications (1984-1988)




## Euro Courses

During 1988, 10 Euro Courses have been held with a total duration of 54 days in the following fields:

- Risk and Reliability Analysis : 4 courses
- The environment : 1 course
- Health Physics and Radioprotection : 2 courses
- Remote Sensing : 2 courses
- Energy : 1 course

The courses are usually given in English with the exception of one course in Health Physics and Radiation Protection which was in Italian; they are generally organized at the Ispra site.

The course "Applied Thermoluminescence Dosimetry" and the course "Meteorology of Air Pollution in the Mediterranean Area" were held in Madrid in collaboration with CIEMAT, Centro de Investigaciones Energeticas, Medioambientales y Tecnologica, Madrid.

The course "Advanced Systems Reliability Modelling" was held in Madrid in collaboration with the Universidad Politecnica de Madrid.

The course "Major Hazard Analysis" was held in Thessaloniki (GR) in collaboration with the Ministry of the Environment, Athens, and the courses "Passive Solar Technologies for Buildings in Mediterranean Climates" and "Energy Auditing Techniques and Methods" were held in Kefalonia (GR) in collaboration with the Technological and Educational Institute of Patras.

## Applications of Results

A limited laboratory activity has been devoted to the promotion of innovation transfer to industry and other potential users. This activity dealt in particular with:

- support of exploitation of new patents,
- further development of inventions and verification of the technical specifications,
- the amelioration of information through the construction of prototypes and demonstration.

11 selected projects (see Table A3) have been supported with a total financial allocation of 260 Kecu and a total manpower contribution of 8 man-years. The fields of application are: Protection of the Environment (3 projects), Energy (3), Norms and Standards-Environment (2), Teleinformatics (1), Materials (1) and Remote Sensing (1). Important achievements from the point of view of possible future applications are:

- completion of the construction and start up of the ISPRA MARK 13 A pilot plant for flue gas desulphurisation at the Saras refinery in Sarroch (Sardinia),
- installation at the request of Club Alpino Italiano of a prototype system for spontaneous downward heat transport on a mountain shelter for the production of water from snow melting,
- beginning commercialization of a new oxygen sensor to control burning processes in industrial furnaces by CIFER SpA.

During the first months of 1988 12 new patent proposals have been put forward and 23 patents have been granted.

## Exhibitions and Fairs

In 1988 the JRC participated in various events, including multisectorial fairs and specialized exhibitions combined with an international conference. A list of the JRC participations is given in Table A4.

In these events the JRC participated with its own stand or as part of the EC stand. The main themes covered by the JRC exhibits were: Protection of the Environment and Safety, Remote Sensing Application Techniques for land use, sea protection, agriculture and development, Computer Modelling and Energy.

JRC knowhow and results were presented by means of live demonstrations, protoypes of patented innovations and audiovisual documents. Demonstrations

included the use of JRC Data Banks (ECDIN, IRIMS, HELP), new software for image treatment and agriculture applications, and various methods for pollution measurements and assessment. Marketable innovations in the field of marine technologies, automatic remote sensing data collection and transmission and development of new advanced sensors were also among the exhibits.

The attendance of visitors was remarkable, especially in the cases where the JRC presented a selection of exhibits covering a single theme of current interest, such as protection of the environment, safety, or space technology-related matters such as remote sensing. In most cases the JRC stand was also visited by the regional and central authorities on their official visit to the exhibition.

## Press and Public Relations

The JRC hosts numerous visitors and meetings at its sites; an overview is given in the table below.

**Table A2:** Visits and meetings

| Visits and Meetings | Number | Days |
|---|---|---|
| Visits | 106 | 112 |
| Scientific and technical meetings | 122 | 221 |
| Internal meetings | 166 | 201 |

Significant events included:

- Visit at Geel of Mrs. P.A. Haigh, Science and Technology Officer of the US Mission to the EC (4 February)
- Signing at JRC Ispra of the Spot Image - JRC contact in the field of Remote Sensing (4 March).
- Signing of a research contract on the study of minor actinide alloys with possible use as fuel for an actinide burner, to be carried out at JRC Karlsruhe, with the Central Research Institute of the Electric Power Industry of Japan, in Brussels on March 7.
- Visit to JRC Ispra of Mr K.H. Narjes, Vice-President of the Commission on the occasion of one of the Board of Governors meeting (19 April).
- Signing of the collaboration agreement between the Lombardy Region Energy Assessorship and the JRC Ispra on energy saving and research into renewable resources (16 May).
- Spring Session of the Arbeitskreis Thermophysik in der Deutschen Keramischen Gesellschaft, held at JRC Karlsruhe on May 16 and 17.
- Participation in the 36th World Congress FCE organization of World Association Women Entrepreneurs (9-12 June) and visit to the JRC Ispra of 300 members (10 June).
- IAEA Seminar on Burn-up Determination in LWR Fuel, held in Karlsruhe on June 13 - 16.

- Visit to JRC Ispra of Mr A. Peponis, Greek Minister for Industry, Energy and Technology (10 June).
- Meeting and Visit at Geel of the Heads of the Press and Information Bureaus of the EC (23-24 June).
- Visit to JRC Ispra of a Chinese delegation led by Mr Chong Wu Ruan, Vice-President of the Commission of Science and Technology of the People's Republic of China (13 July)
- Visit to JRC Ispra of a US Congress Delegation of the Science, Space and Technology Committee of the House of Representatives (27 August).
- Visit to JRC Ispra of an Austrian Delegation of Experts of the Environment Ministry (2 September).
- Microscopic aspects of irreversible processes.
  Lecturer: Prof. Prigogine from University of Brussels and Texas at Austin (Ispra 14 September).
- Visit to JRC Ispra of a Soviet Delegation of experts (22 September).
- Workshop on Spent Fuel as a Nuclear Waste Form, in Karlsruhe on October 5 - 6.
- Visit of Dr. von Krosigk, Federal Ministry of Research and Technology, at JRC Karlsruhe on October 3.
- Visit to JRC Ispra of a Chinese delegation led by Mrs Hu-Qi-Heng; Secretary General of the Chinese Academy of Science (10 October).
- Symposium ''Transuranium Elements Today and Tomorrow'' with 250 delegates from Europe and overseas, in Karlsruhe on October 26 and 27.
- Ceremony at the occasion of the 25th anniversary of the European Institute for Transuranium Elements in Karlsruhe, with Nobel Prize winner Sir John Kendrew, Chairman of the Board of Governors of the JRC, Josef Rembser from the Federal Government, Horst Böhm, Chairman of the Board of Directors of the Karlsruhe Nuclear Research Centre, Kurt Gauly, Mayor of Karlsruhe, J.P. Contzen, Director General of the JRC, and K.H. Narjes, Vice President of the Commission of the European Communities, as speakers. The ceremonial address (''Poineering the Nuclear Age'') was delivered by Nobel Prize winner Glenn T. Seaborg.
- Workshop on Advanced Techniques for Radiochemical Analysis at JRC Karlsruhe on November 8-9.
- Visit at Geel of a delegation from various Research Institutes, PR of China (15 November).
- Meetings at JRC Ispra of the Joint Research Committees EC-Finland (21-22 April), EC-Norway (24-25 November) and EC-Austria (1-2 December).
- Visit at Geel of a delegation from the Fraunhofer Institute for Chemical Technology (1 December).
- German-Italian Seminar with the participation of members of the European Parliament in the presence of the Italian Minister for Research, Mr. A. Ruberti (3 December).
- Signing of the agreement between JRC Ispra and Città degli Studi, Biella (16 December).

**Table A3:** Innovations from JRC Research, 1988

| Project | Achievement |
|---|---|
| MARK 13 A Process for Flue Gas desulphurisation | Completion of the construction phase and start up of the pilot plant at the refinery in Sarroch (Sardinia) |
| GAS controlled Heat Pipe Furnace | Realisation of a prototype vertical gas controlled heat pipe furnace for industrial applications |
| Identification by measuring surface texture | Installation and final tests of the laboratory equipment for specific applications |
| Informatics (Dual Network) | Promotion of the use of the Dual Network in the field of high speed back-bone network (brochures and illustrative panels) |
| Marine Technology-Deep Ocean Operating System | Testing of deep ocean data operating system on Lake Maggiore. Preliminary laboratory investigations of acoustic link electronics for soft lander control unit |
| Passive downward heat transport | Conclusions of the performance measurements campaign. Installation of a prototype on a mountain shelter |
| Oxygen sensors | Completion of the commercial version of the oxygen sensor for industrial furnaces and beginning of commercialization |
| Absorption of Gases in Zeolites | Conclusion of the experimental data collection phase for the preparation of a status report on the accuracy of measurement techniques for trace gases |
| Brush Divertor Collector | Numerical analysis and material studies for the development of the Brush Divertor |
| Antioxydants for plastics | Synthesis of new antioxidant on the laboratory scale |
| Microinjection valve | Modification of the valve and performance tests |

**Table A4:** JRC Participation in fairs and exhibitions during 1988

| Exhibition | Theme | Date |
|---|---|---|
| Eurotech-High Tecnologies in Europe, Glasgow | Environmental Protection (ECDIN) | 16 - 19 March |
| Grande Fiera D'Aprile, Milano | Environmental Protection and Safety of Industrial Plants | 16 - 25 April |
| Hanover Fair-Industry, Hanover | Energy-Energy Bus | 20 - 27 April |
| 8th European PV Solar Energy Conference. Florence | Energy-Photovoltaics | 8 - 13 May |
| Interschutz, Hanover | Environmental Protection (ECDIN) | 28 May - 2 June |
| Ercoftac, Paris | Computer Modelling in Support of the Aerospace Industry | 3 - 6 June |
| Achema, Frankfurt | Energy-Heat Pipe Furnace | 3 - 11 June |
| 7th World Hydrogen Energy Conference, Moscow | Energy Transport (Hydrogen) | 25 - 29 September |
| 22nd Symposium Remote Sensing Environment, Abidjan, Ivory Coast | Remote Sensing for Development | 20 - 26 October |
| Parasitis, Barcelona | Remote Sensing Application in Agriculture | 25 - 28 October |
| 2° Convegno Nazionale ''Associazione Italiana Telerilevamento'' Bolzano | Remote Sensing-Land Use | 9 - 11 November |
| Remote Sensing for Development, Berlaymont, Bruxelles | Remote Sensing for Development | 17 - 22 November |
| Technospace, Bordeaux | Remote Sensing Techniques, General | 6 - 9 December |

ANNEX B

# FINANCIAL STATEMENT OF ACCOUNTS

Two tables are provided to show in more detail the commitments made in 1988 and the general situation as now foreseen for the years 1988/1991.

Table A5: this table compares the commitments made by each research objective with the budget, the personnel expenses being kept apart.

Table A6: this table is similar to table A5 but the personnel cost has been added to the cost of each research objective.

**Table A5:** Detailed breakdown Commitments 1988, Budget 1988

| Year | 1988 | | 1988 | |
|---|---|---|---|---|
| **Reference** | **Commitments** | | **Budget** | |
| 1. Personnel | 124.8* | | 130.3 | |
| - Framework Programme | | 106.4 | | 114.1 |
| - out of Framework Programme | | 18.4 | | 16.2 |
| 2. Quality of lilfe | | | | |
| 2.1. Radiation Protection | 0.9 | | 0.9 | |
| - Evaluation and Monitoring of Radioactivity | | 0.9 | | 0.9 |
| 2.2. Environment | 11.9 | | 12.0 | |
| - Environmental Protection | | 6.2 | | 6.1 |
| - Application of Remote Sensing Techniques | | 3.0 | | 3.3 |
| - Industrial Hazards | | 2.7 | | 2.7 |
| 3. Modernisation of industrial sectors | | | | |
| 3.1. Science and technology of Advanced Materials | 6.1 | | 6.7 | |
| - Advanced Materials | | 6.1 | | 6.7 |
| 3.2. Technical Standards, Measurement Methods and Reference Materials | 9.2 | | 10.5 | |
| - Nuclear Measurements and Reference Materials | | 6.9 | | 7.2 |
| - Reference Methods, reliability of structures | | 0.8 | | 1.8 |
| - Reference Methods for Non-Nuclear Energies | | 1.4 | | 1.5 |
| 4. Energy | | | | |
| 4.1. Fission: Nuclear Safety | 29.8 | | 30.9 | |
| - Reactor Safety | | 13.7 | | 15.4 |
| - Radioactive Waste Management | | 4.0 | | 3.8 |
| - Safeguards and Fissile Materials Management | | 4.4 | | 3.8 |
| - Nuclear Fuels and Actinide Research | | 7.7 | | 8.2 |
| 4.2. Controlled Thermonuclear Fusion | 9.1 | | | |
| - Fusion Technology safety | | 9.1 | 9.3 | 9.3 |
| 5. Exploratory research | 2.3 | 2.3 | p.m. | p.m. |
| Sub-total Framework Programme (incl. Prep. Res.) (2 to 5) | 69.3 | | 70.3 | |
| 6. S/T Support to Commission | 12.4 | | 10.3 | |
| 7. HFR | 10.8 | | 12.4 **) | |
| 8. Other work for third parties | 2.5 | | 1.9 ***) | |
| Sub-total 6 to 8 | 25.7 | | 24.6 | |
| Total within General Budget (1 to 6) | 206.5 | | 210.9 | |
| Total 7 and 8 (outside General Budget) | 13.3 | | 14.3 | |
| GRAND TOTAL | 219.8 | | 225.2 | |

*) Does not include 1.5 Mioecu to cover personnel expenses of people who were transferred to the General Budget.

**) Estimation given in budget 1988 (OJ L 226, 1988)

***) p.m. in budget, internal JRC estimate

**Table A6:** Detailed breakdown Commitments 1988, Budget 1988

| Year | 1988 | | 1988 | |
|---|---|---|---|---|
| **Reference** | **Commitments** | | **Budget*** | |
| 1. Quality of life | | | | |
| 1.1. Radiation Protection | 1.9 | | 2.8 | |
| - Evaluation and Monitoring of Radioactivity | | 1.9 | | 2.8 |
| 1.2. Environment | 33.2 | | 35.8 | |
| - Environmental Protection | | 18.1 | | 19.9 |
| - Application of Remote Sensing Techniques | | 8.8 | | 9.1 |
| - Industrial Hazards | | 6.3 | | 6.8 |
| 2. Modernisation of industrial sectors | | | | |
| 2.1. Science and technology of Advanced Materials | 18.5 | | 19.4 | |
| - Advanced Materials | | 18.5 | | 19.4 |
| 2.2. Technical Standards, Measurement Methods and Reference Materials | 24.6 | | 27.3 | |
| - Nuclear Measurements and Reference Materials | | 17.5 | | 18.7 |
| - Reference Methods, reliability of structures | | 2.4 | | 3.3 |
| - Reference Methods for Non-Nuclear Energies | | 4.7 | | 5.3 |
| 3. Energy | | | | |
| 3.1. Fission: Nuclear Safety | 77.0 | | 80.4 | |
| - Reactor Safety | | 35.1 | | 38.6 |
| - Radioactive Waste Management | | 12.5 | | 12.5 |
| - Safeguards and Fissile Materials Management | | 13.2 | | 11.8 |
| - Nuclear Fuels and Actinide Research | | 16.2 | | 17.5 |
| 3.2. Controlled Thermonuclear Fusion | 18.3 | | 17.8 | |
| - Fusion Technology Safety | | 18.3 | | 17.8 |
| 4. Exploratory research | 4.6 | 4.6 | p.m. | p.m. |
| Sub-total Framework Programme (incl. Prep. Res.) (1 to 4) | 178.1 | | 183.5 | |
| 5. S/T Support to Commission | 23.3 | | 21.6 | |
| 6. HFR | 15.7 | | 17.2 | |
| 7. Other work for third parties | 2.7 | | 2.9 | |
| Sub-total 5 to 7 | 41.7 | | 41.7 | |
| Total within General Budget (1 to 5) | 201.4 | | 205.1 | |
| Total 6 and 7 (outside General Budget) | 18.4 | | 20.1 | |
| GRAND TOTAL | 219.8 | | 225.2 | |

*) Figures computed for each programme objective, by adding personnel credits to specific credits (Table 11).

ANNEX C

# BOARD OF GOVERNORS AND ORGANIZATION CHART

## Board of Governors
Joint Research Centre

**Sir John KENDREW**
Chairman
The Old Guildhall
4 Church Lane
Linton
GB-CAMBRIDGE CB1 6JX

**Monsieur Jean-Pol PONCELET**
Cabinet Mme M. Smet
Secrétaire d'Etat à l'Environnement
Rue de la Loi 56
B-1040 BRUXELLES

**Professor Flemming WOLDBYE**
Danish Research Administration
Holmenskanal 7
DK-1060 COPENHAGEN

**Dr. Günter LEHR**
Finkenbergstrasse 55
D-5300 BONN 3

**Professor A.J. KARABELAS**
Department of Chemical Engineering
School of Engineering
University of Thessaloniki
GR-THESSALONIKI

**Dr. Manuel MONTES PONCE DE LEON**
Director de Tecnologia Nuclear
CIEMAT
Avda Complutense 22
E-28044 MADRID

**Dr. Jules HOROWITZ**
Conseiller Scientifique du CEA
31-33, rue de la Fédération
F-75752 PARIS CEDEX 15

**Mr Anthony MURPHY**
Department of Energy
(outgoing member in March 1988)
substituted by

**Professor Gerard T. WRIXON**
Director
National Micro Electronics Research Centre
Lee Maltings
University College Cork
IRL-CORK

**Ing. Carlo MANCINI**
Direttore
ENEA
Viale Regina Margherita 125
I-00198 ROMA

**Monsieur Jean HOFFMANN**
Commissaire du Gouvernement à l'Energie
Ministère de l'Energie
19-21 Bd. Royal
L-2449 LUXEMBOURG

**Dr. J.J. DE JONG**
Director of Nuclear Energy
Ministerie van Economische Zaken
Postbus 20101
NL-2500 DEN HAAG

**Prof. José Mariano GAGO**
Presidente de JNICT
Av. D. Carlos I, 126, 1° andar
P-1200 LISBOA

**Dr. John W. FAIRCLOUGH**
Chief Scientific Adviser
Cabinet Office
70 Whitehall
GB-LONDON SW1A 2AS

# Organisation Chart
Joint Research Centre

## Directorate-General

**Brussels**

**Director-General** — Jean-Pierre CONTZEN

Adviser hors classe — George Robert BISHOP
Principal Adviser (Methodology of management) — Willem F. GUINEE
Adviser (Marketing, transfer of knowledge) — Piedad GARCIA DE LA RASILLA Y DE PINEDA

Secretariat of Board of Governors — Samuel LLOYD
Assistant to Director-General — Gisèle VANWERT

## Programmes Directorate

**Brussels**

**Director** — Hans Jørgen HELMS

Safety engineer — Marcello BRESESTI
- Coordination of scientific activities — François LAFONTAINE
- Interinstitutional relations — Heinz DETER
- General planning (*) — Roberto CUNIBERTI
- Hosting policy, visiting scientists and fellowships (*) —
- Utilization of research results, Image of the JRC (*) —
- Documentation and Publications (*) — Mary CONNOLLY

units marked (*) are specialized departments

## Administration Directorate for the JRC

**Ispra**

**Director** — Henri HANNAERT

Adviser — Gilles NULLENS
- Human resources — Henri HANNAERT
- Financial management, forecasts and execution — Michel GRIN
- Contracts — Michele ACTIS-DATO (acting)
- Infrastructure, Ispra site — Alberto AGAZZI
- Radiation Protection, Ispra site — Argeo BENCO
- Press, public relations, exhibitions, Ispra (*) — Maria Piera MORETTI
- Central workshop (*) — Learco DI PIAZZA
- Vocation training school, Ispra (*) — Michel LE DET

## Central Bureau for Nuclear Measurements

**Geel**

**Institute Director** — Werner MÜLLER

- Nuclear physics and measurements — Achiel DE RUYTTER
- Reference materials — Richard LESSER
- Personnel, administration and infrastructure — Jan VAN AUDENHOVE

| | |
|---|---|
| **Institute for Transuranium Elements** | **Karlsruhe** |
| **Institute Director** | **Jacobus VAN GEEL** |
| Adviser (Scientific coordination) | Jean FUGER |
| Advise (Programmes) | Hubert BLANK |
| - Scientific projects directly attached to Director | |
| • Technological physics (*) | Michel COQUERELLE |
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| • Nuclear technology (*) | Karl Ernst RICHTER |
| • Nuclear chemistry (*) | Lothar KOCH |
| • Actinides (*) | — |
| - Personnel and Administration | Paul BLAES |
| - Radiation protection (*) | Klaas BUIJS |
| - Technical services (*) | Gérard SAMSEL |
| **Institute for Advanced Materials** | **Petten and Ispra** |
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| Adviser | Walter KLEY |
| Adviser | Jean PERETTI |
| - High-flux Reactor | Jürgen AHLF |
| - Characterization of material | Marcel VAN DE VOORDE |
| - Materials engineering | Hermann KRÖCKEL (acting) |
| - Materials reliability and performance | Peter SCHILLER |
| - Non-destructive testing and instrumentation (*) | Pierre JEHENSON |
| - Functional materials and Cyclotron (*) | Livio MANES |
| - Personnel and administration of the Institute and infrastructure of the Petten site | Abraham BAHBOUT |
| **Institute for Systems Engineering** | **Ispra** |
| **Institute Director** | **Giuseppe VOLTA (acting)** |
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| - Systems Engineering and reliability | Giuseppe VOLTA |
| - Reference methods and measurements for non-nuclear energy sources (*) | Eric ARANOVITCH |
| - Control of fissile materials (*) | Marc CUYPERS |
| **Institute for the Environment** | **Ispra** |
| **Institute Director** | **Friedrich GEISS (acting)** |
| Adviser (Safety of nuclear fuel cycle) | Francesco GIRARDI |
| Adviser (Environmental protection) | Bruno VERSINO |
| - Chemistry | Friedrich GEISS |
| - Radiation chemistry and nuclear chemistry | Sergio FACCHETTI |

| | |
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| **Institute for Remote Sensing Applications** | **Ispra** |
| Institute Director | Raymond KLERSY |
| - Advanced Technologies | Giancarlo BERTOLINI |
| • Laser fluorescence, high-resolution spectrometry, | Giancarlo BERTOLINI |
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| - Projects relating to thematic applications directly attached to Director | |
| • Agriculture (*) | Jean MEYER-ROUX |
| • Land utilization (*) | Jacques MEGIER (acting) |
| • Development aid (*) | Jean-Paul MALINGREAU |
| - Image processing (*) | Jacques MEGIER |
| **Institute for Safety Technology** | **Ispra** |
| Institute Director | Helmut HOLTBECKER |
| - Thermodynamics | Paola FASOLI |
| - Process engineering | Claus BUSSE |
| - Applied mechanics | — |
| - In-pile experiments | Peter VON DER HARDT |
| - Nuclear experiments | — |
| **Centre for Information Technologies and Electronics** | **Ispra** |
| Director of the Centre | Pierre BONNAURE |
| Adviser | Rodolphe NICKS |
| - Informatics Centre | Jean-Pierre AUBINEAU |
| - Advanced information technology applications and knowledge processing | — |
| **Institute for Prospective Technological Studies** | **Ispra** |
| Institute Director | Pierre BONNAURE |
| - Studies and reviews, network coordination | Carlo RINALDI |

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ANNEX E

# GLOSSARY OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ASME | American Society of Mechanical Engineers |
| AORS | Abnormal Occurrencies Reporting System |
| AVHRR | Advanced Very High Resolution Radiometer |
| BCR | Bureau Communautaire de Référence - Community Bureau of Reference |
| BIPM | Bureau International des Poids et Mesures |
| BRAIN | Basic Research in Adaptive Intelligence and Neurocomputing |
| BRITE | Basic Research in Industrial Technologies in Europe |
| CATHARE | French Large System Thermohydraulic code |
| CBNM | Central Bureau for Nuclear Measurement |
| CHEM | Chemical Emergency Management |
| CEA | Commissariat à l'Energie Atomique |
| CIEMAT | Centre for Energy, Environmental and Technological Research |
| CISE | Centro Informazioni Studi Esperienze |
| CONDIF | Computer Code Name (Molten pour behaviour) |
| COST | Scientific and Technical Cooperation |
| DRUFAN | German Large System Thermohydraulic code |
| EAC | European Accident Code |
| ECDIN | Environmental Chemical Data Information Network |
| ECU | European Currency Unit |
| ERCOFTAC | European Research Community on Flow, Turbulence and Combustion |
| ENEL | Ente Nazionale Energia Elettrica |
| ERDS | European Reliability Data System |
| ESARDA | European Safeguards Research and Development Association |
| ESPRIT | European Strategic Programme for Research and Development in Information Technologies |
| ESSOR | Experimental reactor (Ispra) - no longer in operation |
| ESTI | European Solar Test Installation |
| ETHEL | European Tritium Handling Experimental Laboratory |
| EURATOM | European Atomic Energy Community |
| EUROTRAC | European Experiment on Transport and Transformation of Environmentally Relevant Trace Constituents in the Troposphere (EUREKA project) |
| FARO | Experimental Facility for Fuel Melting |
| HFR | High Flux Reactor (Petten Establishment) |
| HTM | High Temperature Materials |
| IAEA | International Atomic Energy Agency |
| IRIMS | Ispra Risk Management Support |
| ISO | International Standard Organisation |
| ISPRA MARK 13A | Flue Gas Desulphurisation Process developed at the JRC Ispra |
| ITER | International Thermal Nuclear Experimental Reactor |
| KFK | Kernforschungsanlange Karlsruhe (FRG) |
| LANDSAT | Earth Observation Satellite (US) |
| LMFBR | Liquid Metal Fast Breeder Reactor |
| LOBI | LWR off Normal Behaviour Investigation (installation) |
| LWR | Light Water Reactor |

| | |
|---|---|
| MARS | Major Accident Reporting System |
| MIRAGE | Migration of Radioisotopes in the Geosphere |
| MOX | Mixed Oxide Fuels |
| NDA | Non Destructive Analysis |
| NEA | Nuclear Energy Agency (of the OECD) |
| NET | Next European Torus |
| NOAA | National Oceanic and Atmospheric Administration (US) |
| OUSR | Operating Unit Status Report |
| PAGIS | Performance Assessment of Geological Isolation |
| PAHR | Post Accident Heat Removal |
| PERLA | Performance and Training Laboratory (Nuclear Safeguards) |
| PETRA | Facility for Treatment of Radioactive Waste |
| PREPERLA | First phase of Perla Laboratory |
| PISC | Programme for Inspection of Steel Components |
| PSA | Probabilistic Safety Analysis |
| REIMEP | Regular European Interlaboratory Measurement Evolution Programme |
| REM | Radioactivity Environmental Monitoring |
| SCK/CEN | Studiecentrum Kernenergie/Centre d'études nucléaires |
| UKAEA | United Kingdom Atomic Energy Authority |
| WHO | World Health Organization |

*Enquiries for further information are welcome and should be addressed to*

Commission of the European Communities
**Directorate-General of the Joint Research Centre**
200, Rue de la Loi
B-1049 Brussels

Phone: + 32-2-235 85 27
Telex: 21 877 COMEU B

*or directly to the JRC Institutes*

Commission of the European Communities
**Joint Research Centre**

**Central Bureau of Nuclear Measurements**
Steenweg op Retie
B-2240 GEEL

Phone: + 32-14-571 292
Telex: 33 589 EURAT B

**Institute for Transuranium Elements**
Postfach 2340
D-7500 KARLSRUHE

Phone: + 49-7247-84 350
Telex: 7825483 EU

**Institute for the Environment**
I-21020 ISPRA (VA)

Phone: + 39-332-78 96 01
Telex: 380042 or 3800058 EUR I

**Institute for Remote Sensing Applications**
I-21020 ISPRA (VA)

Phone: + 39-332-78 97 65
Telex: 380042 or 3800058 EUR I

**Institute for Safety Technology**
I-21020 ISPRA (VA)

Phone: + 39-332-78 97 43
Telex: 380042 or 3800058 EUR I

**Institute for Systems Engineering**
I-21020 ISPRA (VA)

Phone: + 39-332-78 95 11
Telex: 380042 or 3800058 EUR I

**Institute for Advanced Materials**
P.O. Box 2
NL-1755 ZG PETTEN

Phone: + 31-2246 - 5401
Telex: 5721 REACP

**Institute for Prospective Technological Studies**
I-21020 ISPRA (VA)

Phone: + 39-332-78 99 41
Telex: 380042 or 3800058 EUR I

**Centre for Information Technologies and Electronics**
I-21020 ISPRA (VA)

Phone: + 39-332-78 99 41
Telex: 380042 or 3800058 EUR I

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